



Cladding-Technology-Shanxi-Co.,-Ltd- CLADDING-ITP-012-Cladding-Valve- Sealing-Surface-ITP

ITP 阀门密封面堆焊检验与试验计划

ITP Valve Sealing Surface Cladding Inspection and Test Plan

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1. 目的 Purpose

本检验与试验计划（ITP）旨在规范科雷丁技术（山西）有限公司阀门密封面堆焊作业全过程的质量控制要求，明确堆焊层化学成分、硬度、无损检测与密封试验的检验项目、检验方法、验收标准及责任分工，确保阀门密封面堆焊质量满足客户技术要求及行业相关标准，实现产品质量的可追溯性与一致性控制。

This Inspection and Test Plan (ITP) is established to standardize the quality control requirements throughout the valve sealing surface cladding operation at CLADDING-Technology-Shanxi-Co.,-Ltd, clearly defining inspection items, inspection methods, acceptance criteria and responsibility assignments for cladding layer chemical composition, hardness, non-destructive testing



and sealing test, ensuring that the valve sealing surface cladding quality meets customer technical requirements and relevant industry standards, achieving traceability and consistency control of product quality.

2. 适用范围 Scope of Application

本 ITP 适用于科雷丁技术（山西）有限公司承接的各类阀门密封面堆焊项目，包括但不限于以下产品：

This ITP applies to all types of valve sealing surface cladding projects undertaken by CLADDING-Technology-Shanxi-Co.,-Ltd, including but not limited to the following products:

- 闸阀密封面堆焊 Gate valve sealing surface cladding
- 球阀密封面堆焊 Ball valve sealing surface cladding
- 截止阀密封面堆焊 Globe valve sealing surface cladding
- 蝶阀密封面堆焊 Butterfly valve sealing surface cladding
- 止回阀密封面堆焊 Check valve sealing surface cladding
- 各类工况阀门密封面修复堆焊 Cladding repair for sealing surfaces of valves under various operating conditions

适用堆焊工艺包括 TIG 堆焊（钨极惰性气体保护堆焊）和 MIG 堆焊（熔化极惰性气体保护堆焊），堆焊材料涵盖钴基合金（Stellite 系列）、镍基合金（Inconel 系列）、铁基合金及硬质合金等。

Applicable cladding processes include TIG cladding (Tungsten Inert Gas cladding) and MIG cladding (Metal Inert Gas cladding), cladding materials cover cobalt-based alloys (Stellite series), nickel-based alloys (Inconel series), iron-based alloys and hard alloys, etc.

3. 职责 Responsibilities

| 角色 Role | 职责 Responsibility |

| 质量工程师 Quality Engineer | 编制并维护本 ITP 文件；组织检验与试验的实施；审核检验记录；向客户提交质量证明文件 |

| 焊接工程师 Welding Engineer | 编制焊接工艺规程（WPS）；指导堆焊作业；确认工艺参数符合性；参与不合格品评审 |

| 堆焊操作工 Cladding Operator | 按 WPS 要求执行堆焊作业；执行自检并记录；配合检验人员完成各项检验 |

| 无损检测人员 NDT Personnel | 按本 ITP 要求执行外观检查、渗透检测、磁粉检测等无损检测；出具检测报告 |



| 理化检验人员 Physical-Chemical Inspector | 执行化学成分分析、硬度测试；出具理化检验报告 |

| 质量检验员 Quality Inspector | 执行密封试验；审核各项检验结果；签署最终放行意见 |

| 客户代表 Customer Representative | 见证关键检验项目；确认验收结果 |

4. 管理内容与程序 Management Content and Procedures

4.1 检验与试验流程总览 Overview of Inspection and Test Process

阀门密封面堆焊质量控制按照以下流程执行：

Valve sealing surface cladding quality control shall be executed according to the following process:

| 序号 No. | 检验阶段 Inspection Stage | 检验项目 Inspection Item | 检验时机 Inspection Timing | 检验方法 Inspection Method | 验收标准 Acceptance Criteria | 记录文件 Record Document | 责任方 Responsible Party | 见证方 Witness Party |

| 1 | 焊前准备 Pre-weld Preparation | 母材化学成分确认 Base material chemical composition confirmation | 堆焊前 Before cladding | 光谱分析/化学分析 Spectral analysis/Chemical analysis | 符合母材标准要求 Meet base material standard requirements | 材料检验报告 Material Inspection Report | 质量工程师 Quality Engineer | 客户代表 Customer Representative |

