PIP VESPMI01
Positive Material Identification Specification
PURPOSE AND USE OF PROCESS INDUSTRY PRACTICES

In an effort to minimize the cost of process industry facilities, this Practice has been prepared from the technical requirements in the existing standards of major industrial users, contractors, or standards organizations. By harmonizing these technical requirements into a single set of Practices, administrative, application, and engineering costs to both the purchaser and the manufacturer should be reduced. While this Practice is expected to incorporate the majority of requirements of most users, individual applications may involve requirements that will be appended to and take precedence over this Practice. Determinations concerning fitness for purpose and particular matters or application of the Practice to particular project or engineering situations should not be made solely on information contained in these materials. The use of trade names from time to time should not be viewed as an expression of preference but rather recognized as normal usage in the trade. Other brands having the same specifications are equally correct and may be substituted for those named. All Practices or guidelines are intended to be consistent with applicable laws and regulations including OSHA requirements. To the extent these Practices or guidelines should conflict with OSHA or other applicable laws or regulations, such laws or regulations must be followed. Consult an appropriate professional before applying or acting on any material contained in or suggested by the Practice.

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Data Form
VESPMI01-F - Positive Material Identification Report
1. **Scope**

This Practice provides the minimum Positive Material Identification (PMI) requirements to ensure that only the alloy materials specified in the contract documents are provided in equipment, equipment internals, piping and piping components, and weld consumables.

2. **References**

Applicable parts of the following industry codes and standards shall be considered an integral part of this Practice. The edition in effect on the date of contract award shall be used, except as otherwise noted. Short titles are used herein where appropriate.

**Industry Codes and Standards**

- American Petroleum Institute (API)
  - API RP 578 - *Guidelines for a Material Verification Program (MVP) for New and Existing Assets*
- American Society of Mechanical Engineers (ASME)
  - ASME *Boiler and Pressure Vessel Code*
    - Section II - *Materials, Parts A, B, C*
- American Society for Testing and Materials International (ASTM International)
  - ASTM A751 - *Standard Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products*
- Pipe Fabrication Institute (PFI)
  - PFI Standard ES-22 - *Recommended Practice for Color Coding of Piping Materials*

3. **Definitions**

*alloy material*: Non-ferrous metallic material and ferrous metallic materials containing intentionally added alloying elements (other than carbon)

*equipment*: Pressure vessels, tanks, heat exchangers, heaters, drums, rotating machinery internals, piping and piping components, etc.

*heat*: The amount of a given material produced from a single finishing furnace melt and therefore has consistent chemical and physical properties

*lot*: Number of identical items of a single heat produced at one time, from which a representative sample may be taken

*owner*: Party who owns the facility wherein the equipment and/or piping that requires PMI will be used

*Positive Material Identification (PMI)*: Procedure used to test and evaluate material to confirm that it is the specified material

*purchaser*: Party who awards the contract to the supplier. Purchaser may be the owner or the owner’s authorized agent.
**purchaser’s inspector:** Purchaser’s authorized representative with authority to act in the interest of, and on behalf of, purchaser in all quality assurance matters

**supplier:** Party responsible for providing fabricated equipment and/or piping and performing PMI in accordance with this Practice

### 4. Requirements

#### 4.1 General

4.1.1 PMI is required in addition to mill test reports and shall comply with *API RP 578*.

4.1.2 As a minimum, the PMI shall be performed by the supplier, or a third party contracted by the supplier.

4.1.3 The supplier is responsible for ensuring that the requirements of this Practice and supplemental requirements of the owner are met by supplier’s subcontractors.

4.1.4 The method of testing shall be considered so as not to affect the ability of the component to perform.

4.1.5 The supplier’s subcontractor fabrication schedule shall be provided to the purchaser for the purchaser’s use in scheduling, witnessing and inspection activities.

4.1.6 All aspects of the work shall be in accordance with applicable local, county, state, and federal rules and regulations including but not limited to, the rules and standards established by EPA and OSHA, or applicable national standards at the site where the work is performed.

4.1.7 US customary (English) units shall be used for domestic US locations; metric (SI) units may be shown for reference only and shall not be interpreted as a precise conversion.

#### 4.2 Qualification of Procedures and Personnel

4.2.1 A written PMI program/procedure that is in accordance with this Practice and the contract documents shall be provided to purchaser, and purchaser’s approval shall be obtained before start of fabrication.

