



ARGONON, SUSTAINABLE SHIP

FIRST INLAND BARGE ON DUAL FUEL



This project is an investment for your future and is sponsored by the European Regional Development Fund



Agentschap NL
Ministerie van Infrastructuur en Milieu



ARGONON, PROGRESSIVE SUSTAINABLE SOLUTION

The innovative ship argonon is being built in close collaboration with several subcontractors, such as Pon Power, Shipyard Trico, Cryonorm projects and CBRB. The most special aspect of 'Argonon' is that it will run on Dual Fuel - a mixture of 80% natural gas and 20% diesel. This will result in significantly less emissions of CO2 and NOx. Argonon will be the first ship on European inland waterways to run on Dual Fuel. The use of natural gas is not only much better for the environment, but will also decrease operational costs tremendously.



PON POWER

Argonon will be fitted with Caterpillar 3512 DF, 1521 bHP dual-fuel propulsion engines. In addition, Pon Power will also supply two Capstone 30 kW microturbines. These microturbines, fully powered by natural gas, will power the ship of domestic heat water system and central heating.

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CRYONORM PROJECTS

Cryonorm Projects will supply a 40.000 liter special vacuum insulated stainless steel LNG storage tank. This tank will be fitted with a LNG vaporization system, using the Caterpillar motor coolant heat to evaporate the cold LNG into warm natural gas. Cryonorm Project will also supply vacuum insulated bunker connections on starboard and portside of the barge and dedicated onboard system automation, control and safety systems for Argonon.



SHIPYARD TRICO

Shipyard Trico builds Argonon commissioned by Deen Shipping. Shipyard Trico coordinates the whole process from hull, installation of tank, bow thrusters, generators and propulsion until the delivery of the ship.



CBRB

CBRB cooperated with Deen Shipping for the request and acquisition of the subsidy from the European Fund for Local Development (Europees Fonds voor Regionale Ontwikkeling). CBRB also has a controlling role related to this subsidy.



LNG

The normal (gaseous) natural gas is well known in common households and is used for cooking and heating. The purpose of liquefaction from natural gas into LNG is reducing the volume in order to store and transport more energy in smaller tanks. After the liquefaction process, which is done at dedicated LNG liquefaction plants, the LNG temperature is about -162°C and the gas volume has reduced by 630X, for example: 1000 liter of LNG equals about 630 m³ of gaseous natural gas. The LNG storage and bunkering is done in special designed vacuum insulated double walled stainless steel tanks. Vacuum insulation is necessary to avoid excessive warming and boil off of the LNG. The big advantages of LNG are that it's less polluting and more cost-efficient. In the decades to come, global oil sources will become exhausted. However, it is estimated that natural gas reserves will last for at least 200 years. This will have a positive effect on future price development. In spite of the investment being higher, the fuel costs are lower. Apart from the fact that lng is good for your pocketbook, it's also the cleanest fossil fuel. Running on lng produces less CO₂, less nitrogen dioxides and no fine particulate matter, in contrast with diesel. What's more, it cannot pollute surface water.

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LNG AS FUEL FOR INLAND NAVIGATION

DUAL FUEL

The propulsion engines that are currently suitable for natural gas are 'Dual-Fuel'. This means that the engine runs on natural gas and diesel. Argonon has 2 standard Caterpillar 3512 engines that use approximately 20% diesel in order to ignite the gas mixture. These engines have been modified by Pon Power so that the combustion air is enriched with natural gas. This leads to a Dual Fuel engine needing less diesel to produce the required power and keeps the same stability, responsiveness in all conditions.

GAS GENERATORS

Generators can also easily operate on natural gas. Various inland navigation companies already have gas generators in their portfolio that are derived from truck engines. There are already many trucks on the road that are running on natural gas. Progress in this is very rapid and will certainly find its way into inland navigation. And there are also gas-turbine engines that are very suitable for ship use. Argonon has two Capstone gas turbines to power the electrical system.

