I/S RENO-NORD

Technical Specification 2020 Major Overhaul Steam Turbine Line 3

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1 Introduction

I/S Reno-Nord is planning for a major overhaul of the 8 MW AEG Kanis steam turbine in production line 3 (unit 3) at the WtE plant in Aalborg. The turbine was commissioned in 1991 and have since the commissioning of production line 4 in 2006 been kept as back-up unit and thus had only a limited number of operating hours.

Recent scenario studies show that production line 3 will be needed to provide district heating for the city of Aalborg. In order to ensure reliable, safe and efficient operation of the unit a major overhaul of the steam turbine and gear box is needed. The unit is expected to be decommissioned in 2034.

As other major overhauls and lifetime extension works are carried out in parallel, the boiler will be out of operation for several weeks, starting 01.06.2020

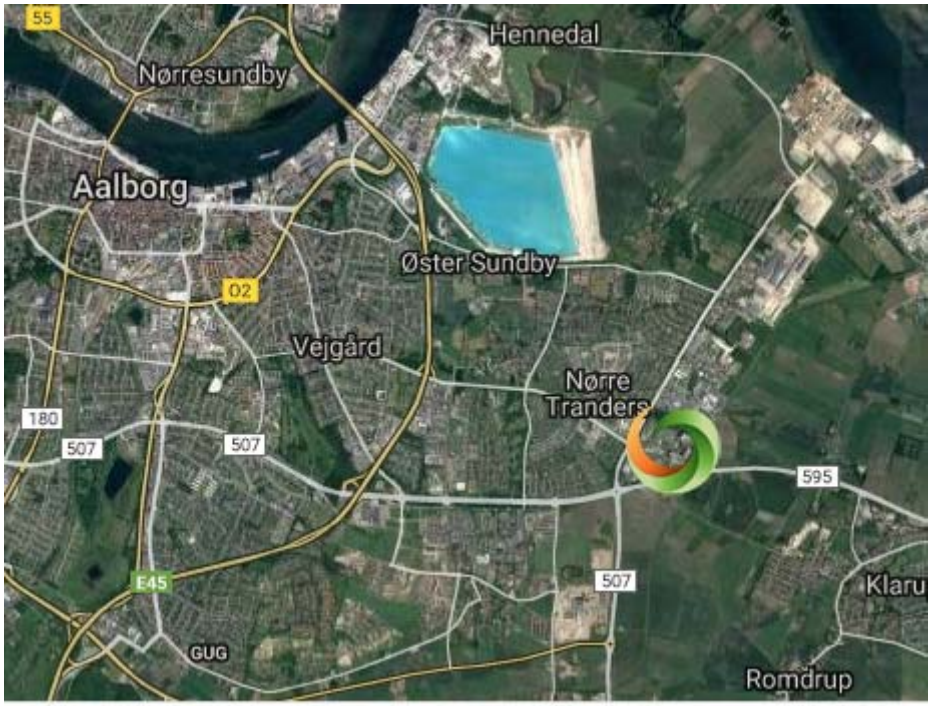
The boiler is planned to be ready to provide steam for I/S Reno-Nord to fulfill the obligations and meet the heating requirements from the grid operator not later than 01.10.2020. Thus, hot re-commissioning of the turbine cannot be performed immediately after mechanical completion.

Also, a replacement of the turbine control system will be carried out during the outage, and test and commissioning of the turbine must be coordinated and planned together with the test of the turbine safety functions.

2 The project

2.1 The WtE plant

The site is located at Troensevej 2, 9220 Aalborg Ø, Denmark:



2.2 Unit and operating data

Turbine

Manufacturer	:	AEG Kanis (ABB Nürnberg)
Type	:	G25
Serial number	:	19095/000
Power	:	7710 kW
Speed	:	10700 rpm
Steam pressure	:	50 bar
Steam temperature	:	425°C
Condenser pressure	:	0,276 bar

