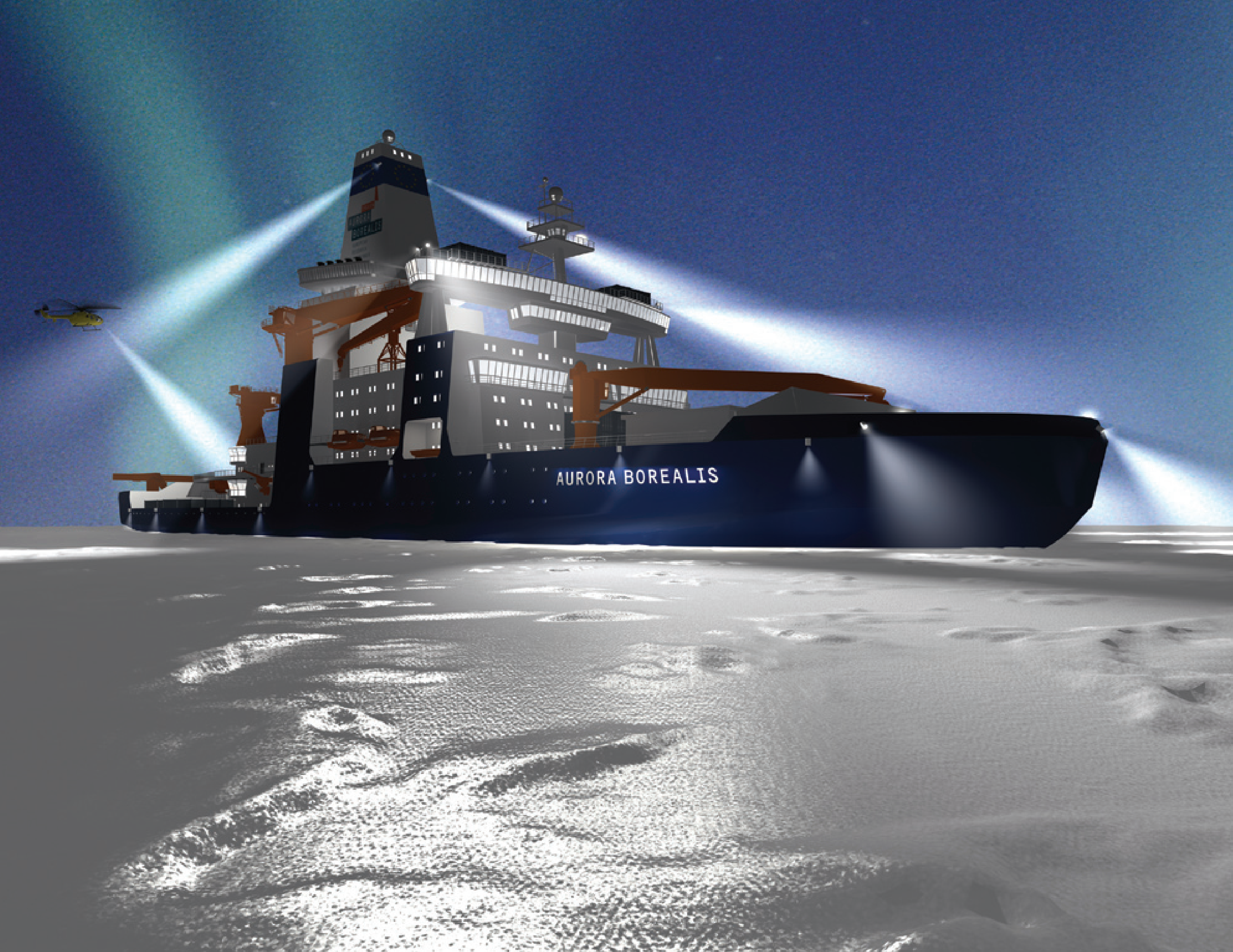
European Research Icebreaker CONsortium AURORA BOREALIS

Work package 4 : Financial Frameworks, Resource Engineering and Cost Forecasting for Multi-Country Commitments to Construction and Operation

Deliverable 4.1

Verified estimates on future running cost escalation, crewing and support of the vessel



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Acknowledgement

The ERICON Management Team expresses its gratitude to all the members of the Financial Advisory Panel for their contribution to the document and their support of the work of the work package 4 on Financial Structures. Their interest in the project, open mindedness and availability allowed us to achieve the difficult task of comparing several European and international models of operation to arrive at the initial estimates of future running costs and escalation costs for the operation of the *Aurora Borealis*.
Their contribution has been greatly appreciated.

The information presented in this document summarises the discussions held in the course of the Financial Advisory Panel (FAP) and has been developed in collaboration with its members.
These figures are the outcome of discussions among the maritime expert members of the FAP and are the result of a consensus of opinion based on the best practices of each country.
However, these figures should not be considered as absolute and are likely to vary according to the economic environment and model selected during the implementation phase.
The members of the FAP recognise the figures presented in the deliverable 4.1 as a realistic and sound representation of the future running cost of the *Aurora Borealis* in the light of the conceptual design of the ship developed by Wärtsilä.
The Financial Advisory Panel is composed of research vessel operators, fleet managers and naval architects who together are managing more than 31 research vessels. The members of the FAP are representatives of the members of the ERICON consortium who nominated them.

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First ERICON Financial Advisory Panel, 27 May 2009

Contents

1. Introduction

1.1 Background

The ERICON Aurora Borealis (AB) project is one the 35 projects identified in the 2006 roadmap of the European Forum on Research Infrastructure (ESFRI)[1] as a new Research Infrastructure of pan-European interest. It is currently the largest project in the Environmental Sciences. Funded by the European Commission for the duration of four years, the project generates the strategic, legal, financial and organisational frameworks required for advancing the decision-making process of national governments to commit financial resources for the construction and running of the European Polar Research Icebreaker *Aurora Borealis*.

The ERICON-AB initiative started in 2004 with a technical feasibility study performed by the University of Applied Sciences Bremen and Hamburg Ship Model Basin (HSVA) which was presented to the German Council of Science and Humanities (Wissenschaftsrat). The Wissenschaftsrat is the highest German scientific advisory body to the Federal Government and the state (Länder) governments; its function is to issue recommendations on the development of science, the university sector as well as to contribute to the safeguarding of the international competitiveness of German science and humanities in the national and European system.

Following the Wissenschaftsrat's positive evaluation and recommendation to realise the *Aurora Borealis*[2] in close collaboration with other European countries, pending the solution of remaining open technical questions, the Federal Ministry of Education and Research (BMBF) granted funds to the Alfred Wegener Institute for Marine and Polar Research (AWI) to demonstrate the feasibility of the suggested technical features, the novel solutions required for the Polar Regions and to set up a European consortium of interested partner countries.

The AWI tasked Wärtsilä Ship Design Germany (WSDG) to work on the conceptual design of the ship and develop the current scientific and technical layout of the research vessel. The design variant is based on the recommendations of the Wissenschaftsrat and reflects the experiences of the current *Polarstern* research icebreaker together with the future logistical and technical demands of international polar scientists. The new and unique design of the *Aurora Borealis* integrates the concept of three different vessels: a research vessel, a drilling vessel and an ice breaker into one vessel, making her a new state-of-the-art polar research drilling vessel capable of operating year-round in all Polar Regions.

Following the technical design work, Wärtsilä Ship Design Germany established a cost calculation for the vessel based on the tendering specification documents.

1.2 General considerations regarding nuclear icebreakers

In the course of the ERICON-AB project, interlocutors often suggested the possibility of developing the *Aurora Borealis* as a nuclear icebreaker. It is true that nuclear icebreakers are common in the Arctic and seven nuclear icebreakers are still in operation. Furthermore, the technology for a nuclear-powered ship has already been implemented in several European and non-European countries (for military purposes mainly) with Russia being the country with by far the most extensive experience in the area.

From an operational point of view the main advantage is that a nuclear icebreaker would be cheaper to operate. The difference in the operating costs resulting from the absence of diesel engines, which drastically reduces the 'fuel' cost.

However, several criteria developed below, both technical and political, suggest that the production of a nuclear research icebreaker is not compatible with the aims and general philosophy of the *Aurora Borealis* which will serve as a flagship for European research, promoting collaboration among researchers and operating in all polar waters.

1.2.1 Technical considerations

1.2.1.1 Access to ports and straits

Access to foreign ports could be complicated for a nuclear-powered icebreaker as the ship would be considered as transporting dangerous goods under the International Convention for the Safety of Life at Sea (SOLAS), 1974[3]. Access to some ports would be possible only after bilateral discussions[4] with the national authorities and under the conditions of the Code of Safety for Nuclear Merchant Ships adopted by the International Maritime Organization (IMO) Assembly in 1981.

Furthermore, even though Article 23 of the 1982 Convention on the Law of the Sea explicitly acknowledges the right of innocent passage through a territorial sea for nuclear vessels, many coastal states have forbidden, or submitted to authorisation, the passage of ships carrying radioactive materials, in a restrictive interpretation of the concept of 'innocent passage'[5]. In these circumstances, operating a nuclear icebreaker could be very difficult and become an administrative nightmare.

1.2.1.2 Access to the Southern hemisphere

The *Aurora Borealis* is aiming at operating in both the Arctic and Antarctic. If the vessel were a nuclear icebreaker, access to Antarctica would be very problematic. The Southern Ocean is regulated by the Antarctic Treaty signed in 1959 and which applies to everything south of 60 degrees south. In this area the Antarctic Treaty states under article V that:

> *1. Any nuclear explosions in Antarctica and the disposal there of radioactive waste material shall be prohibited.*[6]

One could argue that article V covers only nuclear explosion and radioactive disposal but does not forbid the generation of nuclear power. This restrictive interpretation of article V seems to be the correct one as, in 1962, the Americans installed a portable nuclear power station on McMurdo station. However, this power station was decommissioned in 1972[7] and there has been no other example of the use of nuclear energy in the areas covered by the treaty since (at least not on such a scale).

We can assume that access to the area by a nuclear icebreaker would therefore be a highly sensitive issue subject to intensive negotiations with the other members of the treaty. Considering that the treaty now has 46 signatory nations, the diplomatic efforts needed to resolve this issue would be enormous. Furthermore, even if we could consider that the *Aurora Borealis* would gain access to the area thanks to the type of activities she would perform; the risk of this authorisation being used as a precedent for less peaceful activities is too important.

1.2.2 Political considerations: public opinion and nuclear safety

Beside all these technical issues, the implementation of a nuclear icebreaker would also have to take into consideration the political implications of such a decision. In the current context and considering the development of renewable energies as an alternative to nuclear power stations, the decision to develop a nuclear icebreaker would not be considered as neutral. Strong reactions from the general public, politicians, NGOs and even partners could compromise the project.

In Europe, the general public tends to consider nuclear energy as dangerous and polluting. This belief is strongly established and emphasised in the Eurobarometer study on the 'European public opinion on nuclear safety' published in 2007[8]. This study performed by the EU Directorate General for Energy and Transport, Directorate for Nuclear Energy showed that 53% of Europeans perceived nuclear power to be more of a risk than a benefit, and only 33% perceived it as a benefit. This statistic, added to the fact that 50% of EU citizens do not believe that there is a safe way to carry out the final disposal of radioactive waste, shows the potential risk of a negative reaction from the general public to the creation of a European nuclear icebreaker.

The *Mutsu* example

An illustration of this fear of nuclear energy and the possible consequences on public opinion can be found with the example of the *Mutsu*, Japan's first and only nuclear-powered ship. During her testing phase actions by protesters forced the ship to perform in the open sea some tests which were supposed to be made in dock. During these tests a minor accident with no significant radiation exposure occurred resulting in the cancellation of the rest of the tests. However, the incident was immediately reported in the media as a radiation leak and the consequence was a strong reaction from fishermen who blocked the port, forbidding the *Mutsu* to return to port for more than 50 days. Following intensive negotiations the blockade somehow ended, the ship was repaired and finished her testing.

If the technical solutions to the accident on the ship were relatively simple and easily handled, the negative impact on the public opinion on the other hand was severe and took many years to be resolved. The result was a general mistrust of the government and the arousal of strong criticism against the current organisation of nuclear safety in Japan[9]. To address these criticisms the Japanese authorities had to go through a total reorganisation of the way they were handling the inspection of nuclear reactors. This reorganisation took many years and proved to be very costly.

The conclusions of the Eurobarometer together with the consequences of the *Mutsu* accident support the idea that trying to develop a European nuclear icebreaker would be too complicated due to the strong resistance which would have to be faced during the different steps of the project.

1.3 Context

To pool sufficient funding for the construction of the research vessel *Aurora borealis* the commitment of participating countries is needed. This can be achieved only through the development of a sound and reliable business plan. For this reason the work package 4 (WP4) dealing with 'Financial frameworks, resource engineering and cost forecasting for multi-country commitments to construction and operation' has been established. To support its task a Financial Advisory Panel (FAP) has been created composed of maritime experts nominated by the members of the ERICON Consortium, focusing primarily on establishing the first estimates of the operational costs. The outcomes of the FAP are integrated in this document and represent the first deliverable of the work package 4: D. 4.1. The document aims at providing the European Commission and the ERICON-Stakeholders with a realistic concept of the operation costs of the research vessel *Aurora Borealis*, including the evolution of the running costs with time.

In the course of the discussions of the Financial Advisory Panel the cost calculation method for the construction cost established by Wärtsilä Ship Design Germany has also been reviewed and validated.

2. Methodology

2.1 Composition of the panel

The members of the Financial Advisory Panel (FAP) are representatives of the ERICON stakeholders who nominated them. Composed of research vessel operators, ship designers and naval architects, the FAP is also benefiting from the experience of other collaborating experts outside the consortium, whose key expertise is crucial for the project. In combination the experts are managing more than 31 research vessels including the research icebreaker *Polarstern* and both research drilling vessels, the JOIDES *Resolution* and the *Chikyu Hakken* operating in the framework of the Integrated Ocean Drilling Program (IODP).

Used as a forum for exchange of experience and best practices, the Financial Advisory Panel is the backbone of all the work performed on the estimates of the future running costs of the *Aurora Borealis*.

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Ian Sage: NATO Undersea Research Center
Mitchel Malone: Integrated Ocean Drilling Program – U.S. Implementing Organisation

The chronology of the Financial Advisory Panel's work from its creation to this deliverable is shown in Figure 1.

For further information about the discussions held in the course of the FAP and the overall timeline of WP4, please consult the minutes of the FAP.

Annex 2.1 *Minutes of the three Financial Advisory Panels*

Dec. 2008 – April 2009
Creation of the FAP
↓
27 May 2009
1st Financial Advisory Panel –
Validation of detailed breakdown table
↓
June-September 2009
Contribution of experts depending on their field of expertise
↓
August-September 2009
Development of simulation model
↓
1 October 2009
2nd Financial Advisory Panel –
First estimates of running cost
↓
October 2009 – January 2010
Compilation of results
↓
Deliverable 4.1
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Figure 1. Chronology of the Financial Advisory Panel's work.

2.2 Calculation methodology

As a first step the members of the FAP established a common reference table (see Annex 2.2) including the different sub-categories that constitute the operational budget of the ship.

This task was based on an original proposition by Eberhard Wagner from the AWI and considered important because the understanding and composition of each of the cost items varies from one country to another, each country having its own model. The item 'crew costs' for instance may, in some countries, not only incorporate the salaries of the crew members but also all other costs related to their transport to and from the ship as well as their lodging expenses before embarkation.

The reference table also allowed us to identify different types of cost and re-group them under six main categories:

- Crew costs
- Ship's costs
- Research work
- Helicopter costs
- Management costs and charge for ship operator
- Cruise variable costs

Following the set up of a common reference table, the members of the FAP worked on first estimates, trying to evaluate the actual weight of each of the items in the overall budget. The outcome of this work was the identification of six items, which together comprise about 90% of the overall running costs.

The main six items and their proportional contribution are[10]:

Fuel consumption	38%
Crewing costs	24%
Maintenance of the ship	11%
Maintenance scientific equipment	8%
Helicopter costs	6%
Managing entity	3%
Total	**90%**

As each cost item has a strong influence on the total budget of the ship, these six single items have been assessed individually. The remaining 10% of the overall running cost budget encompasses several other cost items, each representing a fraction of the overall running costs which for practical reasons will not be analysed individually. Those remaining 10% will be briefly discussed at a later stage.(See section 3.7 'Other costs')

Annex 2.2 *Breakdown table of running costs.*

3. Cost items

This section presents a close analysis of the six main cost items identified above; the numbering of these items has been performed based on various scenarios to present some realistic overall running costs.