LEGISLATION

According to legislation, it is not yet permitted to use natural gas as a fuel in inland navigation. However, for classification bureaus this is not a problem as maritime has been using LNG for more than 30 years already. If classification approves a LNG proposal, this can then demonstrate equivalence with diesel. Based on this, the vessel can be granted an exemption until the regulations are amended. Because of its vast environmental potential, and thus its social importance, it is high on the European agenda. However, amending the regulations demands patience.

BUNKERING

The availability of liquefied natural gas is in development and is going to really take off in the years to come. Many bunker stations throughout the country are busy applying to construct a LNG bunker facility. This is also being financially encouraged by the government. Until these facilities are there, it is possible to bunker with a tanker at designated locations. The quantities needed vary according to vessel. A water-bus can run for a week on 3 m3 while Argonon needs ± 30 m3 to travel to and from Basel without bunkering.

POSSIBILITIES

Once the bunkering infrastructure and regulations are in order, there will be many LNG applications seen in inland navigation. Actually, all vessels, including existing ships, are suitable for LNG. The biggest challenge is installing the tank. There are many variations of engine possible: from modifying an existing engine to a complete gas-electric propulsion unit. The possibilities differ per vessel.

ARGONON SHIPPING



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Argonon Shipping is a subsidiary of Deen Shipping that owns five ships, including Argonon, and manages a sixth ship in the Deen fleet. A staff of twenty-five looks after the safe transport of the freight: various sorts of oils. Two bunker ships in the ports of Rotterdam and Antwerp supply ocean-going ships with the oil needed for their engines. The other ships transport mineral oils and distillates for refineries. The ships sail to storage depots in the Netherlands, Belgium, Germany and Switzerland.

It is precisely because of the environmentally harmful cargoes that the Deen ships transport that Deen Shipping is constantly thinking about the safety of people and the environment. One of our innovations is the Y-shaped hull that radically limits the risk of disastrous collisions. But our real showpiece is our ship 'Argonon'. this ship will run on Dual Fuel, which drastically reduces emissions.

MISSION & VISION

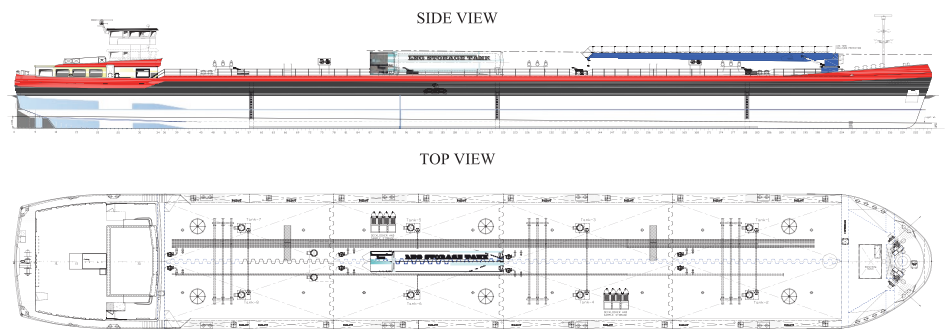
Argonon Shipping wants to be an innovative, distinctive, socially committed and responsible company. We have translated our mission and vision into five core values or vision explanations that can be summarized as follows:

SAFETY

Argonon Shipping wants to satisfy the highest standards for operations for crew, cargo and ship and wants to prevent accidents by working with adequately qualified personnel and up-to-date equipment.

QUALITY

Customers can count on a consistently high quality of service through our use of a quality system that is implemented throughout the company.



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ENVIRONMENT

Limited environmental pollution from our (transport) activities; no spills and a proactive approach to environmental issues through innovative concepts.

RESPONSIVE

Able to respond quickly to our customer's needs.

INNOVATIVE

The company's policy focuses on developing new concepts and methods that contribute to the safety of people and the aquatic environment.