4.2.2 The written procedure shall include the following information:

- a. Complete descriptions of methods and equipment to be used
- b. Schedule showing when PMI will be performed during fabrication cycle including date, location and description of testing environment.
- c. Method to be used to verify that PMI has been performed including reporting format, calibration requirements (methods and frequency) of equipment, condition of testing surface, testing, marking (location, method, timing, and material), and controls placed on the procedure.
- d. Materials, components or parts to be examined and frequency of examination.
- e. Definition of acceptance criteria (e.g., heat or product analysis, tolerance on measurement method).
- f. Qualifications of personnel responsible for performing PMI
g. Documentation and traceability methods

h. Action to be taken in the event of non-compliance.

4.2.3 Personnel responsible for performing PMI shall be tested at the work site by examining a variety of certified reference samples (e.g., National Institute of Standards (NIST)), including the alloys to be verified, and using the equipment and methods to be used on the project.

4.2.4 Personnel shall correctly identify all certified reference samples (e.g., NIST) within the acceptable tolerance of the equipment for qualification to perform PMI.

4.3 Equipment Type and Calibration

4.3.1 Non-destructive PMI verification shall be performed using purchaser approved portable x-ray fluorescent or emission spectroscopy analyzer equipment capable of identifying a material as the specified alloy. This includes identifying the necessary elements (including carbon, when limited) at the specified concentrations.

Comment: Portable optical spectroscopy will leave arc strike pits and the method should be considered only when carbon content analysis is required to be measured.

4.3.2 The equipment shall be calibrated, before use, against a known reference standard (e.g. NIST) matching the specified alloy specification in accordance with the recommendations of the analyzer manufacturer.

4.3.3 The accuracy of the non-destructive testing equipment shall be verified immediately before use and re-verified during use as recommended by the testing equipment manufacturer. Verification shall be to a standard of the alloy being tested. The alloy standard shall be traceable to a reference standard (e.g., NIST). See ASTM A 751.

4.3.4 The condition of the surface to be examined shall conform to the requirements of the analyzer manufacturer (e.g., roughness, level of contaminants, etc.).

4.4 Samples for Destructive Testing

4.4.1 If destructive testing (e.g., wet chemical analysis) is specified by purchaser, a sample from each heat of materials shall be forwarded to a laboratory pre-approved by the purchaser.

4.4.2 A suitable cleaner shall be used in cleaning of tools and sample surfaces before obtaining samples for destructive testing. A cleaner that is not damaging to the materials (e.g. does not contain chlorides, lead, bismuth, etc.) shall be used.

4.4.3 The samples shall be tagged with the purchaser’s purchase order number and item tag number.

4.4.4 Upon receipt, the results of the analysis shall be submitted to the purchaser.

4.5 Scope of PMI

4.5.1 PMI inspection activities shall be in accordance with purchaser’s Inspection and Test Plan, including review, witness, and hold points.
4.5.2 For long lead critical material (e.g., shell, heads, clad plate, major forgings, etc.), PMI shall be performed prior to use in fabrication.

4.5.3 PMI shall be performed during fabrication of sub-assemblies that will be inaccessible after complete assembly (e.g., a pipe length welded into a spool, a nozzle welded into a vessel, tubes prior to insertion into a heat exchanger bundle, etc.).

4.5.4 PMI shall be performed during fabrication, including deposited weld material, on a basis agreed to by the purchaser and supplier.

4.5.5 PMI shall be performed after final assembly except for materials inspected during sub-assembly.

4.5.6 PMI for field fabrication material provided by supplier shall be performed before shipping the material to the facility location. Material received at site may be subject to PMI verification, at purchaser’s option.

4.5.7 For field fabricated alloy materials received at the facility location directly from supply sources, PMI shall be performed by the field fabricator and may be confirmed by the purchaser.

4.5.8 Sampling shall be representative of each welding process used.

4.5.9 Verification of the weld seam alloy shall be on the “wetted” (i.e., process) side of the fabrication. If this is not possible because of restricted access (e.g., small diameter piping) PMI shall be performed on the accessible weld surface.

4.5.10 During fabrication, equipment and piping, including weld overlaid surfaces (i.e., stainless steel or other alloys), shall be subjected to PMI in accordance with the following schedule:

a. Vessels
   1. Shell and head sections
   2. Circumferential and longitudinal weld seams. One sample per seam on the inside and outside.

   *Comment:* A weld seam is defined as a pressure-containing single circumferential seam, a single longitudinal seam, etc.

   3. Nozzle necks, flanges, stub-ends
   4. Weld overlaid components at the depth specified
   5. Clad component surfaces
   6. Loose metallic liners
   7. Nozzle weld seams
   8. Reinforcing pads, saddle pads, clips, lugs, etc.
   9. Vessel Internals
      a. 1 test of each coil or plate of raw material
      b. 5 random tests of each type and material of hardware (e.g., bolts, nuts, clamps, etc.)

