

Engineering Procedure

SAEP-1144

12 October 2005

Magnetic Particle Examination

Non-destructive Testing Standards Committee Members

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Saudi Aramco DeskTop Standards

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1 Scope

- 1.1 This Engineering Procedure establishes the minimum requirements and describes the techniques for magnetic particle (MT) examinations on welds and components conducted in accordance with the requirements of the referenced codes/standards.
- 1.2 This Engineering Procedure applies to Saudi Aramco NDT personnel and to contract personnel seconded to Saudi Aramco on an In-Kingdom Inspection Contract conducting MT examination on behalf of Saudi Aramco.
- 1.3 This SAEP does not apply to NDT companies performing magnetic particle for out of kingdom vendors or on LSTK projects unless specified in the contract or purchasing documents.
- 1.4 Detailed, written, MT examination procedures of Attachments 1 through 3 shall be used during all examinations. Magnetic Particle Examinations deviating from the written procedure shall be recorded on the MT technique sheet (Attachment 5) and submitted to the Inspection Department, NDT Unit for approval prior to use.

2 Conflicts and Deviations

- 2.1 Any conflicts between this procedure and other Saudi Aramco Engineering Standards (SAES's), Materials System Specifications (SAMSS's), Standard Drawings (SASD's), or industry standards, codes, and forms shall be resolved in writing by the Company or Buyer Representative through the Manager, Inspection Department of Saudi Aramco, Dhahran.
 - 2.2 Direct all requests to deviate from this procedure in writing to the Company or Buyer Representative, who shall follow internal company procedure SAEP-302
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and forward such requests to the Manager, Saudi Aramco Inspection Department.

3 References

3.1 Saudi Aramco References

Saudi Aramco Engineering Procedures

<u>SAEP-1140</u>	<i>Qual. and Cert. of NDT Personnel</i>
<u>SAEP-1142</u>	<i>Qual. of Non Saudi Aramco NDT Personnel</i>

3.2 Industry Codes and Standards

American Petroleum Institute

<i>API STD 570</i>	<i>Inspection, Repair, Alteration, and Rerating of In-Service Piping Systems</i>
<i>API STD 620</i>	<i>Design and Construction of Large, Welded, Low Pressure Storage Tanks.</i>
<i>API STD 650</i>	<i>Welded Steel Tanks for Oil Storage</i>
<i>API STD 653</i>	<i>Tank Inspection, Repair, Alteration, and Reconstruction</i>
<i>API STD 1104</i>	<i>Welding of Pipelines and Related Facilities</i>

American Society of Mechanical Engineers

<i>ASME B31.1</i>	<i>Power Piping</i>
<i>ASME B31.3</i>	<i>Chemical Plant and Petroleum Ref. Piping</i>
<i>ASME B31.4</i>	<i>Liquid Transportation Systems</i>
<i>ASME B31.8</i>	<i>Gas Trans. and Distr. Piping Systems</i>
<i>ASME SEC V</i>	<i>Nondestructive Examination</i>
<i>ASME SEC VIII D1</i>	<i>Pressure Vessels</i>

American Society for Testing and Materials

<i>ASTM E709</i>	<i>Std. Practice for Magnetic Particle Exam.</i>
<i>ASTM E1444</i>	<i>Std. Practice for Magnetic Particle Exam.</i>

American Welding Association

<i>AWS D1.1</i>	<i>Structural Steel Welding Code</i>
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4 Personnel

- 4.1 Saudi Aramco Personnel performing MT examinations shall be certified in accordance with [SAEP-1140](#).
- 4.2 Contractor personnel performing MT examinations shall be certified in accordance with [SAEP-1142](#).
- 4.3 Level I personnel may perform MT examination only under the direct supervision of Level II or Level III personnel. Level I personnel shall not independently interpret the results of the examination.

