طرح نگهداشت و افزایش تولید ۲۷ مخزن

NDE PROCEDURE

نگهداشت و افزایش تولید میدان نفتی بینک

Rev.	Date	Purpose of Issue/Status	Prepared by:	Checked by:	Approved by:	CLIENT Approval
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IFA: Issued for Approval
IFR: Issued for Review
IFI: Issued for Information
AFC: Approved for Construction

NISOC	نگهداشت و افزایش تولید میدان نفتی بینک سطح الارض و ابنیه تحت الارض **خرید پکیج های کمپرسور گاز (رفت و برگشتی) بینک** ***(قرارداد BK-HD-GCS-CO-0008_03)***	HIRGAN ENERGY / HAVAYAR INDUSTRIAL GROUP

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	BK	GCS	HY	120	QC	PR	0004	V01

REVISION RECORD SHEET

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1.0 INTRODUCTION

Binak oilfield in Bushehr province is a part of the southern oilfields of Iran, is located 20 km northwest of Genaveh city.

With the aim of increasing production of oil from Binak oilfield, an EPC/EPD Project has been defined by NIOC/NISOC and awarded to Petro Iran Development Company (PEDCO). Also, PEDCO (as General Contractor) has assigned the EPC-packages of the Project to "Hirgan Energy - Design and Inspection" JV.

As a part of the Project, a New Gas Compressor Station (adjacent to existing Binak GCS) shall be constructed to gather of 15 MMSCFD (approx.) associated gases and compress & transfer them to Siahmakan GIS.

2.0 GENERAL DEFINITION

The following terms shall be used in this document.

CLIENT:	National Iranian South Oilfields Company (NISOC)
PROJECT:	Binak Oilfield Development – Surface Fcilities; New Gas Compressor Station
EPD/EPC CONTRACTOR (GC):	Petro Iran Development Company (PEDCO)
OWNER:	OWNER is collectively refer to National Iranian South Oil Company (NISOC) and Petro Iran Development Company (PEDCO)
EPC CONTRACTOR:	Joint Venture of: Hirgan Energy – Design & Inspection (D&I) Companies
VENDOR:	HAVAYAR Company
EXECUTOR:	Executor is the party which carries out all or part of construction and/or commissioning for the project.
THIRD PARTY INSPECTOR (TPI):	The firm appointed by EPD/EPC CONTRACTOR (GC) and approved by CLIENT (in writing) for the inspection of goods.
SHALL:	Is used where a provision is mandatory.
SHOULD:	Is used where a provision is advisory only.
WILL:	Is normally used in connection with the action by CLIENT rather than by an EPC/EPD CONTRACTOR, supplier or VENDOR.
MAY:	Is used where a provision is completely discretionary.

3.0 SCOPE

The scope of this instruction is to describe the non-destructive testing (NDT) which must be performed on welded area of the equipment produced by HAVAYAR Industrial Group.
A non-destructive test is a method by which, one can observe the safety or defects of the material without destroying the examined part. These tests are performed to identify the possible defects as a result of welding operation or the production procedure. Various non-destructive tests including visual test (VT), penetration test (PT), magnetic test (MT), ultrasonic test (UT) and radiography test (RT) are described in the note. This verity of tests could be ensuring the reliable performance of the constructed equipment.

variety

It's noted that NDE test of Bare block, Pump and filter is based on manufacture standard and are not considered in this procedure.

to be clarified.

4.0 REFERENCES

- ASME Sec. VIII Div. 1 (edition 2015) UW-5, 52 & Appendix 4.
- ASME B31.3 (edition 2015)
- ASME Sec. V Article 1, 2, 6, 9 (edition 2014).
- ASTM-E-94, Standard Guide for Radiographic Examination.
- ASNT recommended practices no. SNT-TC-1A for NDT personal qualification and certification (1996 Edition with 1998 Ad.).
- Iranian Petroleum Standard (IPS).
- API 618

V01

5.0 KWANGSHIN MACHINE IND. COMPANY NDE PROCEDURE

- UT PROCEDURE
- PT PROCEDURE

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KWANGSHIN MACHINE IND. CO., LTD.

Title (제목)	Ultrasonic Examination (For Ultrasonic Examination of Forged Crankshafts / ASTM A503) (MANUAL UT)

Revision History (개정이력)

Rev. No. (개정 번호)	Rev. Date (개정 날짜)	Reason of Revision (개정 사유)	Contents of Revision (개정 항목)
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Prepared by UT Level II	김성교 KIM, SUNG KYO	서명	2020.06.09
Reviewed by UT Level II	김현석 KIM, HYUN SEOK	서명	2020.06.089
Approved by UT Level III	김창수 KIM, CHANG SOO	서명	2020.06.09

Certified by **KWANGSHIN MACHINE INDUSTRY CO., LTD.**

QC Dep't Manager : _____ Date: _____

Table of Contents(목차)

1.0. SCOPE (적용범위)

1.1. This is an acceptance specification for the ultrasonic inspection of forged steel crankshafts having main bearing journals or crankpin 4 in.(100㎜) or larger in diameter.

(이 절차서는 직경 4인치(100㎜) 이상의 메인 베어링 저널 또는 크랭크 핀의 단조 크랭크샤프트 초음파 검사 합격 기준을 위한 절차서이다)

1.2. This specification covers the testing equipment required and the test procedure to be followed, and it defines the critical and noncritical areas and limits of acceptance.

(이 절차서는 시험 장비의 요구 사항과 준수해야 할 시험 절차를 포함하고 있으며, 임계 영역과 비임계 영역의 합격기준을 규정한다.)

1.3. This specification is intended to cover both continuous grain flow(CGF) crankshafts for medium and high speed diesel engines as well as solid (slab) forged crankshafts for other applications.

(이 절차서는 중속 및 고속 디젤 엔진의 연속 단류(CGF) 크랭크샤프트와 다른 용도의 단조 크랭크샤프트를 포함한다.)

1.4. This procedures meets the requirements of the ASTM A503/A503M

(이 절차는 ASTM A 503/A503M의 요구 사항을 충족한다.)

2.0. REFERENCES (참고표준)

2.1. ASTM A503/A503M : Standard Specification for Ultrasonic Examination of Forged Crankshafts (2015(2020) Edition)

2.2. ASNT : SNT-TC-1A for NDT Personnel Qualification and Certification (2016 Edition)

2.3. HY-GD-06-03 : Procedure for NDT Personnel Qualification and Certification

3.0. GENERAL (일반사항)

3.1. It is necessary that the crankshaft be identified as being either continuous grain flow or solid (slab) forged.

(크랭크 축은 연속 단류(CGF) 크랭크샤프트 또는 단조 크랭크샤프트로 식별되어야 한다.)

3.2. Unless otherwise specified by means of supplementary ordering information, the test methods and acceptance criteria for the appropriate crankshaft type shall be used.
(보충 주문 정보에 의해 달리 명시되지 않는 한, 해당 크랭크 축 유형에 대한 시험 방법 및 합격 기준을 사용해야 한다.)

4.0. PERSONNEL (검사원)

4.1 Personnel Qualification (검사자 인정)

Personnel performing examination for this procedure shall be satisfied the requirement of HYNDT written practice “HY-GD-06-03” for NDE Personnel Qualification and Certification program which meets the requirements of ASNT Recommended Practice No. SNT-TC-1A.
(본 절차서에 따라 비파괴검사를 수행하는 검사자는 ASNT의 SNT-TC-1A를 만족하는 한양종합검사의 비파괴검사원 자격인정절차서 “HY-GD-06-03”에 따라 자격이 인정된 검사자 이어야 한다.)

4.2 The qualified Level II examiner shall be examination and issue the test report, another UT Level II or Level III shall review and approve the test report.
(검증된 Level II 검사원이 NDE 검사 수행 및 보고서를 작성하고, 또 다른 UT Level II 또는 Level III가 검토 및 승인한다.)

4.3. Qualified and Certified UT Level II shall be examination and preparation of test report, another UT Level II or Level III shall be reviewed & approved.
(검증된 UT Level II 가 NDE 검사 수행 및 보고서를 작성하고, 또 다른 UT Level II 또는 Level III 가 검토 및 승인한다.)

repeated in 4.3

5.0. EQUIPMENT (장비)

5.1. Ultrasonic Test Instrument (UT장비)

5.1.1. An ultrasonic, pulsed, reflection type of instrument shall be used for this examination. The system shall have a minimum capability for examining at frequencies from 1 to 5 ㎒. On examining austenitic stainless forgings the system shall have the capabilities for examining

at frequencies down to 0.4 ㎒.

(초음파, 펄스, 반사형 장비를 시험에 사용하여야 한다. 시스템은 1 ~ 5 ㎒의 주파수에서 검사 할 수 있는 최소한의 성능을 가져야 한다. 오스테나이트계 스테인리스 단조품을 검사 할 때는 0.4 ㎒ 이하의 주파수로 검사 할 수 있어야 한다.)

5.1.2. The ultrasonic instrument shall provide linear presentation (within 5%) for at least 75% of the screen height (sweep line to top of screen). The 5% linearity referred to is descriptive of the screen presentation of amplitude.

(초음파 장비는 화면 높이의 최소 75 % (화면 상단으로 스윕 라인) 동안 선형 프리젠테이션 (5 % 이내)을 제공 해야 한다. 언급 된 5 % 선형성은 진폭의 화면 표시를 설명한다.)

5.1.3. The electronic instrument shall contain an attenuator [accurate over its useful range to ± 10%(± 1 ㏈) of the amplitude ratio] which will allow measurement of indications beyond the linear range of the instrument.

(장비는 직선 범위를 벗어난 표시를 측정 할 수 있는 감쇄비를 [진폭 비의 ± 10 % (± 1㏈) 에 해당하는 유용한 범위 이상으로] 포함 해야 한다.)

5.1.4. The following instruments shall be used.

(다음의 장비를 사용한다.)

Type	Manufacturer (제조사)	Model
Pulse-Echo	Krautkramer (GE)	USM Go, USM 35X

5.2. Search Units (탐촉자)

5.2.1. Search Units having a transducer with a maximum active area of 1 in^2 (650 ㎟) with 3/4 in. (20 ㎜) minimum to 1⅛ in.(30 ㎜) maximum dimensions shall be used for straight-beam scanning.

(수직 빔 주사에 사용하는 탐촉자는 최대 유효 치수가 1 in^2 (650 ㎟)이어야 하며, 변환기는 최소 3/4 in. (20 ㎜)에서 최대 1⅛1 in. (30 ㎜) 이어야 한다.)

type	Manufacturer (제조사)	Model	Frequency (㎒)	transducer size (㎜)
Straight beam	TKS	1C24N 2C24N	1 2	Φ24

5.2.2. Other search units may be used for evaluating and pinpointing indications.
(지시를 평가하고 정확히 찾기 위해 다른 탐촉자를 사용할 수 있다.)

5.3. Couplant (접촉매질)

Couplants having good wetting characteristics such as SAE No.20 or No.30 motor oil, glycerin, pine oil, or water shall be used. Couplants may not be comparable to one another and the same couplant shall be used for calibration and examination.
(SAE No.20 또는 No.30 모터 오일, 글리세린, 송유 또는 물과 같이 우수한 적심성을 가진 접촉매질을 사용하여야 한다. 접촉매질은 다른 접촉매질과 서로 비교할 수 없으며, 동일한 접촉매질로 교정과 시험에 사용하여야 한다.)

6.0. CRITICAL SECTIONS (임계 영역)

6.1. The division of a crankshaft into three volumetric zones, as shown in Fig.1 and Fig.2, for the purpose of ultrasonic examination evaluation is applicable to both solid (slab) forged and continuous grain flow crankshafts.
(초음파검사 평가를 위해 크랭크샤프트를 3 개의 체적 영역으로 분할하는 것은 단조 크랭크샤프트와 연속 단류 크랭크샤프트 모두에 적용 할 수 있습니다.)

6.2. The major critical sections shown as Zone 1 in Fig. 1 include the heavily loaded areas of the crankpins, webs, and main bearings.
(그림 1에서 구역 1로 표시된 주 임계 영역은 크랭크 핀, 웨브 및 메인 베어링의 과부하 영역을 포함한다.)

6.3. The minor critical sections shown as Zone 2 in Fig. 1 include the balance of the surface areas of the main bearing and crankpin journals and adjacent fillets, flanges, and gear fit areas.
(그림 1에서 구역 2로 표시된 주 임계 영역은 메인 베어링 및 크랭크 핀 저널의 표면적과 인접한 필렛, 플랜지 및 기어 맞춤 영역의 균형을 포함합니다.)

6.4. The balance of the crankshaft as shown in Fig. 1, including the remaining sections of the webs, is included in Zone 3.
(그림 1에 표시된 크랭크 샤프트의 균형부는 웨브의 나머지 부분을 포함하여 Zone 3에 포함된다.)

7.0. CALIBRATION (장비 교정)

7.1. For solid (slab) forged crankshafts, the sensitivity of the instrument shall be adjusted so that the thickness to be examined will gives full-scale back reflection. Such calibration shall be done in an area free of interfering indications.
(단조 크랭크샤프트의 경우, 장비의 감도는 시험할 두께가 풀스케일의 저면지시를 제공하도록 조정해야 한다. 그러한 교정은 간섭지시가 없는 영역에서 실시해야 한다.)

7.2. For CGF crankshafts, 80 % of the full-scale back reflection is used when evaluating indications in accordance with Fig. 3.
(CGF 크랭크샤프트의 경우, 저면 지시가 풀스케일의 80 % 일 때 그림 3에 따라 지시를 평가한다.)

8.0. PROCEDURE (절차)

8.1. The crankshaft should be examined after heat treatment, but before machining geometric features such as chamfers and oil holes that could interfere with ultrasonic examination.
(크랭크샤프트는 열처리 후, 초음파 검사를 방해 할 수 있는 모따기 및 오일 구멍과 같은 기하학적 형상을 가공하기 전에 검사해야 한다.)

8.2. Unless otherwise specified by the purchase order, the scanned surfaces shall have a maximum surface roughness of 250μin. [6.35μm].
(구매 주문서에 별도의 규정이 없는 한, 주사하는 표면의 표면 거칠기는 최대 250μin[6.35μm]이어야 한다.)

8.3. The crankshaft shall be scanned as shown in Fig. 2.
(크랭크샤프트의 주사는 그림 2와 같이 하여야 한다.)

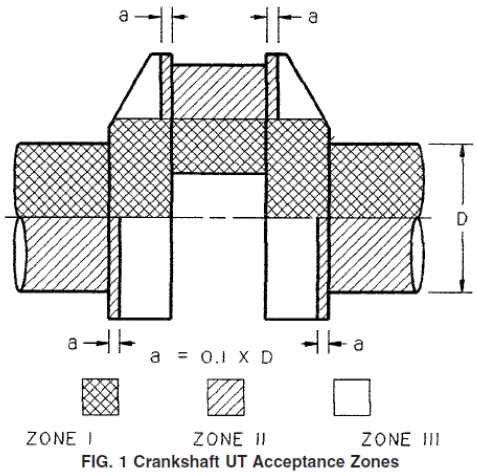

FIG. 1 Crankshaft UT Acceptance Zones

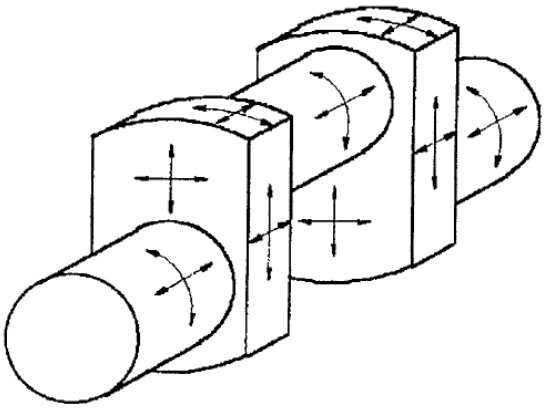

FIG. 2 Scanning Directions

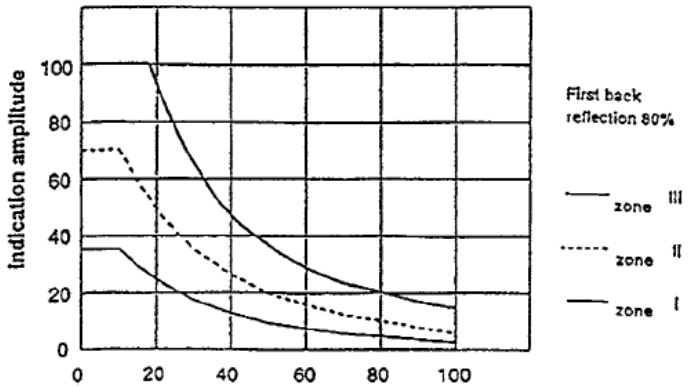

FIG. 3 Distance to Indication as Percentage of Cross-section

9.0. ACCEPTANCE CRITERIA (합격 기준)

9.1. Acceptance Zones (합부판단 구역)

9.1.1. For acceptance purposes, the crankshaft shall be divided into three zones as shown in Fig. 1.
(합부 판단을 위해 크랭크샤프트는 그림 1과 같이 3 개의 구역으로 나눈다.)

