中国华电集团有限公司
CHINA HUADIAN CORPORATION LTD.
中国华电科工集团有限公司
CHINA HUADIAN ENGINEERING CO., LTD.

巴厘通用能源公司
PT GENERAL ENERGY BALI

巴厘通用能源公司

PT. GENERAL ENERGY BALI

#3 机组 A 侧凝汽器循环水进口管道加固技术规范书

Technical Specification for Reinforcement of Circulating Water Inlet Pipe on A-side of Unit 3 Condenser

批准(APPROVE)：

审核(VERIFY) ：

编制（Prepared by）：

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#3 机组 A 侧凝汽器循环水进口管道加固技术规范书

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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”）#3 机组 A 侧凝汽器循环水进口管道（DN1400，管道外部整体为混凝土包裹，本次加固段长度 6m）的腐蚀防泄漏及砼钢复合加固工程。本次招标旨在选定具备相应资质和专业能力的承包方（以下简称“乙方”），工作内容包括但不限于：现场勘查与尺寸复核、甲供物资进场验收与保管、作业平台搭设、混凝土基面凿毛清理与干燥处理、混凝土本体钢板加固（钢板下料、贴装、焊接加固及防腐补涂，具体部位及工程量以加固设计图纸为准）、DN1420 加固钢管现场切割卷制成型与包覆、M27 全丝螺杆化学植筋钻孔注胶安装及螺母紧固、植筋胶（化学锚栓）现场拉力试验并出具报告、麻绳与防水沥青缝隙浇注密封、环氧树脂漆防腐涂装、成品养护、包覆完成后弯头至立管段管道外壁钢板焊接加固（面积约 30m²）、渗漏检查及竣工验收、竣工资料移交等。

This specification applies to the corrosion leak-proofing and concrete-steel composite reinforcement of the circulating water inlet pipe on the A-side of the Unit 3 condenser (DN1400, fully encased in concrete, reinforcement section length 6 m) of PT. General Energy Bali (hereinafter referred to as “Party A”). The purpose of this tender is to select a qualified and professionally competent contractor (hereinafter referred to as “Party B”) to carry out . The work includes but is not limited to: site survey and dimension verification; incoming inspection and storage of Party-A-supplied materials; erection of the working platform; scabbling, cleaning and drying of the concrete base

surface; steel-plate reinforcement of the concrete body (cutting, fitting, welding reinforcement and touch-up coating, with specific locations and quantities subject to the reinforcement design drawing); on-site cutting, forming and wrapping of the DN1420 reinforcing steel pipe; drilling, adhesive injection and installation of M27 all-thread chemical anchors and tightening of nuts; on-site pull-out test of the rebar adhesive (chemical anchors) with a test report; gap pouring and sealing with hemp rope and waterproof asphalt; anti-corrosion coating with epoxy resin paint; curing; after wrapping, external steel-plate welding reinforcement on the elbow-to-riser pipe section (about 30 m^2); leakage inspection and completion acceptance; and handover of as-built documents.

1.2 编制依据

1.2 Compilation Basis

（1）《工业金属管道设计规范》（GB 50316）；

(1) Design Code for Industrial Metallic Piping (GB 50316);

（2）《混凝土结构加固设计规范》（GB 50367）；

(2) Design Code for Strengthening Concrete Structures (GB 50367);

（3）《钢结构工程施工质量验收标准》（GB 50205）；

(3) Standard for Acceptance of Construction Quality of Steel Structures (GB 50205);

（4）《建筑结构加固工程施工质量验收规范》（GB 50550）；

(4) Code for Acceptance of Construction Quality of Building Structure Reinforcement (GB 50550);

（5）《工业设备及管道防腐蚀工程施工规范》（GB 50212）；

(5) Code for Construction of Anticorrosion Engineering of Industrial Equipment and Pipelines (GB 50212);

（6）《混凝土结构后锚固技术规程》（JGJ 145）；

(6) Technical Specification for Post-installed Anchors in Concrete Structures (JGJ 145);

（7）《工程结构加固材料安全性鉴定技术规范》（GB 50728）；

(7) Technical Code for Safety Identification of Retrofitting Materials in Engineering Structures (GB 50728);

（8）#3 机组循环水系统竣工图纸、设备技术参数、运行维护手册及现场管道勘查记录；

(8) As-built drawings, equipment technical parameters, operation and maintenance manuals of the Unit 3 circulating water system, and on-site pipeline survey records;

（9）甲方安全、环保及作业许可管理制度，印度尼西亚共和国相关法律法规，以及印尼国家电力公司（PLN）有关电力设施施工与环境保护的规定。

(9) Party A's safety, environmental protection and work-permit management systems, the relevant laws and regulations of the Republic of Indonesia, and the relevant PLN provisions on power-facility construction and environmental protection.

1.3 工程概况

1.3 Project Overview

#3 机组为电厂核心发电单元，凝汽器循环水系统是机组冷端的关键系统。A 侧凝汽器循环水进口管道长期服役于湿热海洋环境，管道外部混凝土包裹层出现局部老化、疏松，内部金属管壁存在点蚀、缝隙腐蚀及微泄漏风险，结构强度与系统密封性下降。为彻底封堵腐蚀泄漏隐患、恢复并提高管道结构强度，形成“混凝土—钢套管—化学锚栓”复合受力体系，延长管道使用寿命，保障#3 机组长期安全稳定运行，特实施本次砼钢复合加固防泄漏工程。该管道设计流量 30000m³/h，带压连续运行，输送介质为海水/地表水混合循环水。主要技术参数见表 1-1。

Unit 3 is a core power-generation unit of the plant, and the condenser circulating water system is a key system at the cold end of the unit. The A-side condenser circulating water inlet pipe has long been in service in a hot and humid marine environment: the outer concrete encasement shows local aging and loosening, while the inner metallic pipe wall presents risks of pitting corrosion, crevice corrosion and micro-leakage, reducing structural strength and system tightness. To thoroughly seal the corrosion/leakage hazards, restore and improve the structural strength of the pipe, form a “concrete–steel-sleeve–chemical-anchor” composite load-bearing system, extend the service life of the pipe, and ensure long-term safe and stable operation of Unit 3, this concrete-steel composite reinforcement and leak-proofing project is implemented. The pipe has a design flow of

30,000 m³/h, operates continuously under pressure, and conveys mixed seawater/surface-water circulating water. The main technical parameters are given in Table 1-1.

表 1-1 管道及加固工程主要技术参数

Table 1-1 Main Technical Parameters of Pipeline and Reinforcement

项目 Item	参数 Parameter	项目 Item	参数 Parameter
管道名称 Pipeline	A 侧凝汽器循环水进口管道 A-side condenser circulating water inlet pipe	管道规格 Pipeline size	DN1400 DN1400
输送介质 Conveyed medium	海水/地表水混合循环水 Mixed seawater/surface-water circulating water	设计流量 Design flow rate	30000m³/h 30,000 m³/h
运行方式 Operation mode	带压连续运行 Pressurized continuous operation	外部结构 Outer structure	钢板+混凝土整体包裹 Fully encased in concrete
加固段长度 Reinforcement length	6m 6 m	加固方式 Reinforcement method	砼钢复合加固（钢套管+化学锚栓+密封防腐） Concrete-steel composite (steel sleeve + chemical anchors + sealing/coating)
加固钢管（甲供） Reinforcing steel pipe (by Party A)	DN1420 PN16，壁厚 10mm，Q235 DN1420 PN16, wall thickness 10 mm, Q235	包覆范围 Wrapping scope	左、上、右三面（底部不包，以设计图为准） Left, top and right faces (bottom excluded, per design drawing)
化学锚栓（甲供） Chemical anchors (by Party A)	M27×1000mm 8.8 级全丝螺杆，20 根 M27×1000 mm grade 8.8 all-thread rods, 20 pcs	锚固胶（甲供） Anchor adhesive (by Party A)	植筋胶 350ml，60 支 Rebar adhesive 350 ml, 60 cartridges
密封材料（甲供） Sealing materials (by Party A)	麻绳Φ20 共 250m；防水沥青 200kg Hemp rope Φ20, 250 m; waterproof asphalt 200 kg	防腐涂料（甲供） Anti-corrosion coating (by Party A)	环氧树脂漆 80 型、90 型各 20kg（带固化剂） Epoxy resin paint type 80 & 90, 20 kg each (with curing agent)

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：#3 机组 A 侧凝汽器循环水进口管道加固工程。

2.1.1 Project Name: Reinforcement of the circulating water inlet pipe on the A-side of the Unit 3 condenser.

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）#3 机组循环水系统区域，即凝汽器 A 侧进口管道。

2.1.2 Project Location: Circulating water system area of Unit 3, PT. General Energy Bali, Indonesia (Bali Power Plant), i.e. the A-side inlet pipe gallery of the condenser.

2.1.3 项目背景及目的：对 A 侧凝汽器循环水进口管道 6m 加固段实施砼钢复合加固与防泄漏处理，封堵腐蚀微泄漏点，恢复并提高管道结构强度与密封性，形成混凝土—钢套管—化学锚栓复合受力体系，满足 30000m³/h 循环水长期带压连续运行要求，确保#3 机组安全稳定运行。

2.1.3 Background and Purpose: carry out concrete-steel composite reinforcement and leak-proofing on the 6 m reinforcement section of the A-side condenser circulating water inlet pipe, seal corrosion micro-leakage points, restore and improve the structural strength and tightness of the pipe, form a concrete–steel-sleeve–chemical-anchor composite load-bearing system, meet the long-term pressurized continuous operation requirement of 30,000 m³/h circulating water, and ensure safe and stable operation of Unit 3.