It should be emphasised that the figures presented in this document are average estimates with a range of uncertainty. This is due to the fact that the *Aurora Borealis* is a ship with unique technical specifications, prototype equipment and is designed to operate in extreme polar conditions all year-round. Consequently, obtaining data for baseline assumptions has sometimes been difficult (e.g. fuel consumption in relation to the ice concentration in the Central Arctic Ocean outside the optimal weather season).

Furthermore, some decisions on the future operation mode will depend on the policy and framework implemented by the ship owners which, at the current stage of the project, are unknown. These decisions have an important economic impact and will influence the running costs of the ship: e.g. whether to operate the ship with a mix of Heavy Fuel Oil (HFO) and Marine Diesel Oil (MDO) or MDO only. (See section 3-1.1 'Category of fuel' for more information).

3.1 Fuel costs

Fuel costs represent the most important part of the running costs of an icebreaker, taking up to 40% of the budget. It is also the most difficult one to predict, as the overall fuel cost varies significantly depending on three criteria:

- The category of fuel
- The fuel price per ton
- The expedition profile (fuel consumption)

In order to assess the influence of fuel costs on the total running cost, each of the three components are analysed separately and presented here in section 3.

The methodology used, presenting three different scenarios is the same for each component and is the following: identification of the most probable scenario, this scenario being considered as the medium one; then determination of two possible extreme scenarios (low and high) according to their economic impact. The three scenarios are identified as follows:

- A low scenario which is the least expensive option
- **A medium scenario** which has an average economic impact compared to the other two but is also **the most probable one**
- A high scenario which is the one with the highest economic impact

The fuel cost synthesis will present a reliable estimate of the fuel cost in the light of the possible evolutions and combinations of these criteria.

3.1.1 Category of fuel

The *Aurora Borealis* is designed to operate either on heavy fuel oil or marine diesel oil, the decision to use exclusively one type of fuel or a combination of both falls to the operators of the vessel. Their decision will however be influenced by several factors both economic and ecological which should be taken into consideration. The paragraphs below present both types of fuel and the main criteria which will influence this crucial decision.

As already stated, even if designed to operate with a mix of HFO and/or MDO the *Aurora Borealis* could also be powered by other sources of energy. Section 3-1.1.2 'Gas-powered dual-fuel technology' presents one of the possible alternatives to the technology developed in the conceptual design of the ship.

3.1.1.1 Marine fuel oil

The design of the *Aurora Borealis* allows her to run either on Heavy Fuel Oil (HFO) or Marine Diesel Oil (MDO). The main difference between the two types of fuel is their viscosities; the HFO having a higher viscosity than the MDO, as it is nearly exclusively composed of residual oil. The viscosity difference has two impacts: first an economic impact because the HFO (or IFO 380 as it is most commonly known) is cheaper than MDO; second, an environmental impact, because HFO produces higher emissions of sulphur oxides and greenhouse gases.

The emission of pollutants through exhaust gases is a sensitive topic. The regulation of pollution from vessels in general and gas exhausts in particular is likely to become stricter in the coming years. The International Maritime Organization (IMO) under Annex VI of MARPOL 73/78 has already planned to gradually reduce the exhaust emissions of sulphur oxide (SOx) and nitrogen oxide (NOx) for all types of vessels in the coming years. To cope with these regulations a mix between an improvement in the quality of the fuel (for SOx), thus favouring the use of MDO, and the development of new types of engines (for NOx) could be achieved. These new constraints are likely to have an impact on the price of fuel; the level of this impact is however hard to predict.[11]

The *Aurora Borealis* as a flagship for polar research will operate in sensitive environmental areas. She should therefore meet the highest standards of pollution control to be as environmentally friendly as possible. With a lower emission of gases and a better evaporation/dispersion in case of spill, the MDO was identified by the experts as being the best option possible for this purpose. However, as MDO is nearly 40% more expensive than HFO, the decision to run on MDO exclusively would also have some strong economic impacts which need to be taken in consideration during the decision process.

An alternative would be to combine the use of both HFO and MDO depending on the area of operation. The three different scenarios presented below have been created based on this assumption and in the light of the future regulations.

- **Low scenario:** *60% HFO/40% MDO*
  Maximisation of the use of HFO for economic reasons, use of MDO in Antarctica and in Sulphur Emission Control Areas (SECAs). So far, the only SECAs existing in Europe are the North Sea and the Baltic Sea, which are not foreseen as primary areas of operation for the *Aurora Borealis*. However, more extensive areas exist in North America and the creation of new SECAs in Europe is also a possibility[12] which should be taken in consideration.
- **Medium scenario:** *40% HFO/60% MDO*
  Use of HFO for transit on the High Seas only (e.g. transfer from Arctic to Antarctic), use of MDO for Polar Regions and for SECAs. This scenario takes into account the future enforcement of new regulations and the possible development of particular restrictions for polar waters. Those could thus limit the use of HFO to long transits on the High Seas only.
- **High scenario:** *100% MDO*
  The decision to use MDO fuel exclusively would represent the most expensive option, but could reflect the choice of the owners of the vessel to minimise the environmental impact of the deployment of the *Aurora Borealis*.

As already expressed, the final decision on the balance applied between the two types of fuels may be guided by non-economic considerations, their economic consequences would however have to be assessed based on the data presented in section 3-1.4 ‘Fuel consumption and fuel cost synthesis’.

3.1.1.2 Gas-powered dual-fuel technology

The *Aurora Borealis* has been designed to run either on Heavy Fuel Oil (HFO) or Marine Diesel Oil (MDO) but the possibility of using other sources of energy has also been considered in the design phase. Wärtsilä, also investigated the possibility of using liquefied natural gas (LNG) as a source of energy in parallel with regular fuel. The recent technical developments of LNG together with the future regulation of gas exhausts tend to designate this solution as a valid alternative for the future.

The main advantage of these dual-fuel engines compared to the conventional engines running on heavy fuel oil (HFO) is that they offer up to 20-25% lower CO_2 emissions, 90% lower NOx emissions with almost negligible SOx and particulate emissions. In gas mode, the engines already comply with the IMO’s Tier III regulations which will be implemented in 2016.[13]

From an economical point of view, prices for LNG are relatively attractive compared to fossil liquid fuels. Another advantage is that the price of gas, even if following the same trend as the price of petrol is still less volatile. This is an additional guarantee for the operators of the ship.

The option to use a gas-powered dual-fuelled engine was not studied in this document as it is not the technical solution selected by Wärtsilä in the conceptual design. The main reason is that LNG fuel requires large pressure tanks and the liquefied gas cannot just use the available structural hull spaces. Special tanks would have to be added, consequently increasing the overall dimensions of the ship and the related construction costs. From a logistical point of view, the availability of LNG in the ship’s remote area of operation is not guaranteed at this time.”.

However, the future improvement in technology may result in the development of this mode of propulsion which should then be considered by future stakeholders.

3.1.2 Fuel price

The different grades of marine fuel (IFO 380, IFO 180 and MDO) are all derivatives from crude oil. Thus, the change in marine fuel prices may vary in different proportions relative to the price of crude oil, but will always follow its general trend. Consequently, the fuel price for the vessel’s engines is directly linked to the price of the crude oil.

3.1.2.1 Correlation between crude oil and maritime fuel

As already stated, the prices of the various marine fuels change in a similar way to the price of crude oil. This correlation is presented in Figure 2 showing the evolution of the price of crude oil over the past two and half years in comparison to the evolution of the Bunkerworld Index (BWI).

The BWI[14] can be regarded as an international barometer of the bunker fuel markets. It is a weighted daily index (developed by the site http://www.bunkerworld.com), which is based on the price of different fuels in 20 key bunkering ports. To obtain a good geographical representation of the different ports, these are selected according to their size and also to their geographical importance. The ports selected are not only chosen based on the percentage of the worldwide volume they are distributing, but also in comparison with the volume distributed by other ports in the same geographical area.

The main grades IFO 380, IFO 180, MDO and MGO are all included in the spread proportionate to their importance on the bunker market. For example, HFO as the most commonly used fuel will have a bigger influence on the BWI index than the variation of the price of MDO.

The strict correlation between the fluctuation of the price of crude oil and the BWI allows us to focus on the price of crude oil and its variation over time in order to understand the fluctuation of marine diesel fuel prices. Regarding forecasting, once clear assumptions are reached for the future price of crude oil by 2013, the prices of MDO and HFO could be deduced.

3.1.2.2 Price of crude oil

Following a relatively stable period until 2003, the price of oil started to rise significantly as a result of the beginning of the Second Gulf War .This continuous rising trend changed into an exponential increase in early 2008 and reached its maximum in July. Then it fell dramatically in the second half of the year. Indeed, whereas the price of crude oil rose to a record of US$147.27 per barrel on 11 July 2008, it then dropped reaching US$33.87 a barrel on 21 December 2008 which was the lowest for the previous four and a half years (Figure 3).

This period from July 2008 until the end of December 2008 – even if without precedent – is a good example of the general volatility of the fuel market. In those five months, the price of crude oil went from its highest to its lowest, nearly reducing its value by four.

(For a more detailed analysis of crude oil price history: see WTRG economics[15])

In this context it is important to mention that even knowing the influence of economic and political factors[17], it seems impossible to predict whether the market will now remain stable or if such an oil crisis could happen again. Predictions of future crude oil prices are therefore very difficult and even if a general trend could be determined over several years, the peaks would still be impossible to anticipate[18].

With such an unpredictable and volatile market, predictions of the future price of oil should rely on forecasts by national agencies and not on the opinion of single experts only. Consequently for the purpose of this deliverable, the estimates were based on the work of the US Energy Information Administration (EIA)[19] which is the statistical and analytical agency within the US Department of Energy. The EIA's aim is to 'provide policy-neutral data, forecasts, and analyses to promote sound policy making, efficient markets, and public understanding regarding energy and its interaction with the economy and the environment.'[20]

The scenarios developed for this work are assumptions of the possible evolution of the price of crude oil by 2013 and are based on the short-term energy outlook issued by the US Energy Information Administration[21] presented in Figure 4.

According to the source, the price of oil will follow a slow rising trend in the coming years allowing us to estimate that, as a medium scenario, the price of the barrel of crude oil is likely to reach US$90 by 2013.

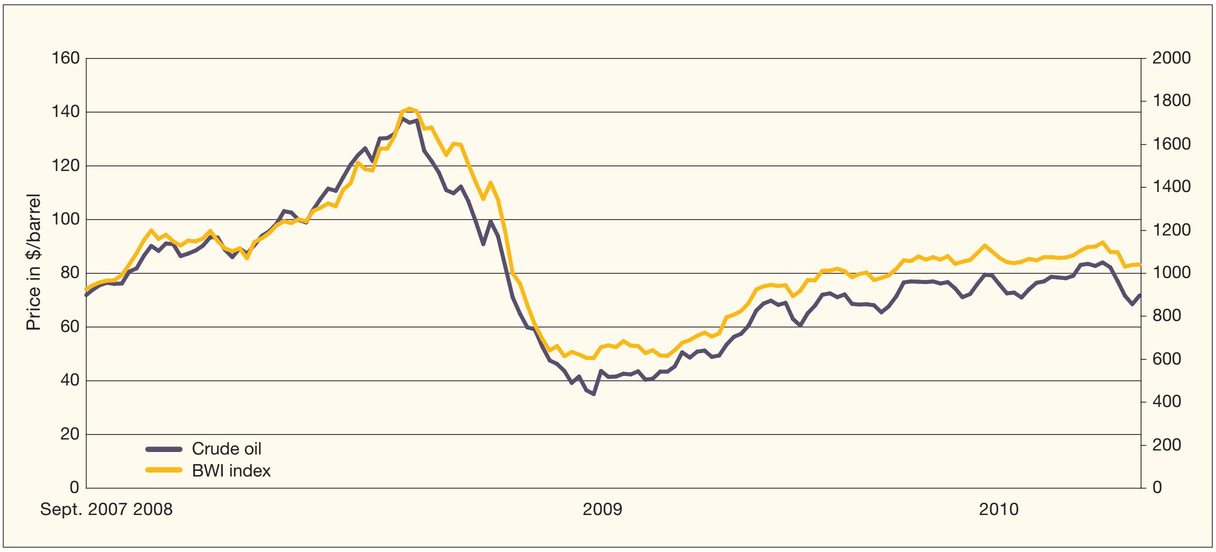


Figure 2. Evolution of crude oil and maritime fuel prices over the past two and half years in comparison to the evolution of the Bunkerworld Index (BWI).
Source: data BWI: Bunkerworld – http://www.bunkerworld.com/prices/index/bwi
Source: data crude oil price: US Energy Information Administration
http://tonto.eia.doe.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=WTOTWORLD&f=W

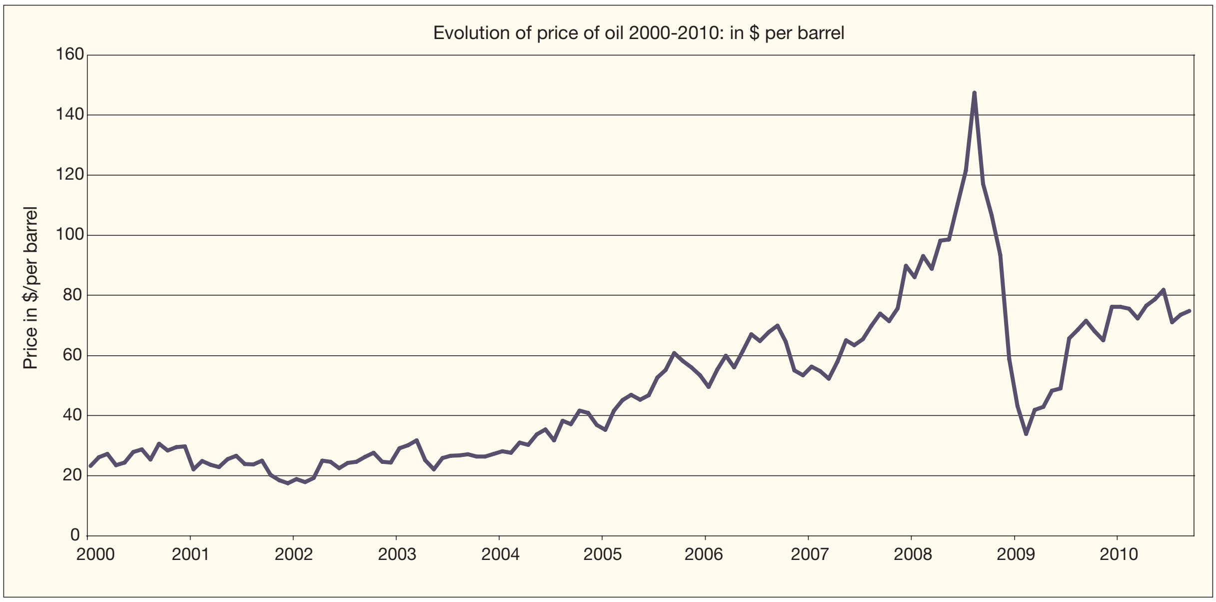


Figure 3. Evolution of the price of crude oil from the year 2000 to August 2010 in US$ per barrel. Source: US Energy Information Administration[16].

