

巴厘通用能源公司

PT.GENERAL ENERGY BALI

#2 循环水泵检修技术规范书

#2 Technical Specification for Maintenance of Circulating Water Pump

批准 (APPROVE):



审核 (VERIFY) :



编制 (Prepared by) :



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#2 循环水泵检修技术规范书

#2 Technical Specification for Maintenance of Circulating Water Pump

1. 总则

1. General Rules

1.1 适用范围

1.1 Scope of Application

本规范书适用于巴厘通用能源公司（以下简称“甲方”）#2 循环水泵的解体大修工作。#2 循环水泵为湖南湘电长沙水泵有限公司制造的 88LKXE-17 型立式斜流泵，配套电机型号为 YKSL2250-16/1500-ITH。本次招标旨在选定具备专业能力的承包方（以下简称“乙方”）对水泵进行解体大修，工作内容包括但不限于：吸入喇叭口检查、叶轮室检查、叶轮检查、主轴弯曲度检查及校验、赛龙导轴承更换、轴套更换、叶轮口环及导叶体口环检查更换、轴承支架检查、易损件更换、阴极保护系统检查等。所有配合部位均须进行尺寸测量，并调整至厂家说明书要求的标准范围。

This specification applies to the major overhaul of circulating water pump #2 of PT. General Energy Bali (hereinafter referred to as "Party A"). Circulating water pump #2 is a Model 88LKXE-17 vertical mixed-flow pump manufactured by Hunan Xiangdian Changsha Water Pump Co., Ltd., with the supporting motor model YKSL2250-16/1500-ITH. The purpose of this tender is to select a contractor with professional capability (hereinafter referred to as "Party B") to carry out the major overhaul of the pump. The work includes but is not limited to: suction bell mouth inspection, impeller chamber inspection, impeller inspection, main shaft bending inspection and verification, Thordon guide bearing replacement, shaft sleeve replacement, impeller wear ring and guide vane wear ring inspection and replacement, bearing bracket inspection, wearing parts replacement, cathodic protection system inspection, etc. All mating parts shall be

measured in dimension and adjusted to the standard range required by the manufacturer's manual.

1.2 编制依据

1.2 Compilation Basis

- (1) 88LKXE-17-SM 型循环泵安装使用说明书（湖南湘电长沙水泵有限公司）；
(1) Installation and Operation Manual of Model 88LKXE-17-SM Circulating Pump
(Hunan Xiangdian Changsha Water Pump Co., Ltd.);
- (2) 88LKXE-17 型循环泵总装图及零部件图纸；
(2) Assembly drawing and component drawings of Model 88LKXE-17 circulating pump;
- (3) 《电力建设施工技术规范 第 3 部分：汽轮发电机组》（DL 5190.3）；
(3) Technical Specification for Electric Power Construction Part 3: Turbine Generator Units (DL 5190.3);
- (4) 《离心泵、混流泵、轴流泵和旋涡泵 运行技术管理规程》（DL/T 839）；
(4) Technical Management Regulation for Operation of Centrifugal Pumps, Mixed-flow Pumps, Axial-flow Pumps and Vortex Pumps (DL/T 839);
- (5) 《压缩机、风机、泵安装工程施工及验收规范》（GB 50275）；
(5) Code for Construction and Acceptance of Compressor, Fan and Pump Installation Engineering (GB 50275);
- (6) 巴厘通用能源公司《汽机检修规程》及相关安全管理制度；
(6) Turbine Maintenance Procedures and relevant safety management systems of PT. General Energy Bali;
- (7) 甲方提供的#2 循环水泵历次检修记录及运行台账。
(7) Previous maintenance records and operation logs of circulating water pump #2 provided by Party A.

1.3 设备概况

1.3 Equipment Overview

#2 循环水泵为 88LKXE-17 型单级立式斜流泵，电机与泵直联、单基础安装，吐出口在基础层之下；垂直向下的喇叭口吸水，水平吐出；泵的下部浸没在水中，采用水润滑导轴承，并有轴保护管将清洁的润滑水与泵输送水隔开；泵为转子可抽出式结构，维修拆卸时不必拆动外筒体、外部管路和安装基础，将需要维修的转子部件从泵壳中向上抽出即可；叶轮和叶轮室之间的间隙值通过上部联轴器处的调整螺母予以调节；水泵的轴向推力由电机承受。泵主要技术参数见表 1-1，电机主要技术参数见表 1-2。

Circulating water pump #2 is a Model 88LKXE-17 single-stage vertical mixed-flow pump. The motor is directly connected with the pump, installed on a single foundation, and the discharge port is below the foundation layer; the vertical downward bell mouth sucks water and discharges horizontally; the lower part of the pump is submerged in water, adopting water-lubricated guide bearings, and a shaft protection tube separates clean lubricating water from the water delivered by the pump; the pump has a rotor-removable structure, so that during maintenance and disassembly, it is not necessary to dismantle the outer cylinder, external pipelines and installation foundation, and the rotor parts requiring maintenance can be pulled upward from the pump casing; the clearance between the impeller and the impeller chamber is adjusted by the adjusting nut at the upper coupling; the axial thrust of the pump is borne by the motor. The main technical parameters of the pump are shown in Table 1-1, and the main technical parameters of the motor are shown in Table 1-2.

表 1-1 泵主要技术参数

Table 1-1 Main Technical Parameters of Pump

项目 Item	参数 Parameter	项目 Item	参数 Parameter
泵型号 Pump Model	88LKXE-17	流量 Q Flow Rate Q	9.67m ³ /s
扬程 H Head H	17m	效率 η Efficiency η	87%
必需汽蚀余量 NPSHr NPSHr	8.18m	转速 n Speed n	372r/min
轴功率 Pa Shaft Power Pa	1908kW	配套功率 P Matching Power P	2250kW
输送介质 Conveying Medium	海水 Seawater	最小淹没深度 Minimum Submergence	4.5m

		Depth	
转向 Rotation Direction	从电机往泵方向看顺 时针 Clockwise viewed from motor to pump	转子提升高度 Rotor Lifting Height	6mm
润滑水流量 Lubricating Water Flow	4m ³ /h	润滑水压力 Lubricating Water Pressure	0.3MPa
泵总重 Total Pump Weight	约 64000kg Approx. 64000kg	最大起吊重量 Maximum Lifting Weight	约 30000kg Approx. 30000kg
导轴承数量 Number of Guide Bearings	4 件 (赛龙材质) 4 pcs (Thordon)	轴套数量 Number of Shaft Sleeves	4 件 4 pcs
主轴结构 Main Shaft Structure	三段式 (主轴 a/b/c, 套筒联轴器联 接) Three-section (shaft a/b/c, sleeve coupling connection)	叶轮形式 Impeller Type	单级斜流式 Single-stage mixed- flow

表 1-2 配套电机主要技术参数

Table 1-2 Main Technical Parameters of Supporting Motor

项目 Item	参数 Parameter	项目 Item	参数 Parameter
电机型号 Motor Model	YKSL2250-16/1500- 1TH	额定功率 Rated Power	2250kW
额定电压 Rated Voltage	6000V	额定电流 Rated Current	306.5A
额定频率 Rated Frequency	50Hz	额定转速 Rated Speed	372r/min
绝缘等级 Insulation Class	F 级 Class F	防护等级 Protection Class	IP54
冷却方式 Cooling Method	IC81W (空空冷却) IC81W (Air-air cooling)	功率因数 Power Factor	0.75
电机效率 Motor Efficiency	94.2%	电机重量 Motor Weight	约 23050kg Approx. 23050kg
冷却水量 Cooling Water Volume	29m ³ /h	冷却水压力 Cooling Water Pressure	≤0.5MPa

