



Pêches et Océans  
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Canada

Canadian  
Coast Guard



## ANNEX A – STATEMENT OF WORK

# CCGV DesGroseilliers Turning Gear Replacement

**Integrated Technical Services Directorate – Canadian Coast Guard**

september 2021

## **1.0 Des Groseilliers Turning Gear Replacement**

### **1.1 Identification**

- 1.1.1 The CCG is seeking to replace the cast iron gear wheels and matching worm gear which are principal parts of the vessel's port and starboard propeller shaft turning gear on the CCGS Des Groseilliers.
- 1.1.2 The existing cast iron turning gear wheel teeth have worn excessively with time. However, the worm gear has suffered no noticeable degradation or wear.
- 1.1.3 The turning gear wheel is comprised of two halves, which are bolted to the thrust shaft flange and at the connecting ends of the half sections. Refer to detail K on drawing 68-2600-01 and drawing AW302862.
- 1.1.4 The turning gear is used primarily to rotate the vessel's propeller shafts when maintenance or repair of the sterntube seals are required. As such, the turning gear are equipment essential for the safe operation of the vessel.

### **2.0 Objective:**

- 2.1 The main objective of this project is to fabricate and install replacement gear wheels and worm gears on the port and starboard turning gears of the CCGS Des Groseilliers according to the requirements of this statement of work.

### **3.0 Definitions:**

- 3.1.1 The word "install" means that the Contractor must connect mechanically and electrically and provide the labour and materiel to complete the installation
- 3.1.2 The word "reinstall" means a piece of equipment that the Contractor has affected repairs on and is to be returned/installed in its original location and be mechanically and electrically connected. The Contractor must provide the labour and materiel to complete the reinstallation;
- 3.1.3 The word "disassemble" means that the Contractor must provide all labour, equipment, and tools to take apart, piece by piece, the equipment, machinery or system to be examined, repaired, or modified;
- 3.1.4 The word "calibrate" means the adjustment of equipment, tools, readings and measurements to a known or standard;

- 3.1.5 The word "inspect" means to examine officially and view closely in critical appraisal of compliance with applicable function, compliance with design, and regulatory requirements and recommendations.
- 3.1.6 The word "verify" means that the Contractor must inspect actual equipment dimensions and component fit to ensure that the deliverables of this contract are compatible with the existing turning gear configuration;
- 3.1.7 The word "test" means that the Contractor must provide labour to conduct the operation of a unit in relation to a stated standard or procedure;
- 3.1.8 The word "trials" means action(s) by which the Contractor proves by a visual or instrumental presentation that the equipment or system satisfies the requirements of the specified trials agenda;
- 3.1.9 The term "functional test" means operation of a piece of equipment in all its normal operating modes and throughout its operating range to establish that it will perform its designed function within normal operating parameters as indicated in the manufacturer's documentation;

## 4.0 References

### 4.1 Equipment data

- 4.1.1 The following shafting data is provided for context and guidance:

Description:	Value:
Propeller diameter	4 m
Propeller shaft mass	14,000 kg
Shaft diameter	630 mm
Shaft mass	37,000 kg
Approximate rotational speed of propeller shaft when turning gear is engaged	5-6 RPM approximately

### 4.2 Drawings

- 4.2.1.1 All technical guidance drawings are issued to the Contractor for guidance purposes only. It is the responsibility of the Contractor to develop working drawings and to ensure that all such drawings receive applicable regulatory approval. The Contractor is to note that not all technical guidance drawings supplied are As-Fitted drawings. It is the responsibility of the Contractor to physically verify all affected items.

4.2.1.2 The following drawings are therefore considered as guidance drawings only:

Drawing Number	DRAWING TITLE	Number of Sheets
AW302862	Gear wheel	
AW201812B	Turning gear details	
AW201812B-2	Turning gear details – Part 73 – Worm gear	
AW201810B	Turning gear arrangement	
AW201813A	Turning gear details	
68-2600-1	Arrangement of shafting and details	
68-H-101	General Arrangement	5

### 4.3 Regulations and standards

4.3.1.1 The following Standards and Regulations apply to work carried out in this statement of work; The Contractor must ensure all work completed in this section complies with these Standards and Regulations as well as any other pertinent Federal/Territorial Regulation or Standard.