2.1.4 工程范围及主要工作内容：甲供物资进场验收与保管、现场勘查及尺寸复核、作业平台与安全防护设施搭设、混凝土基面凿毛清理与干燥、混凝土本体钢板加固（钢板下料、贴装与焊接）、DN1420 加固钢管现场切割卷制成型并包覆定位、M27 全丝螺杆化学植筋钻孔（Φ30）清孔注胶安装及螺母紧固、植筋胶（化学锚栓）现场拉力试验并出具报告、防水沥青热浇注与麻绳复合密封、环氧树脂漆防

腐涂装、成品养护、包覆完成后对弯头至立管段管道外壁焊接约 30m²钢板加固、三级自检及配合甲方验收、竣工资料移交。具体施工项目见表 2-1。

2.1.4 Project scope and main work contents: incoming inspection and storage of Party-A-supplied materials; site survey and dimension verification; erection of working platform and safety protection; scabbling, cleaning and drying of the concrete base surface; steel-plate reinforcement of the concrete body (cutting, fitting and welding); on-site cutting and forming of the DN1420 reinforcing steel pipe and its wrapping and positioning; drilling (Φ30), hole cleaning, adhesive injection and installation of M27 all-thread chemical anchors and nut tightening; on-site pull-out test of the rebar adhesive (chemical anchors) with a test report; hot pouring of waterproof asphalt and composite sealing with hemp rope; anti-corrosion coating with epoxy resin paint; curing; after wrapping, welding of about 30 m² of steel plates externally on the elbow-to-riser pipe; three-level self-inspection and cooperation in Party A's acceptance; and handover of as-built documents. The specific work items are given in Table 2-1.

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，自备除甲供物资以外的施工工器具及检测仪器。本工程全部备品备件及主要材料（含加固钢管、全丝螺杆、螺母、植筋胶、胶枪、环氧树脂漆、麻绳、防水沥青、电锤、钻头等，详见附录 A）均由甲方负责采购、供应并运抵现场；乙方负责进场清点验收、保管、施工安装及试验，不得以材料由甲方供应为由降低施工质量标准。

2.1.5 Contracting Method: Party B shall be responsible for labor, construction period, quality, safety and civilized construction, and shall provide its own construction tools and testing instruments other than the Party-A-supplied materials. ALL spare parts and main materials for this project (including reinforcing steel pipe, all-thread rods, nuts, rebar adhesive, glue guns, epoxy resin paint, hemp rope, waterproof asphalt, electric hammers and drill bits, as detailed in Appendix A) shall be procured, supplied and delivered to site by Party A. Party B is responsible for counting, incoming inspection, storage, construction, installation and testing, and shall not lower the construction quality standard on the grounds that the materials are supplied by Party A.

2.2 施工项目明细

2.2 Work Item Details

本次加固工程的具体施工项目见表 2-1。

The specific work items of this reinforcement project are given in Table 2-1.

表 2-1 施工项目明细表

Table 2-1 Work Item Details

序号 No.	施工项目 Work Item	工作内容 Work Content	备注 Remarks
1	施工准备与现场勘查 Preparation & site survey	复核管道尺寸、腐蚀与泄漏位置、混凝土强度及包裹层厚度；搭设作业平台、防护设施及围挡；甲供物资进场验收、设备调试。 Verify pipeline dimensions, corrosion/leakage locations, concrete strength and encasement thickness; erect working platform, protective facilities and barriers; incoming inspection of Party-A-supplied materials and equipment commissioning.	甲供物资见附录 A Materials by Party A, see App. A
2	基面处理 Base surface preparation	清除表面杂物、油污、浮浆及疏松混凝土，凿毛、打磨、找平；清除管壁腐蚀产物与浮锈；高压吹风/吸尘清洁，保持粘贴面干燥、洁净、粗糙。 Remove debris, oil, laitance and loose concrete; scabble, grind and level; remove corrosion products and loose rust on the pipe wall; clean by high-pressure air/vacuum; keep the bonding surface dry, clean and rough.	
3	混凝土本体钢板加固 Concrete-body steel-plate reinforcement	对管道混凝土包裹体局部老化、疏松、开裂部位按加固设计图纸进行钢板下料、贴装与焊接加固，恢复混凝土结构整体性；焊后清渣、打磨并补涂防腐。 Cut, fit and weld steel plates onto the locally aged, loosened or cracked parts of the concrete encasement per the reinforcement design drawing to restore the structural integrity of the concrete; remove slag, grind and touch-up coat after welding.	钢板材质/厚度按设计图；部位及工程量以设计为准 Plate material/thickness per design; location and quantity per design
4	钢套管制作与包覆 Steel sleeve fabrication & wrapping	按现场实测与排版图将 DN1420×10mm Q235 钢管纵向切割、卷制成型，包覆于混凝土包裹体左、上、右三面；拼接、定位、初步固定，贴合密实。 Cut and form the DN1420×10 mm Q235 steel pipe longitudinally per measured dimensions and the layout drawing, and wrap the left, top and right faces of the concrete encasement; splice, position and temporarily fix with tight contact.	底部不包（以设计图为准） Bottom excluded (per design drawing)
5	钻孔与化学植筋锚固 Drilling & chemical anchoring	按设计点位放线，电锤配 M30×500mm 钻头成孔（Φ30），清孔吹干，注入植筋胶，植入 M27×1000mm 8.8 级全丝螺杆，安装螺母紧固；胶层饱满、固化充分。 Lay out anchor points per design; drill Φ30 holes with an	电锤、钻头、锚栓、植筋胶、螺母均甲供 Hammer, bits,

序号 No.	施工项目 Work Item	工作内容 Work Content	备注 Remarks
		electric hammer and M30×500 mm bits; clean and blow-dry the holes; inject rebar adhesive; embed M27×1000 mm grade 8.8 all-thread rods; install and tighten nuts; ensure full adhesive coverage and adequate curing.	anchors, adhesive and nuts by Party A
6	植筋胶拉力试验 Rebar-adhesive pull-out test	按 JGJ 145 对化学锚栓进行现场抗拔（拉力）试验，检验锚固抗拔承载力，出具正式试验报告。 Conduct an on-site pull-out test on the chemical anchors in accordance with JGJ 145 to verify the anchoring pull-out capacity, and issue an official test report.	乙方必做并出具报告 Mandatory by Party B, with report
7	缝隙填充与密封 Gap filling & sealing	钢套管与混凝土基体缝隙采用防水沥青热浇注密实；拼缝、边角、端部采用Φ20 麻绳+沥青复合密封，转角加强，消除毛细渗漏通道。 Fill the gaps between the steel sleeve and the concrete substrate with hot-poured waterproof asphalt; seal splices, edges and ends with Φ20 hemp rope + asphalt composite; reinforce corners to eliminate capillary leakage paths.	麻绳、沥青甲供 Hemp rope & asphalt by Party A
8	防腐涂装 Anti-corrosion coating	钢套管表面除锈合格后，按产品说明涂装环氧树脂漆（80 型、90 型，带配套固化剂）；底漆、面漆道数及干膜厚度符合产品技术要求。 After qualified derusting of the steel sleeve, apply epoxy resin paint (type 80 & 90, with matching curing agents) per the product instructions; the number of primer/topcoat passes and the dry-film thickness shall meet the product requirements.	环氧漆甲供 Epoxy paint by Party A
9	养护与成品保护 Curing & finished-product protection	植筋胶及沥青密封层自然养护不少于 24h；养护期禁止碰撞、振动、施压、冲水与暴晒，做好防雨、防潮、防污染。 Naturally cure the adhesive and asphalt seal for no less than 24 h; during curing, prohibit impact, vibration, loading, water flushing and direct sun exposure, and protect against rain, moisture and contamination.	
10	弯头至立管段钢板焊接加固 Steel-plate welding, elbow-to-riser	包覆完成后，对#3 机 A 侧凝汽器循环水进口管道弯头至立管段（裸管段）外壁下料、贴装并环向/纵向焊接钢板加固，面积约 30m²；焊缝成型良好、清渣干净并补涂防腐。 After wrapping, cut, fit and externally weld steel plates circumferentially/longitudinally onto the outer wall of the elbow-to-riser (bare-pipe) section of the Unit-3 A-side inlet pipe, total area about 30 m²; neat welds, slag removed and touch-up coated.	钢板材质厚度按设计图；焊工持证 Plate material/thickness per design; certified welders
11	自检、验收与资料移交 Self-inspection, acceptance & handover	完成三级自检，配合甲方现场验收与渗漏检查，提交全套竣工资料及植筋胶抗拔拉力试验报告，做到工完、料尽、场地清。 Complete three-level self-inspection, cooperate with Party A in site acceptance and leakage inspection, submit the full set of as-built documents and the anchor pull-out test report, and leave the site clean upon completion.	

2.3 甲方工作范围

2.3 Scope of Work for Party A

2.3.1 负责本工程全部备品备件及主要材料的采购、供应并按期运抵现场（详见附录 A），随货提供出厂合格证、质量证明书及检测报告；其中弯头至立管段焊接钢板（附录 A 第 12 项）由甲方运至现场指定堆放点。

2.3.1 Responsible for the procurement, supply and on-time site delivery of ALL spare parts and main materials for this project (see Appendix A), and provide factory certificates, quality certificates and test reports together with the goods; the elbow-to-riser welded steel plates (item 12 of Appendix A) shall be delivered by Party A to the designated on-site stacking point.

2.3.2 负责施工期间#3 机组 A 侧循环水系统的隔离、停电、停水、泄压及挂牌上锁（LOTO），为乙方提供必要的作业条件。

2.3.2 Responsible for isolation, power/water cut-off, pressure release and lockout-tagout (LOTO) of the A-side circulating water system of Unit 3 during construction, and provide Party B with the necessary working conditions.

2.3.3 负责办理检修工作票、动火工作票以及高处、受限空间作业许可等相关手续。

2.3.3 Responsible for handling relevant procedures such as maintenance work permits, hot work permits, and working-at-height and confined-space permits.

2.3.4 提供施工所需电源、水源接口及起重设备的协调使用，并向乙方进行现场技术交底。

2.3.4 Provide power and water interfaces and the coordinated use of lifting equipment required for construction, and conduct on-site technical disclosure to Party B.