5 Safety

- 5.1 The inspector shall be responsible for compliance with applicable safety rules in the handling and usage of magnetic particle materials and equipment. A hot work permit shall be obtained as necessary. When conducting MT Examination inside Vessels, Tanks, Heat Exchangers, Furnaces, etc., use ground fault circuit interrupters (GFCIs) to protect from electrical faults.
- 5.2 Adequate ventilation shall be provided when performing an MT examination in confined areas to prevent inhalation of harmful materials.
- 5.3 Wet method solutions with a petroleum distillate are highly volatile, relatively toxic, and may cause skin irritation. Use adequate ventilation at all times and avoid prolonged skin contact.
- 5.4 Flammable inspection materials such as solutions with a petroleum distillate base shall not be used in an area where they may be exposed to open flame or sparks.

6 Equipment and Materials

6.1 MT Equipment

Electromagnetic Yoke (AC or AC/DC)
Electromagnetic Coils
Magnetizing Prods
Stationary Horizontal MT System
Black Lights

UV Light meter

10 lb weight for AC Yoke, 40 lb. weight for DC Yoke

6.2 Materials

- 6.2.1 Approved manufacturers for dry magnetic powders, wet magnetic particles, contrast paint and cleaning solvents are Magnaflux, Castrol, Circle Systems, Parker Research, Johnson and Allen, Brent, Ardrex, and Sherwin. Users should check materials used against latest list of approved materials held by the Supervisor, NDT Unit, Dhahran Phone 874-6605.
- 6.2.2 A thin, uniform coating of white contrast paint, (e.g., Magnaflux WCP-2 or equivalent) may be applied to the examination surface prior to performing a wet or dry particle MT examination to enhance the color contrast of the particles selected. The paint shall be flat white, quick drying, and the thickness of the coating applied should not exceed 0.002 inches (0.05 mm).

7 Lighting

- 7.1 MT examinations performed in the field with visible magnetic particles require a minimum of 377 lux (lx) [35 foot candles (ftc)] of white light illumination at the examination surface for adequate evaluation of indications. Inspections conducted in areas of uncontrolled lighting are considered field examinations. Shop or bench type inspections require 1076 lx (100 ftc) of white light illumination. Shop areas shall have adequate lighting installed or available.
- 7.2 Fluorescent MT examinations performed in the field require a minimum ultraviolet light intensity of $3000 \mu\text{W}/\text{cm}^2$ at the examination surface, or $1000 \mu\text{W}/\text{cm}^2$ in a darkened area (ambient white light intensity is 22 lx (2 ftc) or less).
- 7.3 Ultraviolet (UV) and white light intensities shall be measured at the examination surface and recorded on the MT Inspection Report and UV Light Intensity Log Sheet (Appendix I) prior to performing an MT examination. A UV Light Intensity Log sheet (Appendix I) shall be kept with the black light unit at all times. Details of UV light utilization and equipment requirements are given in Appendix I.

8 Surface Preparation

- 8.1 All surfaces to be examined and any adjacent area within 1 inch (25.4 mm) of the examination area shall be free of rust, scale, slag, sand, grease, paint (contrast paint is acceptable), oily films, or other interfering conditions. Part surface temperature shall not exceed 600°F (316°C) when using dry particles or 122°F (50°C) when using wet particles.

- 8.2 As cast, as rolled, as forged, or as welded surfaces are satisfactory if clean and the weld blends smoothly into the base metal without undercutting. Unusually rough or non-uniform examination surfaces which would interfere with the formation and/or interpretation of indications shall be properly conditioned prior to examination. Conditioning may be in the form of wire brushing, sanding, or other approved methods that will not smear or otherwise mask discontinuities of interest.
- 8.3 MT examinations performed on thin (a maximum of 0.002 inch [0.05 mm] thick), smooth, nonconductive, and/or nonmagnetic coatings, such as paint or corrosion inhibitor coatings, are allowable provided the applied magnetic field at the examination surface is verified as sufficient with a magnetic field indicator. Coatings should be completely removed from all points where electrical contact is made.
- 8.4 Areas where electrical contact will be made on the examination piece shall be thoroughly cleaned to provide low resistance electrical connections to reduce the possibility of arc strikes.

