REPORT ON UPDATED COST AND PROGRAMME FOR VESSELS 801 & 802

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Issue 1		

TABLE OF CONTENTS

1 EXECUTIVE SUMMARY

This report is in response to the request by the Scottish Government for a report on the conditions of the two ferries, 801 and 802, together with a revised programme and cost to complete the vessels. This report does not cover other considerations, such as through life costs, and has an underlying assumption that the business will operate as an ongoing entity.

Within the timescales allowed, a full bottom up review has been undertaken with the aim of establishing a full scope of work, together with the budgets and timescales to complete the scope. The organisation and processes have also been assessed and changes are underway.

The ferry project has suffered significant delays throughout the life of the contract. There have been a number of issues that have been the root cause of these delays. These include:

- lack of project management, particularly critical on 801/02 which are complex ships where no one person has understood and controlled the overall programme
- an absence of project planning and control systems has resulted in a lack of integrated working, out-of-sequence activities and no useful management information
- Engineering processes and controls are weak. Specifications from the customer were not fully understood before design work was carried out resulting in an incomplete design and causing significant rework

Vessel 801 has been in the water for 2 years and the underwater condition has not been established however a drydocking has been planned early in the programme. Internally, the care and protection has been poor resulting in equipment damage. Vessel 802 has been on the berth for over 2 years and the paint protection has degraded in this time both on external surfaces and internally due to rainwater ingress into areas of the ship.

As a result of the immature design and out of sequence working there has been a significant number of defects raised by the customer which have all been reviewed and where required included in the cost and programme. These include a major departure from the specification, the widespread use of axilock couplings, which together with other work, has driven the decision to remove most of the pipework within the engine room.

The cost and timescales for delivery of the vessels are:

Costs:

The cost build up (with no allowance for profit) can be summarised as:

Costs of remedial work	£12.8m
Costs to complete the vessels	£95.1m
CAPEX for yard equipment	£1.6m
Performance penalty provision	£0.8m
Total Cost	**£110.3m**

Programme:

Vessel 801 delivery range – October to December 2021

Vessel 802 delivery range – July to October 2022

As part of the programme, a remediation package of work has been identified which includes not only the clean up and defect clearance on the vessels but also plans to improve key areas of the organisation in engineering, project management and planning and controls. Also, improvement of processes in a number of areas is planned, particularly around planning and project controls.

On completion of the remediation phase, circa 7 months, a review of the programme, costs and risks will be undertaken to better refine cost and delivery forecasts.

In summary, the work has shown that the vessels can be delivered within the time and cost shown above but is not without significant challenges to improve the organisation and its processes in order to ensure the issues around rework and control do not occur. In particular the challenges are:

- The re-energising of a demoralised workforce and the improvement of productivity.
- The ability to attract the right talent to achieve the resource profiles with sufficiently competent people.
- The ability to put in place and operate the new processes required
- The impact of future as yet unidentified rework to the project
- The control and management of the design subcontractor

2 BACKGROUND

In 2015 Ferguson Marine Engineering Limited (FMEL) was awarded a contract to build two dual fuel ferries for routes in Scottish coastal waters. The customer was Caledonian Maritime Assets Limited (CMAL), a company owned by the Scottish Government (SG), and the vessels were due to be delivered in May 2018 and July 2018 The construction of the vessels, identified as hulls 801 and 802, was subject to extensive delays and cost over-runs and FMEL was eventually placed in administration by its creditors on 16th August 2019.

Deloitte LLP were appointed as Administrators and received backing from the Scottish Government which made a commitment to take the business into public ownership and to fund the continued operation of FMEL during administration. An SG-owned company, Macrocom 1067, was appointed as Managing Agent with the brief to stabilise the yard, deliver the ferries and create a sustainable business for the future.

Underpinning the brief was the requirement to create a plan for the completion of the ferries and to provide Ministers with a robust assessment of cost and timetable. This report summarises the situation at FMEL and the condition of the ferries in August 2019; outlines

the work done to create the plan; identifies key assumptions and risks; and provides the funding estimate and programme for completion of the vessels.

A detailed and structured plan was created involving every area of the business and working closely with CMAL. The aim was to capture the current state of the vessels; identify the scope of work to complete; and to create a cost and programme based on this information.

Numerous employees have been involved in the process which is summarised below, often carrying out inspections in difficult circumstances and working additional hours. Their contribution has been essential. The work is summarised below:

1. Both ferries have been thoroughly inspected to establish their current "as built" status and physical condition.
2. Areas which have deteriorated have been identified for remedial action. Work has commenced where possible.
3. Out-of-specification areas have been identified and rework plans produced.
4. CMAL observations from earlier in the project have been reviewed and corrective actions agreed.
5. Design workload has been assessed and resource requirement identified for both outstanding work for current design state and new design work to complete.
6. Role of outsource design consultancy has been re-defined. New controls identified and an outline resource plan agreed.
7. Detailed scopes of work have been created for all activity to complete. Internal cost estimating and cross-functional teams have produced resource plans for these activities.
8. Discussions have been held with subcontractors and equipment suppliers. Material and subcontract cost estimates have been assessed.
9. Support organisation has been reviewed and changes identified.
10. Changes to project management, engineering, and planning processes have been outlined.
11. The overall plan, based on "bottom up" data, has been created to identify the timetable and headcount plan and used as the detail input for financial modelling.
12. Peer group and management team reviews have been carried out throughout the process.

3 INITIAL STATUS

3.1 PROJECT STATUS

During this review phase it has been very difficult to identify management information to use as a baseline for determining the project status. The business does not operate an Enterprise Resource Planning (ERP) system or a document management system and therefore what information exists is fragmented and sits in isolation.

The following key issues have been identified:

The basic design, i.e. the development of the vessels structural drawings and system design has still not achieved completion and approval by Customer, Lloyds and/or MCA except in a small number of areas. This is several years behind schedule and has been a key cause of rework on the vessels.

The status of the detailed design, i.e. the spacial layout of systems and equipment in the 3D model and issuing of information to production, has been difficult to establish. This is because the detailed design has been subcontracted to Vera Navis based in Portugal and there was limited management control established to manage this key contractor. Quantifying the work left to complete has been difficult.

There is no single source information to define the status of the bill of material. It remains uncertain as to whether all equipment has been purchased, particularly where change has occurred. In particular, the estimate of total pipe quantities is uncertain and this is a key component for determining the programme timescales.

There has been inadequate project planning and controls resulting in limited management information as to the status of the programme. With limited information available a bottom up exercise has been undertaken to determine the workscope left to complete.

As a consequence of inadequate planning and a lack of production information work has been undertaken out of sequence in a number of areas. Particularly where insulation, ceilings and cladding have been installed. This gives the appearance of good progress but in reality this will be substantially deconstructed in order for other work to progress, particularly where hotwork is required.

There has been inadequate control of onsite subcontractors who are performing the design and installation of electrical, HVAC and accommodation outfit. This has resulted in limited design oversight and limited integration of the work at the vessel with the overall workscope. The subcontractors have therefore been frustrated in their ability to perform the work and in a number of instances this has resulted in claims.

3.2 Process Issues

As part of the review, key internal processes have been assessed and have generally been found to be poor or non existent to control a project of this magnitude. As a priority, the following processes are being developed as part of the remediation plan.

1. Project Planning and Controls
2. Change Management
3. Configuration Management – drawing issue
4. Defect Management
5. Materials Management – stock control
6. Materials Management – work package control

3.3 VESSEL CONDITION

3.3.1 Care and protection

A care and protection review has been undertaken on both vessels. Vessel 801 has been in the water for 2 years, it has not been possible during the review period to examine the underwater hull and fittings. Whilst cathodic protection has been maintained during this period it is assumed that there will be significant marine growth, particularly around the inlets. It has therefore been decided that the vessel will be docked at the earliest opportunity to examine the condition with the potential for extensive paint repair required (as well as undertaking remedial work packages and removal of launch arrangement). A second docking will therefore be planned prior to sea trials to ensure the hull is clean.

Internally, vessel 801 has a level of equipment protection, however, in a number of instances this has degraded over time. Where protection is absent there has been a level of equipment damage that will require repair. This has been surveyed and a repair package will be undertaken, however, there will be a number of instances where damage has been caused but not identified, in particular Gopfert valve actuators will require repairs – this is identified in the risk register. A care and protection plan has now been initiated and the vessel is in the process of being cleaned and protection applied where required.

Generally, housekeeping and cleanliness is of poor standard with excessive debris and disregarded construction materials, equipment, consumables, uninstalled pipe work, fittings, flanges, Axilock couplings; general waste and disregarded rubbish.

Poor temporary cable management is evident, ventilation and lighting inadequate. The gas free system onboard is now dormant and will require reactivation to allow confined space entry and survey

On areas exposed to weather, there has been a degradation of the paint scheme which requires repair, this has been assessed and a re-instatement is currently underway. Internally, some bilge areas have not been painted and these are a priority to establish the paint scheme to halt further degradation.

On vessel 802, this has been on the berth for 2 years, units have been erected without full consolidation into the block. As a result, internal areas of the vessel are open to water ingress. Also, as a result of the time, the steel holding primer has degraded and is not providing protection. This has been surveyed and a work package to complete the welding of the units (decks a priority) and to also blast and reapply the holding primer has commenced.

3.3.2 Material status

During the course of the programme a significant amount of material has been procured for both vessels and a large proportion has been delivered to site. As the programme has slipped storage of the material has been a big issue. Offsite storage was organised however this has been un-manned and the facilities are in poor condition. It has not been possible during this review to undertake a stock take of the material. The programme includes arrangements for

a full stock take and also for the materials to be relocated and consolidated into a better facility.

3.3.3 Defects

FMEL does not operate a full defect management system. As such, there is no record for defects identified and managed to a conclusion. Also, the FMEL QC department does not have inspectors for mechanical installation and general outfit. Inspection to-date has been limited to structural steel and paint. The source of defect information has come from the Customers (CMAL) onsite team in the form of Owners Observation Reports (OOR's).

At the start of the review the status of OOR's were:

Total OOR's	344
Closed OOR's	183
Open OOR's	161
Percentage Closed (%)	53.2
OOR's on Dry-Dock List	11

As part of the review, all open OOR's have been reviewed and where agreement has been reached that remedial work is required (Will be done WBD) this has been costed and scoped within the programme. To date the status is:

Total OOR's	352
Closed OOR's	193
Will be Done OOR's	120
Open OOR's	39
Percentage Closed (%)	55
OOR's on Dry-Dock List	15

120 OOR's have been identified and costed with the remaining 39 still be reviewed for closure. The full list of OOR's scoped within the programme is shown in Appendix 2.

3.3.4 Project planning and controls

The project planning and controls process is the fundamental process for the management and control of the project and is therefore the first priority process to implement. The current state of the process is:

- Project plans are produced in the Primavera P6 planning software to a level that is not sufficient to control the project.
- Work packages are not produced from the system to allow work to be scheduled at a detailed level.
- Material requirements and information are not therefore aligned to the required work schedule.

- Control account management is absent therefore budgets for work are not assigned to appropriate managers.
- As there are no budgeted work packages actual cost and programme performance cannot be recorded.
- Reports showing the programme status, in terms of time (Schedule performance index SPI) and cost (cost performance index CPI) cannot be produced.

In summary, with no management information the status of the project at any point in time cannot be established.

Before work of any volume can re-commence on both vessels a new process, and organisation, must be put in place. The principles of the process will be:

- Work will be scheduled to work package level and issued with a budget and will ensure that the correct materials and information are available.
- Control accounts will be established to ensure that there is management ownership of the budgets.
- Actual costs will be captured against the budget and management reports will issued for review and action.

3.3.5 Change management

The project is seeing high levels of engineering change as a result of design immaturity. Currently, the control of change is ad-hoc and there is no management visibility of the status of engineering change and therefore there is no:

- Approval of change before it is issued
- Scheduling of change within the programme
- Assessment of the impact of change in terms of cost and programme
- Confirmation that the change has been incorporated.

The effect of engineering change has had a very significant impact to the project however the lack of a process has meant that it has been uncontrolled and there remains an uncertainty that change that has been issued has actually been incorporated.

3.3.6 Configuration management – drawing issue

There has been limited configuration control particularly around the creation and control of the bill of material and the issue of information into production. The project is to far gone to establish a proper process for control of the bill of materials and there will therefore be a continuing uncertainty about whether material bought for incorporation into the vessels is of the right quantity, has been subject to change or is the right form fit or function.

The control of information in the model and subsequent issue to production is an area that has caused problems in terms of establishing what current status the vessel is being built to. This is an area that can still be addressed and a new process will be developed to ensure that

information issued for production is controlled and that obsolete information is effectively withdrawn.

3.3.7 Defect management

As stated in section 3.3.3, a comprehensive defect management system does not exist. This means that:

- There is no internal company inspection of the installation of equipment and systems onboard.
- There is no system to record defects.
- Defects cannot therefore be systematically resolved.
- Overall defects cannot be analysed for root cause.
- Management cannot take action.

A defect management system will be established that scopes fully the activities on the project.

3.3.8 Materials management – stock control

Material stock, such as steel and pipes and fittings are not controlled within the yard. This means that there is no clear understanding as to what has been used on the project, either for the planned work or unplanned work in the form of change or repair. As such there is no clarity as to whether sufficient stock exists to complete the project.

A basic audit has been undertaken and allowances for further procurement of steel and pipe has been made. A process to control stock will be put in place.

3.3.9 Materials Management – work package control

In order to support the new process of work packaging, as outlined in section 3.3, the stores issuing process cannot identify and therefore allocate specific items of equipment to a specific work package as there is no cross reference to a specific location or component within a system.

Also, it is the ambition to move to a point where parts can be "kitted" to support a specific work package. This means that all parts necessary to complete a work package will be brought together by the stores in advance of the scheduled start.

This process will be developed with the planning and controls process.

4 NEW ORGANISATION

In order to deliver the new plan successfully, the organisation will need to build up capability in a number of areas where the capability either does not exist or needs to be increased. The following sections details the key organisational changes.

4.1 PROJECT MANAGEMENT

The organisation will introduce a senior project management capability in the form of a Programme Director who will have the responsibility and authority to deliver the project. The Programme Director will sit as part of the senior management team. The functional heads will deliver their areas of responsibility through the leads as highlighted in purple in figure 1 below.

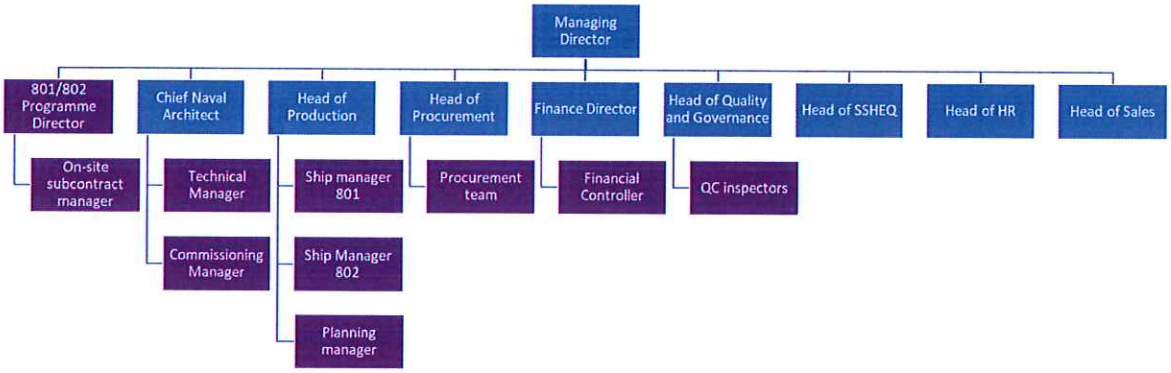


Figure 1: Ferguson Marine Organisation

Another important addition to the organisation is the introduction of an on-site subcontract manager. The programme has substantial packages of work with a number of key subcontractors scoping the design and installation of the full electrical work, HVAC and accommodation/passenger areas outfit. This is an area that has been poorly managed leading to a lack of co-ordination between the yard and subcontractors.

4.2 PROJECT PLANNING AND CONTROLS

In order to deliver the Project planning and controls process outlined in section 3.3, the planning and controls organisation needs to be significantly enhanced. The organisation is shown in figure 2.