Reference	Title	Provided
IACS Unified Requirements W10	Spheroidal or nodular graphite iron castings	No
IACS Unified Requirements W2	Test specimens and mechanical testing procedures for materials	No
ANSI/AGMA 2111-A98	Cylindrical wormgearing tolerance and inspection methods (Metric)	No
ISO 2768-1:1989	General tolerances — Part 1: Tolerances for linear and angular dimensions without individual tolerance indications	No
ANSI B4.2 – 1978 (R2020)	Preferred Metric Limits and Fits	No
ISO 945-1: 2019	Microstructure of cast irons – Part 1: Graphite classification by visual analysis	No
ISO 6892-1: 2019	Metallic materials – Tensile testing – Part 1: Method of test at room temperature	No
ISO 6506-1: 2014	Metallic materials – Brinell hardness test – Part 1: Test method	No
ISO 6508-1: 2016	Metallic materials – Rockwell hardness test – Part 1: Test method	No
ASTM A29: 2016	Standard specification for requirements for steel bars, carbon alloy, hot wrought.	No
ASTM E8: 2021	Standard test methods for tension testing of metallic materials	No
ASTM E10: 2018	Standard test method for brinell hardness of metallic materials	No
ASTM E18: 2020	Standard test method for Rockwell hardness of metallic materials	No



EN 10204: 2004	Metallic products: Types of inspection documents	No
CAN/CGSB 48-9712/ISO 9712: 2012	Non-destructive testing – Qualification and certification of NDT Personnel	No
Canadian Coast Guard Circular 09-2021 COVID-19	Health Screening Questionnaire for Canadian Coast Guard Personnel and Visitors Accessing CCG-only Regional Facilities and CCG Vessels	Yes
Canadian Coast Guard National Standing Operating Procedure (NSOP) 515 COVID-19	Issuance of Contractor Designation Letters During the COVID-19 Pandemic	Yes
Canadian Coast Guard National Standing Operating Procedure (NSOP) 527 COVID-19	International Contractors Entering Canada to Work for the Canadian Coast Guard	Yes
CCG Fleet Safety and Security Manual	Lockout and Tagout – 7.B.5	Yes

## 5.0 Statement of work

### 5.1 Dimensional requirements of gear wheels and worm gears

- 5.1.1 Gear wheels and worm gears must be machined as matching sets with tolerances as per ANSI/AGMA 2111-A98 Grade 5 element tolerances for the appropriate mean diameters and module.
- 5.1.2 Where linear, angular, or radial dimensions are indicated on the drawings with no associated tolerance and where the tolerance has not been addressed by ANSI/AGMA 2111-A98, the required tolerance following machining is ISO 2768-fH.
- 5.1.3 The bore diameter of the worm gears are to be machined for an H7/h6 tolerance according to ANSI B4.2 preferred hole basis metric clearance fits.

### 5.2 Cast iron gear wheel material requirements:

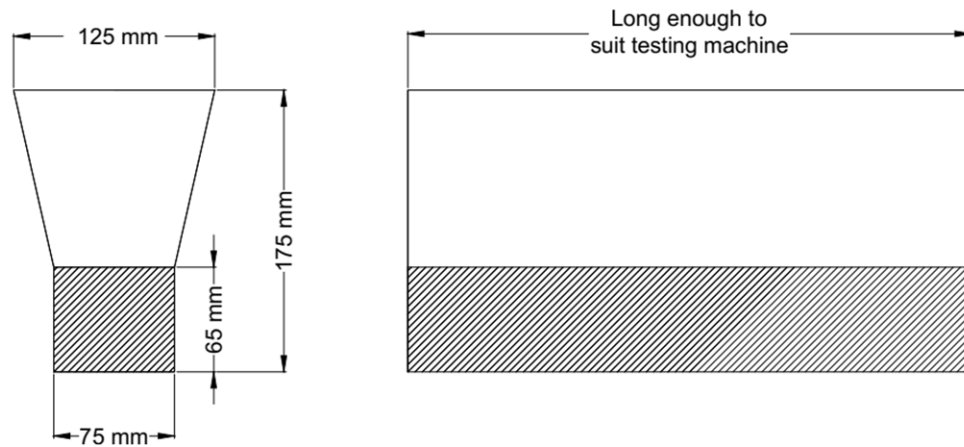
- 5.2.1 The Contractor must fabricate 2 gear wheels with the surface finishes and dimensions as per drawing AW302862, which must be confirmed by the Contractor from measurements taken from the existing gear wheels in service onboard the Des Groseilliers.
- 5.2.2 Each cast iron gear wheel half must have the minimum mechanical properties at the thickest cross sectional area of the castings. illustrated in table 1 – mechanical properties.