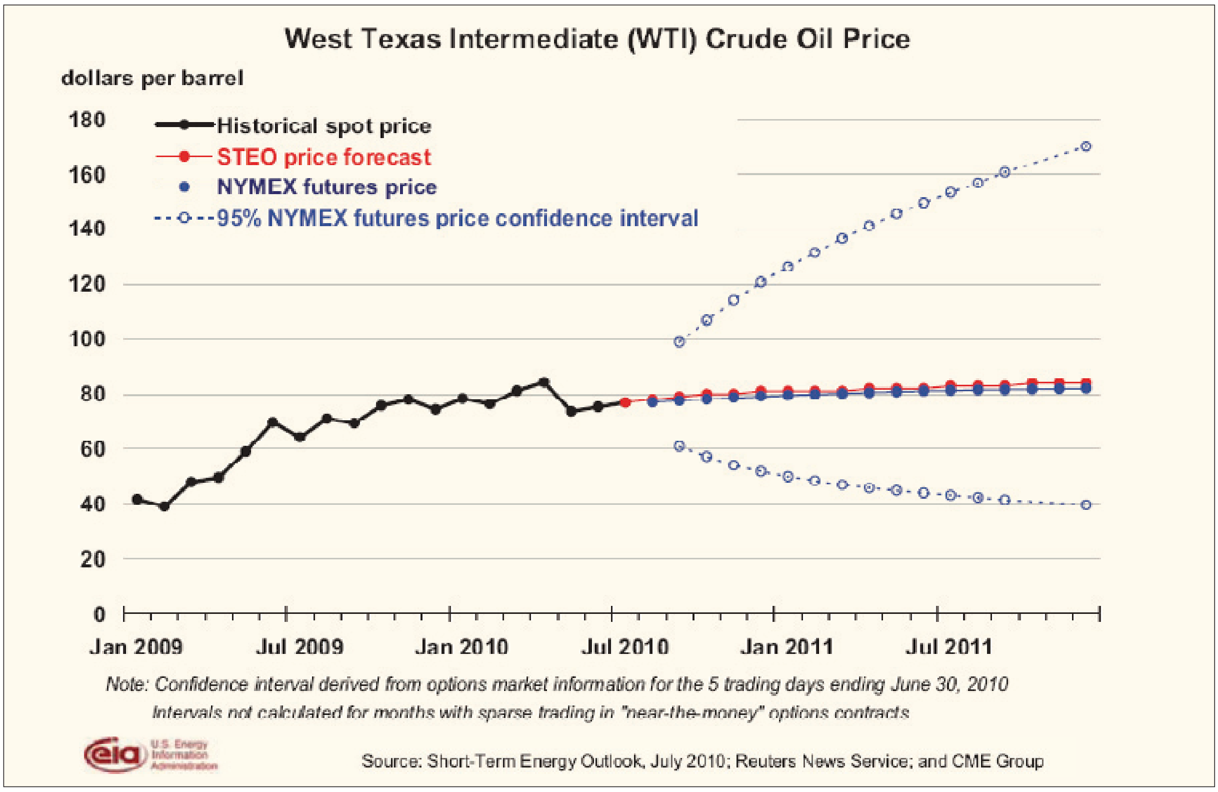


Figure 4. Crude oil price of West Texas Intermediate Oil, Jan 2009 to Dec 2011.

The high and low scenarios are difficult to predict and could be based only on assumptions, the level of uncertainty rises significantly with time (see Figure 4).

The variation of the price of fuel is highly influenced by the economic and political environment. The development of an open conflict in an area of production or an increase of the tensions in the Middle East could result in a significant increase in the price of crude oil. In such a situation prices of the level of July 2008 could be reached again and a price of US$140 per barrel as a high scenario is possible.

Even if on a rising trend, the price of crude oil could still fall again. This could be the case if the economy entered another recession phase or if some new sources of oil were discovered. Prices in the range of those of October 2009, US$70 per barrel could, under those circumstances, be reached again; this would be the low scenario.

The three different scenarios are summarised below:

Scenario for price of crude oil by 2013	
High scenario	US$140/barrel
Medium scenario	**US$90/barrel**
Low scenario	US$70/barrel

3.1.2.3 Price of marine fuels

3.1.2.3.1 Market average

The prices of the various marine fuels are linked to the price of crude oil and follow its general trend. (See section 3-1.2.1 'Correlation between crude oil and maritime fuel')

Assuming that the correlation between the price of crude oil and marine fuels remain constant, i.e. the prices of the MDO and HFO corresponding to the different prices of the crude oil mentioned above (70, 90 and 140 US$/barrel). Then the three scenarios for the prices of MDO and HFO by 2013 are presented in Figure 5.

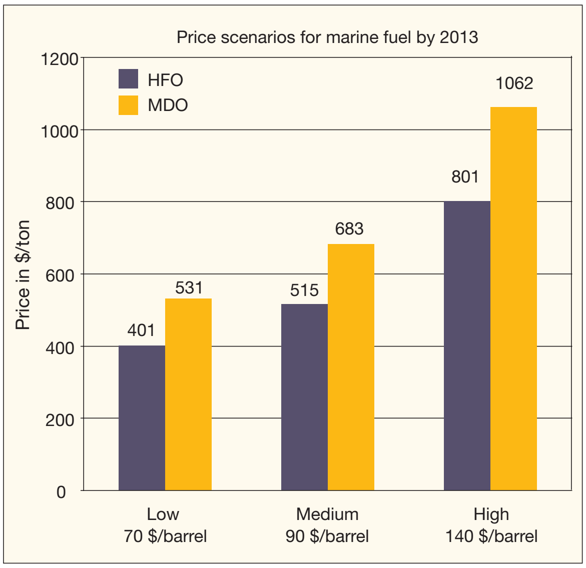


Figure 5. Price scenarios for marine fuel by 2013.

3.1.2.3.2 Geographical location of the port

As the price of petrol varies from one petrol station to another, so the price of marine fuels varies similarly from one port to another. These variations are not only global (between the northern and southern hemisphere) but also regional (between several European ports). In Europe the port of reference is Rotterdam and it could sometimes be more beneficial financially to sail some extra miles and bunker in a cheaper port. The decision between the two options would be based on the price difference between the two ports considered and the quantity of marine fuel needed.

For the calculation of the future fuel consumption of the *Aurora Borealis* it has been agreed to consider the only average prices of the market. Any potential choice between ports being impossible to foresee and could only be made at the time of operation.

Table 1. Scenarios for the price of marine fuel by 2013, comparison Euro/US dollar

Scenario	IFO 380		MDO	
	US Dollar/Ton	Euro/Ton*	US Dollar/Ton	Euro/Ton*
High (US$140//barrel)	**801**	624.48	**1062**	828.36
Medium (US$90 /barrel)	**515**	401.70	**683**	532.74
Low (US$/70 barrel)	**401**	312.78	**531**	414.18

* ratio 1US$=€0.78

N.B.: These three scenarios have been established based on the assumption that the correlation between the price of crude oil and each of the marine fuels remains constant.

3.1.3 Expedition profile

As an icebreaker operating all year-round in Polar Regions the fuel consumption of the *Aurora Borealis* is directly determined by her expedition profile and in particular:

- The scientific expeditions performed (drilling, oceanographic survey etc.)
- The location of operation (central Arctic, Siberian Sea, Davis Strait etc.)
- The period of operation (winter, spring, summer or autumn)

Each of the components has a strong impact on the fuel consumption of the vessel; however, their various combinations are too complex to be analysed individually and vary from one scientific expedition to another.

Therefore the determination of the expedition profile and the related fuel consumption for the *Aurora Borealis* followed another approach divided in two steps: first the creation of a theoretical expedition profile for the ship; second the calculation of the related fuel consumption.

3.1.3.1 Set of scientific expeditions

Taking into consideration the recommendations of the experts, different single missions representing a realistic balance of scientific activities and locations have been determined and brought together to build a coherent annual expedition profile for the *Aurora Borealis*. Two different scenarios have been established according to their potential fuel consumption relating to the drilling expeditions: one in the Central Arctic and considered to be the most demanding (expedition 4, option 1); the second one taking place west of Svalbard, being less fuel consuming (expedition 4, option 2).

This work has been performed by the scientific coordinators of the project in line with the task of work package 2 on Science Integration.

An example of a single expedition is presented in Figure 6; the full *Aurora Borealis* annual expedition profile being integrated and presented in the Annex 3.1.3.2 'Aker Arctic report on fuel consumption'.

N.B.: For the purpose of this task the scientific scenarios developed focused exclusively on the Arctic Ocean as the *Aurora Borealis* is likely to be deployed in this area over her first years of operation. The scenarios developed are also geographically focused rather than spread over the entire Arctic. This was identified by the members of the FAP as a realistic way of operating a research vessel. The scenarios have been chosen for their scientific relevance, to assess the potential fuel consumption of the *Aurora Borealis*, but should not be considered as reflecting the priorities which will be developed in the science plan. For the purpose of this work the port of Tromsø in Norway has been arbitrarily chosen as the logistical base for the *Aurora Borealis* for calculation purposes only.

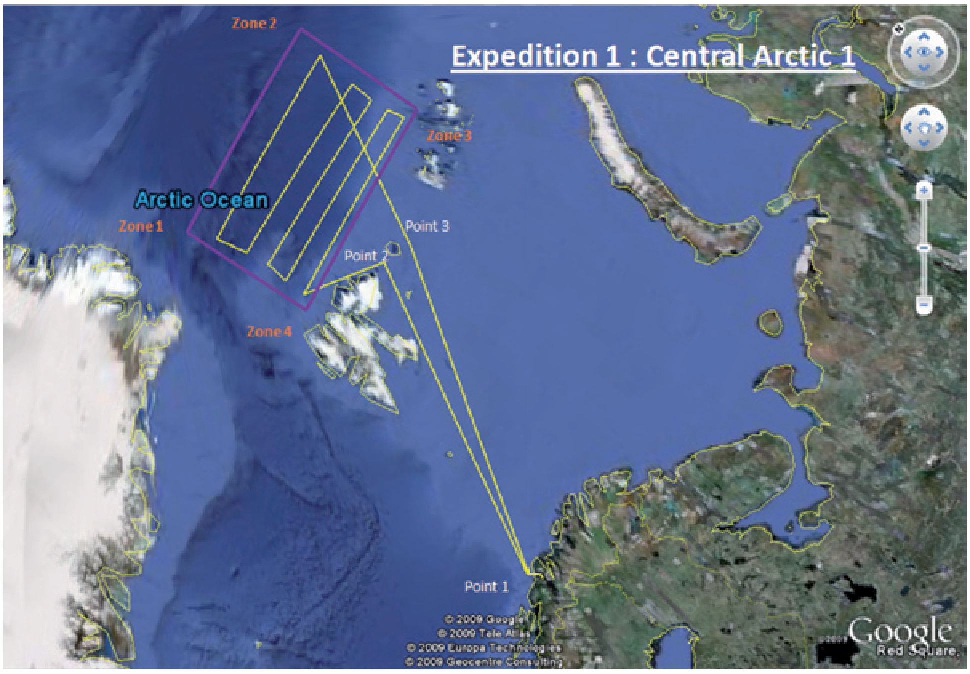


Figure 6. Voyage 1: Central Arctic – Aurora Borealis annual expedition profile.

3.1.3.2 Aker Arctic report on fuel consumption

The Aker Arctic report has calculated the number of days needed to perform a set scientific expedition and the related fuel consumption. Based on this information the number of scientific expeditions the *Aurora Borealis* could perform in a year has been determined and the corresponding fuel consumption estimated. The Aker Arctic report also assessed whether the *Aurora Borealis* could perform all the expeditions considered within the limit of her maximum endurance or whether some of them had to be modified.

➔ **Annex 3.1.3.2** *Aker Arctic report on fuel consumption*

3.1.3.2.1 Methodology

The fuel consumption of the *Aurora Borealis* based on the expedition profiles set was determined by Aker Arctic in the light of the technical details of the ship (power vs. fuel consumption) and ice conditions encountered in the areas of operation.

These technical details were set thanks to the close collaboration between Wärtsilä and Aker Arctic and are the basis of the calculation model developed by Aker Arctic. Knowing the electrical balance, the various ice thicknesses faced according to the seasons and geographical locations; the related duration and fuel consumption of each of the scientific expeditions could be calculated.

For more information on the calculation methodology please see Annex 3.1.3.2 'Aker Arctic report on fuel consumption' pages 12-14.

3.1.3.2.2 Outcomes

The outcomes of the report are summarised in the Tables 2, 3, and 4 and show that the *Aurora Borealis* could perform the five expeditions considered in less than a year, therefore leaving time for a possible sixth expedition. However, for one of the expeditions (drilling expedition in the Central Arctic) the *Aurora Borealis* would exceed the limit of her endurance (10 000 tons); as 12 359 tons would be needed to complete it. An alternative option, allowing the completion of the expedition within the limit of the 10 000 tons, has therefore been created. This expedition is called 'expedition 4 option 1 modified' and is integrated in Table 4.

Tables 2, 3 and 4 summarise the outcome of the report. The list of the different scientific expeditions, the annual mission profile and the related fuel consumption are available in Annex 3.1.3.2 'Aker Arctic report on fuel consumption'.

Table 2. Profile 1: complete expedition profile with drilling expedition 4, option 1

Voyage	Name	Total duration [d]	Fuel oil consumption	Scheduled time	Timing	
					Start	**End**
Loading / unloading		5			1.1.	6.1.
1	Central Arctic 1	59	6 775	January	7.1.	6.3.
Loading / unloading		5			7.3.	12.3.
2	Laptev Sea	61	5 945	Late March – Early April	13.3.	13.5.
Loading / unloading		5			14.5.	19.5.
3	South Arctic Ocean	45	2 366		20.5.	5.7.
Loading / unloading		5			6.7.	11.7.
4 (opt 1)	Drilling Central Arctic	55	12 359	July	12.7.	4.9.
Post drilling demobilisation (1 week)		7			5.9.	12.9.
Loading / unloading		5			13.9.	18.9.
5	South Arctic Ocean	45	2 366	Late September – Early October	19.9.	3.11.
Loading / unloading		5			4.11.	9.11.
Yearly maintenance (3 weeks)		21			10.11.	1.12.
Total		**323**	**29 811**		**1.1.**	**1.12.**

Table 3. Profile 2: complete expedition profile with drilling expedition 4, option 2

Voyage	Name	Total duration [d]	Fuel oil consumption	Scheduled time	Timing	
					Start	End
Loading / unloading		5			1.1.	6.1.
1	Central Arctic 1	59	6 775	January	7.1.	6.3.
Loading / unloading		5			7.3.	12.3.
2	Laptev Sea	61	5 945	Late March – Early April	13.3.	13.5.
Loading / unloading		5			14.5.	19.5.
3	South Arctic Ocean	45	2 270		20.5.	5.7.
Loading / unloading		5			6.7.	11.7.
4 (opt 2)	West Svalbard	54	5 958	July	12.7.	3.9.
Post drilling demobilisation (1 week)		7			4.9.	11.9.
Loading / unloading		5			12.9.	17.9.
5	South Arctic Ocean	45	2 366	Late September – Early October	18.9.	2.11.
Loading / unloading		5			3.11.	8.11.
Yearly maintenance (3 weeks)		21			9.11.	30.11.
Total		**322**	**23 314**		**1.1.**	**30.11.**

Table 4. Profile 3: complete expedition profile with drilling expedition 4, option 1, modified

Voyage	Name	Total duration [d]	Fuel oil consumption	Scheduled time	Timing	
					Start	End
Loading / unloading		5			10.1.	15.1.
1	Central Arctic 1	59	6 775	January	16.1.	15.3.
Loading / unloading		5			16.3.	21.3.
2	Laptev Sea	61	5 945	Late March - Early April	22.3.	22.5.
Loading / unloading		5			23.5.	28.5.
3	South Arctic Ocean	45	2 366		29.5.	14.7.
Loading / unloading		5			15.7.	20.7.
4 (opt 1) Modified	Drilling Central Arctic	39	9 502	July	21.7.	28.8.
Post drilling demobilisation (1 week)		7			29.8.	5.9.
Loading / unloading		5			6.9.	11.9.
5	South Arctic Ocean	45	2 366	Late September - Early October	12.9.	27.10.
Loading / unloading		5			28.10.	2.11.
Yearly maintenance (3 weeks)		21			3.11.	24.11.
Total		**307**	**26 954**		**10.1.**	**24.11.**

3. Cost items

3.1.3.3 Annual fuel consumption

Each of the three profiles can be performed in less than a year leaving time for a possible sixth expedition. Rather than creating a sixth expedition it has been decided to extrapolate the results of the report over a full year to get the annual fuel consumption of the ship. This can be obtained by calculating the daily fuel consumption for each of the profiles and extrapolating it over a full year of operation.

This daily fuel consumption is calculated according to the number of days at sea; the fuel consumption related to the time spent either at port or in dock (58 days total) being considered as negligible.

Table 5 shows the daily fuel consumption and the extrapolated annual fuel consumption for each of the three profiles presented in the Aker Arctic report.

The average annual fuel consumption is calculated as being 31 627 tons. However, a safety margin of 10% should be added for caution as 'the timetables are defined as for guidance only. For example the required unloading/loading time is likely to vary in reality' (Aker Arctic report p. 57). The extrapolated average annual fuel consumption for the *Aurora Borealis* is therefore **35 000 tons**.

3.1.4 Fuel consumption and fuel cost synthesis

The outcome of the fuel consumption calculation exercise is a good indicator of what the fuel consumption of the *Aurora Borealis* would be. This figure should however not be considered definitive as based on a set expedition profile. An expedition profile with different scientific expeditions would result in a different fuel consumption. Nevertheless we can consider the outcome of this work as a fair estimate of what the fuel consumption of the ship will be.

The outcomes of the analysis of the three different criteria to be taken into consideration when trying to evaluate the cost of the fuel for the *Aurora Borealis* are discussed in sections 3.1.1, 3.1.2 and 3.1.3 and are summarised in Table 6.