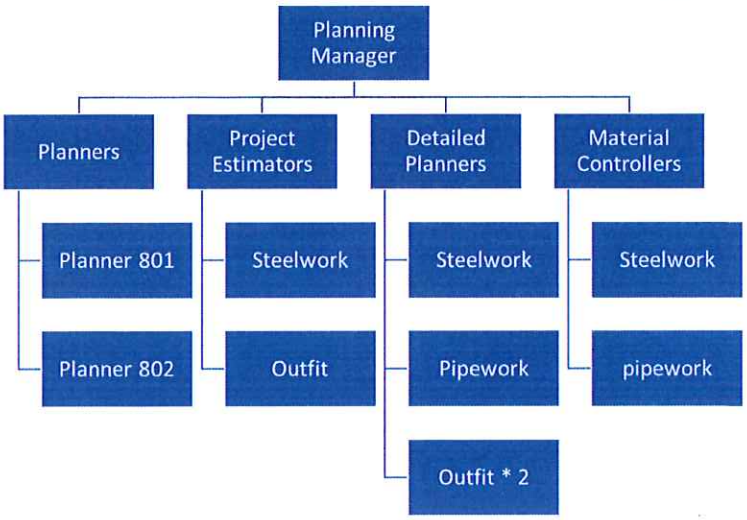


Figure 2 – Planning and controls organisation

4.3 TECHNICAL

Initially the project assumed that with the sub contract of the [redacted] and the [redacted] there was not seen the need for an internal design and drawing office of any size. However, there is a requirement for an enhanced drawing office capability to undertake arrangement and layout drawings, providing solutions to design issues and checking the output [redacted].

There remains a substantial workload to complete the design and the drawing office has been increased in size accordingly. Figure 3 shows the drawing office organisation.

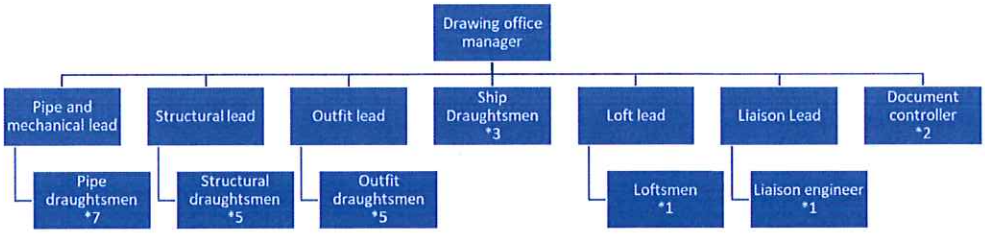


Figure 3 – Drawing Office Organisation

4.4 PRODUCTION

The production organisation will be enhanced with the additional roles of ship manager, one for each vessel. The ship manager will control all production work on the vessel and ensure that work is performed in accordance with the plan and that the vessel remains in a good condition. The production organisation is shown in fig 4.

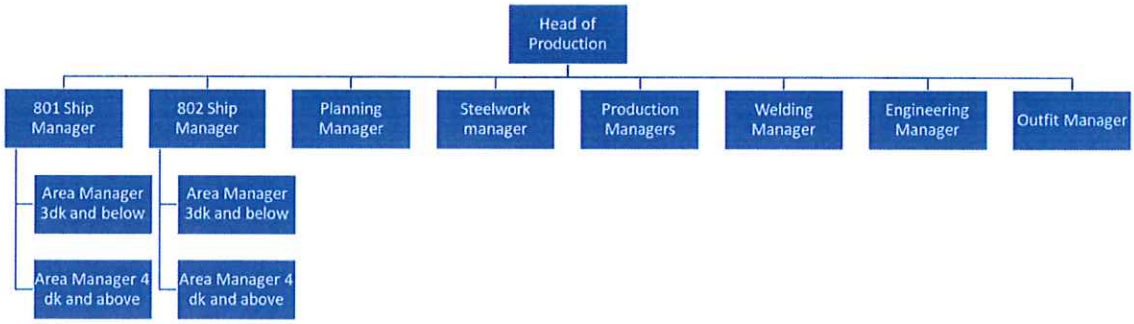


Figure 4 – Production Organisation

4.5 QUALITY CONTROL

The quality control function is a key area for improving and expanding the capability within the team and improving the inspection processes. In particular, the development of the defect management process, see section 3.3.7, and also the promotion of "right first time" and self-verification. The organisation will be developed as shown below.

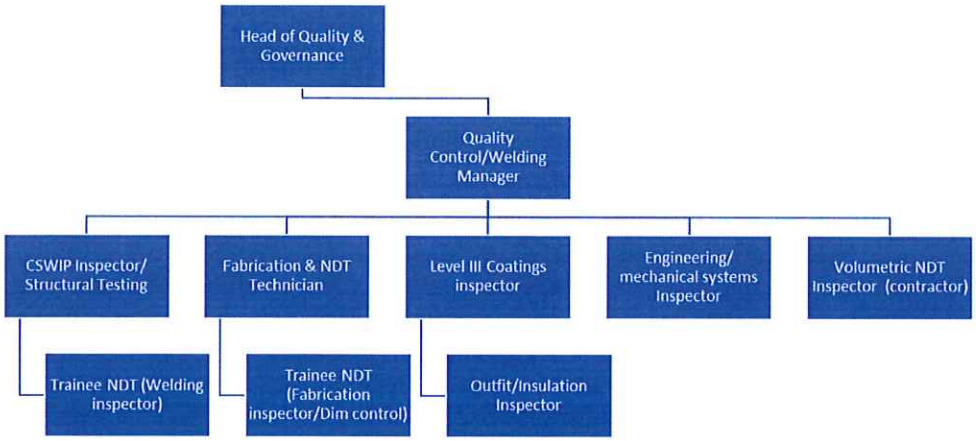


Figure 5 – Quality organisation

5 PROJECT PLAN

As part of the review, a revised project plan has been developed taking into account both the work to complete and also the rework required to be undertaken. There are some key factors that have been taken account of in development of the revised programme. These are:

- The programme allows for the completion of design in an area before further installation work commences. This will minimise further rework and out of sequence working.
- The critical path through the programme is driven by completion of manufacture and installation of pipework in the engine room and diesel generator room.
- The early phase engineering resource required to complete other contracts.
- The strip out of pipework in the engine room and generator room to undertake rework.
- The impact of the public procurement rules.

The revised programme also shows the resource demand required to deliver the programme. The impact of this demand has also been considered in section 5.3.

5.1 KEY PROGRAMME DATES

The delivery range for the vessels is proposed as:

Vessel 801 – October to December 2021

Vessel 802 – July to October 2022

5.2 CRITICAL PATH

The critical path of the programme is shown in Appendix 2 – Critical Path Plan. This has been developed to determine the earliest possible delivery for the date range. The key factors for the critical path are:

5.2.1 Mobilisation

A mobilisation period has been included in the programme plan to allow in the main for building up the project resource. The mobilisation period also allows for some preparatory work for the next phase. This requires the completion of the system design phase. With the engineering demand in this phase to complete other contracts within the yard a greater period of time has been allowed for the completion of this work.

5.2.2 Remediation

A remediation phase has commenced and is included within the programme. There are two parts to the remediation phase. Firstly, work at the ship, supported technically, to undertake change and rework. The plan of activities for this is shown in Appendix 4 – Remediation work. These activities actually extend to August however new work will start in May.

The second element of remediation work are those activities for mobilising the resource and putting in place the organisation, processes and systems necessary to perform the work in accordance with the programme. The scope of the activities are shown in Appendix 5 – Remediation Work

5.2.3 Rework in the engine room and generator room

A considerable amount of rework is required in these areas to bring them to an acceptable state. The least risk, least cost decision is to undertake a strip out of pipework within these areas to ensure as much rework is corrected in this period and that the rework itself is performed in a cost effective manner. The scope of work is still to be finalised in these areas.

5.2.4 Design completion

In order to avoid previous problems of rework caused by immature design, the programme allows for design completion and approval by vessel zone prior to production. The critical path therefore runs through design completion in the engine room and generator room.

5.2.5 Installation of pipework in Z2 – Engine room and diesel generator room

There have been 1000 pipes installed in this area todate (subject to the rework detailed in section 5.2.3) and a further estimated 2500 pipes to fit (approx. 3.75km of piping). The completion of this area is a crucial part of completion of the ship and to fit this many pipes in a sensible duration will require 2 shift working. Also, to support this duration the fabrication of the pipes will be subcontracted as the capacity does not exist within the yard.

5.2.6 Impact of public procurement rules

The programme will be governed by the public procurement rules. This is a new way of operating for the business and the true impact to the project is unknown however the timescales required by the public procurement rules are much longer than those currently used in the procurement process. The programme has taken a view that there will be an impact to the timescales and has estimated this could be of the order of 3 months. At what phase of the programme impacts will be seen is unknown and therefore this impact has been assessed as part of the risk assessment.

5.3 Timescale Risk Analysis

An initial timescale risk analysis (TRA) has been performed on the current schedule and has been undertaken with no risks included and then with key risks from the risk register included. The output from the TRA is shown in Appendix 3 – Timescale Risk Analysis.

The results show that there is a range of probability of delivery for ship 801 between **October and December 2021** (80% probability)

For Ship 802, the range of probability is **July and October 2022** (80% probability)

The delivery range for the vessels is therefore proposed as:

801 – October to December 2021

802 – July to October 2022

5.4 RESOURCE DEMANDS

The current total business resource for Ferguson Marine is 320. This has not seen a significant overall headcount reduction since the period prior to administration. The main changes have been a reduction in contractors and an increase in temporary labour.

The production resource demand from the current programme is shown below.

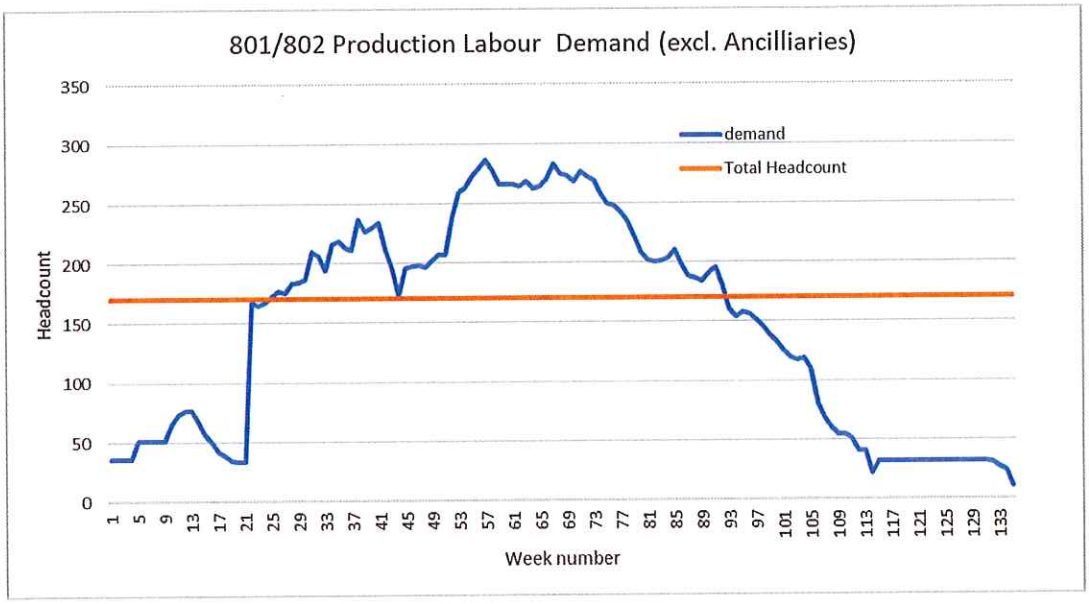


Figure 5 – required headcount for 801/802

Before increasing the labour headcount there are a number of current labour issues that will need to be addressed. These are:

- Labour efficiency has been very low for a long period.
- Year to date sickness levels are high at 7%
- There is an ageing workforce with an average age of 46.
- Apprentice recruitment was cancelled for 2019 as a result of administration.
- There is a very high ratio of temporary contracts to permanent, over 50%, with some 16 temporary workers having been employed in excess of 4 years and 46 over 2 years.
- There is significant local competition for the same resource, both in terms of retaining and attracting resource.

Efforts to attract new resource both in Staff and Production areas is ongoing with mixed results. The aim is to increase the core workforce to an as yet to be agreed level and supplement this with temporary and contract labour.

Figure 6 shows a significant resource demand peaking at an increase of 250 people. There are a number of mitigating actions that have been identified to meet this demand. These are:

- For technical resource, any shortfall in recruitment can be compensated by labour provided by ICE design. This would be people located either at the contractors premises or on site.
- For production resource, there are a number of contract recruitment companies that can provide large numbers of labour across trades.
- For planning resource, contract resource will be required immediately until permanent people can be recruited. A project controls company has been identified and contracted.

A number of risks have been identified in the risk register.

5.5 Key Milestones

Key milestones have been identified from the programme and are shown in Appendix 7 – Key Milestones.

6 Costs

6.1 Assumptions

Costs have been assessed from a bottom up basis as much as has been possible. The following assumptions have been made as part of the cost assessment:

- Ferguson Marine will operate as an ongoing entity throughout the build and on completion
- Any costs before October 31st are not included within this estimate.
- Scottish Government public procurement policies will apply to the yard procurement activities.
- VAT is excluded from the costs
- Neither the warranty nor liquidated damage provisions under the contract with CMAL have been altered.
- There is no financial provision made for Late Delivery payment should the penalty be applied.
- No financial provision has been made for liabilities arising from warranties under the CMAL contract.
- No financial provision has been made to account for cost arising from the absence of supplier warranties.

- The CMAL contract has performance penalties for speed, weight and fuel consumption. We have made a full financial provision for speed and weight as both ships are at, or over, the margin. Whilst we have made a financial allowance we will continue to take the necessary steps to mitigate weight increase. For fuel consumption we have made no financial provision as this is expected to be achieved.
- There is no requirement for performance bonding.

6.2 Cost Build up

The cost build up can be summarised as:

Costs of remedial work	£12.8m
Costs to complete the vessels	£95.1m
CAPEX for yard	£1.6m
Performance penalty provision	£0.8m
Total Value	**£110.3m**

A more detailed cost breakdown is shown in Appendix 8 – Cost Breakdown.

6.3 Costs of remedial work

A remediation phase of 7 months has been assumed within the programme. The scope of work reflects both the physical rework required to bring the vessels to an acceptable condition and also the work associated to develop the processes necessary to perform future work. In particular the planning and control processes and team necessary to deliver the vessels within the time and cost parameters.

6.4 Costs to complete the vessels

The direct labour costs have been derived from the bottom up assessments undertaken. Supervision and ancilliary support are included within the overhead.

Materials have been fully reviewed and the cost takes account of work still to be contracted and also committed costs yet to be invoiced.

Key areas of material costs are:

- Subcontract of pipe manufacture
- Subcontract of hydraulic system pipework manufacture and install
- Additional drydocking for hull repairs

6.5 CONTINGENCY

The full risk register, see Appendix 7, shows a calculated risk contingency of between £13m and £15m. The management assessment has been to assume a contingency of 10% of the cost to complete the vessels until a better understanding is achieved at the end of the remediation phase at which point the contingency will be re-assessed. The risk values associated with the remediation phase are valued between £6m and £7m.

The values associated with the risk register have been built into the cost to complete the vessel as it is highly likely that a significant portion of these costs will be spent.

6.5.1 Cost risk analysis

A cost risk analysis has been made in order to determine the overall uncertainty management contingency to cover potential issues not captured by the risk register. This is shown in Appendix 9 – Cost Risk Analysis.

The output shows a range of cost for completion of the vessel of **£110.3m to £114.3m**

It also shows that the risk allowance of £8.8m included within the cost to complete is within the CRA limit.

6.5.2 Performance penalties

A contingency has been allowed for the contractual penalties for the following:

Weight – the current margin is zero and expected to worsen, whilst we will continue to take mitigating actions to reduce weight where possible we have made the maximum allowance of £250k per vessel.

It should be noted there is also a right to terminate if the maximum allowance is exceeded.

Speed – Ship 801 is currently predicted to be 0.1 knot below the contracted speed of 16.5knots. Ship 802 is on the limit (this has a ducktail incorporated in the design to improve performance). This is based upon the model tests which also have their own margin for error. We have therefore made the maximum allowance of £150k per vessel.

It should be noted there is also a right to terminate if the maximum allowance is exceeded.

Fuel consumption – the expected fuel consumption has been changed via contract amendment and therefore we have made no allowance.

6.6 COSTS FOR CAPEX

This sum has been included to allow for immediate repairs and replacement of key infrastructure, procurement of tools for an increased workforce and improving working conditions.

