Base Load Power Hub (BLPH)

Magnetic Particle Examination Procedure – Structure

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1 INTRODUCTION

1.1 PROJECT OVERVIEW

Crosswind, a Shell and Eneco joint venture, was awarded the tender to develop the offshore Hollandse Kust Noord (HKN) wind farm, located 18.5km off the coast of Netherlands near the town of Egmond aan Zee. The consortium plans to have HKN operational in 2023 with an installed capacity of 759MW generating at least 3.3TWh per year. This is sufficient renewable power to supply more than 1 million Dutch households with green electricity.

Offshore wind farms produce intermittent electricity and balancing these dips and peaks and integrating this electricity into the national energy system requires new technologies. For this reason, the offshore wind farm will include several new technologies that could be implemented at full-scale in the future. The new technologies being explored include a floating solar park, a short-duration battery storage as well as long-term storage via green hydrogen produced by water electrolysis and subsequently consumed in a fuel cell. The combination of these individual measures, herein referred to as the Base Load Power Hub (BLPH) will ensure a continuous power supply regardless of the wind situation.

1.1.1 Project Location

The Hollandse Kust Noord (HKN) wind farm is located 18.5km off the coast of the Netherlands near the town of Egmond aan Zee.

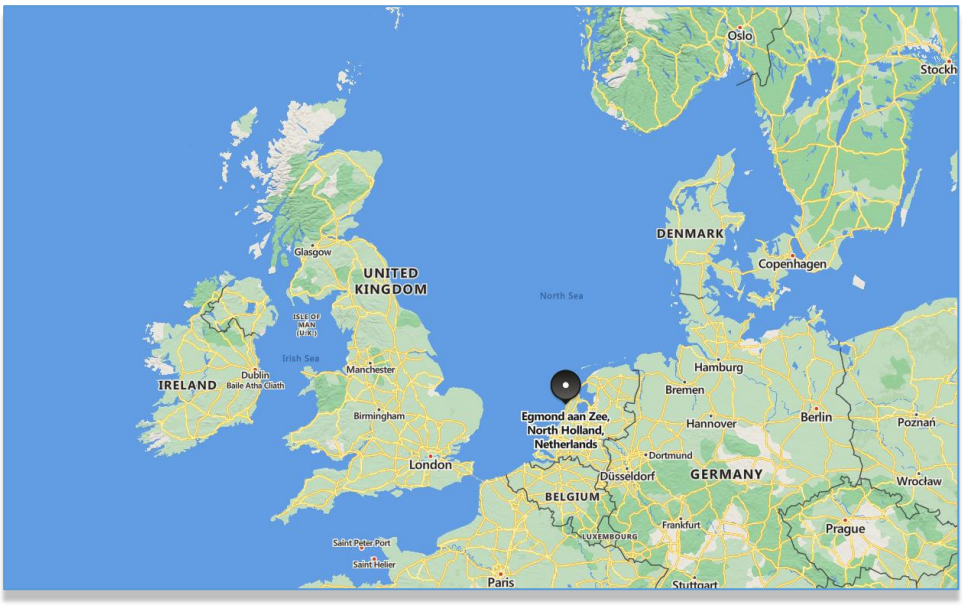


Figure 1 HOLLANDSE KUST NOORD WIND PARK Location Map

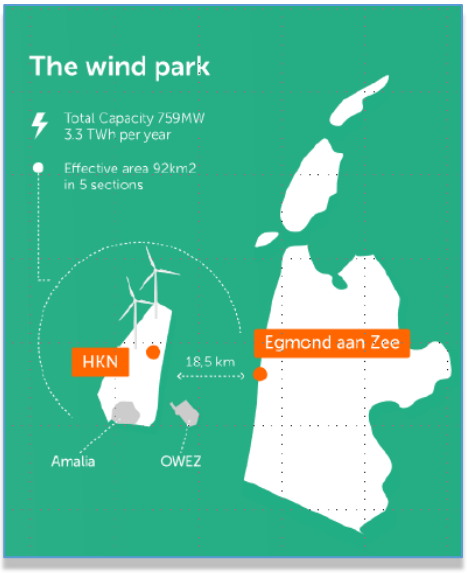


Figure 2 - Wind Park Details

The wind farm will consist of No. 69 x 11.5MW wind turbine generators each to be installed on a dedicated monopile structure. A 70th monopile located on coordinates E 590719.1, N 5841602.3 is reserved for installing the platform accommodating the BLPH. The monopile structure was designed and installed by Van Oord Offshore Wind (VooW) and therefore not part of the BLPH scope.

