SHINKO

# CARGO, TANK CLEANING & BALLAST PUMP TURBINES

## RX／RVR

# RX & RVR STEAM TURBINES

Shinko has manufactured more than 9,500 sets of R type steam turbines since the development of our first cargo oil pump turbines and ballast pump turbines for oil tankers in 1960. To this date, we have constantly focused on improving product quality, operation performance, and many other aspects.
In recent times, the following considerations have also been more vital due to escalating fuel prices, prevention of air pollution, and other environmental issues:

- Improving the efficiency of cargo oil pump turbines
- Reducing fuel consumption

In these situations, we have accelerated multiple improvements to the turbine performance using the CFD analysis method.


## GENERAL CHARACTERISTICS

The vertical R models are Curtis single-stage or Rateau 3-stage steam turbines with a single reduction gear. We have the following 5 standard models classified by maximum output:

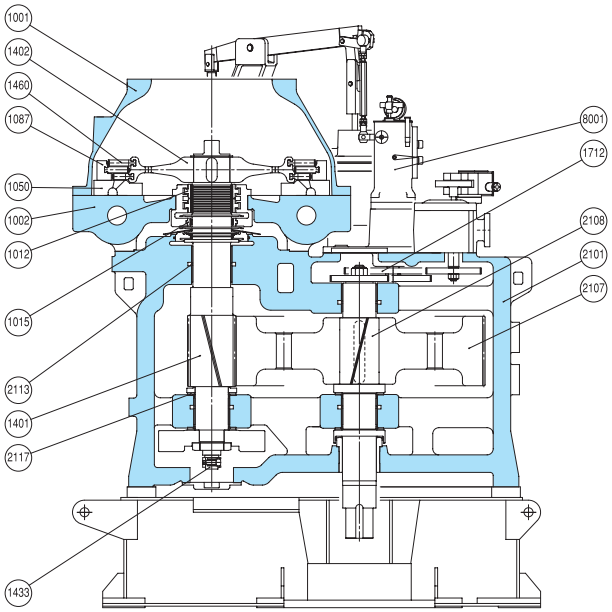
| Item \ Model | RX 0 | RX 1 | RX 2-2 | RVR 1 | RVR 2-2 |
|---|---|---|---|---|---|
| Type | Curtis single-stage | | | Rateau 3-stage | |
| Max. output (kW) | 600 | 1300 | 1850 | 2000 | 4000 |
| Max. speed (turbine shaft) ($min^{-1}$) | 8500 | 7200 | 7200 | 7200 | 7200 |
| Max. reduction gear ratio | 6.45 | 6.65 | 6.06 | 6.11 | 7.17 |
| Inlet steam pressure (MPaG) | 1.85 | | | | |
| Inlet steam tmperature (℃) | 280 | | | | |
| Exhaust steam | −80kPa ～ 0.03MPaG | | | | |
| Rotation of output shaft | Counter-Clockwise facing toward pump | | | | |
| Steam inlet bore (mm) | 100 | 125 | 150 | 150 | 150 |
| Steam exhaust bore (mm) | 300 | 400 | 500 | 500 | 600 |
| Lubrication system | Forced lubrication (turbine oil ISO VG68) | | | | |
| Main LO pump ($m^3/h \times MPaG$) | 5 × 0.1 | 8 × 0.1 | | | |
| Prim. LO pump ($m^3/h \times MPaG$) | 7.2 × 0.04 | | | | |
| LO tank (ℓ) | 190 | 270 | 280 | 280 | 320 |
| LO cooler (S.W.) ($m^2$) | 3 | 4.8 | 5 | 5.7 | 7.3 |
| Cooling water required (S.W.) ($m^3/h$) | 8 | 15 | 15 | 15 | 20 |
| Speed regulating governor | Woodward UG25+ | | | | |
| Range of speed change | Rated × 100 ～ 50% | | | | |
| Weight (kg) | 2300 | 3500 | 4500 | 5500 | 6800 |