7 RISKS

A risk assessment has been undertaken for the project in the form of a new risk register. Risk reviews have been undertaken and will continue as part of the project management process. In particular, mitigation actions have been developed and have been built into the programme. Some of the key mitigations are:

- The strip out of the engine and generator rooms to mitigate the effect of axilocks
- The implementation of an enhanced project planning and controls organisation and process.
- The use of contract production labour.
- The increase in technical department resource

The risk register is included in Appendix 10 – Risk register. The top risks, after mitigation actions have been implemented, are shown below:

1. Work packaging arrangements are not robust enough to control properly the work sequence and capturing performance
2. Impact to the programme of the implementation of the Public Procurement process
3. Production resource labour rates are below industry sector and may require an increase to be competitive in attracting and retaining resource
4. Materials have been stored offsite at Westway in poor conditions and unmanned. The material condition and level of stock is uncertain and may result in material stock write downs
5. Unable to recruit or retain Production staff in the required numbers, with suitable qualifications and experience
6. The level of rework is not sufficiently scoped. Known rework is not fully scoped. Unknown rework will occur particularly during the test and commissioning phase
7. Equipment may not work during the setting to work and commissioning phase as a result of being idle for a significant length of time
8. The significant number of pipes made but not fitted cannot be found or are obsolete. There is a lack of stock control with pipes located at various places in the yard

8 CHALLENGES

In the time available for the review, the project has been assessed from a time, cost and risk perspective. The following are seen as the key challenges going forward.

- The re-energising of a demoralised workforce and the improvement of productivity.
- The ability to attract the right talent to achieve the resource profiles with sufficiently competent people.
- The ability to put in place and operate the new processes required
- The impact of future as yet unidentified rework to the project

- The control and management of [redacted]

APPENDICES

APPENDIX 1 – OWNERS OBSERVATION REPORTS

Owners Observation Reports - Meeting Sheet (CMAL to FMEL)				UPDATED		16/10/2019		PRINTED	
OO No.	Vessel (s)	Report Description	Report By	Date Sent	Sent by	Comments	FMEL	Status	DD REF
31	801	Ballast Tank Suction	[redacted]	03/04/2017	[redacted]	Raised almost 2 years ago. Agreed on what to do but nothing done. To be moved to dry-dock list	[redacted]	WBD	DD31
52	801	Unit 48 the bulbous bow section plate not shaped	[redacted]	25/07/2017	[redacted]	Still ongoing. To be moved to dry-dock list	[redacted]	WBD	DD01
68	801	Heights of Clean and Dirty Oil Bilge Pipes in Sewage Tank Space	[redacted]	02/10/2017	[redacted]	Still ongoing. Not done	[redacted]	WBD	
69	801	Compressed Air Pipes and Valves	[redacted]	02/10/2017	[redacted]	Still ongoing	[redacted]	WBD	
74	801	Cut in steel for Steel adaptor plate for propeller shaft bulkhead glands	[redacted]	10/10/2017	[redacted]	Still ongoing	[redacted]	WBD	DD17
82	802	Shop primer coating at above areas now well past over-coating time and fully broken down these areas now require full re-preparation and coating.	[redacted]	20/10/2017	[redacted]	Still ongoing at slow pace	[redacted]	WBD	
88	801	Pipework for forward thruster hydraulics	[redacted]	04/11/2017	[redacted]	Still ongoing. To be moved to dry-dock list	[redacted]	WBD	DD18
89	801	External U-bolts nuts/washers to be St/steel to comply with the Spec.	[redacted]	07/11/2017	[redacted]	Still ongoing. To be moved to dry-dock list	[redacted]	WBD	DD19
93	801	XP Hardtop Black Polyurethane applied during periods of inclement weather	[redacted]	10/11/2017	[redacted]	Still ongoing at slow pace. Fairing required as well as removal of damaged paint (from fender up to Deck 5).	[redacted]	WBD	
96	801	XP Hardtop Black Polyurethane applied without proper feathering and build-up of undercoat	[redacted]	16/11/2017	[redacted]	Response received from FMEL. Work far away from being started	[redacted]	WBD	
100	801	Final completion survey of underwater coating and measurement of Hull Surface Roughness	[redacted]	17/11/2017	[redacted]	Still ongoing. To be moved to dry-dock list	[redacted]	WBD	DD20
101	801	Final completion of Tank markings before launching	[redacted]	20/11/2017	[redacted]	Still ongoing. To be moved to dry-dock list	[redacted]	WBD	DD06
102	801	Final completion of plate markings before delivery of the vessel	[redacted]	24/11/2017	[redacted]	Still ongoing. To be moved to dry-dock list	[redacted]	WBD	DD21
103	801	Dimension check of vessels draught marks	[redacted]	24/11/2017	[redacted]	Still ongoing. To be moved to dry-dock list	[redacted]	WBD	DD07
104	801	Damage to bow area due to erection stiffening	[redacted]	24/11/2017	[redacted]	Still ongoing. To be moved to dry-dock list	[redacted]	WBD	DD22
108	801	Stern Tube System Filled with Oil Before Being Flushed	[redacted]	01/12/2017	[redacted]	Still ongoing. To be moved to dry-dock list	[redacted]	WBD	DD03
111	801	Position of port and starboard stern tube header tanks	[redacted]	05/12/2017	[redacted]	Still ongoing. To be moved to dry-dock list	[redacted]	WBD	DD23
117	802	Excessive water ingress and long standing (around 6 months)	[redacted]	14/12/2017	[redacted]	Still ongoing for vessel 802. FMEL to provide plan. No plan received	[redacted]	WBD	
123	801	Bilge Wells	[redacted]	23/01/2018	[redacted]	Still ongoing. [redacted] will close off once they do what they said they would do review update 26/9: workshop area will be done	[redacted]	WBD	
128	801	Clean Bilge Pipework in Generator Room	[redacted]	06/02/2018	[redacted]	FMEL to make proposal to put all bilge OOR's into one OOR	[redacted]	WBD	
129	801	Clean Bilge Pipework at Forward End of Starboard Generator	[redacted]	06/02/2018	[redacted]	FMEL to make proposal to put all bilge OOR's into one OOR	[redacted]	WBD	
131	801	Hydraulic Pipework Between Header Tanks and Stern Tubes	[redacted]	07/02/2018	[redacted]	Still ongoing. To be moved to dry-dock list	[redacted]	WBD	DD27
133	801	P&S Pony Motors	[redacted]	15/02/2018	[redacted]	Still ongoing Update 30/09: [redacted]	[redacted]	WBD	
134	801	Motor Efficiencies Minimum Classification	[redacted]	21/02/2018	[redacted]	Still ongoing Update 30/09: [redacted]	[redacted]	WBD	
138	801	Damage to Vent ducting in numerous positions	[redacted]	02/03/2018	[redacted]	Still ongoing	[redacted]	WBD	
145	801	AC Unit Seats Recently Fitted	[redacted]	15/03/2018	[redacted]	FMEL to respond with the possibility of closing	[redacted]	WBD	
147.2	801	Stabiliser Header Tanks	[redacted]	21/03/2018	[redacted]	First part accepted. Second part still not acceptable. FMEL to revert	[redacted]	WBD	DD24
149	801	Number 13 Void Suctions	[redacted]	21/03/2018	[redacted]	FMEL have responded. To be discussed at next OOR meeting Update 15/10: still to be reviewed	[redacted]	Review	
150	801	Ballast Line and Valve IWO Pony Motors	[redacted]	21/03/2018	[redacted]	Still ongoing. Cowling cannot be removed	[redacted]	WBD	
153	Both	Damage to Gearbox Pipework	[redacted]	26/03/2018	[redacted]	Still ongoing. CMAL response sent. FMEL to revert	[redacted]	WBD	
159	801	Damage to Chiller unit copper pipework	[redacted]	27/03/2018	[redacted]	Still ongoing	[redacted]	WBD	
160	801	Water ingress to ECR console sensitive equipment	[redacted]	04/04/2018	[redacted]	Still ongoing. To remain open until equipment is working review update 02/10: no further action	[redacted]	FMEL to advise Kong	
162	801	LNG PLC Cabinet	[redacted]	10/04/2018	[redacted]	FMEL to detail RAL No. To remain open until final inspection of new coating	[redacted]	WBD	
164	801	Possible clash with Starter foundation & already installed pipework	[redacted]	16/04/2018	[redacted]	Still ongoing with drawing office review update 26/9: this appears to be OK update 16/10: still to close	[redacted]	CMAL to close	
173	802	Over-coating on top of pitted steel with lack of surface profile	[redacted]	31/05/2018	[redacted]	Still ongoing. To remain open until surveyed by CMAL	[redacted]	WBD	
175	801	Co-ordination of steelwork coating completion, Seating, outfitting and floor bearers	[redacted]	14/06/2018	[redacted]	Still ongoing. Nothing done. Cables now in. Protection required before blasting	[redacted]	WBD	
177	801	Flanges Above Electrical Equipment STP Room	[redacted]	22/06/2018	[redacted]	176 now part of this. Walkaround took place. Not a great deal done	[redacted]	WBD	
178	801	Ventilation Duct in STP Room	[redacted]	25/06/2018	[redacted]	Still ongoing. To be looked at by drawing office. Nothing done	[redacted]	WBD	

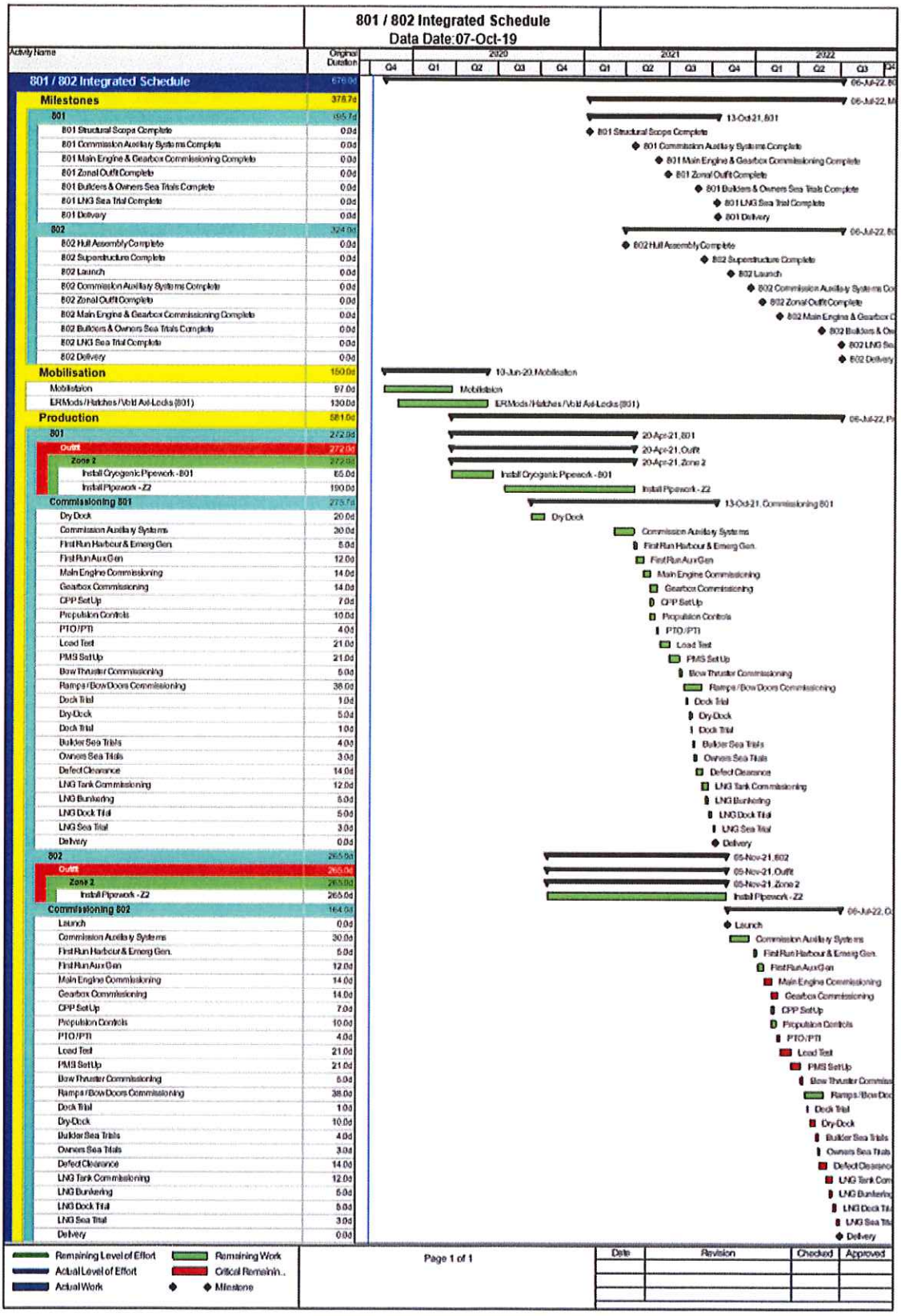
180	802	Full Breakdown of shop holding primer and excessive corrosion of main steelwork sections	[redacted]	03/07/2018	[redacted]	Still ongoing. Being repaired but at slow pace. Lack of resources	[redacted]	WBD	
181	801	Anti-Vibration Concerns	[redacted]	05/07/2018	[redacted]	Still ongoing review update 26/09: Bow thruster panels are fully installaed and wired. No further action proposedupdate 15/10: still to review	[redacted]	CMAL to review	
184	801	Piping at Fwd. Mooring Position	[redacted]	17/07/2018	[redacted]	Still ongoing	[redacted]	WBD	
191	801	Drain Holes in Save-Alls	[redacted]	25/07/2018	[redacted]	Still ongoing	[redacted]	WBD	
192	801	Very large gap at side shell butt frames 26 to 27 block numbers 3 to 4 deck 5 to deck 6	[redacted]	26/07/2018	[redacted]	Change request received. Will remain open until work completed and inspected.	[redacted]	WBD	
196	801	St/by Gearbox pump seats	[redacted]	01/08/2018	[redacted]	Still ongoing. Started work but not finished	[redacted]	WBD	
199	801	Auxiliary Machinery Space Sea Water Suction Strainer	[redacted]	23/08/2018	[redacted]	Still ongoing. Nothing from FMEL	[redacted]	WBD	
200	801	Steering Gear Alignment	[redacted]	27/08/2018	[redacted]	Still ongoing	[redacted]	WBD	DD25
202	801	Starboard Diesel Bunker Line	[redacted]	28/08/2018	[redacted]	Still ongoing. FMEL to comment on rules. Review update 26/09: review regulations on whether axilocks are allowed in this area. If not then fix update 15/10: still to confirm	[redacted]	SD to review	DD27
203	801	Engine Room Landing Area	[redacted]	28/08/2018	[redacted]	Space can't be improved. Can FMEL issue spare touchscreens or provide protection? FMEL to revert review update 26/9: agreed to provide 2 spare touchscreens	[redacted]	WBD	
205	801	Mechanical damage and bend damage to Mezzanine deck handrails on-board the vessel.	[redacted]	04/09/2018	[redacted]	Still ongoing. All to be repaired. Wasn't done as part of care and protection walk around	[redacted]	WBD	
207	801	Generator room Vent-ducting/Pipe system access concerns.	[redacted]	12/09/2018	[redacted]	FMEL to bring vent down and fix. No work done.	[redacted]	WBD	
209	801	Transportation Damage to Air Handling Units	[redacted]	25/09/2018	[redacted]	Still ongoing. Nothing done	[redacted]	WBD	
211	801	Engine Room Sea Water Suction Main Isolating Valves	[redacted]	26/09/2018	[redacted]	Still ongoing. Nothing done review update 02/10: fitted upside down update 15/10: still to confirm	[redacted]	SD to review	
215	801	Deterioration of Steel Throughout Vessel 802	[redacted]	02/10/2018	[redacted]	Still ongoing at a slow pace. Lack of resources and man power	[redacted]	WBD	
216	802	Suction Pipes in Ballast Tanks	[redacted]	09/10/2018	[redacted]	Still ongoing. Nothing done. Same issue as OOR 31 for 801 vessel	[redacted]	WBD	
217	801	Gopfert Valves	[redacted]	01/11/2018	[redacted]	Still ongoing. Update sent to FMEL on 7/1/19. No response. FMEL to revert	[redacted]	WBD	
221	801	Axi-Lock Pipe Connections	[redacted]	05/11/2018	[redacted]	Work being done. Will remain open until all complete and inspected by CMAL	[redacted]	WBD	
223	801	Pipework Support Brackets Being Installed with Elongated Holes	[redacted]	05/11/2018	[redacted]	Still ongoing. Being addressed but widespread problem. FMEL to send email Update 3.09: [redacted] review with CMAL on fix required. Reconfirm yard standard for future.	[redacted]	WBD	
224	801	AMOT Valve 1	[redacted]	05/11/2018	[redacted]	Still ongoing. Nothing happened review update 26/9: check this has been fixed, or there is a plan update 15/10: [redacted] to confirm way ahead for AMOT valves	[redacted]	SD to investigate	
226	801	Seawater Cooling Pipework Sizes	[redacted]	05/11/2018	[redacted]	Official response received from FMEL. [redacted] to send response review update: review with at P&ID meeting review 15/10: review shows pipework can be reduced but need to determine if there is any advantage in doing this, review at vessel	[redacted]	Walkaround	
228	Both	Bolted Doors	[redacted]	06/11/2018	[redacted]	Still ongoing. Doors list (Rev 10) sent to CMAL. Speak to [redacted] for update review update 26/9: to be reviewed [redacted]	[redacted]	Walkaround	
230	Both	Preventative Log	[redacted]	07/11/2018	[redacted]	Update at meeting. FMEL to revert with Wartsila report	[redacted]	WBD	
231	Both	Fast Rescue Boats	[redacted]	07/11/2018	[redacted]	Update at meeting. CMAL to check and email Udate 30.09: Will be moved to offiste store as part of proposed stores consolidation	[redacted]	WBD	
235	801	Insulation Fitted Over Escape Opening Still to be Cut	[redacted]	27/11/2018	[redacted]	Update at meeting. Ongoing. Should be A30 insulation. Work to be done	[redacted]	WBD	
238	801	Axi-lock Couplings on Sounding Pipes for DB Tanks	[redacted]	27/11/2018	[redacted]	Still ongoing. CMAL response sent. FMEL to revert review update 02/10: acceptable to Lloyds, [redacted] to close	[redacted]	CMAL to close	
239	801	Sounding Pipe Fouling on Central Cooling HT Pipework	[redacted]	27/11/2018	[redacted]	Update at meeting. Still ongoing. FMEL to look at review update 26/9: This work appears complete. To be confirmed	[redacted]	CMAL to close	
240	Both	Preventative Maintenance Log	[redacted]	28/11/2018	[redacted]	Update at meeting. FMEL to revert with Wartsila report	[redacted]	WBD	
241	Both	3D Model Observations on Sewage System	[redacted]	30/11/2018	[redacted]	Still awaiting response. Still ongoing. [redacted] to check and will email FMEL review update 02/10: this has a technical solution, to be checked	[redacted]	FMEL to reply	
242	801	Bilges in Steering Gear Compartment	[redacted]	30/11/2018	[redacted]	Update at meeting. FMEL to check and revert	[redacted]	WBD	
243	801	Ro-Ro Hydraulic Power Plant System	[redacted]	05/12/2018	[redacted]	Update at meeting. Drawing office to look at	[redacted]	WBD	
244	801	Starboard Sea Water Cooling Overboard Pipework	[redacted]	05/12/2018	[redacted]	Still ongoing. FMEL have fixed partly. Scallops/clash still to be done	[redacted]	WBD	
245	801	Access to Starboard Main Engine for Maintenance	[redacted]	06/12/2018	[redacted]	Still ongoing. FMEL to look into, work in progressreview update 26/9: Potential to remove the service air compressor, a receiver and associated items. Also Nitrogen compressor. To be reviewedupdate 15/10: air compressor and associated items can be removed. Info to be sent to CMAL for approval. CMAL will approve	[redacted]	P&ID review	