2.3.5 提供系统图纸与工况参数，指派专业技术人员进行现场监督、技术指导及验收。

2.3.5 Provide system drawings and operating parameters, and assign professional personnel to conduct on-site supervision, technical guidance and acceptance.

2.4 乙方工作范围

2.4 Scope of Work for Party B

2.4.1 严格按本规范书、经审批的加固设计图纸以及国家、行业标准组织施工，对工程质量、安全、进度和环境保护全面负责，不得擅自降低标准或变更工艺。

2.4.1 Construct strictly in accordance with this specification, the approved reinforcement design drawings and national/industry standards, and be fully responsible for project quality, safety, schedule and environmental protection; do not lower standards or change the process without authorization.

2.4.2 负责甲供物资的进场清点、验收和保管，核对规格、型号、数量及质量证明文件，发现缺损、不符或过期时及时书面通知甲方；并负责甲供焊接钢板（含弯头至立管段钢板）在场内的二次转运与吊装。

2.4.2 Responsible for counting, incoming inspection and storage of Party-A-supplied materials, verifying specifications, models, quantities and quality documents, and promptly notifying Party A in writing of any defect, discrepancy or expiry, and shall be responsible for the on-site secondary transport and lifting of the Party-A-supplied welded steel plates (including the elbow-to-riser plates).

2.4.3 自备除甲供物资以外的工器具及检测仪器（含锚杆拉力计/拉拔仪），负责作业平台、脚手架及安全防护设施的搭设与拆除；锚杆拉拔仪进场时必须提供有效的计量检定证书并报验。

2.4.3 Provide its own tools and testing instruments other than the Party-A-supplied materials (including an anchor pull-out tester), and be responsible for erecting and removing the working platform, scaffolding and safety protection facilities; the anchor pull-out tester must be submitted for incoming inspection with a valid metrological calibration certificate.

2.4.4 必须按《混凝土结构后锚固技术规程》（JGJ 145）完成植筋胶（化学锚栓）现场拉力（抗拔）试验，出具相应的正式试验报告，并承担试验费用。

2.4.4 MUST conduct the on-site pull-out test of the rebar adhesive (chemical anchors) in accordance with JGJ 145, issue the corresponding official test report, and bear the test cost.

2.4.5 负责施工全过程自检、隐蔽工程报验、成品保护、竣工验收配合、竣工资料编制移交，并承担质保期内的缺陷维修责任。

2.4.5 Responsible for self-inspection throughout construction, hidden-work submission, finished-product protection, cooperation in completion acceptance, and preparation and handover of as-built documents, and undertake defect-repair liability during the warranty period.

3. 技术要求

3. Technical Requirements

3.1 材料要求及质量标准

3.1 Material Requirements and Quality Standards

本工程主要材料及备品备件由甲方供应（详见附录 A）。乙方在材料进场时必须核对名称、规格、型号、数量、材质证明及有效期，并分类妥善保管；不合格、过期、包装破损或已损伤的材料严禁使用。

The main materials and spare parts for this project are supplied by Party A (see Appendix A). On delivery, Party B shall verify the names, specifications, models, quantities, material certificates and validity periods, and store them by category; any unqualified, expired, damaged or poorly packaged material is strictly prohibited from use.

3.1.1 加固钢管

3.1.1 Reinforcing steel pipe

（1）甲方提供钢管，规格 DN1420、PN16、壁厚 10mm、材质为碳钢 Q235，长度 6m，用于现场切割、卷制成型为加固钢套板（套筒）。

(1) Party A provides steel pipes is DN1420, PN16, wall thickness 10 mm, material carbon steel Q235, length 6 m, to be cut and formed on site into the reinforcing steel sleeve (plates).

（2）钢管应具有原厂质量证明书，表面无裂纹、无夹层、无严重锈蚀和变形；下料前应进行外观检查与壁厚复测。

(2) The steel pipe shall have the factory quality certificate; its surface shall be free from cracks, laminations, severe corrosion and deformation; appearance inspection and wall-thickness re-measurement shall be carried out before cutting.

（3）钢套管表面应按 GB 50212 及涂装要求除锈，喷射或抛射除锈等级不低于 Sa2.5 级；采用手工或动力工具除锈时不低于 St3 级。

(3) The steel sleeve surface shall be derusted in accordance with GB 50212 and the coating requirements, with a blast-cleaning grade not lower than Sa2.5; when manual or power-tool cleaning is used, the grade shall not be lower than St3.

3.1.2 全丝螺杆及螺母

3.1.2 All-thread rods and nuts

（1）甲供 M27×1000mm、8.8 级全丝螺杆 20 根，配套 8.8 级螺母 60 个（每根 3 个）；螺杆、螺母应具有材质及性能等级证明，表面无裂纹、滑丝、变形和严重锈蚀。

(1) Party A supplies 20 pieces of M27×1000 mm grade 8.8 all-thread rods and 60 matching grade 8.8 nuts (three per rod); the rods and nuts shall have material and property-class certificates, with surfaces free from cracks, stripped threads, deformation and severe corrosion.

（2）安装前复核螺纹完好、螺母配合顺畅；螺母应按设计扭矩对称、均匀紧固，严禁以焊接代替锚固，严禁随意切割或接长螺杆。

(2) Before installation, verify that the threads are intact and the nuts run smoothly; nuts shall be tightened symmetrically and uniformly to the design torque; welding in place of anchoring, and arbitrary cutting or extension of rods, are strictly prohibited.

3.1.3 植筋胶

3.1.3 Rebar (post-installed anchor) adhesive

（1）甲供 350ml 植筋胶 60 支及配套胶枪 2 把。植筋胶应为双组份注射式锚固胶（改性环氧或同等性能），具有产品合格证、第三方检测报告及安全数据单（MSDS），并在有效期内。

(1) Party A supplies 60 cartridges of 350 ml rebar adhesive and 2 matching glue guns. The adhesive shall be a two-component injectable anchoring adhesive (modified epoxy or equivalent), with product certificate, third-party test report and Safety Data Sheet (MSDS), and within its validity period.

（2）粘结性能应满足 GB 50728 及 JGJ 145 的要求，耐水、耐海水、耐湿热、耐老化、耐疲劳，适用于巴厘岛高温高湿的海洋环境。

(2) The bonding performance shall meet GB 50728 and JGJ 145, and shall be water-, seawater-, humid-heat-, aging- and fatigue-resistant, suitable for the high-temperature, high-humidity marine environment of Bali.

（3）严禁使用过期、包装破损或固化异常的胶；注胶应按厂家规定的配比与工艺进行，自孔底起连续注满，确保无气泡、无缺胶。

(3) Expired, damaged or abnormally curing adhesive is strictly prohibited; injection shall follow the manufacturer's mix ratio and procedure, filling continuously from the bottom of the hole to ensure no air voids or missing adhesive.

3.1.4 环氧树脂漆

3.1.4 Epoxy resin paint

（1）甲供环氧树脂漆 80 型、90 型各 20kg，均带配套固化剂，用于钢套管除锈后的防腐涂装。

(1) Party A supplies 20 kg each of epoxy resin paint type 80 and type 90, each with matching curing agent, for the anti-corrosion coating of the derusted steel sleeve.

（2）按厂家规定配比、熟化后使用；底漆、面漆的使用次序（80 型、90 型）按产品说明执行，涂装道数、重涂间隔及干膜厚度应符合产品技术要求，涂层均匀，无漏涂、无流挂、无脱落。

(2) Mix and cure in accordance with the manufacturer's instructions; the primer/topcoat sequence of types 80 and 90 shall follow the product data sheet, and the number of passes, recoating interval and dry-film thickness shall meet the product requirements, with a uniform coating free from misses, sags and peeling.

3.1.5 麻绳与防水沥青

3.1.5 Hemp rope and waterproof asphalt

（1）甲供Φ20 麻绳 250m，应干燥、无霉变、无腐烂，纤维强度高；防水沥青 200kg，应耐水、防腐、耐温并具有合格证明。

(1) Party A supplies 250 m of Φ20 hemp rope, which shall be dry, free from mildew and rot and of high fiber strength, and 200 kg of waterproof asphalt, which shall be water-resistant, anti-corrosion and temperature-resistant with a certificate of conformity.

（2）沥青加热温度应控制在 160℃～180℃，现场应配置温度实时监测工具（如数显温度计、红外测温仪）进行实时监控，严禁过热老化及超温；麻绳应充分浸润沥青，密封连续、完整。

(2) The asphalt heating temperature shall be controlled between 160℃ and 180℃, with real-time temperature monitoring tools (e.g. digital thermometer, infrared thermometer) configured on site for real-time monitoring; overheating/aging and over-temperature are strictly prohibited; the hemp rope shall be fully impregnated with asphalt to form a continuous and complete seal.

3.1.6 焊接钢板（弯头至立管段）

3.1.6 Welded steel plates (elbow-to-riser)

（1）包覆完成后，用于#3 机 A 侧凝汽器循环水进口管道弯头至立管段（裸管段）外壁焊接加固，面积约 30m²；钢板材质 Q235、厚度及加强肋布置按加固设计图纸执行。

(1) After wrapping, used for external welded reinforcement on the elbow-to-riser (bare-pipe) section of the Unit-3 A-side condenser circulating water inlet pipe, total area about 30 m²; the plate material Q235, thickness and stiffener arrangement shall follow the reinforcement design drawing.

（2）钢板应具有出厂质量证明书，表面无裂纹、夹层和严重锈蚀；下料前复核尺寸与弧度，钢板与管道外壁贴合。

(2) The plates shall have factory quality certificates, with surfaces free from cracks, laminations and severe corrosion; re-check dimensions and curvature before cutting so that the plates fit the pipe outer wall.