Table 5. Extrapolated annual fuel consumption of Aurora Borealis

	Profile 1	Profile 2	Profile 3
Duration of scenarios (days)	323	322	307
Non-sailing days	58	58	58
Days at sea	265	264	249
Total fuel consumption (tons)	29 811	23 314	26 954
Daily fuel consumption (tons)	**112,49**	**88,31**	**108,25**
Total annual days at sea (365-58)	307	307	307
Total annual fuel consumption (tons)	**34 536**	**27 111**	**33 232**
Average including safety margin of 10% (tons)	**35 000**		

Table 6. The *Aurora Borealis* overall fuel criteria (three scenarios)

		Low scenario	Medium scenario	High scenario
Fuel price	price MDO (€/ton)	414.18	532.74	828.36
	price HFO (€/ton)	312.78	401.70	624.78
Type of fuel	Ratio HFO/MDO	60%	40%	0.00%
Fuel consumption	Fuel consumption per metric ton	35 000	35 0000	35 000

Table 7. The *Aurora Borealis* overall fuel consumption (most probable scenario)

		Medium scenario
Fuel price	price MDO (in € per metric ton)	532.74
	price HFO (in € per metric ton)	401.70
Type of fuel	Ratio HFO/MDO	40%
Fuel consumption	Fuel consumptionper metric ton	35 000
	Total fuel cost	16 811 340* €

*The formula used is: (Price MDO*Fuel consumption*(1-ratio HFO/MDO))+(Price HFO*Fuel consumption*ratio HFO/MDO)

Each criterion has a different economic impact on the price of fuel and evolves independently from the others; their combination is random. However, in the course of this work the most probable scenario was always considered as the medium one and should serve as a basis for the calculation of the future fuel cost for the *Aurora Borealis* (see Table 7).

According to the calculation presented in Table 7 we can consider that the average annual fuel cost for the *Aurora Borealis* will be €16 811 340.

➔ **Fuel consumption: 16 811 340 € per year**

3.2 Crewing costs

The crewing cost is the second highest item of the running costs of the ship. It is influenced by two main components: the number of crew members and the level of their salaries. The following section presents the work achieved in the assessment of the number of crew members needed for the operation of the *Aurora Borealis* and the outcome of a survey performed within the Financial Advisory Panel on the different levels of salary in Europe.

3.2.1 Composition of the crew

The *Aurora Borealis* is a unique vessel combining the specifications of three different types of ship: she is a research vessel, an icebreaker and a drilling vessel all in one. This unique multipurpose dimension of the vessel is reflected in the composition of her crew as the *Aurora Borealis* will need categories of crew which are specific to the three types of ship. To this end the complement of the *Aurora Borealis* is mainly taken from the example of two research vessels: the *Polarstern* for the non-drilling crew (ship's crew) and the *Chikyu* for the drilling crew.

The organisational chart presented in Annex 3.2.1 is therefore inspired by those two models and has been submitted for comment to the members of the FAP for the ship's crew, and to other external experts for the drilling crew. The composition of the crew is based on a 24h/7 operations with rotations being based either on an 8-hour shift or a 12-hour shift.

➔ **Annex 3.2.1** *Organisational chart of the Aurora Borealis*

3.2.1.1 Ship's crew

The composition of the ship's crew for the *Aurora Borealis* was developed by Eberhard Wagner from the Alfred Wegener Institute (AWI) thanks to his extensive experience with the research icebreaker *Polarstern*. This first model was then submitted to the critical analysis of the experts of the FAP and their comments integrated. However, as the composition of the crew varies significantly from one country to another depending on the country's model of operation (in relation to the job description/duties of each of the crew member), a true consensus document was not achievable. Table 8 therefore presents the three different possible scenarios identified for the composition of the ship's crew. These are based on the German model and amended by the members of the FAP according to their usual way of operating. An extended version of Table 8 is available in Annex 3.2.1.1 'Scenarios for AB ship's crew'

This breakdown of figures represents realistic scenarios but may not be applicable to all countries as some positions would vary from one country to another depending on the definition of the task allocated to the crew member.

Annex 3.2.1.1 *Scenarios for AB ship's crew.*

3.2.1.2 Drilling crew

The composition of the drilling crew for the *Aurora Borealis* was developed in collaboration with Yoshio Isozaki in the light of his experience with the riser drilling vessel *Chikyu*. This first model was then submitted to other experts from the drilling community; in particular

Table 8: Overview of the ship's crew composition by country

Ship's crew	Germany	Norway	Italy	France	Netherlands
Nautical officers	6	5	5	5	5
Technical officers	5	5	5	5	5
Specific positions	5	5	5	4	5
All AB seamen	6	6	6	6	6
All AB seamen or ship mechanics	6	4	4	3	4
All ship mechanics	5	3	3	5	3
Catering and service staff	6	6	6	6	6
Scientific support for icebreaker operation	4	4	4	2	4
Total number of crew	**43**	**38**	**38**	**36**	**38**

Mitchell J. Malone for his experience with the JOIDES *Resolution*. Their comments have been integrated into the current organisational chart available in the Annex. The drilling crew presented in Annex 3.2.1 is composed of 25 people.

General comment on scientific support

In addition to the number of crew presented in the organisational chart, additional personnel are needed to operate and calibrate the scientific equipment onboard. These people are technicians who are mainly needed for specific works (e.g. drilling), but could also be permanently onboard depending on the use of the scientific equipment they are supervising.
The current organisational chart of the *Aurora Borealis* does not integrate any of these technicians as this subject is tackled in work packages 2 and 5. Task 2.2 in particular, 'Provision of essential services related to a dedicated polar research icebreaker' will determine the level of support needed, whereas task 5.2 'Definition of the functions, staffing, intellectual property and structural divisions of the ERICON Managing Agency' will define whether the related costs should be incorporated into the overall running costs of the vessel.
The outcome of these two tasks will be incorporated into work package 4 at a later stage and presented in the business planning document.

3.2.2 Level of salaries

The salary of the crew is directly linked with the flag country of the ship and also to the type of register. For the same country the kind of flag used (first flag or secondary flag) may also have an impact because of the tax regime applied and the potential restrictions on the nationality of the people hired.

In France, for example, a ship registered under the first register (or the first flag) would have to hire an entirely French crew whereas a ship registered on the International French Register (secondary flag) will only have to hire European officers and make sure that in total (officers included) 25-35% of her crew are European. There is no restriction on the nationality of the rest of crew[22].

The selection of a flag impacts significantly on the overall running cost of the ship and also has some legal implications. All these implications, such as the social security regime and the national law to be enforced, will be further developed in the deliverables of work package 6 on the Legal Framework.

It has been agreed that in the course of this work, as the *Aurora Borealis* is a flagship for European research, the focus will be on first flags only. However, other alternatives such as secondary flags or non-European flags are also possible and would significantly reduce the crew cost.

3.2.2.1 Ship's crew

The Financial Advisory Panel was the opportunity to organise a comparative study among the experts and to have an overview of the different salary levels in Europe. This study has been performed with the collaboration of the experts from Germany, France, Italy, the Netherlands and Norway who provided information on their national salary schemes. The outcome of this work is presented below and is not meant to be exhaustive but reflects the level of cost foreseen when hiring the ship's crew.

The study has been performed for two full crews, over a period of one year, taking into consideration that the ship is operating 24h/7. An attempt has been also been made to estimate the employer's cost and incorporate all taxes, social security, levies and pensions. The complexity of the different social systems and the national specifics however did not always allow the compilation of truly identical data.

In Norway for instance, the sailors employed by the Institute of Marine Research (IMR) are considered to be civil servants. The IMR as partly financed by the Ministry of Fisheries and Coastal Affairs benefits from certain privileges reducing the level of employer's costs to 15%. In comparison, a private company would have to cover additional contributions such as pension schemes and insurances, thus raising the level of employer cost to 20%.

Another national example is Italy where CNR's research vessels are registered under the International Shipping Register, created by the Italian government in 1998 to increase jobs in the Italian maritime sector. The Italian government additionally created a special economic fund for ships with, for example, an entire Italian crew or a crew composed of personnel from other European states.

This fund allows the ships registered under this International Register to benefit from advantages in the tax regime of the shipping companies as well as in the tax and welfare schemes of the maritime personnel. Consequently shipping companies benefiting from these tax reliefs have a low rate of employer's cost of 13%.

Figures 7, 8 and 9 present an overview of the cost considered for each country for different scenarios (43, 38 and 36 crew members), emphasising the importance of the employer's costs in the overall crew cost.

The full breakdown for the two scenarios of crew showing the distinction between gross salaries and employer's cost is presented in Annex 3.2.2.1.

In order not to favour any model or any scenario and still be in the position to advertise a single figure rather than a range, it has been decided to first calculate the average salary of each of the three scenarios. Second, to calculate the average of the averages in order to come up with a single amount. By doing so we do not favour any country or any scenario. The average annual salary for the ship's crew based on these three scenarios and five national examples is €5 474 814.

Annex 3.2.2.1 *Payroll Aurora Borealis*

➔ Non-drilling crew: 5 474 814 € per year

3.2.2.2 Drilling crew

The methodology used for the drilling crew differs from the one used for the non-drilling crew as the kind of profiles needed and their corresponding salaries are related to those of the oil industry. Furthermore as this crew will be needed for only three months per year the duration of the contract considered will also vary. The drilling crew is likely to be hired based on temporary contracts, which is the common practice in this industry.

The figures presented in the table available in Annex 3.2.2.2 and summarised below are based on information from professional recruitment consultants from *Soul*

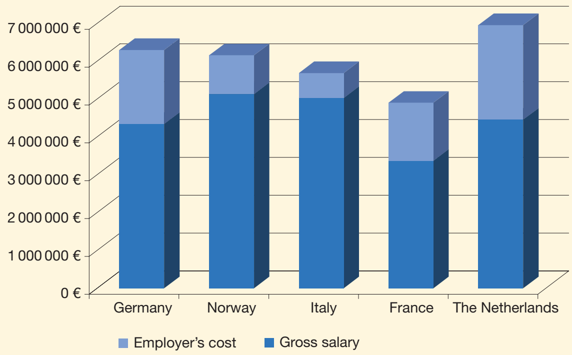


Figure 7. Costs for ship's crew with 43 crew members for a full year, gross salaries plus employer's tax.

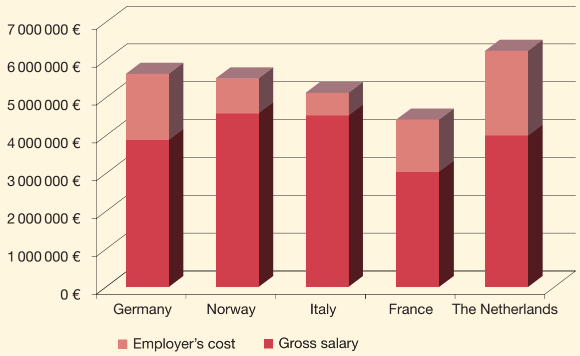
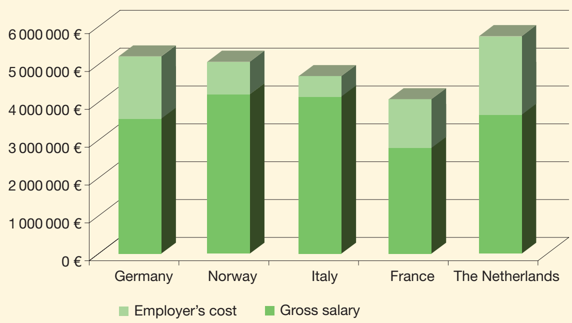


Figure 8. Costs for ship's crew with 38 crew members for a full year, gross salaries plus employer's costs.



N.B.: Rate of employer's costs by country, in percentage of gross salay: Germany 45%, Norway 20% based on private sector, Italy 13%, France 46%, the Netherlands 56%.
A summary of the study presented in Annex is available, the figures given are per month (gross salaries+employer's costs) for a category of crew members.

Figure 9. Costs for ship's crew with 36 crew members for a full year, gross salaries plus employer's costs.

Table 9. Costs for ship's crew of Aurora Borealis

Ship's crew Crew cost per year for two full crews	**Germany* €**	**Norway* €**	**Italy* €**	**France* €**	**The Netherlands* €**	**Average €**
With **43** crew members	6 302 106	6 159 152	5 687 167	4 904 328	6 956 277	6 001 806
With **38** crew members	5 626 916	5 507 636	5 120 014	4 420 338	6 236 194	5 382 220
With **36** crew members	5 284 658	5 161 188	4 771 073	4 162 574	5 822 594	5 040 417
basis: 320 sea-days					**Grand average**	**5 474 814**

* All figures include the sum of gross salaries and employer's costs considered for two full crews for a year

Resources[23] for the drilling crew proper and information from the operators of the JOIDES *Resolution* for the related engineers[24].

For the details of the cost calculation please consult **Annex 3.2.2.2** 'Drilling crew cost estimate'.

➔ **Drilling crew: 1 497 076 € per year**

3.3 Maintenance of the ship

The maintenance costs of the ship and their evolution over time are influenced by the technical specifications of the ship and her geographical area of operation. As some of the technical features of the *Aurora Borealis* and the future area of operation are not entirely defined yet, the methodology used for this section is based on a scale-up of an existing example.

The figures presented in Table 11 are the result of the work of Eberhard Wagner from the Alfred Wegener Institute (AWI) who, based on his experience with the research icebreaker *Polarstern*, provided an estimate of the future annual maintenance cost of the *Aurora Borealis* between her fifth and tenth year of operation. It is important to use ,a research icebreaker as a base for comparison as the *Aurora Borealis* as an icebreaker with the highest ice-class, would have to enter dry dock more often than other sea-going research vessels in order to meet the requirement of the classification societies.

The total figure considered in Table 11 is the forecast annual maintenance cost of the ship between her fifth and tenth year of operation, over this period the maintenance costs of the ship are stable and can considered as 'normal'.

A detailed analysis of the Evolution of the maintenance cost of the ship over her lifetime is developed in section 4 'Cost escalation'.

➔ **Maintenance cost of the ship: 3 950 000 € per year** ('normal' maintenance cost)

3.4 Maintenance of scientific equipment

The *Aurora Borealis* will be able to serve all research fields ranging from geophysics to biology and from meteorology to geology. She has been designed to allow scientists to work under the safest conditions possible in Polar Regions. This will not mean that all the equipment needed for research work will be permanently available on board and it is foreseen that scientists would have to come with some of their own equipment (e.g. Remotely

Table 10. Cost synthesis relating to the drilling crew of the *Aurora Borealis*

	Number	Daily gross salary for number considered (€)
Offshore Installation manager	1	677
Tool pusher	2	1 320
Driller	2	1 080
Assistant Driller	2	780
Derrickman	2	660
Pumpman	1	330
Lead Roughneck	1	330
Roughneck	3	806
Chief Electrician	1	632
Data Technician	2	1 026
Electrician	2	1 026
Chief Mechanic	1	513
Hydraulic Engineer	2	1 214
Assistant Hydraulic Engineer	1	464
Mechanic	1	345
Assistant Mechanic	1	172
Total gross salary for full crew per day		11 376
Gross salary drilling crew for 90 days mission**		1 069 340 €
Total cost drilling crew for 90 days mission*		**1 497 076 €**

* including employer's costs 40% (social security, insurance costs, etc)
** 94 paid days for a 90-day mission

Table 11. Aurora Borealis normal maintenance cost (€)

	Normal maintenance cost (€)
Repair and maintenance costs for deck	750 000
Repair and maintenance costs for engine	1 500 000
Equipment	500 000
Equipment/ship-consumption goods	500 000
Costs for dry-docking	200 000
Repair and refit of the ship systems	500 000
Total	**3 950 000**

Operated Vehicles) for specific missions. The figures presented consequently cover only the scientific equipment permanently available onboard.

It should also be stressed that the figures cover only the equipment and not the personnel performing its maintenance. Indeed, the FAP uses the opportunity to stress that, depending on the national system, the costs relating to the people performing the maintenance of the equipment was either spread among the research institutes or covered by the operator of the ship depending on the model implemented. This item is also further discussed under section 3.6 'Managing entity'; 'General comments on scientific support and science services'.

The life cycles of the scientific equipment (winches/wires, sounders, coring, sampling, container labs, drilling rig etc.) are shorter than that of the ship and differ from one piece of equipment to another.

These different life cycles make the evaluation of the maintenance costs of the scientific equipment challenging. To tackle this problem maintenance costs are estimated as a permanent amount equivalent to a percentage of the initial investment cost of the scientific equipment. This percentage would need to be sufficient and allow the creation of a contingency plan covering the replacement of some of the equipment without further additional investment.

Exchanges between the experts showed that a similar approach is used in many countries, but that the percentages varied from one country to another.