“ DEEN SHIPPING THINKS IN SOLUTIONS, NEVER IN PROBLEMS ”

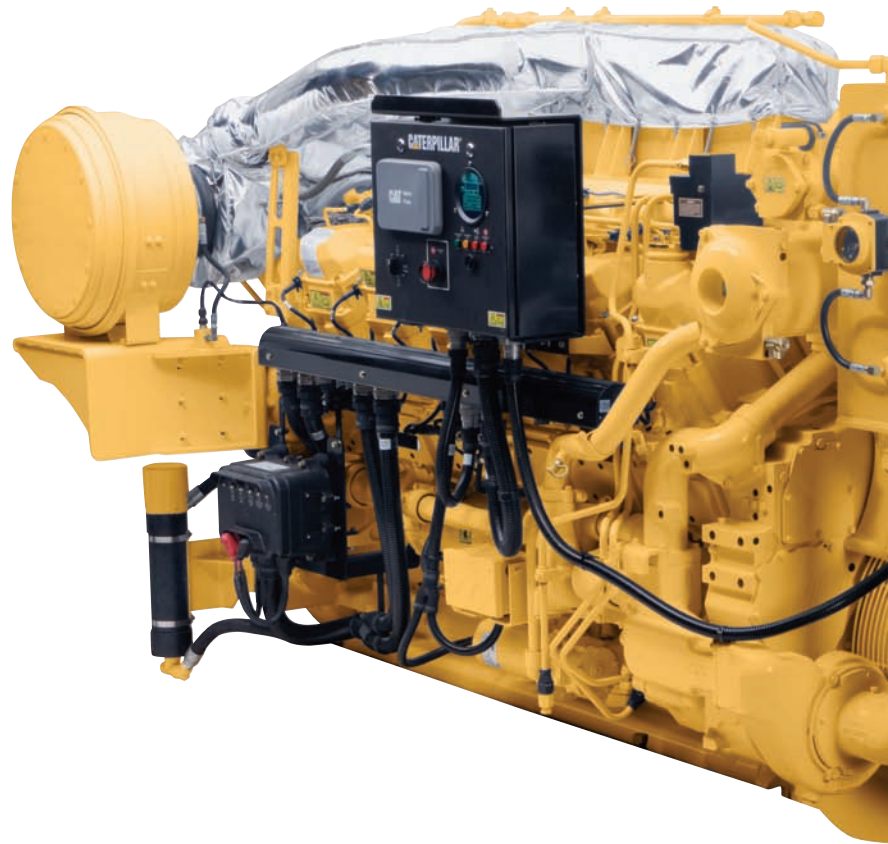
Argonon



The innovative ship Argonon is being built in close collaboration with several subcontractors. The most special aspect of Argonon is that it will run on Dual Fuel - a mixture of 80% LNG (liquefied natural gas) and 20% diesel. This will result in significantly less emissions of CO₂ and NO_x and will even reduce emissions of fine particulate matter! Argonon will be the first ship on European inland waterways to run on Dual Fuel. The Dual Fuel application is not only better for the environment but also cheaper than diesel, which means that, in the long term, it can lead to considerable savings. And it can also be applied to almost all medium and high-speed engines.

MAIN SPECIFICATIONS OF THE BUNKER-SHIP ARGONON

Type	Tanker C-2-2
Hull	Double hull - Y-shape
Length	110
Width	16.20
Draft	4.95
Capacity	6,100 tons
Volume 100%	6,400 m ³
Coating	Mild steel
Load & Unload pipes	2
Bunker mast	Yes (2 lines)
Cargo heating	Yes
Propulsion	2 x Caterpillar Dual-Fuel
Built	2011
Finishing	Trico
Classification	Lloyd's Register of Shipping



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Engine specifications

Propulsion	Caterpillar DF 3512 propulsion engine (DF = Dual Fuel)
Engine output	1,521 bHP
Fuel ratio	20% diesel / 80% natural gas
Range of Argonon	Rotterdam <-> Basel (800 km upstream, 800 km downstream)

TECHNOLOGY OF DUAL FUEL ENGINE

In the Dual Fuel application, natural gas is used as the main fuel and diesel as ignition fuel. The LNG (natural gas is liquid at -162 degrees Celsius and occupies 630 times less volume) flows through a vaporizer where it is heated (by means of coolant from the engines and the microturbine) and transforms into gas. The natural gas is controlled by a metering valve flows through a carburetor into the combustion air. The homogenous mixture is fed into the combustion chamber by the turbocharger, together with the diesel fuel. The mixture of fuel and air is ignited by the diesel process.