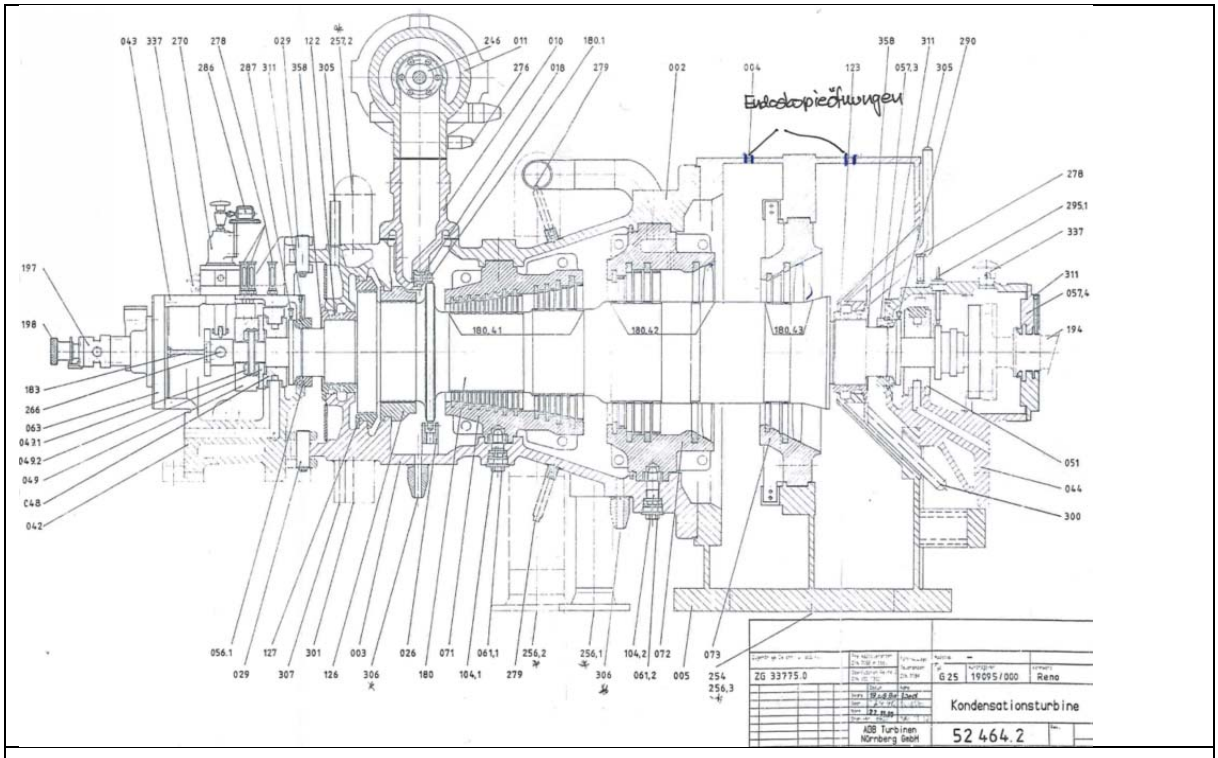


Fig. 2.1.1 Longitudinal section of steam turbine.

It is expected that the unit will reach approximately 135.000 operating hours at the outage 2020). However, for the period since 2004 the number of operating hours has been less than 25.000 equivalent operating hours in total. In the long stand still periods long term conservation means have not been established.

Gear box

Manufacturer	: RENK-TACKE
Type	: TDB-630
Speed	: 10722 rpm/1500 rpm

2.3 Maintenance history

The maintenance history of the turbine and gear in not very well documented.

Year	OH approx.	Starts approx.	Activity
2004			Inspection and major overhaul following a damaged turbine due to high vibrations. Rotor was found bend and sent to Nurnberg for straightening and replacement of all sealings strips and high-speed balancing. Gland bushes were replaced and stator sealing strips, too. Due to erosion between stator row 17 and 18 a high alloy steel ring has been inserted – no details of dimension (design) or material are available.
2019			The generator was inspected and overhauled in 2019. The rotor was pulled out and minor repairs performed, and new bearings installed. A borescope inspection of the turbine performed by SULZER. Only limited access is allowed via the 2 openings indicated on fig. 2.1.1. Lube oil system and turning gear was not in operation so only very limited inspection was performed. No critical observations were made. The hydraulic safety block unit was overhauled and adjusted by GE, Mannheim.

2.4 Timeframe and scheduling

Based on the key milestones below, the Contractor must prepare a detailed main time schedule for the preparation, delivery and execution of the Scope of Works.

If, during the project period, I/S Reno-Nord requests to introduce changes to the main time schedule, the Contractor shall actively cooperate with I/S Reno-Nord to organize and plan the required changes to the time schedule to avoid unnecessary delays.

The duration of Scope of Works defined in this Technical Specification should not exceed 6 weeks. However, the time schedule included in the Contract will apply.