## DESIGN & MATERIALS

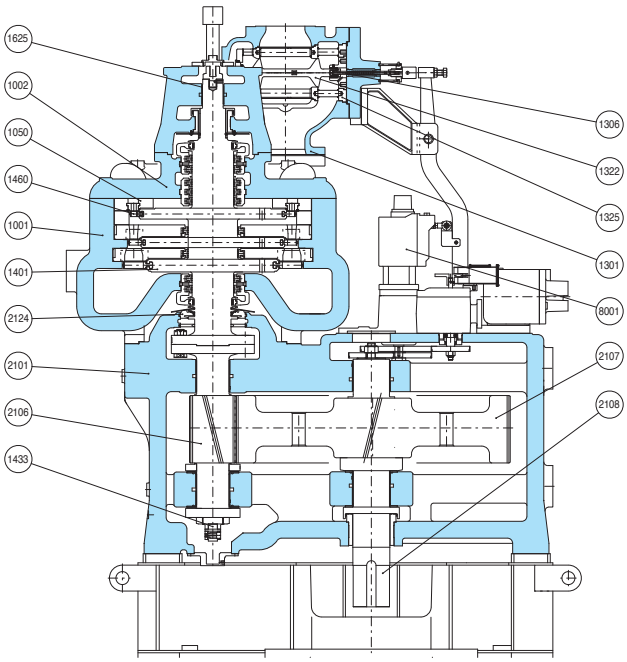
In order to ensure ease of inspection and maintenance of the casing interior as well as simple overhauling of the rotating element, consideration has been given to the following points in our design.

1. The steam chest and reduction gear casing are split vertically.
2. The pipe connections for the steam inlet, LO inlet and outlet, and drainages are fitted on to the casing body.
3. The reduction gear casing cover is fitted to the casing body with a hinge.

RX




RVR




| PART NO. | NAME OF PART | MATERIAL | | | REQ.NO. FOR 1 TURBINE |
|---|---|---|---|---|---|
| | | NAME | JIS | ASTM EQUIVALENT | |
| 1001 | EXHAUST CASING | DUCTILE CAST IRON | FCD400 | A536 60-40-18 | 1SET |
| 1002 | STEAM CHEST | CAST STEEL | SCPH2 | A216 WCB | 1SET |
| 1012 | LABYRINTH PACKING | Ni-BRASS CASTING | | | 2SETS |
| 1015 | STEAM GUARD | Ni-SILVER PLATE WITH STEEL | C7521P S35C | AISI 1035 | 1SET |
| 1050 | NOZZLE | STAINLESS STEEL | SUS403 | A276 403 | 1 |
| 1087 | STATIONARY BLADE SEAT | STEEL | SS400 | A283D | 1 |
| 1401 | TURBINE SHAFT & PINION | Ni-Cr-Mo STEEL | SNCM439 | | 1 |
| 1402 | DISC ROTOR | Ni-Cr STELL | SNC836 | | 1 |
| 1433 | OVERSPEED TRIP SHAFT | CARBON STEEL | S35C | AISI 1035 | 1 |
| 1460 | MOVING BLADE | STAINLESS STEEL | SUS410J1 | S41025 | 1SET |
| 1712 | DRIVING GEAR | CARBON STEEL | S45C | AISI 1045 | 1 |
| 2101 | REDUCTION GEAR CASING | CAST IRON | FC200 | A48 No.35 | 1SET |
| 2107 | WHEEL | FORGED STEEL | SF640B | A668 | 1 |
| 2108 | OUTPUT SHAFT | 〃 | SF540A | 〃 | 1 |
| 2113 | BEARING METAL | WHITE METAL WITH STEEL | WJ2 S25C | B23 AISI 1025 | 1SET |
| 2117 | THRUST BEARING METAL | 〃 | 〃 | 〃 | 1SET |
| 8001 | SPEED REGULATING GOVERNOR | | | | 1SET |