2. 工作范围

2. Scope of Work

2.1 项目概述

2.1 Project Overview

2.1.1 项目名称：#2 循环水泵检修。

2.1.1 Project Name: #2 Maintenance of Circulating Water Pump.

2.1.2 项目地点：印度尼西亚巴厘通用能源公司（巴厘岛电厂）。

2.1.2 Project Location: PT. General Energy Bali, Indonesia (Bali Power Plant).

2.1.3 项目背景及目的：在#2 机组 2026 年 12 月份小修过程中，对#2 循环水泵进行解体大修，消除设备缺陷，恢复泵组各项技术指标至厂家标准，确保机组安全稳定运行。

2.1.3 Project Background and Purpose: During the minor repair of Unit #2 in December 2026, the circulating water pump #2 will be disassembled and overhauled to eliminate equipment defects, restore all technical indicators of the pump unit to manufacturer standards, and ensure safe and stable operation of the unit.

2.1.4 工程范围及主要工作内容：#2 循环水泵转子、叶轮整体吊出，吸入喇叭口检查，叶轮室检查，叶轮检查，主轴弯曲度检查并校验，赛龙导轴承、轴套、叶轮口环、导叶体口环、轴承支架及易损件进行更换，阴极保护系统检查及线路修复。所有配合部位进行尺寸测量，并调整到厂家说明书要求的标准。

2.1.4 Project scope and main work contents: #2 circulating water pump rotor and impeller are hoisted out as a whole, suction bell mouth inspection, impeller chamber inspection, impeller inspection, spindle curvature inspection and verification, cylon guide bearing, shaft sleeve, impeller mouth ring, guide vane body mouth ring, bearing bracket and wearing parts replacement, cathodic protection system inspection and circuit repair. Measure the dimensions of all mating parts and adjust them to the standards required by the manufacturer's manual.

2.1.5 承包方式：乙方包工、包工期、包质量、包安全、包文明施工，自备检修使用工器具。备品备件由甲方提供，乙方负责检修施工及更换。

2.1.5 Contracting Method: Party B shall be responsible for labor, construction period, quality, safety and civilized construction, and shall provide tools and instruments for maintenance by itself. Spare parts are provided by Party A, and Party B is responsible for maintenance construction and replacement.

2.2 检修项目明细

2.2 Maintenance Item Details

本次#2 循环水泵解体大修的具体检修项目见表 2-1。

The specific maintenance items for this major overhaul of circulating water pump #2 are shown in Table 2-1.

表 2-1 检修项目明细表

Table 2-1 Maintenance Item Details

序号 No.	检修项目 Maintenance Item	工作内容 Work Content	备注 Remarks
1	泵解体 Pump Disassembly	拆除联轴器防护罩、分开电机与泵联轴器、拆除电机接线 Remove coupling guard, separate motor and pump coupling, disconnect motor wiring	电机不抽转子 Motor rotor not removed
2	转子部件抽出 Rotor Component Extraction	将泵转子部件（含主轴、叶轮、导叶体、轴套等）整体从外筒体中向上抽出 Hoist the pump rotor assembly (including main shaft, impeller, guide vane, shaft sleeve, etc.) upward out of the outer cylinder as a whole	最大起吊约 30t Max lifting approx. 30t
3	吸入喇叭口检查 Suction Bell Mouth Inspection	检查内锥面磨损、腐蚀情况，检查防预旋筋片 Check inner cone surface wear and corrosion, check anti-pre-swirl ribs	
4	叶轮室检查 Impeller Chamber Inspection	检查内表面磨损、汽蚀情况，检查外锥面配合精度 Check inner surface wear and cavitation, check outer cone surface fitting accuracy	
5	叶轮检查 Impeller Inspection	检查叶片汽蚀、磨损、裂纹，测量叶轮与叶轮室间隙，做静平衡试验 Check blade cavitation, wear, cracks; measure impeller-to-chamber clearance; perform static balance test	

6	导叶体检查 Guide Vane Body Inspection	检查导叶体流道磨损、汽蚀，检查导轴承 安装面 Check guide vane flow passage wear and cavitation, check guide bearing mounting surface	
7	主轴检查校验 Main Shaft Inspection and Verification	三段主轴（a/b/c）逐段检查径向跳动， 超差进行校直，检查键槽、螺纹 Check radial runout of three-section shaft (a/b/c) section by section; straighten if out of tolerance; check keyways and threads	
8	导轴承更换 Guide Bearing Replacement	更换 4 件赛龙导轴承，测量轴承与轴套配 合间隙 Replace 4 Thordon guide bearings, measure bearing-to-shaft-sleeve clearance	甲方供备件 Spare parts by Party A
9	轴套更换 Shaft Sleeve Replacement	更换 4 件轴套（含填料轴套），检查轴套 与轴配合 Replace 4 shaft sleeves (including packing shaft sleeve), check shaft sleeve-to-shaft fit	甲方供备件 Spare parts by Party A
10	密封件更换 Seal Replacement	更换所有 O 形密封圈、密封垫板、填料 Replace all O-rings, sealing gaskets and packing	甲方供备件 Spare parts by Party A
11	阴极保护检查 Cathodic Protection Inspection	检查阴极保护系统外观、接线、阳极状 态， <u>在外筒壁中间部分加装一根阴极保护</u> <u>线路。</u> Check the appearance, wiring and anode state of the cathodic protection system, and install a cathodic protection line in the middle part of the outer cylinder wall..	
12	清理泵坑底部贝壳 Clean the shells at the bottom of the pump pit	循环水泵吸水室底板、侧壁及拦污栅上贝 壳、牡蛎等海生物附着物清除干净泵进口 区域无杂物 The bottom plate, side wall and trash rack of the suction chamber of the circulating water pump shall be cleaned of marine organisms such as shells and oysters, and the inlet area of the pump shall be free of sundries.	
13	回装及调试 Reassembly and Commissioning	转子回装、联轴器对中、转子窜动量调 整、盘车试验、试运行 Rotor reassembly, coupling alignment, rotor end play adjustment, barring test, trial operation	

2.3 甲方工作范围

2.3 Scope of Work for Party A

2.3.1 负责#2 循环水泵检修所需备品备件的采购与供应。

2.3.1 Responsible for the procurement and supply of spare parts required for the maintenance of circulating water pump #2.

2.3.2 负责#2 循环水泵外筒壁检查脚手架的搭设工作。

2.3.2 Responsible for the erection of scaffolding for inspection of the outer cylinder wall of circulating water pump #2.

2.3.3 负责循环水泵坑底部排水隔离工作。因闸板阀隔离时不严密，泵坑底部会留存 10cm~20cm 积水无法排净，乙方施工时应采取相应防护措施。

2.3.3 Responsible for drainage isolation at the bottom of the circulating water pump pit. Due to incomplete isolation by the gate valve, 10cm to 20cm of accumulated water will remain at the bottom of the pump pit and cannot be drained completely. Party B shall take corresponding protective measures during construction.

2.3.4 负责办理检修工作票、动火工作票等相关作业许可手续。

2.3.4 Responsible for handling relevant work permit procedures such as maintenance work permits and hot work permits.

2.3.5 提供检修所需的电源、水源及起重设备（行车）的协调使用。

2.3.5 Provide coordinated use of power supply, water supply and lifting equipment (overhead crane) required for maintenance.