Contract period		Subject to penalty
Detailed time schedule from Contractor	Award of Contract + 4 weeks	
Pre-visit by supervisor at site	To be agreed	
Witness points and QA plan	To be agreed	
Delivery of purchased spare parts at site	Outage start ÷4 weeks	Yes
Dimension check protocols – templates for I/S Reno-Nord approval	Outage start ÷4 weeks	

Fact Finding Report and Variation Order templates for I/S Reno-Nord approval	Outage start ÷4 weeks	
Tools at site	Outage start ÷n days	
Steam turbine unit shut down	Outage start ÷n days	
Contractor's supervisor at site to witness shut down and run down	Outage start ÷n days	
Steam turbine cooled down	1 June 2020 (Outage start)	
Cable and instruments removed by I/S Reno-Nord	Outage start	
Personnel for overhaul at site	Outage start (+ n days)	
Cladding and insulation removed, steam turbine ready for opening	Outage start +2 days	
Visual inspection, NDT, blue dye check and fact finding finalized for all components	ASAP, part of contract	Yes
Steam turbine ready for turning gear operation	To be agreed	Yes
Steam turbine ready for insulation	To be agreed	
Steam turbine ready for cold commissioning	To be agreed	
Steam turbine ready for hot commissioning	To be agreed*	
Steam turbine ready for start-up and vibration test	To be agreed*	
Unit ready for commercial operation/Handing over	To be agreed*	Yes
All documentation delivered and approved by Reno-Nord	≥2 months after I/S Reno-Nord is in commercial operation. Draft submitted for I/S Reno-Nord to comment not later than 3 months after Hand-over.	
*: Milestones dependent on live steam availability. A preliminary handover (after cold testing) may be considered and conditions agreed upon.		

2.5 Warranty and guarantees

2.5.1 Performance guarantees

Tests to verify the performance of the unit will be carried out before and after the overhaul. These tests will determine whether the operational data (power, efficiency, vibration etc.) after the overhaul of steam turbine are comparable to the operational data before the overhaul or better.

I/S Reno-Nord will carry out the performance test and prove the turbine efficiency by using the operating instruments prior to and after the overhaul at comparable load and operating conditions.

I/S Reno-Nord has the right to claim a compensation or a remedy (including re-opening of the steam turbine if deemed relevant for a root-cause analysis) if the operational data are not comparable or better after the overhaul. The Contractor will get access to all test results.

The Contractor must in the Scope of Works include a vibration verification measurement with a reference measurement before the outage and a measurement after recommissioning of the plant.

The level of vibrations for turbine- and gear shafts must meet normal levels (and not exceed the upper (tripping) levels) originally defined by the OEM:

Shaft vibrations (peak-to-peak)	Max/trip	Normal
	µm	µm
Turbine front	95	20-30
Turbine rear	95	20-30
Gear pinion	95	20-30
Gear bull	240	80-100

The guarantee values shall apply until the expiry of the warranty period.

2.6 Hand-over

A Hand-over certificate will be issued by I/S Reno-Nord when the unit is deemed ready for commercial operation.

3 Scope of Works

The Scope of Works includes the following activities:

- Planning, arranging and performing the major overhaul of turbine, gear, main and auxiliary oil pumps, turning gear, turbine-/gear- and generator coupling, turbine valves, check and extraction valves
- Removal and reinstallation of cabling and instrumentation
- Inspection and NDT of turbine and gear parts
- Delivery of spare parts purchased as part of the Contract (options and/or recommended spare parts)
- Delivery of options and repairs after fact finding and by prior agreement with I/S Reno-Nord
- Delivery of all needed tools (except special tools and plant specific devices provided by I/S Reno-Nord)
- Vibration measurement before and after the outage (reference and verification measurement performed with the installed instrumentation)
- Commissioning after the overhaul
- Documentation of all works performed and for all delivered spare parts, including all quality plans, photos (and videos).

The Contractor has the full responsibility for the supply of spare parts and replacement works, and the acquisition of all necessary spare parts as well as handling of parts supplied from other suppliers (e.g. parts from I/S Reno-Nord) if needed during the overhaul.

The Contractor has no liability for parts delivered by I/S Reno-Nord, only for the correct installation of such parts.

The Scope of Works includes visual inspection of dismantled parts, measuring of tolerances and clearances and performing NDT of relevant parts (PT, MPI and UT). The proposed extent and method of NDT must be clearly described in the NDT plan provided with the tender.

Refurbishment and repair of used components and parts, and supply of new components will be required.

Should the Contractor find it necessary to cut one or more pipelines, it rests with the Contractor to re-establish these pipelines and produce documentation for implementation, control and approval of the work. Cutting of any pipeline requires the approval of I/S Reno-Nord.

In case of transport of any part from site to workshop (or vice versa) the following is included in the Contractor's services:

- Preparing the part for transport
- All transport costs
- Needed and approved transport frame/box (for transport of rotor)
- Road transport permit (if applicable for larger items)
- Transport insurance.

Cleaning by blasting is included (whenever applicable) in the Scope of Works, also for parts sent to any off-site workshop. On-site blasting is arranged for by I/S Reno-Nord.