| PART NO. | NAME OF PART | MATERIAL | | | REQ.NO. FOR 1 TURBINE |
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| | | NAME | JIS | ASTM EQUIVALENT | |
| 1001 | TURBINE CASING | DUCTILE CAST IRON | FCD400 | A536 60-40-18 | 1SET |
| 1002 | STEAM CHEST | CAST STEEL | SCPH2 | A216 WCB | 1 |
| 1050 | NOZZLE | CARBON STEEL STAIN. STEEL | S25C SUS403 | AISI 1025 A276 403 | 1SET |
| 1301 | GOVERNOR VALVE CASING | CAST STEEL | SCPH2 | A216 WCB | 1 |
| 1306 | GOVERNOR VALVE STEM | STELLITE | | | 1 |
| 1322 | GOVERNOR VALVE | STAINLESS STEEL | SUS420J2 | AISI 420 | 1 |
| 1325 | GOVERNOR VALVE SEAT | 〃 | SUS403 | A276 403 | 1 |
| 1401 | TURBINE ROTOR | Cr-Mo STEEL | | | 1 |
| 1433 | OVERSPEED TRIP SHAFT | CARBON STEEL | S35C | AISI 1035 | 1 |
| 1460 | MOVING BLADE | STAINLESS STEEL | SUS410J1 | S41025 | 2SETS |
| 1625 | BEARING METAL | WHITE METAL WITH STEEL | WJ2 S25C | B23 AISI 1025 | 1SET |
| 2101 | REDUCTION GEAR CASING | CAST IRON | FC200 | A48 NO.35 | 1SET |
| 2106 | PINION | Ni-Cr-Mo STTEL or Ni-Cr STEEL | SNCM439 SNC815 | | 1 |
| 2107 | WHEEL | FORGED STEEL | SF640B | A668 | 1 |
| 2108 | OUTPUT SHAFT | 〃 | SF540A | 〃 | 1 |
| 2124 | OIL GUARD | BRONZE | CAC406 | B584 C83600 | 1SET |
| 8001 | SPEED REGULATING GOVERNOR | | | | 1SET |

## ●Speed Control System

The Woodward UG or PG governor is employed on the turbine and its speed can be adjusted between 50%~100% of the rated speed by operating the control switch in the cargo control room, or on site.

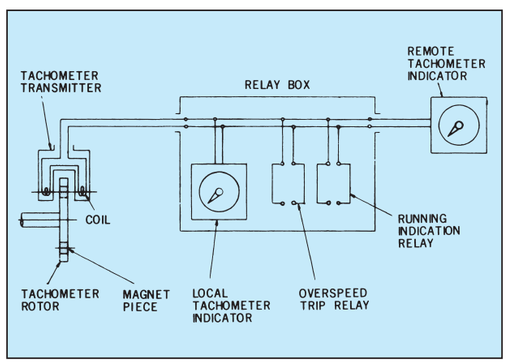
## ●Lubrication System

During operation of the turbine, the LO is supplied to the bearing metal, reduction gear, and other components through the main LO pump.
Besides, in order to maintain safe operation, an independent electric motor driven priming LO pump is utilized. When the turbine starts, it is inter-locked so as not to start even if the inlet steam valve is open until the pressure of the LO line reaches between 0.02~0.03MPaG. On the contrary when the turbine stops, the priming LO pump stays operating to keep the LO pressure at 0.02 to 0.03MPaG until the turbine stops completely.

| | Actuation | P.LO pump | M.LO pump | LO press. MPaG |
|---|---|---|---|---|
| Start | Switch on (P.LO pump) | start | stop | 0.02~0.03 |
| | Main steam v. open | stop | start | 0.085 |
| | Normal operation | stop | nor.run. | 0.1~0.15 |
| Stop | Main steam v. close | start | down | 0.045 |
| | Turbine stop | run. | stop | 0.02~0.03 |
| | Switch off (P.LO pump) | stop | stop | 0 |