246	801	Air Trunking - Generator Room (Starboard Aft)	[redacted]	06/12/2018	[redacted]	Still ongoing. FMEL to speak to [redacted] and update us	[redacted]	WBD	
248	801	Starboard Aft Bunkering Station	[redacted]	07/12/2018	[redacted]	Update at meeting. To be done	[redacted]	WBD	
249	801	Starting Air Bottles Base Supports	[redacted]	11/12/2018	[redacted]	Update at meeting. Nothing done. Temporary or fixed? Linked with 154	[redacted]	WBD	
251	801	Application of A60 Fire Insulation	[redacted]	31/12/2018	[redacted]	Update at meeting. FMEL to revert review update 02/10: DH and IC to review onboard	[redacted]	FMEL to reply	
252	801	Support Brackets for 300MM Sea Water O/B Pipe	[redacted]	07/01/2019	[redacted]	Response received and accepted. To be inspected onboard	[redacted]	WBD	
254	801	Starboard Main Engine F.O. Circ. Pumps Foundation Supports	[redacted]	08/01/2019	[redacted]	FMEL response received. Not accepted by CMAL. FMEL to revert update 15/10: pumps will be turned, new seats produced. WBD	[redacted]	WBD	
256	801	Port Access to No. 5 Void	[redacted]	17/01/2019	[redacted]	Still ongoing. Sump restricts access. Needs changed. FMEL to revert	[redacted]	WBD	
257	801	Starboard Sea Suction Chest	[redacted]	17/01/2019	[redacted]	To remain open until repair completed. Currently not protected	[redacted]	WBD	
258	Both	Bare steel area shown on Drawing number 801_2-511-1 Deck 7 Bridge Deck Insulation Plan-Deck-heads	[redacted]	22/01/2019	[redacted]	Response received. We will await work carried out onboard. Technical Specification to be met for thermal insulation. Drawing to be updated	[redacted]	WBD	
259	801	Large roughly cut hole through main longitudinal structural member to facilitate a scavenge air pipe from Stbd main engine	[redacted]	05/02/2019	[redacted]	FMEL have responded and sent sketch to [redacted] for approval. Await further response from FMEL.	[redacted]	WBD	
260	802	Access ladder fitted as above without preparing and coating structure below and around the ladder area	[redacted]	07/02/2019	[redacted]	Update at meeting. Still ongoing	[redacted]	WBD	
262	801	Badly corroded areas require draining, cleaning, preparation and coating.	[redacted]	14/02/2019	[redacted]	Response received. Was in poor condition. CMAL to inspect and respond.	[redacted]	WBD	
263	802	Strong-backs welded to external shell	[redacted]	14/02/2019	[redacted]	CMAL response sent.FMEL to revert	[redacted]	WBD	
265	801	Excessive openings cut through main frames below deck 5 above Mezzanine deck without structural compensation.	[redacted]	19/02/2019	[redacted]	Compensation pieces ordered. Work still not done. Nothing fitted.	[redacted]	WBD	
266	?	Fitting of pipe supports without preparation and coating of contact points between piping and support faces	[redacted]	19/02/2019	[redacted]	Response received. Proposal acceptable but will remain open until completed onboard vessel	[redacted]	WBD	
267	?	LNG P&S Spaces	[redacted]	21/02/2019	[redacted]	Response received. Remain opened until proposal from Wartsila Update 30.09: [redacted]	[redacted]	WBD	
268	801	Sea Water Pumps – Eductor System	[redacted]	27/02/2019	[redacted]	CMAL Response sent. To remain opened until proven in commissioning	[redacted]	WBD	
269	801	Poorly Fabricated Hatches that do not meet Specification Requirements or comply with Owners Drawing Comments	[redacted]	07/03/2019	[redacted]	Still ongoing. FMEL to send reply update 15/10: WBD but need to agree the technical solution between [redacted]	[redacted]	FMEL to reply	
270	801	Large openings cut through frame 103 Port and Starboard facilitate FW pipes to Condensers	[redacted]	07/03/2019	[redacted]	Response received and replied to. To remain open until work completed onboard. Work might be done CMAL to look at	[redacted]	WBD	
272	Both	Pipe Support Standards	[redacted]	07/03/2019	[redacted]	Raised at meeting on 10/4/19. Nothing done. FMEL to revert	[redacted]	WBD	
273	801	MCT Penetration	[redacted]	07/03/2019	[redacted]	Response received. More adequate answer required	[redacted]	WBD	
274	801	Protective kick-plate upstands	[redacted]	12/03/2019	[redacted]	No response	[redacted]	WBD	
278	801	Monitoring Tanks for Stern Tube Aft Seals	[redacted]	19/03/2019	[redacted]	No response review update 02/10: part of Wartsila discussions, SD to review update 15/10: solution to be reviewed with CMAL	[redacted]	SD to review	
279	801	Application of final coat Hardtop XP white without full preparation or completion of first four coats of the specified system	[redacted]	20/03/2019	[redacted]	Still ongoing. CMAL response sent. To remain open until work completed	[redacted]	WBD	
280	801	Safe operation of hatch into Pipe cable and transformer space	[redacted]	20/03/2019	[redacted]	FMEL to send response. Do not combine with 269 - one safety/one quality review update 02/10: agreed WBD but needs a technical solution update 15/10: WBD but need to agree the technical solution between [redacted]	[redacted]	SD to review	
281	801	Stern Tube Oil Sampling	[redacted]	20/03/2019	[redacted]	No response review update 02/10: CMAL to review update 15/10: still to review	[redacted]	CMAL to review	
282	801	Emergency Drain Tank for Stern tube Lub Oil System	[redacted]	20/03/2019	[redacted]	No response review update 02/10: CMAL to review update 15/10: still to review	[redacted]	CMAL to review	
283	Both	Hydraulic Oil Tank Completion with Admiralty Pad Eyes & Top Stays	[redacted]	22/03/2019	[redacted]	FMEL to send response. 198 now part of this	[redacted]	WBD	
286	801	Removal of Intermediate Shaft for Survey	[redacted]	25/03/2019	[redacted]	No response review update 26/9: WBD	[redacted]	WBD	
287	801	Client final behind linings inspections	[redacted]	26/03/2019	[redacted]	FMEL to invite CMAL to behind lining inspection before being closed	[redacted]	WBD	
289	Both	Protection of Insulation where contact with oil and water is possible	[redacted]	04/04/2019	[redacted]	No response review update 26/9: WBD	[redacted]	WBD	
290	801	Steering Flat Walkways	[redacted]	09/04/2019	[redacted]	FMEL response received. Not accepted by CMAL. FMEL to revert	[redacted]	WBD	
291	802	Excessive corrosion of underside of deck 5 areas all block sections	[redacted]	09/04/2019	[redacted]	FMEL response received. To remain open until inspected by CMAL	[redacted]	WBD	
292	801	Installation Design/Quality/Supervision concerns	[redacted]	12/04/2019	[redacted]	No response	[redacted]	WBD	
293	801	Completion of A60 insulation at transverse bulkhead without completing pipe penetration welding at stabiliser side	[redacted]	12/04/2019	[redacted]	No response	[redacted]	WBD	
294	801	Penetration of main structural frames below deck3 without following required standards	[redacted]	12/04/2019	[redacted]	No response	[redacted]	WBD	

295	801	Pipe systems clash	[redacted]	17/04/2019	[redacted]	No response review update 26/9: couldn't locate this at vessel update 15/10: still to locate	[redacted]	Model/ Walkaround	
296	801	Central Cooling Cross Over Valves in AMS	[redacted]	18/04/2019	[redacted]	No response review update 02/10: DMacD to check update 15/10: valves are OK but position still to be checked	[redacted]	CMAL to confirm	
297	801	Starboard Bunker Station Fuel Oil Line	[redacted]	18/04/2019	[redacted]	No response	[redacted]	WBD	
298	801	Starboard Sea Water Cooling Pipe Route	[redacted]	18/04/2019	[redacted]	No response	[redacted]	WBD	
299	801	Fire Main Pipeline in Starboard Passenger Stairway	[redacted]	18/04/2019	[redacted]	No response	[redacted]	WBD	
300	801	Damage to coating and Thermal Insulation.	[redacted]	23/04/2019	[redacted]	No response	[redacted]	WBD	
301	801	Design Philosophy	[redacted]	23/04/2019	[redacted]	No response review update 26/9: WBD	[redacted]	WBD	
302	801	LT Thermostatic Valve, Position and Accessibility	[redacted]	23/04/2019	[redacted]	No response review update 26/9: difficult to move the valve, review position or whether an alternative valve can used update 15/10: review with 224	[redacted]	SD to investigate	
303	801	Sea Water Back-Flush Filters Structure	[redacted]	23/04/2019	[redacted]	No response	[redacted]	WBD	
304	801	Cabling Concern	[redacted]	23/04/2019	[redacted]	Response received. We await feedback from KME. Send response back	[redacted]	FMEL to reply	
305	801	Damage to Various Pumps and Small Gauge Pipework	[redacted]	24/04/2019	[redacted]	No response	[redacted]	WBD	
306	801	Aft Heeling Pump and Mounting Plate	[redacted]	24/04/2019	[redacted]	No response	[redacted]	WBD	
307	801	Harbour Generator – Pipework in Way of Flywheel	[redacted]	24/04/2019	[redacted]	No response review update 26/9: WBD	[redacted]	WBD	
308	801	Clean Bilge Pipework - Port Aft of Generator Room	[redacted]	24/04/2019	[redacted]	No response review update 26/9: confirm complete update 15/10: still to confirm	[redacted]	CMAL to close	
309	801	Cutting of pipe openings without adhering to agreed standard EG FMEL Steelwork Standard Document item S.P11	[redacted]	01/05/2019	[redacted]	No response review update 02/10: to be review by [redacted]	[redacted]	FMEL to reply	
310	801	Unacceptable form of securing behind linings	[redacted]	09/05/2019	[redacted]	No response	[redacted]	WBD	
311	801	Cables passing through "B" Class linings	[redacted]	13/05/2019	[redacted]	Confirm what is the boundary update 15/10: still to review	[redacted]	FMEL to reply	
312	801	A60 Fire Insulation	[redacted]	13/05/2019	[redacted]	No response review update 02/10: to be review by [redacted]	[redacted]	FMEL to reply	
313	801	Axi-Lock Couplings	[redacted]	15/05/2019	[redacted]	No response review update 26/9: CMAL to review systems to identify what cannot be accepted. FMEL to look at training for future use of fittings	[redacted]	Investigate	
314	802	Lashing Pot to fit	[redacted]	21/05/2019	[redacted]	No response	[redacted]	WBD	
315	801	General Housekeeping and Lying Water	[redacted]	23/05/2019	[redacted]	No response	[redacted]	WBD	
316	802	Below Deck 3 Concerns	[redacted]	23/05/2019	[redacted]	No response	[redacted]	WBD	
317	801	Galvanised Pipework with Poor Weld Fusion and Lack of Weld Spatter Removal	[redacted]	29/05/2019	[redacted]	No response Update 30.09: DH to walk the vessel with CMAL	[redacted]	WBD	
318	801	Prima-berg Units Fitted at Emergency Gen Room and Air Handling Machinery Room Deck 7	[redacted]	31/05/2019	[redacted]	No response review update 26/9: to be investigated. Can the large unit be split or how is it protected when open update 15/10: still to review	[redacted]	SD to investigate	
320	802	LNG Tank Protection	[redacted]	10/06/2019	[redacted]	No response	[redacted]	WBD	
321	801	Protection of All Main Switchboards	[redacted]	10/06/2019	[redacted]	No response	[redacted]	WBD	
322	801	Pipework in Engineers Office	[redacted]	12/06/2019	[redacted]	No responsereview update 26/9: a working arrangement, that may utilise the MCR to be producedupdate 15/10: still to review	[redacted]	SD to investigate	
323	801	Pipework - Heat Recovery Units	[redacted]	12/06/2019	[redacted]	No response review update 26/9: consider relacation Update 15/10: potential to relocate 1 unit to port side	[redacted]	SD to investigate	
324	801	Pipework Clashes - 1	[redacted]	12/06/2019	[redacted]	No response	[redacted]	WBD	
325	801	Pipework Clashes - 2	[redacted]	12/06/2019	[redacted]	No response	[redacted]	WBD	
326	801	Bilge Suctions in Engine Room	[redacted]	17/06/2019	[redacted]	No response	[redacted]	WBD	
327	801	Pipework - PME HT 3-Way Valve	[redacted]	17/06/2019	[redacted]	No response review update 26/9: to be investigated. Update 15/10: consider with 302	[redacted]	SD	
328	801	Sounding Pipes	[redacted]	17/06/2019	[redacted]	No response review update 26/9: CMAL to check pipes with a tape and advise any issues	[redacted]	CMAL to review	
329	801	Bilge Pipework between Generators by Fwd. Bulkhead	[redacted]	17/06/2019	[redacted]	No response review update 26/9: WBD	[redacted]	WBD	
330	801	Pipework - HT Outlet from Starboard Generator	[redacted]	17/06/2019	[redacted]	No response review update 26/9: WBD	[redacted]	WBD	