（3）该部分钢板列入附录 A 第 12 项甲供物资清单，具体规格、尺寸及技术要求详见附录 A；钢板由甲方按设计厚度采购供应并运抵现场指定堆放点，乙方负责场内二次转运、吊装、下料、贴装、焊接及防腐补涂。

(3) These plates are listed as item 12 of the Party-A-supplied materials in Appendix A, and their specific specifications, dimensions and technical requirements are given in Appendix A; Party A shall procure the plates per the design thickness and deliver them to the designated on-site stacking point, and Party B shall be responsible for on-site secondary transport, lifting, cutting, fitting, welding and touch-up anti-corrosion coating.

3.2 加固施工质量标准

3.2 Reinforcement Construction Quality Standards

3.2.1 基面处理

3.2.1 Base surface preparation

（1）混凝土表面凿毛深度不小于 2mm，露出坚实基层；平整度误差不大于 3mm/m、全长不大于 10mm，无疏松、空鼓、起砂和开裂部位。

(1) The concrete surface shall be scabbled to a depth of no less than 2 mm to expose a sound base; the flatness tolerance shall not exceed 3 mm/m and 10 mm over the full length, with no loose, hollow, sandy or cracked areas.

（2）采用高压吹风或工业吸尘清洁，粘贴面应洁净、干燥，表面含水率不大于 8%。

(2) Clean with high-pressure air or an industrial vacuum; the bonding surface shall be clean and dry, with a surface moisture content not exceeding 8%.

（3）环境相对湿度大于 85%或雨天时，不得进行植筋注胶及防腐涂装作业；巴厘岛属高湿海洋气候，作业前应确认天气与湿度条件，必要时采取遮挡、除湿措施。

(3) Rebar-adhesive injection and anti-corrosion coating shall not be carried out when the ambient relative humidity exceeds 85% or in rainy weather; as Bali has a high-humidity

marine climate, confirm the weather and humidity conditions before work and take sheltering and dehumidifying measures where necessary.

3.2.2 钢套管制作与包覆

3.2.2 Steel sleeve fabrication and wrapping

（1）按现场实测尺寸和加固排版图切割下料，切口平直、无毛刺；拼接缝隙不大于 1mm，错边量不大于 1mm。

(1) Cut according to site-measured dimensions and the reinforcement layout drawing, with straight, burr-free cut edges; the splice gap shall not exceed 1 mm and the edge misalignment shall not exceed 1 mm.

（2）钢套管应与混凝土基面贴合紧密，局部间隙不大于 0.5mm，无翘曲、鼓包和悬空；仅包覆左、上、右三面，底部不包覆（具体以加固设计图纸为准）。

(2) The steel sleeve shall fit tightly against the concrete surface, with a local gap not exceeding 0.5 mm and no warping, bulging or suspension; only the left, top and right faces are wrapped and the bottom is not wrapped (subject to the reinforcement design drawing).

（3）钢管的切割、焊接应符合 GB 50205 的规定，焊缝平整、无焊接缺陷，焊渣清理干净并对焊接及损伤部位补涂防腐。

(3) Cutting and welding of the steel pipe shall comply with GB 50205; welds shall be smooth and free from defects, welding slag shall be removed, and welds and damaged spots shall be touch-up coated.

3.2.3 钻孔与化学植筋锚固

3.2.3 Drilling and chemical anchoring

（1）按加固设计点位放线，孔位均匀、间距均衡，并避开原有钢筋及应力集中部位；孔位偏差不大于 5mm，成孔直径为Φ30mm（M30 钻头）。

(1) Set out holes according to the reinforcement design, with uniform positions and spacing, avoiding existing rebar and stress-concentration areas; the hole-position deviation shall not exceed 5 mm and the hole diameter shall be Φ30 mm (M30 bit).

（2）成孔深度及 M27 螺杆的有效锚固深度，应按加固设计图纸和植筋胶厂家技术要求，结合现场实测的混凝土包裹层厚度确定，确保满足设计抗拔承载力；孔壁应光滑，无塌孔、无裂纹。

(2) The hole depth and the effective embedment depth of the M27 rods shall be determined according to the reinforcement design drawing and the adhesive manufacturer's requirements, combined with the site-measured thickness of the concrete encasement, so as to ensure the design pull-out capacity; the hole wall shall be smooth, without collapse or cracks.

（3）钻孔后应采用专用毛刷和高压吹风清孔（不少于三刷三吹），孔内洁净、干燥、无粉尘和积水；清孔合格后应及时注胶植筋，防止孔壁再次污染。

(3) After drilling, clean the holes with a dedicated brush and high-pressure air (no fewer than three brush-and-blow cycles); the holes shall be clean, dry and free from dust and water; after cleaning, inject adhesive and set anchors promptly to prevent re-contamination.

（4）螺杆植入前应清除油污和浮锈；注胶自孔底起连续饱满，植入后孔口应有胶体均匀溢出，无气泡、无缺胶；螺杆植入垂直度偏差不大于 2°，固化期内严禁扰动。

(4) Oil and loose rust shall be removed from the rods before setting; inject adhesive continuously and fully from the hole bottom, with adhesive evenly extruding at the mouth after setting, without air voids or missing adhesive; the rod verticality deviation shall not exceed 2°, and disturbance during curing is strictly prohibited.

（5）植筋胶自然固化时间按厂家要求执行且不少于 24h（环境温度不低于 20℃）；固化达到要求并经植筋胶拉力试验合格后，锚栓方可受力并进行螺母最终紧固。

(5) The natural curing time of the adhesive shall follow the manufacturer's requirements and be no less than 24 h (ambient temperature not lower than 20℃); only after adequate curing and a qualified pull-out test may the anchors be loaded and the nuts finally tightened.

（6）施工前应查阅循环水入口前池及管廊区施工图纸，锚孔定位应尽量避开原有钢筋分布区域；钻孔过程中如遇原有结构钢筋，禁止强行钻孔，应立即停止并报甲方、设计单位现场确认，调整锚栓点位，不得损伤原有受力钢筋。

(6) Before construction, consult the construction drawings of the circulating-water inlet forebay and pipe gallery, and locate anchor holes away from the existing rebar as far as possible; if an existing structural rebar is encountered during drilling, forcible drilling is strictly prohibited — stop immediately, report to Party A and the designer for on-site confirmation, adjust the anchor position, and do not damage the existing load-bearing rebar.

（7）本工程植筋锚固处于海水/循环水侵蚀环境，锚栓外露段、螺母及锚固周边应采取防海水腐蚀措施（如环氧树脂漆封闭、密封防水），植筋胶及防护材料应满足耐海水侵蚀要求。

(7) As the chemical anchoring is located in a seawater/circulating-water erosion environment, anti-seawater-corrosion measures (such as epoxy sealing and waterproofing) shall be taken for the exposed rod sections, nuts and the anchor surroundings, and the adhesive and protective materials shall meet the seawater-resistance requirements.

3.2.4 缝隙填充与密封

3.2.4 Gap filling and sealing

（1）钢套管与混凝土基体之间的缝隙采用防水沥青热浇注密实，无孔洞、蜂窝和裂缝；浇注应由下至上、由内至外连续进行。

(1) The gap between the steel sleeve and the concrete substrate shall be densely filled with hot-poured waterproof asphalt, without holes, honeycombing or cracks; pouring shall proceed continuously from bottom to top and from inside to outside.

（2）拼缝、边角和端部采用Φ20 麻绳缠绕紧密并充分浸润沥青，阴阳角等转角部位加强密封；密封层应连续、完整、无断点，试水检查无渗漏。

(2) Splices, edges and ends shall be tightly wound with Φ20 hemp rope and fully impregnated with asphalt, with reinforced sealing at internal/external corners; the seal shall be continuous and complete without breaks, and show no leakage under water testing.

3.2.5 防腐涂装与养护

3.2.5 Anti-corrosion coating and curing

（1）钢套管除锈合格后应及时涂装环氧树脂漆，涂层道数和干膜厚度满足产品技术要求，外观均匀，无漏涂、流挂和脱落。

(1) After qualified derusting, the steel sleeve shall be promptly coated with epoxy resin paint; the number of passes and dry-film thickness shall meet the product requirements, with a uniform appearance free from misses, sags and peeling.

（2）植筋胶和沥青密封层自然养护不少于 24h，养护环境温度不低于 20℃；养护期内严禁扰动、敲击、加载、冲水和暴晒，并采取防雨、防潮措施。

(2) The adhesive and asphalt seal shall be naturally cured for no less than 24 h at an ambient temperature not lower than 20℃; during curing, disturbance, striking, loading, water flushing and direct sun exposure are strictly prohibited, and rain- and moisture-protection measures shall be taken.

3.2.6 弯头至立管段钢板焊接

3.2.6 Steel-plate welding (elbow-to-riser)

（1）钢板与原管道外壁贴合、定位准确；环向、纵向焊缝及加强肋焊接应符合 GB 50205，焊脚尺寸、焊缝高度按加固设计图纸。

(1) The plates shall fit the original pipe wall accurately and be positioned correctly; circumferential and longitudinal welds and stiffener welding shall comply with GB 50205, with fillet size and weld height per the reinforcement design drawing.

（2）焊缝表面不得有裂纹、夹渣、气孔、未焊满和烧穿；焊后清渣，按规定进行无损检测（检测方法、比例及合格等级按设计文件执行，如超声波检测 UT、磁粉检测 MT），检测合格后补涂环氧树脂漆。

(2) Weld surfaces shall be free from cracks, slag inclusion, porosity, incomplete fill and burn-through; remove slag after welding and carry out NDT as specified (method, proportion and acceptance grade per the design documents, e.g. ultrasonic testing UT or magnetic particle testing MT); touch up with epoxy resin paint after NDT is qualified.

3.2.7 混凝土本体钢板加固

3.2.7 Steel-plate reinforcement of the concrete body

（1）混凝土包裹体局部老化、疏松、开裂部位应按加固设计图纸进行钢板下料、贴装与焊接加固；钢板材质 Q235，厚度及加强肋布置按加固设计图纸，焊缝质量应符合 GB 50205。

(1) Steel plates shall be cut, fitted and welded onto the locally aged, loosened or cracked parts of the concrete encasement per the reinforcement design drawing; the plate material shall be Q235, and the thickness and stiffener arrangement shall follow the reinforcement design drawing, with weld quality complying with GB 50205.