9 General Requirements

- 9.1 The recommended examination methods and techniques described in the following paragraphs apply to all MT methods of examination and are considered mandatory unless otherwise specified.
 - 9.2 Measure and record the temperature of the examination surface with an accurate surface thermometer. The temperature shall not exceed 600°F (316°C) for dry particles or 122°F (50°C) for wet particles.
 - 9.3 Ensure, by measurement, that the light intensity is adequate to perform the examination.
 - 9.4 Clean the examination surface and adjacent area within 3 inches (76.2 mm) of the examination area.
 - 9.5 A visual inspection of the examination surface shall be performed prior to magnetization to verify the surface cleaning operation was thorough and complete, to identify gross discontinuities, and to identify areas of interest where an indication will be expected to occur. Prior to performing a fluorescent MT examination, the examination surface should be scanned with UV light to assure that all contaminants have been removed.
 - 9.6 The surface to be tested and 1 inch (25.4 mm) of adjacent area shall be examined for evidence of particle accumulations unless otherwise specified. Indications shall be interpreted to determine the cause of the accumulation and
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the indication size evaluated to the appropriate acceptance criteria. The surface to be tested shall be examined in suitable increments. Adjacent examination areas shall overlap a minimum of 10%.

- 9.7 Two (2) separate examinations shall be carried out on each area to be tested. The second examination shall be with the lines of flux perpendicular (90°) to those used for the first examination in that area. A different method of magnetization may be used for the second examination. When possible, a circular magnetization shall be followed with longitudinal magnetization.
- 9.8 The method of MT examination selected for use shall provide an applied magnetic field having sufficient strength to produce satisfactory indications but not strong enough to cause masking of indications.
- 9.9 After a defect is thought to have been removed and prior to making weld repairs, the area shall be reexamined by MT or any suitable NDT method to assure the defect has been eliminated or reduced to an acceptable size.
- 9.10 AC yokes shall be tested for adequate magnetization strength prior to use each day by being able to pick up a 10 lb. steel weight. Similarly, DC yokes shall be tested using a 40 lb. steel weight.
- 9.11 Where magnetization field strength is uncertain, an ASME pie gauge or Burmah castrol strip may be used to verify adequate magnetization of a part.

10 Interpretation

- 10.1 All indications shall be interpreted and evaluated in accordance with the appropriate acceptance criteria after each individual examination and the results recorded on the MT Examination Request and Report Sheet (Attachment 4).
- 10.2 Indications believed to be non-relevant shall be reexamined, by a different NDT method if necessary, to verify that no defects are present.

11 Demagnetization

- 11.1 When the presence of residual magnetism within the piece could interfere with subsequent processing or usage, the piece shall be demagnetized. Residual magnetism shall not exceed ± 2 gauss. Demagnetization shall always be performed on parts, which are to be welded after an MT examination has been performed to prevent arc blow.
 - 11.2 The presence or absence of residual magnetism shall be demonstrated and verified using a calibrated Gaussmeter, Magnetic Field Meter, or a Hall Effect Probe Gaussmeter and recorded on the MT Inspection Report form.
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- 11.3 Demagnetization shall be accomplished using either the AC coil, DC step-down, or yoke method. The magnetic field intensity of the first demagnetization shot shall always be equal to or higher than the last magnetization shot of the MT examination.

12 Post Examination Cleaning

- 12.1 Following each MT examination, the part being examined shall be cleaned to remove all residual magnetic particle materials. Any method that will remove all residual MT materials from the part surface and does not harm the part is considered acceptable.
- 12.2 A visual examination of the part being examined shall be performed at the conclusion of the post-cleaning operation to assure that the cleaning was thorough and complete, all residual magnetic particle examination materials have been removed, and that the part was not damaged in any way.
- 12.3 If wet fluorescent MT examination was performed, the part shall be scanned with the blacklight to assure that post-cleaning was adequate.