On deck of Argonon an LNG tank will be placed, which will be fitted with a vaporizer to transform the liquid LNG into natural gas.

A ratio of 20/80 guarantees stability, responsiveness and power in all conditions. This ratio enables the propulsion engine to deliver full power quickly in any situation, even maneuvering. The Dual Fuel engine can also run entirely on diesel, but not entirely on natural gas.

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PON POWER



BENEFITS OF THE DUAL FUEL APPLICATION

- Reduction of emissions.
Combusting of natural gas is clean with a significant reduction of CO₂.
- Saves the remaining reserves of fossil fuels
- Reduces fuel costs: the price of LNG is considerably less than diesel.
- Service intervals can be extended due to the cleaner combustion, which decreases the total cost of ownership.

EMISSION VALUES

At the moment, we cannot say exactly what reductions can be achieved but we foresee a reduction of 20% CO₂, 40% NO_x and 90% PM.

Pon Power is part of the Caterpillar dealer network since 1926 and supplies and maintains Caterpillar marine engines with outputs of 90 to 5,400 kW and Caterpillar generator sets of 11 to 6,500 kVa. Pon Power also supplies and maintains Capstone microturbines with outputs of 30 and 65 kVa. With more than 170 service engineers, 6 service centers in the Netherlands and a worldwide Caterpillar service network, Pon Power is able to offer its customers an extensive package of services, resulting in efficient energy solutions with Caterpillar engines as their reliable power source.

Generator specifications

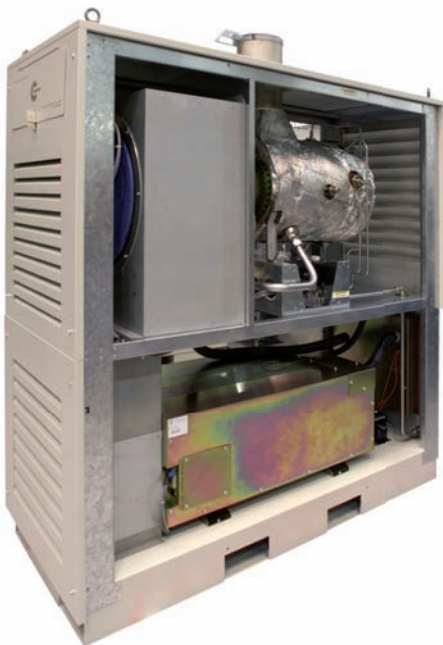
Type of generator	Capstone microturbine
Output	30 kW

The microturbine in Argonon will be fully powered by natural gas, is virtually maintenance-free, generates power and heat and has a cogeneration capability.

The exhaust gases, at a temperature of 300 degrees Celsius, pass through a heat exchanger that heats the water up to a temperature of 80 to 90 degrees Celsius. The water heats the LNG vaporizer and the main engines, the central heating and also produces heat for the boiler and the domestic heat water system. It also provides heat for the absorption machine to produce conditioned air. Extra ventilation ducts to the ambient have been made in the engine room.

BENEFITS OF THE CAPSTONE MICROTURBINE

- Microturbines operating on natural gas produce a minimal amount of NO_x and hardly any fine particulate matter.
- The microturbine does not require any lubricants and/or coolants.
- The microturbine emits a low level of sound: 65 dB (within 10 meter).
- The microturbine requires less maintenance.



THE OUTFITTING OF A LNG INLAND VESSEL



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Shipyard Trico B.V. is the main contractor of the prestigious 'Argonon Project'. On her site in Rotterdam, between city centre and worlds' largest port, takes the complete outfitting of this LNG inland vessel place. The outfitter is responsible for the integration of all components into a complete vessel. The way the components are configured is the main driver of innovation for the 'Argonon'. Due to a different manner of installing proven components a Europe's first application of LNG on board of a inland river vessel has become reality. The construction of a vessel on LNG is a complex project that demands a solid preparation to achieve the required functionality and achieve the highest level of safety for crew and environment. In addition to that Shipyard Trico has explored every opportunity to exploit the new possibilities to the full extend. The aim of lowering the CO2 footprint is not limited by installing the LNG arrangement only. For instance the boil-off gas will be used to generate electricity, the residual heat will heat the accommodation area and provides warm water. Finally the gas turbines are indirectly the compressors of the air-conditioning system as well. The heating and cooling system of the accommodation area will therefore be climate neutral.