| 2 | 焊前准备 Pre-weld Preparation | 堆焊材料确认 Cladding material confirmation | 堆焊前 Before cladding | 材料证书核查 Material certificate verification | 符合 WPS 规定 Meet WPS requirements | 材料证书 Material Certificate | 焊接工程师 Welding Engineer | — |

| 3 | 焊前准备 Pre-weld Preparation | 坡口加工与清洁检查 Groove machining and cleaning inspection | 堆焊前 Before cladding | 目视检查 Visual inspection | 坡口尺寸符合图纸；表面无油污、氧化皮 Groove dimensions meet drawing; surface free from oil, oxide scale | 焊前检查记录 Pre-weld Inspection Record | 堆焊操作工 Cladding Operator | 质量检验员 Quality Inspector |

| 4 | 焊接过程 Welding Process | 焊接工艺参数监控 Welding process parameter monitoring | 堆焊过程中 During cladding | 设备参数记录 Equipment parameter recording | 电流、电压、速度符合 WPS Current, voltage, speed meet WPS | 焊接参数记录表 Welding Parameter Record | 堆焊操作工 Cladding Operator | 焊接工程师 Welding Engineer |

| 5 | 焊接过程 Welding Process | 层间温度控制 Interpass temperature control | 堆焊过程中 During cladding | 测温仪测量 Temperature measurement | 符合 WPS 规定温度范围 Meet WPS specified temperature range | 焊接参数记录表 Welding Parameter Record | 堆焊操作工 Cladding Operator | — |



| 6 | 焊后检验 Post-weld Inspection | 外观检查 Visual inspection | 堆焊完成后 Immediately after cladding | 目视检查+放大镜检查 Visual inspection + magnifying glass inspection | 无裂纹、气孔、夹渣、咬边；堆焊层高度、宽度符合图纸 No cracks, porosity, slag inclusion, undercut; cladding layer height and width meet drawing | 外观检查记录 Visual Inspection Record | 质量检验员 Quality Inspector | 客户代表 Customer Representative |

| 7 | 焊后检验 Post-weld Inspection | 堆焊层化学成分分析 Cladding layer chemical composition analysis | 堆焊完成后 After cladding | 光谱分析/化学分析法 Spectral analysis/Chemical analysis | 符合堆焊材料标准要求 Meet cladding material standard requirements | 化学成分分析报告 Chemical Composition Analysis Report | 理化检验人员 Physical-Chemical Inspector | 客户代表 Customer Representative |

| 8 | 焊后检验 Post-weld Inspection | 堆焊层硬度测试 Cladding layer hardness test | 堆焊完成后 After cladding | 洛氏硬度计/维氏硬度计 Rockwell/Vickers hardness tester | 符合技术协议规定硬度范围 Meet hardness range specified in technical agreement | 硬度测试报告 Hardness Test Report | 理化检验人员 Physical-Chemical Inspector | 客户代表 Customer Representative |

| 9 | 焊后检验 Post-weld Inspection | 无损检测 Non-destructive testing | 堆焊完成后 After cladding | 渗透检测 PT/磁粉检测 MT Penetrant testing/Magnetic particle testing | 无裂纹、未熔合等线性缺陷 No cracks, lack of fusion and other linear defects | 无损检测报告 NDT Report | 无损检测人员 NDT Personnel | 客户代表 Customer Representative |

| 10 | 焊后检验 Post-weld Inspection | 密封试验 Sealing test | 机加工完成后 After machining | 水压试验/气压试验 Hydrostatic test/Pneumatic test | 无渗漏，保压时间符合要求 No leakage, holding time meets requirements | 密封试验报告 Sealing Test Report | 质量检验员 Quality Inspector | 客户代表 Customer Representative |

| 11 | 最终检验 Final Inspection | 综合质量评审 Comprehensive quality review | 出厂前 Before delivery | 文件审核 Document review | 所有检验项目合格 All inspection items qualified | 质量放行单 Quality Release Certificate | 质量工程师 Quality Engineer | 客户代表 Customer Representative |

4.2 堆焊层化学成分检验 Chemical Composition Inspection of Cladding Layer

4.2.1 检验目的 Inspection Purpose

验证堆焊层化学成分是否符合技术协议及堆焊材料标准要求，确保堆焊层的耐腐蚀性、耐磨性及密封性能满足阀门工况要求。

Verify that the chemical composition of the cladding layer meets the technical agreement and cladding material standard requirements, ensuring that the corrosion resistance, wear resistance and sealing performance of the cladding layer meet the valve operating condition requirements.