1.1.2 Project Concept

All components included in the BLPH will be integrated onshore on a topsides and installed in an offshore location within the boundaries of the HKN wind farm. At its simplest, the BLPH will store energy during periods of high electricity generation from renewable sources (a wind turbine generator and the floating solar PV farm) and release it during periods of low generation. In practice. It is expected that the energy stored will supplement generation from renewable sources to ensure that at least 1.0MW of power is exported to the electrical grid regardless of wind/solar availability.

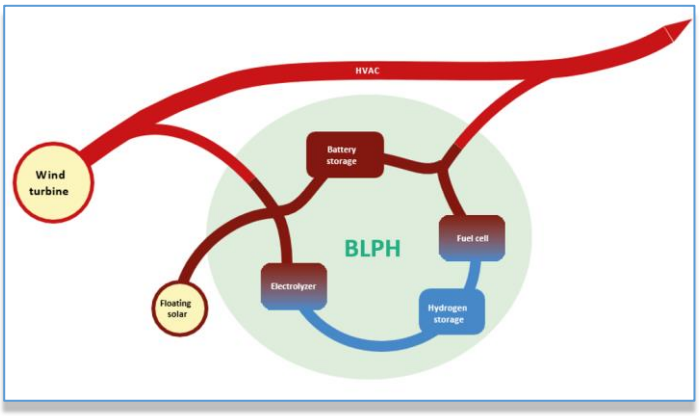


Figure 3 – BLPH Concept

Electricity in the BLPH will be stored in the form of electrons in a battery energy storage system (BESS) as well as converted into green hydrogen via water electrolysis. When the power output from the connecting wind

turbine drops to below 1 MWe, the BLPH will return its stored energy to supplement the remaining power output. This will be by discharging the BESS, while stored hydrogen will be converted back into electricity using a fuel cell to extend the discharge duration.

The purpose of the BLPH s to function as a testbed for the integration of energy storage technologies with renewable generation. It is expected that equipment installed on the BLPH will operate as Normally Unmanned Installation for at least two (2) years with no or minimal maintenance and it will have its own independent control room with the ability to communicate with Crosswind's control room.

2 DOCUMENT SCOPE

This procedure establishes the method for the execution, examination and evaluation of magnetic particle inspection to detect discontinuities on surface and sub-surface of ferromagnetic materials.

This method involves magnetizing an area to be examined and applying ferromagnetic particles to the surface.

This procedure applies also to qualification of welders and welding procedures.

The welds shall be tested at 100% of external surface and internal surface if accessible if accessible.

Final Non-Destructive Tests (NDT) shall not be carried out sooner than 48 hours after completion of welding.

2.1 REFERENCES (Applicable edition)

Doc. No.	Description
K559-2254-MT-SPE-001	Structural Fabrication Specification
EEMUA_158	Construction Specification for fixed offshore structures
EN ISO 9934-1	Non Destructive testing – Magnetic particle examination. Part 1: General principles
ISO 9712	Non-destructive testing — Qualification and certification of NDT personnel

Table 1 - Reference Documents

2.2 DEFINITIONS AND ABBREVIATIONS

COMPANY or Client (CPY):	Crosswind
CONTRACTOR (CTR):	ROSETTI MARINO S.p.A.
PROJECT:	HOLLANDSE KUST NOORD WIND PARK Project
NDT:	Non Destructive test
MT	Magnetic Test

Table 2 - Definitions and Abbreviations

3 PERSONNEL QUALIFICATION

The examiner who carries out magnetic particle test and evaluates indication on all the other welds shall be qualified as a Level 2 or 3 in the applicable method and on the relevant product sector in accordance with the requirements of ISO9712.

The operator shall have a valid near vision acuity test, which permits reading, a minimum of Times Roman N°4.5 or equivalent letters Jaeger 1 at not less than 30 cm with one or both eyes, either corrected or uncorrected.

Colour vision shall be sufficient that the candidate can distinguish contrast between the colours used in NDT method.