The Scope of Works must include, but not be limited to, the following equipment and services (the Contractor's offer describes in more details the scope):

3.1 Planning of the overhaul

- 1 or 2 project meetings on site before the overhaul by the Project Manager in order to prepare the overhaul in detail
- A site visit before the overhaul by the Project Manager and the Site Manager to prepare the overhaul (inspect tools, lifting equipment, site facilities, discuss time schedule and other practicalities)
- A de-commissioning engineer must be available on site for making necessary records such as pre-outage tests, check of rotor run out, oil pressure records, bearing temperature etc. when the plant it shut down and the turbine runs down.

3.2 Disassembly of turbine and gear

- Blocking of foundation springs
- Remove all auxiliaries, valves, pipes, hoses, covers etc. to gain necessary access and cut small drain-pipes if required
- Remove and overhaul of turning gear
- Opening of the bearing covers, coupling covers and gear cover
- Opening of all couplings and perform alignment measurements for the complete shaft line (including gear/generator)
- Opening and removal of all turbine and gear bearings
- Remove stop valve
- Loosen outer split line bolts and remove turbine top casing
- Loosen inner split line bolts and remove all upper parts (blade carriers, balance piston no. 1 (inner gland), balance piston no. 2 etc.)

- Remove top gland bushes
- Measure all radial and axial clearances (rotor and stator blades, sealing segments, sealing strips etc.)
- Lift out turbine rotor and remove all lower parts like blade carriers, balance piston no. 1 (inner gland), balance piston no. 2, steam glands etc. from the lower casing
- Check foundation bolts for turbine and gear box
- remove all sealing elements and oil deflectors.

3.3 Bearings for turbine and reduction gear

- General cleaning externally and internally
- Visual inspection of bearings, including pedestals, sliding plate, keys and shims
- Perform PT of white metal (Babbitt), and UT to check bonding according to DIN/ISO 4386 or similar standard. Replacement of Babbitt parts depends on inspection results; reference is made to section 4 Options
- Check of the bearing clearances (before and after)
- Check bearing electrical insulation
- Check bearing shaft seals and clearances (before and after).

3.4 Turbine outer casing and blade carriers

The turbine has three blade carriers:

- Blade carrier 1: 12 rows
- Blade carrier 2: 4 rows
- Blade carrier 3: 2 rows

- General cleaning of outer casing including carefully preparation for NDT by hand cleaning at the grooves for the blade carriers, balance pistons and steam glands
- 100% blast cleaning of all blade carriers
- Visual inspection of all parts for cracks, rubbing, scaling, erosion, corrosion etc.
- Perform NDT (according to detailed NDT plan provided by Contractor) as a minimum 100% at blades and areas with smaller radius/transitions, high loads and other critical places
- Check of turbine casing and blade carriers for roundness, dimensions etc.
- Check the joint faces of the outer casings and blade carriers for erosion and steam leakage and verify it by blue print. The Contractor must perform necessary scraping/polishing by hand of the split line flanges to have clean surfaces. If repair or machining of a split line flange is performed must it be verified by a blue dye check test (cost for repair/machining and extra blue dye check is not part of the base scope, but must be carried out as extra work by prior agreement)
- Inspection of flange bolts including cleaning by blasting, NDT and length measurement. The loosening of the bolts must be made according to bolt design, and provision of all equipment needed for loosening of the bolts is included in the Scope of Works
- Calculation of the flange bolts' permanent stretch/elongation
- Perform test to verify that the blades are correctly fixed and secured
- Check of supports for lower parts (axial and lateral keys) for sliding ability, clearances etc.
- Replacement of gaskets underneath turbine (drains, extraction and bleed lines, excluding the exhaust)

3.5 Balance pistons and steam glands

- General cleaning
- 100% blast cleaning of all parts
- Visual inspection of all parts for cracks, rubbing, scaling, erosion, corrosion etc.
- Perform NDT (according to detailed NDT plan provided by Contractor)
- Check for roundness, dimensions etc.
- Check the joint faces for erosion and steam leakage and verify it by blue dye check. The Contractor must perform necessary scraping/polishing by hand of the split line flanges to have clean surfaces. If repair or machining of a split line flange is performed must it be verified by a blue dye check test (cost for repair/machining and extra blue dye check is not part of the base scope but must be carried out as extra work by prior agreement).

3.6 Turbine rotor

- Check the condition of the rotor sealing strips (inter stage. Balance piston and glands have machined grooves)
- Cleaning of complete rotor (by blasting). Unless seal strips are deemed too worn or damaged at the initial visual inspection, they must be covered to avoid being damaged during blasting
- Visual examination of all surfaces (including shaft journals, rotor blades, shrouds and locking pieces)
- Perform NDT at the coupling holes, shaft journals, rotor blades, areas with smaller radius and transitions and other critical places. Special attention on the control stage shroud and damping wire, as the design historically have shown to have its weaknesses
- Check and document the size, distribution and condition of balancing weights
- Measure rotor straightness
- Check and document rotor blade off-set
- Perform test to verify that the blades are correctly fixed and secured
- Transport of rotor on-site and off-site including delivery of transport stands (shall be approved).