4.2.2 检验方法 Inspection Method

化学成分分析采用以下方法之一：

Chemical composition analysis shall adopt one of the following methods:

- 直读光谱分析法（OES）：适用于常规元素快速分析
- 化学湿法分析：适用于精确含量测定及仲裁分析
- X 射线荧光光谱分析（XRF）：适用于无损或微损成分分析

4.2.3 取样要求 Sampling Requirements

取样位置 Sampling Location	取样方法 Sampling Method	取样数量 Sampling Quantity
堆焊层表面 Cladding layer surface	钻取法/车削取样 Drilling/Machining sampling	每个阀门至少 1 个试样 At least 1 specimen per valve
堆焊层截面 Cladding layer cross-section	线切割取样 Wire cutting sampling	按技术协议要求 As required by technical agreement

取样位置应避开焊缝起弧、收弧端部，选择堆焊层均匀区域。

Sampling location shall avoid the arc starting and ending ends of the weld, and select the uniform area of the cladding layer.

4.2.4 验收标准 Acceptance Criteria

堆焊层化学成分验收标准依据技术协议规定执行，常见堆焊材料化学成分要求如下：

The acceptance criteria for cladding layer chemical composition shall be executed according to the technical agreement. The chemical composition requirements for common cladding materials are as follows:

堆焊材料 Cladding Material	C	Cr	Co	Ni	Fe	其他 Others
Stellite 6	0.80-1.20	27.0-32.0	余量 Balance	2.5-4.5	≤5.0	Mo 2.5-3.5; Mn 0.5-1.5
Stellite 12	0.90-1.20	27.0-32.0	余量 Balance	2.5-4.5	≤5.0	Mo 2.5-3.5; Mn 0.5-1.5
Stellite 21	0.80-1.20	27.0-32.0	余量 Balance	2.5-4.5	≤5.0	Mo 2.5-3.5; Mn 0.5-1.5
Inconel 625	≤0.10	20.0-23.0	—	余量 Balance	≤5.0	Mo 8.0-10.0; Nb+Ta 3.15-4.15
Inconel 622	≤0.15	20.0-23.0	—	余量 Balance	≤5.0	Mo 8.0-10.0; Nb+Ta 3.15-4.15

注：以上数值为参考值，实际验收标准以技术协议为准。

Note: The above values are for reference only. The actual acceptance criteria shall be based on the technical agreement.

4.2.5 不合格处理 Non-conformance Handling

化学成分检验不合格时，应：



When chemical composition inspection fails:

- 扩大取样范围进行复验
- 分析不合格原因（材料问题、稀释率过高、工艺参数不当等）
- 由焊接工程师和质量工程师共同评审，确定处置方案
- 必要时进行返工或重新堆焊

4.3 堆焊层硬度检验 Hardness Inspection of Cladding Layer

4.3.1 检验目的 Inspection Purpose

验证堆焊层硬度是否满足技术协议要求，确保阀门密封面具有足够的耐磨性和抗擦伤性能。

Verify that the cladding layer hardness meets the technical agreement requirements, ensuring that the valve sealing surface has sufficient wear resistance and anti-galling performance.

4.3.2 检验方法 Inspection Method

硬度测试采用以下方法：

Hardness testing shall adopt the following methods:

- 洛氏硬度测试（HRC）：适用于堆焊层厚度 $\geq 6\text{mm}$ 的情况
- 维氏硬度测试（HV）：适用于堆焊层厚度较薄或精确硬度测定的情况
- 布氏硬度测试（HB）：适用于粗晶粒堆焊材料

4.3.3 测试位置与数量 Test Location and Quantity

| 阀门规格 Valve Size | 测试点数 Test Points | 测试位置 Test Location |

| $\text{DN} \leq 100$ | 不少于 3 点 Not less than 3 points | 密封面均匀分布 Evenly distributed on sealing surface |

| $\text{DN} 100 \sim 300$ | 不少于 8 点 Not less than 8 points | 密封面均匀分布 Evenly distributed on sealing surface |

测试点应避开焊缝边缘及起收弧位置，各测试点间距不小于 3mm。

Test points shall avoid the weld edge and arc starting/ending positions, and the distance between test points shall not be less than 3mm.

4.3.4 验收标准 Acceptance Criteria

堆焊层硬度验收标准依据技术协议规定执行，常见堆焊材料硬度要求如下：

The acceptance criteria for cladding layer hardness shall be executed according to the technical agreement. The hardness requirements for common cladding materials are as follows:

| 堆焊材料 Cladding Material | 硬度要求 Hardness Requirement |



Stellite 6	HRC 40-50 / HV 400-500
Stellite 12	HRC 40-50 / HV 400-500
Stellite 21	HRC 40-50 / HV 400-500
Inconel 625	HB 180-220 / HV 190-240
Inconel 622	HB 180-220 / HV 190-240

硬度值应在规定范围内，单点硬度值允许超出规定范围 $\pm 10\%$ ，但平均值必须满足要求。

The hardness value shall be within the specified range. A single point hardness value is allowed to exceed the specified range by $\pm 10\%$, but the average value must meet the requirement.