4 NDT EXTENSION

The extend shall be in accordance to Spec. K559-2254-MT-SPE-001 and will reported on design drawings and inspection test plan.

5 SURFACE PREPARATION

Prior to magnetic particle examination, the surface to be examined and all adjacent areas within at least 1" (25,4 mm) shall be free of all dirty, grease, scale or other extraneous matter that could interfere with the examination.

If and when necessary, surfaces to be examined can be cleaned by grit or metal blasting.

The weld shall be prepared by grinding if necessary, to assure that the examination shall be performed properly and that the surface condition of the weld is not causing misleading interpretations of the results.

For butt weld requiring cap to be ground flush for inspection purposes final MT examination shall be performed after cap removal.

The status of the weld shall be reported in MT inspection report.

All temporary attachments for scaffolding, temporary bracings, temporary lifting appliances, moved supports, equipment or piping, etc., shall be removed and inspected by MT.

6 CONSUMABLES

In all cases the magnetic detection media shall be of a wet suspension type, a contrast white lacquer shall be applied to surfaces to be inspected after cleaning and prior to magnetization, in order to improve the contrast and to facilitate the mobility of the magnetic particles.

Lacquer is to be applied by spraying (also from spray cans).

Black magnetic powder shall be used as an examination medium.

The following materials shall be used:

a) wet particles:

CGM LK 35 BLACK COLOUR

ELITE – BLACK MAGNETIC INK BW2

b) white lacquer:

CGM VECOPLAST

WHITE BACKGROUND LACQUER WBL5

Or equivalent.

Particles shall be used within the temperature range limitations set by the manufacturer of the particles.

7 EXAMINATION

Visual examination shall be performed prior to start magnetic particle examination.

The Magnetic examination shall be performed not earlier than 48 hours after completion weld.

The technique shall be carried out in the continuous mode and test shall be performed at least in two perpendicular directions to detect any discontinuities regardless their position and orientation (see Attachment 1).

Magnetization shall be made using sufficient overlap to assure 100% coverage at the required sensitivity of the controlled areas.

To ensure detection of imperfections in all orientations, the welds shall be magnetized in two directions approximately perpendicular to each other with a maximum deviation of 30°.

Electromagnetic yoke (A.C. alternative current) shall be used.

Each alternative current electromagnetic yokes shall be verified prior to every use, establishing their lifting force equal or more than 4,5 kg at the maximum pole spacing that will be used.
Magnetic field adequacy and direction indicator shall be used to check magnetic field adequacy (see attachment 2).
For the structural steels in welds, a tangential field between 2kA/m to 6kA/m is required.

8 PARTICLES APPPLICATIONS

Magnetic suspension solution shall be applied, during application of magnetic force (continuous method), by means of a sprayer to provide a homogeneous distribution.

The magnetizing current shall be turned on after the particles have been applied.

Flow of particles shall stop with the application of current.

Wet particles applied from aerosol spray cans may be applied before and/or after magnetizing current is applied.

Wet particles may be applied during the application of magnetizing current if they are not applied directly to the examination area and are allowed to flow over the examination area or are applied directly to the examination area with low velocities insufficient to remove accumulated particles.

9 VIEWING CONDITION

All the testing area shall be easily accessible in safety condition; if necessary, the part shall be moved, to avoid that limited access could interfere with the test results.

The area under test shall be evenly illuminated at a level of not less than 500 lx (lux) daylight or artificial light.

Light meters shall be calibrated at least once a year or whenever a meter has been repaired.

If meters have not been in use for one year or more, calibration shall be done before being used.

10 DEMAGNETIZATION

After testing with alternating current, residual magnetization will normally be low for low carbon steels, and there will generally be no need for demagnetization of the object.

11 ACCEPTANCE CRITERIA

The acceptance criteria shall be in accordance with EEMUA_158:2014, §7.5.5

All surfaces to be examined shall be free of the following:

- Relevant linear indications
- Relevant rounded indications greater than 4mm
- 4 or more relevant rounded indications in a line, separated by 1,5mm or less (Edge to Edge)

11.1 Relevant indications

A "relevant" indication is that caused by defect rather than by weld geometry.

11.2 Linear Indication

A "linear" indication is one having a length greater than three times the width. Intermittent and aligned indications shall be treated as a linear indication.

11.3 Rounded Indication

A "rounded" indication is one having circular or elliptical shape with the length equal or less than three times the width.