13 Example Acceptance Criteria

- 13.1 The indication of a discontinuity may be larger than the actual discontinuity that causes it, however, the size of the indication and not the size of the discontinuity is the basis for acceptance or rejection.
- 13.2 Example acceptance criteria for examinations performed to ASME B31.1; ANSI/ASME B31.3; ASME Section VIII, Division 1; API STD 1104; and AWS D1.1 are given in Appendix II.
 - 13.2.1 Acceptance criteria for API STD 570, API STD 620, API STD 650, and API STD 653 are in accordance with ASME Section VIII, Division 1.
 - 13.2.2 Acceptance Criteria for ASME B31.4 and B31.8 are in accordance with API STD 1104.
- 13.3 The examiner must verify actual acceptance criteria per the applicable code or purchase specification before the examination. Acceptance criteria for special projects shall be pre-approved by a Saudi Aramco Inspection Department MT Level III.

14 Records

- 14.1 Results of magnetic particle examinations shall be recorded on a Magnetic Particle Examination Request and Report Sheet (Attachment 4). MT examinations performed and results recorded by an MT Level I shall be reviewed and approved on the MT Report by an MT Level II or III. The reports shall be kept on file and available for review in the Inspection Department.
- 14.2 A sketch, chart, or marked-up drawing shall be provided showing enough detail on relevant indications to permit duplication of the examination in the future. Permanent records pertaining to the MT examination such as photographs, indications lifted with transparent tape, lacquers or fixers, magnetic rubber, or sketches shall be attached to the MT report.

Revision Summary

12 October 2005	Revised the "Next Planned Update". Reaffirmed the contents of the document, and reissued with minor changes.
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Attachment 1 – Electromagnetic Yoke Technique

1. Scope

- 1.1 This procedure covers the use of an Alternating Current (AC) yoke for the examination of ferrous materials for surface indications using wet or dry particles and the continuous method.
- 1.2 This method shall only be used to detect surface discontinuities using AC current. Half Wave Direct Current (HWDC) may be used for verification of discontinuities and special applications. Unless otherwise specified, the current control on the yoke shall be set at maximum.
- 1.3 The prod technique should not be used on highly polished or machined surfaces due the possibility of arc damage to the surface.

2. Equipment

Magnetization is to be performed using a Parker AC/DC contour probe (yoke) Model DA-200 or DA-400, Magnaflux Y6 or Y-7, Johnson and Allen JAY, or equivalent. The yoke shall demonstrate adequate magnetization force by being able to lift a 10 lb. weight for AC and 40 lbs. for DC.

Dry powder shall be chosen to provide the greatest contrast between the powder and the background. It is recommended to apply a light application of white paint before application of the wet visible technique.

3. Procedure

- 3.1 The yoke shall be placed in contact with the surface to be examined and energized.
- 3.2 While maintaining the magnetic field, apply the magnetic particles so that a light, uniform coating settles on the examination surface.
- 3.3 For the dry technique, while maintaining the magnetic field, remove the excess particles by using a low pressure air stream from a hand actuated rubber bulb. For the wet technique, allow the solution to drain from the part while maintaining the magnetic field.
- 3.4 Observe the particle formation during application and excess particle removal.

- 3.5 For the wet fluorescent technique, the black light shall be warmed up for 5 minutes prior to the examination and external visible light shall be excluded from the examination area.