（2）钢板应与混凝土表面贴合紧密，焊缝表面无裂纹、夹渣、气孔、未焊满和烧穿等缺陷；焊后清渣、打磨，并按 3.2.5 要求补涂防腐涂层。

(2) The plates shall fit tightly against the concrete surface, and the weld surfaces shall be free from cracks, slag inclusion, porosity, incomplete fill and burn-through; remove and grind the slag after welding, and touch up the anti-corrosion coating per 3.2.5.

（3）钢板加固施工及锚固（如需）不得损伤原有受力钢筋、管道本体及已完成工序；隐蔽部位应经甲方现场确认并留存影像记录。

(3) The plate reinforcement and anchoring (if any) shall not damage the existing load-bearing rebar, the pipe body or the completed works; hidden parts shall be confirmed on site by Party A with photos/videos retained.

表 3-1 关键尺寸与施工参数

Table 3-1 Key Dimensions and Construction Parameters

序号 No.	项目 Item	参数要求 Requirement	允许偏差 Tolerance	检验方式 Inspection
1	加固段长度 Reinforcement length	6m 6 m	±10mm ±10 mm	钢卷尺测量 Steel tape
2	加固钢管 Reinforcing steel pipe	DN1420 PN16，壁厚 10mm，Q235 DN1420 PN16, wall 10 mm, Q235	壁厚 ±0.5mm Wall ±0.5 mm	质保书+游标卡尺 Certificate + caliper
3	包覆工作面 Wrapped faces	左、上、右三面，底部不包 Left, top, right; bottom excluded	— —	目视+尺量 Visual + tape
4	化学锚栓 Chemical	M27×1000mm 8.8 级全丝螺杆 20 根 M27×1000 mm grade 8.8 rods, 20 pcs	数量不短缺	清点+质保书 Count +

序号 No.	项目 Item	参数要求 Requirement	允许偏差 Tolerance	检验方式 Inspection
	anchors		No shortage	certificate
5	成孔孔径 Hole diameter	Φ30（M30 钻头） Φ30 (M30 bit)	±1mm ±1 mm	卡尺/塞尺 Caliper/feeler
6	成孔/锚固深度 Hole/embedment depth	按设计图纸及胶厂家要求 Per design drawing & adhesive maker	+10/0mm +10/0 mm	深度尺 Depth gauge
7	锚栓垂直度 Anchor verticality	植入垂直 Perpendicular setting	≤2° ≤2°	靠尺/线坠 Straightedge/plumb
8	基面凿毛 Scabbling depth	≥2mm，露出坚实基层 ≥2 mm, sound base exposed	— —	尺量/目视 Tape/visual
9	基面平整度 Surface flatness	≤3mm/m，全长≤10mm ≤3 mm/m, ≤10 mm overall	— —	2m 靠尺+塞尺 2 m straightedge + feeler
10	拼缝/错边 Splice gap/offset	间隙≤1mm，错边≤1mm Gap ≤1 mm, offset ≤1 mm	≤1mm ≤1 mm	塞尺 Feeler gauge
11	贴合间隙 Contact gap	钢套管与基面局部间隙 Local sleeve-to-base gap	≤0.5mm ≤0.5 mm	塞尺 Feeler gauge
12	注胶饱满度 Adhesive fill	满胶、无气泡、无缺胶 Full, no void/missing adhesive	无缺胶 No void	目视+拉拔试验 Visual + pull-out test
13	沥青浇注 Asphalt pouring	密实、无孔洞蜂窝 Dense, no void/honeycomb	无空洞 No cavity	敲击/试水 Hammering/water test
14	边角密封 Edge sealing	Φ20 麻绳+沥青 Φ20 hemp rope + asphalt	无间隙 No gap	目视+试水 Visual + water test
15	养护时间/温度 Curing time/temp.	≥24h，环境≥20℃ ≥24 h, ambient ≥20℃	— —	施工记录 Construction record
16	结构安全系数 Structural safety factor	复合结构（强度校核文件） Composite structure (strength verification)	≥3.0 ≥3.0	计算文件复核 Calculation review
17	弯头至立管段钢板 Elbow-to-riser plates	外壁焊接加固，约 30m² External welded reinforcement, ~30 m²	面积按设计 Per design	尺量+焊缝外观 Tape + weld visual
18	焊缝质量 Weld quality	无裂纹/夹渣/气孔，焊脚按设计 No crack/slag/porosity; fillet per design	— —	外观+无损检测（方法/比例/等级按设计） Visual + NDT (method/proportion/grade per design)
19	混凝土本体钢板 Concrete-body plates	Q235，厚度按设计；钢板加固混凝土包裹体局部老化、疏松部位 Q235, thickness per design; steel-plate reinforcement of locally aged/loosened concrete encasement	— —	尺量+焊缝外观 Tape + weld visual

序号 No.	项目 Item	参数要求 Requirement	允许偏差 Tolerance	检验方式 Inspection
20	混凝土本体钢板焊缝 Concrete-body plate welds	无裂纹/夹渣/气孔，焊脚按设计 No crack/slag/porosity; fillet per design	— —	外观+无损检测（方法/比例/等级按设计） Visual + NDT (method/proportion/grade per design)

3.3 植筋胶拉力（抗拔）试验

3.3 Pull-out Test of Rebar Adhesive (Chemical Anchors)

（1）乙方必须在植筋胶完全固化并达到产品规定的固化龄期后，使用经计量检定合格的锚杆拉力计（数显拉拔仪），按《混凝土结构后锚固技术规程》（JGJ 145）对 M27 化学锚栓进行现场抗拔（拉力）试验。

(1) After the adhesive is fully cured and reaches the curing age specified by the product, Party B MUST conduct an on-site pull-out test on the M27 chemical anchors using a calibrated anchor pull-out tester (digital), in accordance with JGJ 145.

（2）试验抽样数量与部位由甲方（监理）现场确定，最低抽样数量不低于锚栓总数量的 10%且不少于 3 根，应覆盖左、上、右三个工作面及不同施工批次，且具有代表性；抽样比例、加载方式与结果评定按 JGJ 145 的规定执行。

(2) The sampling quantity and locations shall be determined on site by Party A (the supervisor), with the minimum sample size not lower than 10% of the total number of anchors and no fewer than 3 anchors, covering the left, top and right working faces and different construction batches, and shall be representative; the sampling ratio, loading method and result evaluation shall follow JGJ 145.

（3）试验一般采用非破损检验，分级、匀速加载至设计锚固力（或 JGJ 145 规定的检验荷载）并按规定持荷；以持荷期间锚栓无滑移、混凝土无裂缝、胶体与锚栓无破坏，且抗拔应力不低于 30MPa（或满足设计要求的锚固力，以较大者为准）为合格。若设计未给定检验荷载，应按 JGJ 145 相应规定取值并经甲方书面确认。

(3) A non-destructive test is generally adopted, loading stepwise and uniformly to the design anchorage force (or the inspection load specified in JGJ 145) and holding as

specified; the test is qualified if, during the hold period, the anchor does not slip, the concrete does not crack, the adhesive/anchor is not damaged, and the pull-out stress is not lower than 30 MPa (or meets the design anchorage force, whichever is higher). If the design does not specify the inspection load, it shall be taken according to JGJ 145 and confirmed in writing by Party A.

（4）试验过程应逐项记录锚栓编号、部位、孔径孔深、植筋胶批号、各级加载值、位移量及试验结果；试验合格后由乙方出具正式的《植筋胶（化学锚栓）抗拔拉力试验报告》，试验人、审核人签字并加盖乙方单位公章后提交甲方存档。

(4) During the test, record the anchor number, location, hole diameter/depth, adhesive batch number, load at each step, displacement and result; after passing, Party B shall issue the official “Rebar Adhesive (Chemical Anchor) Pull-out Test Report”, signed by the tester and reviewer and stamped with Party B’s official seal, and submit it to Party A for filing.

（5）对试验不合格的锚栓，乙方必须按规范要求在邻近部位返工补植并重新试验，直至全部合格，相关费用由乙方承担。

(5) For any anchor failing the test, Party B shall re-install a replacement anchor nearby and re-test in accordance with the code until all anchors pass, at Party B’s cost.

（6）植筋胶拉力试验合格是化学植筋工序隐蔽验收以及后续螺母最终紧固、锚栓受力的前置条件；未经验收合格，不得进入下一道工序。

(6) A qualified pull-out test is a precondition for the hidden-work acceptance of the chemical anchoring process and for subsequent final nut tightening and loading of the anchors; the next process shall not start before acceptance is passed.

3.4 施工工艺要求

3.4 Construction Process Requirements

3.4.1 施工准备

3.4.1 Construction preparation

（1）乙方应组建由项目负责人、技术负责人、专职安全员和足够数量专业施工人员组成的施工队伍，焊工、电工、架子工、起重工等特种作业人员必须持证上岗；所有人员经三级安全教育和技术交底后方可作业。

(1) Party B shall organize a team comprising a project manager, a technical manager, a full-time safety officer and sufficient professional workers; special-operation personnel such as welders, electricians, scaffolders and riggers must hold valid certificates; all personnel may work only after three-level safety education and technical disclosure.

（2）编制施工方案、施工进度计划和应急预案，办理工作票、动火票及高处、受限空间作业许可；检查工器具、锚杆拉拔仪、钢丝绳索具等完好且检定/检验有效。

(2) Prepare the construction scheme, schedule and emergency plan; obtain work permits, hot work permits and working-at-height/confined-space permits; verify that tools, the anchor pull-out tester and riggings are in good condition with valid calibration/inspection.

（3）完成甲供物资进场验收、现场勘查、尺寸复核与测量放线，搭设并验收作业平台、脚手架及安全防护设施。

(3) Complete incoming inspection of Party-A-supplied materials, site survey, dimension verification and setting-out, and erect and accept the working platform, scaffolding and safety protection facilities.