Any questionable or doubtful indications shall be re-examined (after cleaning of the surface) to determine whether or not they are relevant; in case of doubt, it's possible to use other NDT method for identification and confirmation of suspected flaw indications.

12 WELD REPAIR

All defects after repair with a new magnetic particle examination, shall be carried out all over the interested area including 50 mm on either side of defects.
The examination after repair shall be performed not earlier than 48 hours after completion weld.
Welding repairs (or replaced welds) shall be examined with the methods prescribed for the original WPS.

13 EXAMINATION REPORT

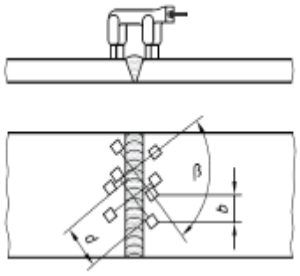
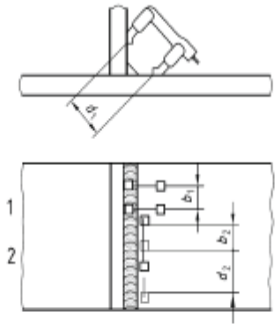
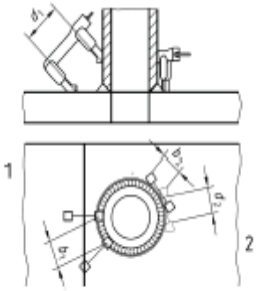
All NDT shall be documented, and all reports shall be generate by database (See attachment 3)
The documentation shall include as minimum the following information, where appropriate:

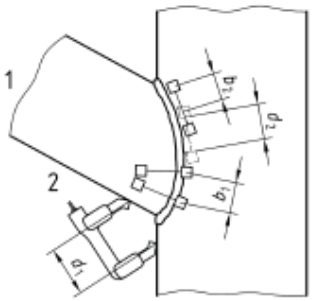
- contract number;
- applicable procedure specification;
- weld identification;
- material type and dimensions;
- welding process used;
- surface conditions;
- post weld heat treatment (if required)
- temperature of the object;
- type of magnetization equipment
- testing technique
- type of current
- detection media
- viewing conditions
- date of testing;
- approval signature of responsible inspector.
- magnetic field strength verification

14 ATTACHMENT

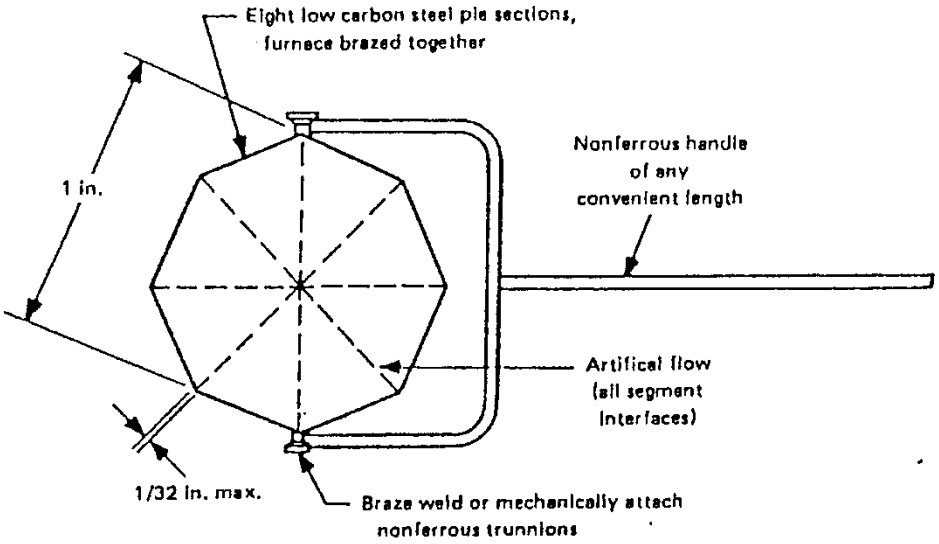
Attachment 1 - Example of an area to be examined by yoke magnetization technique
Attachment 2 – Magnetic particle field indicator
Attachment 3 – Examination Report
Attachment 4 – Instruction sheet IDL-QCI-MT-006