3.7 Main oil pump and auxiliary pumps

- Dismantle main oil pump and 2 auxiliary pumps and opening for visual inspection
- Cleaning externally, internally and all parts
- Visual inspection of internals, bearings etc.
- Replacement all gaskets and soft sealings (part include in the scope)
- Assembly and alignment of main oil pump and checking of lube oil pressure and flow
- Test of function.

3.8 Valves

Major overhaul of Emergency Shutdown Valve (ESV) and Control Valves (CV's), check valves in bleed lines (LBQ10AA010, LBS10AA010), and control valve and check valve in extraction line (NAA20AA010, NAA20AA020) including blue dye check of seats and flanges.

Removal of control valve seats is only due if they are found unfit for further, long-term operation.

- Dismantle and open actuators and clean all parts. Exchange of all soft materials in the actuators are parts of the scope.
- Visual inspection of the casings for cracks and erosion
- Clean and check steam strainer
- Blast cleaning of all internal components and bolts
- Perform NDT inspection inside and, if needed, outside (according to the NDT plan provided by the Contractor),
- Visual inspection of internal components (valve seats, valve heads, spindles, bushings, sealings etc.) for cracks, deformity and erosion
- Perform NDT of all internal components (valve seats, valve heads, spindles, bushings, sealings strainer etc.)
- Inspection of all the spindles for wear/erosion and measure deformity
- Check of the bushings and seats for rubbing/wear
- Verify flanges and valve seats/heads by blue print. Light machining by hand is part of the scope
- Assembly of actuators, adjustment and functional test
- Check clearances and tolerances
- Replacement of all consumables (gaskets, seals etc. according to list of recommended spares provided by the Contractor as part of the tender)

3.9 Major overhaul of reduction gear

Major overhaul of the reduction gear includes:

- Opening and disassembly of all auxiliaries, oil pipes, sensors, valves, covers etc. in order to gain necessary access to all the internal gear parts.
- Remove the bull gear and pinion gear from housing to inspect
- Check and cleaning of all parts
- NDT all tooth for cracks and wear with penetrant and ultrasound
- Check tooth contact pattern by dye check
- Check shafts runout
- Check surface condition of journals
- Visually inspection and NDT of couplings
- Check pump drive coupling
- Install new gaskets
- Assembly and test run
- Check operation of auxiliary equipment.

3.10 Assembly of turbine and gear

- Install all lower parts, bearings, rotor, gear and coupling shaft. All needed shims, keys and guiding elements for adjustment is part of the scope
- Measure all radial and axial clearances (rotor and stator blades, glands, balance piston, sealing strips etc.)
- Assembly of turning gear
- Assembly of gland seals top part
- Place all upper parts and tighten split line bolts
- Place top outer casing and tighten split line bolts
- Proper surface contact shall be verified by blue-check where relevant, e.g. on bearing saddles, covers, housings, casings, blade carriers, valve seats and flanges etc.

- Alignment check of the turbine/gear/generator (complete shaft line) includes all necessary coupling measurements/checks (like run out, parallelism, concentricity, gab etc.). If re-alignment is necessary, it must be carried out as extra work by prior agreement
- Assembly of all bearings, couplings and covers
- Assembly of all auxiliaries, valves, pipes, hoses etc.
- Unblocking of foundation springs

3.11 Commissioning

The Contractor is responsible for the re-commissioning of the turbine and gear after the overhaul but I/S Reno-Nord will support with the operational staff. As the control system is being replaced during the outage, certain test must be allowed for and coordinated with the 3. party Contractor.

The Contractor shall prepare a commissioning program and time schedule that shall be presented to I/S Reno-Nord for approval.

The following is as a minimum included:

- Cold commissioning
  - Test of instrumentation
  - Post outage tests and checks
  - Valve curves and systems
  - Start up and test of oil systems
  - Inspection and test of safety systems (Contractor must coordinate with 3. party)
  - Run out test from of unit from turning operation.
- Hot commissioning
  - Test of steam gland systems
  - Tightness test of turbine valves
  - Full speed no load
  - Run out test of unit from full speed
  - Operating data recording
  - General commissioning tests
  - Synchronization
  - Tests in different load points – decision of and performed by I/S Reno-Nord
  - Vibration verification measurement (reference measurement prior to outage and verification during commissioning)
  - Balancing if needed (cost for balancing is not part of the Scope of Work but will be considered as Variation).