3.4.2 施工工序

3.4.2 Construction sequence

加固施工应按下列工序连续、有序进行：施工准备及系统隔离 → 混凝土基面凿毛清理 → 钻孔、清孔、注胶植筋及螺母初装 → 植筋胶固化 → 植筋胶拉力（抗拔）试验 → 混凝土本体钢板加固 → 加固钢管切割、卷制与排版 → 钢套管包覆、

定位 → 防水沥青浇注及麻绳边角密封 → 钢套管环氧树脂漆防腐涂装 → 包覆完成后弯头至立管段管道外壁钢板下料、贴装与焊接 → 成品养护 → 渗漏检查及竣工验收。上道工序未经验收合格，不得进入下道工序。

The reinforcement construction shall be carried out in a continuous and orderly manner according to the following procedures: construction preparation and systematic isolation → chiseling and cleaning of concrete base surface → drilling, hole cleaning, injecting rebar and initial installation of nuts → curing of rebar adhesive → tensile test of rebar adhesive → reinforcement of concrete body steel plate → cutting, rolling and typesetting of reinforced steel pipe → coating and positioning of steel sleeve → pouring waterproof asphalt and sealing of hemp rope corners → anticorrosive coating of steel sleeve with epoxy resin paint → coating. The previous procedure shall not enter the next procedure without passing the acceptance test.

（1）先完成混凝土基面处理并验收，再进行钢套管包覆，避免包覆后基面无法处理。

(1) Complete and accept the concrete base preparation before wrapping the steel sleeve, so that the base is not left untreated after wrapping.

（2）化学植筋应在钢套管就位、锚孔对位后进行；钻孔时应控制孔深与角度，不得伤及原金属管壁及内部管道。

(2) Chemical anchoring shall be carried out after the sleeve is positioned and the holes are aligned; control the hole depth and angle during drilling, and do not damage the original metallic pipe wall or the inner pipe.

（3）植筋胶拉力试验合格后，方可进行螺母最终紧固以及沥青密封、防腐涂装；隐蔽工序须经甲方现场确认，并留存影像和记录。

(3) Final nut tightening, asphalt sealing and anti-corrosion coating may proceed only after the pull-out test is passed; hidden works shall be confirmed on site by Party A, with photos/videos and records retained.

（4）密封、涂装完成后按规定养护，养护期满进行外观检查和渗漏检查，配合甲方组织竣工验收。

(4) After sealing and coating, cure as specified; upon expiry of the curing period, carry out appearance and leakage inspections and cooperate with Party A in the completion acceptance.

（5）弯头至立管段钢板焊接在主钢套管包覆完成后进行；焊接属动火作业，须办理动火工作票，对下方及周边已完成的防腐、密封部位采取防火隔离，焊后清渣并补涂防腐。

(5) The elbow-to-riser steel-plate welding shall be carried out after the main steel-sleeve wrapping is completed; as hot work, a hot-work permit is required, fire isolation shall be provided for the finished anti-corrosion and sealing works below and around, and slag shall be removed and touch-up coated after welding.

3.5 试验及验收

3.5 Testing and Acceptance

3.5.1 验收程序

3.5.1 Acceptance process

（1）施工班组自检：每道工序完成后，作业人员自行检查并填写施工记录，确保符合质量标准。

(1) Work-team self-inspection: after each process, the operators inspect the work and fill in construction records to ensure compliance with quality standards.

（2）项目部复检：由项目技术、质量负责人复检并组织隐蔽工程报验。

(2) Project-department re-inspection: the project technical and quality leads re-inspect and organize hidden-work submission.

（3）甲方（监理）验收：甲方专业人员进行材料复核、尺寸检查、植筋拉拔试验见证、渗漏检查及资料审查。

(3) Party A (supervisor) acceptance: Party A’s professionals conduct material verification, dimension checks, witnessing of the anchor pull-out test, leakage inspection and document review.

（4）验收结论分为合格与不合格；不合格项必须限期整改并重新报验，直至合格，费用由责任方承担。

(4) The acceptance conclusion is either qualified or unqualified; unqualified items must be rectified within a time limit and re-submitted until qualified, at the responsible party's cost.

3.5.2 试验项目与合格标准

3.5.2 Test Items and Acceptance Criteria

本次加固应完成的主要检验、试验项目见表 3-2，所有检验、试验数据均应记录存档。

The main inspection and test items for this reinforcement are given in Table 3-2, and all inspection and test data shall be recorded and filed.

表 3-2 试验/检验项目与合格标准

Table 3-2 Test/Inspection Items and Acceptance Criteria

序号 No.	试验/检验项目 Test/Inspection Item	试验方法或依据 Method / Basis	合格标准 Acceptance Criteria
1	材料进场检验 Material incoming inspection	核对合格证、质保书、检测报告及规格数量 Verify certificates, quality documents, test reports, specs and quantities	资料齐全、外观合格、在有效期内 Documents complete, sound appearance, within validity
2	钢套管壁厚/尺寸 Sleeve thickness/dimensions	游标卡尺、钢卷尺复测 Vernier caliper and steel tape	壁厚 10mm（±0.5mm），尺寸符合排版图 Wall 10 mm (±0.5 mm), dimensions per layout
3	基面处理 Base surface preparation	目视、靠尺、含水率测定 Visual, straightedge, moisture meter	凿毛≥2mm，平整≤3mm/m，含水率≤8% Scabble ≥2 mm, flatness ≤3 mm/m, moisture ≤8%
4	成孔质量 Hole quality	尺量、深度尺检查 Tape and depth gauge	孔径Φ30，孔深符合设计，孔内洁净干燥 Φ30 holes, design depth, clean and dry
5	植筋胶拉力试验 Anchor pull-out test	JGJ 145，锚杆拉拔仪分级加载、持荷 JGJ 145, pull-out tester, stepwise loading & hold	抗拔应力不低于 30MPa（或满足设计锚固力），无滑移、无裂缝、无胶体破坏，报告合格 Pull-out stress ≥30 MPa (or per design anchorage force); no slip/crack/bond failure; report passed
6	混凝土本体外部加装钢板 Steel plates are installed outside the concrete body.	外观检查+尺量+焊缝无损检测（按设计） Visual inspection + tape + weld NDT (per design)	钢板贴合密实，焊缝无裂纹/夹渣/气孔 The steel plate is tightly attached, and there is no crack/slag inclusion/air hole in the weld.
7	密封/渗漏检查 Sealing/leakage	外观检查+试水/渗漏检查 Visual + water/leakage test	沥青麻绳密实连续，无渗漏、无湿渍 Dense continuous asphalt/rope, no

序号 No.	试验/检验项目 Test/Inspection Item	试验方法或依据 Method / Basis	合格标准 Acceptance Criteria
	inspection		leakage or damp marks
8	防腐涂装 Anti-corrosion coating	外观检查+干膜测厚 Visual + dry-film thickness gauge	涂装道数、干膜厚度符合产品要求，无漏涂流挂 Passes and DFT meet product, no miss or sag
9	强度校核 Strength verification	复核加固设计/强度计算文件 Review reinforcement design/calculation	复合结构安全系数≥3.0 Composite structural safety factor ≥3.0
10	弯头至立管段钢板焊缝 Elbow-to-riser plate welds	焊缝外观检查+无损检测（方法、比例及合格等级按设计文件） Visual weld inspection + NDT (method, proportion and acceptance grade per design documents)	无裂纹/夹渣/气孔，焊脚尺寸符合设计，无损检测合格，补涂防腐合格 No crack/slag/porosity; fillet size per design; NDT passed; touch-up coated

4. 进度要求

4. Schedule Requirements

4.1 本工程计划于 2026 年 11 月 10 日开工，2026 年 11 月 30 日竣工，总工期 20 日历天，不得超期。

4.1 The project is scheduled to start on November 10th, 2026 and be completed on November 30th, 2026, with a total construction period of 20 calendar days, which shall not be extended.

4.2 乙方应在开工前提交详细的施工进度计划（横道图或网络图），明确各工序节点和工期。表 4-1 为建议进度安排，乙方可结合现场实际细化，但竣工日期不得晚于 2026 年 11 月 30 日。

4.2 Party B shall submit a detailed construction schedule (Gantt chart or network diagram) before commencement, defining each process node and duration. Table 4-1 gives the indicative schedule; Party B may refine it according to site conditions, but completion shall be no later than November 30, 2026.

4.3 乙方应合理配置人员、设备和周转材料，关键工序连续施工，建立每日进度汇报机制，避免停工待料；主要工种及用工数量详见附录 E。

4.3 Party B shall reasonably allocate personnel, equipment and consumables, carry out key processes continuously, establish a daily progress-reporting mechanism, and avoid work stoppage while waiting for materials; the main trades and labour numbers are detailed in Appendix E.

4.4 因甲供物资未按期到场、系统未按期隔离或其他甲方原因影响工期的，乙方有权要求顺延工期，顺延天数由双方协商确定；因乙方原因造成工期延误的，按第 6 章承担违约责任。

4.4 If the schedule is affected by late delivery of Party-A materials, delayed system isolation or other Party-A reasons, Party B may request an extension, with the number of days agreed by both parties; delays caused by Party B shall incur liability under Chapter 6.

4.5 如检修窗口期变动，甲方应提前通知乙方调整到厂时间；乙方应采取必要的赶工措施，确保在机组启动前完成全部加固工作并验收合格。

4.5 If the maintenance window changes, Party A shall notify Party B in advance to adjust the arrival time; Party B shall take necessary acceleration measures to ensure all reinforcement is completed and accepted before unit start-up.

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；所有施工方案、作业许可应同时满足印尼当地劳工、安全作业要求及电厂要求。

5.1.1 Compliance with laws and regulations: Strictly abide by the production-safety laws and regulations of the People’s Republic of China and the Republic of Indonesia, and by the safety management systems of PT. General Energy Bali; all construction schemes and

work permits shall also comply with Indonesian local labour and safety-at-work requirements and the plant requirements.