**Table 1 – Mechanical Properties**

Description :	Value :
Tensile strength (Rm)	510 Mpa
0.2% proof strength (Rp0.2)	340 Mpa
Elongation after fracture (A)	7%
Brinell hardness (HBW)	170-230
Graphite nodularity (ISO 945-1)	90% Type VI, remaining 10% combination of Type V and Type IV

- 5.2.3 The Contractor will be responsible for ensuring that all testing described in section 5 of this statement of work is accomplished. Tests must demonstrate that the above mechanical properties have been achieved in the main casting. The Contractor must produce QA/QC documentation that provides assurance that the properties evaluated in test samples are representative of those in the main casting. The Contractor must provide the CCG TA and attending ABS inspector details of the mold used and cooling curves that illustrate the cooling rates of the casting prior to shakeout.
- 5.2.4 The CCG TA and ABS inspector must be permitted to inspect the main castings following shake out from their molds at the foundry.
- 5.2.5 The Contractor must identify the main castings with raised numerals or letters so that they can be traced to the ladles from which they were poured. The system of marking and identification is up to the discretion of the Contractor.
- 5.2.6 The Contractor must ensure that sufficient test material for required tensile tests, possible re-tests, and metallographic inspections must be provided.
- 5.2.7 Test material must be cast side by side into the same mold as the main casting. Test coupons must be cast in the form as illustrated in figures 1 with the indicated dimensions.

**Figure 1 – Test coupons**



- 5.2.8 The number of coupons is left to the discretion of the Contractor. However, at least one coupon per ladle must be poured.
- 5.2.9 Test coupons must be identified and marked to ensure traceability to their representative castings throughout testing.
- 5.2.10 The Contractor must provide the CCG TA and attending ABS surveyor a plan for sectioning test bars from the test coupons for approval prior to proceeding with tests.
- 5.2.11 The Contractor must ensure that the chemical composition of the cast iron is sufficient to yield the required mechanical properties and metallographic structures. Chemical composition is therefore left to the foundry's discretion provided that the requirements in table 1 are met.
- 5.2.12 Heat treatment is acceptable where it is necessary to achieve the required mechanical and metallographic requirements identified in table 1 in the main castings. Where heat treatment is used the Contractor must ensure that:
- A) The procedure is submitted for to the CCG TA and ABS for approval prior to casting.
  - B) The CCG TA and attending ABS inspector are permitted to witness heat treatment to ensure that the procedures are followed.

- C) Test coupons are subjected to heat treatment with their respective castings prior to separation and machining into test bars.

5.2.13 Chemical analyses and test coupons must be provided from each ladle poured.

5.2.14 Repairs by welding are not permitted. Non serious surface defects can be removed by local grinding upon the CCG TA and attending ABS inspector approval.

5.2.15 Where subsurface defects that render the casting defective are found during machining, it will be rejected and must be recast.

5.2.16 Where mechanical tests fail as per section 6.2, the casting will be rejected and must be recast.

5.2.17 Costs for recasting in either situation will be at the Contractor's expense.

### **5.3 Steel worm gear material requirements:**

5.3.1 The Contractor must fabricate 2 worm gears with dimensions as per drawing AW201812B-2. The gear wheels and worm gear must be machined to be matching sets.

5.3.2 Worm gears must be made of ASTM A29 grade 1060 steel, hardened to 55-60 HRC.

5.3.3 The heat treatment methods are at the manufacture's discretion. However, distortion must be controlled so that that the worm gears meet the required dimensional tolerances as indicated in section 5.1.1.