In the Netherlands, for instance, the Royal Netherlands Institute for Sea Research (NIOZ) uses a rate of 14% (Marieke Rietveld, Personal Communication) whereas in Norway a percentage of 8% (Per Wilhelm Nieuwejaar, Personal Communication) is applied. The difference between the various percentages considered depends on many variables, the main ones being: the sophistication of the equipment considered, the intensity of the usage of the equipment (is the equipment used on other vessels?), the area of operation, the frequency and level of maintenance. Such criteria are difficult to assess in advance but the members of the FAP agreed on a percentage of 10% of the initial investment cost for the scientific equipment, as a reliable estimate. In the case of the *Aurora Borealis*, 10% of the investment cost represents €4 875 000.

➔ Maintenance of scientific equipment: 4 875 000 € per year

3.5 Helicopter costs

The helicopter costs are directly linked with the ship's mission profile, which at the moment is not completely defined. However, the versatile and multitasking design of the *Aurora Borealis* allows the performance of various scientific activities which will need different types of helicopters to support those activities.

Helicopters are needed to carry out principal research and operational support tasks such as:

- Ice monitoring and reconnaissance in pack ice fields during drilling missions
- Air sampling or remote sensing campaigns when equipped with instrumentation
- Transfer of small scientific parties to the ice
- Long flights over open sea to/from shore (casualty transfer, replacement of crew, transfer of spare parts)
- Re-supply from coastal stations by sling loads.

These different tasks requiring different types of helicopters and the management of the airborne equipment available on the ship should be as flexible as possible. The solution recommended by the experts of the FAP is to lease the equipment which would allow a choice of the exact type of helicopters needed for specific expeditions, keeping in mind that all the expeditions do not require helicopters.

Leasing the helicopters would also be more cost effective as the ship owners will neither have to hire a flight crew and maintenance personnel experienced in polar operations all year round, nor handle the logistics needed for the helicopter maintenance (hangars, tool and repair shops at a home base).

The estimate for the helicopter costs has been reached thanks to the contribution of the PNRA (Programma Nazianale Ricerche in Antartide) and the AWI; both institutes being used to chartering helicopters for their operations in Polar Regions, either in the operation of a permanent base in the Antarctic or with the *Polarstern* for the AWI.

Based on these experiences the total cost considered for the chartering of helicopters over a full year including pilots, mechanics and fuel is considered to be around €2 000 000.

➔ Helicopter costs: 2 000 000 € per year

General comments on scientific support and science services

The data presented in **Annex 3.6a** 'Scenarios for the managing entity' cover the personnel needed for the management and operation of the *Aurora Borealis*. In addition to this category a certain number of workforces will be needed for:

- The operation and maintenance of scientific equipment and tools on board. (see also section 3.2.1.2 'Drilling crew'
- The onshore repairs, calibration and testing of equipment including technical user support
- The data and sample curation, management and storage

The number of staff needed for each of these categories varies significantly and depends on the type of scientific activities performed as well as the governance and organisational frameworks of the implementation consortium. An overview of the potentially different categories is given Table 12 for illustration, based on the example of the Marine Research Facility (MRF, courtesy of Marieke Rietveld).

Potential collaborations with other institutes and research programmes also influence these figures. For example, if the drilling expeditions are performed under the IODP framework, the necessary technical and operational support needed could be determined, contracted and provided by the IODP itself. The operational cost of the ship would in this particular case not be influenced.

Table 12. Potential different categories of personnel needed

Technical support	
Head/interface PS	1
Tech. prep equipment/logistics/transports/	6
Electronics	5
Calibration e.o. specialists	3
Data management	2
Web maintenance	1
Communication hardware/software	1
Analytical support	3
Total	**22**

The current scenario for the managing entity presented in the deliverable 4.1 does not include scientific support staff. This topic is subject to analysis and recommendations to the stakeholders in the work packages 2 and 5. Task 2.2 'Provision of essential services related to a dedicated polar research icebreaker' shall determine the level of scientific support needed. Task 5.2 'Definition of the functions, staffing, intellectual property and structural divisions of the ERICON Managing Agency' shall define whether their related costs should be incorporated into the overall running cost of the vessel or not.

The outcome of these two tasks will be incorporated in work package 4 at a later stage and presented in the business planning document.

Table 13. Cost for the managing entity in Euros

***Aurora Borealis* management entity** German example	**Number**	**Monthly gross salary in €**	**Total per category in €**
Lead Manager	1	7000	7000
Coordinator Logistics	1	5000	5000
Coordinator Science Services and Technical Systems	1	5000	5000
Medical and logistical expert	0.5	5000	2500
Administrative assistants, including travel support coordination	2	3500	7000
Manager port material repository	1	4000	4000
Administrative support freight and dangerous goods transports	0.5	3500	1750
Administrative Assistant Customs declarations and transport	0.5	3500	1750
Head Inspector	1	7000	7000
Nautical Inspector	1	5000	5000
Technical Inspector	1	5000	5000
Inspector Electronic/Electrical systems	1	5000	5000
Administrative support	1	3000	3000
Total	**12.5**	Total per month (gross)	**59 000**
		Total per year (gross)	**708 000**
	Total year including employer's costs*		**991 200**

* 40% employer's costs based on German example of onshore personnel

3.6 Managing entity

The managing entity is the onshore organisation in charge of the technical management and operation of the ship. Its scope of work includes hiring the crew, issuing contracts for regular service and maintenance intervals of the ship and all other administrative procedures. This entity can either be dedicated to the *Aurora Borealis* or integrated into an already existing institution.

A feedback on this issue was received from the experts of the Netherlands, Germany, Italy, Norway and France. The information focused on the number/category of personnel used for the management of existing research vessels, taking into consideration that these entities already exist and also deal with several other vessels. As the *Aurora Borealis* may benefit from a dedicated managing entity, some of the experts also developed such a scenario. The results of this study are developed in the table available in Annex 3.6a.

The experts highlighted that the integration of the *Aurora Borealis* into an existing structure will be more interesting from an economical point of view as the salaries of some of the staff could be shared with the other users of the managing entity. The decision to use one model or the other should be weighed up against the outcomes of the work package 5 on Governance.

3.6.1 Personnel cost for the managing entity

The personnel cost for the onshore management staff was calculated based on the German example of a dedicated entity for the *Aurora Borealis* using two existing cost frameworks:

- For scientific-technical and administrative staff the German collective labour agreement for public service employees: Tarifvertrag Länder TV-L (available in Annex)
- For nautical-technical staff, existing salary levels in the shipping industry

3.6.1.1 Tarifvertrag Länder TV-L cost framework

Salaries are based on the level of assigned responsibilities and the level of professional experience (in years). Similar classifications for management staff were chosen by comparing the structure of the AWI Logistics and Platform Operations Department.

- Senior management (e.g. Logistic and Technical Managers); TV-L groups 14 and 15
- Logistical and technical support staff : TV-L groups 11-13,
- Administrative and office support staff: TV-L groups 8-10, in line with German Federal workplace regulations.

N.B.: All senior onshore management staff shall have a minimum level of ten years' relevant professional experience. For other staff, the mandatory minimum professional experience of five or more years shall be sufficient.

3.6.1.2 Shipping industry cost framework

The nautical technical inspection personnel are employed by a private shipping company at the AWI Operations Division. For this category of personnel the minimum professional requirements are certification as nautical or technical senior officers (Master Mariner, Master Marine Engineer) and a minimum of ten years' relevant professional experience as these inspectors serve as direct onshore supervisors of the master and officers of the vessels. Their salary levels thus slightly surpass salary levels for offshore senior officers.

The breakdown of the different staff categories and their corresponding salaries are summarised in Table 13.

Annex 3.6a Scenarios for the managing entity
Annex 3.6b German collective labour agreements for public service employees (Tarifvertrag Länder TV-L)

→ Managing entity: 991 200 € per year

3.7 Other costs

As presented in section 2.2 'Calculation methodology' the remaining cost items of the operational budget of the ship represent altogether around 10% of the running cost. These elements include (non-exhaustive list):

- Inspection on shore
- Crew change (accommodation and flights)
- Insurance
- Harbour costs
- Cost of communication
- Transport costs

Each of these items, even if of importance from a logistical point of view, represents only a fraction of the overall budget. The experts from the FAP agreed that in the case of the *Aurora Borealis*, taking into consideration the information available at the moment, an assessment of each of the 'other cost items' is impossible and a global estimate was recommended. A global estimate of the 'other costs' according to the total of the six main items has been agreed and represents 1/9 of their sum.

→ Other costs : 3 955 492 € per year

3.8 Cost synthesis

Following the analysis of the different cost items an overview of the overall running cost for the *Aurora Borealis* is summarised in Table 14.

The figures in Table 14 represent a snapshot of a possible scenario based on multiple criteria. The evolution of the economic environment and/or decisions from the stakeholders would result in a variation of the total running cost.

→ **Total running cost: 39 554 922 € per year**

Table 14. *Aurora Borealis* cost synthesis

Category	€
Fuel cost	16 811 340
Ship's crew	5 474 814
Drilling crew	1 497 076
Maintenance of the ship	3 950 000
Maintenance of scientific equipment	4 875 000
Helicopter cost	2 000 000
Managing entity	991 200
Other expenses	3 955 492
Total running cost	**39 554 922**

4. Cost escalation

The cost escalation is the assessment of the possible evolution of the running cost with time and is aimed at providing the stakeholders with a long-term perspective of financing needs.

Each component of the running cost fluctuates more or less independently according to different parameters such as the economic environment (price of fuel) or the lifetime of the ship (maintenance of the ship). On the other hand some components such as the crew, the managing entity, the helicopters and the other costs are commonly influenced by general inflation.

Limit of cost escalation

The cost escalation exercise focuses on the first 15 years of the lifetime of the ship. After these 15 years a mid-life refurbishment would be needed to extend the lifetime of the ship for another 15 years (see section 4.3 'Maintenance of the ship'). This document does not address this midlife refurbishment as it is impossible to foresee the level of investment needed.

It should however be clear that, depending on the state of the ship, an investment in the range of a hundred million Euros may be required. The decision to carry out this midlife refurbishment is therefore very important, and the negotiations leading to it will be different from those leading to the annual funding of the operations of the vessel.

4.1 Inflation

General financial inflation impacts directly on most of the items in the running cost and has a significant impact on their increase. The study of inflation has been performed according to the variation of the Harmonized Indices of Consumer Prices (HICPs) for the European Union and is summarised in Figure 10. The data are coming from Eurostat[25], the statistics office of the European Union.

Even though the average inflation in the EU over the past 12 years has been around 2%, a conservative approach should prevail in this cost escalation exercise and an inflation rate of 2.2% considered.

4.2 Foreign exchange risk: Euro vs. US dollar

The fuel cost estimate developed in this document is based on forecasts of the price of crude oil. This price is mentioned in US dollars per barrel thus integrating a possible exchange risk if the exchange rate at the time of implementation differs significantly from the one used in this document. However, it should be stressed that this risk can be a loss or a benefit depending on the fluctuation.

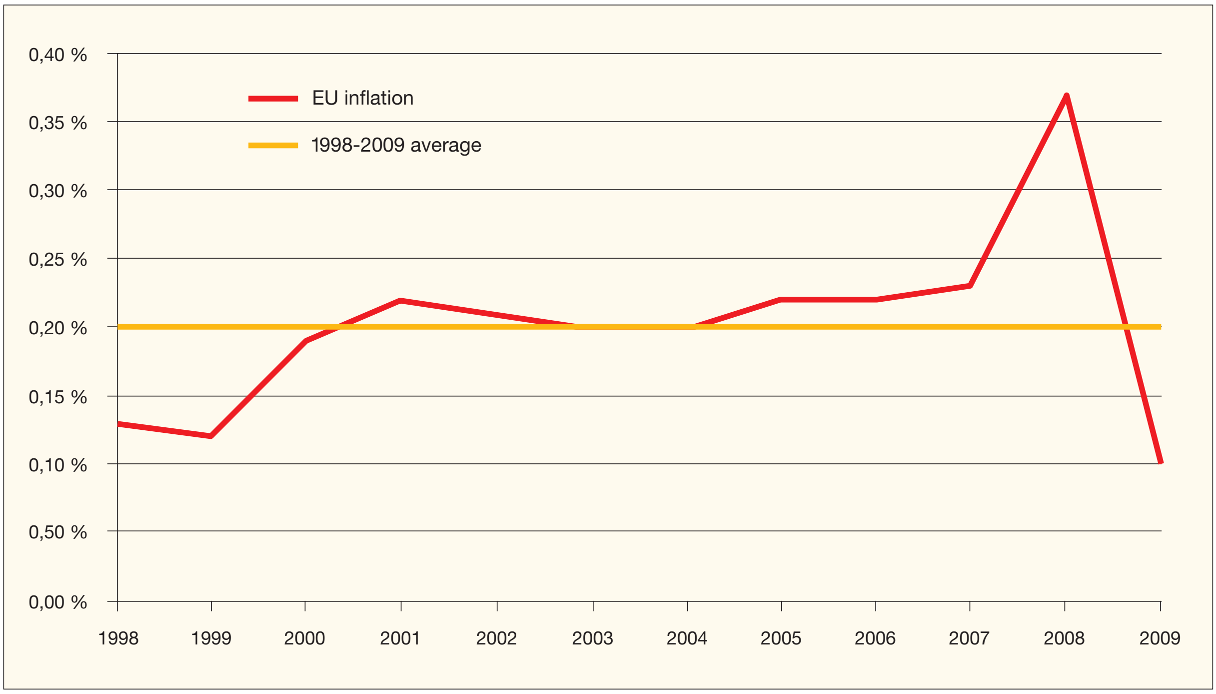


Figure 10. Evolution of the Harmonized Indices of Consumer Prices (HICPs) in the European Union 1998-2009 (included). Source: Eurostat.

4. Cost escalation

Figure 11. Evolution of the US dollar vs. Euro, over a five-year period Sept. 2005-Sept 2010. Source: Yahoo finance.

The exchange rate used in the document between the US dollar and the Euro is 0.78 which means that for US$1 you would get €0.78. This rate is higher than the average rate over the past five years (see Figure 11) and is in line with the current economic situation.

For the purpose of the cost escalation exercise the exchange rate will be regarded as remaining stable over the considered period because trying to estimate the true variation of the rate over the next 15 years is too complex.

4.3 Maintenance of the ship

The evolution of the ship's maintenance cost has been performed through the feedback of experience from other European research vessels and research icebreakers in particular (Per Wilhelm Nieuwejaar, Marieke Rietveld and Eberhard Wagner, Personal Communication). The result of the discussions with the experts is summarised in Figure 12.

The evolution of the maintenance cost of the ship is presented as an index fluctuating with time. The base of this index; index = 1 is equivalent to €3 950 000 and represents the normal maintenance costs occurring between year 5 and 10 as presented in section 3.3 'Maintenance of the ship'.

Figure 12 covers a period of 20 years and has five different phases:

- Phase 1: Low cost as most of the maintenance costs are covered under the shipyard's warranty (default of fabrication, adjustments etc.).
- Phase 2: Extra maintenance costs related to the implementation of modifications which have not been planned in the design phase.
- Phase 3: All adjustments have been implemented, resulting in the reduction of the maintenance cost to their 'normal' level.
- Phase 4: Exponential increase of maintenance cost as most of the equipment starts to deteriorate raising the need to operate a partial or full refurbishment of the ship. Phase 4 can start between year 10 and 15 of her operation depending on the quality of the construction of the ship and the maintenance performed.
- Phase 5: Partial or full refurbishment of the ship bringing the maintenance cost back to their 'normal' level.

Midlife refurbishment

The midlife refurbishment taking place at the end of phase 4 is crucial as without it the vessel with rapidly deteriorate over the years. This operation needs some strong financing to be conducted correctly and could be partly anticipated through the integration of a contingency plan for the maintenance cost of the ship. However, the decision to do so is outside the scope of this document which is focusing only on the running costs of the vessel, but will be addressed in the business plan which will be looking at the full life cycle of the vessel.