4. Direction of Magnetization

- 4.1 Two separate examinations shall be carried out on each area. The yoke shall be placed so the magnetic field during the second examination is approximately perpendicular (90°) to the field of the first examination forming an "X" pattern. The legs of the yoke shall be positioned for maximum contact with the surface being tested.
- 4.2 For welds on flat surfaces, the yoke shall be placed across the weld at an angle of 30° - 45° from the long axis of the weld. The second examination shall be perpendicular to the first.
- 4.3 For examining circumferential (pipe) and fillet welds, the yoke shall be initially positioned so the legs straddle the weld or the area of interest and the applied field is perpendicular to the long axis of the weld. For the second examination, the yoke legs shall be positioned parallel to the long axis of the weld, on the crown of the weld or immediately beside the weld. Caution shall be exercised when performing successive shots to note the position of the legs (poles) on the previous shot. Assure the area of the established field sufficiently overlaps the area of the previous field, especially at the pole positions of the previous field.

5. Examination Coverage

- 5.1 Yoke leg spacing shall be between a minimum of 3 inches (76.2 mm) and a maximum of 8 inches (203.2 mm). Shorter spacing may be used to compensate for the geometry of the area being examined or to increase sensitivity, but leg spacing less than 3 inches (76.2 mm) is not recommended due to the strength of the longitudinal magnetic field at the poles.
- 5.2 The area to be examined shall be limited to a maximum distance of one-fourth ($\frac{1}{4}$) of the spacing on either side of a centerline joining the two yoke poles.

6 Inspection

The surface to be tested and 1 inch (25.4 mm) of additional adjacent area shall be examined for evidence of particle accumulations. Interpret and evaluate all indications to the appropriate acceptance criteria after each examination.

Record all pertinent information on the MT report. Attach a sketch of the area examined and all permanent records.

7. Post Examination Cleaning

Remove all residual magnetic particle materials from the part examined. Perform a visual inspection to assure the post cleaning operation was thorough and complete and the part was not damaged.

Attachment 2 – Prod Technique Using Dry or Wet Magnetic Particles

1. Scope

This procedure covers the prod technique for the examination of ferrous materials for surface indication using dry or wet particles and the continuous method.

This method can be used to detect surface or subsurface discontinuities using Alternating Current (AC), Direct Current (DC), or Half Wave Direct Current (HWDC).

2. Application

2.1 HWDC or Full Wave Direct Current (FWDC) shall be used unless otherwise specified. AC may be used for special applications such as verification of discontinuities or treatment of non-relevant indications.

2.2 Wet or dry magnetic particles may be used with the prod method depending upon the sensitivity of the examination required. The continuous method of particle application shall be used.

3. Magnetizing Technique

Magnetization is accomplished by the use of portable prod-type electrical contacts pressed against the surface in the area to be examined. A remote control switch built into the prod handles or a foot pedal permits the inspector to turn the current on after the prods have been properly positioned and to turn it off before the prods are removed in order to prevent arcing. Current shall be applied for a minimum of 5 seconds after particle application to allow indications to form. The duty cycle shall be 2 minutes on and 2 minutes off unless otherwise specified by the manufacturer.

4. Magnetizing Current

The magnetizing current required is calculated using 100-125 amperes per inch (40-50 amp/cm) of prod spacing for sections 0.75 inch (19.1 mm) thick or greater. For sections less than 0.75 inch (19.1 mm) thick, amperage shall be 90-110 amperes per inch (36-44 amp/cm) of prod spacing. Always use the lowest calculated current setting for the first examination to prevent local overheating, arcing, or burning of the surface being examined.

5. Direction of Magnetization

5.1 Two separate examinations shall be carried out on each area. The prods shall be placed so that the magnetic field of the second examination is approximately perpendicular (90°) to the field of the first examination.

5.2 For examinations of welds, the prods shall initially be aligned approximately 30° - 45° to the long axis of the weld and with the prods positioned on opposite sides of the weld. The second examination shall be perpendicular to the first forming an "X" pattern.

6. Examination Coverage

6.1 Prod spacing shall be between a minimum of 3 inches (76.2 mm) and a maximum of 8 inches (203.2 mm). Shorter spacing may be used to compensate for the geometry of the area being examined or to increase sensitivity, but prod spacing less than 3 inches (76.2 mm) usually is not recommended due to banding of the particles around the prod contact area.