4.4 无损检测 Non-Destructive Testing

4.4.1 检验目的 Inspection Purpose

检测堆焊层及堆焊层与母材结合处是否存在裂纹、未熔合、气孔、夹渣等缺陷，确保堆焊质量满足密封性能要求。

Detect whether there are defects such as cracks, lack of fusion, porosity, slag inclusion in the cladding layer and the joint between the cladding layer and the base material, ensuring that the cladding quality meets the sealing performance requirements.

4.4.2 外观检查 Visual Inspection

外观检查为必检项目，应在堆焊完成后立即进行。

Visual inspection is a mandatory item and shall be carried out immediately after cladding.

| 检查项目 Inspection Item | 验收标准 Acceptance Criteria |

| 裂纹 Cracks | 不允许 Not allowed |

| 气孔 Porosity | 单孔直径 $\leq 1\text{mm}$ ，每 100mm^2 面积内不超过 3 个 Single pore diameter $\leq 1\text{mm}$, not more than 3 per 100mm^2 area |

| 夹渣 Slag inclusion | 不允许 Not allowed |

| 咬边 Undercut | 深度 $\leq 0.5\text{mm}$ ，连续长度 $\leq 50\text{mm}$ Depth $\leq 0.5\text{mm}$, continuous length $\leq 50\text{mm}$ |

| 堆焊层高度 Cladding layer height | 符合图纸要求，偏差 $\pm 0.5\text{mm}$ Meet drawing requirements, deviation $\pm 0.5\text{mm}$ |

| 堆焊层宽度 Cladding layer width | 符合图纸要求，偏差 $\pm 1\text{mm}$ Meet drawing requirements, deviation $\pm 1\text{mm}$ |

| 表面粗糙度 Surface roughness | $R_a \leq 6.3\mu\text{m}$ （堆焊态） $R_a \leq 6.3\mu\text{m}$ (as-clad condition) |

4.4.3 渗透检测 Penetrant Testing (PT)

渗透检测适用于检测堆焊层表面开口缺陷。



Penetrant testing is applicable for detecting surface-breaking defects in the cladding layer.

| 项目 Item | 要求 Requirement |

| 检测方法 Detection method | 液体渗透检测（荧光法或着色法） Liquid penetrant testing (fluorescent or dye method) |

| 检测标准 Test standard | GB/T 18851 或 ISO 3452 GB/T 18851 or ISO 3452 |

| 检测比例 Inspection ratio | 100%全检 100% full inspection |

| 验收等级 Acceptance level | 不允许线性显示；圆形显示直径 $\leq 1.5\text{mm}$ No linear indications allowed; circular indication diameter $\leq 1.5\text{mm}$ |

| 人员资质 Personnel qualification | 持有 II 级及以上渗透检测资格证书 Hold II level or above PT qualification certificate |

4.4.4 磁粉检测 Magnetic Particle Testing (MT)

磁粉检测适用于检测铁磁性堆焊材料及堆焊层与母材结合处的表面及近表面缺陷。

Magnetic particle testing is applicable for detecting surface and near-surface defects in ferromagnetic cladding materials and the joint between the cladding layer and the base material.

| 项目 Item | 要求 Requirement |

| 检测方法 Detection method | 连续法磁粉检测 Continuous method magnetic particle testing |

| 检测标准 Test standard | GB/T 15822 或 ISO 9934 GB/T 15822 or ISO 9934 |

| 检测比例 Inspection ratio | 100%全检 100% full inspection |

| 验收等级 Acceptance level | 不允许线性显示；圆形显示直径 $\leq 1.5\text{mm}$ No linear indications allowed; circular indication diameter $\leq 1.5\text{mm}$ |

| 人员资质 Personnel qualification | 持有 II 级及以上磁粉检测资格证书 Hold II level or above MT qualification certificate |

4.5 密封试验 Sealing Test

4.5.1 检验目的 Inspection Purpose

验证阀门密封面堆焊及机加工后的密封性能，确保阀门在额定工况下无渗漏，满足密封等级要求。

Verify the sealing performance of the valve sealing surface after cladding and machining, ensuring that the valve has no leakage under rated operating conditions and meets the sealing class requirements.