### **5.4 Packaging and transportation**

5.4.1 The Contractor must transport the parts to 101 Boulevard Champlain, Québec, QC, G1K 7Y7, DDP INCOTERMS 2020.

5.4.2 The cast iron gear wheels and steel worm gears must be delivered to the CCG no later than May 16th 2022.

5.4.3 Prior to transport, the Contractor must package each cast iron gear wheel half individually in wooden crates with dimensions no greater than 8' x 4' x 2'.

5.4.4 The Contract must apply a temporary protective coating to the parts. The coating must be suitable for transportation in a marine environment, and durable for 2 years.

- 5.4.5 The Contractor must photograph the parts in detail prior to application of temporary protective coating and prior to placing them in their transportation crates; this includes close up photographs from each side of each cast iron part. These photographs must be transmitted to the CCG TA within the following 24 hours.

## **5.5 Required onsite work by the Contractor:**

- 5.5.1 The CCG DesGroseilliers will be alongside at Québec City for the preliminary measurement verification and subsequent installation of the turning gear parts.
- 5.5.2 In the two weeks following the award of contract, the Contractor must come aboard the vessel to verify measurements of the port and starboard gear wheels and worm gears prior to fabricating the parts. The CCG will assist the Contractor by removing guards surrounding the gear wheel. See photos in Appendix A. All measurements must be verified without removing the in service parts.
- 5.5.3 In the case where unplanned work arises from the know work described in this statement of work, costs will be treated with a PWGSC 1379 form, with the approval of the CCG Technical Authority.
- 5.5.4 The Contractor must perform the following installation work during the CCGS Des Groseilliers planned alongside maintenance period, scheduled to begin May 16<sup>th</sup> 2022.
- 5.5.5 All installation and final testing must be completed by June 15th, 2022.
- 5.5.6 The Contractor will be responsible for loading the parts on the ship's flight deck, and moving them to the propulsion motor room via flight deck hatches and general stores. Refer to drawing 68-H-101.
- 5.5.7 The Contractor must provide the crane for loading the crates onto the ship and lowering into the general stores compartment.
- 5.5.8 Prior to starting any work, the Contractor's workers and onsite supervisor must:
- 5.5.8.1 Conduct an onsite familiarization with the vessel's Chief Engineer and CCG TA.
  - 5.5.8.2 Conduct an onsite Operational Hazard Identification and Risk Assessment with the vessel's Chief Engineer and CCG TA which must be documented in the vessel's risk register.

- 5.5.8.3 Conduct an onsite review of drawings AW201812B, AW201810B, and AW201813A with the vessel's Chief Engineer and CCG TA to establish a disassembly and reassembly plan. This must be included in the Contractor's ITP and signed off by the Contractor and CCG TA or Vessel's Chief Engineer.
- 5.5.8.4 Ensure that both turning gears have been properly isolated and locked out according to FSSM procedure 7.B.5. This must be confirmed with the vessel's Chief Engineer and CCG TA and be documented in the vessel's lock out/tag out register.
- 5.5.9 The Contractor must remove the guard covering the cast iron gear wheels on both port and starboard turning gears.
- 5.5.10 The Contractor must disassemble and remove the existing cast iron gear wheels from the thrust shaft coupling. The removed sections are to be handled carefully to avoid damage. The CCG will retain these cast iron sections.
- 5.5.11 The Contractor must install the new cast iron gear wheels and worm gears.
- 5.5.12 The Contractor must verify and note the worm gear adjustment (items 77 and 78 on drawing AW201810B) prior to dismantling the worm gear drive shaft. This must be done in the presences of the vessel's Chief Engineer.
- 5.5.13 The Contractor must verify and note the worm gear vertical height on its drive shaft (controlled by items 76 on drawing AW201801B) prior to dismantling the worm gear drive shaft. These measurements must be taken in the presence of the vessel's Chief Engineer.
- 5.5.14 The Contractor must disassemble both turning gears worm gear drive shaft assembly and accessories to the extent necessary to install the new worm gears on the port and starboard turning gears, referring to drawings AW201812B, AW201810B, and AW201813A .
- 5.5.15 The Contractor must protect the bronze worm wheel at the top of the worm gear shaft during the work. Prior to removal of the worm gear shaft, the Contractor must drain the oil from the gear box (approximately 5L) and dispose of the oil. This oil can be disposed of onboard. Upon reassembly the Contractor must refill the gear box with oil to half way up the sight glass. The oil will be provided by the CCG.
- 5.5.16 The Contractor must reinstall the worm gear drive shaft assembly with new bearings (item 69 on drawing AW201801B). The bearings must be supplied by the Contractor.