9.1.2. Because of crankshaft geometry, particularly for CGF crankshafts, the ultrasonic examination shall be carried out to the maximum extent possible.
(크랭크샤프트 형상 때문에, 특히 CGF 크랭크샤프트는, 초음파 검사는 가능한 한 최대로 수행하여야 한다.)

9.2. Solid Forged Crankshafts (단조 크랭크샤프트)

9.2.1. In Zone 1, indications equal to or greater than 20 % of the back reflection as established in 7.1 shall be cause for rejection.
(구역 1은, 7.1에서 설정된 바와 같이 저면 반사의 20 % 이상의 지시는 불합격이다.)

9.2.2. Indications in Zone 2 equal to or greater than 50 % of the back reflection shall be cause for rejection.
(구역 2에서 나타나는 지시 중 저면 반사의 50 % 이상은 불합격이다)

9.2.3. Indications in Zone 3 equal to or greater than 100 % of the back reflection shall be cause for rejection.
(구역 3에서 나타나는 지시 중 저면 반사의 100 % 이상은 불합격이다)

9.2.4. Loss of back reflection in excess of 50 % in any zone, and not caused by geometric configuration, shall be recorded in terms of size and location. Normally this condition shall be cause for rejection, but it may be referred to the purchaser for disposition.
(어떤 구역에서 50 % 를 초과하는 저면 반사 손실은 기하학적 형상에 기인하지 않고 크기와 위치의 관점에서 기록되어야 한다. 일반적으로 이 조건은 불합격의 원인이 되지만 구매자에게 처리를 의뢰 할 수 있다.)

9.3. Continuous Grain Flow Crankshafts (CGF) (연속 단류 크랭크샤프트)

9.3.1. Ultrasonic indications detected in CGF crankshafts shall be evaluated in accordance with Fig. 3. Indications that exceed the appropriate zone curve are cause for rejection.
(CGF 크랭크샤프트에서 검출 된 초음파 지시는 그림 3에 따라 평가한다. 적절한 영역 곡선을 초과하는 지시는 불합격이다.)

9.3.2. Loss of back reflection in excess of 50 % in any zone, and not attributable to geometric configuration shall be recorded in terms of percentage loss and location. Normally this condition shall be cause for rejection, but it may be referred to the purchaser for disposition.
(어떤 구역에서 50 % 를 초과하는 저면 반사 손실은 기하학적 형상에 기인하지 않고 손실률 및 위치의 비율로 기록해야 한다. 일반적으로 이 조건은 불합격의 원인이 되지만 구매자에게 처리를 의뢰 할 수 있습니다.)

10.0. POST-EXAMINATION CLEANING (후처리)

Post-examination cleaning is necessary in those cases where residual couplant or foreign material could interfere with subsequent processing or with service requirements. Those residual materials shall be completely removed by water rinse or other suitable technique.

(잔류접촉매질 또는 이물질이 후속공정에 방해가 되거나, 요구사항인 경우 세척제 또는 다른 적절한 방법으로 완전히 제거해야 한다.)

11.0. RECORDS (기록)

11.1. An ultrasonic examination report shall be completed for all examinations. As a minimum, the report shall contain the following:
(초음파탐상 보고서는 최소한 다음의 내용이 포함 되어야 한다.)

1) the examination procedure used with its revision number;
(절차서 식별번호 및 개정번호)
2) ultrasonic instrument identification (including manufacturer's serial number);
(초음파탐상 장치의 식별(제조자의 일련번호 포함)
3) search unit(s) identification (including manufacturer's serial number, frequency, and size;
(탐촉자 식별(제조자의 일련번호, 주파수, 크기 포함)
4) beam angle(s) used; (빔각도)
5) couplant used, brand name or type; (접촉매질, 상표명 또는 형식)
6) search unit cable(s) used, type and length; (탐촉자 케이블, 형식 및 길이)
7) identification and location of weld or volume scanned;
(주사한 용접부 또는 체적의 식별 및 위치)
8) calibration data [including reference reflector(s), indication amplitude(s), and distance reading(s)];
(교정데이터(대비 반사체, 지시 진폭 및 거리 눈금값 포함)
9) calibration block identification; (교정시험편 식별)
10) surface condition; (표면조건)
11) map or record of rejectable indications detected or areas cleared;
(검출한 불합격 대상 지시에 대한 또는 지시가 없는 부위에 대한 그림 또는 기록)
12) areas of restricted access or inaccessible (if requirement);
(접근이 제한되거나 불가능한 부위(필요시))
13) examination personnel identity and, when required by referencing Code Section, qualification level;
(비파괴검사원의 식별 및 적용 기술기준에서 요구할 경우 자격등급)
14) time and date of examination (검사를 실시한 시간 및 일자)

Report Form of Ultrasonic Examination (초음파탐상시험 보고서 양식)

REPORT OF ULTRASONIC TESTING

초 음 파 탐 상 시 험 보 고 서

한양종합검사

Report No. :

Page No. : of

Customer / Manufacturer 발 주 처 / 제 조 사	Project Name / Unit 공 사 명 / 호 기
Project No. 공 사 번 호	Item Name 제 품 명
Part Name. / No. 부 품 명 / 번 호	DWG. No 도면번호
☐ TRV No. ☐ MPP No. ☐ ITP No. ☐ QP No. Rev. Oper. (Seq.)	Procedure No. & Rev. No. 절차서/ Acceptance Criteria 합격기준
Material Type (재질) :	Thickness (두께) :
Examination Phase (검사시기) :	Method (검사방법): ☐ Contact ☐ Immerse
Surface Condition (표면상태) : ☐ As Welded ☐ As Ground ☐ As Machined ☐ As Rough Machined ☐ As Final Machined	

Equipment (장비)		Probe (탐촉자)					Calibration Block (교정시험편)	
ID No.		Maker	Type/Serial No	MHz	Size(mm)	Angle	Type	ID No.
Type								
Maker								
Serial No.								
Due Date								

Screen Height Linearity(직 선 성) : Within ± 5%	Amplitude Control Linearity(증 폭 성) : Within ± 20%

Setting Sensitivity Method (감도설정방법)				Couplant Type(접촉매질)
Probe (탐촉자)	Method (방법)	Standard(표준감도)	Scanning(주사감도)	☐ Glycerin ☐ Oil ☐ C.M.C ☐ Water
				Temp. Diff. (온도차)
				℃ (Block ℃ / Exam Part ℃)
				Search Unit Cable (등축케이블)
				Type : Length : meter

* Thermometer ID No. :

Joint (part) No. 이음(부품)번호	Result(결과)	Interpretation(평가)	Remarks(비고)

Examined / Evaluated By Level 검 사 자	☐ Witnessed By (입회자) ☐ Reviewed By (검토자)
Reviewed & Approved By Level 승 인 자	☐ Witnessed By (입회자) ☐ Reviewed By (검토자)

Hanyang Inspection & Engineering, Ltd. QF-UT-01-1(Rev.6)

한양종합검사 REPORT OF ULTRASONIC TESTING 초 음 파 탐 상 시 험 보 고 서		Report No. :	
		Page No. : of	
Joint (part) No. 이음(부품)번호	Result(결과)	Interpretation(평가)	Remarks(비고)

Examined / Evaluated By 검 사 자	Level	☐ Witnessed By (입회자) ☐ Reviewed By (검토자)
Reviewed & Approved By 승 인 자	Level	☐ Witnessed By (입회자) ☐ Reviewed By (검토자)

Hanyang Inspection & Engineering, Ltd. QF-UT-01-1(Rev.6)

Title (제목)	Ultrasonic Examination (MANUAL UT) (For heavy steel forgings / ASTM A388/A388M, ASME SA388)

Revision History (개정이력)			
Rev. No. (개정 번호)	Rev. Date (개정 날짜)	Reason of Revision (개정 사유)	Contents of Revision (개정 항목)
0		First Issue	-

Prepared by UT Level III	김현석 KIM, HYUN SEOK 서명	2022.07.21
Reviewed by UT Level III	김창수 KIM, CHANG SOO 서명	2022.07.21
Approved by UT Level III	김창수 KIM, CHANG SOO 서명	2022.07.21

Certified by **KWANGSHIN MACHINE INDUSTRY CO., LTD.**

QC Dep't Manager : _____ Date: _____

Table of Contents (목차)

1.0. SCOPE (적용범위)

1.1. This procedure covers the contact, pulse-echo ultrasonic examination of heavy steel forgings by the straight beam technique.
이 절차서는 단강품에 대한 수직, 접촉, 펄스-에코 초음파탐상시험에 대한 요건과 기법을 시술한다.

1.2. This procedures meets the requirements of the ASTM A388/A388M(ASME SA388).
본 절차서는 ASTM A388/A388M(ASME SA 388)의 요구조건을 만족한다.

2.0. REFERENCES (참고문헌)

2.1. ASME Sec. V, Art 5 : Ultrasonic Examination Methods for Materials (2021 Edition)

2.2. ASME Sec.V, Art 23 SA388 : Standard Practice for Ultrasonic Examination of Steel Forgings (2021 Edition)

2.3. ASTM A388 : Standard Practice for Ultrasonic Examination of Steel Forgings (2019Edition)

2.4. ASNT: SNT-TC-1A for NDT Personnel Qualification and Certification (2016 Edition)

2.5. HY-GD-06-03 Procedure for NDE Personnel Qualification and Certification

to be clarified.

3.0. GENERAL (일반사항)

3.1. In order to perform ultrasonic examination to this procedure, it may be necessary for the client to provide the following information.
이 절차에 따라 초음파검사를 하기 위해서는 구매자는 다음과 같은 정보를 제공해야 한다.

3.1.1. Method of establishing the sensitivity. 감도설정 방법

3.1.2. Designate the extent of testing. 검사 범위 지정

3.1.3. The acceptance standards. 합격기준

4.0. Personnel(검사원)

4.1 Personnel performing examination for this procedure shall be satisfied the requirement of **Hanyang Inspection & Engineering, Ltd.** written procedure “HY-GD-06-03” for NDE Personnel Qualification and Certification program which meets the requirements of ASNT Recommended Practice No. SNT-TC-1A.

(본 절차서에 따라 비파괴검사를 수행하는 검사자는 ASNT의 SNT-TC-1A를 만족하는 한양종합검사의 비파괴검사자 자격인정절차서 "HY-GD-06-03"에 따라 자격이 인정된 검사자 이어야 한다.)

4.2 Personnel performing UT within the scope of this procedure shall be at least UT Level II or Level III.
(본 절차서의 적용범위 내에서 UT검사를 수행하는 검사자들은 최소한 UT Level II 또는 Level III 이어야 한다.)

4.3 Personnel performing review/approval for the UT report within the scope of this specification shall be UT Level II or Level III other than UT examiner specified in para. 4.2.
(UT 보고서의 검토/승인을 수행하는 자는 4.2항에서 규정한 UT 검사자와는 다른 UT Level II 또는 Level III 이어야 한다.)

5.0. EQUIPMENT(장비)

5.1. Ultrasonic Test Instrument(초음파장비)

5.1.1. An ultrasonic, pulsed, reflection type of instrument shall be used for this examination. The system shall have a minimum capability for examining at frequencies from 1 to 5 MHz. On examining austenitic stainless forgings the system shall have the capabilities for examining at frequencies down to 0.4 MHz.
이 시험에는 펄스반사식 초음파탐상장치를 사용해야 한다. 이장치는 주파수 1~5 MHz 에서 시험할 수 있는 최소한의 성능을 갖추어야 한다. 오스테나이트계 스테인레스강 단강품의 시험 시, 시스템은 0.4 MHz 이하의 주파수에서 시험할 수 있는 성능을 갖추어야 한다.

5.1.2. The ultrasonic instrument shall provide linear presentation (within 5%) for at least 75% of the screen height (sweep line to top of screen). The 5% linearity referred to is descriptive of the screen presentation of amplitude.
초음파탐상장치는 최소한 스크린 높이(소인선에서 스크린의 최상단까지)의 75%에 대하여 5% 이내의 직선성이 있어야 한다. 5% 직선성은 진폭의 스크린 표시를 설명하기 위해 적용된다.

5.1.3. The electronic instrument shall contain an attenuator [accurate over its useful range to ± 10%(± 1dB) of the amplitude ratio] which will allow measurement of indications beyond the linear range of the instrument.
전자장치는 장치의 직선성 범위를 초과하는 지시도 측정이 가능하도록 감쇠기(진폭비의 유효 범위가 ±10%(±1dB) 초과하는 정밀도를 갖는)를 갖추어야 한다.

5.1.4. The following instruments or equivalent shall be used with this procedure.
이 절차서에 사용되는 장비는 아래와 같거나 동등한 장비를 사용한다.

Type	Model	Manufacturer
Pulse-Echo	USM GO, D20+	GE, SONATEST

5.1.5. Basic qualification of the ultrasonic test instrument shall be performed at intervals not to exceed 12 months or whenever maintenance is performed that affects the equipment function. The date of the last calibration and the date of the next required calibration shall be displayed on the test equipment.
초음파탐상장치의 기본 인정은 12 개월을 초과하지 않는 간격으로 또는 장비 기능에 영향을 주는 유지 보수가 수행될 때마다 수행되어야 한다. 마지막 교정 일자와 다음에 요구되는 교정 일자가 시험 장비에 표시되어야 한다.

5.2. Search Units(탐촉자)

5.2.1. The ultrasonic search units in the following table or equivalent shall be used.
탐촉자는 아래 표 및 이와 동등한 것이 사용되어야 한다.

type	Manufacturer (제조사)	Model	Frequency (㎒)	transducer size (㎜)
Straight beam	TKS TKS Krautkramer	1C24N, 2C24N MB4SE	1 2 4	Φ24 Φ24 Φ10

5.2.2 Other search units may be used for evaluating and pinpointing indications.
지시의 평가 및 위치지정을 위해 다른 탐촉자가 사용될 수 있다.

5.3. Couplant(접촉매질)

5.3.1. Couplants having good wetting characteristics such as SAE No.20 or No.30 motor oil, glycerin, or water shall be used. Couplants may not be comparable to one another and the same couplant shall be used for calibration and examination.
SAE No. 20 또는 No.30 기계유, 글리세린 또는 물과 같은 좋은 적심성을 가진 접촉매질이 사용되어야 한다. 한 접촉매질이 다른 접촉매질과 특성이 다를 수 있으므로, 동일한 접촉매질이 교정 및 시험에 사용되어야 한다.

5.4. Reference Blocks(대비시험편)

5.4.1. Reference Blocks containing flat bottom holes may be used for calibration of equipment in accordance with 5.1.2 and may be used to establish recording levels for straight-beam examination when so specified by the order or contract.

평저공이 있는 대비시험편은 5.1.2 에 따라 장비 교정에 사용될 수 있고, 주문서 또는 계약서에 규정된 경우, 수직빔 시험에 기록수준을 정하기 위해 사용될 수 있다.

6.0. PREPARATION OF FORGING FOR ULTRASONIC EXAMINATION

초음파탐상시험을 위한 단강품의 준비

6.1. Unless otherwise specified in the order or contract, the forging shall be machined to provide cylindrical surfaces for radial examination in the case of round forgings; the ends of forgings shall be machined perpendicular to the axis of the forging for the axial examination. Faces of disk and rectangular forgings shall be machined flat and parallel to one another.

주문서 또는 계약서에 달리 규정되지 않는 한, 단강품은 원형 단강품의 경우 반지름 방향의 시험이 가능하도록 원주표면을 가공해야 한다; 단강품의 끝 부분은 축방향 시험을 위해 단강품의 축과 수직으로 가공해야 한다. 원판(disk) 및 직사각형 단강품의 표면은 평활하게 가공해야 하고 반대쪽 면과 평행해야 한다.

6.2. The surface roughness of exterior finishes shall not exceed 250μin.(6μm) unless otherwise shown on the forging drawing or stated in the order or the contract.

외면가공의 표면거칠기는 단강품 도면에 달리 나타나거나 주문서 또는 계약서에 달리 언급하지 않는 한 6μm 를 초과해서는 안 된다.

6.3. The surfaces of the forging to be examined shall be free of extraneous material such as loose scale, paint, dirt, etc.

시험될 단강품의 표면은 들뜬 스케일, 페인트, 오염물 등과 같은 이물질이 없어야 한다.

7.0. PROCESS (절차)

7.1. General (일반사항)

7.1.1. As far as practicable, subject the entire volume of the forging to ultrasonic examination.

가능한 한 단강품의 전체 체적에 대해 초음파탐상시험을 실시한다.

7.1.2. Perform the ultrasonic examination after heat treatment for mechanical properties (exclusive of stress-relief treatments) but prior to drilling holes, cutting keyways, tapers, grooves, or machining sections to contour.