332	801	Starboard Bilge Pump	[redacted]	25/06/2019	[redacted]	No response review update 26/9: smaller handwheel required, check if impeller can be removed update 15/10: JD to respond	[redacted]	SD to investigate	
333	801	Pipework Clashes - Stbd. Main Engine Gas/ LT Inlet Pipes	[redacted]	25/06/2019	[redacted]	No response review update 26/9: WBD, in hand [redacted]	[redacted]	WBD	
336	802	Continuity of 140x7 BF at Shell Double Bottom Connections	[redacted]	16/07/2019	[redacted]	No response	[redacted]	WBD	
337	801	Axi-locks, Standards and Supervision	[redacted]	23/07/2019	[redacted]	No response review update 26/9: as 313 update 15/10: standards, training and inspection have been reviewed and a way ahead agreed, CMAL to be advised	[redacted]	FMEL to reply	
338	801	Pipework - Obstructing Pump Maintenance	[redacted]	23/07/2019	[redacted]	No response review update 26/9: review cranking the pipe	[redacted]	SD to review	
339	801	Gopfert Valve Alignment	[redacted]	23/07/2019	[redacted]	No response review update 26/9: WBD	[redacted]	WBD	
340	801	Main Engines - Cooling Water Drainage Arrangement	[redacted]	23/07/2019	[redacted]	No response review update 26/9: P&ID review	[redacted]	P&ID review	
341	801	Accessibility Issues	[redacted]	23/07/2019	[redacted]	No response review update 26/9: WBD on case by case basis	[redacted]	WBD	
342	801	Hydrant Next to Transformers in Pipe/Cable Space	[redacted]	23/07/2019	[redacted]	No response review update 26/9: WBD, remove from P&ID	[redacted]	WBD	
343	801	Manhole Access to Forepeak Tank Number 24	[redacted]	24/07/2019	[redacted]	No response	[redacted]	WBD	
344	801	Pipe Galvanising Finish	[redacted]	25/07/2019	[redacted]	No response	[redacted]	WBD	
345	801	E/L Valve Accessibility in Generator Room (Port)	[redacted]	25/07/2019	[redacted]	No response review update 26/9: WBD	[redacted]	WBD	
346	Both	Storage of Equipment & Material at Unit F3 Westway Renfrew	[redacted]	30/07/2019	[redacted]	No response Update 30.09: will be scoped as part of offsite stores consolidation	[redacted]	WBD	
347	801	Seating Arrangements and Additional Stiffening for Various Pumps	[redacted]	03/10/2019	[redacted]				
348	801	Seating arrangements and additional stiffening – Main Generator Room and Engineers Workshop	[redacted]	04/10/2019	[redacted]				
349	801	UPS/Power Units in ECR	[redacted]	07/10/2019	[redacted]				
350	801	HT Cooling Pipework – Fwd. of Starboard Generator	[redacted]	07/10/2019	[redacted]				
351	801	Bilge Suctions – Port Fwd. Generator Room	[redacted]	07/10/2019	[redacted]			WBD	
352	801	Size of Vent Trunk on Deck 5 and 6	[redacted]	08/10/2019	[redacted]			WBD	
353	801	Seating arrangements and additional stiffening Bow thruster area connections to Tank Top	[redacted]	10/10/2019	[redacted]				
354	both	Removal of Failed Alternators /Shaft Generators	[redacted]	14/01/2019	[redacted]				

APPENDIX 2 – CRITICAL PATH PLAN



NOTE: This critical path plan has been developed to determine the earliest possible delivery for the date range

APPENDIX 3 – TIMESCALE RISK ANALYSIS

A timescale risk analysis has been undertaken based upon the latest development of the schedule.

The first pass has been undertaken on the deterministic schedule with risk excluded, the second pass includes key risks from the risk register.

The estimation of range for each of the (non risk) schedule activities is:

Best Case	-15%
Most Likely	0%
Worst Case	+25%

TRA with risks excluded

The outcome for ship 801 is shown below:

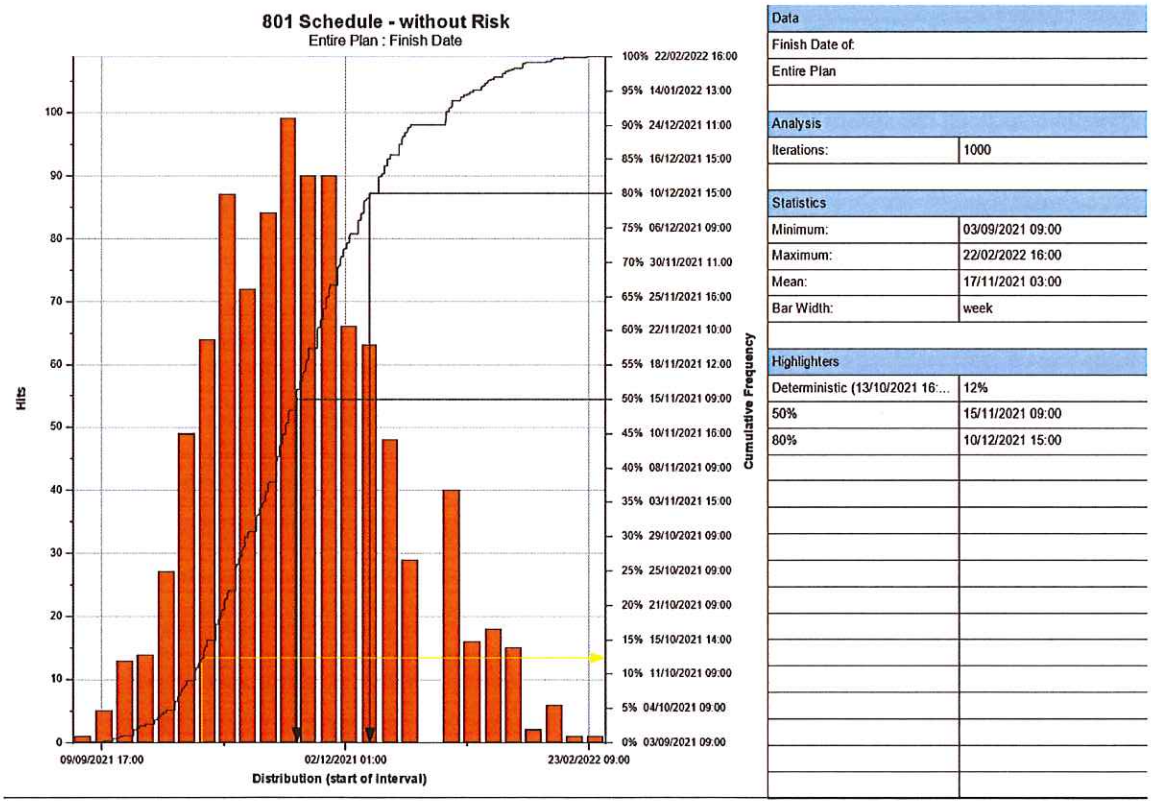
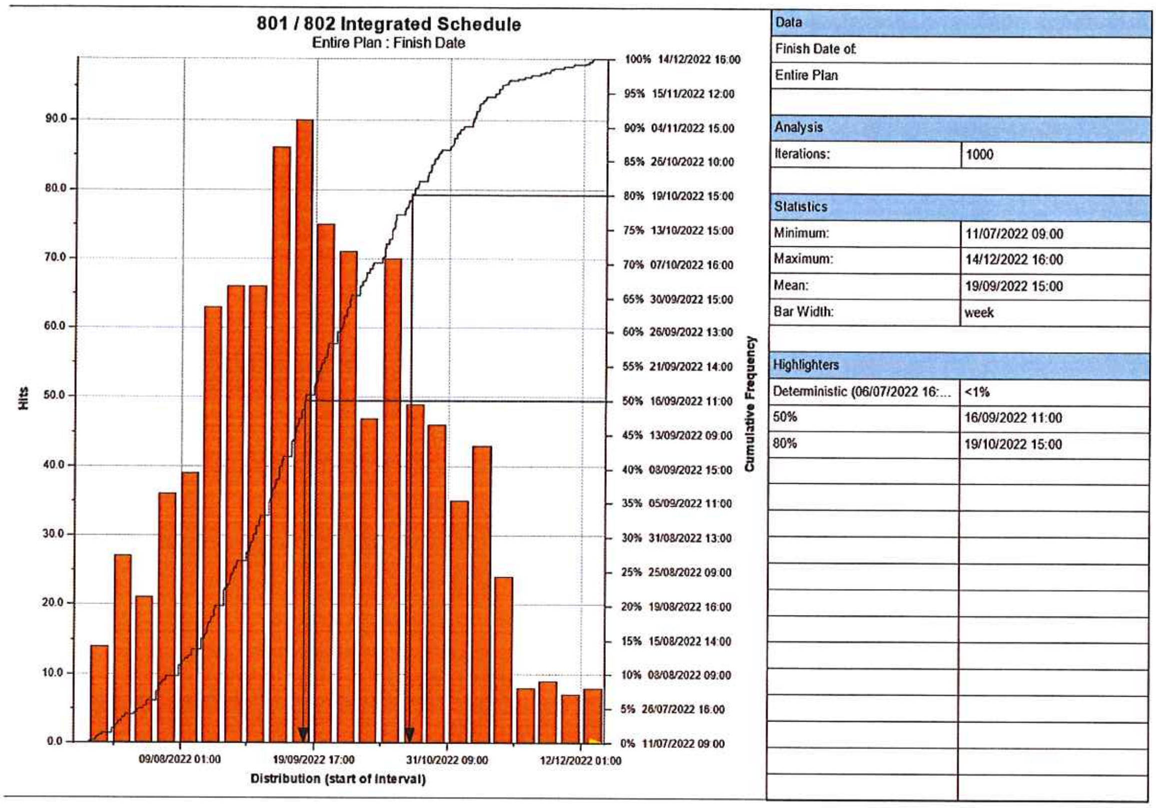


Fig1: Ship 801 TRA without risk

The outcome for ship 802 is shown below:

FERGUSON marine



The results show that there is a range of probability of delivery for ship 801 between **October and December 2021** (80% probability)

For Ship 802, the range of probability is **July and October 2022** (80% probability)

TRA with risks included

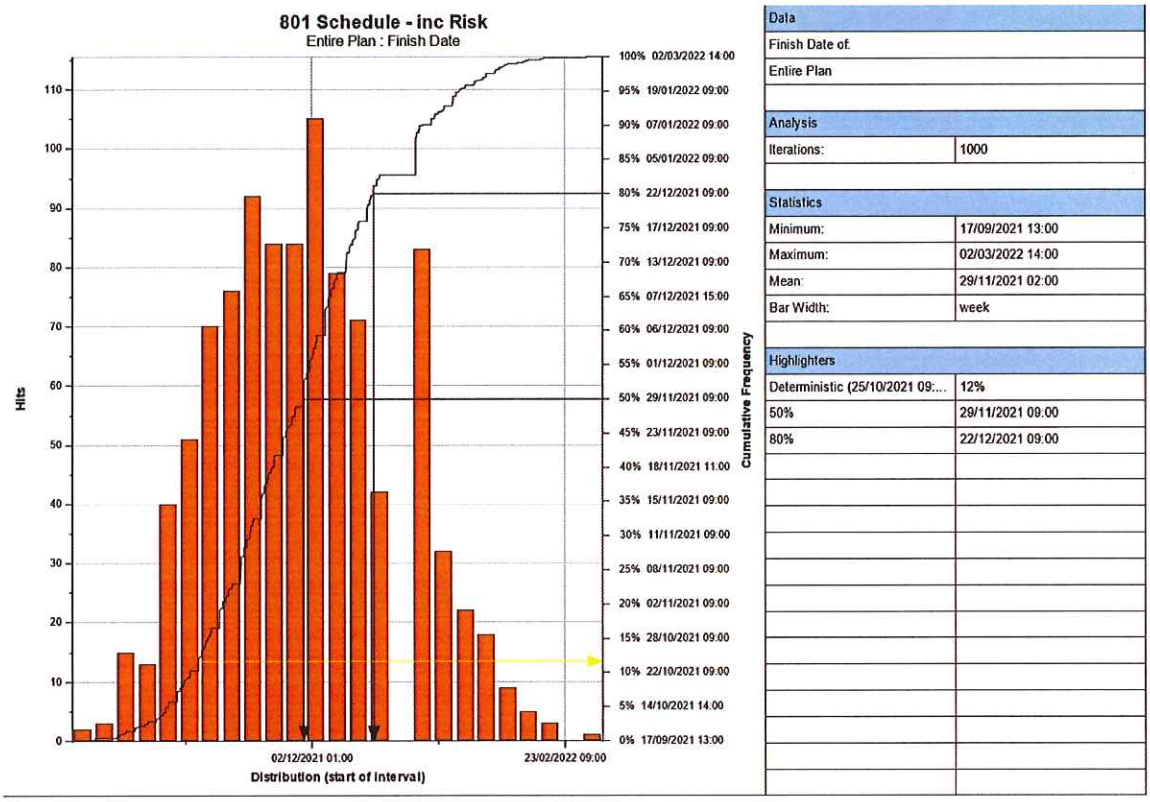
A further analysis has been undertaken with the following risks included (highlighted in green):

	Risk Category	Risk Identified By:	Risk Description	Controls in Place	Current Impact	Current Likelihood	Current Risk Score	Change to Risk Score	Action Planned	Target Impact	Target Likelihood	Target Risk Score
[illegible]	Project	[redacted]	Workpackaging arrangements are not robust enough to control properly the work sequence and capturing performance	No workpackaging arrangement currently in place	50	5	[illegible]		1. Introduce a process for workpackaging 2. Improve the organisation to deliver the new process	50	4	[illegible]
[illegible]	Supply Chain	[redacted]	Impact to the programme of the implementation of the Public Procurement process		50	5	[illegible]		1. Increase procurement headcount 2. Allow for time in the programme	50	4	[illegible]
05	Production	[redacted]	Production resource labour rates are below industry sector and may require an increase to be competitive in attracting and retaining resource		50	5	[illegible]		1. review allowance against market rates 2. Include allowance for potential increase	50	4	[illegible]
[illegible]	Supply Chain	[redacted]	Materials has been stored offsite at [illegible] in poor condition and unmanaged. The material condition and level of stock is uncertain and may result in material stock write downs		50	5	[illegible]		1. relocate all offsite materials to a new storage facility 2. undertake a stock take 3. improve store location capability	50	4	[illegible]
[illegible]	Production	[redacted]	Unable to recruit or retain Production staff in the required numbers with suitable qualifications and experience	Resource plans from revised programme, together with yard plan	50	5	[illegible]		1. develop the programme resource demand 2. produce a yard resource plan showing all projects 3. develop a resource supply strategy 4. Assumes subcontract labour will be provided at same internal rate 5. Extra supervision may be required	50	3	[illegible]
37	Project	[redacted]	Late delivery of 801/802	Risks associated with late delivery are captured elsewhere in the risk register with planned controls	50	5	[illegible]		1. Include a time allowance for programme slippage	50	3	[illegible]
38	Project	[redacted]	Programme launch date of 802 not met	Risks associated with late launch are captured elsewhere in the risk register with planned controls	50	5	[illegible]		1. Include time allowance for programme slippage (same as late delivery)	50	3	[illegible]
[illegible]	Project	[redacted]	The level of rework is not sufficiently scoped. Known rework is not fully scoped. Unknown rework will occur particularly during the test and commissioning phase	As part of the re-baselining, OOR's, 200 series drawings and other sources of information have been reviewed, costed and added to the programme. Future rework will be controlled by a more robust engineering change process	50	5	[illegible]		1. Completion of re-baseline evaluation 2. Updated and improved change control process 3. Allow additional time in the commissioning programme	25	5	[illegible]
[illegible]	Commissioning	[redacted]	Equipment may not work during the setting to work and commissioning phase as a result of being idle for a significant length of time	there is a limited equipment maintenance package for all equipment with the exception of anti condensation heating and main engine supplier maintenance	25	4	[illegible]		1. appoint a commissioning manager 2. review maintenance requirements	25	4	[illegible]
[illegible]	Production	[redacted]	The significant number of pipes made but not fitted cannot be found or are obsolete. There is a lack of stock control with pipes located at various places in the yard	There are no controls currently for made and stored pipes	25	5	[illegible]		1. Audit of pipes underway and grouping by system 2. Provide better storage location for pipes 3. Review pipes duplicate pipes made against latest iso and scrap surplus 4. Provide an allowance for pipes to be remade	24	4	[illegible]
46	Technical	[redacted]	Vessel cannot meet contract deadweight	Lightship weight continues to grow	50	5	[illegible]		1. Continue to limit weight growth wherever possible and practical 2. Commercial impact has been limited	25	4	[illegible]
47	Project	[redacted]	Hull vibration analysis indicates that there may be an inherent design problem	Vibration analysis report completed and vibration trials planned	25	4	[illegible]		1. Will need to await trials and fix as required	25	4	[illegible]
48	Project	[redacted]	LR internal noise and vibration limits are exceeded	Noise trials planned	25	4	[illegible]		1. Will need to await trials and fix as required	25	4	[illegible]
49	Project	[redacted]	Environmental noise limits are exceeded	Noise trials planned	25	4	[illegible]		1. Will need to await trials and fix as required	25	4	[illegible]
53	Technical	[redacted]	Machinery and Equipment maintenance access is not possible	Main items have removal/overhaul arrangements produced	50	4	[illegible]		1. plan for a demonstration of engine overhaul 2. produce remaining removal routings	25	4	[illegible]
77	Technical	[redacted]	the stability criteria may not be met	Ongoing development of stability model to analyse margins	50	4	[illegible]		Continue to develop stability model, updating to reflect all predicted weight/centre reviews	25	4	[illegible]
55	Supply Chain	[redacted]	Failure of equipment during warranty period. Supplier guarantees have expired	warranty controls and spreadsheet is live to allow ongoing review of current position	50	5	[illegible]		warranty review meeting completed and information shared on all live warranties - where warranty is no longer able to be extended (Wartsila) a care and maintenance plan will be put in place	30	3	90
[illegible]	Production	[redacted]	Dirt and foreign body ingress into piping systems causes commissioning problems. Caused by inadequate protection on pipe ends	Pipes have been stored externally for some time and open to the elements. Internal pipework is not always blanked off	50	4	[illegible]		1. Plan for chemical flushing of key systems 2. Improve pipe storage 3. Improve blanking for open ends	25	3	75
[illegible]	Technical	[redacted]	The approval status of stage 1 design is not closed out and final approval may cause rework in Stage 2 & 3 and production	Stage 1 design is finished in most areas, but still a few incomplete	25	4	[illegible]		1. Continue to review and chase outstanding approvals 2. Increase effort to submit any new drawings for approval as soon as they are released	25	3	75
[illegible]	Technical	[redacted]	The status of stage 2 and 3 is unclear which may cause rework or extra work	The workscope was not clearly defined and scheduled	50	6	[illegible]		1. S2/S3 work has been scoped by FMEL and VH. 2. VH scope to be reviewed to ensure completeness and achievability 3. Dedicated resource will be focused on the machinery spaces to resolve issues as they arise	25	3	75