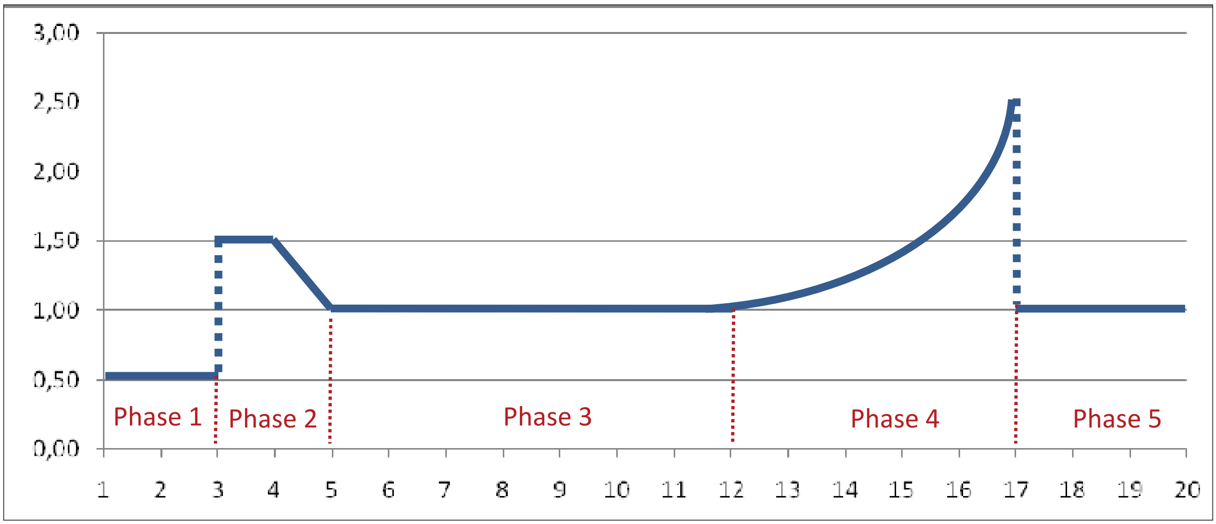


Figure 12. Evolution of maintenance cost index with time.

4.4 Maintenance of scientific equipment

The maintenance costs of the scientific equipment can be considered stable over the life cycle of the ship as the impact of inflation has already been incorporated into the 10% of investment costs considered for the maintenance of scientific equipment.

4.5 Fuel costs

As already mentioned, the evolution of the fuel costs and the price of fuel in particular is really difficult to assess as no real model exist to foresee future fluctuations. This uncertainty, which is already high for a short-term forecast, increases with time and trying to estimate the future price of crude oil (as well as HFO and MDO) up to 2030 is unrealistic.

Therefore due to its weight in the overall running cost and the uncertainty around its evolution, the cost of the fuel will be regarded as following only general inflation. This would facilitate the assessment of its influence on the evolution of the other running costs of the *Aurora Borealis*. Without this measure, any fluctuation in the cost of the fuel would inhibit the impact of the other costs.

In the light of all the information presented above, a cost simulation model has been created to support decision makers (see Table 15).

4. Cost escalation

Table 15. Evolution of *Aurora Borealis* running costs, 15 years perspective.

Evolution of AURORA BOREALIS running costs, 15 years perspective

Category	Sub Category	Year 1	Year2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
Fuel	HFO	5 623 800 €	5 747 524 €	5 873 969 €	6 003 196 €	6 135 267 €	6 270 243 €	6 408 188 €	6 549 168 €
	MDO	11 187 540 €	11 433 666 €	11 685 207 €	11 942 281 €	12 205 011 €	12 473 522 €	12 747 939 €	13 028 394 €
Crew	non drilling	5 474 814 €	5 595 260 €	5 718 356 €	5 844 159 €	5 972 731 €	6 104 131 €	6 238 422 €	6 375 667 €
	drilling	1 497 076 €	1 530 012 €	1 563 672 €	1 598 073 €	1 633 230 €	1 669 161 €	1 705 883 €	1 743 412 €
Maintenance of the ship (based on EW work)	Engines	1 000 000 €	1 000 000 €	3 000 000 €	3 000 000 €	2 000 000 €	2 000 000 €	2 000 000 €	2 000 000 €
	Deck and Hull	975 000 €	975 000 €	2 925 000 €	2 925 000 €	1 950 000 €	1 950 000 €	1 950 000 €	1 950 000 €
Maintenance scientific equipment	Scientific equipment	4 875 000 €	4 875 000 €	4 875 000 €	4 875 000 €	4 875 000 €	4 875 000 €	4 875 000 €	4 875 000 €
Helicopter cost (incl. Personnel)		2 000 000 €	2 044 000 €	2 088 968 €	2 134 925 €	2 181 894 €	2 229 895 €	2 278 953 €	2 329 090 €
Managing entity		991 200 €	1 013 006 €	1 035 293 €	1 058 069 €	1 081 346 €	1 105 136 €	1 129 449 €	1 154 297 €
Other expenses related to ship operation		3 736 048 €	3 801 496 €	4 307 274 €	4 375 634 €	4 226 053 €	4 297 454 €	4 370 426 €	4 445 003 €
Total Running Cost		**37 360 478 €**	**38 014 964 €**	**43 072 737 €**	**43 756 338 €**	**42 260 533 €**	**42 974 542 €**	**43 704 260 €**	**44 450 031 €**

Category	Sub Category	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
Fuel	HFO	6 693 250 €	6 840 501 €	6 990 992 €	7 144 794 €	7 301 980 €	7 462 623 €	7 626 801 €
	MDO	13 315 018 €	13 607 949 €	13 907 324 €	14 213 285 €	14 525 977 €	14 845 548 €	15 172 151 €
Crew	non drilling	6 515 932 €	6 659 282 €	6 805 787 €	6 955 514 €	7 108 535 €	7 264 923 €	7 424 751 €
	drilling	1 781 767 €	1 820 966 €	1 861 028 €	1 901 970 €	1 943 814 €	1 986 577 €	2 030 282 €
Maintenance of the ship	Engines	2 000 000 €	2 000 000 €	2 000 000 €	2 000 000 €	2 300 000 €	2 500 000 €	2 900 000 €
	Deck and Hull	1 950 000 €	1 950 000 €	1 950 000 €	1 950 000 €	2 242 500 €	2 437 500 €	2 827 500 €
Maintenance scientific equipment	Scientific equipment	4 875 000 €	4 875 000 €	4 875 000 €	4 875 000 €	4 875 000 €	4 875 000 €	4 875 000 €
Helicopter cost (incl. Personnel & Kerozene)		2 380 330 €	2 432 697 €	2 486 217 €	2 540 913 €	2 596 813 €	2 653 943 €	2 712 330 €
Managing entity		1 179 692 €	1 205 645 €	1 232 169 €	1 259 277 €	1 286 981 €	1 315 294 €	1 344 231 €
Other expenses related to ship operation		4 521 221 €	4 599 116 €	4 678 724 €	4 760 084 €	4 909 067 €	5 037 934 €	5 212 561 €
	Total Running Cos	**45 212 210 €**	**45 991 156 €**	**46 787 239 €**	**47 600 837 €**	**49 090 666 €**	**50 379 344 €**	**52 125 606 €**

Assumptions

Convertion $/€	0,78
Price HFO in $	515
Price MDO in $	683
fuel conspt	35 000
Ratio HFO/MDO	40%
General inflation	2,2%

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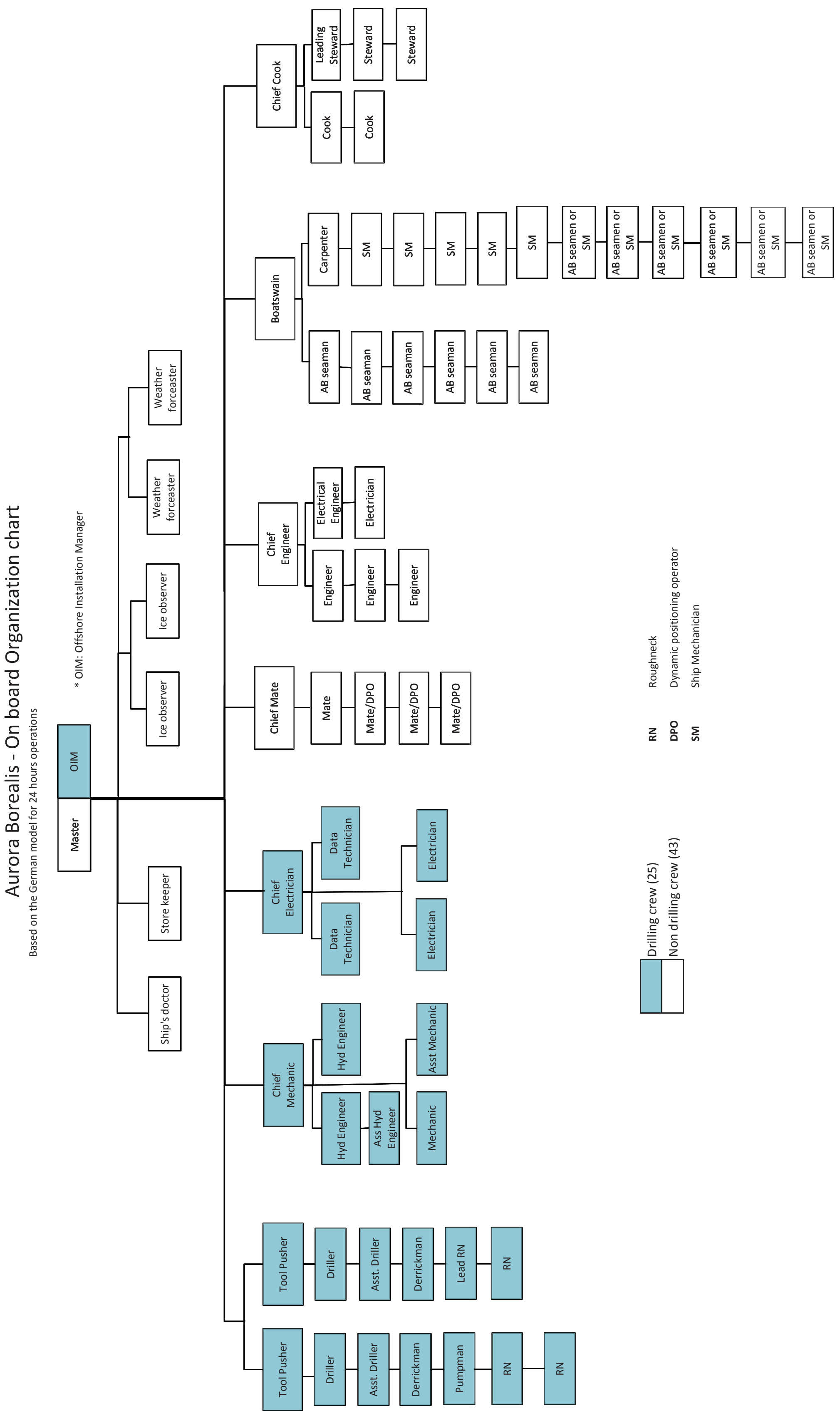
Table of Annexes

The annexes available online can be accessed at the following link: http://www.esf.org/index.php?id=7578

Annex 2.2

Group	Term	Planning cost	currency	Budget	Remarks
					page 1
A	**Personnel costs**				
1	Crew **A**, 35 + weather forecaster + ice observer		€		Crew change 1 : 1/ Helicopter crew not included
2	Crew **B**, 35 + weather forecaster + ice observer		€		Crew change 1 : 1/ Helicopter crew not included
3	Scientific specialcally staff		€		Mostly electronic engineers
4	Drilling crew, 25 people		€		**only on drilling voyage** / average 3 months
5	Cost for crew change/ hotels + flights etc.		€		only for ships crew of Aurora Borealis
6	Total costs for storehouse in the home port		€		Incidental expenses in the home port of **AB**
7	Forward logistic		€		
8	Doctor		€		
9	Cost for communication - ship - shore		€		betw. inspection office and AURORA BOREALIS
10	Science management		€		
B	**Ship's costs**				
11	Permit for access		€		
12	Harbour cost		€		loading and off-loading, tugs, freshwater etc.
13	Agent cost		€		in all habours
14	Insurance cost		€		Insurance for anti collision and for total crew
15	Costs for repair and maintenance deck		€		Costs for all work on deck, excluding nr. 29 to 33
16	Costs for repair and maintenance engine		€		
17	costs for equipment and spare parts deck		€		for example sea charts, ropes, paint etc.
18	costs for equipment and spare parts engine		€		primary spare parts f. engines, seals, valves, etc.
19	equipment/consumption goods		€		cleaner, bedclothes
20	Provisions / Catering		€		total for scientist and full crew
21	Heavy fuel		€		for engines
22	Marine diesel oil		€		for engines
23	Arctic diesel		€		emergency generator and scientific work on ice
24	Kerosene		€		for helicopters
25	Lubrication oil		€		all lubricating oils according to lubrication plan
26	Additional chemicals and grease		€		grease, chemicals
	Running cost of AURORA BOREALIS				page 2
B	**Ship's costs**				
27	Dry-docking in the shipyard		€		1 x per year
28	Transport costs for equipment, spare parts		e		only for ships operation
29	Transport costs for scientific equipment		€		only for research work
30	Transport costs for drilling equipment		€		only for drilling operation
C	**Costs for research work**				
31	Costs f. repair a. maintenance scientific equipm.(incuding IT)		€		installed onboard
32	Costs f. repair a. maintenance scientific equipm.		€		mobile equipment, ship owned
33	Repair and maintenance drilling rigg		€		installed onboard
34	Cost f. repair a.maintenance of research winches		€		only f. winches f. research work, installed, mobile
35	Costs f. installation scientif. equipment on-board		€		for example - ROV adaptation
36	Cost for cable and wire		€		only for winches for research work
37	Costs for scientific material and equipment		€		weather ballons etc.
38	Scientific consumption material		€		for example - all kind of gases for research work
39	Cost for scientists change		€		included costs for hotel and flight
40	Cost for communication of the scientists		€		only for scientific operation
41	Special cost		€		for example - cost f. pass the Northern Sea Route
D	**Helicopter cost**				
42	Total cost for the charter contract for helicopters		€		Including crew, excluding kerosine
E	**Management costs and charge for ships operator**				
43	Cost for inspection on shore		€		Personnel costs of the ships operator
44	Cost for inspection office		€		Incidental expenses in the home port of **AB**
45	Management costs		€		
46	Charge for ships operator		€		
F	**Additional costs**				
47	Logging cost		€		
48	Ice monitoring		€		
49	Sat com		€		
50	Wer house		€		
51	Transport		€		
52	Weather forecast		€		
53	Waste management		€		
54	Medicine		€		
55	Training costs		€		
	Total sum:				

Annex 3.2.1



Aurora Borealis - On board Organization chart
Based on the German model for 24 hours operations
* OIM: Offshore Installation Manager
Master
OIM
Ship's doctor
Store keeper
Ice observer
Ice observer
Weather forceaster
Weather forceaster
Tool Pusher
Driller
Asst. Driller
Derrickman
Pumpman
RN
RN
Tool Pusher
Driller
Asst. Driller
Derrickman
Lead RN
RN
Chief Mechanic
Hyd Engineer
Ass Hyd Engineer
Hyd Engineer
Mechanic
Asst Mechanic
Chief Electrician
Data Technician
Data Technician
Electrician
Electrician
Chief Mate
Mate
Mate/DPO
Mate/DPO
Mate/DPO
Chief Engineer
Engineer
Engineer
Engineer
Electrical Engineer
Electrician
Boatswain
AB seaman
AB seaman
AB seaman
AB seaman
AB seaman
AB seaman
Carpenter
SM
SM
SM
SM
SM
AB seamen or SM
AB seamen or SM
AB seamen or SM
AB seamen or SM
AB seamen or SM
AB seamen or SM
Chief Cook
Cook
Cook
Leading Steward
Steward
Steward
Drilling crew (25)
Non drilling crew (43)
RN Roughneck
DPO Dynamic positioning operator
SM Ship Mechanician