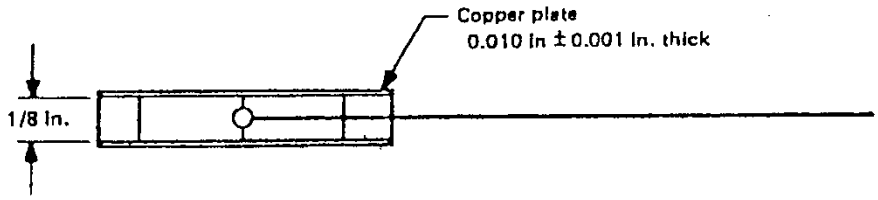
Attachment 1 - Example of an area to be examined by yoke magnetization technique.

	Material type: *Ferromagnetic material*	*Dimensions in mm*
1		$75 \le d \le 250$ $b_1 \le 0.5d$ $b_2 \le d - 50$ (minimum overlap 50) $b \approx 90°$
2		$d_1 \ge 75$ $b_1 \le 0.5d_1$ $b_2 \le d_2 - 50$ (minimum overlap 50) $d_2 \ge 75$
3		$d_1 \ge 75$ $d_2 \ge 75$ $b_1 \le 0.5\ d_1$ $b_2 \le d_2 - 50$ (minimum overlap 50)

	Material type: *Ferromagnetic material*	*Dimensions in mm*
4		$d_1 \geq 75$ $d_2 \geq 75$ $b_2 \leq d_2 - 50$ (minimum overlap 50) $b_1 \leq 0.5\ d_1$

Attachment 2 – Magnetic particle field indicator





MAGNETIC PARTICLE FIELD INDICATOR

Attachment 3 – Examination Report

ROSETTI MARINO

NDT ACTIVITIES - TEST REPORT

RAPPORTO DI ESAME MAGNETOSCOPICO

MAGNETIC PARTICLE TEST REPORT

REPORT N°

DATA DELL'ESAME / Examination Date

FOGLIO / Sheet n° 1 DI / of

CLIENTE / Client	COMMESSA N°/Job No	DISCIPLINA / Discipline	ORDINE N°/ Order N°	PROGETTO/Project

CODICE - PROCEDURA / Code - Procedure	SPECIFICA / Specification	ACCETTABILITA' / Acceptance levels	INSPECTION TEST PLAN / ITP No	FASE ITP / Phase ITP
Rev.			Rev.	

TECNICA DI SALDATURA / Welding process	PROC. di SALDATURA / WPS	FASE DEL CONTROLLO / Examination phase	TRATTAMENTO TERMICO / PWHT
			☐ PRIMA DEL TT / Before PWHT ☐ DOPO IL TT / After PWHT ☐ NON APPLICABILE / Not Applicable

OGGETTO / Object	MATERIALE / Material	TEMPERATURA PEZZO / Piece temperature	ISTRUZIONE DI LAVORO MT / MT Work Instruction
☐ MAT. BASE / Parent Material ☐ SALDATURA / Weld Metal			

CONDIZIONI DI VISIONE / Viewing conditions

☐ NATURALE / Naturall light ☐ ARTIFICIALE / Artificial light — TIPO ILLUMINATORE / Lighting equipment

☐ LAMPADA DI WOOD / Wood Lamp ☐ ALTRO / Other — ILLUMINAZIONE / Lighting intensity

STATO DELLA SUPERFICIE / Surface condition

☐ COME SALDATO / As welded ☐ SPAZZOLATO / As brushed ☐ LAVORATO DI MACCHINA / As machined ☐ COME CALANDRATO / As formed

☐ MOLATO / As ground ☐ COME LAMINATO / As rolled ☐ GREZZO / As forged ☐ ALTRO / Other

TECNICA DI MAGNETIZZAZIONE / Magnetization technique

☐ PUNTALI / Prods ☐ GIOGO / Yoke ☐ BOBINA / Coil ☐ CONDUTTORE CENTRALE / Neutral Wire ☐ ALTRO / Other

SMAGNETIZZAZIONE FINALE/ Final Demagnetization	CORRENTE/ Current	INTENSITA'/ Intensity

DISTANZA PUNTALI / Pole Spacing (mm)	TIPO APPARECCHIO/ Magnetic Equipment	NUMERO DI SERIE / Serial number

PARTICELLE MAGNETICHE UTILIZZATE PER L'ISPEZIONE / Magnetic particles used for inspection

TIPOLOGIA CONTROLLO / Examination kind ☐ SECCO / Dry ☐ UMIDO / Wet ☐ FLUORESCENTE/Fluorescent

COLORE / Color ☐ BLU / Blue ☐ ROSSA / Red ☐ NERA / Black ☐ ALTRO / Other

MARCA / Trade	TIPO / Type	Batch N.