The risks have been added to the programme as discrete activities and modelled with an estimate of range as:

Best Case	0
Most Likely	50% of worst case time
Worst Case	planned activity duration

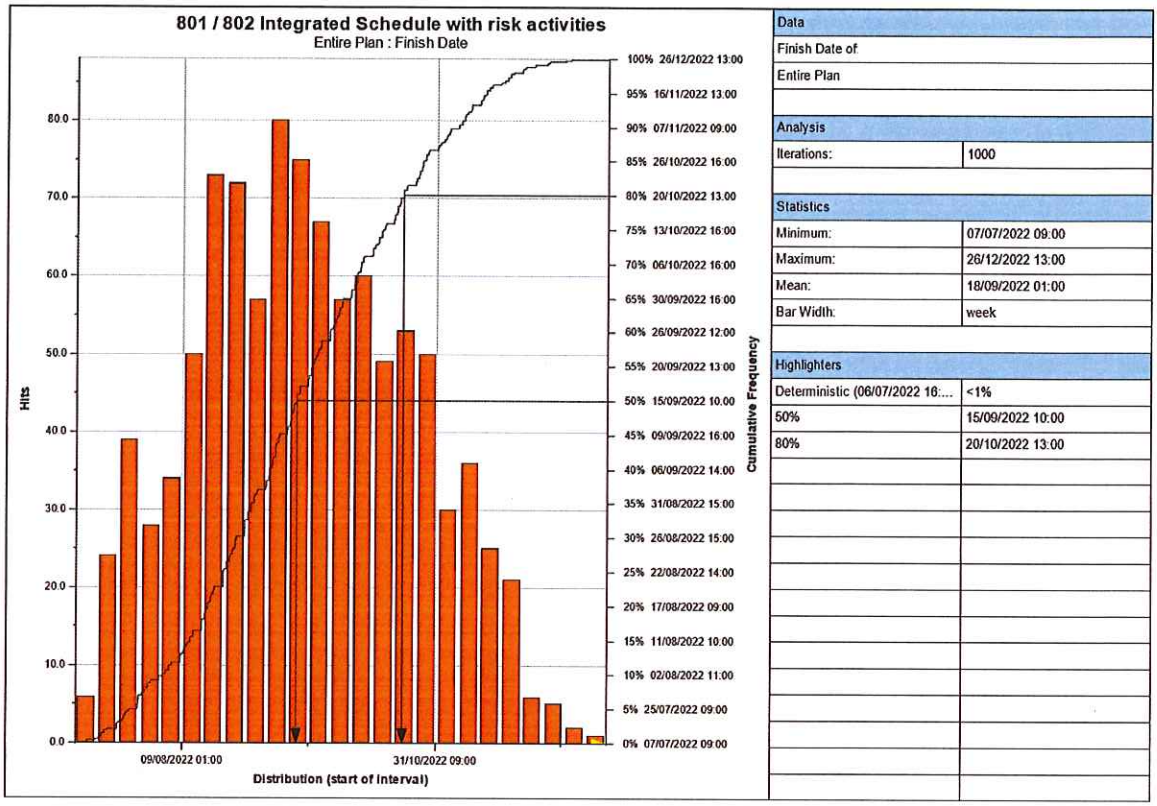
The outcome for ship 801 is shown below:



Data	
Finish Date of:	
Entire Plan	
Analysis	
Iterations:	1000
Statistics	
Minimum:	17/09/2021 13:00
Maximum:	02/03/2022 14:00
Mean:	29/11/2021 02:00
Bar Width:	week
Highlighters	
Deterministic (25/10/2021 09:...	12%
50%	29/11/2021 09:00
80%	22/12/2021 09:00

Fig3: Ship 801 TRA with risk

The outcome for ship 802 is shown below:



Data	
Finish Date of	
Entire Plan	
Analysis	
Iterations:	1000
Statistics	
Minimum:	07/07/2022 09:00
Maximum:	26/12/2022 13:00
Mean:	18/09/2022 01:00
Bar Width:	week
Highlighters	
Deterministic (06/07/2022 16:...	<1%
50%	15/09/2022 10:00
80%	20/10/2022 13:00

Fig4: Ship 802 TRA with risk

The results show that there is a range of probability of delivery for ship 801 between **October and December 2021** (80% probability)

For Ship 802, the range of probability is **July and October 2022** (80% probability)

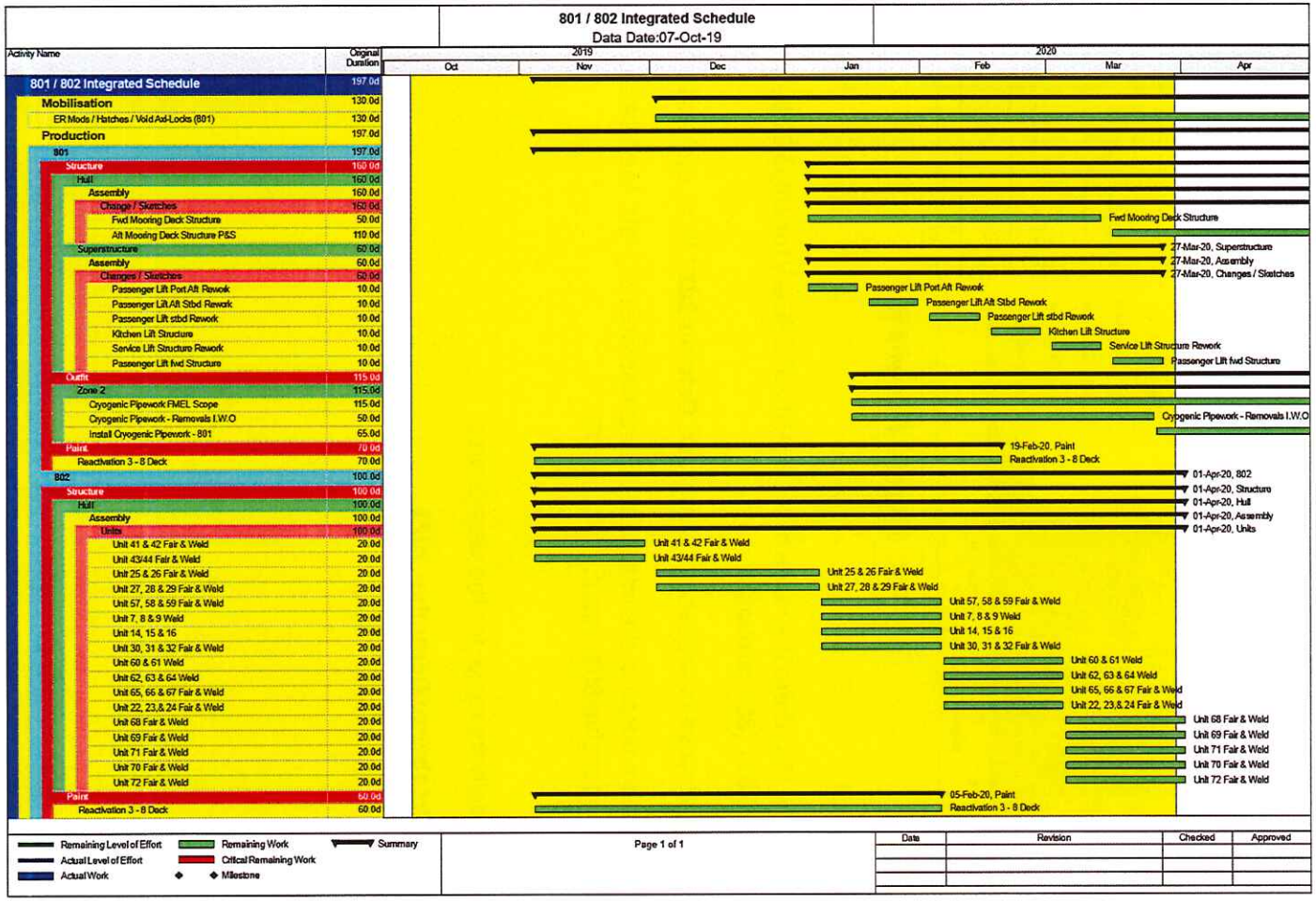
Comparing the two outputs, the impact of adding discrete risks into the TRA has only made a small difference for ship 801 and non for ship 802.

Therefore the delivery range for the vessels are:

801 – October to December 2021

802 – July to October 2022

APPENDIX 4 – REMEDIATION WORK AT SHIP



APPENDIX 5 – REMEDIATION WORK

	Q4 2019 to Q1 2020	Q1 2020	Q2 2020
Resource – Production	Design and agree Production Management Structure Agree core workforce based on high level plan	Identify temporary staff to be made permanent Liaise with recruitment agencies and set up contracts Commence and complete recruitment process of core workforce Management Structure in place Calibrate core workforce between high level plan and detailed plan	Commence the mobilisation of workforce to undertake the plan Manage the resources with temporary workforce in line with plan
Resource - Engineering	Review of organisation structure within design team and drawing office Identified gaps in skills and knowledge to be filled Vacancies advertised Reward analyst engaged to review and evaluate jobs, salaries and grades Jobs evaluated and new grading structure identified New starts commencing	Complete engineering recruitment [redacted]	
Planning and Controls Process	New planning team in place Planning process developed Control accounts developed Programme plan developed to L2 Reporting pack agreed	Programme plan baselined Remedial work commenced by work package Project reporting in place 6 week look ahead undertaken	All work controlled by work package Project performance analysed with forecast at completion 12 week look ahead in place

	Q4 2019 to Q1 2020	Q1 2020	Q2 2020
	Remedial workscope planned First trial work package produced	Risk reviews embedded	
Engineering mobilisation	Assessment of alternative engineering model Develop P&ID's – incorporating major change Commence 3D model clean up Agreement of change	Detailed design contracted Z2 design commenced	Z2 design completed
Offsite stores consolidation	Sign lease for new storage facility Arrangements in place for equipment movement and stock take	Equipment relocated Stock take complete Equipment missing or damaged identified and re-ordered	
Major on-site subcontractors	Re-engage with subcontractors [redacted]	Sub contractor contracts updated Sub contractor scope of work incorporated into baseline plan [redacted] Identify potential alternative electrical contractors	Agree overall electrical package scope of work
Axilock review	Agree way forward with CMAL Develop quality control approach Review impact to programme	Complete axilock remedial work	
Cryogenic pipework installation	Allocate engineering resource	Develop engineering data for work in way Prepare cryogenic piping route at ship	Install cryogenic pipework on 801

	Q4 2019 to Q1 2020	Q1 2020	Q2 2020
Business Improvement – General	[redacted]	Develop and roll out the business improvement plan	
Business Improvement – organisation	Review organisation for: Production Supply Chain Engineering (linked to engineering mobilisation)	Finalise and implement organisational changes	
Business Improvement – processes	Develop and implement planning and controls process Develop an engineering change process	Implement an engineering change process Develop a configuration management process Develop and implement a defect management process Develop a stock control process Develop a work package material control process	Implement a stock control process Implement a configuration management process Implement a work package material control process

APPENDIX 7 – KEY MILESTONES

Quarter	General	801	802
2020			
1	Programme has been baselined. Detailed design work for the ships has recommenced. Key process changes have been implemented. key resource has been mobilised. Work is being issued as work packages.	Full remediation work has commenced.	Fair and weld of steel structure on the berth commenced.
2	Detailed design production outputs for critical path issued. 6 week look ahead programme operating.	Remediation work on the ship continues. Forward mooring deck is complete. Engine room rework completed.	Commence fabrication of final structural units in the production hall.
3	Detailed design production outputs issued to support zone plan.	Remediation work completed. Full production work commenced. cryogenic pipe work installed.	Completion of the structure continues. Outfitting work commences.
4		outfit work commences on upper passenger and crew decks.	Outfit work continues in machinery spaces
2021			
1	Detailed design production outputs complete.	All ship structural work is complete.	
2		outfit work in ciritical path engine rooms near completion. commissioning commenced.	Unit fabrication of hull complete and erected, steel strcuture is complete.
3		Major outfitting complete. Propulsion systems commissioned. Ship prepared for sea trials. Dock trials complete.	Zone 1 hotwork complete. Outfit across the ship progressing.
4		post sea trials work completed. final defect clearance. Delivery and handover to CMAL.	Ships superstructure completed. Commissioning of ship systems commenced.
2022			
1			Major outfitting complete. Ship Launch.
2			Main engine commissioning complete.
3			Propulsion systems commissioned. Builders sea trails complete.
4			post sea trials work completed. final defect clearance. Delivery and handover to CMAL.