10. Process wetted parts not listed above
b. Heat Exchangers
   (1) Vessel PMI requirements in accordance with Section 4.5.10.a.
   (2) 10% random selection of shell and tube heat exchanger tubes in each heat in each bundle. Verification shall be performed before tubes are stabbed into the bundle.
   (3) Expansion joints
   (4) 10% random selection of air cooled exchanger tubes and fins in each heat of each bundle. Verification shall be performed before tubes are inserted into the tubesheets.
   (5) Baffles, tubesheets, tie rods and spacers

c. Heaters and Boilers
   (1) 10% random selection of tubes from each heat of tube material. Verification shall be performed before tube installation.
   (2) Tube hangers and tube supports
   (3) Baffles and tubesheets
   (4) Weld seams as agreed between the purchaser and supplier

d. Piping
   (1) Pipe, pipe fittings, flanges, weld attachments, and other piping components prior to assembly, after fabrication of the pipe spool, and after installation
   (2) Pipe and pipe fittings which are longitudinally welded shall have the welds PMI verified by testing the welds and base metal on a random sampling basis.
   (3) Valves including pressure containing parts such as: body, flanges, bonnet, stem, etc.
      Comment: Consideration may be given to an option of testing samples from large production runs of multiple, identical valves.
   (4) Expansion joints and bellows
   (5) Tubing

e. Machinery
   Machinery rotating equipment PMI is required for all alloy parts and components in contact with the process. Examples of these items are: case, cover plate, seal gland(s) components, impeller(s), shaft, wear rings, and bowl assemblies. PMI may be specified for any component the owner determines is appropriate based on their risk profile and experience.

f. Welds and Welding Consumables
   Welding consumables shall be defined per lot number. Samples shall be verified by depositing a weld pad for coated electrodes or by checking the bare filler metal (wire) directly. Sample pads shall be in accordance with ASME Section II, Part C, SFA 5.4, Paragraph 9.3.
g. Alloy Bolting and Gaskets
   (1) Stud fasteners, bolting and nuts shall be tested by random sampling. Provided traceability is maintained by heat, testing shall be 2% per heat. Without heat traceability the testing shall be at least 10% by lot.
   (2) Coated bolts and nuts shall be inspected prior to coating.
   (3) Metallic and semi-metallic gaskets

h. Refractory Anchors, Assemblies and Metallic Fibers
   (1) Individual anchor: PMI shall be performed on randomly selected samples consisting of 0.5 percent (rounded up to the next whole number) of each component style, component size, metallurgy.
   (2) Continuous assemblies (e.g., hexmesh and flexmesh): PMI shall be performed at one random location on each continuous assembly.
   (3) Metallic reinforcing fibers: Perform PMI on one randomly selected sample per pallet or fraction of a pallet for each style, metallurgy (lot and heat), and manufacturer with a minimum of one sample. Sample size shall be adequate for the testing method used.

4.6 PMI Verification

4.6.1 General

4.6.1.1 PMI inspection and analysis results shall be shown on \textit{PIP VESP\text{MI01}-F} PMI Report Form and provided to the purchaser for review.

4.6.1.2 Quality records and other forms and reports required by this Practice shall be maintained and copies provided to the purchaser.

4.6.1.3 All PMI tests shall be certified as follows:
   a. Performed in accordance with this Practice
   b. Performed by personnel qualified in accordance with this Practice
   c. Performed at a point in the fabrication process which ensures the correct material was used

4.6.1.4 Purchaser shall have discretion to witness the required examinations and application of identification marking in accordance with Section 4.6.5.

4.6.2 Inspection Hold Points

4.6.2.1 The purchaser reserves the right to establish inspection hold points for each fabricated item including one hold point immediately before surface preparation and painting.

4.6.2.2 Hold points shall be used to verify that the correct materials, including deposited weld metal, and marking have been used before the loss of material identity marking during surface preparation.

4.6.2.3 Hold point verification shall include a review of the PMI Analysis Reports (\textit{VES\text{PMI01}-F}) and a random spot check of the data collected to confirm to the required chemistry of the tested material witnessed by the purchaser and/or purchaser’s inspector.
4.6.3 Acceptance Criteria

4.6.3.1 All alloy materials shall contain the amounts of specified principle alloying elements within the tolerance range of materials specifications (e.g., ASME Section II, Parts A or B, UNS number or ASTM) or as specified by the owner if more restrictive.