6.2 The area to be examined shall be limited to a maximum distance of one-fourth ($\frac{1}{4}$) of the spacing on either side of a line joining the two prods.

7. Inspection

7.1 The surface to be tested and 1 inch (25.4 mm) of additional adjacent area shall be examined for evidence of particle accumulations.

7.2 Interpret and evaluate all indications to the appropriate acceptance criteria after each examination and record all pertinent information on the MT report. Attach a sketch of the area examined and all permanent records.

8. Demagnetization

When residual magnetization will interfere with subsequent processing or usage, the part shall be demagnetized by use of an AC yoke upon completion of the examination. Demagnetize the examination piece to ± 2 gauss or less.

9. Arc Strikes

Any arc strikes shall be removed by sanding, filing, or grinding, and visually reexamined.

10. Post Examination Cleaning

Remove all residual magnetic particle materials from the part examined. Perform a visual inspection to assure the post-cleaning operation was thorough and complete and the part was not damaged.

Attachment 3 – Direct Contact Method

1. Application

Half Wave Direct Current (HWDC) or Full Wave Direct Current (FWDC) shall be used unless otherwise specified. Alternating current may be used for special applications such as verification of discontinuities or treatment of non-relevant indications.

2. Wet or dry magnetic particles may be used with the direct contact method depending upon the sensitivity of the examination required. The continuous method of particle application shall be used.

3. Magnetizing Technique

Magnetization of the piece is accomplished by passing current from end to end through the examination piece. Alligator Clamps, "C" Clamps, Magnetic Leeches or other approved means may be used to attach the power cables to the piece being tested.

4. Magnetizing Current

4.1 HWDC or FWDC current level shall be set as follows:

- 4.1.1 For parts with outer diameters up to 5 in. (125 mm) - 700 amp/in to 900 amp/in of diameter shall be used
- 4.1.2 For parts with outer diameters over 5 and up to 10 in. (125 to 250 mm) - 500 amp/in to 700 amp/in of diameter shall be used.
- 4.1.3 For parts with outer diameters over 10 and up to 15 in. (250 to 380 mm) - 300 amp/in to 500 amp/in of diameter shall be used.
- 4.1.4 For parts with outer diameters over 15 in. (380 mm) - 100 amp/in to 330 amp/in of outer diameters shall be used.

NOTE: Always use the lowest calculated current setting for the first examination to prevent local overheating, arcing, or burning of the piece being examined.

4.2 For parts with geometric shapes other than round, the greatest cross-sectional diagonal in a plane at right angles to the current flow shall determine the inches to be used in the computations of paragraph 4.1.

4.3 Parts with multiple diameters to be tested shall be magnetized in order of diameter size, from smallest to largest or from the lowest current setting required to the largest.

4.4 For parts with length to diameter ratios less than 2, an alternate form of magnetization shall be used.

5. Direction of Magnetization

5.1 The direct contact method produces a circular magnetic field that is approximately perpendicular (90°) to the direction of the current flow. Two separate examinations shall be carried out on each area. The second examination shall be with the lines of magnetic flux approximately perpendicular to those used for the first examination in that area. A different means of magnetizing, typically a coil shot, may be used for the second examination.

5.2 For examinations of welds, the contacts shall initially be aligned approximately 30° - 45° to the long axis of the weld and the contacts positioned on opposite sides of the weld. The second examination shall be perpendicular to the first forming an "X" pattern. Additionally, the contacts shall be positioned on opposite sides (180°) of a pipe diameter.

5.3 The first magnetizing shot on the examination piece shall always be used to demonstrate and verify the sensitivity and performance of the MT system. A magnetic particle field indicator shall be used to verify that adequate magnetic flux in the desired direction has been established.