APPENDIX 8 – COST BREAKDOWN

FUNDING REQUIREMENT (incl carried costs less 803/04/05)	2019/20 Forecast	2020/21 Forecast	2021/22 Forecast	2022/23 Forecast	Total
801 Costs					
Labour	1.3	6.7	2.8	1.2	12.1
Material	5.4	9.4	4.3	0.5	19.6
Accounts Payable	0.7	0.0	0.0	0.0	0.7
Contingency for performance penalties			0.4		0.4
					32.8
802 Costs					
Labour	0.8	7.0	8.2	1.7	17.7
Material	3.3	8.4	14.7	0.4	26.7
Accounts Payable	1.1	0.0	0.0	0.0	1.1
Contingency for performance penalties				0.4	0.4
					45.9
General					
Consumables	0.1	0.4	0.4	0.1	1.1
Overheads	3.4	8.2	7.8	1.7	21.1
SGA	1.2	3.0	2.9	0.7	7.8
CAPEX	0.0	1.6	0.0	0.0	1.6
Total	**17.2**	**44.6**	**41.5**	**6.8**	**110.3**

Phase 1 Remedial (7 months)					
801 Direct Labour	1.3	1.0	0	0	2.3
801 Direct Material	0.1	0.0	0	0	0.1
801 Accounts Payable	0.7	0.0	0	0	0.7
802 Direct Labour	0.8	1.1	0	0	1.9
802 Direct Material	0.1	0.0	0	0	0.1
802 Accounts Payable	1.1	0.0	0	0	1.1
General Consumables	0.1	0.1	0	0	0.2
General Overheads	3.4	1.5	0	0	4.9
General SGA	1.2	0.5	0	0	1.7
Remedial Cost	**8.6**	**4.2**	**0.0**	**0.0**	**12.8**
Phase 2 Build					
801 Direct Labour	0.0	5.7	2.8	1.2	9.8
801 Direct Material	5.4	9.4	4.3	0.5	19.6
801 Accounts Payable	0.0	0.0	0.0	0.0	0.0
801 - Contingency for performance penalt	0.0	0.0	0.4	0.0	0.4
802 Direct Labour	0.0	5.9	8.2	1.7	15.8
802 Direct Material	3.2	8.4	14.7	0.4	26.7
802 Accounts Payable	0.0	0.0	0.0	0.0	0.0
802 - Contingency for performance penalt	0.0	0.0	0.0	0.4	0.4
General Consumables	0.0	0.4	0.4	0.1	0.9
General Overheads	0.0	6.7	7.8	1.7	16.2
General SGA	0.0	2.5	2.9	0.7	6.1
Build Cost	**8.6**	**38.9**	**41.5**	**6.8**	**95.9**
Capex	**0.0**	**1.6**	**0.0**	**0.0**	1.6
Total Funding Requirement	**17.2**	**44.6**	**41.5**	**6.8**	**110.3**

APPENDIX 9 – COST RISK ANALYSIS

Cost Risk Analysis (CRA)

A cost risk analysis has been undertaken in order to:

a) Determine the level of risk inherent within the programme but not identified with the risk register
b) Verify whether the risk contingency included within the cost, £8.8m, is adequate.

The CRA is based upon the latest development of the schedule.

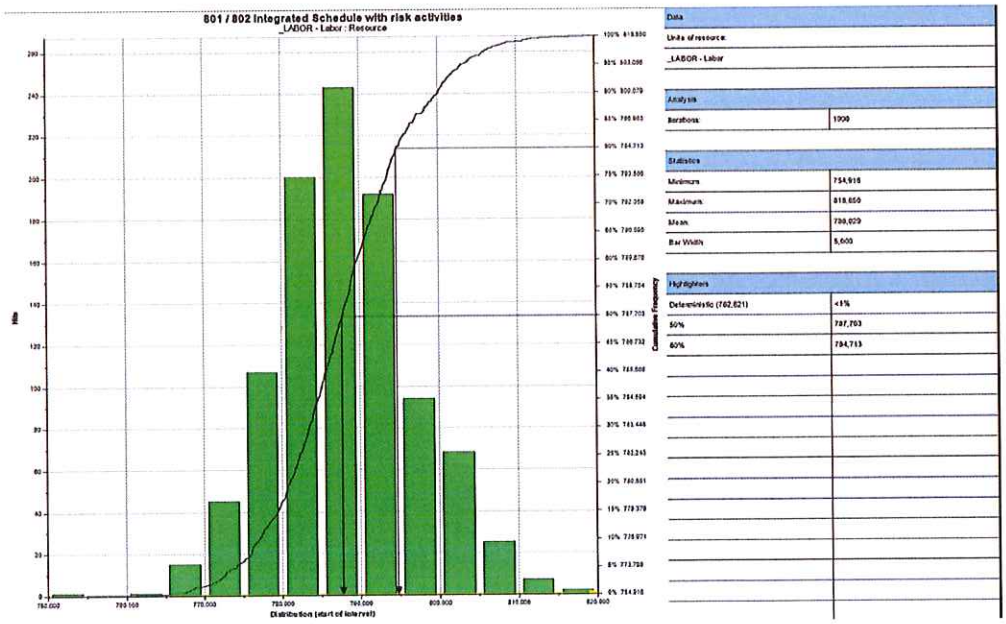
CRA with risks excluded

The first pass has been undertaken on the deterministic schedule with risk excluded. The CRA is based upon the manhours associated with the schedule and is then pro-rata against the manhours and materials for the vessel completion costs. (not remediation, capex or penalty costs which can be considered fixed). The CRA results therefore allow a final cost range to be assessed.

The estimation of range for each of the (non risk) schedule activities is:

Best Case	-15%
Most Likely	0%
Worst Case	+25%

The outcome is shown below:



The range of risk is between deterministic (762,621 manhours) and 80% probability (794,713 manhours). The percentage increase is therefore 4.2%.

Applying this to the cost base to complete the vessels (£95.1m) shows a maximum cost of £99.1m.

Note: this has been applied to the material costs as well as there are significant on-site subcontractor costs that would be affected.

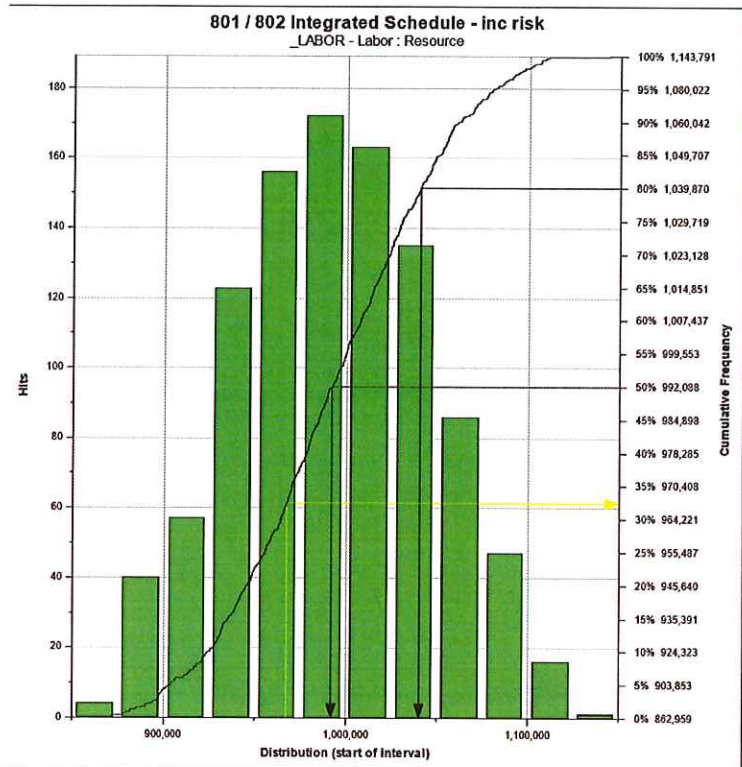
The cost range to complete vessels 801 and 802 is: £110.3m to £114.3m

CRA with risks included

The following key risks have been included in the CRA:

	Risk Category	Risk identified by:	Risk Description	Risk Contingency	Impact to manhours	Impact to materials	Manhours to include in risk (Maximum)
22	Project		Workpackaging arrangements are not robust enough to control properly the work sequence and capturing performance	2,000k	2,000,000	-	80,000
84	Supply Chain		Impact to the programme of the implementation of the Public Procurement process	100k 3 months programme	100,000	-	4,000
85	Production			1,500k	1,500,000		60,000
86	Supply Chain		Materials has been stored offsite at Westway in poor conditions and unmanned. The material condition and level of stock is uncertain and may result in material stock write downs	1,800k	-	1,800,000	-
35	Production		Unable to recruit or retain Production staff in the required numbers, with suitable qualifications and experience	250k	250,000	250,000	10,000
37	Project		Late delivery of 801/802	3,500k 3 months delay	3,000,000	500,000	120,000
14	Project		The level of rework is not sufficiently scoped. Known rework is not fully scoped. Unknown rework will occur particularly during the test and commissioning phase	1,000k	800,000	200,000	32,000
16	Commissioning		Equipment may not work during the setting to work and commissioning phase as a result of being idle for a significant length of time	100k	20,000	80,000	800
18	Production		The significant number of pipes made but not fitted cannot be found or are obsolete. There is a lack of stock control with pipes located at various places in the yard	175k	50,000	125,000	2,000
46	Technical		Vessel cannot meet contract deadweight	100k			-
47	Project						-
48	Project		LR Internal noise and vibration limits are exceeded	150k	75,000	75,000	3,000
49	Project		Environmental noise limits are exceeded	200k	100,000	100,000	4,000
53	Technical		Machinery and Equpiment maintenance access is not possible	200k	200,000	-	8,000
77	Technical		the stability criteria may not be met	250k	150,000	150,000	6,000
55	Supply Chain		Failure of equipment during warranty period, Supplier guarantees have expired	50-100k	-	100,000	-
17	Production		Dirt and foreign body ingress into piping systems causes commissioning problems. Caused by inadequate protection on pipe ends	50-100k	100,000	-	4,000
19	Technical		The approval status of stage 1 design is not closed out and final approval may cause rework in Stage 2 & 3 and production.	50-100k	100,000	-	4,000
20	Technical		The status of stage 2 and 3 is unclear which may cause rework or extra work	50-100k	100,000	-	4,000

The output is:



Data	
Units of resource:	
_LABOR - Labor	
Analysis	
Iterations:	1000
Statistics	
Minimum:	862,959
Maximum:	1,143,791
Mean:	992,828
Bar Width:	25,000
Highlighters	
Deterministic (967,421)	33%
50%	992,088
80%	1,039,870

The range of risk is between deterministic (967,421 manhours) and 80% probability (1,039,870 manhours). The percentage increase is therefore 7.5%.

Prior to undertaking the CRA we had already made an assumption of adding in a risk contingency of £8.8m to the costs to complete the vessels (£95.1m). This represents a 9% increase to the cost. The CRA output shows that this assessment is still considered adequate.