2.3.6 指派专业技术人员进行现场监督、技术指导及验收。

2.3.6 Assign professional and technical personnel to conduct on-site supervision, technical guidance and acceptance.

3. 技术要求

3. Technical Requirements

3.1 检修质量标准

3.1 Maintenance Quality Standards

3.1.1 轴的检查与校验

3.1.1 Shaft Inspection and Verification

(1) 轴表面应光洁，无裂纹、无弯曲变形、无严重磨损，键槽完好无变形，螺纹无毛刺、无乱扣。

(1) The shaft surface shall be smooth, free from cracks, bending deformation and severe wear; the keyway shall be intact without deformation; the thread shall be free from burrs and disordered threads.

(2) 键与键槽配合良好，不松动，两侧接触均匀，键顶部留有 0.10mm~0.12mm 间隙。

(2) The key and keyway shall be well fitted, not loose, with uniform contact on both sides, and a clearance of 0.10mm to 0.12mm shall be left at the top of the key.

(3) 轴的弯曲度测量：将轴置于 V 形垫铁上，支承位置靠近轴两端精加工面，在每一轴承和联轴器部位每 300mm 跨距进行测量。轴的最大径向跳动允许值按厂家标准： δ (mm)=0.083L (L 为测量跨距，最大取 1/2 轴长，单位 m)，测量处应为精加工面。超出此范围的轴必须进行校直处理。

(3) Shaft bending measurement: Place the shaft on V-shaped blocks, with support positions near the finished surfaces at both ends of the shaft, and measure at every 300mm span at each bearing and coupling position. The allowable maximum radial runout of the shaft shall be in accordance with the manufacturer's standard: δ (mm)=0.083L (L is the measurement span, maximum 1/2 shaft length, in meters), and the measurement point shall be a finished surface. Shafts exceeding this range must be straightened.

(4) 内控分段弯曲度标准（严于厂家标准，作为检修验收控制值）：轴颈处不大于 0.02mm；轴套处不大于 0.03mm；叶轮处不大于 0.05mm；联轴器处不大于 0.02mm。

(4) Internal control sectional bending standard (stricter than manufacturer standard, used as maintenance acceptance control value): no more than 0.02mm at the journal; no more than 0.03mm at the shaft sleeve; no more than 0.05mm at the impeller; no more than 0.02mm at the coupling.

(5) 叶轮内孔与轴配合间隙应小于 0.03mm。

(5) The fitting clearance between the impeller inner bore and the shaft shall be less than 0.03mm.

3.1.2 叶轮与叶轮室

3.1.2 Impeller and Impeller Chamber

(1) 叶轮无汽蚀、无裂纹、无严重磨损，流道内光滑畅通。叶片进水边、出水边及叶尖部位应重点检查。

(1) The impeller shall be free from cavitation, cracks and severe wear, and the flow passage shall be smooth and unobstructed. Special attention shall be paid to the blade inlet edge, outlet edge and blade tip.

(2) 叶轮室下端精加工锥面与吸入喇叭口精加工锥面应完全贴合，用 0.05mm 塞尺沿圆周 8 个方向检查均不能通过。

(2) The finished conical surface at the lower end of the impeller chamber and the finished conical surface of the suction bell mouth shall be fully fitted, and a 0.05mm feeler gauge shall not pass when checked in 8 directions along the circumference.

(3) 叶轮与叶轮室之间的间隙值通过上部联轴器处的调整螺母调节，转子提升高度为 6mm。各叶片间隙值应趋于均匀，最大值与最小值之差不大于设计值的 20%。

(3) The clearance between the impeller and the impeller chamber is adjusted by the adjusting nut at the upper coupling, and the rotor lifting height is 6mm. The clearance of each blade shall tend to be uniform, and the difference between the maximum and minimum values shall not exceed 20% of the design value.

(4) 叶轮应做静平衡试验检查磨损情况，静平衡精度应符合厂家要求。

(4) The impeller shall be subjected to a static balance test to check wear, and the static balance accuracy shall meet the manufacturer's requirements.

(5) 泵壳接合面光滑无损伤痕迹，接合面涂密封胶密封。

(5) The joint surface of the pump casing shall be smooth without damage marks, and the joint surface shall be sealed with sealant.

3.1.3 导轴承与轴套

3.1.3 Guide Bearings and Shaft Sleeves

(1) 本次检修更换全部 4 件赛龙导轴承及 4 件轴套。

(1) All 4 Thordon guide bearings and 4 shaft sleeves shall be replaced in this maintenance.

(2) 导轴承与轴套的设计单侧间隙（当轴径 $d=185\text{mm}$ 、水温 $t=25^{\circ}\text{C}\sim 30^{\circ}\text{C}$ 时）为 $0.474\text{mm}\sim 0.635\text{mm}$ 。当单侧间隙大于设计值的 2~2.5 倍时，必须更换导轴承和/或轴套。

(2) The design single-side clearance between the guide bearing and the shaft sleeve (when shaft diameter $d=185\text{mm}$ and water temperature $t=25^{\circ}\text{C}\sim 30^{\circ}\text{C}$) is $0.474\text{mm}\sim 0.635\text{mm}$. When the single-side clearance exceeds 2 to 2.5 times the design value, the guide bearing and/or shaft sleeve must be replaced.

(3) 填料轴套外表面磨损沟纹单侧深度超过 0.3mm 时，应进行研磨或更换。

(3) When the single-side depth of wear grooves on the outer surface of the packing shaft sleeve exceeds 0.3mm , it shall be ground or replaced.

(4) 轴套安装时，紧定螺钉钉头不得高出轴套外表面；装紧定螺钉前须在轴上钻三个深 3mm 锥形孔作为轴套定位用。若新轴套定位螺孔与原方位不对，应根据新轴套在轴上重新钻孔攻丝。

(4) When installing the shaft sleeve, the head of the set screw shall not protrude above the outer surface of the shaft sleeve; before installing the set screw, three 3mm -deep tapered holes shall be drilled on the shaft for shaft sleeve positioning. If the positioning screw

holes of the new shaft sleeve do not align with the original positions, new holes shall be drilled and tapped on the shaft according to the new shaft sleeve.

(5) 各级节流套与轴套配合直径间隙为 0.30mm~0.40mm; 平衡节流套与轴套配合直径间隙为 0.40mm~0.52mm。

(5) The fitting diameter clearance between throttle sleeves and shaft sleeves at all stages is 0.30mm~0.40mm; the fitting diameter clearance between the balance throttle sleeve and the shaft sleeve is 0.40mm~0.52mm.

3.1.4 联轴器对中

3.1.4 Coupling Alignment

(1) 泵和电机的对中: 在电机联轴器上安放检测仪表托架, 调整检测仪表使其针端落在泵联轴器最大外圆上。盘动电机轴, 调整电机位置直至指针读数在 0.05mm 以下。

(1) Alignment of pump and motor: Install the instrument bracket on the motor coupling, adjust the instrument so that its pointer tip rests on the maximum outer circle of the pump coupling. Rotate the motor shaft and adjust the motor position until the pointer reading is below 0.05mm.

(2) 电机轴和泵轴的同轴度 $\leq 0.05\text{mm}$ 。

(2) The coaxiality of the motor shaft and pump shaft shall be $\leq 0.05\text{mm}$.