기계적 성질(응력제거 열처리 제외)을 위해 열처리 후에 초음파탐상시험을 실시해야 하지만, 드릴가공 구멍, 키웨이 절단, 테이퍼, 그루브 또는 외형 가공부는 가공 전에 초음파탐상시험을 한다.

7.1.3. To assure complete coverage of the forging volume, index the search unit with at least 15 percent (15%) overlap with each pass.

단강품 체적의 전체 범위를 확인하기 위해 탐촉자를 최소한 각 패스(pass)마다 15% 중첩시킨다.

7.1.4. Do not exceed a scanning rate of 6in./s (150 ㎜/s).
주사속도는 150 ㎜/s(6in./s)를 초과해서는 안 된다.

7.1.5. If possible, scan all sections of forgings in two perpendicular directions.
가능한 한 단강품의 모든 단면을 서로 수직되는 두 방향에서 주사한다.

7.1.6. Scan disk forgings using a straight beam from at least one flat face and radially from the circumference, whenever practicable.
가능한 한 원판형 단강품을 최소한 한쪽 평면에서 수직 빔을 사용하여 원주로부터 반지름 방향으로 주사한다.

7.1.7. In Rechecking or reevaluation by manufacturer or purchaser, use comparable equipment, search unit, Frequency, and couplant.
판매자 또는 구매자가 재검사 또는 재평가할 때는 동등한 장치, 탐촉자, 주파수, 접촉매질을 사용해야 한다.

7.2. Straight-Bean

7.2.1. For straight
however, 1
testing dist
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desirable fe
수직 빔의
입도가 조
탐촉자를
주파수가
또는 결함

Use the back reflection from the opposite side of the part as a calibration standard to set the sensitivity for the test. The two surfaces (entry surface and the reflecting surface) must be parallel to each other. Place the transducer in an area of the forging, when possible, so that the geometry will not have an effect on the beam spread. Increase the gain to obtain a 75 % full screen height back reflection, increase the gain by up to an additional 20 dB (10:1). If no indications are present (indication free) return the gain to the original dB setting of the 75 % full screen height (1:1), this will be the reference level. Scanning should be done at a level greater than the reference level, such as 6 dB (2:1). During the scanning, the back reflection shall be monitored for any significant loss of amplitude not attributed to the geometry. Carry out the evaluationofdiscontinuitieswiththegaincontrolsetatthereference level (75 % full screen height). Recalibration is required for significant changes in section thickness or diameter.

7.2.2. Establish the instrument sensitivity by either the back reflection or reference-block technique.
저면반사기법 및 대비시험편교정에 의한 장치감도 설정

1) Back-Reflection Technique 저면 반사 기법

With the attenuator set at an appropriate level, for example 5 to 1 or 14 dB, adjust the instrument controls to obtain a back reflection approximately 75% of the full screen height from the opposite side of the of the forging. Scan the forging at the maximum amplification setting of the attenuator (attenuator set at 1 to 1). Carry out the evaluation of discontinuities with the gain control set at the reference level. Recalibration is required for significant changes in section thickness or diameter.

감쇠기를 적정한 수준으로 설정하고, 단강품의 반대쪽 면으로부터 전 스크린 높이의 약 75%인 저면 반사가 되도록 장치 조정기를 조절한다. 감쇠기의 최대 진폭 설정값(감쇠기를 1:1 로 설정한다.)에서 단강품을 주사한다. 이득 조정을 대비수준에 맞추어 불연속부 평가를 수행한다. 재교정은 단면두께 또는 지름의 중대한 편화가 있을 때 요구된다.

2) Reference-Block Technique (대비시험편 기법)

The test surface roughness on the calibration standard shall be comparable to but no better than the item to be examined. Adjust the instrument controls to obtain the required signal amplitude from the flat bottom hole in the specified reference block. Utilized the attenuator in order to set up on amplitudes larger than the vertical linearity of the instrument. In those cases, remove the attenuation prior to scanning the forging.

교정기준에서 시험표면의 거칠기는 시험 대상과 비슷해야 하며 더 나빠서는 안 된다. 규정된 대비시험편의 평저공으로부터 요구되는 신호진폭을 얻을 수 있도록 장치 조정기를 조절한다. 장치의 수직 직선성보다 큰 진폭을 설정하기 위해 감쇠기를 이용한다. 이러한 경우, 단강품을 주사하기 전에 감쇠를 제거한다.

7.2.3. Recalibration (재교정)

Any change in the search unit, couplant, instrument setting, or scanning speed from that used for calibration shall require recalibration. Perform a calibration check at least once every 8 hours shift. When a loss of 15% or greater in the gain level is indicated, reestablish the required calibration and reexamine all of the material examined in the preceding calibration period. When an increase of 15% of greater in the gain level is indicated, reevaluate all recorded indications.

교정에 사용된 탐촉자, 접촉매질, 장치설정 또는 주사속도에 어떤 변동이 있으면 재교정이 필요하다. 8 시간마다 최소한 1 번은 교정점검을 실시한다. 이득수준의 손실이 15% 이상 나타나는 경우, 필요한 교정을 재설정하고 교정기간 전에 시험된 모든 재료는 재시험한다. 이득수준의 증가가 15% 이상 나타나는 경우, 기록된 모든 지시를 재평가한다.

7.2.4. During the examination of forging, monitor the back reflection for any significant reduction in amplitude. Reduction in back-reflection amplitude may indicate not only the presence of a discontinuity but also poor coupling of the search unit with the surface of the forging, nonparallel back - reflection surface, or local variations of attenuation in the forging. Recheck any areas causing loss of back reflection.

단강품을 시험하는 동안, 진폭이 현저히 감소하는지에 대해 저면 반사를 관찰한다. 저면 반사 진폭의 감소는 불연속부의 존재뿐 아니라 단강품의 표면과 탐촉자의 접촉불량, 평행하지 않은 저면 반사 표면 또는 단강품의 국부적 감쇠변화를 나타낼 수도 있다. 저면 반사의 손실을 일으키는 부위는 재시험을 실시한다.

8.0. RECORDING (기록)

8.1. Straight-Beam Examination (수직 빔 시험)

Record the following indications as information for the purchaser. These recordable indications do not constitute a rejectable condition unless negotiated as such in the purchase order.
구매자를 위한 정보로서 다음의 지시를 기록한다. 기록해야 할 이들 지시는 구매주문서에 규정하지 않는 한 불합격 상태로 규정해서는 안 된다.

8.1.1. For individual indications, report (단독지시)

1) In the back-reflection technique, individual indications equal to or exceeding 10% of a nominal back reflection from an adjacent area free from indications, and
저면 반사 기법에서 지시가 없는 인접부분으로부터 저면 반사의 10% 이상인 단독지시

Note: individual indication : single indications showing a decrease in amplitude as the search unit is moved in any direction from the position of maximum amplitude and which are too small to be considered traveling or planar.
비고: 단독지시 : 탐촉자가 최고 진폭을 나타내는 위치로부터 어떤 방향으로 움질일 때 진폭이 감소하는 단일지시이며, 너무 작기 때문에 평면 또는 이동지시로 간주하지 않는다.

2) In the reference-block, indications equal to or exceeding 100% of the reference amplitude.
대비시험편기법에서 대비진폭의 100% 이상인 지시

8.1.2. For indications that are planar, traveling, or clustered, determine the location of the edges and the major and minor axes using the half-amplitude (6dB drop) technique and report:
평면, 이동 또는 군집 지시의 경우, 6dB 기법을 사용하여 지시의 모서리와 주축 및 소축의 위치를 결정하여 기록한다.

1) The variation in depth or planar area, or both, of traveling indications,
이동지시의 깊이 또는 평면 면적, 또는 두가지 모두의 변화,

2) The length of major or minor axes of planar indications, and
평면지시의 긴 쪽 및 짧은 쪽의 길이

3) The volume occupied by indication levels and the amplitude range.
지시수준 및 진폭 범위가 차지하는 체적

9.0. REPORTS (보고서)

9.1. The report shall include the following.
다음과 같은 사항을 포함한다.

9.1.1. All recordable indications (see Section 8).
기록해야 할 모든지시

9.1.2. For the purpose of reporting the locations of recordable indications, a sketch shall be prepared showing the physical outline of the forging including dimensions of all areas not inspected due to geometric configuration, the purchaser's drawing number, the purchaser's order number, and the manufacturer's serial number, and the axial, radial, and circumferential distribution of recordable ultrasonic indications.
기록해야 할 지시의 위치를 나타내고자 할 경우, 기하학적 형상으로 인해 시험되지 않은 모든 부위의 치수, 구매자의 도면번호, 구매자의 주문번호, 제조자의 제조번호 및 기록해야 할 초음파탐상지시의 축방향, 반지름 방향 및 원주방향 분포를 포함한 단강품의 외형을 나타내는 스케치 및 사진을 첨부한다.

9.1.3. The designation (including year date) to which the examination was performed as well as the frequency used, method of setting sensitivity, type of instrument, surface finish, couplant, and search unit employed.
시험에 사용된 주파수, 감도설정법, 장치의 종류, 표면마무리, 접촉매질, 탐촉자 및 시방서

9.1.4. An examination report shall be signed and dated by the qualified and certified Level II and approved by the Level II or Level III.
자격인증된 시험요원의 서명 및 시험일자

9.2. Examination report shall be prepared and furnished to the client. Report of Ultrasonic Examination may be used unless otherwise specified by client.
검사 보고서는 작성하여 주문주에게 제출하며, 주문주가 특별히 요구하지 않는 한 예시의 보고서를 사용한다.

9.3. The inspection report review and approver will review the entire inspection report.
검사 보고서 검토 및 승인자는 검사 보고서 전체 내용을 검토한다.

9.4. Review the inspection report by reviewing the inspection report.
검사 보고서 검토를 위해서 확인 점검표를 작성하여 검사 보고서를 검토한다.

10.0. QUALITY LEVELS (품질수준)

10.1. Acceptance standard (합격기준)_ASTM A 388/SA 388

10.1.1. No indications larger than 20 percentage of the reference back reflection.
대비 저면 반사의 20%보다 큰 지시가 없을 것.

10.1.2. No areas showing loss of back reflection larger than 50 percentage of the reference back reflection.
대비 저면 반사의 50%보다 큰 저면 반사의 손실을 나타내는 부위가 없을 것.

10.1.3. No indications equal to or large than the indication received form the flat-bottom hole in a specific reference block or blocks.
규정된 대비시험편의 평저구멍으로부터 수신된 지시와 같거나 큰 지시가 없어야 한다.

10.1.4. No indications per 10.1.1 or 10.1.3 coupled with some loss of resultant back reflection per 10.1.2.
10.1.2 에 따라 결과적인 저면반사의 손실과 결합하여 10.1.1 또는 10.1.3 에 따른 지시가 없어야 한다.

Report Form of Ultrasonic Examination (A)

REPORT OF ULTRASONIC EXAMINATION 초 음 파 탐 상 검 사 보 고 서	Report No. : Page No. : of

Customer / Manufacturer 발 주 처 / 제 조 사	Project Name / Unit 공 사 명 / 호 기
Project No. 공 사 번 호	Item Name 제 품 명
Part Name. / No. 부 품 명 / 번 호	DWG. No 도면번호
☐ TRV No. ☐ MPP No. ☐ ITP No. ☐ QP No. Rev. Oper. (Seq.)	Procedure No. & Rev. No. 절차서/ Acceptance Criteria 합격기준
Material Type (재질) :	Thickness / Size (두께/치수)
Examination Phase (검사시기) :	Method (검사방법): ☐ Contact ☐ Immerse
Surface Condition (표면상태) : ☐ As Welded ☐ As Ground ☐ As Machined ☐ As Rough Machined ☐ As FInal Machined	
Date of the Exam.(검사일) :	Place of Exam.(검사장소):

Equipment (장비)		Probe (탐촉자)					Calibration Block (교정시험편)	
ID No.		Maker	Type/Serial No	MHz	Size(mm)	Angle	Type	ID No.
Type								
Maker								
Serial No.								
Due Date								

Screen Height Linearity(직 선 성) : Within ± 5%	Amplitude Control Linearity(증 폭 성) : Within ± 20%

Setting Sensitivity Method (감도설정방법)				Couplant Type(접촉매질)
Probe (탐촉자)	Method (방법)	Standard(표준감도)	Scanning(주사감도)	☐ Glycerin ☐ Oil ☐ C.M.C ☐ Water
				Temp. Diff. (온도차)
				℃ (Block ℃ / Exam. Part ℃)
				Search Unit Cable (동축케이블)
				Type : Length : meter

* Thermometer ID No. :

Joint (part) No. 이음(부품)번호	Result(결과)	Interpretation(평가)	Remarks(비고)

Examined & Evaluated By (검사 및 평가) 검 사 자	Level(등급)	☐ Witnessed By (입회자) ☐ Reviewed By (검토자)
Reviewed & Approved By (검토 및 승인) 승 인 자	Level(등급)	☐ Witnessed By (입회자) ☐ Reviewed By (검토자)

Hanyang Inspection & Engineering, Ltd. QF-UT-01-1(Rev.8)

Report Form of Ultrasonic Examination (B)

한양종합검사 REPORT OF ULTRASONIC EXAMINATION 초 음 파 탐 상 검 사 보 고 서			Report No. : Page No. : of
Joint (part) No. 이음(부품)번호	Result(결과)	Interpretation(평가)	Remarks(비고)
Examined & Evaluated By (검사 및 평가) 검 사 자	Level(등급)	☐ Witnessed By (입회자) ☐ Reviewed By (검토자)	
Reviewed & Approved By (검토 및 승인) 승 인 자	Level(등급)	☐ Witnessed By (입회자) ☐ Reviewed By (검토자)	

Hanyang Inspection & Engineering, Ltd. QF-UT-01-1(Rev.8)

Title (제목)	Liquid Penetrant Examination Procedure

Revision History (개정이력)			
Rev. No. (개정 번호)	**Rev. Date (개정 날짜)**	**Reason of Revision (개정 사유)**	**Contents of Revision (개정 항목)**
0		First Issue	-

Prepared by PT Level III	김현석 KIM, HYUN SEOK 서명	2022.07.21
Reviewed by PT Level III	김창수 KIM, CHANG SOO 서명	2022.07.21
Approved by PT Level III	김창수 KIM, CHANG SOO 서명	2022.07.21

Certified by **KWANGSHIN MACHINE INDUSTRY CO., LTD.**

QC Dep't Manager : _____ Date: _____

Table of Contents (목차)

1.0 Scope (적용 범위)

1.1 This procedure is to govern color contrast penetrant technique, solvent removable technique of the liquid penetrant examination.
(이 절차서는 용제제거성 액체 염색 침투탐상기법에 대해 규정한다.)

1.2 This procedure is applied to the products with carbon, low alloy, high alloy and nonferrous materials. The materials, shapes or sizes to be examined, and the extent of the examination shall be based on fabrication drawing.
(이 절차서는 탄소강, 저합금강, 고합금강과 비철금속으로 만들어진 재료에 적용한다. 탐상되는 시험품의 크기 및 모양 그리고 탐상면적에 대해서는 제작도면을 근거로 해야 한다.)

2.0 Reference Documents (참고 문서)

2.1 ASME Sec.I : Rules for Construction of Power Boiler (2021 Edition)

2.2 ASME Sec.V Article 6 : Liquid Penetrant Examination (2021 Edition)

2.3 ASME Sec.V Article 24 : Liquid Penetrant Standards (2021 Edition)

2.4 ASME Sec.VIII Div.1 : Rules for Construction of Pressure Vessel (2021 Edition)

2.5 ASME B 31.1 : Power Piping (2020 Edition)

2.6 ASME B31.3 : Process Piping (2020 Edition)

2.7 ASTM E165/E165M : Standard Particle for Liquid Penetrant Examination (2018 Edition)

2.8 ASNT : SNT-TC-1A for NDT Personnel Qualification and Certification (2016 Edition)

2.9 HY-GD-06-03 : Procedure for NDE Personnel Qualification and Certification

3.0 Personnel (검사자)

3.1 Personnel performing examination for this procedure shall be satisfied the requirement of **Hanyang Inspection & Engineering, Ltd.** written procedure “HY-GD-06-03” for NDE Personnel Qualification and Certification program which meets the requirements of ASNT Recommended Practice No. SNT-TC-1A.
(본 절차서에 따라 비파괴검사를 수행하는 검사자는 ASNT의 SNT-TC-1A를 만족하는 한양종합검사의 비파괴검사자 자격인정절차서 “HY-GD-06-03”에 따라 자격이 인정된 검사자 이어야 한다.)

3.2 Personnel performing PT within the scope of this procedure shall be at least PT Level II or Level III.

(본 절차서의 적용범위 내에서 PT검사를 수행하는 검사자들은 최소한 PT Level II 또는 Level III 이어야 한다.)