- 5.5.17 The Contractor must replace or repair any component damaged during the installation of the new worm gears at their own cost.
- 5.5.18 The Contractor must ensure that the worm gear drive shaft assembly is adjusted to obtain the required backlash of 0.762mm. This must be done in the presence of the Vessel's Chief Engineer.
- 5.5.19 The Contractor must ensure that the worm gear is positioned vertically so that the worm gear axial midpoint is at 90 degrees to the gear wheel central axis.
- 5.5.20 During assembly and prior to any functional testing, the Contractor must ensure that all mechanical components are sufficiently greased and grease cups are full. The Contractor must supply the grease.
- 5.5.21 The CCG TA and vessel's Chief Engineer must complete a survey of the work carried out with the Contractor following the completion of the reassembly and installation, and prior to any functional testing.
- 5.5.22 The Contractor must perform a functional test of both the port and starboard turning gears upon completing of the reassembly and installation of the turning gear wheels. This test must be witnessed by the vessel's Chief Engineer, the CCG TA, and the attending ABS inspector.
- 5.5.23 The Contractor must reinstall the guard covering the cast iron gear wheels on both port and starboard turning gears.

## **5.6 Pandemic**

- 5.6.1 Due to the COVID-19 pandemic, the Contractor must comply with Canadian Coast Guard Circular 09-2021 COVID-19 - Health Screening Questionnaire for Canadian Coast Guard Personnel and Visitors Accessing CCG-only Regional Facilities and CCG Vessels.
- 5.6.2 The Contractor must ensure that all its employees and sub-contractors wear medical masks while on board the vessel. The contractor must provide these masks to its employees and subcontractors. The contractor must also make hand sanitizer available to its employees and subcontractors.
- 5.6.3 Contractor Essential Service Letters will be issued in accordance with CCG National Standard Operating Procedure (NSOP) 515 COVID-19 - Issuance of Contractor Designation Letters During the COVID-19 Pandemic, if they are required by the Contractor or subcontractors if they are required to permit travel for work on the vessel.

- 5.6.4 Any foreign national employed by the Contractor who must travel to Canada to perform this work must meet all Government of Canada COVID 19 entry criteria for discretionary travel and follow all pre-entry instructions. The Contractor must follow the procedures in CCG National Standard Operating Procedure (NSOP) 527 COVID-19 - International Contractors Entering Canada to Work for the Canadian Coast Guard.

## **6.0 Proof of performance:**

### **6.1 Contractor responsibilities – Production, inspection, testing, and trials**

- 6.1.1 The Contractor must contact, coordinate, schedule, and be completely prepared for all regulatory inspections and surveys by the attending ABS inspector as indicated by individual sections of this statement of work.
- 6.1.2 The Contractor is informed that CCGS Des Groseilliers is now under the Delegated Statutory Inspection Program and that the Canadian Coast Guard has retained the American Bureau of Shipping (ABS) as a Transport Canada RO.
- 6.1.3 The CCG TA is responsible for direct payment of all regulatory inspection fees.
- 6.1.4 The Contractor must produce and maintain a production plan indicating production, delivery, assembly, and inspection milestones. The plan must identify emergent project risks; these risks must be ranked according to their impact on the project schedule and cost. The plan must include mitigation strategies for all risks identified as high. The Contractor must update this plan should there be any changes to the schedule.
- 6.1.5 The Contractor must update the production plan should there be any changes to the schedule. The Contractor must submit this plan and any subsequent updates to the CCG TA.
- 6.1.6 The Contractor must track and control the quality of contracted work during this project. To this end, the Contractor must create and maintain an enumerated list of all inspection test and trial points. This list can be referred to as the Contractor's Inspection Testing Plan (ITP). The plan should include all elements that the contractor deems necessary to assure the quality of the work, but must also include items defined in section 7 of this statement of work. The ITP must include a procedure for functional testing onboard once the new parts have been installed.
- 6.1.7 The Contractor must submit the production plan and ITP to the CCG TA for approval prior to beginning the work. The ITP must be updated with current test



results and electronically transmitted in the 48 hours following the completion of hold points for the CCG TA's review.

