Metal Visual Testing (VT) Services

Technical Specification & Engineering Procurement Manual

> **Overview:** Visual Testing (VT) is the most fundamental, cost-effective, and widely utilized Non-Destructive Testing (NDT) method. It serves as the primary line of defense in quality control, ensuring that structural anomalies, surface defects, and dimensional deviations are identified before subsequent NDT methods or service deployment.

1. Visual Testing Methodologies

Visual inspection is categorized into two core execution methodologies based on component accessibility:

- **Direct Visual Testing:** Conducted when the inspector's eye can be placed within 24 inches (610 mm) of the surface being examined, at an angle not less than 30 degrees to the surface. Natural or artificial illumination must meet strict minimum intensity thresholds.
- **Remote Visual Testing (RVT):** Utilized when direct access is restricted by geometry, safety hazards, or confined space limitations. Employs optical aids such as borescopes, fiberscopes, videoscopes, mirrors, and robotic pan-tilt-zoom cameras to transfer high-resolution imagery to the inspector.

2. Industrial Applications & Equipment Matrix

Inspection Target	Common Visual Anomalies Detected	Critical Tools & Gauges Used
Structural Welds	Undercut, porosity, surface cracks, slag inclusions, excess reinforcement, misalignment.	Bridge Cam gauge, Hi-Lo welding gauge, fillet weld gauges, magnifying loupes.
Castings & Forgings	Cold shuts, surface blowholes, scale inclusions, parting line defects, hot tears.	Linear scales, contour templates, optical comparators.
Process Piping & Pressure Vessels	Internal corrosion, pitting, erosion-corrosion, structural deformation, mechanical damage.	Flexible digital videoscopes, pit depth gauges, laser profilers.
Bolted & Fastened Joints	Thread wear, deformation, lack of engagement, washer torque slip marks.	Calibrated torque wrenches, thread pitch gauges, calipers.

3. Standard Operating Procedure (SOP) Framework

A certified Visual Inspection sequence must adhere to the following steps to ensure audit readiness:

- **Surface Preparation:** The target metal surface must be clean, dry, and completely free of scale, slag, spatter, heavy oil, or thick paint coatings that can obscure surface-breaking defects.
- **Illumination Verification:** Minimum light intensity must be verified using a calibrated light meter. For standard inspections, a minimum of 100 foot-candles (1076 lux) is required; detailed micro-surface checks require a minimum of 250 foot-candles (2691 lux).
- **Geometric Evaluation:** The technician applies specified gauges to measure alignment, Weld Reinforcement Height, Fillet Leg Length, and throat dimensions against design drawings.
- **Discontinuity Assessment:** Surface indications are categorized as relevant or non-relevant, and dimensions (length, width, depth) are documented meticulously.
- **Reporting & Verification:** Results are recorded on a formal VT Inspection Report including mapping diagrams or photographic records, signed off by a certified professional.

4. Code Compliance & Personnel Certifications

To establish regulatory compliance and structural validity, VT services must be executed under the following international frameworks:

- **Personnel Qualification:** Inspectors must hold an active certification conforming to **ASNT SNT-TC-1A**, **ANSI/ASNT CP-189**, or **ISO 9712** (Level II or Level III preferred for autonomous sign-off).
- **ASME Section V, Article 9:** Governs mandatory visual examination requirements, procedure qualifications, and report details for pressure equipment.
- **AWS D1.1 / D1.6:** Governs structural steel and stainless steel welding code acceptance criteria.
- **API 510 & API 570:** Establishes visual in-service inspection mandates for pressure vessels and piping networks.

5. Standard Weld Acceptance/Rejection Thresholds

Discontinuity Type	Acceptance Criteria (Typical Structural/ Pressure Application)	Disposition Action
Cracks / Fissures	Zero tolerance; any linear indication is completely unacceptable.	Mandatory reject; grind out and repair.
Undercut	Maximum depth allowed is 1/32 inch (1 mm) or 10% of base metal thickness.	Reject if exceeded; repair by welding.
Surface Porosity	No single pore diameter > 1/16 inch (1.5 mm); max 1 pore cluster per 12 inches of weld.	Reject if exceeded; blend out or weld repair.
Misalignment (High-Low)	Strictly governed by wall thickness; typically max 1/16 inch (1.5 mm) offset.	Engineering review or fit-up rejection.

Document Reference: VT-ENG-PROC-2026. This technical framework outlines generic visual inspection requirements and does not replace site-specific engineering designs or project specification overrides.