4.5.2 试验条件 Test Conditions

密封试验应在阀门机加工完成后进行，试验前确认：



Sealing test shall be carried out after valve machining is completed. Before the test, confirm:

- 堆焊层及母材各项检验合格
- 密封面机加工尺寸符合图纸要求
- 密封面表面粗糙度达到 $Ra \leq 1.6\mu m$
- 阀门装配完整，无松动

4.5.3 水压试验 Hydrostatic Test

| 项目 Item | 要求 Requirement |

| 试验介质 Test medium | 清洁水 Clean water |

| 试验压力 Test pressure | 1.5 倍公称压力 (PN) 1.5 times nominal pressure (PN) |

| 保压时间 Holding time | 不少于 5 分钟 Not less than 5 minutes |

| 验收标准 Acceptance criteria | 无渗漏、无可见变形 No leakage, no visible deformation |

| 环境温度 Ambient temperature | $5^{\circ}C-40^{\circ}C$ |

4.5.4 气压试验 Pneumatic Test

| 项目 Item | 要求 Requirement |

| 试验介质 Test medium | 干燥压缩空气 Dry compressed air |

| 试验压力 Test pressure | 1.1 倍公称压力 (PN) 1.1 times nominal pressure (PN) |

| 保压时间 Holding time | 不少于 3 分钟 Not less than 3 minutes |

| 验收标准 Acceptance criteria | 无渗漏（肥皂水检漏无气泡） No leakage (no bubbles in soap solution leak test) |

| 环境温度 Ambient temperature | $5^{\circ}C-40^{\circ}C$ |

4.5.5 密封等级 Sealing Class

阀门密封等级依据 API 598 或 GB/T 13927 标准执行，常见密封等级要求如下：

Valve sealing class shall be executed according to API 598 or GB/T 13927 standard. The sealing class requirements are as follows:

| 密封等级 Sealing Class | 允许泄漏率 Allowable Leakage Rate |

| Class I | 按 API 598 Class I 标准 Per API 598 Class I standard |

| Class II | 按 API 598 Class II 标准 Per API 598 Class II standard |

| Class III | 按 API 598 Class III 标准 Per API 598 Class III standard |

| Class IV | 按 API 598 Class IV 标准 Per API 598 Class IV standard |

| Class V | 按 API 598 Class V 标准 Per API 598 Class V standard |



| Class VI | 按 API 598 Class VI 标准（零泄漏） Per API 598 Class VI standard (zero leakage)

5. 监督考核 Supervision and Assessment

5.1 检验记录管理 Inspection Record Management

所有检验与试验记录应真实、完整、可追溯，记录内容包括：

All inspection and test records shall be authentic, complete and traceable. Record contents include:

- 产品标识（阀门型号、规格、数量）
- 检验日期及检验人员
- 检验方法及设备信息
- 检验数据及结果
- 验收结论
- 不合格品处理记录

5.2 质量考核 Quality Assessment

| 考核项目 Assessment Item | 考核标准 Assessment Criteria | 考核周期 Assessment Period |

| 检验项目完成率 Inspection item rate | 100% | 每月 Monthly |

| 一次检验合格率 First-time inspection pass rate | $\geq 95\%$ | 每月 Monthly |

| 客户投诉率 Customer complaint rate | $\leq 1\%$ | 每季度 Quarterly |

| 不合格品处理及时率 Non-conformance handling timeliness | 100% | 每月 Monthly |

5.3 持续改进 Continuous Improvement

质量工程师应定期汇总分析检验数据，识别质量改进机会，提出改进措施并跟踪验证。

The quality engineer shall periodically summarize and analyze inspection data, identify quality improvement opportunities, propose improvement measures and track verification.

6. 附则 Supplementary Provisions

6.1 相关文件 Related Documents

| 文件编号 Document No. | 文件名称 Document Name |

| CLADDING-WPS-001 | 阀门密封面 TIG 堆焊焊接工艺规程 |

| CLADDING-WPS-002 | 阀门密封面 MIG 堆焊焊接工艺规程 |



CLADDING-QP-001	质量检验管理程序
CLADDING-QP-002	不合格品控制程序
CLADDING-QP-003	纠正和预防措施控制程序

6.2 参考标准 Reference Standards

标准编号 Standard No.	标准名称 Standard Name
GB/T 19453	增材制造 术语
GB/T 18851	无损检测 渗透检测
GB/T 15822	无损检测 磁粉检测
GB/T 13927	工业阀门 压力试验
API 598	阀门检验与试验
ISO 9934	无损检测 磁粉检测
ISO 3452	无损检测 渗透检测
ISO 5817	焊接 融合焊接的缺陷等级

6.3 文件修订记录 Revision History

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