## ●Tachometer (Patented)

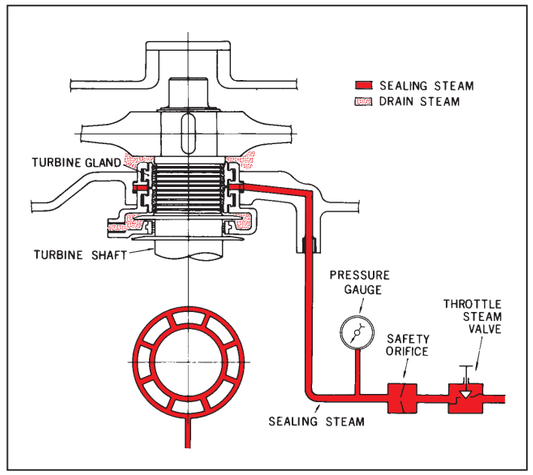
This tachometer, having three functions showing the number of revolutions, the running indications, and the overspeed trip, is a patented electronic system. As shown in the figure below, this system is composed of a transmitter, receivers, and speed relays, and needs no external power source.

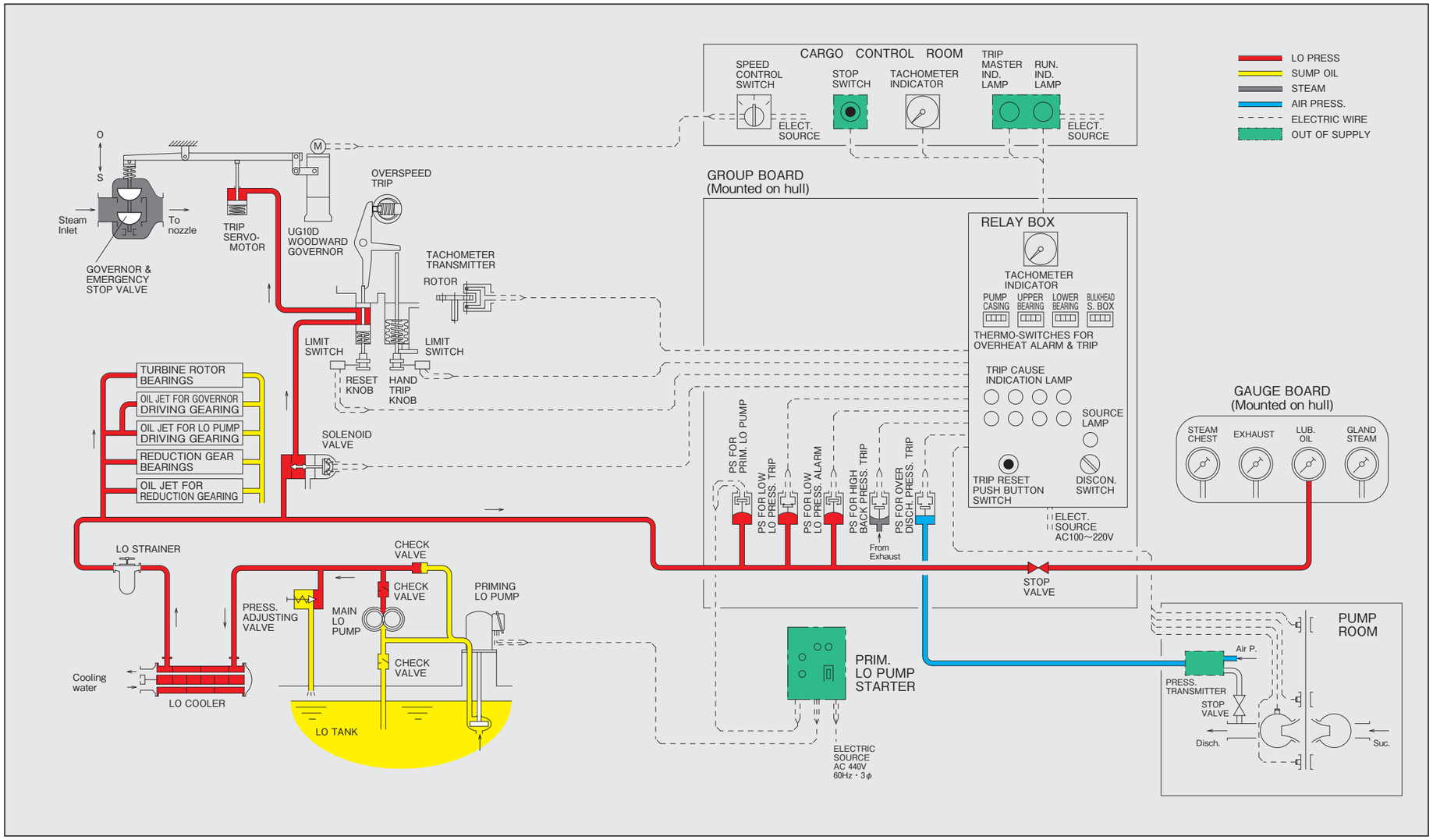



## ●Turbine Gland Seal

The turbine glands are sealed with labyrinth packing when the exhaust steam is led to the vacuum condenser.

To prevent air from entering into the turbine casing, sealing steam is led to the turbine glands. The sealing steam first passes through the throttle steam valve and then the safety orifice in order to reduce its pressure to 0.01~0.08MPaG before reaching the turbine glands.



## ●Alarm & Trip Systems

Alarms and trips are very important functions to avoid pump & turbine trouble, and automatic actuation is essential.