- 6.1.8 The CCG reserves the right to audit the Contractor's production plan and ITP throughout the period of the contract to ensure that they are being followed.
- 6.1.9 The Contractor must schedule and ensure that all pre-determined hold points as determined by the Inspection requirements described in this section of the statement of work and the Contractor's ITP, are witnessed by the CCG TA and when applicable the attending ABS inspector for the Contracted work item.
- 6.1.10 The CCG TA and attending ABS surveyor must be permitted to witness all hold points. Should the Contractor's facilities be within Québec, the Contractor must give the CCG TA and attending ABS inspector 48 hours notice prior to any hold point. For locations outside of Québec, the Contractor must give 5 business days notice. Where the CCG TA is unable to attend the contractor's facilities, or it is not possible due to geographic location, written reports, including photographs, detailing the activities carried out during these hold points, results, and actions taken, must be submitted to the CCG TA for approval before proceeding with the remainder of the work.
- 6.1.11 All NDT inspectors, MT or volumetric, must be qualified level 2 or 3 according to CAN/CGSB 48-9712, ISO 9712, or ASNT SNT-TC-1A.
- 6.1.12 The Contractor must be present onboard the vessel during all functional testing.

## **6.2 Material testingN requirements**

### **6.2.1 Chemical analysis:**

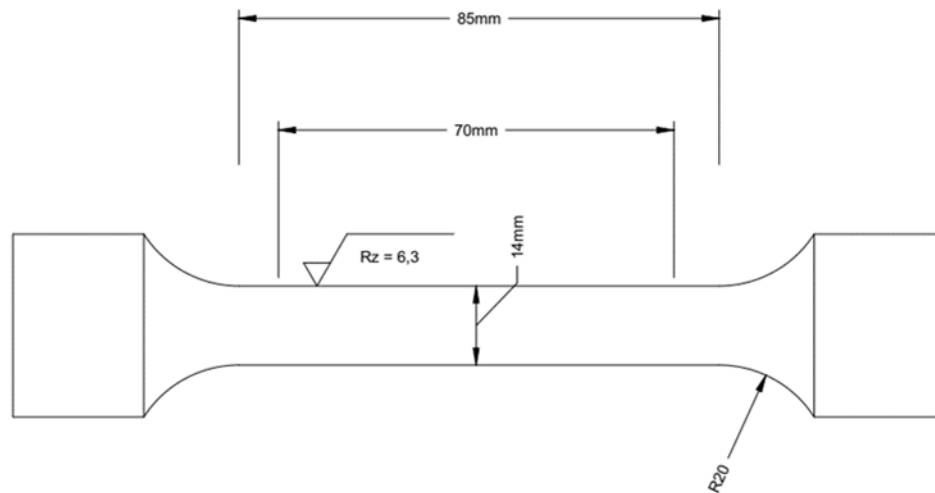
- 6.2.1.1 The Contractor must conduct a chemical analysis of the metal from each ladle poured during the casting of the gear wheels. The report must be submitted to the CCG TA and ABS inspector.
- 6.2.1.2 The Contractor must provide copies of EN 10204 Type 3.1 material test reports for the steel used to machine the worm gears to the CCG TA and ABS inspector.

### **6.2.2 Mechanical testing of cast iron gear wheels:**

- 6.2.2.1 Tensile testing must be carried out according to ISO 6892-1 or ASTM E8. Test bars machined from test coupons must have the dimensions as indicated in figure 2. Should tensile testing fail to meet the tensile, proof, and elongation requirements in table 1, 2 additional tests can be made from the same test

coupon. The castings will be deemed acceptable should both additional tests meet these requirements. However, should 1 of the 2 tests fail, the castings will be rejected and must be recast at the Contractor's cost.

