



Cladding-Technology-Shanxi-Co.,-Ltd- CLADDING-ITP-004-Cladding-Reducer- ITP

检验与试验计划（ITP）

Inspection and Test Plan (ITP)

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Inspection and Test Plan for Concentric/Eccentric Forming of Welded Reducers	
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1. 目的 Purpose

本检验与试验计划旨在规范科雷丁技术（山西）有限公司在堆焊异径管同心/偏心成形过程中的质量控制活动，明确各工序的检验项目、检验方法、检验频次、合格标准及记录要求，确保堆焊异径管产品的几何精度、堆焊层质量及力学性能满足设计要求和相关标准规定。

This Inspection and Test Plan is established to standardize the quality control activities during the concentric and eccentric forming process of welded reducers at CLADDING-Technology-Shanxi-Co.,-Ltd, specifying inspection items, inspection methods, inspection frequency, acceptance criteria and documentation requirements for each process, ensuring that the geometric accuracy, weld overlay quality and mechanical properties of welded reducer products meet design requirements and relevant standard specifications.

2. 适用范围 Scope

本计划适用于公司采用 TIG 堆焊、MIG 堆焊及电弧增材制造工艺，对碳钢、合金钢、不锈钢等材质的异径管进行同心或偏心堆焊成形作业的全过程检验与试验管理，涵盖原材料入厂检验、堆焊前准备检验、堆焊过程检验、堆焊后成形检验、无损检测、力学性能试验及最终出厂检验。

This plan applies to the inspection and test management throughout the entire process of concentric or eccentric weld overlay forming operations on reducers made of carbon steel, alloy steel, stainless steel and other materials, using TIG welding overlay, MIG welding overlay and arc additive manufacturing processes, covering incoming material inspection, pre-welding preparation inspection, in-process welding inspection, post-weld forming inspection, non-destructive testing, mechanical property testing and final delivery inspection.

3. 职责 Responsibilities

部门 Department	职责 Responsibilities
质量部 Quality Department	负责本计划的编制、修订与解释；组织并实施各项检验与试验活动；审核检验记录与试验报告；对不合格品进行判定与处置
Responsible for the preparation, revision and interpretation of this plan; organizing and	



implementing various inspection and test activities; reviewing inspection records and test reports; determining and disposing of non-conforming products	
技术部 Technical Department	负责提供堆焊工艺规程、焊接工艺评定报告（WPS/PQR）；确定堆焊层厚度、稀释率等技术参数；参与不合格品的技术分析与处理
Responsible for providing welding procedure specifications and welding procedure qualification records; determining technical parameters such as weld overlay thickness and dilution rate; participating in technical analysis and handling of non-conforming products	
生产部 Production Department	负责按工艺规程执行堆焊作业；配合质量部完成过程检验；对检验发现的不合格项进行整改
Responsible for executing welding overlay operations according to procedure specifications; cooperating with Quality Department to complete in-process inspections; rectifying non-conformities identified during inspections	
设备部 Equipment Department	负责堆焊设备、检测设备的维护保养与校准；确保设备处于良好状态
Responsible for maintenance and calibration of welding equipment and testing equipment; ensuring equipment is in good condition	

4. 检验与试验项目 Inspection and Test Items

4.1 原材料入厂检验 Incoming Material Inspection

序号 No.	检验项目 Inspection Item	检验方法 Inspection Method	检验频次 Inspection Frequency	合格标准 Acceptance Criteria	记录记录 Record
1	基材化学成分 Chemical	光谱分析 Spectral	每批次每炉号 Each batch and	符合 GB/T 3077 或材料标	材料质保书 Material