(3) 联轴器与轴端调整螺母之间不平行度小于 0.02mm。

(3) The non-parallelism between the coupling and the shaft end adjusting nut shall be less than 0.02mm.

(4) 对中数据应填写至联轴器对中数据表, 拧紧电机与电机支座联接螺栓后应反复测量跳动值确认无变化。

(4) Alignment data shall be recorded in the coupling alignment data sheet. After tightening the connecting bolts between the motor and the motor support, the runout values shall be measured repeatedly to confirm no change.

3.1.5 转子窜动量与盘车

3.1.5 Rotor End Play and Barring

(1) 在主轴 c 上端安装起吊工具，吊起转子，使导叶体端面 A 与叶轮上端面 B 贴合，此时在轴上端测量转子最大窜动量，窜动量必须大于转子提升高度（6mm）。

(1) Install a lifting tool at the upper end of main shaft c, lift the rotor so that the end face A of the guide vane body is fitted with the upper end face B of the impeller. At this time, measure the maximum end play of the rotor at the upper end of the shaft, which must be greater than the rotor lifting height (6mm).

(2) 将转子落至最下位置，再提升转子 6mm，盘车检查转子是否灵活，无卡涩、无异常摩擦声。

(2) Lower the rotor to the lowest position, then lift the rotor by 6mm, and perform barring to check whether the rotor rotates flexibly without jamming or abnormal friction noise.

(3) 盘车合格后将转子放下至最下位置。

(3) After passing the barring test, lower the rotor to the lowest position.

3.1.6 密封与紧固件

3.1.6 Seals and Fasteners

(1) 更换所有密封垫板、O 形密封圈和填料，上述零件不得重复使用。

(1) Replace all sealing gaskets, O-rings and packing; the above parts shall not be reused.

(2) 所有法兰螺栓应对称均匀拧紧，法兰结合面无渗漏。

(2) All flange bolts shall be tightened symmetrically and uniformly, and the flange joint surfaces shall be free from leakage.

(3) 锈蚀损坏的紧固件必须更换。

(3) Rusted or damaged fasteners must be replaced.

(4) 零件配合表面清洁后应涂稀释防锈油，需要防锈的部位涂防锈漆。

(4) After cleaning, the mating surfaces of parts shall be coated with diluted rust-preventive oil, and rust-preventive paint shall be applied to parts requiring rust prevention.

3.2 试运行质量标准

3.2 Trial Operation Quality Standards

3.2.1 泵组试运行振动值 $\leq 0.076\text{mm}$ （电机与电机支座法兰处测量）。

3.2.1 The vibration value of the pump unit during trial operation shall be $\leq 0.076\text{mm}$ (measured at the flange between the motor and the motor support).

3.2.2 各接合面无泄漏，填料函泄漏量在允许范围内（以不成线滴为宜）。

3.2.2 All joint surfaces shall be free from leakage, and the leakage of the stuffing box shall be within the allowable range (preferably not forming a continuous drip).

3.2.3 轴承无异音，填料不过热，冷却润滑水畅通。润滑水流量 $4\text{m}^3/\text{h}$ 、压力 0.3MPa ；电机冷却水流量 $29\text{m}^3/\text{h}$ 、压力 $\leq 0.5\text{MPa}$ 。

3.2.3 Bearings shall be free from abnormal noise, packing shall not overheat, and cooling and lubricating water shall flow smoothly. Lubricating water flow $4\text{m}^3/\text{h}$, pressure 0.3MPa ; motor cooling water flow $29\text{m}^3/\text{h}$, pressure $\leq 0.5\text{MPa}$.

3.2.4 电机绕组温度、电机轴承温度 $<75^\circ\text{C}$ （或按电机厂家技术文件要求执行）。

3.2.4 Motor winding temperature and motor bearing temperature shall be $<75^\circ\text{C}$ (or executed in accordance with the motor manufacturer's technical documentation requirements).

3.2.5 泵出口压力、电流、电压、频率等运行参数在正常范围内，运行平稳无异常噪声。

3.2.5 Operating parameters such as pump outlet pressure, current, voltage and frequency shall be within the normal range, and the operation shall be stable without abnormal noise.

3.2.6 连续试运行时间不少于 4 小时，各项参数稳定无异常波动。

3.2.6 Continuous trial operation time shall be no less than 4 hours, with all parameters stable and no abnormal fluctuations.

3.3 检修工艺要求

3.3 Maintenance Process Requirements

3.3.1 检修准备

3.3.1 Maintenance Preparation

(1) 现场须由项目负责人 1 人、专业工程师不少于 3 人组成检修队伍，其中必须持有《特种作业操作证（起重机械作业）》的起重工。所有作业人员须经健康检查 and 安全生产培训，考核合格后方可上岗。

(1) The site shall have a maintenance team consisting of 1 project leader and no less than 3 professional engineers, including a rigger who must hold the Special Operation Certificate (Lifting Machinery Operation). All operators must undergo health examinations and safety production training, and may only take up their posts after passing the assessment.

(2) 准备齐工器具、材料、备件、枕木或专用支架等。检查起重设备应完好，钢丝绳、卸扣等索具检验合格且在有效期内。

(2) Prepare all tools, materials, spare parts, sleepers or special supports, etc. Check that the lifting equipment is in good condition, and that riggings such as wire ropes and shackles have passed inspection and are within the validity period.

(3) 安全措施、技术措施已组织落实，工作票手续已办理。

(3) Safety measures and technical measures have been organized and implemented, and work permit procedures have been completed.

(4) 在必要的配合处做好相配标记，以便回装。准备小箱子盛装拆卸下来的小型零件，每处拆下的紧固件分别装箱并标记部位和零件名称，切忌混杂。

(4) Make matching marks at necessary mating positions for reassembly. Prepare small boxes to hold disassembled small parts; fasteners removed from each location shall be boxed separately and marked with location and part name, and must not be mixed.

(5) 准备好稀释防锈油和防锈漆，以便涂于零件配合表面和防锈部位。

(5) Prepare diluted rust-preventive oil and rust-preventive paint for application to mating surfaces and rust-preventive parts of components.

(6) 对照检修文件包进行技术交底，明确检修工序、质量标准和安全注意事项。

(6) Conduct technical disclosure against the maintenance document package, clarifying maintenance procedures, quality standards and safety precautions.

3.3.2 拆卸工序

3.3.2 Disassembly Procedure

泵组拆卸为安装的逆过程，通常泵筒体部件不须拆卸，但每次拆卸都需要检查泵支撑板水平度是否满足 0.05mm/m。拆卸顺序如下：

Pump unit disassembly is the reverse process of installation. Normally, the pump cylinder components do not need to be disassembled, but each disassembly requires checking whether the levelness of the pump support plate meets 0.05mm/m. The disassembly sequence is as follows:

(1) 断开电机电源，拆除电机接线，做好接线标记。

(1) Disconnect the motor power supply, remove the motor wiring, and make wiring marks.

(2) 拆除联轴器防护罩，分开泵与电机联轴器。

(2) Remove the coupling guard and separate the pump and motor couplings.

(3) 利用合适工具紧固泵转子，放下泵转子直至叶轮落到叶轮室上。

(3) Use appropriate tools to secure the pump rotor, and lower the pump rotor until the impeller rests on the impeller chamber.