Annex 3.2.1.1

Scenarios for AB ship's crew

Ships crew		Germany	Norway	Italy	France	The Netherlands
Captain		1	1	1	1	1
Chief mate	off watch/ responsible f. research work	1	1	1	1	1
2. Mate	off watch/ responsible f. research work	1	1	1	1	1
2. Mate	watch officer	1	1	1	1	1
2. Mate	watch officer	1	1	1	1	1
2. Mate	watch officer	1	N/A	N/A	N/A	N/A
Nautical Officers		6	5	5	5	5
Chief engineer	off watch	1	1	1	1	1
1.Engineer	watch engineer	1	1	1	1	1
2.Engineer	like 2. mate / watch engineer	1	1	1	1	1
3.Engineer	like 2. mate / watch engineer	1	1	1	1	1
Electrical engineer	like first engineer	1	1	1	1	1
Technical Officers		5	5	5	5	5
Ship's doctor	like chief mate	1	1	1	1	1
Boatswain		1	1	1	1	1
Carpenter	like boatswain	1	1	1	N/A	1
Storekeeper	like boatswain	1	1	1	1	1
Electrician	like storekeeper	1	1	1	1	1
Specific Positions		5	5	5	4	5
A.B. seaman	with min. 5 year experience	1	1	1	1	1
A.B. seaman	with min. 5 year experience	1	1	1	1	1
A.B. seaman	with min. 5 year experience	1	1	1	1	1
A.B. seaman	with min. 5 year experience	1	1	1	1	1
A.B. seaman	with min. 5 year experience	1	1	1	1	1
A.B. seaman	with min. 5 year experience	1	1	1	1	1
All A.B. seaman		6	6	6	6	6
A.B. seaman or ships mechanician	with min. 5 year experience	1	1	1	1	1
A.B. seaman or ships mechanician	with min. 3-4 year experience	1	1	1	1	1
A.B. seaman or ships mechanician	with min. 3-4 year experience	1	1	1	1	1
A.B. seaman or ships mechanician	with min. 3-4 year experience	1	1	1	N/A	1
A.B. seaman or ships mechanician	with min. 1-2 year experience	1	N/A	N/A	N/A	N/A
A.B. seaman or ships mechanician	with min. 1-2 year experience	1	N/A	N/A	N/A	N/A
All A.B. seaman or ships mechanician		6	4	4	3	4
Ships mechanician	with min. 5 year experience	1	1	1	1	1
Ships mechanician	with min. 5 year experience	1	1	1	1	1
Ships mechanician	with min. 5 year experience	1	1	1	1	1
Ships mechanician	with min. 5 year experience	1	N/A	N/A	1	N/A
Ships mechanician	with min. 5 year experience	1	N/A	N/A	1	N/A
All ship mechanician		5	3	3	5	3
Chief cook	like boatswain + storekeeper	1	1	1	1	1
2. Cook	like ships mech.1-2 year exp.	1	1	1	1	1
2. Cook	like ships mech.1-2 year exp.	1	1	1	1	1
Leading steward	like 2. cook	1	1	1	1	1
Steward's staff	like seaman/ 3. to 4. year	1	1	1	1	1
Steward's staff	like seaman/ 3. to 4. year	1	1	1	1	1
Catering and service staff		6	6	6	6	6
Weather forceaster	like chief mate	1	1	1	1	1
Weather forceaster	like chief mate	1	1	1	N/A	1
Ice observer	like chief mate	1	1	1	1	1
Ice observer	like chief mate	1	1	1	N/A	1
Scientific support for icebreaker operation		4	4	4	2	4
Total number of crew		**43**	**38**	**38**	**36**	**38**

Annex 3.2.2.1

Crew payroll High scenario: 43 crew members

Number	Ships crew	Remarks	German salaries Gross (€)	German Employer's cost (€) 45%	Norwegian sal. Gross (€)
Pay- roll for one crew *Aurora Borealis* per month					
1	Captain		**6 233**	2 805	**6 911**
1	Chief mate	off watch/ responsible f. research work	**5 048**	2 272	**5 586**
1	2. Mate	off watch/ responsible f. research work	**4 708**	2 119	**5 074**
1	2. Mate	watch officer	**4 708**	2 119	**5 074**
1	2. Mate	watch officer	**4 708**	2 119	**5 074**
1	2. Mate	watch officer	**4 708**	2 119	**5 074**
1	Chief engineer	off watch	**5 701**	2 565	**5 839**
1	1.Engineer	watch engineer	**4 946**	2 226	**5 412**
1	2.Engineer	like 2. mate / watch engineer	**4 708**	2 119	**5 412**
1	3.Engineer	like 2. mate / watch engineer	**4 708**	2 119	**5 412**
1	Electrical engineer	like first engineer	**4 946**	2 226	**5 309**
1	Ship's doctor	like chief mate	**5 048**	2 272	**5 586**
1	Boatswain		**4 012**	1 805	**5 245**
1	Carpenter	like boatswain	**4 012**	1 805	**5 245**
1	A.B. seaman	with min. 5 year experience	**3 975**	1 789	**4 387**
1	A.B. seaman	with min. 5 year experience	**3 975**	1 789	**4 387**
1	A.B. seaman	with min. 5 year experience	**3 975**	1 789	**4 387**
1	A.B. seaman	with min. 5 year experience	**3 975**	1 789	**4 387**
1	A.B. seaman	with min. 5 year experience	**3 975**	1 789	**4 387**
1	A.B. seaman	with min. 5 year experience	**3 975**	1 789	**4 387**
1	A.B. seaman or ships mechanician	with min. 5 year experience	**3 677**	1 655	**4 387**
1	A.B. seaman or ships mechanician	with min. 3-4 year experience	**3 677**	1 655	**4 387**
1	A.B. seaman or ships mechanician	with min. 3-4 year experience	**3 677**	1 655	**4 387**
1	A.B. seaman or ships mechanician	with min. 3-4 year experience	**3 677**	1 655	**4 387**
1	A.B. seaman or ships mechanician	with min. 1-2 year experience	**3 372**	1 517	**4 387**
1	A.B. seaman or ships mechanician	with min. 1-2 year experience	**3 372**	1 517	**4 387**
1	Storekeeper	like boatswain	**4 012**	1 805	**5 245**
1	Electrician	like storekeeper	**4 012**	1 805	**5 245**
1	Ships mechanician	with min. 5 year experience	**3 975**	1 789	**4 387**
1	Ships mechanician	with min. 5 year experience	**3 975**	1 789	**4 387**
1	Ships mechanician	with min. 5 year experience	**3 975**	1 789	**4 387**
1	Ships mechanician	with min. 5 year experience	**3 975**	1 789	**4 387**
1	Ships mechanician	with min. 5 year experience	**3 975**	1 789	**4 387**
1	Chief cook	like boatswain + storekeeper	**4 012**	1 805	**5 381**
1	2. Cook	like ships mech.1-2 year exp.	**3 372**	1 517	**5 381**
1	2. Cook	like ships mech.1-2 year exp.	**3 372**	1 517	**5 381**
1	Leading steward	like 2. cook	**3 372**	1 517	**5 381**
1	Steward's staff	like seaman/ 3. to 4. year	**2 690**	1 211	**4 336**
1	Steward's staff	like seaman/ 3. to 4. year	**2 690**	1 211	**4 336**
1	Weather forceaster	like chief mate	**5 048**	2 272	**5 586**
1	Weather forceaster	like chief mate	**5 048**	2 272	**5 585**
1	Ice observer	like chief mate	**5 048**	2 272	**5 585**
1	Ice observer	like chief mate	**5 048**	2 272	**5 586**
Total: 43 crew member		**per month for one crew**			
Sum carried over to page 2:			**181 095**	81 493	**213 859**
			262 588		
Crew costs per year for **one crew**		basis: 320 sea-days	**2 173 140 €**	977 913	**2 566 313 €**
Crew costs per year for **two crews**		basis: 320 sea-days	**4 346 280 €**	1 955 826	**5 132 627 €**
Remarks:			**6 302 106 €**		

Norwegian Employer's costs private sector 20%	**Italian sal. Gross (€)**	Italian Employer's costs (€) 13 %	**French Sal. Gross (€)**	French Employer's costs (average) (€) 46%	**Dutch Sal. Gross (€)**	Dutch Employer's costs (€) 56%
1 382	**7 641**	997	**6 678**	2 741	**6 540**	3 662
1 117	**6 493**	847	**5 459**	2 551	**5 755**	3 223
1 015	**5 221**	681	**3 634**	1 581	**4 930**	2 761
1 015	**5 221**	681	**3 634**	1 581	**4 930**	2 761
1 015	**5 221**	681	**3 634**	1 581	**4 930**	2 761
1 015	**5 221**	681	**3 634**	1 581	**4 930**	2 761
1 168	**7 300**	952	**6 306**	2 847	**5 755**	3 223
1 082	**6 493**	847	**5 459**	2 551	**4 930**	2 761
1 082	**5 221**	681	**3 634**	1 581	**4 930**	2 761
1 082	**5 221**	681	**3 634**	1 581	**4 930**	2 761
1 062	**6 493**	847	**3 634**	1 581	**4 930**	2 761
1 117	**6 493**	847	**5 800**	2 624	**5 755**	3 223
1 049	**4 537**	592	**3 183**	1 421	**3 970**	2 223
1 049	**4 537**	592	**3 183**	1 421	**3 970**	2 223
877	**4 168**	544	**2 435**	1 139	**3 970**	2 223
877	**4 168**	544	**2 435**	1 139	**3 970**	2 223
877	**4 168**	544	**2 435**	1 139	**3 970**	2 223
877	**4 168**	544	**2 435**	1 139	**3 970**	2 223
877	**4 168**	544	**2 435**	1 139	**3 970**	2 223
877	**4 168**	544	**2 435**	1 139	**3 970**	2 223
877	**3 674**	479	**2 380**	1 173	**3 510**	1 966
877	**3 674**	479	**2 380**	1 173	**3 510**	1 966
877	**3 674**	479	**2 380**	1 173	**3 510**	1 966
877	**3 674**	479	**2 380**	1 173	**3 510**	1 966
877	**3 674**	479	**2 380**	1 173	**3 180**	1 781
877	**3 674**	479	**2 380**	1 173	**3 180**	1 781
1 049	**4 537**	592	**2 380**	1 173	**3 970**	2 223
1 049	**4 537**	592	**3 085**	1 407	**3 970**	2 223
877	**4 168**	544	**3 058**	1 352	**3 970**	2 223
877	**4 168**	544	**2 701**	1 222	**3 970**	2 223
877	**4 168**	544	**2 701**	1 222	**3 970**	2 223
877	**4 168**	544	**2 701**	1 222	**3 971**	2 224
877	**4 168**	544	**2 701**	1 222	**3 972**	2 224
1 076	**4 639**	605	**3 019**	1 346	**3 970**	2 223
1 076	**4 463**	582	**2 667**	1 218	**3 180**	1 781
1 076	**4 463**	582	**2 652**	1 253	**3 180**	1 781
1 076	**4 463**	582	**2 964**	1 337	**3 180**	1 781
867	**3 674**	479	**2 508**	1 193	**3 035**	1 700
867	**3 674**	479	**2 508**	1 193	**3 035**	1 700
1 117	**6 493**	847	**3 634**	1 581	**5 755**	3 223
1 117	**6 493**	847	**3 634**	1 581	**5 755**	3 223
1 117	**6 493**	847	**3 634**	1 581	**5 755**	3 223
1 117	**6 493**	847	**3 634**	1 581	**5 755**	3 223
42 772	**209 623**	27 342	**140 573**	63 774	**185 798**	104 047
	236 965		**204 347**		**289 845**	
513 263 €	**2 515 478 €**	328 106 €	**1 686 878 €**	765 286	**2 229 576 €**	1 248 563
1 026 525 €	**5 030 956 €**	656 212 €	**3 373 756 €**	1 530 572	**4 459 152 €**	2 497 125
6 159 152 €	**5 687 167 €**		**4 904 328 €**		**6 956 277 €**	
Average	**6 001 806 €**					

Annex 3.2.2.1

Crew payroll, Medium scenario: 38 crew members

Pay- roll for one crew *Aurora Borealis* per month

Number	Ships crew	Remarks	German salaries Gross (€)	German Employer's cost (€) 45%	Norwegian sal. Gross (€)
1	Captain		**6 233**	2 805	**6 911**
1	Chief mate	off watch/ responsible f. research work	**5 048**	2 272	**5 586**
1	2. Mate	off watch/ responsible f. research work	**4 708**	2 119	**5 074**
1	2. Mate	watch officer	**4 708**	2 119	**5 074**
1	2. Mate	watch officer	**4 708**	2 119	**5 074**
1	2. Mate	watch officer			
1	Chief engineer	off watch	**5 701**	2 565	**5 839**
1	1.Engineer	watch engineer	**4 946**	2 226	**5 412**
1	2.Engineer	like 2. mate / watch engineer	**4 708**	2 119	**5 412**
1	3.Engineer	like 2. mate / watch engineer	**4 708**	2 119	**5 412**
1	Electrical engineer	like first engineer	**4 946**	2 226	**5 309**
1	Ship's doctor	like chief mate	**5 048**	2 272	**5 586**
1	Boatswain		**4 012**	1 805	**5 245**
1	Carpenter	like boatswain	**4 012**	1 805	**5 245**
1	A.B. seaman	with min. 5 year experience	**3 975**	1 789	**4 387**
1	A.B. seaman	with min. 5 year experience	**3 975**	1 789	**4 387**
1	A.B. seaman	with min. 5 year experience	**3 975**	1 789	**4 387**
1	A.B. seaman	with min. 5 year experience	**3 975**	1 789	**4 387**
1	A.B. seaman	with min. 5 year experience	**3 975**	1 789	**4 387**
1	A.B. seaman	with min. 5 year experience	**3 975**	1 789	**4 387**
1	A.B. seaman or ships mechanician	with min. 5 year experience	**3 677**	1 655	**4 387**
1	A.B. seaman or ships mechanician	with min. 3-4 year experience	**3 677**	1 655	**4 387**
1	A.B. seaman or ships mechanician	with min. 3-4 year experience	**3 677**	1 655	**4 387**
1	A.B. seaman or ships mechanician	with min. 3-4 year experience	**3 677**	1 655	**4 387**
1	A.B. seaman or ships mechanician	with min. 1-2 year experience			
1	A.B. seaman or ships mechanician	with min. 1-2 year experience			
1	Storekeeper	like boatswain	**4 012**	1 805	**5 245**
1	Electrician	like storekeeper	**4 012**	1 805	**5 245**
1	Ships mechanician	with min. 5 year experience	**3 975**	1 789	**4 387**
1	Ships mechanician	with min. 5 year experience	**3 975**	1 789	**4 387**
1	Ships mechanician	with min. 5 year experience	**3 975**	1 789	**4 387**
1	Ships mechanician	with min. 5 year experience			
1	Ships mechanician	with min. 5 year experience			
1	Chief cook	like boatswain + storekeeper	**4 012**	1 805	**5 381**
1	2. Cook	like ships mech.1-2 year exp.	**3 372**	1 517	**5 381**
1	2. Cook	like ships mech.1-2 year exp.	**3 372**	1 517	**5 381**
1	Leading steward	like 2. cook	**3 372**	1 517	**5 381**
1	Steward's staff	like seaman/ 3. to 4. year	**2 690**	1 211	**4 336**
1	Steward's staff	like seaman/ 3. to 4. year	**2 690**	1 211	**4 336**
1	Weather forceaster	like chief mate	**5 048**	2 272	**5 586**
1	Weather forceaster	like chief mate	**5 048**	2 272	**5 585**
1	Ice observer	like chief mate	**5 048**	2 272	**5 585**
1	Ice observer	like chief mate	**5 048**	2 272	**5 586**
Total: 38 crew member		**per month for one crew**			
Sum carried over to page 2:			**161 693**	72 762	**191 237**
			234 455		
Crew costs per year for **one crew**		basis: 320 sea-days	**1 940 316 €**	873 142	**2 294 848 €**
Crew costs per year for **two crews**		basis: 320 sea-days	**3 880 632 €**	1 746 284	**4 589 697 €**
Remarks:			**5 626 916 €**		