3.3 Personnel performing review/approval for the PT report within the scope of this specification shall be PT Level II or Level III other than PT examiner specified in para. 3.2.
(PT 보고서의 검토/승인을 수행하는 자는 3.2항에서 규정한 PT 검사자와는 다른 PT Level II 또는 Level III 이어야 한다.)

4.0 Equipment (장비)

4.1 Material (재료)

The following materials shall be used in this procedure. For the examination of nickel base alloys, austenitic stainless steels, and titanium, the residual total halogen and sulfur content be in accordance with 5.1 in this procedure. Intermixing of penetrant materials from different families or different manufactures is not permitted.
(다음 재료를 사용한다. 니켈계열 합금, 오스테나이트 스테인리스 강, 티타늄에 대한 시험 경우 할로겐 및 황 잔류 함량은 본 절차서 5.1항에 따른다. 그룹이 다르거나 제조자가 다른 탐상재료의 혼합은 허용되지 않는다.)

Penetrant Materials	Model	Type	Manufacturer
Removers	NPR 1-3	Solvent	NAWOO
Penetrants	NPP-2	Visible	
Developers	NPD-4	Nonaqueous	

5.0 Miscellaneous Requirements (기타 요건)

5.1 Control of Contaminants (불순물 관리)

Hanyang Inspection & Engineering, Ltd. shall obtain certification of contaminant content for all liquid penetrant materials used on nickel base alloys, austenitic or duplex stainless steels, and titanium. These certifications shall include the penetrant manufacturers' batch numbers and the test results obtained in accordance with Appendix 1 of this procedure. These records shall be maintained as required by the referencing Code Section.
(한양종합검사는 니켈 기저합금, 오스테나이트 또는 듀플렉스 스테인리스강 및 티타늄 합금에 사용되는 모든 침투탐상제의 불순물 함량에 대한 시험성적서를 확보하여야 한다. 이 시험성적서는 제조자의 제조번호와 본 절차서 부록 1 요건에 따른 시험결과를 포함하여야 한다. 이 기록은 적용 기술기준에 요구된 대로 관리되어야 한다.)

5.2 Surface Preparation (표면 준비)

5.2.1 In general, satisfactory results may be obtained when the surface of the part is in the as-welded, as-rolled, as-cast, or as-forged condition. Surface preparation by grinding, machining, or other methods may be necessary where surface irregularities could mask indications. Blasting with short or dull sand shall not to be used because it may peen discontinuities at the surface.
(일반적으로, 검사품의 표면이 용접, 압연, 주조 또는 단조상태인 경우는 만족한 결과를 얻을 수 있다. 불연속 지시를 가릴 우려가 있는 불균일한 표면은 연삭, 기계가공 또는 기타의 방법으로 표면준비를 할 수 있다. 가늘거나 무딘 모래를 이용한 블라스팅은 표면에서 불연속을 두드려 막을 수 있기 때문에 사용되어서는 안 된다.)

5.2.2 Prior to each liquid penetrant examination, the surface to be examined and all adjacent areas within at least 1 in. (25 mm) shall be dry and free of all dirt, grease, lint, scale, welding flux, weld spatter, oil and other extraneous matter that could obscure surface openings or otherwise interfere with the examination.
(각 침투탐상검사 전에 검사할 면 및 인접한 1인치 (25 mm) 이상의 모든 부위는 건조되어야 하고, 표면 개구부를 불명료하게 하거나 침투탐상검사를 방해하는 오물, 그리스, 보푸라기, 스케일, 용접플럭스, 용접스패터, 도장, 기름 및 기타 이물질이 없어야 한다.)

5.2.3 Typical cleaning agents which may be used are detergents, organic solvents, descaling solutions and paint removers. Degreasing and ultrasonic cleaning methods may also be used.
(대표적인 세척제로는 세제, 유기용제, 스케일제거제 및 도장제거제를 사용할 수 있으며, 탈지세정 및 초음파 세정법도 사용할 수 있다.)

5.2.4 Cleaning solvents shall meet the requirements of 5.1. The cleaning method employed is an important part of the examination process.
(세척제는 5.1의 요구조건을 만족해야 한다. 적용되는 세척방법은 침투탐상검사의 중요한 공정이다.)

5.3 Drying after Preparation (표면 준비후 건조)

After cleaning, drying of the surfaces to be examined shall be accomplished by normal evaporation or with forced hot or cold air. A minimum drying time for the surface shall be 3 minutes prior to application of the penetrant.
(세척 후 검사면은 자연증발, 온풍강제순환 또는 냉풍강제순환으로 건조하여야 한다. 침투액을 적용하기 전 표면 최소건조 시간은 3분이어야 한다.)

6.0 Technique (기법)

6.1 Technique for Standard Temperature (표준온도에서의 기법)

As a standard technique, the temperature of the penetrant and the surface of the part to be processed shall not be below 40°F (5°C) nor above 125°F (52°C) throughout the examination

period. Local heating or cooling is permitted provided the part temperature remains in the range of 40°F (5°C) to 125°F (52°C) during the examination.
(표준온도에 대한 기법을 적용하는 침투탐상검사는 침투액 및 검사할 부품표면의 온도를 검사 동안에 40°F (5°C) 미만 또는 125°F (52°C) 초과하면 안 된다. 검사 중에 부품온도를 40°F (5°C) ~ 125°F (52°C) 범위로 유지한다면 국부가열 또는 냉각이 허용된다.)

6.2 Light meter and Thermometer Calibration (조도계 및 온도계 교정)

Light meters and thermometer shall be calibrated at least once a year or whenever the meter has been repaired. If meters have not been in use for one year or more, calibration shall be done before being used.
(조도계 및 온도계는 1년 이내에 최소 한번은 교정하여야 하며, 장치를 수리하였을 경우에도 교정하여야 한다. 만약 측정기가 1년 또는 그 이상 사용하지 않은 경우 사용하기 전에 교정을 하여야 한다.)

7.0 Examination (검사)

7.1 Penetrant Application (침투액 적용)

The penetrant may be applied by any suitable means, such as brushing.
(침투액은 솔질과 같은 적절한 방법으로 적용한다.)

7.2 Penetration (Dwell) Time (침투 시간)

Penetration (dwell) time is critical. The minimum penetration time shall be as required in Table 3 for standard temperature range from 40 °F (5 °C) to 125 °F (52 °C). The maximum dwell time shall not exceed 2 hr. Regardless of length of the dwell time, the penetrant shall not be allowed to dry. If for any reason the penetrant does dry, the examination procedure shall be repeated, beginning with a cleaning of the examination surface.
(침투(유지) 시간은 중요하다. 최소 침투시간은 표준온도 40 °F (5 °C) ~ 125 °F (52 °C)에서 표 3에 따라 적용해야 한다. 침투(유지) 시간은 최대 2시간을 초과하면 안 된다. 침투(유지) 시간의 길이와 상관없이 침투제가 건조되게 놔둬서는 안 된다. 만약 어떠한 이유로 침투제가 건조되면 검사표면의 전처리를 포함하여 처음부터 재검사해야 한다.)

Table 3: Minimum Dwell Time (침투액 최소 적용 시간)

Material	Form	Type of Discontinuity	Dwell Times Penetrant
Aluminum, magnesium, steel, brass and bronze, titanium and high-temperature alloys	Castings and welds	Cold shuts, porosity, lack of fusion, cracks (all forms)	5
	Wrought materials-extrusions, forgings, plate	Laps, cracks	10

Note: For temperature range from 50 °F (10 °C) to 125 °F (52 °C). For temperatures from 40 °F (5 °C) up to 50 °F (10 °C), minimum penetrant dwell time shall be 2 times the value listed.
(온도범위는 50 °F (10 °C)~125 °F (52 °C)이다. 온도범위 40 °F (5 °C) ~ 50 °F (10 °C)에서 최소 침투시간은 상기 표에 기술된 시간의 2배이어야 한다.)

7.3 Excess Penetrant Removal (과잉 침투액의 제거)

After the specified penetration (dwell) time has elapsed, any penetrant remaining on the surface shall be removed, taking care to minimize removal of penetrant from discontinuities.
(규정된 침투시간이 경과한 후, 불연속부에서 최소량의 침투액이 제거되도록 주의하면서 표면에 잔류한 침투액을 제거하여야 한다.)

7.3.1 Solvent Removable Penetrant (용제 제거성 침투액)

Excess solvent removable penetrants shall be removed by wiping with a clean, dry, lint-free cloth or absorbent paper, repeating the operation until most traces of penetrant have been removed. The remaining traces shall be removed by lightly wiping the surface with cloth or absorbent paper, lightly moistened with solvent. To minimize removal of penetrant from discontinuities, care shall be taken to avoid the use of excess solvent. Flushing the surface with solvent, following the application of the penetrant and prior to developing, is prohibited.
(잉여의 용제 제거성 침투액은 침투액의 흔적이 거의 없어질 때까지 깨끗하고, 마르고, 보프라기가 없는 천 또는 흡수성이 있는 종이로 문지르는 조작을 반복하여 제거해야 한다. 잔류하고 있는 흔적은 용제를 가볍게 묻힌 천 또는 흡수성이 있는 종이로 표면을 가볍게 문질러 제거해야 한다. 불연속부 내부로부터 침투액이 최소한도로 제거될 수 있도록 과잉의 용제를 사용하지 않도록 주의해야 한다. 침투액 적용 후 현상처리 전에 용제를 표면에 흘리는 것은 금지한다.)

7.4 Drying After Excess Penetrant Removal (과잉 침투액 제거 후 건조)

For the solvent removable technique, the surfaces may be dried by normal evaporation, blotting, wiping, or forced air. After removal of excess penetrants, the surfaces shall be dried not more than 30 minutes by normal evaporation.
(용제 제거성 침투액을 적용하는 경우, 표면은 자연증발, 빨아들이기, 문지르기, 또는 강제공기로써 건조시킨다. 과잉 침투액 제거 후, 시험 표면은 자연 증발에 의해 30분를 초과하여 건조되어서는 안 된다.)

7.5 Developing (현상)

The developer shall be applied as soon as possible after penetrant removal. The interval time shall not exceed 30 minutes. With color contrast penetrants, only a wet developer shall be used.
(현상제는 침투액을 제거한 후 가능한 한 빨리 적용해야 한다. 시간 간격은 30분을 초과해서는 안 되며, 염색침투제를 현상할 때는 습식현상제만을 사용해야 한다.)

7.5.1 Wet Developer Application (습식현상제 적용)

a) Nonaqueous developers shall be applied by spraying. For solvent removable penetrants, the developer may be applied as soon as practical after excess penetrant removal. Drying shall be by normal evaporation.
(비수성현상제는 분무법으로 적용해야 한다. 용제 제거성 침투제의 경우, 현상제는 가능한한 과잉침투제가 제거된 후 바로 적용한다. 건조는 자연증발에 의해 이루어져야 한다.)

b) The nonaqueous developer made by shall be applied by spraying.
(비수성 현상제는 표면이 완전히 덮일 때까지 분무법으로 적용한다.)

c) Prior to applying developer to the surface, the developer shall be thoroughly agitated to ensure adequate dispersion of suspended particles. The application of excessive developer shall be avoided, since it is possible for a thick coating of developer to mask indications. Conversely, a developer coating too thin in application prevents adequate background contrast from being achieved, and may not draw in the penetrant out of discontinuities.
(시험표면에 현상제를 적용하기 전에 부유분말이 충분히 분산되어 있는 것을 확실히 하도록 현상제를 잘 교반해 주어야 한다. 과잉의 현상 막 두께는 지시모양을 가릴 수 있기 때문에 과잉현상이 되지 않도록 해야 한다. 역으로 현상 막 두께가 너무 얇으면 충분한 대비 배경의 형성이 어렵고, 불연속으로부터 침투액의 지시가 나타나지 않을 수 있다.)

7.5.2 Developing Time (현상 시간)

Developing time for final interpretation begins immediately after the application of a dry developer or as soon as a wet developer coating is dry.
(최종 판독의 현상시간은 건식현상제 적용직후 또는 습식현상제의 현상막이 건조되는 시점으로부터 시작한다.)

8.0 Interpretation (판독)

8.1 Final Interpretation (최종 판독)

Final interpretation shall be made not less than 10 min. nor more than 60 min. after the requirements of 7.5.2 are satisfied. If bleed-out does not alter the examination results, longer periods are permitted. If the surface to be examined is large enough to preclude complete examination within the prescribed or established time, the examination shall be performed in increments.
(최종 판독은 7.5.2의 요건이 만족된 후 10~60분 사이에 종료되어야 한다. 지시모양이 변형되지 않는 경우, 보다 긴 기간도 허용된다. 검사할 표면이 크고, 규정된 시간 내에 완전히 검사할 수 없는 표면은 단계적으로 나눠서 검사해야 한다.)

8.2 Characterizing Indications (지시모양의 특징)

The type of discontinuities are difficult to evaluate if the penetrant diffuses excessively into the developer. If this condition occurs, close observation of the formation of indication during application of the developer may assist in characterizing and determining the extent of the indications.
(침투액이 현상중에 과잉으로 퍼져 있을 경우, 불연속 종류의 평가가 곤란하다. 이러한 상태가 발생한 경우, 현상제 적용중의 지시모양 형성의 자세한 관찰은 지시모양의 범위를 특성화하거나 결정하는데 도움이 된다.)

8.3 Color Contrast Penetrants (염색 침투액)

With a color contrast penetrant, the developer forms a reasonably uniform white coating. Surface discontinuities are indicated by bleed-out of the penetrant which is normally a deep red color that stains the developer. Indications with a light pink color may indicate excessive cleaning. Inadequate cleaning may leave an excessive background making interpretation difficult. Illumination (natural or supplemental white light) of the examination surface is required for the evaluation of indications. The minimum light intensity shall be 100 fc (1,076 lx). The light intensity, natural or supplemental white light source, shall be measured with a white light meter prior to the evaluation of indications or a verified light source shall be used. Verification of light sources is required to be demonstrated only one time, documented, and maintained on file.
(염색침투액을 사용한 경우, 현상제는 적절히 균일한 백색도막을 형성한다. 표면불연속부는 일반적으로 침투액의 흡출에 의해 현상제를 착색하여 짙은 붉은 색으로 나타난다. 옅은 분홍색을 갖는 지시는 과잉 세척을 의미할 수도 있다. 부적절한 세척은 판독을 어렵게 하는 과잉 백그라운드를 만들 수 있다. 지시의 평가를 위해 시험면에 조명(자연조명 또는 보조 백색등)이 요구된다. 최소 조도는 100 fc (1,076 lx) 이어야 한다. 조도, 자연광원 또는 보조 백색 광원은 조도계를 사용하여 지시에 대한 평가가 수행되기 전에 측정되거나 검증된 광원이 사용되어야 한다. 광원의 확인은 한 번만 증명되어야 하고, 문서화되어 기록으로 유지되도록 요구된다.)

8.4 Lighting Equipment (조명장비)

Lighting equipment shall be used as following materials. Refer to Lighting Source Demo Report in detail.
(조명장치는 아래 자재를 사용한다. 자세한 사항은 조명원 실증 보고서를 참고한다.)

Light source (조명원)	Manufacturer (제작사)	Model (형식)
LED	Roadfree	XML-L2 1500LM (LC-A31)

8.5 Post-Examination Cleaning (검사 후 세척)

When post-examination cleaning is required by the procedure, it should be conducted as soon as practical after Evaluation and Documentation using a process that does not adversely affect the part.
(절차서에서 검사 후 세척이 요구될 경우, 평가 및 문서화 이후에 부품에 해로운 영향을

주지 않는 공정을 사용하여 가능한 한 신속하게 세척을 실시해야 한다.)

9.0 Evaluation (평가)

9.1 Evaluation of Indications (지시의 평가)

An indication of an imperfection may be larger than the imperfection that cause it; however, the size of the indication is the basis for acceptance evaluation. Only indications which have any dimension greater than 1/16 in. (1.5 mm) shall be considered relevant.
(결함 지시는 지시의 원인이 되는 결함보다 더 크게 나타날 수도 있으나, 나타난 지시의 크기는 합.부 판정을 위한 기본이 된다. 크기가 1/16 인치 (1.5 mm)를 초과하는 지시만이 관련 지시로 간주한다.)

a) a linear indication is one having a length greater than three times the width.
(선형 지시는 길이가 폭의 3배 이상인 지시이다.)

b) a rounded indication is one of circular or elliptical shape with the length equal to or less than three times the width.
(원형 지시는 원형 또는 타원형으로서 길이가 폭의 3배 또는 보다 작은 지시이다.)

c) any questionable or doubtful indications shall be reexamined to determine whether or not they are relevant.
(임의의 의심스러운 또는 확실치 안은 지시는 그것이 관련 지시인지 아닌지 확인하기 위해 재시험 되어야 한다.)