VERNICE DI CONTRASTO / Surface contrast paint	MARCA / Trade	TIPO / Type	Batch N.

OGGETTO CONTROLLATO / Object tested

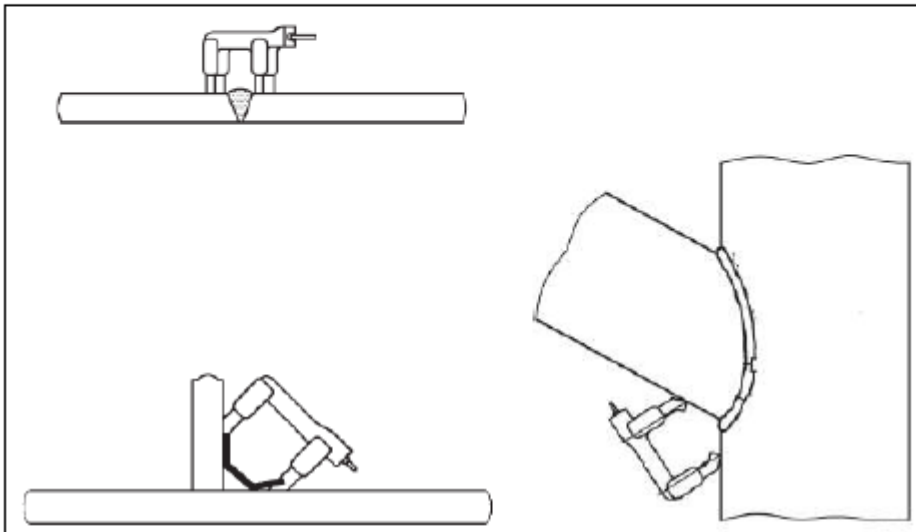
SALDATURA / Weld Number	DISEGNO / Sheet DWG / sheet	MARCA / Mark	DIMENSIONI / Dimension	SPESSORE / Thickness	TIPO DI GIUNTO / Type of joint	TIPO DI GIUNTO / Type of joint	LUNGHEZZA CONTROLLATA / Inspected length	ESITO / Result

NOTE / Remarks

TECNICO CND Livello 2 / NDT Technician Level 2	CONTROLLO QUALITA' / Q.C. Supervisor	ISPETTORE CONTRATTISTA / Contractor Repr.	ISPETTORE CLIENTE / Company Repr.	ISPETTORE TERZA PARTE / Third party inspector
Company: Operator:				

Attachment 4 – Instruction sheet IDL-QCI-MT-006

ROSETTI MARINO SPA	NDT INSTRUCTION SHEET SPECIFICATION	N° IDL-QCI-MT-06 Rev. 00 Data 07/01/2019



GIOGO **JOKE CGM** YOKE	TIPO **48 VOLTS** TYPE	INTENSITA' **NON APPLICABILE** INTENSITY **NOT APPLICABLE**
VERNICE DI CONTRASTO BIANCA **ELITE** CONTRAST WHITE LACQUER **Type WBL5**		LIQUIDO NERO IN SOSPENSIONE **ELITE** BLACK INK **Type BW2**
VERIFICA GIOGO YOKE VERIFICATION	**Sollevare 4.5 kg. a 200mm. di distanza dei puntali** **4.5 Kg. of weigh lifting at 200mm. of prod spacing**	
Verifica della direzione del campo magnetico **Magnetic field direction verification**		SMAGNETIZZAZIONE FINALE: **NON APPLICABILE** DEMAGNETIZATION: **NOT APPLICABLE**
TECNICA USATA YOKE TECNIQUE	**Le particelle magnetiche saranno applicate mentre si produce il campo.** *Il controllo dovrà essere eseguito dal lato esterno ed interno della saldatura se accessibile* **Magnetic powder shall be applied with continuous method during magnetic force application.** *Check shall be performed external and internal side of the weld if accessible*	