APPENDIX 10 – RISK REGISTER

	Risk Category	Risk identified by	Risk Description	Controls in Place	Current Impact	Current Likelihood	Current Risk Score	Change to Risk Scoring	Action Planned	Target Impact	Target Likelihood	Target Risk Score	Change to Risk Scoring	Risk Contingency	M1 contingency	M2 contingency	new risk/ans during ...ning period	Risk Owner	Date Last Updated	Date Last Reviewed	Change explanation
12	Project		Acting & staging arrangements are not robust enough to control properly the work sequence and capturing performance	No or inadequate staging arrangement currently in place	10	5	50		1. Introduce a process for managing staging 2. Improve the organisation to deliver the new process	10	4	40									
14	Supply Chain		Impact to the programme of the implementation of the Public Procurement process		10	5	50		1. Increase procurement headcount 2. Allow flexibility in the programme	10	4	40		10.0k 1 month programme	5.0k	10k	25.0k 3 months programme				
15	Production		Production schedule slippage due to low reliability and productivity, output and increase in the competitive scheduling and planning process		10	5	50		1. Improve structure and organisation 2. Include all critical elements in new design/facility	10	4	40		1.00k	500	1.5k	3.00k				
16	Supply Chain		Material Shortfall / Inadequate Supply of Materials to Site (Consumables) generated. The delay, disruption and knock-on effects to production and may result in working outside scope.		10	5	50		1. Increase the number of suppliers 2. Include all critical elements in new design/facility 3. Improve communication quality	10	4	40		5.00k	500k	1.5k	3.00k		2021-08		
17	Production		Failure to meet all Contract Dates and the required numbers with Update specification and programme	Production plan from revised programme. Improved with yard plan	10	5	50		1. Review the programme and plan in detail 2. produce yard resource plan showing shortfalls 3. Develop a recovery plan strategy 4. Assumes subcontract labour will be provided at some commercial risk 5. Extra supervision may be required	10	3	30		10.0k	5.0k	15.0k	15.0k		2019-19		
18	Project		Late delivery of SCV02	Work plan produced with late delivery and slippage plan implemented. No risk mitigation in place to	10	5	50		1. Include some allowance for programme slippage	10	5	50		5.00k 3 months delay	2.50k	7.50k			Sep-19		
19	Project		Programme slippage due to late FAT and trial	Work plan produced with slippage plan implemented in the programme	10	5	50		1. Include some allowance for programme slippage (same as late delivery)	10	5	50		5.00k 3 months delay					Sep-19	2019	
20	Project		The level of risk is not sufficiently scoped. Given new build activity is scoped. Given the new build activity, particularly during the build and commissioning phase	No plan of the risk/activity SCV01, 02 or 03 was in place. Given the nature of the build activity, it has been difficult to control and action the programme. Future risk is within the control of the individual departments (Yard & Ferry)	10	5	50		1. Completion of the above evaluation 2. Update and implement the risk control measures 3. Allow additional time in the commissioning programme	25	5	125		5.00k	2.5k	7.5k			Sep-19		
21	Commissioning		Engineering resource during the outfitting work and commissioning phase as a result of being on the wrong side of a significant change	Yard & Ferry plan for appointment and assessed package for full engagement of the vessel on the work completed to date and agreed with engineering support and ongoing support from Ferry	25	4	100		1. Appoint a commissioning manager 2. Increase the resource requirements	25	4	100		10.0k	5k	15k			Sep-19		
22	Production		The significant number of pipes made but not fitted cannot be found or are damaged. There is also a lot of work commenced on pipes and all various pipework on the yard	There are no controls currently for made and fitted pipes	25	5	125		1. Audit of pipes stores and progress by admin 2. Provide better storage location for pipes 3. Review pipes & spools pipes made regarding drawing and pipe supply 4. Provide an allocated area for pipes to be stored	20	4	80		17.5k	7.5k	25k	17.5k		2019-19		
23	Technical		Lateral weld seam cracks on deck	Lighting weight contractor to grow	10	5	50		1. Continue to limit weight growth wherever possible and practical 2. Commercial weight management team	25	4	100		10.0k	5k	15k			2019-19		
24	Project		High vibration issues due to vessel that has not been an inherent design problem	Vibration analysis has all completed and where that has been	25	4	100		1. Address the vibration issues	25	4	100		10.0k 4 No.	5k	15k			Sep-19		
25	Project		Life time issues and obsolescence management	Issues are picked	25	4	100		1. Address life issues and identify equipment	25	4	100		10.0k	5k	15k			Sep-19		
26	Project		Lack of spares and holding areas not full	Issues are picked	25	4	100		1. Address life issues and identify equipment	25	4	100		10.0k	5k	15k			Sep-19		
27	Technical		Machinery and equipment maintenance access is not possible	Work from those who have worked and progressively produced	25	4	100		1. Look for a permanent solution change overhaul 2. Include additional provision in FMEA	25	4	100		10.0k	5k	15k			2019-19		
28	Technical		The stability changes by full crowd	Ongoing development of stability limits for applied weights	25	4	100		Continue to develop stability limits, applying to which all practical weight limits are known	25	4	100		10.0k	5k	15k			2019-19		
29	Supply Chain		Failure of equipment during a warranty period. Support guaranteed has expired	warranty, contract and spreadsheet is held to show ongoing review of warranty work	10	5	50		warranty review meeting (monthly) and information about impact of all the warranties where warranty is no longer valid to be extended where practical and maintenance plan of the vessel	10	3	30		5.00k	2.50k	10.00k			2019-19	October	
30	Production		Delayed Design Duty Holder Engineering Authority issues. Commissioning problems. Cause by already agreed to be done on plans held.	Agreed between client and Authority for some time and specific to be remedy. Internal process is not always followed	10	4	40		1. Plan for Technical Authority Duty Holders 2. Improve pipe storage 3. Improve planning for spool work	25	3	75		10.00k	5.0k	15.00k			2019-19	2019-19	
31	Technical		The approval date of Stage 1 design is late in construction and that approval has a late review of Stage 1 & 2 design/construction	Stage 1 design scheme has not been fully developed, but still active incomplete	25	4	100		1. Continue to review and close outstanding approvals 2. Increase efforts to get all they are drawings that require full approval as soon as they are issued	25	3	75		17.50k	10.00k	5	22.50k		2019-19	2019-19	
32	Technical		The structural design is not properly defined and scheduled	The architecture is not properly defined and scheduled	10	5	50		1. Look at the risk from a safety, time, and cost 2. Work closely between the actual completed and achievability 3. Dedicated resource will be focused on the machinery space to realise issues pathway early	25	3	75		10.00k	10.00k		10.00k		2019-19		
33	Technical		Working arrangements with workboats cause delays to the programme as crewing and engineering have to ring	Limited management controls in place	10	5	50		1. Check Time Zones on this. Is it time 2. A reduction of the workboats are allocated to include crewing 3. Improved planning and confirmation is established to involve programmes may be required	25	3	75		10.00k	10.00k		10.00k		2019-19		
34	Project		Poor change control management leads to changes being submitted between handovers	Improved and flexible Engineering Change control process	25	5	125		1. Modify and improve the revised change control process 2. Audit the process to ensure effectiveness	25	3	75		10.00k	5.00k	15.00k	10.00k		Sep-19		
35	Technical		Failure to install or retain niches and part of the required hardware, with resulting quality issues and rework	Increase planning and involvement process is underway	10	5	50		1. Improve installation 2. Investigate mechanisms to fit and verify fixings of primary items	25	3	75		10.00k	5.0k	15.00k			2019-19		
36	Quality		Safety does not comply with various aspects SOLAS and Rules	Using rules and SOLAS part of A1 subject of future consultancy at this time	25	5	125		1. Improve installation and commissioning plan with ETS prior to 2021 2. Improve installation and commissioning plan with ETS prior to 2021	25	3	75		10.00k	5.0k	15.00k			2019-19		
37	Project		Inexperience in the shipyard and human and physical resources	Yard ETS and Ferry planned to complete this over 10 session for technical staff to have account of such services. Yard ETS also commit to complete Q2 2020. Production personnel have account of this. For Italian riders, the impact to ETS Engineering will be assessed before any commitments are made	25	3	75		1. Develop a particularly plan for all yard resources 2. Regularly review resource demands vs availability 3. Review any future contracts against current contracts	25	1	25		10.00k	10.00k		10.00k		Sep-19		
38	Production		Delays to Openings Hatches, Ramp Access and Watertight	Commitment and review of Shipyard and Vessel plan	25	1	25		1. Review shipyard and vessel plan weekly by Shipyard	25	1	25		10.00k	10.00k	10.00k			2019-19		
39	Production		The time limit and basic arrangements are complex causing issues during STW and commissioning		25	4	100		1. Review of STW and commissioning plan with ETS prior to STW	25	3	75		10.00k	5.0k	15.00k			2019-19		
40	Supply Chain		Shortage cost for yard and maintenance plan may exceed the budget		25	4	100		Early engagement and negotiation of shortage points of claims and ready to work to a plan	25	3	75		10.00k	5.00k	15.00k	10.00k		2019-19		
41	Production		Dangerous pipework (gripping/pressurised or Pipe Damage)	The dangerous gripping times are not figured out in the event of weakness in the welding or pipe during pressurised or and the pipe is not welded	10	2	20		Worker awareness and the installation. Also check at the ground, and pipes installation and out	25	2	50		10.00k	5.00k	15.00k			2019-19		
42	Technical		Design does not comply with various aspects SOLAS and Rules	Using rules and SOLAS part of A1 subject of future consultancy at this time	10	3	30		1. Continue to review and close outstanding approvals 2. Ensure risk assessment is in place	25	2	50		5.00k	2.50k	10.00k			2019-19		
43	Technical		Handover documentation not provided in time	Information and drawings collected throughout project and handover	25	4	100			25	2	50		10.00k	5.00k	15.00k			2019-19		
44	Project		Weather conditions may impact on the ability of the vessel to undertake planned trials, crew production	The Ferry and complete positions are required to weather the trials, crew production	10	5	50		1. Provide protection for external work, e.g. painting	10	5	50		10.00k	5.00k	15.00k			2019-19		
45	Technical		Safety concerns with specification of vessels commonly	Many Ferry and Cruising commonly used to be noted	25	4	100		Ensure vessel is to the latest issues / changes	25	2	50		10.00k	10.00k	15.00k	10.00k		2019-19		
46	Technical		Hydrostatic test of the hull not approved by LR	Decisions of all expenditures are urgently to review all hull approved plans	25	4	100		Continue to notify owner of requirement of hydrostatic test	25	2	50		10.00k	5.00k	15.00k			2019-19		
47	Supply Chain		Availability of key stock for yard and vessel from key vendors in accordance with the programme	Scope of supply to be defined and fully planned	25	4	100		Any loss scope to be confirmed and fixed (priority to agreed) Early communication and clarifying with Ship Builder	25	2	50		10.00k	10.00k				2019-19	October	
48	Supply Chain		Subsidy qualified MSC certified crewing not to be available to support the operations	Scope of new to be defined and fully planned	25	4	100		Form scheme required for ships and early engagement with crewing	25	2	50		10.00k	5.00k	15.00k			2019-19	October	
49	Production		The risk of poorly located commissioning problems - leakage - and poor through the maintenance injury. The use of services is not considered and Ferry required to fit the noise sufficient	A review of stock limit of the engine and ETO items and the purchase and procurement actions removed and remaining actions will be QC checked	10	5	50		1. A yard standard to be produced 2. Installation training to be provided 3. QC oversight to be established 4. Known actions to be removed 5. ER and ETO present at the project yard and monitored	10	4	40		10.00k	5.00k	15.00k	10.00k		2019-19		
50	Quality		The yard structural elements are not to design and construction rules		25	4	100		Conduct a time review commissary of hull structure in full and as clarified as anticipated to specific company information to Design model Engineer and issues on the hull from finishing joiners and engineers to commissioning yard	10	4	40		10.00k	5.00k	15.00k	10.00k		2019-19		
51	Production		Damage to Cylinder Liner actuators, charge air blower as injection and after cover. Previous experience of ship 721 required a number to be replaced	Jack and block in place has not	10	5	50		1. Improved training and protection plan	10	4	40		10.00k	5.00k	15.00k			2019-19		
52	Production		Inadequate Design and Planning of the Project to commence a number of activities in parallel to the delay	Yard process management plan	10	5	50		1. Clarify programme and resource with all stakeholders to agree a plan 2. Allocate the resource identified in the plan	10	4	40		10.00k	5.00k	15.00k			2019-19		
53	Technical		Ship has not met the requirements of the Ship Construction Certificate (SCC)	No structure has been identified	10	3	30		No further action to be taken given status of	10	3	30		5.00k	2.50k	10.00k			2019-19		
54	Project		Lack of control of subcontractors work leading to disruptive working and costs	Subcontract manager on the appointed	10	5	50		1. Agree T&Cs and appoint project manager 2. Advertise and appoint subcontractor/s	10	3	30		5.00k 1 month delay	2.50k	10.00k			2019-19		
55	Supply Chain		Equipment items cannot be sourced and timely logistics support in the appointed	No current SCV, many equipment issues have not been identified	10	5	50		Ensure equipment and SCV are known. Facility in hand to follow and then in hand review and action close to full extent possible	10	3	30		5.00k	2.50k	10.00k			2019-19	October	
56	Technical		Machinery and equipment not originally fixed aligned and operating	Arrangements in place but out of date	25	4	100		1. Establish the root cause of the issue and implement 2. Review and update the maintenance plan	10	3	30		10.00k	5.00k	15.00k	10.00k		2019-19		
57	Project		Duplication and quality of key documents (SCV02) need to be rectified		25	4	100		1. Review the current drawing issue	10	3	30		10.00k	5.00k	15.00k			2019-19		
58	Project		Only one vessel built	Regular meetings with Ship Builder and specific agreements formed with Ship Builder. Ship Builder to be scoped and for the commissioning programme	10	4	40		1. Market regular meetings 2. Ensure agreed SCV02 are scoped and for the programme and implemented 3. Review Master Ship plan, agreed and published	10	3	30		10.00k	5.00k	15.00k			2019-19		
59	Technical		The requirements for engine room noise is not met		10	3	30		1. Review the noise levels and procedure	10	3	30		10.00k	5.00k	15.00k	10.00k		2019-19	2019-19	
60	Production		There is insufficient quality throughout the yard and installation to support the programme	Programme between the yard issues and installation plans and completed activities	10	5	50		1. Improve quality throughout the yard and installation 2. Produce plans for completion and complete installation issue 3. Produce specific plans for outfitting and installation of hull and pipework	10	3	30		10.00k	5.00k	15.00k			2019-19	2019-19	
61	Supply Chain		Currency risk with client suppliers	Exchange rate has been calculated and contracted the rate as over Jan 2019	10	1	10		Minimum scope from Europe and supplies has been confirmed, ongoing risk would be agreed	10	3	30		10.00k	5.00k	15.00k			2019-19		
62	Supply Chain		Equipment delivery may not be sufficiently covered	The equipment from suppliers previously where vessel / service and stocking analysis storage to date where issues	10	3	30		Care and protection during delivery with vessel / service and protection service and storage to date where issues. Close down of parts required to be carried out during 3 months	10	2	20		10.00k	5.00k	15.00k			2019-19		
63	Production		SCV Facilities and site set up not known for vessel. Client work and for SCV	Limited production / commissioning plan / opportunity to operate on a client work to complete commissioning	10	2	20		1. production review of facilities to be agreed to improve on ship construction	10	2	20		10.00k	5.00k	15.00k			2019-19		
64	Technical		Overhaul and Maintenance - Overhaul is considered and commissioning plan for the engine and engine systems and the engine is not to be done to a high standard	Overhaul and Maintenance - Overhaul is considered and commissioning plan for the engine and engine systems and the engine is not to be done to a high standard	10	4	40		1. Identify the noise in the yard and the overall opportunity	10	2	20		10.00k	5.00k	15.00k			2019-19		
65	Commissioning		Inadequate commissioning plan of the vessel and systems, with subsequent delays to the programme	Inadequate requirements developed	10	3	30		1. Implement the commissioning manager 2. Use a third party to review and provide support	10	2	20		10.00k	5.00k	15.00k			2019-19		
66	Commissioning		Late Submission of Documentation to the Class Society that has not been approved	Many CoC, MACE and following the documentation submitted	10	3	30		1. Agreement on planned submission and submitting of CoC will be undertaken	10	2	20		10.00k	5.00k	15.00k			2019-19	2019-19	
67	Supply Chain		Equipment that does not meet specification or duty has been ordered, resulting in out of specification equipment	All the vessel equipment is approved by Design and Owners, some is not	10	2	20		Ongoing compliance with agreed drawings and work with existing Owners to ensure that the vessel is delivered to the correct specification	10	2	20		10.00k	5.00k	15.00k			2019-19	2019-19	
68	Production		Machinery not sufficient to cope with the load of the yard	Vessel is not yet fully complete	10	4	40		1. Review vessel and equipment against the commissioning requirements	10	2	20		10.00k	5.00k	15.00k			2019-19		
69	Supply Chain		Equipment does not meet the specification and the length of time required to be used	Vessel equipment is not yet fully complete	10	1	10		Ongoing compliance with agreed drawings and work with existing Owners to ensure that the vessel is delivered to the correct specification	10	2	20		10.00k	5.00k	15.00k			2019-19	2019-19	
70	Supply Chain		Late confirmation of commissioning requirements from the Owners and / or Contractors	Vessel is not yet fully complete. The logical delivery of the Contracts in place for negotiations	10	3	30		Contracts to be issued / delivered to the yard and agreed with the Owners. Ongoing liaison and negotiations and monitoring arrangements to ensure compliance with the Contract requirements	10	2	20		10.00k	5.00k	15.00k			2019-19		
71	Supply Chain		Not enough of the length of the hawser supply chains and installation of the support requirements	Contracts in place	25	5	125		Short term and provision of the hawser and associated costs. Support arrangements and agreements and commissioning and delivery of material to the vessel and	10	2	20		10.00k	5.00k	15.00k			2019-19		
72	Technical		Ongoing pipework installation requirements are not being properly. The work is ongoing and installation of the pipework is not fully understood	The risk currently is not known. Knowledge is quite. However quite a lot of this has been undertaken with the contractor	25	5	125		1. A reduction in course and pipes the yard and to install drawings 2. All outstanding work removed along pipe/pipe 3. Clarify issues with the technical team and the yard and to the contracts	5	3	15		10.00k	5.00k	15.00k			2019-19		
73	Technical		Hydrostatic test commissioning and commissioning of the pipes and pipe fittings	No defects are in place	25	5	125		1. Develop and be managed by a dedicated resource and refer to the pipe fittings 2. Ownership of pipe work and be followed	5	2	10		10.00k	5.00k	15.00k			2019-19		
74	Supply Chain		A commercial decision and resolve is not managed to allow working quickly to progress to the yard	Ongoing meetings and budgets not to be covered	10	1	10		Ongoing meetings and discussions. Agreement in place. Ratings agreed and budget and progress	5	2	10		10.00k	5.00k	15.00k			2019-19		
75	Commissioning		Projects not to be fully ready by 1st to 1st to provide information to the yard	Projects not to be fully ready by 1st to 1st to provide information to the yard	25	4	100		1. Ship and be managed by the Ferry teams to commission the projects	5	2	10		10.00k	5.00k	15.00k			2019-19		
76	Supply Chain		Vessel SCV02 or SCV03 not to be ready	Vessel plans have been identified and approved by ETO and Technology	5	2	10		Ratings agreed with yard and in place	5	2	10		10.00k	5.00k	15.00k			2019-19	2019-19	
77	Supply Chain		Impact of Brexit to the supply base		10	2	20		Yard engagement has been performed, schedule and plans to import and issue on the yard to be ready for the Brexit date	5	2	10		10.00k	5.00k	15.00k			2019-19	2019-19	
78	Technical		Damage to Main Engine Components, Auxiliary Machinery and Equipment Items, Failure of Main Engine Turbocharger, Failure of Main Engine Cylinder Liner, Failure of Main Engine Piston, Failure of Main Engine Crankshaft, Failure of Main Engine Bearings, Failure of Main Engine Camshaft, Failure of Main Engine Valve Train, Failure of Main Engine Fuel Injection System, Failure of Main Engine Governor, Failure of Main Engine Starting System, Failure of Main Engine Lubricating Oil System, Failure of Main Engine Cooling Water System, Failure of Main Engine Exhaust System, Failure of Main Engine Control System, Failure of Main Engine Safety System, Failure of Main Engine Alarm System, Failure of Main Engine Monitoring System, Failure of Main Engine Instrumentation, Failure of Main Engine Electrical System, Failure of Main Engine Hydraulic System, Failure of Main Engine Pneumatic System, Failure of Main Engine Fuel System, Failure of Main Engine Lubricating Oil System, Failure of Main Engine Cooling Water System, Failure of Main Engine Exhaust System, Failure of Main Engine Control System, Failure of Main Engine Safety System, Failure of Main Engine Alarm System, Failure of Main Engine Monitoring System, Failure of Main Engine Instrumentation, Failure of Main Engine Electrical System, Failure of Main Engine Hydraulic System, Failure of Main Engine Pneumatic System		1	1	1													
79	Commissioning		Loss of the Vessel's Class Notation during Sea Trials	Sea trials are not yet complete	25	1	25		1. Ship and be managed by a dedicated resource and refer to the pipe fittings 2. Ownership of pipe work and be followed	25	1	25		10.00k	5.00k	15.00k			2019-19		
80	Production		There may not be sufficient qualified Engineering Authority	Qualified engineering authority provided	10	4	40		1. Review the engineering authority and provide support to the yard	1	1	1		10.00k	5.00k	15.00k			2019-19		
81	Technical		The use of outside Classes commissioning problems - leakage - and work through the maintenance injury. The use of services is not considered and work to be reviewed						The impact and actions have been assigned where risk is												
82	Technical		Overhaul and Maintenance - Overhaul is not engineered in the Subyard and not for maintenance, removal of overhaul																		
83	Project		Contract Milestone not achieved	Extra associated with late delivery of milestones are captured elsewhere in the risk register with planned controls					Impact finance will be provided through the Scottish Government rather than previous ship payments Milestones will be revisited given the revised programme										Sep-19		
84	Project		Final cost of SCV02 not met to budget	Full review of costs has been undertaken					Currently not to hit										Sep-19		
85	Project		Vessel delivered late to client due more than 6 months	Outfitting is quite currently the only services that can be managed. This is driven by another risk. All other operations are already late					Unavoidable no hit										Sep-19		
87	OWN or FWSL		Change in ownership position																		
88	OWN		The vessel cannot access all specified ports																		
89	YARD		There is a risk to personnel during dynamic working and outing																		
90	Project		Lack of resource for SCV02 handing / work activity logistic arrangements																		
														Value of high "risk" risk to	11.325k	8.33k	5.167k	9.82k			
														"orange" risk	1.250-2.42k	543-1.665k	262-725k	502 - 1.125k			
														low "yellow" risk	243-1.25k	133-662k	112-662k	93 - 500k			
														risk range	12.75k - 11.325k	7.23k - 8.330k	5.167 - 6.167k	9.82k - 7.25k			