9.2 Discontinuities at the surface will be indicated by bleed-out of penetrant; however, localized surface irregularities due to machining marks or other surface conditions may produce false indications.
(표면의 불연속부는 침투액의 흡출에 의해 나타난다. 그러나, 기계가공흔적 또는 다른 표면상태에 의한 국부적인 표면요철이 의사지시를 만드는 경우도 있다.)

9.3 Broad areas of fluorescence or pigmentation which could mask indications of discontinuities are unacceptable, and such areas shall be cleaned and reexamined.
(불연속의 지시모양을 가릴 수 있는 형광 또는 염색침투액이 넓게 퍼져 있으면 검사과정이 부적절한 것으로 간주하여 그 부위를 세척하고 재검사하여야 한다.)

10.0 Acceptance Standards (합격 기준)

Relevant acceptance criteria for crank case to be remained and others to be deleted.

10.1 ASME Sec. I A-270

All surfaces to be examined shall be free of: (시험표면에는 다음의 지시가 없어야 한다.)

a) relevant linear indications; (관련 선형 지시)

b) relevant rounded indications greater than 3/16 in. (5 mm);
(3/16 인치 (5 mm) 보다 큰 관련 원형지시)

c) four or more relevant rounded indications in a line separated by 1/16 in. (1.5 mm) or less (edge to edge).
(지시의 끝과 끝의 간격이 1/16 인치 (1.5 mm) 이하이며, 동일선상에 존재하는 4개 이상의 관련된 원형지시)

10.2 ASME Sec. VIII, Div. 1, Mandatory App. 7 & 8

10.2.1 All surfaces to be examined shall be free of :
(모든 검사표면은 다음과 같은 지시가 없어야 한다.)

a) Relevant linear indications ;
(관련 선형지시)

b) Relevant rounded indications greater than 3/16 in. (5 mm) ;
(3/16 인치 (5 mm)를 초과하는 관련 원형지시)

c) Four or more relevant rounded indications in a line separated by 1/16 in. (1.5 mm) or less (edge to edge) ;
(한 선상에 지시의 끝과 끝 사이의 거리가 1/16 인치 (1.5 mm) 이내로 분리되어 있는 4개 이상의 관련 원형지시)

12.1.2 Crack like indications detected, irrespective of surface conditions, are unacceptable.
(균열 같은 지시가 검출되면, 표면 조건과 관계없이 불합격이다.)

12.1.3 Surface indications determined by liquid penetrant examination are unacceptable if they exceed the following limits:
(침투탐상검사에 의해 결정된 표면 표시는 다음 한계를 초과할 경우 허용되지 않는다.)

a) all cracks and hot tears;
(모든 균열과 핫티어)

b) any group of more than six linear indications other than those in a) above in any rectangular area of 11/2 in. × 6 in. (38 mm × 150 mm) or less or any circular area having a diameter of 31/2 in. (88 mm) or less, these areas being taken in the most unfavorable location relative to the indications being evaluated;
(11/2인치X× 6인치(38 mm × 150 mm) 이하 직사각형 또는 직경이 31/2인치(88 mm) 이하인 원형 영역에서 위의 a)를 제외한 6개 이상의 선형 표시의 모든 그룹, 이러한 영역은 평가되는 지표에 비해 가장 불리한 위치에서 취한다.)

c) other linear indications more than 1/4 in. (6 mm) long for thicknesses up to 3/4 in. (19 mm) inclusive, more than one-third of the thickness in length for thicknesses from 3/4 in. to 2-1/4 in. (19 mm to 57 mm), and more than 3/4 in. (19 mm) long for thicknesses over 2-1/4 in. (57 mm) (aligned acceptable imperfections separated from one another by a distance equal to the length of the longer imperfection are acceptable);
(최대 3/4 인치 (19 mm)까지 두께의 경우 1/4 인치 (6 mm)를 초과하는 기타 선형 표시, 3/4 인치 ~ 2-1/4 인치 (19 mm ~ 57 mm)의 두께의 1/3 이상, 그리고 2-1/4인치(57 mm) 이상의 두께에 대한 길이 3/4 인치 (19 mm) 이상 (가장 긴 불완전한 길이와 같은 거리에 의해 서로 분리되는 정렬 허용 결함))

d) all indications of nonlinear imperfections which have any dimension exceeding 3/16 in. (5 mm).
(치수가 3/16 인치 (5 mm)를 초과하는 모든 비선형 결함 지시)

10.2 ASME B31.1 para. 136.4.4

Indication whose major dimensions are greater than 1/16 in. (2.0 mm) shall be considered.
(주요 크기가 1/16 인치 (2.0 mm) 이상인 지시를 관련 지시로 한다.)

The following relevant indications are unacceptable :
(다음의 관련 지시는 불합격이다.)

a) Any cracks or linear indications ;
(모든 종류의 크랙 혹은 선형지시)

b) Rounded indications with dimensions greater than 3/16 in. (5.0 mm) ;
(3/16 인치 (5.0 mm)을 초과하는 원형지시)

c) Four or more rounded indications in a line separated by 1/16 in. (2.0 mm) or less edge to edge.
(가장자리와 가장자리 사이의 간격이 1/16 인치 (2.0 mm)이하로 분리되어 일직선상에 4개 이상으로 배열되어 있는 원형지시.)

d) Ten or more rounded indications in any 6 sq.in. (3870 ㎟) of surface with the major dimension of this area not to exceed 6 in. (150 mm) with the area taken in the most unfavorable location relative to the indications being evaluated.
(지시가 가장 심한 위치에서 한 변의 길이가 6 인치 (150 mm)를 넘지 않는 6 스퀘어인치 (3870 ㎟) 영역 내에서 10개 이상 존재하는 원형지시.)

12.2. ASME B31.3. Chapter VI, 344.4.2

12.2.1 All surfaces to be examined shall be free of :
(모든 검사표면은 다음과 같은 지시가 없어야 한다.)

a) relevant linear indications ;
(관련 선형지시)

b) relevant rounded indications > 3/16 in. [5.0 mm]
(3/16 인치 (5.0 mm)를 초과하는 관련 원형지시)

c) four or more relevant rounded indications in a line separated by 1/16 in. [1.5 mm] or less, edge to edge.
(한 선상에 지시의 끝과 끝 사이가 1/16 인치 (1.5 mm) 이내로 분리되어 있는 4개 이상의 관련 원형지시)

11.0 Records (기록)

11.1 Recording of Indications (지시의 기록)

11.1.1 Nonrejectable Indications (합격기준을 초과하지 않은 지시)
Nonrejectable indications shall be recorded as specified by the referencing Code Section.
(합격기준을 초과하지 않는 지시는 참조 규격에 규정된 요건에 따라 기록하여야 한다.)

11.1.2 Rejectable Indications (불합격 지시)
Rejectable indications shall be recorded. As a minimum, the type of indications (linear or rounded), location and extent (length or diameter or aligned) shall be recorded.
(불합격 지시는 기록하여야 한다. 최소한 지시의 형태 (선형 또는 원형), 위치 및 범위 (길이 또는 직경, 정렬상태)를 기록하여야 한다.)

11.2 Examination Records (검사 기록)
For each examination, the following information shall be recorded.
(각 검사에 있어서 다음의 정보를 기록하여야 한다.)

a) date of the examination (검사 날짜)

b) name and/or identity and certification level (if applicable] for personnel performing the examination.
(검사를 수행한 자에 대한 성명, 식별 및 자격인정 등급 (적용 가능한 경우))

c) identification of the weld, part, or component examined including weld number, serial number, or other identifier
(용접, 부품(부분)의 식별, 또는 용접 번호를 포함한 검사 부품, 고유번호의 식별, 또는 다른 식별자)

d) examination method, technique, procedure Identification, and revision

(검사방법, 기법, 절차서 식별 및 개정)

e) results of the examination (검사의 결과)

f) procedure identification and revision. (절차서 번호 및 개정번호)

g) liquid penetrant type (액체침투제 종류)

h) type (number or letter designation) of each penetrant, penetrant remover, emulsifier, and developer used;
(사용된 각 침투액, 침투액 제거제, 유화제, 현상제의 종류 (숫자 또는 문자표시))

i) map or record of indications (지시에 대한 기록 및 위치 그림)

j) material and thickness (재질 및 두께)

k) lighting equipment (조명 장치)

11.3 An examination report shall be furnished to the client. Report of Liquid Penetrant Examination will be used otherwise specified by the client.
(검사 보고서는 고객에게 제출되어야 한다. 고객의 특별한 요구사항이 없으면 첨부된 액체침투탐상검사 보고서 양식을 사용한다.)

Appendix 1: Control of Contaminants for Liquid Penetrant Examination
(부록 1: 액체침투탐상검사의 불순물 관리)

1.0 Scope (적용 범위)

This Appendix contains requirements for the control of contaminant content for all Liquid Penetrant materials used on nickel base alloys, austenitic stainless steels, and titanium.
(이 부속서는 니켈합금, 오스테나이트 스테인레스강 및 티타늄에 사용되는 모든 액체침투탐상제에 대한 불순물 함량의 제어를 위한 요구조건을 포함한다.)

2.0 Requirements (요구 사항)

2.1 Nickel Base Alloys (니켈합금)

When examining nickel base alloys, all penetrant materials shall be analyzed individually for sulfur content in accordance with SE-165, Annex 4. Alternatively, the material may be decomposed in accordance with SD-129 and analyzed in accordance with SD-516. The sulfur content shall not exceed 0.1% by weight.
(니켈합금을 탐상할 경우, 모든 탐상제는 각 각에 대하여 SE-165의 부록 4에 따라 황 함량을 분석하여야 한다. 또는 SD-129에 따라 분해될 수 있고 SD-516에 따라 분석될 수 있다. 황 함유량은 무게의 0.1%를 초과해서는 안 된다.)

2.2 Austenitic or Duplex Stainless Steel and Titanium
(오스테나이트 또는 듀플렉스 스테인리스 강 및 티타늄)

When examining austenitic or duplex stainless steel and titanium, all penetrant materials shall be analyzed individually for halogens content in accordance with SE-165, Annex 4. Alternatively, the material may be decomposed and analyzed in accordance with SD-808 or SE-165, Annex2 for chlorine and SE-165, Annex 3 for fluorine. The total halogens content shall not exceed 0.1% by weight.
(오스테나이트 또는 듀플렉스 스테인리스 강 및 티타늄을 탐상할 경우, 모든 탐상제는 각각에 대하여 SE-165의 부록 4에 따라 할로겐 함량을 분석하여야 한다. 또는 염소는 SD-808 또는 SE-165의 부록 2에 따라 분해되고 분석될 수 있고 불소는 SE-165 부록 3에 따라 분석될 수 있다. 염소와 불소를 합한 함유량은 무게로 0.1%를 초과하여서는 안 된다.)

Report Form of Liquid Penetrant Examination (A)

REPORT OF LIQUID PENETRANT EXAMINATION / **침 투 탐 상 검 사 보 고 서**

Report No. :

Page No. : of

Customer / Manufacturer 발 주 처 / 제 조사	Project Name / Unit 공 사 명 / 호기
Project No. 공 사 번 호	Item Name 제 품 명
Part Name / No. 부 품 명 / 번호	DWG No. 도 면 번 호
☐ TRV No. ☐ MPP No. ☐ ITP No. ☐ QP No. Rev. Oper. (Seq.)	Procedure No. & Rev. No. 절차서/ Acceptance Criteria 합격기준
Material Type (재질) :	Thickness / Size (두께/치수):
Examination Phase (검사시기) :	Place of Exam.(검사장소):
Surface Condition (표면상태) : ☐ As Welded ☐ As Ground ☐ As Machined ☐ As Rough Machined ☐ As FInal Machined	
Date of the Exam.(검사일) :	Examination Time (검사시간) : ~
Method / Type (방법 / 형태) : ☐ Visible ☐ Fluorescent ☐ Solvent-Removable ☐ Water-Washable ☐ Post-Emulsifiable	

Penetrant (침투제)		Remover (세척제)		Developer (현상제)	
Brand		Brand		Brand	
Type		Type		Type	
Batch No.		Batch No.		Batch No.	
Apply		Apply		Apply	
Penetrant Time	min	Remove		Bleed Out Time	min

category (항목)	Thermometer (온도계)	Lux Meter (광조도계)	category (항목)	Black Light (자외선조사등)	Light Equipment (조명)
ID No. (관리번호)			ID No. (관리번호)		
Type (종류)			Model (모델)		
Model (모델)			Maker (제조사)		
Maker (제조사)			Due Date (유효일)		N/A
Due Date (유효일)			Intensity (강도)	μW/cm²	lx
Test Temp. (시험온도)		℃			

Joint (part) No. 이음(부품)번호	Result(결과)	Interpretation(평가)	Remarks(비고)

Examined & Evaluated By (검사 및 평가) 검 사 자 Level(등급)	☐ Witnessed By (입회자) ☐ Reviewed By (검토자)
Reviewed & Approved By (검토 및 승인) 승 인 자 Level(등급)	☐ Witnessed By (입회자) ☐ Reviewed By (검토자)

Hanyang Inspection & Engineering, Ltd. QF-PT-01-1(Rev.8)

Report Form of Liquid Penetrant Examination (B)

HY Inspection 한양종합검사 REPORT OF LIQUID PENETRANT EXAMINATION 침 투 탐 상 검 사 보 고 서			Report No. : Page No. : of
Joint (part) No. 이음(부품)번호	Result(결과)	Interpretation(평가)	Remarks(비고)
Examined & Evaluated By (검사 및 평가) 검 사 자	Level(등급)	☐ Witnessed By (입회자) ☐ Reviewed By (검토자)	
Reviewed & Approved By (검토 및 승인) 승 인 자	Level(등급)	☐ Witnessed By (입회자) ☐ Reviewed By (검토자)	

Hanyang Inspection & Engineering, Ltd. QF-PT-01-1(Rev.8)

NDE Procedure for Other Equipment

6.0 VISUAL TEST (VT) PROCEDURE

This is the first non-destructive test which is done on the external and internal accessible parts.

6.1 VALIDITY

This instruction is applicable for identification of visual defects in welding units in HAVAYAR Industrial Group or the contractor's workshops.

6.2 Responsibilities

The quality control operator is responsible for performing this test and the quality control manager is in charge of supervision and the final approval.

NDE personnel shall be qualified, in accordance with SNT-TC-1A (ASNT). Only qualified and certified Level II or Level III personnel will be done all examination and evaluation.

The vendor shall be responsible to for damages to property or for personal injuries which result from the gross negligence of the Supervisor(s) while performing his duty.

6.3 Defects

Usually, the visual test done on the equipment and under-pressure parts shows the surface defects on the parts and the weld. Below, different defects and their adjustments are mentioned:

6.4 Corrosion on the Materials Used

This defect is usually seen on the surface of the materials which are kept in a situation good for corrosion for a long time Of course some of these effects can be created because of the improper producing methods or situations. In this case the quality control operator can approve or not.

Approve the defect according to the related standards regarding to the range of the corrosion (of course there is a defect called "Mill Scale" or "the factory oxidation" on most of the materials, which is NOT considered as a surface- defect).

Note: In visual tests every kind of breaking, cutting, bending or crushing which is caused during transferring or falling is not acceptable.

6.5 Weld under Cut

This is a common defect in welding which usually appears near the weld lines and is seen as depression or sharp and disordered edges near the weld. These defects are caused mainly because of the improper place of the welder, not adjusting the voltage and the ampere and also the improper size of the selected filler and electrode. Those defects with the depth exceeding 0.8mm or 10% of the base thickness, whichever less, are not acceptable. Undercuts with a length exceeding 10% of the weld length shall be repaired.

6.6 Worm Hole (surface hydrogen bubbles)

This defect is usually seen as big or small holes on the weld's surface (sometimes this defect appears on the middle layers which cannot be seen in visual tests). This defect is mainly appeared

because of the grease on the welding surfaces, filters, electrodes or even the welder's gloves. To remove this defect, the surface of the welds must ground and again the welding operation should be performed.

6.7 Burn Trough

This defect is seen around the weld lines and on the metal surface as black or dark blue (according to the metal) extended spots. This defect is mainly appeared as a result of the high ampere or the uneven temperature on the parts/materials. To prevent this defect, it is better not to use high ampere and to move the temperature of the melted area on the thicker parts.

5.8 Root & Cap Concavity

This defect is seen as a concavity on the root or the cap and it is usually caused as a result of the high pace, low filtration and the improper electrode.

6.9 Spatters

This defect is seen as weld spatters on and around the weld line. This defect is mainly appeared as a result of welding operation with high ampere. All spatters shall be removed prior to painting.

7.0 OPERATION DESCRIPTION AND THE PROCEDURE

Definition and Usage

This instruction is used for visual testing of the weld lines and other parts that must be tested in this way. Visual test is considered as a non-destructive test. All the tests always begin with the visual tests.