6. Inspection

6.1 The surface to be tested and 1 inch (25.4 mm) of additional adjacent area shall be examined for evidence of particle accumulations.

6.2 Interpret and evaluate all indications to the appropriate acceptance criteria after each examination and record all pertinent information on the MT report. Attach a sketch of the area examined and all permanent records.

7. Demagnetization

When it is absolutely necessary to demagnetize the examination piece and the standard demagnetization equipment is not available, the following method may be used.

DC Step Down Demagnetization Method

If polarity of the current is not reversible, place the contacts on the same areas of

the examination piece that were used to perform the examination, but with the contact positions reversed. Apply current for at least 0.5 second at the same amperage used for the examination. Reverse the contacts or reverse the polarity of the current and apply 20 to 40 amps less current. Continue this procedure reducing the amperage each time the polarity or the contacts are reversed until demagnetization is complete.

8. Post-Examination Cleaning

Remove all residual magnetic particle materials from the examination piece. Perform a visual inspection to assure the post-examination cleaning operation was thorough and complete and the part examined was not damaged.

Attachment 4 – Magnetic Particle Examination Request and Report Sheet

[illegible]

Reviewed by: _____

Notes: All blanks are to filled in or marked N/A (not applicable).
Tests performed by Level I Technicians require a sign-off by a Level II or III.

Audited by: _____

Attachment 5 – Magnetic Particle Technique Sheet

MAGNETIC PARTICLE INSPECTION – ASTM E709					
PART NUMBER			PART DESCRIPTION (Pipe, Plate, etc.)		
MATERIAL		THICKNESS		SURFACE CONDITION	
MAGNETIC PARTICLE EQUIPMENT					
STATIONARY			PORTABLE		
SPECIAL					
APPLICATION PROCEDURE					
PARTICLE MFG.		PARTICLE TYPE: DRY: _____ VISIBLE: _____ WET: _____ FLOURESCENT: _____		VEHICLE OIL: _____ WATER: _____	
				PARTICLE COLOR	
				CURRENT TYPE AC: _____ FWDC: _____ HWDC: _____	
DIRECTION OF MAGNETIZATION AND AMPERAGE ±10%					
CIRCULAR			LONGITUDINAL		
SHOT SEQ.	HEAD SHOT → ←	CENTRAL CONDUCTOR 	COIL WRAP # of Coil Turns		YOKE 
			TURN		
			TURN		
DEMAGNETIZATION METHOD:					
POSTCLEANING METHOD:					
INSPECT FOR:					
SPECIAL INSTRUCTIONS:					

Appendix I – Ultraviolet Light Utilization Requirements

1. Examinations requiring the use of ultraviolet light shall be conducted in a darkened area of 22 lux (lx) [2 foot candles (ftc)] or less of white light intensity as measured at the surface to be tested. Every attempt shall be made to darken the area as much as possible prior to conducting a fluorescent magnetic particle examination through the use of a blanket, hood, or portable booth.
2. The ultraviolet light intensity at the examination surface shall be measured:
 - 2.1 At least every 4 hours.
 - 2.2 Whenever the work location is changed.
 - 2.3 After changing a component of the unit such as a filter or bulb.
 - 2.4 After a black light unit failure.
3. The ultraviolet light intensity shall be determined using a UVP Model J-221 Long Wave UV Meter, Spectroline DSE-100X, DME-365, or equivalent. The light meters shall be calibrated every 6 months and bear an authentic seal which presents the date calibration was accomplished and the next due date.
4. A minimum of 3000 $\mu\text{W}/\text{cm}^2$ is required for field inspections in areas of ambient white light which exceed 2 ftc as measured at the examination surface. A minimum value of 1000 $\mu\text{W}/\text{cm}^2$ is required for work in a darkened area of 2 ftc or less.
5. Ultraviolet light intensity shall be measured at the examination surface prior to the fluorescent MT examination. The light sensor shall be placed on the surface to be tested. The black light should be centered perpendicular (90°) to the light sensor at a distance of 15 inches (38.1 cm). The light should be maneuvered in such a manner as to monitor the light meter and achieve the highest intensity reading. The reading shall be recorded on the MT Inspection Report and the Ultraviolet (UV) Light Intensity Log Sheet.
6. A Light Intensity Log Sheet shall be kept with the black light unit at all times and the black light unit intensity monitored for fading trends before each usage.