**Figure 2 – Tensile test bars**



Description	Value
Lo – Original gauge length	70 mm
Lc – Minimum parallel length	85 mm
D – Diameter of test piece on gauge length	14 mm
R – Transition radius	20 mm
Rz – Surface roughness along gauge length	6.3 $\mu\text{m}$

6.2.2.2 Hardness testing must be carried out according to ISO 6506-1 or ASTM E10 provided that the test uses the ISO recommended force-diameter indices for cast iron. Four (4) hardness indentations must be made on the side face of the gear tooth rim at mid-thickness; 2 on each side 180 degrees apart and 90 degrees apart from side to side.

6.2.2.3 Metallographic examination of bars sectioned from the test coupons must be conducted according to ISO 945-1 to determine graphite nodularity. All graphite must be nodular with at least 90% Type VI and the remainder any combination of Type V and Type IV.

6.2.2.4 Where heat treatment is required to obtain the specified graphite nodularity and mechanical properties:

- A) the procedure must be submitted for ABS approval.
- B) the CCG TA and attending ABS inspector must witness heat treatment to ensure that the procedures are followed.

### **6.2.3 Mechanical testing of worm gears**

6.2.3.1 The hardness of the worm gear material is to be measured following final heat treatment, on either the finished part or blank on the gear rim according to either ISO 6058-1 or ASTM E18 Rockwell Hardness test methods.

### **6.2.4 Visual and dimensional inspections of gear wheels and worm gears:**

6.2.4.1 Main castings must be cleaned and prepared for visual inspection by the CCG TA and attending ABS inspector. No peening, hammering or other treatment that hides defects is permitted.

6.2.4.2 Suitable mechanical means must be used to trim excess materials. No thermal methods are permitted.

6.2.4.3 The main castings are to be visually inspected on both sides, and on all surfaces. No cracks or defects that would render the castings unsound are permitted. Castings must therefore be complete with smooth surfaces that are free from metallic projections, cavities, discontinuities, surface defects or any other flaw that could act as stress raisers and initiate cracks.

6.2.4.4 Tolerances for gear wheel and worm gear dimensions are ANSI/AGMA 2111-A98 Grade 5. The Contractor must calculate the applicable controlling dimensions using formulae in section 5 of this same standard, according to module and mean diameters of gear wheel and worm gear.

6.2.4.5 The Contractor must measure these controlling dimensions; measurements of run out, pitch, accumulative pitch, profile, form, and all variations must be made on all teeth, and on both right and left flanks.

6.2.4.6 The Contractor must prepare a dimensional inspection report that graphically displays the calculated controlling dimensions and compares them with the measured values for each gear wheel and worm gear pair.

6.2.4.7 Measuring methods and equipment are left to the discretion of the Contractor. All equipment must be calibrated according to a recognized international

standard. The Contractor must provide recent calibration certificates to the CCG TA.

#### **6.2.5 Non destructive examination of gear wheels:**

##### **6.2.5.1 MT inspection must be carried out on:**

- A) All machined, ground, polished, drilled, or reamed surfaces.
- B) At all fillets and abrupt changes of section.
- C) Where surplus metal has been removed.
- D) Where risers, runners, gates, seams, or flashing have been removed.
- E) Where excess sand has been removed by mechanical means.
- F) At all finished bolt holes.
- G) On all gear tooth contact faces and roots.
- H) On any surface defect found during the visual inspection prior to and following repairs.
- I) At any location where a chaplet, insert, or chill was used in the casting.

6.2.5.2 Volumetric NDT is not required unless there is any reason to suspect the soundness of the casting during the visual or MT inspections. In this case, the Contractor must either reject and remake the casting, or conduct radiographic (RT) NDT of the casting; details of which must be submitted to ABS for an engineering review. However, should the ABS review of the RT data determine that the casting is defective, it will be rejected notwithstanding any previous certification and recast at the contractor's expense.