Testing Procedure

- Visual tests are usually done to define the condition of the surface, parallelism of two parts, the appearance or the leaking problem. Also, the lucidity, clearness and existence of other materials on the surface can be tested.
- Welds shall be examined visually before any other non-destructive examinations are performed. All cracks, lack of fusion, surface slag /scale overlaps, undercuts, arc strikes and surface porosity are unacceptable.
- The visual test must be done on all of the welded joints.
- All the weld surfaces must be cleaned by a wire brush (100% weld lines).
- Testing the fitting edges and its approval/non-approval (according to WPS) must be done before the visual test.
- Welding Gauge is used to measure the weld dimensions.
- All surfaces to be welded shall be visually inspected: they shall contain no limitations or other injurious defects.
- Structural attachment welds shall be continuous (skip welding not permitted). Filler welds shall have a minimum leg length of 4 mm.
- The temporary welds shall be subsequently removed and ground flush with the base material, and then inspected by non-destructive methods (magnetic particle or dye penetrant). On non-magnetic materials, this examination shall be made by dye penetrant method.

Fillet

- Any defect found during this inspection shall be removed and repaired by a qualified welder using welding procedures approved by the Contractor. The method of removing attachments shall not injure the metal surface (i.e., they shall not be removed by hammering off).
- Defects that are outside of the applicable codes and standards, this specification, project specifications or other requirements stated on the purchase order, shall be cause for rejection and the manufacturer shall take such remedial action as is necessary to secure acceptance. Such work shall be subject to the inspection agency approval and shall be at the sole expense of the manufacturer.
- Complete repair of a weld is found by inspection to be unsound, or which are deposited from those properly qualified, shall be rejected, completely removed from the equipment, and replaced using an approved procedure.
- When welding is judged to be unsatisfactory by inspection agency, the individual responsibility for the work shall be suspended from welding and all his work examined by non-destructive means. Welding found to be unacceptable by the inspection agency shall be repaired. The individual may be repaired assigned only after additional training, the completion of satisfactory requalification tests, and with the approval of the inspection agency.
- All repairs shall be documented and shall be included in the Manufacturer's data book. Repairs shall be advised to the inspection agency; the repair method, the welding procedure and welder qualification, etc., shall be in accordance with this specification and shall be approved by the inspection agency before any repair being initiated.
- Weld containing cracks shall be subject to additional non-destructive testing (Ultrasonic or magnetic particle) and then, the extent of repair shall be decided by the inspection agency. Repair welding will only be permitted after consideration of the nature and cause of cracking.
- Unacceptable defects shall be removed by chipping, grinding, machining or air-arc gouging. Where air-arc gouging is used, all carbon, cooper and other debris, including carburized metal, shall be removed by grinding or other mechanical methods approved by the inspection agency. Oxygen gouging of quenched and tempered steels or other high strength steels is not permitted.
- For partial repairs, the cut-out portion shall be sufficiently deep and long to remove the defect. At the ends and sides of the cut, there shall be a gradual taper from the base of the cut to the surface of the weld metal. The width and profile of cut shall provide adequate access for re-welding. Special care shall be taken to remove weld defects located at the root in order to obtain an acceptable root gap.
- Prior to commencing any repair, the repair groove shall be examined by dye penetrant method in accordance with ASME Code Section V to ensure all defects are removed.
- All repaired welds in joints shall be checked by repeating the original inspection procedure.

Different Tests

- Direct testing is a kind of visual test in which the distance between the eye and the material is less than 24 inches and the vision angle is less than 30°. In this test one can use a mirror to adjust the vision angle or the magnifying lens to enlarge the object. Also, there must be enough light and a torch, a projector, etc. can be used, if needed. In normal situations, the light needed for the visual testing is equal to 100 FC (1000 LUX) and in special situations like testing small parts, this

amount increases to 50 FC. It is obvious that the eye of the tester must be well enough to see the objects.

- Sometimes the visual tests are done indirectly and by the means of other tools. For example, mirror, binoculars, microscope, baroscopic, or the optical fiber can be used. Even in some cases using tools to perform the test is better than the direct visual test.
- Visual tests can be performed with helping lights, which is more than the environment light, that is somehow a supplementary for the direct visual test. In this method by shining direct light to the surface dark and light spots can be seen well. Light spots are defected parts. This method is used for glass or transparent materials. The light of the environment must be unchanging while testing. Classification of these defects is described in the employer's standards. Approval/ no approval of the defects in the visual test is according to the standards or the contract.

Report

Visual test reports are documented in "Visual Inspection Report" form. Name of the part, the date of the inspection, method of inspection, the results and the general specification of the part must be included in the report.

Manufacture: HAVAYAR Tomorrow Needs Innovation.	VISUAL INSPECTION REPORT	Client:

Equipment :	Serial No.:	Sub Project:	Form No.:	Date:

Welding Process :

Line No.	Welders No.	Joint Type	Result			Kind of Defect	Remarks
			Acc.	Rep.	Rej.		

HAVAYAR	TPI	HE/DI	PEDCO	NISOC
Vendor	Third Party Ins.	EPC Contractor	EPD/EPC Contractor(GC)	Owner
Name:	Name:	Name:	Name:	
Date:	Date:	Date:	Date:	
Sign:	Sign:	Sign:	Sign:	

8.0 PENETRATION TEST (PT)

The liquid penetrant examination method (Penetration Test) is an effective means for detecting discontinuities which are open to the surface of nonporous metals and other materials. Typical discontinuities detectable by this method are cracks, seams, laps, cold shuts, laminations, and porosity.

In principle, a liquid penetrant is applied to the surface to be examined and allowed to enter discontinuities. All excess penetrant is then removed, the part is dried, and a developer is applied. The developer functions both as a blotter to absorb penetrant that has been trapped in discontinuities, and as a contrasting background to enhance the visibility of penetrant indications. The dyes in penetrants are either color contrast (visible under white light) or fluorescent (visible under ultraviolet light).

Requirements

- The detail and description of requirements for pre-examination and minimum time for drying and etc. refer to ASME SEC. V Article 6 (edition 2010, addenda 2012), (paragraph T-621.1).
- All necessary additional information will be provided on liquid penetration test report.
- All weld deposit overlay including clad restoring at weld seams, whether by manual or automatic procedure, shall be 100% liquid dye penetrant examined in accordance with methods described in ASTM E165.
- Weld deposit overlay machined surfaces shall be 100% PT on finished condition.
- All cracks and circular defects greater than 1.6 mm diameter in weld deposit overlay shall be removed. Repaired areas shall be 100% re-inspected by liquid dye penetrant.

TABLE T-621
REQUIREMENTS OF A LIQUID PENETRANT EXAMINATION PROCEDURE

Requirement	Essential Variable	Nonessential Variable
Identification of and any change in type or family group of penetrant materials including developers, emulsifiers, etc.	X	...
Surface preparation (finishing and cleaning, including type of cleaning solvent)	X	...
Method of applying penetrant	X	...
Method of removing excess surface penetrant	X	...
Hydrophilic or lipophilic emulsifier concentration and dwell time in dip tanks and agitation time for hydrophilic emulsifiers	X	...
Hydrophilic emulsifier concentration in spray applications	X	...
Method of applying developer	X	...
Minimum and maximum time periods between steps and drying aids	X	...
Decrease in penetrant dwell time	X	...
Increase in developer dwell time (Interpretation Time)	X	...
Minimum light intensity	X	...
Surface temperature outside 40°F to 125°F (5°C to 52°C) or as previously qualified	X	...
Performance demonstration, when required	X	...
Personnel qualification requirements	...	X
Materials, shapes, or sizes to be examined and the extent of examination	...	X
Post-examination cleaning technique	...	X

General Comments

- Dye penetration test on root passes after back chipping of the weld seems to be conducted after satisfactory on visual check.
- Temperature of the part to be examined as a standard technique temperature of the part to be processed shall not be below 50 °F (10°C) nor above 125° F (52℃) throughout the examination period.
- Surface preparation of parts before PT inspection shall meet the requirement ASME SEC V (edition 2010, addenda 2012) CHAPTER T-642
- The surface to be examined and all adjacent area within at least 25 mm shall be dry and free from all dirt, grease, lint, scale, welding flux, spatter and oil or other extraneous matter that could obscure surface indication and interfere with the examination. Excessive weld ripples, unevenness, etc. with may interfere with the evaluation of discontinuities shall be ground smooth.

Examination Medium

Using 3 special kinds of liquid sprays is essential to conduct PT which detail is indicated as below:

- “Cleaner” (thinner) is a transparent liquid spray that utilized to clean the Surfaces of the welded joints prior to the test and remove the excess penetrant on surface.
- “Dye penetrant” is a red color liquid spray, which indeed its usage is to penetrate into the smallest cracks of the weld joints. Applying method for penetration material is spraying and shall meet the requirement ASME SEC V (edition 2015), chapter T-671.
- “Developer” is a white liquid spray, which indeed shows the defects of weld areas.
- Penetrant material to be used or applied on austenitic stainless steel or titanium, chlorine and fluorine content shall be less than 1% by weight. In addition, in this case certificates of examination material shall be provided.
- PT materials is solvent washable type.
- Brand name of PT material is MAGNUFLUX (cleaner=SKC-S type & developer=SKD S2 type & penetrant=SKL-SP1 type). Irrespective of method or system all component materials (penetrant, cleaner and developer) shall be from the same brand or manufacture’s system. Interchanging or use of penetrant, developer & developer from different brand or manufacture shall not permitted.
- Excess water washable penetrant shall be removed with water spray. The water pressure shall not exceed 50psi and the water temperature shall not exceed 43 centigrade.
- Method of applying developer is done by spraying that provides a thin surface coating is obtained over entire surface being examined.
- Developer dwell time for final interpretation shall made within 10 to 60 min after the requirement of ASME SEC V (edition 2015), T-675.3 are satisfied. If bleed out does not alter the examination results, longer period is permitted. If surface to be examined is large enough to preclude complete examination within the prescribed or established time, the examination shall be performed in increments.

TABLE T-672 MINIMUM DWELL TIMES

Material	Form	Type of Discontinuity	Dwell Times [Note (1)] (minutes) Penetrant
Aluminum, magnesium, steel, brass and bronze, titanium and high-temperature alloys	Castings and welds	Cold shuts, porosity, lack of fusion, cracks (all forms)	5
	Wrought materials — extrusions, forgings, plate	Laps, cracks	10
Carbide-tipped tools	Brazed or welded	Lack of fusion, porosity, cracks	5
Plastic	All forms	Cracks	5
Glass	All forms	Cracks	5
Ceramic	All forms	Cracks	5

NOTE:
(1) For temperature range from 50°F to 125°F (10°C to 52°C). For temperatures from 40°F (5°C) up to 50°F (10°C), minimum penetrant dwell time shall be 2 times the value listed.

- Minimum light intensity of 500 LX is required to ensure adequate sensitivity during the examination and evaluation of indication.
- Performance demonstration of above PT material shall meet the requirement related data sheet that has been attached.
- Hydrophilic or lipophilic emulsifier information is not applicable for water washable method.
- Cleanliness shall be maintained after completion of welding. All Rods, flux and foreign materials shall be removed from the equipment of piping.

Personnel Qualification

- Qualification of personnel for dye penetration test is according to SNT-TC-1A (at least level II) 1996 edition with 1998 or similar.
- Interpretation shall be performed by personal qualification according to SNT-TC- 1A, level II or III.

Penetration Test Procedure

Prior to start the PT the entire joints surfaces and all adjacent areas within at least 25.4 mm shall be reform any rust, grease, burs, etc.

- After cleaning and drying of the surface to be examined shall be accomplished by normal evaporation or with forced hot or cold air. A minimum period of time shall be established to ensure that the cleaning solution has evaporated prior to application of the penetrant.
- Pressurized air would take away the dust & burs. Air should be clean and shall not contain oil, water or dirt.
- The targeted area which will undergo the test shall be cleaned-out by using a cleaner spray, using cleaner spray would remove all the probable grease and Residue stock to the joint areas.
- Cleaning the surface by using pieces of fabrics and also be dried-out (minimum drying time 5 min.), so that the surface is completely ready to start the test.
- 4.5-5) At this stage the red liquid spray will be applied (PENETRANT) after which that the liquid Penetrates into the cracks, which could take about 5 minutes for welds & min. 10 minutes for forging and plates to penetrate into the cracks.

- Before Appling the cleaner spray for removing all applied PENETRANT, area should be completely Dried-out.
- At this stage the surface metal is completely cleaned and dried so that the area is ready to apply the developer.
- After spraying the developer, one should wait for at-least 10 minutes up until the liquid completely issue out of the Cracks and only at that time, we could see the probably cracks & fractures.
- Study of Weld Defect such as pin holes and etc. is according to acceptance criteria: ASME Sec. VIII. Div. 1 appendix 8. (Edition 2015)
- After grinding the defected areas, it should be inspected by PT and to assure that the defects are completely repaired, all the above stages should be again applied by PT to the welded areas. Re–inspection by PT is in accordance with this procedure.
- The area & distance of spraying should be carefully measured in order to be most effective.
- Post examination cleaning:
- Post-examination cleaning shall be performed as soon as possible after the examination. Solvent or water, as applicable, shall be used to remove the residual penetrant and developer by spraying, wiping with cloths, or brushing.

Evaluation and Acceptance Standards

- The reference for evaluation & interpretation will be done according to ASME SEC VIII, Div. 1, and APP.8 (edition 2015).
- The examination shall be evaluated and reported by qualified personnel.

Safety Precautions

- The area of the test should be completely cleaned and covered to avoid the wind.
- Avoid contact with skinned eyes. In case of contact with eyes, rinse And Seek Medical device. During performance, do not eat, drink or smoke. Wear suitable gloves and eye/face Protection. Contains no CFC propellant. Non-flammable propellant. Protect from sunlight, which do not expose to temperatures in excess of 50◦C according to ASTM-E 165 Minimum temperature for PT test is 15°C.

Reports

Finishing the test procedures, all the observations and analysis must be recorded in the Penetration Test Report form and after being signed by the quality control manager, the relevant inspector must confirm it and it must be kept in the project documentations.

Some information which must be recorded in the PT test report is: parts' materials, the name of the weld line or the part, reports conclusion, the kind of the defect (if any), etc.

Manufacture: HAVAYAR Tomorrow Needs Innovation.	PENETRATION TEST REPORT	Client:

Equipment :	Serial No.:	Sub Project:	Form No.:	Date:

Reference :

Joint Name	Material	Time(min.)		Type of Defect	Result			Acceptance Criteria	Remark
		Pen.	Deve.		Acc.	Rep.	Rej.		

HAVAYAR	TPI	HE/DI	PEDCO	NISOC
Vendor	Third Party Ins.	EPC Contractor	EPD/EPC Contractor(GC)	Owner
Name:	Name:	Name:	Name:	
Date:	Date:	Date:	Date:	
Sign:	Sign:	Sign:	Sign:	

9.0 RADIOGRAPHY TEST PROCEDURE

General

Surface Preparation

Surfaces shall satisfy the requirements of the applicable materials specifications, with additional conditions, if necessary, by any suitable process to a degree that surface irregularities cannot mask or be confused with discontinuities. Maximum weld reinforcement shall not exceed the values given in ASME, Sec. VIII Div-1 UW-35 (edition 2015).

Methods of Identification

The method shall be used to produce permanent identification to the radiographies traceable to the contract, components, welds or weld seams, or part numbers, as appropriate. This identification mark shall not obscure the area of interest.

Radiation Back Scatters

As per ASME, Sec. V, T223, a lead symbol B with minimum dimensions of ½ in. In height and 1/16 in. in thickness. Shall be attached to the back of each film holder during each exposure to determine if back scatters radiation is exposing the film.

If a light image of the "B" letter appears on a darker background of the radiograph, the radiograph shall be considered unacceptable. In this case the protection against backscatters must be improved and the film retaken.

Personnel Qualification

Personnel performing radiography examination to this procedure shall be qualified and certified by IRAEO, (Islamic Republic Atomic Energy Organization) also shall meet the requirements of SNT-TC-1A at least level II (1996 Edition with 1998 ad.). Film interpreter shall have level II as a minimum.

Operation of radiographic generators will be undertaken by trained SNT-TC-1A level I radiographic machine operators.

Radiographer and his assistant radiographer must have at least a degree equivalent to ASNT-SNT-TC-1A and 3 years and 2 years of relevant practical experience in the construction of oil and gas projects and facilities, respectively.

Also, the X-ray interpreter must have at least a certificate equivalent to ASNT-SNT-TC-1A with 5 years of relevant film reading experience in the construction of oil and gas projects and facilities.

Safety: Before performing radiography, the personnel must be trained for using GAMA-Ray. They will be obliged to wear the dosimeter films badge.

V01

Equipment and Materials

Film

Any commercially available industrial radiography films may be used in accordance with SE 1815 (ASTM) standard test method for film system in industrial radiography. Radiography film for carbon steel and stainless-steel equipment shall be ultra-fine grain (Kodak type M or D4 (AGFA GEVAERT)). The film length shall be 150 mm minimum.