	composition of base material	analysis	heat number	准要求 Meet GB/T 3077 or material standard requirements	certificate
2	基材力学性能 Mechanical properties of base material	拉伸试验 Tensile test	每批次 Each batch	符合材料标准要求 Meet material standard requirements	力学性能报告 Mechanical property report
3	焊丝/焊材化学成分 Chemical composition of welding wire	光谱分析 Spectral analysis	每批次 Each batch	符合焊材标准要求 Meet welding material standard requirements	焊材质保书 Welding material certificate
4	焊丝/焊材外观检查 Appearance inspection of welding wire	目视检查 Visual inspection	每批次 Each batch	无锈蚀、油污、机械损伤 No rust, oil contamination, mechanical damage	入厂检验记录 Incoming inspection record
5	保护气体纯度 Purity of shielding gas	气体纯度检测 Gas purity testing	每批次 Each batch	氩气纯度 $\geq 99.99\%$ Argon purity $\geq 99.99\%$	气体检验报告 Gas test report

4.2 堆焊前准备检验 Pre-welding Preparation Inspection

序号 No.	检验项目 Inspection Item	检验方法 Inspection Method	检验频次 Inspection Frequency	合格标准 Acceptance Criteria	记录 Record
1	基材坡口加工尺寸 Groove dimension of base material	卡尺/量具测量 Caliper/measuring tool measurement	每根 Each piece	符合工艺文件要求 Meet procedure specification requirements	坡口检验记录 Groove inspection record



2	基材表面清洁度 Surface cleanliness of base material	目视检查 Visual inspection	每根 Each piece	坡口及两侧 20mm 范围内无油污、锈蚀、氧化皮 Groove and 20mm on both sides free from oil, rust, oxide scale	清洁度检查记录 Cleanliness inspection record
3	焊接设备参数确认 Welding equipment parameter confirmation	仪表读数检查 Instrument reading check	每班次 Each shift	电流、电压、送丝速度等参数符合 WPS 要求 Current, voltage, wire feed speed meet WPS requirements	设备点检记录 Equipment check record
4	焊接工艺参数确认 Welding procedure parameter confirmation	参数核对 Parameter verification	每根 Each piece	与 WPS/PQR 一致 Consistent with WPS/PQR	工艺参数记录 Process parameter record
5	预热温度 Preheating temperature	测温仪测量 Temperature measurement	每根 Each piece	符合工艺要求（通常 100-200℃） Meet process requirements (typically 100-200℃)	预热记录 Preheating record

4.3 堆焊过程检验 In-process Welding Inspection

序号 No.	检验项目 Inspection Item	检验方法 Inspection Method	检验频次 Inspection Frequency	合格标准 Acceptance Criteria	记录 Record
1	层间温度 Interpass	测温仪测量 Temperature	每层 Each	符合工艺要求（通常	层间温度记



	temperature	measurement	layer	$\leq 250^{\circ}\text{C}$) Meet process requirements (typically $\leq 250^{\circ}\text{C}$)	录 Interpass temperature record
2	堆焊层外观 Weld overlay appearance	目视检查 Visual inspection	每层 Each layer	无裂纹、气孔、夹渣、未熔合、咬边等缺陷 No cracks, porosity, slag inclusion, lack of fusion, undercut	外观检验记录 Appearance inspection record
3	堆焊层厚度 Weld overlay thickness	超声波测厚仪测量 Ultrasonic thickness gauge measurement	每层 Each layer	符合设计要求（单层厚度 1-3mm） Meet design requirements (single layer thickness 1-3mm)	厚度记录 Thickness record
4	稀释率控制 Dilution rate control	金相分析 Metallographic analysis	每根 Each piece	符合工艺要求 （TIG $\leq 15\%$, MIG $\leq 25\%$ ） Meet process requirements (TIG $\leq 15\%$, MIG $\leq 25\%$)	稀释率报告 Dilution rate report
5	同心/偏心尺寸控制 Concentric/eccentric dimension control	三坐标测量/专用量具 CMM/special measuring tool	每层 Each layer	同心度/偏心量符合设计要求 Concentricity/eccentricity meet design requirements	尺寸检验记录 Dimension inspection record
6	焊接电流电压记录 Welding current and voltage recording	焊接电源数据记录 Welding power source data recording	连续记录 Continuous recording	参数波动在 $\pm 10\%$ 范围内 Parameter fluctuation within $\pm 10\%$	焊接参数记录 Welding parameter record