Alarm items are command, which informs to operate the equipment attentively. The contacts of each alarm signal are sent to a Cargo Control Room (CCR). Depending on the alarm, it is necessary to take an action to reduce the turbine speed at CCR or to visit the machine side (pump or turbine) to verify the abnormality of the equipment.

### Alarm & Trip setting list

Turbine

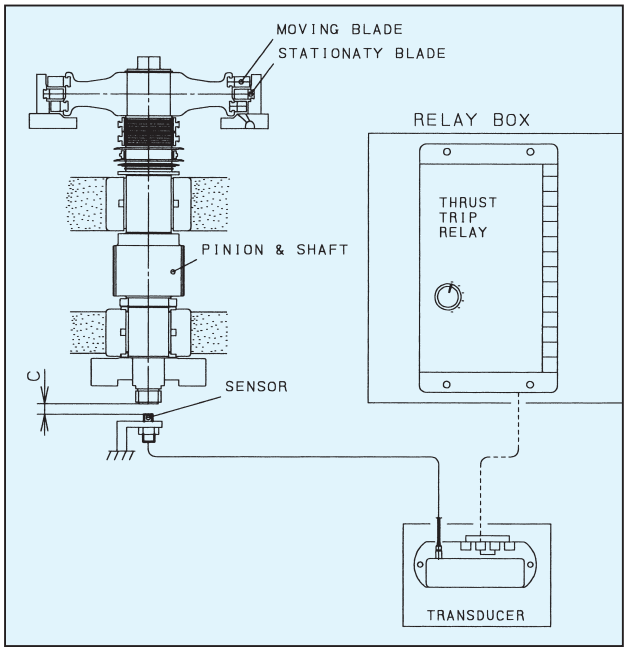
| Item | | Alarm | Trip | Remarks |
|---|---|---|---|---|
| Overspeed trip (elect.) | ($min^{-1}$) | – | 113% of rated | |
| Overspeed trip (mech.) | ($min^{-1}$) | – | 115% of rated | |
| Low LO press. | (kPaG) | 60 | 50 | |
| High back press. | (kPaG) | 70 | 90 | |
| Sentinel valve | (kPaG) | 70 | – | |
| High LO temp. | (℃) | 53 | – | |
| Inert gas low press. (external signal) | | – | trip:off | COP only |
| Plant abnormal (external signal) | | – | trip:off | |
| Turb. shaft BRG high temp. | (℃) | 75 | 80 | |
| Wheel shaft BRG high temp. | (℃) | 75 | 80 | |
| Low sealing steam press. | (kPaG) | +5 | −5 | |
| Reverse rotation | (kPaG) | −6.7 | – | |
| Low LO tank level | (mm) | nor.level −60 | – | DNV |
| Rotor axial movement | (mm) | 0.5 | 0.7 | LR |