4.6.3.2 If the material analysis is outside the limits of Section 4.6.3.1, a third party quantitative chemical analysis may be performed for verification.

4.6.3.3 The PMI results for weld consumable shall be in accordance with ASME Section II, Part C or AWS for the principle elements of weld consumable used.

4.6.3.4 If the results of a PMI test are not conclusive, a destructive test may be used to confirm the results.

4.6.3.5 If the PMI test results of any piece from a random sample fall outside of the permitted ranges, the remainder of that lot shall be verified by performing a 100% examination. Percentage non-conformance shall not be permitted.

4.6.3.6 Items with PMI results that do not meet the requirements of Sections 4.6.3.1 through 4.6.3.5 shall be rejected.

4.6.3.7 Items shall not be shipped until all PMI has been completed, documented, and approved by the purchaser.

4.6.4 Rejected Materials

4.6.4.1 If an item is rejected after PMI, all remaining pieces of the same item from the same supplier shall be verified.

4.6.4.3 All materials failing to pass PMI testing shall be isolated in a hold area and tagged as rejected.

4.6.4.4 A non-conformance report in the format agreed upon by the purchaser and supplier shall be prepared for each rejected item. Non-conformance report shall document type of non-conformance, material involved, testing performed, location of material or component relative to equipment design, status of fabrication when non-conformance was discovered.

4.6.4.5 Controls shall be established to prevent the inadvertent use of rejected materials.

4.6.5 Marking

4.6.5.1 In addition to marking typically required by applicable codes or other local requirements, the following PMI marking shall be provided.

a. After PMI has been completed, each item tested shall be permanently marked to identify the alloy type (e.g., PMI 1¼ Cr or PMI 316).

b. Either low stress stamps or vibra-etch marking methods shall be used. Alternate marking methods require the purchaser’s authorization.

c. If color coding is specified, the coding shall be in accordance with
**PFI Standard ES-22.**

**Comment:** Color coding typically will not survive heat treatment, exposure to weather or adjacent welding. Fabrication and environmental conditions should be considered when applying color coding systems.

d. PMI markings shall be transferred to all pipe lengths cut from PMI examined material.

4.6.5.2 Items sampled by lot or which cannot be marked individually in accordance with Section 4.6.5.1 shall be tagged with the identification information placed on tags. For items sampled by lot tags may be affixed to their containers.

4.6.5.3 Ink or paint used for marking shall be in accordance with the following:

   a. Not detrimental to the material being identified at any potential exposure temperature including heat treatments.

   b. Indelible type or other type which cannot easily be removed

   c. Shall not contain harmful substances (e.g., chlorides, sulfur, zinc, lead or aluminum)

4.6.5.4 Items shall have each piece identified a sufficient number of times and at different locations to ensure visibility of identification during the fabrication or erection cycle.

4.6.5.5 Markings shall be made adjacent to plate heat numbers and welder stamps.
## Positive Material Identification Report

**Facility Name/Location:**

**Purchaser Project No.:**

**PMI Performed At (Location):**

**PMI Request By:**

**PMI Performed By:**

**Analyzer Used And Calibration/Reference Standard Check Date:**

<table>
<thead>
<tr>
<th>Item Or Tag No.</th>
<th>Sample Size</th>
<th>Material</th>
<th>Mill Cert. No.</th>
<th>Heat No.</th>
<th>Description</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Item Or Tag No.</th>
<th>No. Of Pieces Exam.</th>
<th>No. Of Pieces Accepted</th>
<th>No. Of Pieces Rejected</th>
<th>Material Identified As</th>
<th>Cr</th>
<th>Mo</th>
<th>Ni</th>
<th>Mn</th>
<th>Ti</th>
<th>V</th>
<th>Fe</th>
<th>Co</th>
<th>Cu</th>
<th>Nb</th>
<th>W</th>
</tr>
</thead>
</table>

## Examination Results (List Composition If Analyzer Fails To Identify Material)

<table>
<thead>
<tr>
<th>Item Or Tag No.</th>
<th>No. Of Pieces Exam.</th>
<th>No. Of Pieces Accepted</th>
<th>No. Of Pieces Rejected</th>
<th>Material Identified As</th>
<th>Cr</th>
<th>Mo</th>
<th>Ni</th>
<th>Mn</th>
<th>Ti</th>
<th>V</th>
<th>Fe</th>
<th>Co</th>
<th>Cu</th>
<th>Nb</th>
<th>W</th>
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</table>

**Manufacturer That Produced Rejections:**

**Additional Information:**

**Manhours And Other Loss Incurred Due To Rejections:**

**PMI Supervisor Signature/Date:**