4.4 堆焊后成形检验 Post-weld Forming Inspection

序号 No.	检验项目 Inspection Item	检验方法 Inspection Method	检验频次 Inspection Frequency	合格标准 Acceptance Criteria	记录 Record
1	成品外径尺寸 Finished outer diameter	卡尺/千分尺测量 Caliper/micrometer	每根 Each piece	符合图纸公差要求 Meet	尺寸检验记录 Dimension



		measurement		drawing tolerance requirements	inspection record
2	成品内径尺寸 Finished inner diameter	内径千分尺测量 Internal micrometer measurement	每根 Each piece	符合图纸公差要求 Meet drawing tolerance requirements	尺寸检验记录 Dimension inspection record
3	同心度/偏心率 Concentricity/eccentricity	三坐标测量/专用 检具 CMM/special gauge	每根 Each piece	同心度 $\leq 0.5\text{mm}$ 或偏 心率符合设计 要求 Concentricity $\leq 0.5\text{mm}$ or eccentricity meets design requirements	同心度检验 记录 Concentricity inspection record
4	堆焊层总厚度 Total weld overlay thickness	超声波测厚仪测量 Ultrasonic thickness gauge measurement	每根 Each piece	符合设计要求（通常 3- 15mm） Meet design requirements (typically 3- 15mm)	厚度检验记录 Thickness inspection record
5	表面粗糙度 Surface roughness	粗糙度仪测量 Roughness tester measurement	每根 Each piece	$Ra \leq 6.3\mu\text{m}$ 或 符合设计要求 $Ra \leq 6.3\mu\text{m}$ or meet design requirements	粗糙度记录 Roughness record
6	直线度/圆度 Straightness/circularity	三坐标测量/专用 量具 CMM/special measuring tool	每根 Each piece	符合图纸要求 Meet drawing requirements	形位公差记录 Geometric tolerance record



4.5 无损检测 Non-destructive Testing

序号 No.	检验项目 Inspection Item	检验方法 Inspection Method	检验频次 Inspection Frequency	合格标准 Acceptance Criteria	记录 Record
1	表面裂纹检测 Surface crack detection	渗透检测 PT Penetrant testing	100%全检 100% inspection	无裂纹缺陷 No crack defects	PT 检测报告 PT test report
2	内部缺陷检测 Internal defect detection	超声波检测 UT Ultrasonic testing	100%全检 100% inspection	无超标缺陷 No defects exceeding acceptance criteria	UT 检测报告 UT test report
3	堆焊层与基材结合检测 Bonding detection between overlay and base	超声波检测 UT Ultrasonic testing	100%全检 100% inspection	无未熔合、分层缺陷 No lack of fusion, lamination defects	UT 检测报告 UT test report
4	射线检测（必要时） Radiographic testing (when required)	RT 射线检测 RT radiographic testing	按设计要求 As required by design	符合 NB/T 47013 标准 Meet NB/T 47013 standard	RT 检测报告 RT test report

4.6 力学性能试验 Mechanical Property Testing

序号 No.	检验项目 Inspection Item	检验方法 Inspection Method	检验频次 Inspection Frequency	合格标准 Acceptance Criteria	记录 Record
1	堆焊层硬度 Weld overlay hardness	布氏/维氏硬度试验 Brinell/Vickers hardness test	每根 Each piece	符合设计要求 Meet design requirements	硬度试验报告 Hardness test report
2	堆焊层化学成	光谱分析	每批次 Each	符合设计要求	化学成分报告



	分 Weld overlay chemical composition	Spectral analysis	batch	Meet design requirements	Chemical composition report
3	弯曲试验 Bend test	横向弯曲试验 Transverse bend test	每批次 Each batch	弯曲 180°无裂纹 Crack-free after 180° bending	弯曲试验报告 Bend test report
4	冲击试验（必要时） Impact test (when required)	夏比冲击试验 Charpy impact test	按设计要求 As required by design	符合设计要求 Meet design requirements	冲击试验报告 Impact test report