Note1. :SHINKO standard

Each trip is designed to stop the turbine by closing the governor valve automatically.
The trip signal activates the local trip-solenoid valve (Trip:off) via relay box, resulting in the release of LO pressure and the closure of the governor valve.
The signals to the CCR are as follows;
Trip cause indication lamps are provided on the local relay box and the trip signals are sent to the master trip lamp in the CCR.

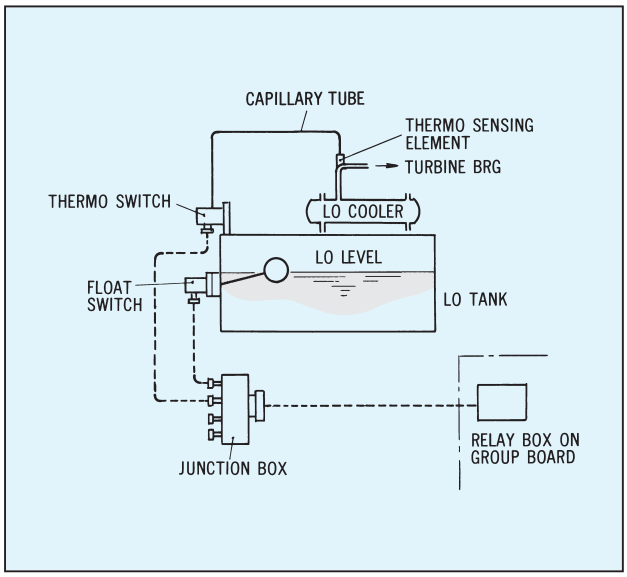
## ●Rotor Axial Movement Trip (Option)

In the case that the turbine rotor moves abnormally in an axial direction for some reason, the moving and stationary blades may come into contact and may cause severe damage.
This trip is fitted in place with a 1mm clearance (C) from the shaft end. When the thrust bearing wears down by 0.7mm and clearance (C) becomes 0.3mm, the turbine is tripped.




## ●High LO Temp. Level Alarm
## ●Low LO Level Alarm (Option)

In the case that LO temperature rises to 53℃ or the LO level lowers from normal level to 60mm due to LO line failure, the thermo switch or float switch actuates sending alarms to the CCR/ECR respectively.



# ACCESSORIES

## Standard

| | Item | A Standard | | B Standard | | Remarks |
|---|---|---|---|---|---|---|
| | | Type | Q'ty | Type | Q'ty | |
| Turbine | Priming LO pump | centri. | 1 | centri. | 1 | |
| | LO cooler | shell & tube | 1 | shell & tube | 1 | |
| | Thermometer for LO temp. | bar type | 2 | bar type | 2 | |
| | Thermometer for bearing temp. | dial type | 4～5 | dial type | 4～5 | |
| | Tachometer transmitter | pulse type | 1 | pulse type | 1 | |
| | Tachometer indicator (CCR & Local) | □110 | 1set | □110 | 1set | |
| | Gauge root valve | | 4 | | 4 | |
| | Gauge board with press. gauges | ϕ75gauge | 1set | ϕ75gauge | 1set | |
| | Group board with relay box | | 1set | | 1set | |
| | Speed control switch (CCR) | | 1 | | 1 | |
| Safety device | Overspeed trip | elect. | 1 | elect. | 1 | |
| | | mech. | 1 | mech. | 1 | |
| | Low LO press. trip | elect. | 1 | elect. | 1 | |
| | Low LO press. alarm | 〃 | 1 | 〃 | 1 | |
| | High back press. trip | 〃 | 1 | 〃 | 1 | |
| | Sentinel valve | mech. | 1 | mech. | 1 | |
| | High LO temp. alarm | elect. | 1 | elect. | 1 | |
| | Hand trip device | mech. | 1 | mech. | 1 | |
| | Remote trip device at CCR | elect. | 1 | elect. | 1 | |
| | Inert gas low press. trip | 〃 | 1 | 〃 | 1 | |
| | Plant abnormal trip (BLR HH trip etc.) | 〃 | 1 | 〃 | 1 | |
| Others | Drain separator & drain trap | cyclone | ★ | cyclone | 1set/ship | Only single stage turbine |
| | Priming LO pump starter | elect. | ★ | elect. | 1 | |