(4) 拆除吐出弯管与外部管道之间的伸缩节联接，脱开泵出口与外部管道。

(4) Remove the expansion joint connection between the discharge elbow and the external pipeline, and disconnect the pump outlet from the external pipeline.

(5) 拆除润滑冷却水系统管路联接。

(5) Remove the lubricating cooling water system pipeline connections.

(6) 拆除电机与电机支座联接螺栓，将电机吊离（电机不抽转子，整体放置在专用支架上）。

(6) Remove the connecting bolts between the motor and the motor support, and lift the motor away (the motor rotor is not removed; the motor is placed as a whole on a special support).

(7) 拆除填料函体、导流片接管等上部部件。

(7) Remove upper components such as the stuffing box body and guide vane adapter.

(8) 在主轴 c 上端安装起吊工具，将泵转子部件（含主轴 a/b/c、叶轮、导叶体、轴套、叶轮室等）整体从外筒体中向上抽出，放置在专用检修支架上。

(8) Install a lifting tool at the upper end of main shaft c, and extract the pump rotor assembly (including main shafts a/b/c, impeller, guide vane body, shaft sleeve, impeller chamber, etc.) upward from the outer cylinder as a whole, and place it on a special maintenance support.

(9) 转子部件解体：按主轴 c→主轴 b→主轴 a 顺序分段拆卸，拆除套筒联轴器、连接卡环、止推卡环，分离各段主轴；拆除叶轮哈夫锁环，吊下叶轮；从导叶体中拆除导轴承和密封环。

(9) Rotor component disassembly: Disassemble section by section in the order of main shaft c → main shaft b → main shaft a. Remove sleeve couplings, connecting snap rings and thrust snap rings to separate each section of the main shaft; remove the impeller half lock ring and lift off the impeller; remove guide bearings and seal rings from the guide vane body.

(10) 拆卸过程中所有零件按部位分类放置，做好标记。

(10) During disassembly, all parts shall be placed by location and properly marked.

3.3.3 零件检查与修理

3.3.3 Parts Inspection and Repair

(1) 用钢丝刷清理所有泵零件，检查是否有磨损、腐蚀、锈蚀，检查叶轮、导叶体是否完好无损。

(1) Clean all pump parts with a wire brush, check for wear, corrosion and rust, and check whether the impeller and guide vane body are intact.

(2) 主轴校验：按 3.1.1 条标准检查三段主轴径向跳动，超差进行校直；检查键槽、螺纹完好性。

(2) Main shaft verification: Check the radial runout of the three-section main shaft according to the standard in Clause 3.1.1, and straighten if out of tolerance; check the integrity of keyways and threads.

(3) 泵转子校验：用手转动泵转子，在所有叶片的三处部位（进水边、中心、出水边）测量叶片与叶轮室间隙，超过规定值按组装规则调节。

(3) Pump rotor verification: Rotate the pump rotor by hand, measure the blade-to-impeller-chamber clearance at three positions of all blades (inlet edge, center, outlet edge), and adjust according to assembly rules if exceeding the specified value.

(4) 检查轴套和导轴承间隙：磨损超标的轴套和导轴承全部更换。

(4) Check shaft sleeve and guide bearing clearances: Replace all shaft sleeves and guide bearings with excessive wear.

(5) 叶轮静平衡试验：检查叶轮磨损情况，必要时进行静平衡校正。

(5) Impeller static balance test: Check impeller wear and perform static balance correction if necessary.

(6) 更换所有密封垫板、O 形圈和填料。

(6) Replace all sealing gaskets, O-rings and packing.

(7) 对锈蚀或防护涂层脱落的零件表面进行除锈及重新涂装处理；已影响泵正常运行的零件予以更换。

(7) Perform rust removal and repainting on part surfaces with rust or peeled protective coating; replace parts that have affected the normal operation of the pump.

(8) 清理检查冷却润滑水供应系统，包括阀门、流量开关灵敏度、管道结垢情况、阀门及接头完好性。

(8) Clean and inspect the cooling and lubricating water supply system, including valves, flow switch sensitivity, pipeline scaling, and integrity of valves and joints.

(9) 检查阴极保护系统：检查牺牲阳极状态、接线完整性、系统外观。

(9) Inspect the cathodic protection system: Check sacrificial anode condition, wiring integrity and system appearance.

(10) 检查吸入喇叭口防预旋筋片是否完好。

(10) Check whether the anti-pre-swirl ribs of the suction bell mouth are intact.

3.3.4 回装工序

3.3.4 Reassembly Procedure

回装为拆卸的逆过程，回装前所有零件应已检查合格并清洗干净。回装顺序如下：

Reassembly is the reverse process of disassembly. Before reassembly, all parts shall have passed inspection and been cleaned. The reassembly sequence is as follows:

(1) 转子部件组装：按主轴 a→主轴 b→主轴 c 顺序组装。在主轴 a 上安装轴套、短键、紧定螺钉；安装叶轮键、叶轮、叶轮哈夫锁环；将叶轮室套入；安装导叶体（含导轴承和密封环）；通过套筒联轴器和连接卡环依次联接主轴 b、主轴 c。

(1) Rotor component assembly: Assemble in the order of main shaft a → main shaft b → main shaft c. Install shaft sleeve, short key and set screw on main shaft a; install impeller key, impeller and impeller half lock ring; insert the impeller chamber; install the guide vane body (including guide bearing and seal ring); connect main shaft b and main shaft c in sequence through sleeve couplings and connecting snap rings.

(2) 各段主轴联接时，键与键槽应对正，套筒联轴器固定螺钉应紧固。

(2) When connecting each section of the main shaft, the key and keyway shall be aligned, and the sleeve coupling fixing screws shall be tightened.

(3) 吊起组装好的可抽出部件，放入泵壳体内。叶轮室外圆周上的防转凸耳应卡入外接管 a 的防转凹槽中，凸耳位置标记应延伸到便于观察的地方。

(3) Lift the assembled removable component and place it into the pump casing. The anti-rotation lugs on the outer circumference of the impeller chamber shall snap into the anti-rotation grooves of the outer connection pipe a, and the lug position marks shall extend to a location convenient for observation.

(4) 确认叶轮室下端精加工锥面与吸入喇叭口精加工锥面完全贴合。

(4) Confirm that the finished conical surface at the lower end of the impeller chamber is fully fitted with the finished conical surface of the suction bell mouth.

(5) 安装内接管、导流片接管、填料函体（含导轴承、O形圈、纸垫）。

(5) Install the inner connection pipe, guide vane adapter and stuffing box body (including guide bearing, O-ring and paper gasket).

(6) 安装电机支座，吊装电机就位。

(6) Install the motor support and lift the motor into position.

(7) 按 3.1.4 条进行联轴器对中调整。

(7) Perform coupling alignment adjustment according to Clause 3.1.4.

(8) 按 3.1.5 条测量转子窜动量并调整转子提升高度至 6mm，盘车检查灵活无卡涩。

(8) Measure rotor end play and adjust rotor lifting height to 6mm according to Clause 3.1.5, and perform barring to check flexibility without jamming.

(9) 安装润滑冷却水系统管路，接通电机接线。

(9) Install the lubricating cooling water system pipeline and connect the motor wiring.

(10) 安装出口伸缩节，与外部管道联接。伸缩节与泵出口法兰预留 15mm 调整间隙，安装后检查外部管道与伸缩节联接后张口值 $<0.8\text{mm}$ 。

(10) Install the outlet expansion joint and connect it with the external pipeline. Reserve a 15mm adjustment clearance between the expansion joint and the pump outlet flange. After installation, check that the opening value after connecting the external pipeline with the expansion joint is $<0.8\text{mm}$.