The film treatment shall be in accordance with the film supplier recommendations to fulfill the EN 584-1 category requirements.

In radiographing a continuous length of weldment with separate films, the separate films shall overlap at least 10 mm to ensure that no portion of the weld length remains unexamined.

Lead Screens

Definition: the two thin lead sheets on both sides of a radiography film are called lead screens or intensity screens.

Reasons for using intensity lead screens:

- By using these screens, the exposure duration decreases.
- By using these screens scattered radiant cannot reach the film from the floor.
- These screens can somehow protect the films.

Image Quality Indicator (IQI) Design

Penetrometers shall be either the whole type or the wire type and shall be manufactured and identified in accordance with the requirements or alternatives allowed in SE 142 or SE 1025 (for hole type) and SE-747 (for wire type), and appending. ASME V (edition 2015) & ASME Sec VIII Div. I (edition 2015) standard penetrometers shall consist of those in table T-233.1 for hole type and those in table T 233.2 for wire type (Wire type IQI shall be used for welds).

Densitometer

Densitometer shall be used for assuring compliance with film density requirements and densitometer calibration shall be verified by comparison with a calibrated step wedge film traceable to a national standard.

Calibration certificate shall be provided.

Cassette

Flexible PVC or rubber type cassette shall be used and film holders shall be light tight.

Film Viewing Illuminator

Film viewing illuminator shall provide sufficient light for comfortable viewing. Film viewing illuminator should provide sufficient light intensity to penetrate 4.0 densities. The brightness of surroundings should be about the same as the area of interest in radiograph. Single-film viewing shall be used, and the film density shall be in the range of 2.5 to 3.5.

Shim

The shim dimensions shall exceed to penetrometer dimensions such that the outline of at least three sides of the penetrometer images shall be visible in radiographies.

Calibration

Source Size

The equipment manufacturers or suppliers' publications, such as technical manuals, decay curves, or written statements documenting the actual or maximum source size or focal point, shall be acceptable as source size verification.

Step Wedge Film and Densitometer

The density of step wedge comparison film and densitometers calibration shall be verified by comparison with a calibration step wedge film traceable to a national standard. The densitometer shall be calibrated in accordance with paragraph 5 of SE-1079- calibration of transmission densitometers.

Examination

Source Selection of Radiation Energy

Gamma Radiation

The recommended minimum thickness for which radio-active isotopes may be used as follow:

Material	Minimum thickness of Iridium192 cobalt 60	
Steel	0.75 in	1.5 in
Copper or high nickel copper	0.65 in	1.3 in
Aluminum	2.50 in	--

The maximum thickness for the use of radioactive isotopes is primarily dictated by exposure time, therefore; upper limits are not shown. The minimum Recommended thickness limitation may be reduced when the radiography techniques are used to demonstrate that the required radiography sensitivity have been obtained, by purchaser approval.

Special Conditions

When special conditions do not make it practical to perform radiography within the limitations outlined in above table, the procedure shall be proved satisfactory by actual demonstration of penetrometer resolution on the minimum thickness of the material radio graphed.

Direction of Radiation

The direction of the central beam of radiation shall be centered on interest When-ever practical.

Geometric Un-sharpness

Geometric un-sharpness of the radiograph shall be determined in accordance with ASME Sec. V Article2

$$U_g = \frac{F\ d}{D}$$

Where:

U_g: Geometric un-sharpness.

F : Source size: the maximum projected dimension of the radiating source (or effective focal point) in the plane, Perpendicular to the distance from the weld or object is subjected to radiography.

D : Distance from source of radiation to weld or object being radio graphed.

d: Distance from source side of weld or object being radio graphed to the film.

When required by the referencing code section geometric Un-sharpness of the radiography shall not exceed the following:

The geometrical un-sharpness shall not exceed 0.2 mm.

Radiography Techniques

A single-wall exposure technique shall be used for radiography whenever practical. When it is not practical to use a single-wall technique, a double-wall technique shall be used as alternative.

Single Wall Viewing

- In single wall viewing technique, the radiation passes through only one wall of the weld (material), which is viewed for acceptance on the radiograph. Source side markers shall be used when radiography the following:
  - Flat components or cylindrical castings curved or side is toward the source and when the “source-to-material” distance is less than the inside radius of the castings. Curved or spherical castings or welding whose convex side is toward the source.
- Film side markers shall be used when performing radiography, either curved or spherical components whose concave side is toward the source and when the “source-to material” distance is greater than the inside radius.
- Either side markers shall be used when radiography either curved or spherical components whose concave side is toward the source and the “source-to-material” distance is equal to the inside radius of the component.

Double Wall Viewing

For double-wall viewing, at least one location marker shall be placed on the source side surface adjacent to the weld (or on the material in the area of interest) for each radiograph.

Mapping

Mapping the placement of location marks when inaccessibility or other limitations prevent the placement of markers as stipulated in ASME Sec. V (edition 2015) article 2T-275.1 and T-275.2 a dimensioned map of the actual marker placement shall accompany the radiographs to show that full coverage has been obtained such as:

- Seam weld no. & film no.
- Welder stamp
- Weld thickness
- Location mark
- Client name
- Radiography date
- Item No.
- Repair & Re-shooting marker (R1, R2…)
- “F” marker when penetrometer is placed on film side.

Location markers (ASME Sec. V (edition 2015) article 2fig.T-275- attached) which are to appear as radiography images on the film, shall be placed on the part (not on the exposure holder/cassette). The identification marks shall include, project identification, equipment Tag No. and date of testing.

Traceability: all longitudinal and circumferential weld lines shall be properly numbered. During the radiography test, start and end points shall be clearly indicated.

Penetrometer/(IQI) Selection

IQI’s Material shall be selected from either the same alloy material group or grade as identified in ASME Sec. V (edition 2015), SE.1025. For welds joining dissimilar materials or filler metal the IQI material shall be selected based on materials group 1 (SE. 1025-7.3.4).

Size:

The designated hole penetrometer with essential hole or designated wire diameter shall be as specified in ASME Sec. V (edition 2015).

Article 2 table T-276. A Smaller hole in a thicker Penetrometer may be substituted for any section thickness listed in table T-276, provided equivalent penetrometer sensitivity (EPS) is maintained and all other requirements for radiographies are met. In determining sensitivity any allowable weld reinforcement should be accounted. For welds with strips or backing rings, the thickness of backing ring is not regarded in determination of sensitivity.

Number of penetrometers:

When one or more film holders are used for an exposure, ate least one penetrometer imager shall appear on each radiograph.

If the requirements of T-282 are met by using more than one penetrometer, one shall be representative of the lightest area of interest and the other the darkest area of interest.

The intervening densities, on the radiograph, shall be considered as having acceptable density.

Placement of penetrometers:

Penetrometer shall be placed adjacent to the weld seam in accordance with ASME Sec. V, Para. T 277.1

Sensitivity:

The sensitivity required using wire type IQI shall be 2%.

Part thickness at IQI location:

Where inaccessibility prevents hand placing the penetrometer (s) on the source side, it shall be placed on the film side in contact with the part being examined. A lead letter “F” shall be placed adjacent to or on the penetrometer (s).

Film Processing

After performance of radiography all films shall be developed as below sequence for manual processing:

a) Developer

Replenishment rates and renewal of solutions shall be done according to manufacturer's recommendation.

- 5 to 8 minutes in 20 °C

b) Stop bath in 20 °C

When the temperature is higher or lower, development line must be changed and manufacturer's recommendation should be followed.

c) Fixing

- Hangers should be agitated vertically for 10 to 20 seconds and again at the end of the first minute in order to obtain uniform fixing.
- At least twice clearing time to 15 minutes.

d) Washing

- Clean running water hourly flow.
- Care should be taken not to over wash the films.
- 16 ~ 30 °C

e) Drying

- Warm, filtered or circulating air dries the film.
- 30 to 45 minutes in ambient temperature to 60 °C

Evaluation

Quality of Radiographies

All radiographies shall be free from mechanical, chemical, mechanical or the blemishes to the extent that they do not mask and are not confused with the image of any discontinuity in the area of interest of the object being radio graphed.

Radiography Density

The transmitted film density through the radiographic image of the body of the appropriate hole penetrometer or adjacent to the designated wire of a wire penetrometer and the area of interest shall be 2.0 minimum for radiographies made with a gamma ray source. A tolerance of 0.05 in density is allowed for variations between densitometer readings (ASME Sec. V Art. 2 (edition 2015) paragraph. T-282-1, T-282).

IQI (penetrometer) Sensitivity Film Density

IQI (penetrometer) sensitivity film density shall be within a range of 2.5 to 3.5 radiography shall be performed with a technique of sufficient sensitivity to display the hole penetrometer image and the 2T hole, or the designated wire of a wire penetrometer, which are essential indications of the image quality of the radiograph. The sensitivity maximum shall be according to Table-6.

Table 6. Image quality indicator sensitivities

Specimen thickness (mm)	IQI sensitivity (%, maximum value)
3	3.0
6	2.5
12.5	2.0
25	1.7
40	1.5
50	1.3
75	1.1
100	1.0
150	0.9

Extent of Examination

The extent of examination shall be according to NDT table and following the requirements of the code and relative client specification.

Acceptance Standards

Refer to ASME Sec VIII, Div. 1 (edition 2015)-UW-51(b) a) Butt welded joints surfaces shall be sufficiently free from coarse ripples, grooves, overlaps and abrupt ridges and valleys to permit proper interpretation of radiographic and the required nondestructive examinations.

If there is a question regarding the surface condition of the weld when interpreting a radiographic film, the film shall be compared to the actual weld surface for determination of acceptability.

Indications shown on the radiographies of welds and characterized as imperfections are un-acceptable under the following condition:

1) Any indications characterized as a crack or zone of incomplete fusion or penetration.

2) Any other elongated indication at radiography, which has length greater than:

(a) 1/4 in. (6mm) for t up to 3/4 in. (19mm)

(b) 1/3 t for t from 3/4 in. (19mm) to 2 1/4 in. (57mm)

(c) 3/4 t (19mm) for t over 2 1/4 in. (57mm)

Where:

t= thickness of weld excluding any allowable reinforcement.

3) Any group of aligned indications that have an aggregate length greater than t in a length of 12t , except when the distance between the successive imperfections exceed 6L where L is the length of the longest imperfection in the group.

4) Rounded indications in excess of that specified by the acceptance standards given in ASME sec. VIII, DIV I, (edition 2010, addenda 2012).

Note: spot RT shall be done as per ASME Sec. VIII, Div. 1 (edition 2015) UW-52; however, the acceptance criteria shall be according to UW-51 (as specification).

Record

- Each radiography shall be documented on the format radiography examination on report form. The report shall be signed and dated by the Qualified and certified personnel, whom evaluate the results of radiographies.
- The following radiography records shall be maintained as agreed upon between purchaser and supplier.
- Radiography standard shooting sketch.
- Weld repair documentation.
- Film
- Film interpretation record containing as a minimum:
  - Disposition of each radiography (acceptable or reject-able).
  - If reject-able, cause for rejection.
  - Surface indication verified by visual examination (mold, mark, etc.)
  - Signature of the film interpreter.
- An original radiography examination and original films report and RT. Films shall be prepared and furnished by NDT. Contractor to the client. Report of radiography examination (Exhibit-1) will be used unless otherwise specified by client.

- Type, power and focal size of the γ-ray camera shall be indicated in test report.

Report

HAVAYAR Tomorrow Needs Innovation.	**Quality Control Radiographic Test Report**	Code No:	Date & Rev:
		Report No:	Date:
		Page: of	

Item No.	RT No.	Weld Location	Weld No.	Welder No.	THK (mm)	Film Length	Film Segment	ACC.	RP.	RS.	RET.	Type of Defect/ Lengt	Remark

JUDGMENT: **ACC:Accept,** **RP:Repair,** **RS:Reshoot,** **RET:Retake**

Type of Defect:

SL:Slag line, **LF**: Lack of Fusion, **LC**: Longitudinal Crack, **FM**:Film Mark, **CU**:Cap Under Cut, **SP**:Spherical Porosity, **CL**:Cold Lap, **TC**: Transverse Crack, **IW**: Incomplate Weld, **RU**: Root Undercut, **CP**:Cluster Porosity, **LP**: Lack of Penetration, **CC**: Crater Crack, **EP**: Excess Penetration, **HB**: Hollow Bead, **PH**: Pin Hole, **WH**: Worn Hole, **RC**: Root Concavity, **SC**:Shrinkage Cavity, **SI**: Slag Inclusion

Remark:

HAVAYAR	TPI	HE/DI	PEDCO	NISOC
Vendor	Third Party Ins.	EPC Contractor	EPD/EPC Contractor(GC)	Owner
Name:	Name:	Name:	Name:	
Date:	Date:	Date:	Date:	
Sign:	Sign:	Sign:	Sign:	

10.0 ULTRASONIC TEST PROCEDURE

Scope

This procedure describes the Ultrasonic examination method and acceptance standard of welds in steel for construction of Air Receiver that to be fabricated in HAVAYAR Industrial Group Co. and meet the requirement of ASME code section VIII, ASME B 31.1 and section V.

Personnel Qualification

All personnel who will perform non-destructive examination shall be qualified and certified as level II in accordance with the requirements of ASNT recommended practice SNT-TC-1A.

General Requirement

Applicable Parts

1. On all pressure resistance welds that cannot be radiography tested.
2. When thickness is greater than 50 mm on all pressure resistance welds after hydro test.
3. When other tests do not give clear and entirely comprehensive results.
4. UT of head knuckle.

Equipment

SITESCAN 140 is a Pulse-echo

A-scan; direct contact type ultrasonic equipment is used. It's capable to receiving & presenting reflects pulses on its screen. All instruments shall be calibrated for the examination specified herein and shall be capable of meeting the requirements of screen height linearity and amplitude control linearity in paragraph 5.1.

Search Units

Straight or angel beam probes are the search units with commercial name of ORION. Angel beam probes exist in 45°, 60° and 70°. The search unit size shall be selected according to the following table:

Straight Beam

Material Thickness (mm)	Frequency (MHz)
25.4 or less	4 or 5
Over 25.4	2 or 4

Angle Beam

Material Thickness (mm)	Frequency (MHz)	Search Unit Angle
12.5 or less	4 or 5	70°
12.5 to 25.4	2 or 4	60° , 70°
over 25.4	2 or 4	45° , 60° or 45° ,70°

Search units with contoured contact wedges may be used to aid ultrasonic coupling.

Frequency

This examination shall be conducted with a pulse-echo ultrasonic instrument capable of generating frequencies over the range of at least 1 MHz to 5 MHz. Instrument operating at other frequencies may be used if equal or better sensitivity can be demonstrated and documented.

Screen Height Linearity

The ultrasonic instrument shall provide linear vertical presentation within ± 5% of the full screen height for 20 % to 80% of the calibrated screen height.

The procedure for evaluation screen height linearity is provided in appendix I of article 5, ASME Code Sec. V and shall be performed at the beginning of each period of extended use (or every 3 months, whichever is less).

Amplitude Control Linearity

The ultrasonic instrument shall utilize an amplitude control, accurate over useful range to ± 20 % of the nominal amplitude ratio, to allow measurement of indications beyond the linear range of the vertical display on the screen. The procedure for evaluation amplitude control linearity is given in appendix II of article 5, ASME. Code Sec.V and shall be performed at the beginning of each period of extended use (or every 3 months, whichever is less).

Coupland

SAE No.20 or No.30 motor oil, glycerin, pine oil, water, walls paper adhesive or water base paste shall be used. Coupland's may not be comparable to one another and Couplet shall be used for calibration and examination.

Calibration

Basic Calibration Block (s)

The basic calibration reflectors shall be used to establish a primary reference response of the equipment. The basic calibration reflectors may be located either in the component material

or in a basic calibration block. Where the block thickness ±1 in. spans two of the weld thickness ranges shown in fig.1, the block's use shall be acceptable in those portions of each thickness range covered by 1 in.

Basic calibration blocks shall be of similar metallurgical structure and the same or an equivalent p-number grouping as the finished component for the purposes of this, p-numbers 1, 3, 4 & 5 materials are considered equivalent.

System Calibration:

The calibration shall be calibrated according to the following explanation:

Angle Beam Calibrations:

The calibration shall provide the following measurements. (Refer to Article 4, Appendix B, ASME Code Sec.V)

(1) Sweep range calibration

(2) Distance- amplitude calibration

(3) Position calibration

(4) Echo amplitude measurement from the surface notch in the basic calibration block when an electronic amplitude correction device is used, the primary reference response shall be equalized at a nominal constant screen height at or between 40 to 80 % of full screen height over the distance range to be employed in the examination.