★Yard supply

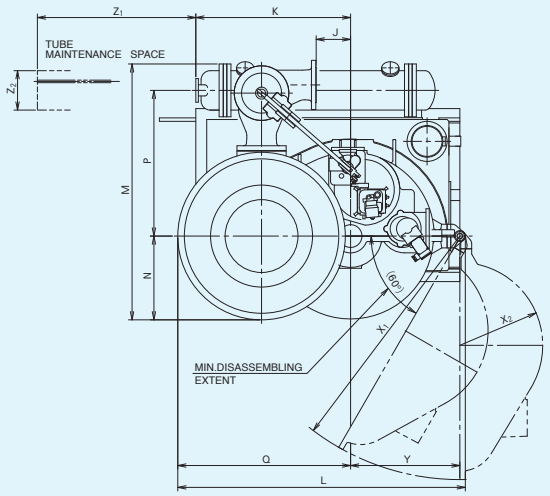
## Option

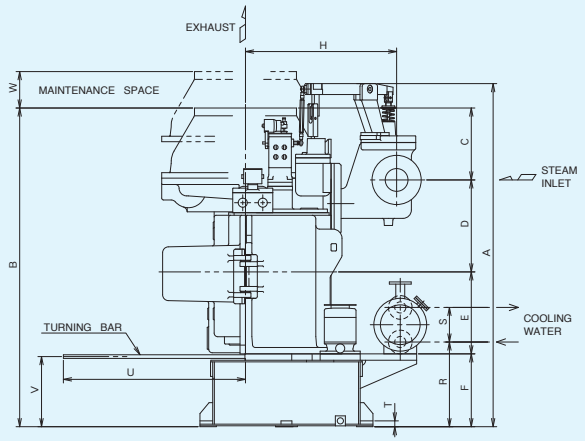
| | Item | A Standard & B Standard | | Remarks |
|---|---|---|---|---|
| | | Type | Q'ty | |
| Safety device | Turbine shaft BRG high temp. alarm & trip | elect. | 2～3 | High speed |
| | Wheel shaft BRG high temp. alarm & trip | 〃 | 2 | Low speed |
| | High back press. alarm | 〃 | 1 | |
| | Low sealing steam press. alarm | 〃 | 1 | |
| | Reverse rotation alarm | 〃 | 1 | |
| | Low LO tank level alarm | float | 1 | DNV |
| | Rotor axial movement alarm & trip | elect. | 1 | LR |
| | Rotor axial movement alarm, trip & monitoring at TBN | 〃 | 1 | BV , RINA |
| | TBN vibration (gear casing) alarm monitoring at TBN | 〃 | 1 | BV , RINA |
| Instrument | Tachometer indicator (ECR) | 〃 | 1 | |
| | Rpm D/A converter | 〃 | 1 | |
| | Chest press. remote indication device | 〃 | 1set | |
| | Exh. press. remote indication device | 〃 | 1set | |
| | LO press. remote indication device | 〃 | 1set | |
| | Limit switch for exh. valve | 〃 | 1 | |
| Others | Remote starting device model 〔KKS〕 | elect. | 1set | |
| | LO temp. control valve | wax | 1 | Only sea water |
| | LO duplex strainer | duplex | 1 | |
| | Piano type CCR console | piano | 1set/ship | |
| | Panel type ECR console | panel | 1set/ship | |
| | Counter flange | flange | 1set/ship | |