MT ARGONON

Shipyard Trico received the order for the MT Argonon by Deen Shipping B.V. as a turn-key vessel. The construction of the hull is outsourced to the Saintry Marine Shipyard in China. The keel laying was in 2009 and the construction was finished in 2010. After a 3 month voyage on sea the vessel arrived in the Port of Rotterdam in March 2011, together with 7 similar vessels. The outfitting has started in May 2011 and the vessel will be handed over to the owner in of the fourth quarter of 2011. The vessel has an overall length of 110 meter, a beam of 16,20 meter and has a tonnage of around 6.100 tonnes. The ratio between length and beam is unique for a inland river vessel. Additionally the Besides that the vessel has the patented Y-shaped hull construction to limit the environmental impact in case of a



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collision. Due to this safeguard the vessel is allowed to have larger tanks so she only has 8 tanks. The ship is equipped to bunker other vessels, therefore she has a bunkerboom and a cargo heating system.

DEEN SHIPPING

The relationship between Deen Shipping B.V., and it's subsidiary Argonon Shipping B.V., was already an existing one. Deen Shipping already has two Trico vessels in her fleet. At the end of 2009 the MT Amphiro was handed over and in 2010 the MT Achilles was added as well. The experiences from the first two projects created a base of trust to initiate a project like the 'Argonon' with confidence.

TRICO PIPING

Trico Piping, a fully owned subsidiary of Shipyard Trico, is active with the Argonon project as well and is responsible for the all piping that is the direct result of the implementation of LNG. For the primary system these are the non-cryogenic gas lines between the tank, engines and turbines. The secondary system prevents the vaporizer from freezing. To achieve this Trico Piping will connect the cooling water system of the main engines and the heat recovery from the turbines to the vaporizer on deck.

ABOUT SHIPYARD TRICO

Shipyard Trico is a young and entrepreneurial company founded in 2008 and delivered her first vessel in 2009. Since then nearly 20 new builds are delivered and many reparations to inland vessels are completed. The product portfolio varies from the largest cargo vessels to tankers suitable for the small German canals in assignment of clients from the Benelux, Germany and Switzerland. The yard is equipped with a quay of 275 meters, a 30 tonnes crane and large storage facility.

MORE INFORMATION

For the project Argonon the following team is responsible on behalf of Shipyard Trico. The project manager is Peter Snijders MSc. B.Eng and is working alongside on this project with Robert Joosten who is responsible for the execution outside. On behalf of Trico Piping Elvira Teekman bears the responsibility to make this project a success. Team Trico makes the whole greater than the sum of its parts.

CRYONORM PROJECTS



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Our company, Cryonorm Projects, located close to Amsterdam, the Netherlands, has manufactured several natural gas liquefaction (LNG), nitrogen and oxygen plants since 1995. Besides the turn key plants Cryonorm Projects is developing and producing cryogenic systems, vaporizers, cryogenic pipe skids, storage tanks and LNG Fuel system solutions. From our air separation and cryogenic background we have entered the LNG market in 2003 with great success and now, 2011, we proudly announce to be ready to cover the complete LNG Supply Chain!

IN THIS FRAMEWORK, WE HAVE BUILT OR HAVE UNDER CONSTRUCTION:

- 100 ton per day natural gas liquefaction plant for PL Energia Poland
- 200 ton per day natural gas liquefaction plant for Petroecuador, Ecuador
- LNG re-gas terminal for ENAP in Quintero Bay, Chile
- LNG Vehicle and boat fuel solutions
- Marine LNG Fuel System onboard MTS Argonon of Argonon Shipping
- LNG Satellite plant for Tank Services Pernis

Several other plants for LNG and air gases have been built for generation of LNG, oxygen, nitrogen and argon. Further we render services to all major (Industrial) Gas companies. Our services cover engineering studies, trouble shooting, construction, commissioning and start-up of LNG plants, air separation plants, cryogenic systems and related facilities.