#### **6.2.6 Non destructive examination of worm gear**

6.2.6.1 The Contractor must perform MT on the finished worm gears.

6.2.6.2 Cracks, bursts, seams, or laps are not permissible and will be cause for rejection.

6.2.6.3 The maximum size of permissible indication is 3.2 mm.

## **7.0 CCG required minimum inspection points**

7.1 The Contractor must hold for inspection by the CCG TA and ABS inspector where required at each of the hold points identified in the following section:

- 7.1.1 Visual inspection of main castings following shake out from the mold (as per section 5.2.4)
- 7.1.2 Heat treatment at the Contractor's heat treatment facility (as per section 5.2.13 (C)).
- 7.1.3 Visual and dimensional inspection following machining processes (as per section 6.2.4.1)
- 7.1.4 MT NDE on gear wheels and worm gears (as per sections 6.2.5 and 6.2.6)
- 7.1.5 Contractor onsite vessel familiarization (as per section 5.5.8.1)
- 7.1.6 Operational hazard identification and risk assessment (as per section 5.5.8.2)
- 7.1.7 Onsite review of drawings AW201812B, AW201810B, and AW201813A (as per section 5.5.8.3).
- 7.1.8 Verification of worm gear adjustment prior to disassembly (as per section 5.5.12).
- 7.1.9 Verification of worm gear height prior to disassembly (as per section 5.5.13).
- 7.1.10 Verification of worm gear backlash following reassembly (as per section 5.5.18)
- 7.1.11 Inspection following installation on the ship (as per section 5.5.8.17).
- 7.1.12 Functional testing and trial onboard the ship (as per section 5.5..8.18).

## **8.0 CCG required timelines**

8.1 Onsite measurement verifications and preliminary worksite visit completed within the 2 weeks following the award of contract and by November 24<sup>th</sup> 2021 at the latest.

8.2 Delivery of parts at CCG QC facilities by May 16th 2022.

8.3 Installation and functional trials successfully completed no later than June 15<sup>th</sup> 2022.

## 9.0 Documentation

9.1 The Contractor must present documentation for CCG TA and ABS review:

- 9.1.1 Production schedule (as per sections 6.1.4 and 6.1.5).
- 9.1.2 Inspection and test plan (as per sections 6.1.6 and 6.1.7).
- 9.1.3 Heat treatment procedures (as per section 6.2.2.4).
- 9.1.4 Results of chemical analysis from each ladle of metal poured to fabricate the main castings (as per section 6.2.1.1).
- 9.1.5 Copies of EN 10204 Type 3.1 MTRs for the steel used to fabricate the worm gears (as per section 6.2.1.2).
- 9.1.6 Sectioning plan for mechanical and metallographic test samples cut from test coupons (as per section 5.2.10).
- 9.1.7 Tensile testing reports detailing results of UTS, proof, and % elongation of the cast iron test samples (as per section 6.2.2.1, containing the information as outlined in chapter 22 of ISO 6892-1).
- 9.1.8 Metallographic analysis indicating graphite nodularity of cast iron test samples (as per section 6.2.2.3, containing the information as outlined in chapter 9 of ISO 945-1).
- 9.1.9 Hardness test reports of cast iron gear wheel halves (as per section 6.2.2.2 containing the information as outlined in chapter 9 of ISO 6506-1).
- 9.1.10 Hardness test reports of steel worm gears (as per section 6.2.3.1, containing the information as outlined in chapter 9 of ISO 6508-1).
- 9.1.11 Dimensional inspection report of gear wheel and worm gear pairs (as per section 6.2.4.4).
- 9.1.12 Equipment calibration certificates (as per section 6.2.4.7)
- 9.1.13 Results of MT or any other NDE conducted on either the gear wheels or worm gear (as per sections 6.2.5 and 6.2.6).
- 9.1.14 Functional test procedure to be followed once the new parts have been installed.

## Appendix A: Photos

Photo 1 – Port side cast iron gear wheel wear





Photo 2 – Starboard side cast iron gear wheel wear





Photo 3 – Port side worm gear as viewed through access way (starboard side is identical)



Photo 4 – Port side shaft turning gear (looking forward towards starboard-outboard)



Photo 5 – port side turning gear (looking aft towards starboard side-outboard)



Photo 6 – port side turning gear (looking aft towards starboard side-outboard)





Photo 7 – Port side turning gear (looking aft towards port side-inboard)



Photo 8 – port side turning gear (looking midships towards starboard side-outboard)



Photo 9 – starboard turning gear (looking forward towards port side-inboard)



Photo 10 – Starboard turning gear (looking aft towards starboard side-outboard)





Photo 11 – Starboard turning gear (looking aft towards starboard side-outboard)



Photo 12 – Starboard turning gear (looking aft towards port side-inboard)