(11) 安装联轴器防护罩。

(11) Install the coupling guard.

(12) 回装完成后全面检查，确认无遗漏工具、零件，所有螺栓紧固到位。

(12) After reassembly is complete, conduct a comprehensive inspection to confirm no tools or parts are left behind and all bolts are tightened in place.

3.4 试验及验收

3.4 Testing and Acceptance

3.4.1 验收流程

3.4.1 Acceptance Process

(1) 检修人员自检：检修人员在完成每道工序后，自行检查设备，确保符合质量标准，并做好检修记录。

(1) Self-inspection by maintenance personnel: After completing each process, maintenance personnel shall inspect the equipment by themselves to ensure compliance with quality standards and make maintenance records.

(2) 维护班组验收：由班组负责人或技术员对检修后的设备进行验收，检查检修记录完整性和数据准确性。

(2) Maintenance team acceptance: The team leader or technician shall accept the repaired equipment and check the completeness of maintenance records and accuracy of data.

(3) 生产技术部专业人员验收：由汽机专业人员对设备进行验收，包括外观检查、尺寸复核、功能试验、性能测试等。

(3) Acceptance by professionals of the Production Technology Department: Turbine professionals shall accept the equipment, including appearance inspection, dimension verification, functional tests, performance tests, etc.

(4) 试运行验收：泵组连续试运行不少于 4 小时，各项运行参数稳定合格后，由甲方专业人员签署验收合格证明。

(4) Trial operation acceptance: After the pump unit has been in continuous trial operation for no less than 4 hours and all operating parameters are stable and qualified, Party A's professionals shall sign the acceptance certificate.

3.4.2 试验项目与合格标准

3.4.2 Test Items and Acceptance Criteria

本次检修应完成以下试验项目，所有试验数据应记录存档：

The following test items shall be completed in this maintenance, and all test data shall be recorded and archived:

表 3-1 试验项目与合格标准

Table 3-1 Test Items and Acceptance Criteria

序号 No.	试验项目 Test Item	试验方法 Test Method	合格标准 Acceptance Criteria
1	主轴径向跳动测量 Main Shaft Radial Runout Measurement	V 形垫铁支承, 百分表测量各截面 V-block support, dial indicator measurement at each section	$\delta \leq 0.083L$ (厂家标准); 内控: 轴颈 $\leq 0.02\text{mm}$ 、轴套 $\leq 0.03\text{mm}$ 、叶轮 $\leq 0.05\text{mm}$ 、联轴器 $\leq 0.02\text{mm}$ $\delta \leq 0.083L$ (mfr standard); Internal: journal $\leq 0.02\text{mm}$, sleeve $\leq 0.03\text{mm}$, impeller $\leq 0.05\text{mm}$, coupling $\leq 0.02\text{mm}$
2	叶轮室与喇叭口锥面贴合检查 Impeller Chamber & Bell Mouth Cone Surface Fit Check	0.05mm 塞尺沿圆周 8 个方向检查 0.05mm feeler gauge check in 8 circumferential directions	8 个方向塞尺均通不过 Feeler gauge cannot pass in all 8 directions
3	转子窜动量测量 Rotor End Play Measurement	起吊转子使导叶体端面 A 与叶轮端面 B 贴合, 测量轴上端窜动量 Lift rotor to fit guide vane end face A with impeller end face B, measure shaft upper end play	窜动量 $> 6\text{mm}$ (转子提升高度) End play $> 6\text{mm}$ (rotor lifting height)
4	盘车试验 Barring Test	转子提升 6mm 后人工盘车 Manual barring after lifting rotor 6mm	转子转动灵活, 无卡涩、无异常摩擦声 Rotor rotates flexibly, no jamming, no abnormal friction noise
5	联轴器对中测量 Coupling Alignment Measurement	百分表架在电机联轴器上, 盘动电机轴测量泵联轴器外圆 Dial indicator	同轴度 $\leq 0.05\text{mm}$; 不平行度 $< 0.02\text{mm}$ Coaxiality $\leq 0.05\text{mm}$; Non-

		mounted on motor coupling, rotate motor shaft to measure pump coupling outer circle	parallelism <0.02mm
6	导轴承与轴套间隙测量 Guide Bearing & Shaft Sleeve Clearance Measurement	塞尺或压铅丝测量单侧间隙 Feeler gauge or lead wire compression for single-side clearance	单侧间隙 0.474mm~0.635mm (d=185mm 时), 不超过设计值 2~2.5 倍 Single-side clearance 0.474mm~0.635mm (d=185mm), not exceeding 2~2.5 times design value
7	振动测量 Vibration Measurement	试运行时在电机支座法兰处测量 Measure at motor support flange during trial operation	振动值 ≤0.076mm Vibration value ≤0.076mm
8	温度测量 Temperature Measurement	试运行监测电机绕组、轴承温度 Monitor motor winding and bearing temperature during trial operation	温度 <75℃ (或按电机厂家标准) Temperature <75℃ (or per motor manufacturer standard)

4. 进度要求

4. Schedule Requirements

4.1 #2 机组计划于 2026 年 12 月 01 日停机, 2026 年 12 月 14 日启机, 小修总工期共 14 天。

4.1 Unit #2 is scheduled to be shut down on December 1, 2026 and started up on December 14, 2026, with a total minor repair period of 14 days.

4.2 乙方到厂施工工期为 2026 年 12 月 01 日至 2026 年 12 月 12 日, 共 12 天 (需提前 1 天入厂做准备工作)。

4.2 Party B's on-site construction period is from December 1, 2026 to December 12, 2026, totaling 12 days (required to enter the plant 1 day in advance for preparation work).

4.3 乙方应在开工前提交详细的检修进度计划（横道图或网络图），明确各工序节点和工期。

4.3 Party B shall submit a detailed maintenance schedule (Gantt chart or network diagram) before commencement, clarifying each process node and duration.

4.4 如小修工期变动，甲方会提前一周通知乙方提前或延后到厂时间。

4.4 If the minor repair schedule changes, Party A will notify Party B one week in advance to advance or postpone the arrival time.

4.5 乙方应合理安排人力和工器具，确保在合同工期内完成全部检修工作并验收合格。

4.5 Party B shall reasonably arrange manpower and tools to ensure that all maintenance work is completed and accepted within the contract period.

5. 安全及环保要求

5. Safety and Environmental Protection Requirements

5.1 安全管理

5.1 Safety Management

5.1.1 遵守法律法规：严格遵守中华人民共和国和印度尼西亚共和国有关安全生产的法律法规，以及巴厘通用能源公司各项安全管理制度。

5.1.1 Compliance with laws and regulations: Strictly abide by the laws and regulations on production safety of the People's Republic of China and the Republic of Indonesia, as well as various safety management systems of PT. General Energy Bali.

5.1.2 安全培训：所有入厂人员必须经过三级安全教育（公司级、车间级、班组级），考核合格后方可上岗。

5.1.2 Safety training: All personnel entering the plant must undergo three-level safety education (company level, workshop level, team level), and may only take up their posts after passing the assessment.

5.1.3 安全管理机构：乙方须设立专职安全管理人员，必须持证上岗，明确项目经理为安全生产第一责任人。

5.1.3 Safety management organization: Party B shall establish full-time safety management personnel who must hold certificates to take up their posts, and clarify that the project manager is the first person responsible for production safety.