Straight Beam Calibrations:

The calibration shall provide the following measurements. (Refer to Article 4, Appendix C, ASME Code Sec.V)

(1) Sweep range calibration

(2) Distance-amplitude correction When an electronic distance-amplitude correction device is used, the primary reference response shall be equalized on the basic calibration block at a screen height between 40% and 80% of full screen height over the distance range to be employed in the examination.

Calibration:

Shall be performed prior to use of the system in the thickness range under examination. A calibration check shall verify the sweep range calibration and distance amplitude correction.

Sweep Range Correction:

If a point on the DAC curve has moved on the sweep line more than 10% of the sweep reading or 5% of full sweep, whichever is greater, correct the sweep range calibration and note the correction in the examination record. If reflectors are recorded on the data sheets, those data sheets shall be voided and a new calibration shall be recorded. All recorded indications since the last valid calibration or calibration check shall be re-examined with the corrected calibration and their values shall be changed on the data sheets.

DAC Correction:

If a point on the distance-amplitude correction (DAC) curve has decreased 20% or 2 dB of its amplitude, all data sheets since the last calibration check shall be marked void. A new calibration shall be made and recorded and the area covered by the voided data shall be re-examined. If any point of the distance-amplitude correction (DAC) curve has increased more than 20% or 2 dB of its amplitude, all recorded indications since the last valid calibration or calibration check shall be re-examined with the corrected calibration and their values shall be changed on the data sheets.

Examination Procedure

WELD and HAZ

General Requirements

The scanning shall be performed at gain setting at least two times the primary reference level. Evaluation shall be performed with respect to the primary reference level. The volumes shall be scanned by straight and angle beam techniques as described in detail in para.7.1.2. and 7.1.3. Two angle beams, having nominal angles of 45° and 60° with respect to a perpendicular to the examination surface, shall generally be used. Other pairs of angle beams are permitted provided the measured difference between the angles is at least 10°.

Angle Beam Method

Scanning shall be made basically from outside surface of the vessel by direct contact method. The angle beam shall be directed at approximate right angle to the weld axis from two directions where possible to detect the reflectors oriented parallel to the weld. In addition, the angle beam shall be directed essentially parallel to the weld axis to detect the reflectors-oriented transverse to the weld. The search unit shall be manipulated so that the ultrasonic energy passes through the whole volumes of weld and heat affected zone (20 mm) of base metal.

Straight Beam Method

I. The heat affected zone and weld where practicable shall be scanned with the straight beam search unit. The scanning shall be performed at a gain setting of at least two times the primary reference level and evaluation shall be performed with respect to the primary reference level.

II. The scanning of the adjacent base metal shall be performed to detect reflectors that affect interpretation of angle beam results, and is not to be used as an acceptance rejection examination. Locations and areas of such reflectors shall be recorded.

Angle Beam Examination

The refraction angle of the angle beam transducer shall be measured using IIW standard calibration block. The tolerance of the refraction angle shall not be more than ± 2°.

Scanning Sensitivity

The scanning shall be performed at a gain setting at least two times the primary reference level and evaluation shall be performed with respect to the primary.

Detection of Defects Parallel to the Weld

The angle beam shall be directed at approximately right angle to the weld axis from two directions where possible. The search unite shall be manipulated so that the ultrasonic beam passes through the required volumes of weld and adjacent base metal.

Detection of Transverse Defects

The angle beam shall be directed parallel to the weld axis. The search unit shall be manipulated so that the ultrasonic beam passes through the all of the volume to be examined.

Surface Condition

✓ **Base Metal:** The base metal on each side of the weld shall be free of weld spatter, surface irregularities, or foreign matter that might interfere with the examination.

✓ **Weld Metal:** Where the weld surface interferes with the examination, the weld shall be prepared as needed to permit examination.

Extent of Scanning

Examination Coverage

The volume shall be examined by moving the search unit over the examination surface so as to scan the entire examination volume.

Each pass of the search unit shall overlap a minimum of 10 % of the transducer dimension perpendicular to the scan.

Rate of Search Unit Movements

The rate of search unit movement for examination shall not exceed 6 in. /sec unless calibration is verified at scanning speed.

Length Measurement

The length of the reflector shall be obtained by recording the position from reference line and the location along the length of weld as determined by 50 % of DAC for each of reflector.

BASE METAL

General requirement

The equipment shall be of the pulse-echo straight beam type. The transducer is normally 1 to 11/8 in. [25 to 30 mm] in diameter or 1 in [25 mm] square; however, any transducer having a minimum active area of 0.7 in2 [450 mm2] may be used. The test shall be performed by direct contact method.

Test Conditions

The examination shall be conducted in an area free of operations that interfere with proper functioning of the equipment. Plate surface shall be clean and smooth sufficiently to maintain a reference back reflection from the opposite side of the plate at least 50% of the full-scale during scanning.

The surface of plates inspected by this method may be expected to contain a residue of oil or rust or both. Any specified identification which is removed when grinding to achieve proper surface smoothness shall be restored.

Apparatus

The amplitude linearity shall be checked by positioning the transducer over the depth resolution notch in the IIW or similar block so that the signal from the notch is approximately 30% of the screen height, and the signal from one of the back surfaces is approximately 60% of the screen height (two times the height of the signal from the notch).

A curve is then plotted showing the deviations from the above-established 2:1 ratio that occurs as the amplitude of the signal from the notch is raised in increments of one scale division until the back reflection signal reaches full scale, and then is lowered in increments of one scale division until the notch signal reaches one scale division.

At each increment the ratio of the two signals is determined. The ratios are plotted on the graph at the position corresponding to the larger signal. Between the limits of 20% and 80% of the screen height, the ratio shall be within 10% of 2:1. Instrument settings used during inspection shall not cause variation outside the 10% limits established above.

Procedure

Unless otherwise specified, ultrasonic examination shall be made on either major surface of the plate.

Test Frequency

A nominal test frequency of 2 1/ 4 MHz is recommended. When testing plates less than 3/4 in. (20mm) thick a frequency of 5 MHz may be necessary. A clear, easily interpreted trace pattern should be produced during the examination.

Scanning

Scanning shall be along continuous perpendicular grid lines on nominal 9-in. [225-mm] centers, or at the option of the manufacturer, shall be along continuous parallel paths, transverse to the major plate axis, on nominal 4-in.

[100-mm] centers, or shall be along continuous parallel paths parallel to the major plate axis, on 3-in. [75-mm] or smaller centers. Measure the lines from the center or one corner of the plate with an additional path within 2 in. [50 mm] of all edges of the plate on the searching surface.

Test shall be started with adjusted instrument that will produce a first reflection from the opposite side of a sound area of the plate from 50% to 90% of full scale. Minor sensitivity adjustments may be made to accommodate for surface roughness.

When a discontinuity condition is observed during general scanning adjust the instrument to produce a first reflection from the opposite side of a sound area of the plate of 75 ± 5% of full scale. Maintain this instrument setting during evaluation of the discontinuity condition.

Thickness Measurement

Procedures used for ultrasonic examination for thickness determination shall conform to the following standards in Article 23, as applicable:

a) SE-114 Recommended Practice for Ultrasonic Pulse-Echo Straight-Beam Testing by the Contact Method

b) SE-797 Standard Practice for Thickness Measurement by Manual Contact Ultrasonic Method

Acceptance Standards

This standard shall apply unless other standards are specified for specific applications within this division.

ASME Section VIII Div.1

All imperfections that produce an amplitude greater than 20% of the reference level shall be investigated to the extent that the operator can determine the shape, identity and location of all such imperfections and evaluate them in terms of the following acceptance standards.

I. Imperfections that are interpreted to be cracks, lack of fusion or incomplete penetration is unacceptable regardless of length.

II. All other linear type imperfections are unacceptable if the amplitude exceeds the reference level and the length of the imperfection exceeds the following.

- 1/4” (6mm) for T up to 3/4”
- 1/3T for T from 3/4” to 2 ¼” (19mm to 57mm);
- 3/4” for T over 2 ¼” (57mm)

1 Where T is the thickness of the weld excluding any allowable reinforcement.

For a butt weld joining two members having different thickness at the weld, T is thinner of these two thicknesses. If a full penetration weld includes a fillet weld, the thickness of the throat of the fillet shall be included in T.

ASME Sec.V

Acceptance–rejection standard, Imperfections that cause an indication greater that 20% of the reference level shall be investigated to the extent that the ultrasonic examination personnel can determine their shape, identity, and evaluate them in terms of I and II.

I. Crack, lack of fusion or incomplete penetration is unacceptable regardless of length.

II. Other imperfections are unacceptable if the indication is unacceptable regardless of length.

- 1/4” for T up to 3/4 “
- 1/3T for T from 3/4” to 21/4”
- 3/4” for T over 2 1/4”

2 Where T is the thickness of the weld being examined. If the weld joins two members, having different thickness at the weld. T is the thinner of these two thicknesses.

Post Cleaning

If examination carried on before welding, the area shall be cleaned with brushing, washing or any other way that cannot produce any problem either for base metal or welding or weld metal.

Report

The result of ultrasonic examination shall contain following information as minimum:

Project Name & No., Client, Report No., Request No., WPS No., Procedure No., Test technique, Probes, Weld No., Type of material/ Dimensions, Ultrasonic examination system (equipment), Examination personnel identity and level, Calibration sheet identity, Identification and location of weld or volume scanned, Surface from which examination is conducted, Map or record of indications detected or areas clear, Date and time examinations were performed, Couplant, Basic calibrations block identification, Surface condition, Frequency, Special equipment, Calibration & Reference block, Sensitivity.

ISSUE:	HAVAYAR Tomorrow Needs Innovation.	ULTRASONIC TEST REPORT(UT)	QCP.No:	Rev
VER:			Report No:	
Code:			Page: of	Date:

Project:	Equipment Name:	Drawing No:	Weld No:
Client:	Contractor:	Equipment No:	Part No:
Material:		Testing Subject:	
Thickness:		Base Metal ☐	Weld Metal ☐ Casting ☐
Surface Condition:	Standard:	Welding Process:	Groove Type:
Equipment Maker:	Model:	Calibration Black:	Base Material:
Probe Angle:	Calibration Range:	Couplant:	Examination Method:
Frequency:	Size:	Evaluation Standard:	Transfer Correction(db):
Standard Sensitivity:	SDH ☐	FBH ☐	Notch ☐

No	Head No.	Scan dir.	Thickness	Distance	Length	Depth	DAC. %	Defect	Result

HAVAYAR	TPI	HE/DI	PEDCO	NISOC
Vendor	Third Party Ins.	EPC Contractor	EPD/EPC Contractor(GC)	Owner
Name:	Name:	Name:	Name:	
Date:	Date:	Date:	Date:	
Sign:	Sign:	Sign:	Sign:	

11.0 MAGNETIC PARTICLE TEST PROCEDURE

Scope

This procedure covers the magnetic particle examination (MT) for pressure parts & non pressure parts to pressure parts welds line that performed in fabrication of Vessels according to related weld map & NDT table.

Personal Qualification

Personal qualification for MT operator & interpretation shall meet the requirement ASME SEC V-ARTICLE 7 (Ed 2015) mandatory appendix chapter I-722.

Surface Preparation

Prior to magnetic particle examination surface preparation & contrast shall meet the requirement of ASME SEC V-article 7 (Ed 2015) chapter T-741.

Equipment

Applicable MT method for this procedure is Yoke with AC current and white contrast method. This method only useful to detect discontinuities that be open to the surface of the part. For this technique, alternating current electromagnetic yokes shall be used. For material thickness less than 6 mm alternating current yokes are superior to direct or permanent magnet yokes of equal lifting power for the direction of surface discontinuities.

Calibration

Lifting Power

Prior to use, the magnetizing power of electromagnetic yokes shall have been checked within the past year. The magnetizing power of permanent yokes shall be checked daily prior to use. The magnetizing power of all yokes shall be checked whenever the yoke has been damaged. Each alternating current electromagnetic yoke shall have a lifting power of at least 4.5 Kg at the maximum pole spacing that will be used.

Magnetic Field Adquecy & Direction:

Pie shaped magnetic particle field indicator according fig ASME SEC V (ed 2015) T-764.1.1 shall be positioned on the surface to be examined, such that the copper-plated side is away from the inspected surface. A suitable field strength is indicated when a clearly defined line (or lines) of magnetic particles from a cross the copper face of the indicator when the magnetic particles are applied simultaneously with the magnetizing force. When a clearly defined line of particle is not formed, the magnetizing technique shall be changed as needed.

Examination

The ferromagnetic particle for yoke method (white contrast) is wet type (aerosol spray cans) applied when magnetizing current remain on the parts.

Examination coverage shall be conducted with sufficient field overlap to ensure 100% coverage at the required sensitivity according to ASME SEC V-T-774&764.

Direction of magnetizing: at least two separate examinations shall be performed on each area. During the second examination, the lines of magnetic flux shall be approximately perpendicular to those for magnetization may be used for second examination.

The temperature of the wet particle suspension and the surface of the part shall not exceed 60˚c and not less than medium freeze temperature.

The magnetic field will be held for minimum 5 second to allow particle magnetization and then it will be withdrawn.

Excess particle removal: Accumulations of excess dry particles in examination shall be removed with a light air stream from a bulb or syringe or other source or power shall be maintained while removing the excess particles.

Demagnetizing and post examination cleaning is not required for this method.

Interpretation

The interpretation shall identify if an indication as false, non-relevant or relevant. False and non-relevant indication shall be proven as false or non-relevant. Interpretation shall be carried out to identify the location of indication & character of indication.

For visible (color contrast) magnetic particles method surface discontinuities are indicated by accumulation of magnetic particles which should contrast with the examination surface. The color of magnetic particle shall be sufficiently different than the color of the examination surface. A minimum light intensity 1000 lx is required on the surface to be examined to ensure adequate sensitivity during the examination & evaluation of indication.

Evaluation

Evaluation of indication shall meet the requirement of ASME SEC VIII.DIV 1 (Ed 2015) appendix 6, chapter 6-3.

a) All indications shall be evaluated in terms of the acceptance standards of the referencing.
b) Discontinuities on or near the surface are indicated by retention of the examination medium. However, localized surface irregularities due to machining marks or other surface condition may produce false indications.
c) Broad areas of particle accumulation, which might mask indications from discontinuities, are prohibited, and such areas shall be cleaned and reexamined.

Acceptance Criteria

Acceptance criteria shall meet the requirement of ASME SEC VIII.DIV 1 (Ed 2015) appendix 6, chapter 6-4 as below:

All surfaces to be examined shall be free from of:

(A) Relevant linear indications.

rounded

(B) Relevant linear indications greater than 4.8 mm.

(C) Four or more relevant rounded indication in line separated by 1.6mm or less, edge to edge.

Re Examination

✓ Treatment of indications believed a non-relevant any indication which is believed to be non- relevant shall be regarded as an imperfection unless it is by reexamination by the same method or by the use of other nondestructive methods and/ or by surface conditioning that no unacceptable imperfection is perfect.

✓ **Examination of areas from where imperfections have been removed:** After a defect is removed and prior to making weld repairs, the area shall be examined by suitable method to ensure it has been removed or reduced to an acceptable size imperfection.

✓ **Re Examination of Repair Areas:** After repairs have been made, the repaired area shall be blended into the surrounding surface so as to avoid sharp notches, crevices, or corners and re- examined by the magnetic particle method and by all other methods of examination that were originally required for the affected area, except that, when the depth of repair is less than the radiographic sensitivity required, re- radiography may be omitted.

Record & Reporting

Magnetic Particle Examination records shall be filed for the period required by contract unless otherwise agreed to by the interested parties.

Examination condition and interpretation & evaluation shall be recorded on the report form of Magnetic Particle.

The report shall indicate all requirements that described in ASME SEC V (Ed 2010) article 7-T-792.

Blank format of MT report has been attached

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Magnetic Particle Test Report

Code No:	Date & Rev:
Report No:	Date:
Page: of	

Item No.	MT No.	Weld Location	Weld No.	Welder No.	THK(mm)	Film Length	Film Segment	ACC.	RP.	RS.	RET.	Type of Defect/Length	Remark

JUDGMENT: ACC:Accept, RP:Repair, RS:Reshoot, RET:Retake

Pre Examination: | **Surface Preparation:**

Method of Inspection?
Dry ☐ Wet ☐ Visible ☐ Floursent ☐

How the magnetic field applied to the media?
Residual ☐ Continuous ☐ True-Continuous ☐ AC ☐ DC ☐ Half-wave ☐
Prods
Yoke ☐ Cable warp ☐ Other ☐

Direction of field: Longitudinal ☐ Circular ☐ | **Strength of Field:**

Post Examination: | **Demagnetizing Technique (if required):**

Cleaning (if required): | **Marking method:**

Remark:

HAVAYAR	TPI	HE/DI	PEDCO	NISOC
Vendor	Third Party Ins.	EPC Contractor	EPD/EPC Contractor(GC)	Owner
Name:	Name:	Name:	Name:	
Date:	Date:	Date:	Date:	
Sign:	Sign:	Sign:	Sign:	