Appendix I (Cont'd.)
Ultraviolet (Uv) Light Intensity Log

UV LIGHT MFG: _____ UV LIGHT MODEL #: _____
UV LIGHT S/N: _____ LOCATION: _____

DATE	INTENSITY @ 15 INCHES (38.1 cm)	EMPLOYEE BADGE NUMBER	DATE	INTENSITY @ 15 INCHES (38.1cm)	EMPLOYEE BADGE NUMBER

NOTES:

Ambient white light 2 ftc or less.

If UV meter reads lower than 1000 $\mu\text{W}/\text{cm}^2$, clean the filter and reflector as required and re-measure. If still below 1000 $\mu\text{W}/\text{cm}^2$, replace bulb.

Black light intensity should be minimum 1000 $\mu\text{W}/\text{cm}^2$ @ 15 inches in a darkened area and 3000 $\mu\text{W}/\text{cm}^2$ @ 15 inches in all other areas.

Appendix II – Example Acceptance Criteria

1. ANSI/ASME B31.1 Power Piping

The following relevant indications are unacceptable:

- 1.1 Any cracks or linear indications.
- 1.2 Rounded indications with dimensions greater than 3/16 inch (4.8mm).
- 1.3 Four or more rounded indications in a line separated by 1/16 inch (1.6 mm) or less edge to edge.
- 1.4 Ten or more rounded indications in any 6 square inches (3,870 mm²) of surface with the major dimension of this area not to exceed 6 inches (150 mm) with the area taken in the most unfavorable location relative to the indications being evaluated.

2. ASME B31.3 Chemical Plant and Refinery Piping

Any cracks or linear indications are unacceptable.

3. ASME Section VIII, Division 1

- 3.1 Indications with any major dimension greater than 1/16 inch (1.6 mm) shall be considered relevant. All surfaces to be examined shall be free of:
 - 3.2 Relevant linear indications
 - 3.2.1 Relevant rounded indications greater than 3/16 inch (4.8 mm).
 - 3.2.2 Four or more rounded defects in a line separated by 1/16 inch (1.6 mm) or less (edge to edge) except where the specification for the material establishes different requirements for acceptance so far as defects are concerned.

4. API STD 1104 Welding of Pipelines and Related Facilities

Any indication with a dimension greater than 1/16 inch (1.6 mm) shall be considered relevant. Relevant indications shall be unacceptable when any of the following conditions exist:

- 4.1 Linear indications evaluated as crater cracks or star cracks which exceed 5/32 inch (3.96 mm) in length.

- 4.2 Linear indications evaluated as cracks other than crater cracks or star cracks.
- 4.3 Linear indications evaluated as incomplete fusion (IF) and exceed 1 inch (25.4 mm) in total length in a continuous 12 inch (304.8 mm) length of weld or 8% of the weld length.
- 4.4 Individual or scattered porosity (P) shall be unacceptable when any of the following conditions exists:
 - 4.5 The size of an individual pore exceeds 1/8 inch (3.17 mm) or 25% of the thinner of the nominal wall thicknesses joined.
 - 4.6 Cluster porosity (CP) in any pass except the finish pass shall be unacceptable when any of the following conditions exist:
 - 4.7 An individual pore within a cluster exceeds 1/16 inch (1.6 mm).
 - 4.8 The CP diameter exceeds ½ inch (12.7 mm).
 - 4.9 The aggregate length of CP in a continuous 12 inch (304.8 mm) length of weld exceeds ½ inch (12.7 mm).