5.1.4 现场安全管理：开工前须进行安全评估和危险源辨识；临时用电须符合“三级配电、五芯电缆、漏电保护”要求，严禁私拉乱接；合理规划施工现场，设置安全警示标志；严禁违章作业。

5.1.4 On-site safety management: Safety assessment and hazard source identification must be conducted before commencement; temporary power consumption must meet the requirements of "three-level power distribution, five-core cable, leakage protection", and unauthorized wiring is strictly prohibited; reasonably plan the construction site and set up safety warning signs; illegal operations are strictly prohibited.

5.1.5 文明施工：合理规划场地布局，保障施工人员休息与饮食安全。每天工作结束后清理工作现场，切断电动工器具总电源，确认动火地点及周围无明火，孔洞盖板周围栏杆齐全完整、标志明显。

5.1.5 Civilized construction: Reasonably plan the site layout to ensure the rest and food safety of construction personnel. Clean up the work site after work every day, cut off the main power supply of electric tools, confirm no open fire at and around hot work locations, and ensure that railings around hole covers are complete and signs are obvious.

5.1.6 责任追究：对违反安全规定的行为，依法依规追责；发生事故严肃调查处理。

5.1.6 Accountability: Those who violate safety regulations shall be held accountable according to laws and regulations; accidents shall be seriously investigated and dealt with.

5.2 专项安全措施

5.2 Special Safety Measures

5.2.1 密闭空间作业

5.2.1 Confined Space Operation

(1) 因检查外筒壁涉及密闭空间作业，乙方相关作业人员须经健康检查和安全生产培训，考核合格后上岗。

(1) As the inspection of the outer cylinder wall involves confined space operation, Party B's relevant operators must undergo health examinations and safety production training, and take up their posts after passing the assessment.

(2) 作业前必须进行气体检测，携带不少于 2 台便携式气体检测报警器，检测氧气、可燃气体、有毒有害气体浓度合格后方可进入。

(2) Gas detection must be carried out before operation. Carry no less than 2 portable gas detection alarms, and may enter only after the concentrations of oxygen, combustible gas and toxic/harmful gas are detected as qualified.

(3) 作业期间设专人在外监护，保持通讯畅通，严禁单人作业。

(3) During operation, assign a dedicated person to monitor outside, maintain smooth communication, and single-person operation is strictly prohibited.

(4) 作业场所应保持通风，必要时使用机械通风设备。

(4) The workplace shall be kept ventilated, and mechanical ventilation equipment shall be used when necessary.

5.2.2 起重作业

5.2.2 Lifting Operation

(1) 起重作业人员必须持有《特种作业操作证（起重机械作业）》，持证上岗。

(1) Lifting operators must hold the Special Operation Certificate (Lifting Machinery Operation) and work with the certificate.

(2) 起吊前检查起重设备、钢丝绳、卸扣、吊环等索具完好，检验合格且在有效期内。

(2) Before lifting, check that lifting equipment, wire ropes, shackles, lifting rings and other riggings are in good condition, have passed inspection and are within the validity period.

(3) 最大起吊重量约 30 吨（转子部件），应核算起重设备额定载荷，严禁超载。

(3) The maximum lifting weight is approximately 30 tons (rotor components). The rated load of the lifting equipment shall be calculated, and overloading is strictly prohibited.

(4) 起吊重物下方严禁站人，设专人指挥，信号统一明确。

(4) Standing under lifted heavy objects is strictly prohibited. Assign a dedicated person to command with unified and clear signals.

(5) 转子抽出和回装时应保持垂直，防止碰撞外筒壁和导叶体。

(5) During rotor extraction and reassembly, keep it vertical to prevent collision with the outer cylinder wall and guide vane body.

5.2.3 高空作业

5.2.3 Working at Heights

(1) 高空作业人员必须系好安全带，高挂低用。

(1) Personnel working at heights must fasten their safety belts, hooking high and using low.

(2) 对工作中揭开的孔洞盖板设置临时围栏及明显标志。

(2) Set up temporary fences and obvious signs for hole covers uncovered during work.

(3) 高空作业时下部设置临时围栏，派专人监护，避免交叉作业。

(3) When working at heights, set up temporary fences below, assign dedicated personnel to monitor, and avoid cross operations.

5.2.4 动火作业

5.2.4 Hot Work

(1) 动火作业必须办理动火工作票，落实防火措施。

(1) Hot work must have a hot work permit and implement fire prevention measures.

(2) 动火地点周围清除易燃易爆物品，配备足够的灭火器材。

(2) Clear flammable and explosive materials around the hot work location and equip with sufficient fire extinguishing equipment.

(3) 动火期间设专人监护，动火结束后检查确认无残留火种。

(3) Assign dedicated personnel to monitor during hot work, and check and confirm no residual fire sources after hot work is completed.

5.3 环保要求

5.3 Environmental Protection Requirements

5.3.1 乙方应负责检修及试验过程中产生的废弃物、废油的处理，按照环保要求进行分类收集，确保不对环境造成污染。

5.3.1 Party B shall be responsible for the treatment of waste and waste oil generated during maintenance and testing, and collect them by classification according to environmental protection requirements to ensure no pollution to the environment.

5.3.2 检修产生的废油、含油抹布等危险废物应分类存放，交由有资质的单位处理，严禁随意倾倒。

5.3.2 Hazardous wastes such as waste oil and oil-containing rags generated during maintenance shall be stored by classification and handed over to qualified units for treatment. Random dumping is strictly prohibited.

5.3.3 更换下来的废旧零件、包装材料等应分类收集，可回收部分回收利用，不可回收部分按规定处置。

5.3.3 Replaced waste parts, packaging materials, etc. shall be collected by classification; recyclable parts shall be recycled, and non-recyclable parts shall be disposed of according to regulations.

5.3.4 施工过程中应采取措施防止油污、废水污染循环水泵坑及周边环境。

5.3.4 During construction, measures shall be taken to prevent oil pollution and wastewater from contaminating the circulating water pump pit and the surrounding environment.

6. 违约责任

6. Liability for Breach of Contract

6.1 进度违约责任

6.1 Schedule Breach Liability

6.1.1 因乙方原因未按照合同约定竣工日期完成工期，每延误一日，按合同价款的1%向甲方支付违约金。

6.1.1 If Party B fails to complete the construction period by the completion date agreed in the contract due to Party B's reasons, it shall pay Party A a penalty of 1% of the contract price for each day of delay.

6.1.2 因不可抗力导致工期延误，乙方应在事件发生后14日内提交书面报告并提供证明文件，经甲方确认后可免除相关责任。

6.1.2 If the construction period is delayed due to force majeure, Party B shall submit a written report and provide supporting documents within 14 days after the occurrence of the event, and may be exempted from relevant liabilities after confirmation by Party A.

6.1.3 因甲方原因导致工期延误，乙方有权要求顺延工期，具体顺延天数由双方协商确定。

6.1.3 If the construction period is delayed due to Party A's reasons, Party B has the right to request an extension of the construction period, and the specific number of extension days shall be determined through negotiation between both parties.

6.2 质量违约责任

6.2 Quality Breach Liability

6.2.1 乙方不得擅自修改技术标准。违反本规范书要求造成施工质量不合格的，乙方负责返工、修理，并赔偿由此给甲方造成的损失。

6.2.1 Party B shall not modify technical standards without authorization. If the construction quality is unqualified due to violation of the requirements of this specification, Party B shall be responsible for rework, repair, and compensation for losses caused to Party A.