# STANDARD SPARE PARTS (per ship)

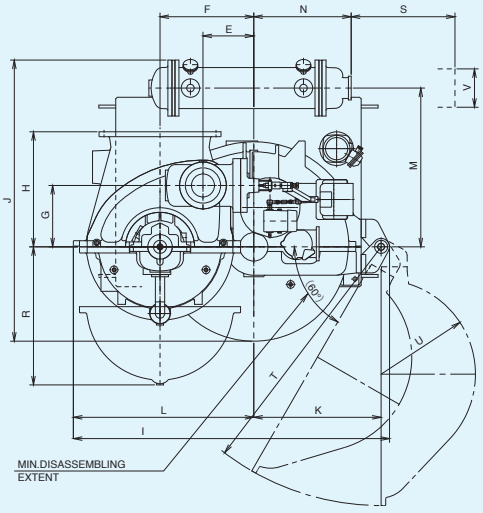
Journal bearing metal ·····1/set*
Thrust bearing metal ·····1/set*
Each kind of spring ·····1/set*
Special gasket & packing·····1/set*
LO cooler cooling tube ····· 2.5% of total amount/set*
Priming LO pump ball bearing ·····1/set*
Relay box auxiliary relay ····· 1/set*
Relay box pilot lamp ····· 10% of total amount/set*
Relay pilot lamp globe ····· 2/set*
Relay box fuse element ···· 100% of total amount/set*
Solenoid valve coil ····· 1/set*
(set*=all units of the same model and application)

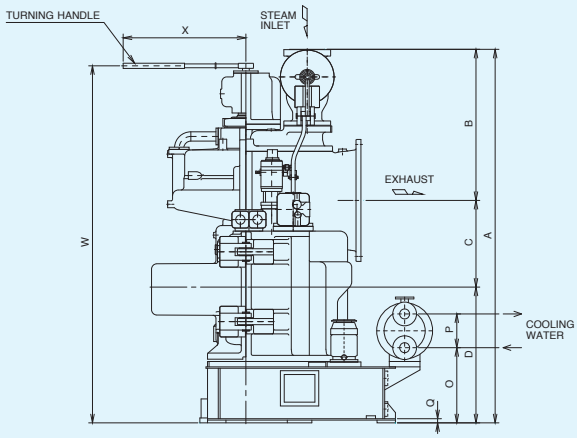
## RX




## RVR




Dimensions : mm

| Model | A | B | C | D | E | F | H | J | K | L | M | N | P | Q | R | S | T | U | V | W | $X_1$ | $X_2$ | Y | $Z_1$ | $Z_2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RX 0 | 1714 | 1500 | 280 | 455 | 405 | 360 | 600 | 107 | 830 | 1240 | 1207 | 382 | 680 | 676 | 425 | 190 | 32 | 1200 | 350 | 200 | R1110 | R385 | 530 | 650 | 200 |
| RX 1 | 1890 | 1750 | 395 | 505 | 450 | 400 | 830 | 189 | 850 | 1580 | 1405 | 460 | 800 | 950 | 465 | 190 | 32 | 1200 | 385 | 200 | R1338 | R455 | 600 | 950 | 200 |
| RX 2-2 | 1949 | 1780 | 405 | 495 | 480 | 400 | 830 | 255 | 970 | 1760 | 1527 | 532 | 850 | 1025 | 465 | 190 | 32 | 1200 | 360 | 200 | R1540 | R527 | 630 | 1150 | 200 |

| Model | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RVR 1 | 2420 | 920 | 620 | 880 | 233 | 513 | 400 | 650 | 1710 | 1527 | 680 | 988 | 880 | 630 | 465 | 190 | 14 | 810 | 1150 | R1460 | R510 | 200 | 2330 | 800 |
| RVR 2-2 | 2435 | 985 | 565 | 885 | 331 | 611 | 400 | 750 | 2060 | 1833 | 830 | 1176 | 1035 | 635 | 490 | 220 | 27 | 900 | 850 | R1690 | R615 | 250 | 2330 | 800 |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