The company employs 78 people of which 18+ engineers having a long term background in cryogenic LNG projects, air separation and industrial gas installations. Our construction facilities cover 8.000 m² and about 45 skilled workers execute the manufacturing in direct supervision of the design engineers. The short-cut organization, in-house engineering and construction under direct supervision, allows us not only to deliver a high quality product, but also a competitive price.

Cryonorm Projects possesses over its own engineering standards for cryogenic engineering and construction, standards which exceeds the minimum requirements of the international standards. The company is ISO 9001 certified.



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LNG CRYO ENERGY

- Natural Gas to LNG liquefaction plants
- Biogas liquefaction plants
- Cryogenic logistics and storage
- Regasification plants
- L-CNG and LNG Fuelling stations
- LNG Satellite plants
- LNG fueled vehicle solutions
- LNG fueled boat solutions
- LNG ship bunker solutions

OTHER PRODUCTS RELATED TO INDUSTRIAL GASES AND LNG CRYO ENERGY

- Cryogenic Liquid Vaporizers
- Cryogenic liquid storage and transportation systems
- Cryogenic pumps
- Vacuum insulated pipelines
- Spare parts, maintenance, overhaul for LNG and air separation plants

AIR SEPERATION PLANTS

- Gas plants Oxygen and nitrogen
- Full liquid air separation plants
- Oxygen and nitrogen liquefaction plants





CBRB

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The Centraal Bureau voor de Rijn- en Binnenvaart or Dutch Central Bureau for Rhine and Inland Navigation (CBRB) is an association in more than one sense. Of course, its legal status is that of an association, but there's more to it than that. The CBRB unites the most diverse professional groups and companies in inland navigation. That is possible only if the organization is structured in such a way that all of these different entrepreneurs and companies are certain that their sometimes conflicting interests are optimally served. It has to be a very special organization - and it is.

The multifaceted nature of the CBRB is a reflection of the industry that the association represents. Based on water-borne transport, the core of CBRB's membership are ship-owners. These range from bargemen with one ship transporting sand, a newly built tanker or container ship, to shipping companies with tens of tankers or more than a hundred lighters. Among others, there are 250 independent ship-owners in the CBRB.

Moreover, there are companies that are members of the CBRB that actually do not have their own fleet but carry responsibility for the organization and management of transport chains, such as operators, cargo brokers and other logistical service providers. Apart from the fact that the companies are very diverse, there is also great diversity in the market in which CBRB members operate: ferry services, towing services, container transport, large-scale lighter transportation, sand and gravel transportation, passenger transportation and dry bulk.

The dividing line between the various groups is not always clear. For example, an operator may own a number of ships and also be the client of a group of independent contractors. This calls for a high level of flexibility on the part of CBRB staff.



THE REGULATIONS

All cargo vessels sailing on inland waterways in Europe must follow regulations. This seems logical now, but it has not always been the case. First of all, here are a few boring dates.

Let's go back to 1816. August 15th of that year saw the first meeting of the Central Commission in Mainz. On March 31st, 1831, the Convention of Mainz was adopted. This was the first Rhine Navigation Treaty which set down uniform legal principles for Rhine Navigation. The convention also contained a great many police regulations. So there's nothing new under the sun - then too, a lot of discussion took place before an agreed document was finalized. The first regulations concerning the transport of hazardous substances were adopted in 1838. These were regulations governing the transport of gunpowder. The first Rhine Navigation Police Regulations saw the light of day in 1850. In 1861 the Commission moved from Mainz to Mannheim, following which, the Convention of Mannheim was signed on October 17th, 1868. The majority of the stipulations of this convention still apply to navigation on the Rhine. 1900 saw new stipulations for the transport of corrosive and poisonous substances and in 1905 these were followed by stipulations for the transport of petroleum and refinery products. So an embryonic ADNR was already there, although it would still take many years to evolve into its present form. In 1904, the first Regulations for the Investigation of Ships on the Rhine (Reglement Onderzoek Schepen op de Rijn) were adopted. This also established the foundations for the regulations on the transport of hazardous substances. Then World War I took place and, as befits the victors, the armistice was followed in 1919 by the signing of the Treaty of Versailles, which included a number of new rules for the Commission. One of the consequences of the war was that the Commission would no longer reside in Mannheim. In 1920, it was moved to Strasbourg and housed in the former imperial palace, which from then on would also be known as the Palais du Rhin. This palace was built between 1884 and 1888 to a design by Hermann Eggert. It was built in a neo-renaissance style as a residence for the German Emperor Wilhelm II for his visits to Alsace-Lorraine, which was a German possession at the time. Up to 1914, he