Norwegian Employer's costs private sector 20%	**Italian sal. Gross (€)**	Italian Employer's costs (€) 13 %	**French Sal. Gross (€)**	French Employer's costs (average) (€) 46%	**Dutch Sal. Gross (€)**	Dutch Employer's costs (€) 56%
1 382	**7 641**	997	**6 678**	2 741	**6 540**	3 662
1 117	**6 493**	847	**5 459**	2 551	**5 755**	3 223
1 015	**5 221**	681	**3 634**	1 581	**4 930**	2 761
1 015	**5 221**	681	**3 634**	1 581	**4 930**	2 761
1 015	**5 221**	681	**3 634**	1 581	**4 930**	2 761
1 168	**7 300**	952	**6 306**	2 847	**5 755**	3 223
1 082	**6 493**	847	**5 459**	2 551	**4 930**	2 761
1 082	**5 221**	681	**3 634**	1 581	**4 930**	2 761
1 082	**5 221**	681	**3 634**	1 581	**4 930**	2 761
1 062	**6 493**	847	**3 634**	1 581	**4 930**	2 761
1 117	**6 493**	847	**5 800**	2 624	**5 755**	3 223
1 049	**4 537**	592	**3 183**	1 421	**3 970**	2 223
1 049	**4 537**	592	**3 183**	1 421	**3 970**	2 223
877	**4 168**	544	**2 435**	1 139	**3 970**	2 223
877	**4 168**	544	**2 435**	1 139	**3 970**	2 223
877	**4 168**	544	**2 435**	1 139	**3 970**	2 223
877	**4 168**	544	**2 435**	1 139	**3 970**	2 223
877	**4 168**	544	**2 435**	1 139	**3 970**	2 223
877	**4 168**	544	**2 435**	1 139	**3 970**	2 223
877	**3 674**	479	**2 380**	1 173	**3 510**	1 966
877	**3 674**	479	**2 380**	1 173	**3 510**	1 966
877	**3 674**	479	**2 380**	1 173	**3 510**	1 966
877	**3 674**	479	**2 380**	1 173	**3 510**	1 966
1 049	**4 537**	592	**2 380**	1 173	**3 970**	2 223
1 049	**4 537**	592	**3 085**	1 407	**3 970**	2 223
877	**4 168**	544	**3 058**	1 352	**3 970**	2 223
877	**4 168**	544	**2 701**	1 222	**3 970**	2 223
877	**4 168**	544	**2 701**	1 222	**3 970**	2 223
1 076	**4 639**	605	**3 019**	1 346	**3 970**	2 223
1 076	**4 463**	582	**2 667**	1 218	**3 180**	1 781
1 076	**4 463**	582	**2 652**	1 253	**3 180**	1 781
1 076	**4 463**	582	**2 964**	1 337	**3 180**	1 781
867	**3 674**	479	**2 508**	1 193	**3 035**	1 700
867	**3 674**	479	**2 508**	1 193	**3 035**	1 700
1 117	**6 493**	847	**3 634**	1 581	**5 755**	3 223
1 117	**6 493**	847	**3 634**	1 581	**5 755**	3 223
1 117	**6 493**	847	**3 634**	1 581	**5 755**	3 223
1 117	**6 493**	847	**3 634**	1 581	**5 755**	3 223
38 247	**188 718**	24 615	**126 778**	57 403	**166 565**	93 276
	213 334		**184 181**		**259 841**	
458 970 €	**2 264 621 €**	295 385 €	**1 521 336 €**	688 833	**1 998 780 €**	1 119 317
917 939 €	**4 529 243 €**	590 771 €	**3 042 672 €**	1 377 666	**3 997 560 €**	2 238 634
5 507 636 €	**5 120 014 €**		**4 420 338 €**		**6 236 194 €**	
Average	**5 382 220 €**					

Annex 3.2.2.1

Crew payroll, Medium scenario: 36 crew members

Pay- roll for one crew *Aurora Borealis* per month					
Number	**Ships crew**	**Remarks**	**German salaries Gross (€)**	German Employer's cost (€) 45%	**Norwegian sal. Gross (€)**
1	Captain		**6 233**	2 805	**6 911**
1	Chief mate	off watch/ responsible f. research work	**5 048**	2 272	**5 586**
1	2. Mate	off watch/ responsible f. research work	**4 708**	2 119	**5 074**
1	2. Mate	watch officer	**4 708**	2 119	**5 074**
1	2. Mate	watch officer	**4 708**	2 119	**5 074**
1	2. Mate	watch officer			
1	Chief engineer	off watch	**5 701**	2 565	**5 839**
1	1.Engineer	watch engineer	**4 946**	2 226	**5 412**
1	2.Engineer	like 2. mate / watch engineer	**4 708**	2 119	**5 412**
1	3.Engineer	like 2. mate / watch engineer	**4 708**	2 119	**5 412**
1	Electrical engineer	like first engineer	**4 946**	2 226	**5 309**
1	Ship's doctor	like chief mate	**5 048**	2 272	**5 586**
1	Boatswain		**4 012**	1 805	**5 245**
1	Carpenter	like boatswain			
1	A.B. seaman	with min. 5 year experience	**3 975**	1 789	**4 387**
1	A.B. seaman	with min. 5 year experience	**3 975**	1 789	**4 387**
1	A.B. seaman	with min. 5 year experience	**3 975**	1 789	**4 387**
1	A.B. seaman	with min. 5 year experience	**3 975**	1 789	**4 387**
1	A.B. seaman	with min. 5 year experience	**3 975**	1 789	**4 387**
1	A.B. seaman	with min. 5 year experience	**3 975**	1 789	**4 387**
1	A.B. seaman or ships mechanician	with min. 5 year experience	**3 677**	1 655	**4 387**
1	A.B. seaman or ships mechanician	with min. 3-4 year experience	**3 677**	1 655	**4 387**
1	A.B. seaman or ships mechanician	with min. 3-4 year experience	**3 677**	1 655	**4 387**
1	A.B. seaman or ships mechanician	with min. 3-4 year experience			
1	A.B. seaman or ships mechanician	with min. 1-2 year experience			
1	A.B. seaman or ships mechanician	with min. 1-2 year experience			
1	Storekeeper	like boatswain	**4 012**	1 805	**5 245**
1	Electrician	like storekeeper	**4 012**	1 805	**5 245**
1	Ships mechanician	with min. 5 year experience	**3 975**	1 789	**4 387**
1	Ships mechanician	with min. 5 year experience	**3 975**	1 789	**4 387**
1	Ships mechanician	with min. 5 year experience	**3 975**	1 789	**4 387**
1	Ships mechanician	with min. 5 year experience	**3 975**	1 789	**4 387**
1	Ships mechanician	with min. 5 year experience	**3 975**	1 789	**4 387**
1	Chief cook	like boatswain + storekeeper	**4 012**	1 805	**5 381**
1	2. Cook	like ships mech.1-2 year exp.	**3 372**	1 517	**5 381**
1	2. Cook	like ships mech.1-2 year exp.	**3 372**	1 517	**5 381**
1	Leading steward	like 2. cook	**3 372**	1 517	**5 381**
1	Steward's staff	like seaman/ 3. to 4. year	**2 690**	1 211	**4 336**
1	Steward's staff	like seaman/ 3. to 4. year	**2 690**	1 211	**4 336**
1	Weather forceaster	like chief mate	**5 048**	2 272	**5 586**
1	Weather forceaster	like chief mate			
1	Ice observer	like chief mate	**5 048**	2 272	**5 585**
1	Ice observer	like chief mate			
Total: 36 crew member		**per month for one crew**			
Sum carried over to page 2:			**151 858**	68 336	**179 208**
Crew costs per year for **one crew**		basis: 320 sea-days	**1 822 296**	820 033	**2 150 495**
Crew costs per year for **two crews**		basis: 320 sea-days	**3 644 592**	1 640 066	**4 300 990**
Remarks:			**5 284 658 €**		

Norwegian Employer's costs private sector 20%	**Italian sal. Gross (€)**	Italian Employer's costs (€) 13 %	**French Sal. Gross (€)**	French Employer's costs (average) (€) 46%	**Dutch Sal. Gross (€)**	Dutch Employer's costs (€) 56%
1 382	**7 641**	997	**6 678**	2 741	**6 540**	3 662
1 117	**6 493**	847	**5 459**	2 551	**5 755**	3 223
1 015	**5 221**	681	**3 634**	1 581	**4 930**	2 761
1 015	**5 221**	681	**3 634**	1 581	**4 930**	2 761
1 015	**5 221**	681	**3 634**	1 581	**4 930**	2 761
1 168	**7 300**	952	**6 306**	2 847	**5 755**	3 223
1 082	**6 493**	847	**5 459**	2 551	**4 930**	2 761
1 082	**5 221**	681	**3 634**	1 581	**4 930**	2 761
1 082	**5 221**	681	**3 634**	1 581	**4 930**	2 761
1 062	**6 493**	847	**3 634**	1 581	**4 930**	2 761
1 117	**6 493**	847	**5 800**	2 624	**5 755**	3 223
1 049	**4 537**	592	**3 183**	1 421	**3 970**	2 223
877	**4 168**	544	**2 435**	1 139	**3 970**	2 223
877	**4 168**	544	**2 435**	1 139	**3 970**	2 223
877	**4 168**	544	**2 435**	1 139	**3 970**	2 223
877	**4 168**	544	**2 435**	1 139	**3 970**	2 223
877	**4 168**	544	**2 435**	1 139	**3 970**	2 223
877	**4 168**	544	**2 435**	1 139	**3 970**	2 223
877	**3 674**	479	**2 380**	1 173	**3 510**	1 966
877	**3 674**	479	**2 380**	1 173	**3 510**	1 966
877	**3 674**	479	**2 380**	1 173	**3 510**	1 966
1 049	**4 537**	592	**2 380**	1 173	**3 970**	2 223
1 049	**4 537**	592	**3 085**	1 407	**3 970**	2 223
877	**4 168**	544	**3 058**	1 352	**3 970**	2 223
877	**4 168**	544	**2 701**	1 222	**3 970**	2 223
877	**4 168**	544	**2 701**	1 222	**3 970**	2 223
877	**4 168**	544	**2 701**	1 222	**3 971**	2 224
877	**4 168**	544	**2 701**	1 222	**3 972**	2 224
1 076	**4 639**	605	**3 019**	1 346	**3 970**	2 223
1 076	**4 463**	582	**2 667**	1 218	**3 180**	1 781
1 076	**4 463**	582	**2 652**	1 253	**3 180**	1 781
1 076	**4 463**	582	**2 964**	1 337	**3 180**	1 781
867	**3 674**	479	**2 508**	1 193	**3 035**	1 700
867	**3 674**	479	**2 508**	1 193	**3 035**	1 700
1 117	**6 493**	847	**3 634**	1 581	**5 755**	3 223
1 117	**6 493**	847	**3 634**	1 581	**5 755**	3 223
35 842	**175 857**	22 938	**119 350**	54 091	**155 518**	87 090
430 099	**2 110 282**	275 254	**1 432 195**	649 092	**1 866 216**	1 045 081
860 198	**4 220 564**	550 508	**2 864 390**	1 298 184	**3 732 432**	2 090 162
5 161 188 €	**4 771 073 €**		**4 162 574 €**		**5 822 594 €**	
Average	**5 040 417 €**					

Annex 3.2.2.2

Cost estimate for drilling crew

EUROPEAN PERONNEL ; BASED ON A 90 DAYS ROTATION (FOUR DAYS PAID PER ROTATION

	GBP	Euros	Number needed	Total Euros for number considered
Offshore Installation manager		677	1	677
Tool pusher	550	660	2	1 320
Driller	450	540	2	1 080
Assistant driller	325	390	2	780
Derrickman	275	330	2	660
Pumpman	275	330	1	330
Lead roughneck	275	330	1	330
Roughneck	224	269	3	806
	USD	Euros		Euros
Chief Electrician	810	632	1	632
Data technician	658	513	2	1 026
Electrician	658	513	2	1 026
Chief Mechanic	658	513	1	513
Hydraulique Engineer	778	607	2	1 214
Ass. Hydraulique Engineer	595	464	1	464
Mechanic	443	345	1	345
Ass. Mechanic	220	172	1	172
	total gross salary for full crew per day			11 376

gross salary drilling crew for 90 days mission	1 069 340
total cost drilling crew for 90 days mission	**1 497 076 €**

Assumptions

Number of days paid: 1 year	195.5
Paid working days	94
£ to €	1.2
US to €	0.78
Average employer's cost depending on contracting country	40%

Annex 3.6a

Managing Entity

National examples

France – Genavir	Number
Fleet manager	0.25
Operations officer	0.5
Designated person ashore (ISM, ISPS and QA)	0.25
Crew manager	0.5
Technical manager	3
Section Head Electronical instruments	1
Electronic technician	2
Logistics support	2
Administrative office	2
	11.5

Norway – IMR RV department	Number
Fleet manager	1
Section Head Ship operations	1
Crew manager	1
Technical manager	1
Accountant	1
Operations officer	1
Logistics support	1
Section Head Electronical instruments	1
Instrument maintenance and calibration	5
	13

Italy – CNR-Urania	Number
Fleet manager	1
Designated person ashore	1
Crew manager	1
Technical manager	1
ISPS (International Ship and Port Facilities Security)	1
Quality manager	1
Technician for scientific equipment	1
Electronic technician	5
Administrative office	3
	15

Germany – AWI logistic dept	Number
Manager logistics	1
Deputy manager logistics	1
Coordinator scientific technical operations	1
Coordinator Logistics research vessels	1
Medical and logistical expert (not only for PS)	1
Logistical and scientific coordinator Planes and Helico	1
Administrative assistants, including travel support coo	2
Manager port material repository	1
Logistic/technical coordinator (not only for PS)	1
Logistical coordinator land expeditions Antarktica via	1
administrative support freight and dangerous goods tr	1
Administrative Assistant Customs declarations and tra	1
Plus scientific coordinator PS	1
	14

Netherlands Marine Research Facility Mgt	Number
Head – Contract holder	1
Overall Coordinator	1
Scheduler/interface PS	1
Tech interface ship contractor	1
Logistics manager & interface PS	1
Finances/accounts	1
Travel – adm	1
Medical – adm	1
Customs – Dangerous Goods	1
Dipclear – secretariat	1
Stores/Supplies/materials repository	1
DPA/QA	1
	12

Proposal for a dedicated entity for the *Aurora Borealis*

Aurora Borealis management office – French example	Number
Fleet manager	1
Operations officer	1.5
Designated person ashore (ISM, ISPS and QA)	0.5
Crew manager	1
Technical manager	3
Section Head Electronical instruments	1
Electronic technician	3
Logistics support	2
Administrative office	2
	15

Aurora Borealis management office – Norwegian example	Number
Fleet manager	1
Designated person ashore (ISM, ISPS and QA)	1
Crew manager	1
Technical manager	1
Accountant	1
Operations officer	1
Logistics support	1
Technician for scientific equipment	1
Instrument maintenance and calibration	3
	11

Aurora Borealis management office – German example	Number
Lead Manager	1.0
Coordinator Logistics	1.0
Coordinator Science Services and Technical Systems	1.0
Medical and logistical expert	0.5
Administrative assistants, including travel support coordination	2.0
Manager port material repository	1.0
Administrative support freight and dangerous goods transports	0.5
Administrative Assistant Customs declarations and transport	0.5
Head Inspector	1.0
Nautical Inspector	1.0
Technical Inspector	1.0
Inspector Electronic/Electrical Systems	1.0
Administrative Support	1.0
	12.5

Aurora Borealis managemet office – average scenario	Number
Fleet manager	1
Designated person on shore	1
Operation Officer	1
Crew manager	1
Logistics support	2
Technical manager	2
Administrative/Accountant	2
Technician/equipment maintenance	3
	13

Annex 3.6b

Anlage A 2

Anlage A 2 zum TV-L

Tabelle TV-L - Gültig in den Tarifgebieten West und Ost ab 1. März 2010 -						
Entgelt-gruppe	**Grundentgelt**		**Entwicklungsstufen**			
	Stufe 1	**Stufe 2**	**Stufe 3**	**Stufe 4**	**Stufe 5**	**Stufe 6**
15	**3.674,32**	**4.075,63**	**4.226,77**	**4.763,59**	**5.170,11**	
14	**3.325,13**	**3.689,95**	**3.903,64**	**4.226,77**	**4.721,89**	
13	**3.064,54**	**3.403,31**	**3.585,72**	**3.940,12**	**4.430,03**	
12	**2.746,62**	**3.048,90**	**3.476,27**	**3.851,52**	**4.336,22**	
11	**2.652,81**	**2.939,46**	**3.153,14**	**3.476,27**	**3.945,33**	
10	**2.553,78**	**2.835,22**	**3.048,90**	**3.262,59**	**3.669,11**	
9 1)	**2.256,71**	**2.501,66**	**2.626,75**	**2.970,73**	**3.241,74**	2)
8	**2.110,78**	**2.340,10**	**2.444,33**	**2.543,36**	**2.652,81**	**2.720,56** 3)
7	**1.975,27** 4)	**2.188,96**	**2.329,67**	**2.433,91**	**2.517,30**	**2.590,26**
6	**1.938,79**	**2.147,26**	**2.251,50**	**2.355,73**	**2.423,49**	**2.496,45** 5)
5	**1.855,40**	**2.053,45**	**2.157,69**	**2.256,71**	**2.334,89**	**2.387,00**
4	**1.761,59** 6)	**1.954,43**	**2.084,72**	**2.157,69**	**2.230,65**	**2.277,56**
3	**1.735,53**	**1.923,15**	**1.975,27**	**2.058,66**	**2.126,41**	**2.183,74**
2	**1.600,02**	**1.772,01**	**1.824,13**	**1.876,25**	**1.996,12**	**2.121,20**
1	**Je 4 Jahre**	**1.422,82**	**1.448,88**	**1.480,15**	**1.511,42**	**1.589,60**

Für Beschäftigte im Pflegedienst, die unter § 43 fallen

1)

E 9 b	**Stufe 3**	**Stufe 4**	**Stufe 5**	**Stufe 6**
	2.720,56	**2.887,34**	**3.090,60**	**3.283,43**

2) **3.455,42**
3) **2.762,25**
4) **2.027,39**
5) **2.553,78**
6) **1.813,71**

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