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；焊工、电工、架子工、起重工等特种作业人员必须持证上岗。

5.1.2 Safety training: All personnel entering the plant must receive three-level safety education (company, workshop and team levels) and may work only after passing the assessment; special-operation personnel such as welders, electricians, scaffolders and riggers must hold valid certificates.

5.1.3 安全管理机构：乙方须设立专职安全管理人员并持证上岗，明确项目负责人为安全生产第一责任人。

5.1.3 Safety organization: Party B shall appoint full-time, certified safety management personnel, and clarify that the project manager is the first person responsible for production safety.

5.1.4 现场安全管理：开工前须进行危险源辨识和安全技术交底；临时用电应符合“三级配电、两级保护”要求，由持证电工接线，严禁私拉乱接；合理规划施工现场，设置安全警示标志和警戒区，严禁违章作业。

5.1.4 On-site safety management: Hazard identification and safety/technical disclosure shall be conducted before commencement; temporary power shall meet the “three-level distribution and two-level protection” requirements and be wired by certified electricians, with unauthorized wiring strictly prohibited; plan the site reasonably, set safety warning signs and cordoned areas, and prohibit illegal operations.

5.1.5 文明施工：每日工作结束后清理现场、切断电动工器具总电源，确认动火地点及周围无明火，孔洞、临边防护栏杆齐全完整、标志明显，做到工完、料尽、场地清。

5.1.5 Civilized construction: After work each day, clean the site, cut off the main power of electric tools, confirm no open flame at and around hot-work points, and ensure complete, clearly marked railings at holes and edges; leave the work finished, materials consumed and the site clean.

5.1.6 责任追究：对违反安全规定的行为依法依规追责；发生事故应立即报告并严肃调查处理。

5.1.6 Accountability: Violations of safety rules shall be held accountable according to laws and regulations; any accident shall be reported immediately and seriously investigated and handled.

5.2 专项安全措施

5.2 Special Safety Measures

5.2.1 高处及临边作业

5.2.1 Working at heights and near edges

（1）高处作业人员必须正确系挂安全带，做到高挂低用；脚手架、作业平台和防护网搭设牢固，须经甲方（或第三方）验收合格并挂牌后方可投入使用。

(1) Personnel working at height must properly fasten safety belts (hook high, use low); scaffolding, working platforms and safety nets shall be firmly erected and put into use only after acceptance and tagging by Party A (or a third party).

（2）对揭开的孔洞和临边设置牢固的临时围栏及明显标志，下部设警戒区并派专人监护，严禁上下抛物和无防护交叉作业。

(2) Provide firm temporary fences and clear signs at opened holes and edges, set cordoned areas below with dedicated monitors, and strictly prohibit throwing objects and unprotected cross operations.

5.2.2 动火与沥青加热

5.2.2 Hot work and asphalt heating

（1）动火及沥青加热必须办理动火工作票，清除周围易燃易爆物品，配备足够的灭火器材和消防水，并设专人监护。

(1) Hot work and asphalt heating require a hot work permit; remove surrounding flammables/explosives, provide sufficient extinguishers and fire water, and assign a dedicated monitor.

（2）沥青采用专用设备加热，温度控制在 160℃～180℃，严防溢流、火灾和烫伤；作业人员穿戴耐高温防护用品并佩戴防毒口罩，保持通风，作业结束后确认无残留火种。

(2) Heat asphalt with dedicated equipment at 160℃–180℃ to prevent overflow, fire and burns; operators shall wear heat-resistant PPE and respirators, maintain ventilation, and confirm no residual fire after work.

5.2.3 临时用电与电动工具

5.2.3 Temporary power and electric tools

（1）电锤、切割机、电焊机等电动工具绝缘良好、接地可靠，装设漏电保护装置，由持证人员操作并设专人监护。

(1) Electric hammers, cut-off saws, welders and other power tools shall be well insulated and reliably grounded with leakage protection, operated by certified personnel with dedicated monitoring.

（2）潮湿环境和受限空间内作业应使用安全电压照明，电缆架空敷设，防止碾压、浸泡。

(2) In wet environments and confined spaces, use safety-voltage lighting; cables shall be routed overhead to prevent crushing and immersion.

5.2.4 受限空间作业

5.2.4 Confined-space operation

（1）进入凝汽器进口管廊等受限空间前，必须办理受限空间作业许可，进行氧气、可燃气体及有毒有害气体检测，携带不少于 2 台便携式气体检测报警器，检测合格后方可进入。

(1) Before entering confined spaces such as the condenser inlet pipe gallery, obtain a confined-space permit, test oxygen, combustible gas and toxic/harmful gases, and carry no fewer than two portable gas detectors; entry is allowed only after qualified tests.

（2）作业场所应保持机械通风，设专人在外监护并保持通讯畅通，严禁单人作业。

(2) Keep mechanical ventilation at the workplace, assign a dedicated monitor outside with unobstructed communication; single-person work is strictly prohibited.

5.2.5 化学植筋与涂装作业

5.2.5 Chemical anchoring and coating

（1）植筋胶、环氧树脂漆及固化剂应分类存放、远离火源，严格按 MSDS 要求使用；作业场所通风良好，作业人员佩戴防护手套、护目镜和防毒口罩。

(1) Rebar adhesive, epoxy paint and curing agents shall be stored separately away from fire and used strictly per the MSDS; keep the workplace ventilated, and operators shall wear protective gloves, goggles and respirators.

（2）严禁在现场随意倾倒余胶、废溶剂和油漆废料；皮肤接触后应立即清洗。

(2) Random dumping of surplus adhesive, waste solvents and paint waste on site is strictly prohibited; wash immediately after skin contact.

5.3 环保与职业健康要求

5.3 Environmental and Occupational Health Requirements

5.3.1 施工废料、废胶、废沥青、油漆桶及包装材料应分类收集、集中存放，按印度尼西亚环保法规及甲方制度交由有资质的单位处置，严禁随意丢弃、倾倒和掩埋；危险废弃物应分类装箱、标识清晰，危废转移联单及处置凭证作为竣工资料一并移交甲方。

5.3.1 Construction waste, waste adhesive, waste asphalt, paint drums and packaging shall be collected by category and stored centrally, and disposed of by qualified units in accordance with Indonesian environmental regulations and Party A’s system; random discarding, dumping and burial are strictly prohibited; hazardous waste shall be sorted and boxed with clear labels, and the hazardous-waste transfer manifest and disposal certificates shall be handed over to Party A as part of the as-built documents.

5.3.2 沥青熬制和涂装作业应控制烟气与异味，必要时采取局部通风；钻孔、凿毛作业应采取湿法或吸尘措施控制粉尘，噪声应符合电厂及当地标准。

5.3.2 Control fumes and odors during asphalt boiling and coating, using local ventilation where necessary; use wet methods or dust extraction during drilling and scabbling, and keep noise within plant and local standards.

5.3.3 应采取措施防止油污、废水、余胶污染循环水管廊、管道及周边土壤和水体；作业完成后恢复场地、设备和设施原貌。

5.3.3 Take measures to prevent oil, wastewater and surplus adhesive from contaminating the pipe gallery, pipelines and surrounding soil/water; restore the site, equipment and facilities to their original condition after work.

5.3.4 现场应配备急救药品和应急物资，明确应急联系人、应急路线和处置流程；高温环境下合理安排作息，预防中暑和职业伤害。

5.3.4 Provide first-aid supplies and emergency materials on site, and define emergency contacts, routes and response procedures; arrange work/rest reasonably in high-temperature conditions to prevent heatstroke and occupational injury.

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 因乙方原因未按合同约定竣工日期（2026 年 11 月 15 日）完工的，每延误一日，按合同价款的 0.1%向甲方支付违约金，违约金累计不超过合同总价的 10%。

6.1.1 If Party B fails to complete the works by the contract completion date (November 15, 2026) for reasons attributable to Party B, it shall pay Party A a penalty of 0.1% of the contract price for each day of delay, with the total accumulated penalty not exceeding 10% of the contract price.

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

6.1.2 If the schedule is delayed by force majeure, Party B shall submit a written report and supporting documents within 14 days after the event, and may be exempted from relevant liability after confirmation by Party A.

6.1.3 因甲方原因（含甲供物资未按期到场、系统未按期隔离）导致工期延误的，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 schedule is delayed for Party-A reasons (including late delivery of Party-A materials or delayed system isolation), Party B may request an extension, with the number of days to be agreed by 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或变更工艺。违反本规范书要求造成施工质量不合格的，乙方应负责返工、修理，并赔偿由此给甲方造成的损失；植筋胶拉力试验不合格且未按要求返工的，按质量违约处理。

6.2.1 Party B shall not modify technical standards or change the process without authorization. If non-conforming quality results from violating this specification, Party B shall rework and repair, and compensate Party A for the resulting losses; a failed anchor pull-out test without the required rework shall be treated as a quality breach.

6.2.2 施工质量验收不合格的，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 fails acceptance, Party B must rectify it 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；质保期为竣工验收合格之日起 12 个月。质保期满且无质量问题的，甲方在 60 日内返还质量保证金（不计利息）。

6.2.3 After qualified completion acceptance, Party B shall retain a quality deposit of 10% of the contract price; the warranty period is 12 months from the date of qualified completion acceptance. Upon expiry of the warranty period without quality problems, Party A shall return the quality deposit within 60 days (without interest).

6.2.4 质保期内因乙方施工质量原因出现渗漏、松动、脱粘或锚固失效等缺陷的，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；如现场条件受机组运行限制而无法立即处理的，乙方应提交专项处置方案，经甲方审批后择检修窗口期实施。

6.2.4 If defects such as leakage, loosening, debonding or anchor failure occur during the warranty period due to Party B's construction quality, Party B shall attend site within 48 hours after notice from Party A to remedy them free of charge, and bear the resulting direct losses; if the site conditions are restricted by unit operation and immediate remedy is not possible, Party B shall submit a dedicated treatment plan and, after Party A's approval, implement it during a maintenance window.