4.7 最终出厂检验 Final Delivery Inspection

序号 No.	检验项目 Inspection Item	检验方法 Inspection Method	检验频次 Inspection Frequency	合格标准 Acceptance Criteria	记录 Record
1	外观质量 Appearance quality	目视检查 Visual inspection	100%全检 100% inspection	表面无裂纹、气孔、夹渣等缺陷 Surface free from cracks, porosity, slag inclusion	外观检验记录 Appearance inspection record
2	尺寸精度 Dimensional accuracy	综合尺寸测量 Comprehensive dimension measurement	100%全检 100% inspection	全部尺寸符合图纸要求 All dimensions meet drawing requirements	尺寸检验记录 Dimension inspection record
3	标识标记 Marking	目视检查 Visual inspection	100%全检 100% inspection	标识清晰、正确、完整 Marking clear, correct and complete	标识检查记录 Marking inspection record
4	文件资料审查	文件核对	每批 Each	检验报告齐	出厂检验报告



	Document review	Document verification	batch	全、数据完整 Inspection reports complete with full data	Delivery inspection report
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5. 检验与试验程序 Inspection and Test Procedure

5.1 检验流程 Inspection Flow

第一步：原材料入厂后，质量部依据供应商质保书进行核对，并按本计划 4.1 条款执行入厂检验，检验合格后方可入库使用。

Step 1: After incoming materials arrive, Quality Department shall verify against supplier certificates and execute incoming inspection per Section 4.1 of this plan. Materials may only be stored and used after passing inspection.

第二步：生产部在堆焊作业前，完成基材坡口加工、表面清理及预热等准备工作，质量部按 4.2 条款执行堆焊前准备检验，确认合格后方可开始堆焊。

Step 2: Before welding overlay operations, Production Department shall complete base material groove preparation, surface cleaning and preheating. Quality Department shall execute pre-welding preparation inspection per Section 4.2. Welding overlay may only commence after confirmation of qualification.

第三步：堆焊过程中，操作人员按 WPS 执行作业，质量部按 4.3 条款执行过程检验，重点监控层间温度、堆焊层外观、厚度及同心/偏心尺寸，发现异常立即停止作业并报告。

Step 3: During welding overlay operations, operators shall execute work per WPS. Quality Department shall execute in-process inspection per Section 4.3, focusing on interpass temperature, weld overlay appearance, thickness and concentric/eccentric dimensions. Upon detecting abnormalities, operations shall be immediately stopped and reported.

第四步：堆焊完成后，质量部按 4.4 条款执行成形检验，对成品尺寸、同心度/偏心量、堆焊层厚度等关键参数进行测量，确保符合设计要求。

Step 4: After welding overlay, Quality Department shall execute forming inspection per Section 4.4, measuring key parameters including finished dimensions, concentricity/eccentricity and weld overlay thickness to ensure compliance with design requirements.

第五步：按 4.5 条款执行无损检测，对堆焊层表面及内部质量进行全面检测，确保无超标缺陷。



Step 5: Execute non-destructive testing per Section 4.5, conducting comprehensive inspection of weld overlay surface and internal quality to ensure no defects exceeding acceptance criteria.

第六步：按 4.6 条款执行力学性能试验，验证堆焊层的硬度、化学成分及力学性能满足设计要求。

Step 6: Execute mechanical property testing per Section 4.6, verifying that weld overlay hardness, chemical composition and mechanical properties meet design requirements.

第七步：所有检验与试验项目完成后，质量部按 4.7 条款执行最终出厂检验，汇总各项检验记录，出具出厂检验报告，经质量负责人签字确认后方可出厂。

Step 7: After of all inspection and test items, Quality Department shall execute final delivery inspection per Section 4.7, consolidate all inspection records, issue delivery inspection report, and products may only be released after signature confirmation by Quality Manager.