3.12 Transport and blast cleaning

If the Contractor prefer to carry out the blasting on site, the provision of a blasting tent with proper ventilation is included in the Scope of Works. Blasting equipment, blasting media and skilled personnel are provided by the Contractor. Disposal of used blasting media must be agreed with I/S Reno-Nord. I/S Reno-Nord will assign a location within the premises for erection of the blasting tent.

The Scope of Works also includes all on-site and off-site transportation and handling of parts.

- All needed on-site and off-site transport (to workshops) are included in the scope, for any option and for extra work
- The Contractor is solely responsible for the organization of the transport. All cost related to the transportation shall be included in the offered prices. This includes, but is not limited to transportation cost, packing, needed transport frame/box, road transport permit, insurance for transportation of equipment etc.
- The transport company must be qualified to transport high value items.

3.13 Documentation

The Contractor must thoroughly document all inspections, measurements, repairs, and materials for each component re-furbished or manufactured. All documents must be traceable for each component.

A fact-finding report must be delivered as soon as possible after the inspection, and copies of the (hand-written) raw measurement data must be provided as soon as the protocols have been filled in.

Templates for dimension check protocols and fact-finding report are provided by the Contractor for I/S Reno-Nord's approval prior to the outage start. I/S Reno-Nord do not have protocols from previous inspections or original installation at hand for comparison.

The final documentation is delivered in Danish or English in an electronic copy on a portable HD drive. All documents of the final documentation should be one open PDF file with all reports included. It should include bookmarks/index for an easy overview and navigation and divided into main groups (like: Fact finding report, protocols, commissioning, new spare parts).

Drawings shall be delivered in .DWG or .DXF and .pdf.

All documents (reports, datasheets, protocols etc.) shall be delivered in latest versions of Microsoft Office (Word, Excel, Project) or as open .pdf.

The identification system for Power Stations (KKS) must be used where applicable (delivery of spare parts, fact findings, protocols).

The documentation must be submitted on a continuous basis and the final version must include the following as a minimum:

- Supervision - daily report(s)
- Fact finding check list (to be discussed and delivered as soon as possible after inspection has been completed) including statements with agreed actions and repair and a fulfilling description of all works performed and recommendations given
- Measurements of all clearances during disassembly and assembly
- Measurement of bolt lengths, as well as calculation for tightening and permanent stretch
- Measurements of rotor straightness
- Measurements of roundness/dimensions of casings, blades carriers, balance pistons, steam glands etc
- Result from blue print of casing and other contact surfaces
- Size and distribution of balance weights
- NDT reports (bearings, gears, valves, rotor blades etc.)
- Measurements of alignment at the couplings during disassembly and assembly
- Manufacturing drawings and material certificate of all new components
- Commissioning report
- Balancing report, if applicable.

3.14 Manpower

3.14.1 The work is to be organised, manned and supervised by the Contractor. Project management

The Contractor must appoint a Project Manager with the required experience and competence to oversee the project planning and execution who communicate efficiently in English or Danish.

I/S Reno-Nord has the right to visit the workshops or other facilities of the Contractor or his subcontractor(s), as well as attend any step in the manufacturing/refurbishment process or any measurement/quality control.

The Contractor must participate in coordination meetings with I/S Reno-Nord and other Suppliers, as required. One (1) weekly meeting during the outage must be expected.

3.14.2 Site personnel

The Contractor must estimate the need for staffing in his offer, and must as a minimum provide the following personnel for the overhaul:

- 1 Site Manager who communicates efficiently in English or Danish
- 1 turbine Supervisor per shift
- All needed mechanical fitters. The Contractor shall provide enough manpower during the overhaul, to ensure that it is finished according to the time schedule
- Certified crane drivers
- All needed assistance for cleaning
- Fact-finder
- NDT specialist(s) according to the NDT plan
- Balancing specialist available during start-up
- A Commissioning Engineer must be available at site during shut-down and start-up until the plant is operating normally.

Project Manager do not need to be onsite during the complete overhaul. Access via e-mail or phone is accepted.

The Site Manager can leave site in case all main parts have been shipped to a workshop.

The balancing specialist's availability during start-up (3 days) is part of the Scope of Work. If vibration issues would require the balancing specialist to carry out additional balancing it will be considered Variation settled according to daily rates.

The scope includes all travel and accommodations cost. The scope should also include costs for an extra travel for the Commissioning Engineer, the Site Manger and 1 mechanical fitter between cold and hot commissioning. It much be the same personnel for cold and hot commissioning. Additional cost for extra days on-site to be informed and will be according to hourly rates.