6.2.2 若施工质量验收不合格，乙方必须限期整改，每逾期一日按合同价款的 0.1% 支付违约金。

6.2.2 If the construction quality acceptance is unqualified, Party B must make rectification within a time limit, and pay a penalty of 0.1% of the contract price for each overdue day.

6.2.3 工程竣工验收合格后，乙方按合同价款的 10% 留存质量保证金，质保期为检修验收合格后 6 个月（或机组运行 4000 小时，以先到者为准）。质保期满且无质量问题后，甲方在 60 日内返还质量保证金（不计利息）。

6.2.3 After the project is completed and accepted, Party B shall retain a quality deposit of 10% of the contract price. The warranty period is 6 months after the maintenance acceptance is qualified (or 4000 hours of unit operation, whichever comes first). After the warranty period expires and there are no quality issues, Party A shall return the quality deposit within 60 days (without interest).

6.2.4 质保期内因乙方检修质量原因导致设备故障，乙方应在接到甲方通知后 48 小时内到场免费处理，并承担由此造成的直接损失。

6.2.4 If equipment failure occurs during the warranty period due to Party B's maintenance quality, Party B shall arrive at the site within 48 hours after receiving Party A's notice to handle it free of charge, and bear the direct losses caused thereby.

6.3 争议解决

6.3 Dispute Resolution

6.3.1 争议解决方式：双方应首先通过友好协商解决争议。

6.3.1 Dispute resolution method: Both parties shall first resolve disputes through friendly negotiation.

6.3.2 协商不成的，可由第三方（如行业协会、调解机构）介入协助调解。

6.3.2 If negotiation fails, a third party (such as an industry association or mediation institution) may intervene to assist in mediation.

6.3.3 调解不成的，双方同意将争议提交合同签订地有管辖权的人民法院诉讼解决。

6.3.3 If mediation fails, both parties agree to submit the dispute to the people's court with jurisdiction at the place of contract signing for litigation resolution.

6.3.4 争议处理期间，除争议事项外，双方应继续履行合同其他条款。

6.3.4 During dispute resolution, except for the disputed matters, both parties shall continue to perform other terms of the contract.

7. 附录

7. Appendix

附录 A 主要备品备件清单

Appendix A List of Main Spare Parts

以下备品备件由甲方提供，乙方负责核对型号规格并更换。

The following spare parts are provided by Party A, and Party B is responsible for verifying the models and specifications and replacing them.

表 A-1 主要备品备件清单

Table A-1 List of Main Spare Parts

序号 No.	备件名称 Spare Part Name	规格/型号 Specification/Model	数量 Quantity	材质 Material
1	赛龙导轴承 Thordon Guide Bearing	按 88LKXE-17 总装图 Per 88LKXE-17 assembly drawing	4 件 4 pcs	赛龙 (Thordon)
2	轴套 (含填料轴 套) Shaft Sleeve (incl. packing sleeve)	按 88LKXE-17 总装图 Per 88LKXE-17 assembly drawing	4 件 4 pcs	不锈钢/衬胶 Stainless steel/Rubber- lined
3	叶轮口环 Impeller Wear Ring	按 88LKXE-17 总装图 Per 88LKXE-17 assembly drawing	1 套 1 set	不锈钢 Stainless steel
4	导叶体口环/密 封环 Guide Vane	按 88LKXE-17 总装图 Per 88LKXE-17 assembly drawing	1 套 1 set	不锈钢 Stainless steel

	Wear Ring/Seal Ring			
5	O 形密封圈 O-ring	各规格 Various sizes	全套 Full set	橡胶（耐海水） Rubber (seawater resistant)
6	密封垫板/纸垫 Sealing Gasket/Paper Gasket	各规格 Various sizes	全套 Full set	耐油石棉纸/橡胶板 Oil-resistant asbestos paper/Rubber sheet
7	填料 Packing	按填料函尺寸 Per stuffing box size	1 套 1 set	石墨/聚四氟乙烯编织 Graphite/PTFE braided
8	紧固件（螺栓、螺母、垫圈） Fasteners (bolts, nuts, washers)	各规格 Various sizes	按需 As required	不锈钢/镀锌 Stainless steel/Galvanized

附录 B 主要工器具清单

Appendix B List of Main Tools and Instruments

表 B-1 主要工器具清单

Table B-1 List of Main Tools and Instruments

序号 No.	工器具名称 Tool/Instrument Name	规格/型号 Specification/Model	数量 Quantity
1	转子起吊工具（专用） Rotor Lifting Tool (special)	按厂家配套 Per manufacturer 配套	1 套 1 set
2	楔形对中块（专用） Wedge Alignment Block (special)	按厂家配套 Per manufacturer 配套	1 套 1 set
3	吊环螺钉 Eyebolt	M24/M30 等 M24/M30 etc.	若干 Several
4	V 形垫铁 V-block	200mm	2 副 2 pairs
5	百分表及表架 Dial Indicator & Stand	0~10mm/0~30mm	4 套 4 sets
6	塞尺 Feeler Gauge	0.02~1.0mm	2 把 2 pcs

7	游标卡尺 Vernier Caliper	0~300mm	2 把 2 pcs
8	外径千分尺 Outside Micrometer	150~200mm	1 把 1 pc
9	便携式气体检测报警器 Portable Gas Detection Alarm	四合一 (O2/CO/H2S/LEL) 4-in-1 (O2/CO/H2S/LEL)	≥2 台 ≥2 units
10	扭矩扳手 Torque Wrench	各规格 Various sizes	2 套 2 sets
11	钢丝刷、铜棒、铜锤 Wire Brush, Copper Rod, Copper Hammer	各规格 Various sizes	若干 Several

附录 C 检修记录表格

Appendix C Maintenance Record Forms

乙方在检修过程中应填写以下检修记录，检修完成后提交甲方存档：

Party B shall fill in the following maintenance records during the maintenance process and submit them to Party A for archiving after completion:

(1) 主轴径向跳动测量记录表（三段主轴分别记录）；

(1) Main shaft radial runout measurement record form (recorded separately for three sections of shaft);

(2) 导轴承与轴套间隙测量记录表；

(2) Guide bearing and shaft sleeve clearance measurement record form;

(3) 叶轮与叶轮室间隙测量记录表；

(3) Impeller and impeller chamber clearance measurement record form;

(4) 联轴器对中数据表；

(4) Coupling alignment data sheet;

(5) 转子窜动量测量记录表；

(5) Rotor end play measurement record form;

(6) 泵支撑板水平度检测记录表（0.05mm/m）；

- (6) Pump support plate levelness inspection record form (0.05mm/m);
- (7) 试运行参数记录表（振动、温度、压力、电流等）；
- (7) Trial operation parameter record form (vibration, temperature, pressure, current, etc.);
- (8) 零件更换记录表；
- (8) Parts replacement record form;
- (9) 检修工作总结报告。
- (9) Maintenance work summary report.

附录 D 参考资料

Appendix D Reference Materials

- (1) 88LKXE-17-SM 循环泵安装使用说明书（中英版）；
- (1) 88LKXE-17-SM circulating pump installation and operation manual (Chinese-English version);
- (2) 88LKXE-17 型循环泵总装图；
- (2) Assembly drawing of Model 88LKXE-17 circulating pump;