visited the palace only five times. With the move to Strasbourg, a permanent secretariat was also appointed. The first Regulations for Rhine Navigation Permits (Reglement Rijnschipperspatenten) followed in 1922 and then everything went quiet for a long time. This was partly due to World War II but the work of the Central Commission resumed after the liberation in 1945. In 1963, the Convention of Strasbourg was signed, which made a number of amendments to the Convention of Mannheim. 1968 saw the first regulations for the use of radar by barges and in 1971 - no less than 66 years after the last amendment - finally the first ever ADNR, which entered into force in 1972. But after this, amendments came pretty quickly. In addition to normal changes, sweeping changes were made to the Regulations for the Investigation of Ships on the Rhine and the ADNR in 1976 and 1995. The ADNR was also radically changed once again in 2003. In 1979 there was also a second additional protocol to the Convention of Mannheim that set down stipulations regarding the qualification of ships for Rhine navigation, in 1989 a fourth additional protocol regarding structural reorganization and in 1999 a fifth additional protocol regarding the "old-for-new" rule. 1998 also saw the adoption of further Rhine Navigation Police Regulations and also Regulations for Rhine Navigation Permits that were adapted to technical developments. The reason why there were regular amendments to the regulations from the nineteen-seventies onwards has to do with the formation of a large number of working groups that adapt the regulations to the current state of technology. We now know that, in addition to the regulations listed above, European regulations have also applied for a number of years. For example, there is the European Directive 2006/87/EG. As the date suggests, this entered into force in 2006. The text of the directive is almost identical to that of the Regulations for the Investigation of Ships on the Rhine. In Europe, there is also a Framework Directive for the transport of hazardous substances. According to this directive, all vessels transporting hazardous goods in Europe must satisfy the stipulations of the ADN. This ADN replaced the ADNR on January 1st, 2011. Fortunately you can choose whether a vessel should satisfy the RISR or the European Directive.

Both regimes allow transportation on European inland waterways. If we now wish to deviate from one of the rules mentioned above, we have to apply for so-called equivalence. In the event of such an application, we have to show that the alternative design is just as safe as the prescribed one. For example, a lot of applications are now being submitted for using a different fire-extinguishing substance in fixed fire-extinguishing installations to the one stipulated in the regulations. Such an application has always to be submitted for each vessel individually until the time when the regulations have been adapted to the new substance. In the case of a different fuel, such as LNG, you have to show that its use is not more hazardous than the diesel allowed today. In the case of an application for equivalence to the CCR in Strasbourg, the application has to be approved by all member states. If not, negotiations will have to continue until approval is granted. In the case of the European Directive and the ADN, approval depends on a majority of votes but because the same people sit on all three committees, permission will depend on approval in Strasbourg. This is usually a long-term procedure and you should not expect a result from one or two meetings. So the first organization to apply for such equivalence has to invest a lot of patience as well as money. It's then easier for the next one though. When applying for equivalence it is important that all the pros and cons are examined and that solutions are put forward for the disadvantages. Well-substantiated research, with the help of a classification bureau, for example, is a good investment. Although, in demonstrating equivalence for the Argonon, we believe that we have done everything we can to demonstrate equivalent safety, a lot of questions are still being asked by various delegations. These too must be answered satisfactorily and this will finally lead to equivalence being granted. But our work will not end there. One of the conditions is that there will be annual evaluations that are then assessed by the member states. However, let us hope that the changes to the regulations will go quicker than in the early days of regulations for inland navigation, otherwise we will soon lag behind road transport and that is something that we certainly do not want.



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