It is very important for I/S Reno-Nord that the fact finding, and identification of necessary repairs and replacements are finalized as early as possible. Therefore, disassembly works must be finalised as soon as possible.

3.15 Tools and consumables

A tool container including hand tools is part of the Scope of Works. In addition, special tools, lifting equipment, supports, rotor stands (also for transport if needed) not available at I/S Reno-Nord must be included.

Tools for untightening and tightening of flange and coupling bolts are to be provided by the Contractor.

I/S Reno-Nord has some special tools on-site, which must be inspected during the site visit prior to mobilisation.

Consumables (minor bolts, screws, nuts, gaskets etc.), cleaning materials, cleaning agents are included in the Scope of Works.

All personal safety equipment shall be included in the scope.

3.16 Quality, Health, Safety and Environment (QHSE)

The Contractor shall prepare a Workplace Assessment (WPA) including a risk assessment for the job. The WPA shall be sent to I/S Reno-Nord three (3) weeks before starting up at the site.

I/S Reno-Nord's HQSE guidelines must be observed at any time for all on-site activities.

4 Options

The Tender must include optional prices and delivery time according to the Price List for the following optional deliveries:

4.1 Split line stud bolts for turbine outer casing

It may have been two decades since the turbine have been opened for inspection, and the condition of the split line bolts have not been recorded. It must be foreseen, that some bolts and nuts are sacrificed during disassembly. Thus, new bolts, nuts (and sleeves if applicable) must be offered by the Contractor

I/S Reno-Nord does not have any information on amount or dimensions of the split line bolts.

The Contractor must base his offer on replacement parts on knowledge from similar machines or a best estimate. The basis (material used, dimension) for the offer must appear clearly from the offer.

4.2 New sealing strips for the rotor

The following must be included, as a minimum:

- Install rotor in the lathe
- Remove old sealing strips
- Clean sealing strip grooves

- Fabricate new sealing strips
- Install new sealing strips (caulking)
- Machine sealing strips to correct dimensions (height)
- Supply report included clearances, tolerances and findings.

The cost of new sealing strips must be based on the following:

- A start-up cost for placing/preparing the rotor in lathe machine
- Prices per sealing strip to be replaced for:
  - Between blades
  - Balance piston I
  - Balance piston II
  - Front gland
  - Rear gland

4.3 New sealing strips for stationary parts

The following must be included, as a minimum:

- Install blade carriers in machine
- Remove old sealing strips
- Clean sealing strip grooves
- Fabricate new sealing strips
- Install new sealing strips by stemming
- Machine sealing strips to correct dimensions
- Supply report included clearances, tolerances and findings.

The cost of new sealing strips must be based on the following:

- A start-up fee for placing/preparing one blade carrier in vertical lathe machine
- Prices per sealing strip to be replaced for:
  - blade carrier 1 (total of 32)
  - blade carrier 2 (total of 14)

4.4 New blades and replacement

Manufacturing and installation of new blades must be offered:

- Row 1 of rotating blades
- Row 12 of rotating blades (shrouded)
- Row 18 of rotating blades (free standing)

The cost shall include removing old blades, delivery and installation of new blades (incl. shims, keys, locks etc.), preparation of blade groove and machining shrouds to correct diameter.

If a row of rotating blades needs to be replaced option **4.6 High-speed balancing of turbine rotor** will be required by prior agreement.

4.5 Control Stage

The control stage is designed with a damping wire caulked into the shroud. It is a recognized weakness in the turbine design, and the OEM have previously issued a technical note describing the issue.

The condition of the wire is not known, but visual inspection and NDT of the wire and shroud must have special focus.

The Contractor must provide an option price for a complete replacement of the blade row and wire. A detailed description of the proposed solution with choice of materials stated must be included in the offer.

The Contractor must also provide an offer for an alternative solution without the use of damping wire. The alternative solution must be described in detail in the offer, and references must be included.

In case the control stage is to be replaced option **4.6 High-speed balancing of turbine rotor** may come into force by prior agreement.

4.6 High-speed balancing of turbine rotor

A high-speed balancing can be required in case replacement or repair works have been performed on the rotating blades or the rotor itself.

The following must be included, as a minimum:

- Transport to balancing bunker
- Needed and approved transport frame/box
- Road transport permit (if applicable)
- Transport insurance
- Install rotor in bunker
- A balancing according to ISO 11342 and 1940-1 class G 2,5
- Perform test to verify that the blades are still correctly fixed and secured
- Remove rotor from bunker
- Transport to site
- Balancing report (in English. All run-ups/downs must be reported and form part of the documentation)

The scope shall include needed bearing(s) for the high-speed balancing.

The Contractor shall inform I/S I/S RENO-NORD if a slot for the high-speed balancing of the rotor must be booked up front to make sure that a bunker is available during the outage.