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: 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 body) may 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.

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, both parties shall continue to perform the other contract terms except for the disputed matters.

7. 附录

7. Appendix

附录 A 甲供主要物资清单

Appendix A List of Main Materials Supplied by Party A

以下备品备件及主要材料全部由甲方负责采购、供应并运抵现场，乙方负责进场清点、核对、保管以及施工安装。

The following spare parts and main materials are ALL procured, supplied and delivered to site by Party A; Party B is responsible for counting, verifying and storing them, and for construction and installation.

表 A-1 甲供主要物资清单

Table A-1 List of Main Materials Supplied by Party A

序号 No.	名称 Description	规格/型号 Specification/Model	单位 Unit	数量 Quantity
1	全丝螺杆 All-thread rod	M27×1000mm 8.8 级 M27×1000 mm, grade 8.8	支 pcs	20
2	螺母 Nut	配套全丝螺杆使用，8.8 级 For matching all-thread rods, grade 8.8	个 pcs	60
3	植筋胶 Rebar adhesive	350ml 350 ml	支 cartridge	60
4	胶枪 Glue gun	配套植筋胶使用 For matching rebar adhesive	支 pcs	2
5	环氧树脂漆 Epoxy resin paint	80 型，带配套固化剂 Type 80, with matching curing agent	KG kg	20
6	环氧树脂漆 Epoxy resin paint	90 型，带配套固化剂 Type 90, with matching curing agent	KG kg	20
7	麻绳 Hemp rope	Φ20 Φ20	米 m	250
8	防水沥青 Waterproof asphalt	防水、防腐密封用 For waterproofing and anti-corrosion sealing	公斤 kg	200
9	电锤 Electric hammer	830 全配套（1480W） 830 full kit (1480 W)	套 set	2
10	钻头 Drill bit	配电锤使用，M30×500mm For electric hammer, M30×500 mm	根 pcs	4
11	无缝钢管 Seamless steel pipe	DN1420 PN16，壁厚 10mm，材质：碳钢 Q235 DN1420 PN16, wall thickness 10 mm, material: carbon steel Q235	米 m	6
12	焊接钢板（弯头至立管段）	Q235，板厚按设计（××mm）；用于 DN1400 管道弯头至立管段（裸管段）	m² m²	约 30

序号 No.	名称 Description	规格/型号 Specification/Model	单位 Unit	数量 Quantity
	Welded steel plates (elbow-to-riser)	外壁加固，下料尺寸按现场实测及排版图，约 30m² Q235, plate thickness per design (×× mm); for external reinforcement of the DN1400 elbow-to-riser (bare-pipe) section, cutting dimensions per site measurement and layout, ~30 m²		
13	电焊机 electric welder		台	2

附录 B 乙方主要施工工器具清单

Appendix B List of Main Tools and Instruments Provided by Party B

除附录 A 所列甲供物资外，乙方应自备（或自行租赁）下列主要施工工器具、检测仪器及安全防护用品，并确保其完好、检定（检验）合格且在有效期内。

In addition to the Party-A-supplied materials in Appendix A, Party B shall provide (or lease) the following main construction tools, testing instruments and PPE, and ensure they are in good condition, calibrated/inspected as qualified and within validity.

表 B-1 乙方主要施工工器具清单

Table B-1 List of Main Tools and Instruments Provided by Party B

序号 No.	工器具名称 Tool/Instrument Name	规格/要求 Specification/Requirement	数量 Quantity
1	锚杆拉力计（数显拉拔仪） Anchor pull-out tester (digital)	量程满足 M27 锚栓设计抗拔力，进场时提供有效计量检定证书并报验 Range covering the M27 design pull-out force; valid metrological calibration certificate submitted for incoming inspection	1 套 1 set
2	沥青加热锅（熔沥青设备） Asphalt heating kettle	带控温温度计，控温 160～180℃ With temperature control, 160–180℃	1 套 1 set
3	脚手架/作业平台 Scaffolding/working platform	验收合格挂牌后使用 Use after acceptance and tagging	按需 As required

附录 C 施工记录与竣工资料清单

Appendix C List of Construction Records and As-built Documents

乙方应在施工过程中及时填写、整理下列记录与资料，竣工时向甲方提交（纸质版 2 套并签字盖章齐全，同时提交 PDF 电子版）存档：

Party B shall promptly complete and organize the following records and documents during construction, and submit them to Party A at completion (two signed and stamped hard copies, together with PDF electronic versions) for filing:

（1）甲供物资进场验收记录（含出厂合格证、质量证明书、检测报告核对）；

(1) Incoming inspection records of Party-A-supplied materials (including verification of factory certificates, quality certificates and test reports);

（2）现场勘查及尺寸复核记录；

(2) Site survey and dimension verification records;

（3）混凝土基面处理检查记录；

(3) Concrete base surface preparation inspection records;

（4）钢套管制作、包覆安装记录（切割、排版、拼缝、贴合、焊接）；

(4) Steel sleeve fabrication and wrapping/installation records (cutting, layout, splices, fit, welding);

（5）混凝土本体钢板加固及弯头至立管段钢板焊接施工记录（钢板下料、贴装、焊接、无损检测及防腐补涂记录）；

(5) Construction records of the concrete-body steel-plate reinforcement and the elbow-to-riser steel-plate welding (plate cutting, fitting, welding, NDT and touch-up coating records);

（6）植筋钻孔及化学锚固施工记录（锚栓编号、孔位、孔径、孔深、清孔、植筋胶批号、固化条件）；

(6) Drilling and chemical anchoring records (anchor number, position, hole diameter/depth, cleaning, adhesive batch, curing conditions);

（7）植筋胶（化学锚栓）拉力/抗拔试验报告（由乙方出具，试验人、审核人签字并盖章）；

(7) Rebar-adhesive (chemical anchor) pull-out test report (issued by Party B, signed by the tester and reviewer and stamped);

（8）加固设计/强度校核文件（复合结构安全系数≥3.0）；

(8) Reinforcement design/strength verification documents (composite structural safety factor ≥3.0);

（9）防水沥青浇注、麻绳密封及隐蔽工程验收记录（含影像资料）；

(9) Asphalt pouring, hemp-rope sealing and hidden-work acceptance records (including photos/videos);

（10）环氧树脂漆防腐涂装记录（除锈等级、涂装道数、干膜厚度）；

(10) Epoxy anti-corrosion coating records (derusting grade, number of passes, dry-film thickness);

（11）养护记录及渗漏检查/试验记录；

(11) Curing records and leakage inspection/test records;

（12）竣工图、三级自检记录、验收报告及施工总结。

(12) As-built drawings, three-level self-inspection records, acceptance report and construction summary.

附录 D 参考资料

Appendix D Reference Materials

（1）《工业金属管道设计规范》（GB 50316）；

(1) Design Code for Industrial Metallic Piping (GB 50316);

（2）《混凝土结构加固设计规范》（GB 50367）；

(2) Design Code for Strengthening Concrete Structures (GB 50367);

（3）《钢结构工程施工质量验收标准》（GB 50205）；

(3) Standard for Acceptance of Construction Quality of Steel Structures (GB 50205);

（4）《建筑结构加固工程施工质量验收规范》（GB 50550）；

(4) Code for Acceptance of Construction Quality of Building Structure Reinforcement (GB 50550);

（5）《工业设备及管道防腐蚀工程施工规范》（GB 50212）；

(5) Code for Construction of Anticorrosion Engineering of Industrial Equipment and Pipelines (GB 50212);

（6）《混凝土结构后锚固技术规程》（JGJ 145）；

(6) Technical Specification for Post-installed Anchors in Concrete Structures (JGJ 145);

（7）《工程结构加固材料安全性鉴定技术规范》（GB 50728）；

(7) Technical Code for Safety Identification of Retrofitting Materials in Engineering Structures (GB 50728);

（8）#3 机组循环水系统竣工图纸及现场勘查记录。

(8) As-built drawings of the Unit 3 circulating water system and site survey records.

附录 E 施工人员配置及用工表

Appendix E Labour and Personnel Allocation

乙方应按下列工种及数量配置现场施工人员（高峰期/连续施工配置），特种作业人员必须持证上岗；人员配置应与表 4-1 进度相匹配，可按工序高峰动态调整，但竣工日期不得突破 2026 年 11 月 15 日。

Party B shall staff the site with the following trades and numbers (peak/continuous-construction configuration); special-operation personnel must hold valid certificates. The staffing shall match the schedule in Table 4-1 and may be adjusted dynamically with the process peaks, but completion shall not extend beyond November 15, 2026.

表 E-1 施工人员配置（用工）表

Table E-1 Construction Personnel (Labour) Allocation

序号 No.	工种 Trade	人数 No.	岗位职责 Responsibility	备注 Remarks
1	项目负责人 Project manager	1	全面负责施工组织、协调，安全生产与质量第一责任人 Overall organization and coordination; first responsible for safety and quality	总工期 20 天 The total construction period is 20 days.
2	焊工（持证） Welder (certified)	3	钢套管拼接及弯头至立管段约 30m²钢板焊接 Sleeve splice welding and ~30 m² elbow-to-riser plate welding	持有效合格证 Valid welding certificate
3	普工 General labourer	4	材料加工、搬运、现场清理及辅助作业 Material handling, site cleaning and assistance	
	合计 Total	8	高峰期合计 8 人，可按工序错峰或两班制动态调配 8 at peak; may be staggered or split into	

序号 No.	工种 Trade	人数 No.	岗位职责 Responsibility	备注 Remarks
			two shifts per process	

（1）焊工、电工、架子工、起重工等特种作业人员必须持有效证件上岗；焊工须具备相应钢材材质与焊接位置的资格。

(1) Special-operation personnel (welders, electricians, scaffolders, riggers) must hold valid certificates; welders must be qualified for the relevant steel material and welding position.