5.2 不合格品控制 Non-conforming Product Control

1. 2.1 检验过程中发现的不合格品，质量部应立即标识隔离，填写《不合格品处置单》，通知技术部和生产部。
2. 2.1 Non-conforming products identified during inspection shall be immediately marked and isolated by Quality Department, with a Non-conforming Product Disposition Form completed and Technical Department and Production Department notified.
3. 2.2 技术部对不合格品进行原因分析，提出返工、返修或报废处置方案。
4. 2.2 Technical Department shall conduct root cause analysis of non-conforming products and propose rework, repair or scrap disposition plans.
5. 2.3 返工返修后，必须重新执行相关检验与试验项目，合格后方可放行。
6. 2.3 After rework or repair, relevant inspection and test items shall be re-executed. Products may only be released after passing inspection.
7. 2.4 不合格品处置记录应纳入产品质量档案，作为质量改进的依据。
8. 2.4 Non-conforming product disposition records shall be included in product quality files as basis for quality improvement.

5.3 检验记录管理 Inspection Record Management

9. 3.1 所有检验与试验记录应真实、准确、完整，由检验人员当场填写并签字确认。
10. 3.1 All inspection and test records shall be truthful, accurate and complete, filled in by inspectors on-site and signed for confirmation.
11. 3.2 检验记录保存期限不少于产品质保期，质保期结束后至少保存 10 年。
12. 3.2 Inspection records shall be retained for no less than the product warranty period, and at least 10 years after the warranty period expires.



13. 3.3 检验记录由质量部统一归档管理，建立台账索引，便于追溯查询。
14. 3.3 Inspection records shall be uniformly archived and managed by Quality Department, with ledger index established for traceability and inquiry.

6. 监督考核 Supervision and Assessment

15. 1 质量部每月对本计划的执行情况进行检查，检查内容包括检验项目执行率、检验记录完整性、不合格品处置及时性等。
16. 1 Quality Department shall conduct monthly inspection of this plan's execution, including inspection item execution rate, inspection record completeness and non-conforming product disposition timeliness.
17. 2 对未按要求执行检验与试验活动的部门和个人，按公司《质量奖惩管理制度》进行考核。
18. 2 Departments and individuals failing to execute inspection and test activities as required shall be assessed per the company's Quality Reward and Punishment Management .
19. 3 因检验与试验不到位导致质量事故的，追究相关责任人责任，并按公司规定处理。
20. 3 Quality accidents caused by inadequate inspection and testing shall result in accountability of responsible personnel, handled per company regulations.

7. 附则 Supplementary Provisions

21. 1 本计划由质量部负责解释和修订。
22. 1 This plan shall be interpreted and revised by Quality Department.
23. 2 本计划自批准之日起生效，原有相关检验规定同时废止。
24. 2 This plan shall take effect from the date of approval, and previous related inspection regulations shall be simultaneously abolished.
25. 3 本计划每年评审一次，根据标准更新、工艺改进及实际执行情况适时修订。
26. 3 This plan shall be reviewed annually and revised as appropriate based on standard updates, process improvements and actual execution status.
27. 4 本计划未尽事宜，按国家相关标准及公司质量管理体系文件执行。
28. 4 Matters not covered in this plan shall be executed per relevant national standards and company quality management documents.

相关文件 Related Documents:

- CLADDING-WPS-001 堆焊焊接工艺规程 Welding Procedure Specification for Weld Overlay
- CLADDING-QP-001 不合格品控制程序 Non-conforming Product Control Procedure



- CLADDING-QP-002 检验与试验控制程序 Inspection and Test Control Procedure

相关记录 Related Records:

- CLADDING-FM-001 入厂检验记录 Incoming Inspection Record
- CLADDING-FM-002 过程检验记录 In-process Inspection Record
- CLADDING-FM-003 成品检验记录 Finished Product Inspection Record
- CLADDING-FM-004 不合格品处置单 Non-conforming Product Disposition Form
- CLADDING-FM-005 出厂检验报告 Delivery Inspection Report