4.7 Turbine bearings

Inspection, white metal condition and bonding check is included in general scope of work, outcome of this work determines if bearings are unfit for further, long-term operation and are to be replaced.

New turbine journal bearings must be offered for front and rear. Also, a complete set of 12 segments (6 pcs. cw, 6 pcs. ccw) thrust bearing pads must be offered.

As an alternative offer for re-babbitting of journal bearings (front and rear) must be provided as a price apiece.

4.8 Gear Bearings

Re-babbitting of bearings for the pinion and bull gear shafts must be offered (unit prices).

(Gearbox Renk-Tacke TDB-630 ref. no. 722679. Year of manufacture: 1990.

4.9 Seats for control valves

I/S Reno-Nord have in the storage a new seat for each of the control valves (3 pcs.). The seats may be manufactured at original, final dimension. In case the seats need to be replaced and excessive cleaning and machining of the fitting surfaces in the casing leaves the clearances out of tolerance two scenarios are foreseen:

- 1. The seats in the storage are applied with a final machining allowance and machined to correct dimension during the overhaul
- 2. A new set of seats are manufactured

A price for both variants must be provided by the Contractor.

Removal of old seats and installation of new seats will be considered as Variation to be settled according to hourly rates and timesheets.

4.10 Oil deflector rings for the turbine

An option price for the delivery of

- Front end oil deflector ring
- Rear end oil deflector ring

I/S Reno-Nord has a set of used deflector rings in the storage, but whether the parts are fit for further use or if a reconditioning is possible will need to be verified.

4.11 Additional work and extra manning from Contractor

All extra work based on findings during inspection and NDT must be agreed with I/S Reno-Nord in writing.

Ordering of extra work can be based either on a fixed price offer from Contractor or on the Contractor's hourly rates depending on the nature of the work.

Price sheet with the Contractor's hourly and daily rates for the relevant personnel shall be included in the tender and the rates must include travel time, travel cost, daily allowances, transport, PPE (Personal Protective Equipment) etc.

For additional work carried out based on hourly rates the Contractor’s weekly timesheets must be approved by I/S Reno-Nord before the work can be invoiced.

4.11.1 On-site balancing of the entire turbine shaft

An on-site balancing of the entire turbine shaft may be needed after the overhaul. The balancing is **not part of the basic scope** and will be according to hourly rates.

4.12 Transport of main components to workshop

In case the Contractor plan to perform all works on site, prices for shipping any main components must be included as an option.

The following must be included, as a minimum:

- Transport to workshop and back to power plant
- Supply of transport frame/box approved for transport
- Road transport permit
- Transport insurance.

4.13 Recommended spare parts or services

Spare parts or services not mentioned in this Technical Specification should be recommended in case the Contractor finds them necessary to successfully complete the major overhaul of turbine and gear.

Recommendations must include breakdown prices for all recommended parts and services. All recommended spare parts must hold a unique ID as well as delivery time.

I/S Reno-Nord's storage only holds a very limited stock of spare parts. All parts have been stored for a long time (may have been part of strategic spares purchased along with the turbine in 1991).

Some of the parts are previously used and the applicability of all parts must be confirmed by the Contractor before being used. Among the unused parts are new spindle(s) and seats (3 pcs) for the control valve, and a new set of spindles for the main lube oil pump (Allweiler).

5 Supply by I/S Reno-Nord

I/S I/S RENO-NORD Production will be responsible for the following:

- Removal and re-assembly of noise screen
- Removal and renewal of the turbine insulation is handled by I/S Reno-Nord or third party
- Scaffolding
- Ensuring the double isolating shutting off live steam (witnessing and approval by the Contractor)
- Execution of a performance test / recording parameters of the turbine set before and after the overhaul of the turbine (if decided)
- Inspection of lubrication oil and hydraulic systems
- Changing of filters in lubrication oil and hydraulic systems
- Power outlet 1 x 230 VAC, 16 A and 3 x 400 VAC 16/32A CEE
- Pressurized air approx. 7 bar
- Site facilities (high-speed internet connection (DSL and WLAN), sanitary facilities (shower facilities), locker room, water (potable and service water).
- Access to I/S Reno-Nord's workshop for the Contractor when agreed
- Crane at site can be used (by Contractor's certified personnel only)
- Special tooling at site can be used

6 Marking of spare parts

Upon delivery, spare parts (ordered as options or as extra work) shall be packed and preserved for long-term storage.

The packaging of individual parts shall be marked with the following information:

- I/S Reno-Nord turbine 3
- Purchase order number and date
- Position number as per order or requisition
- Description
- Drawing number, position number, spare part number
- KKS number.