

EMAT UNIT

As Part Of EMATEST-PL – Equipment For Non-Contact Ultrasonic Examination Of Plates.

Brief Specification.



1. Generalities

EMAT Units (or UT-probes) are essential parts of the EMATEST-PL. EMAT Units are intended for generating/receiving ultrasonic shear waves into/from steel plates.

Application of shear waves (SW) very sensitive to all the real defects including laminations is a great advantage of EMATEST-PL.

Both transmission and receiving of ultrasonic waves are performed strictly normal to the plate surface, regardless the UT-probe inclination. This is a second important advantage of the EMAT to conventional UT-probes.

EMAT Units for plate body testing have an identical design with the EMAT Units devoted to longitudinal and transversal edges of plates. Generally, EMATEST-PL has two lines of the EMAT Units for testing of plate body, and four EMAT Units for testing of both longitudinal edges. All the EMAT Units can test also transversal edges.

EMAT Units have eight coils, connected to the respective flaw detection electronics, creating eight independent acoustical and electronic channels.

Each EMAT Unit consists of:

- Housing with an assembly of eight coils (EMAT-block);
- Magnetization block;
- Suspension system enabling EMAT Units reliable descending/retracting onto/from the plate.

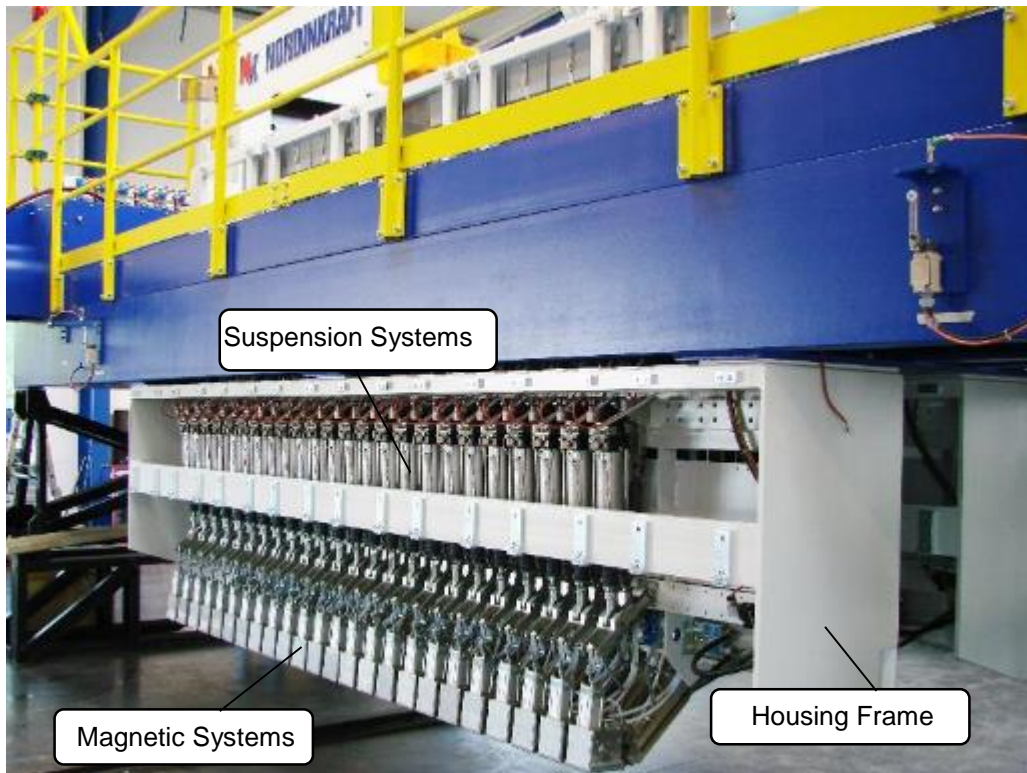


Fig. 1 – Line of the EMAT Units

2. EMAT-block

EMAT-block is the best instrument to test plates for any internal imperfections. The coils implemented into EMAT-block provide transformation of electromagnetic energy into the energy of ultrasonic waves and (after interaction with borders of plates or defects) perform an inverse transformation.



Fig. 2 – Multichannel Electromagnetic-acoustic Transducer

The active element of the EMAT is an assembly of 8 “butterfly” shaped electrical coils. An example of such coils assembly is represented below:



Fig. 3 – Assembly of 8-channels electrical coils

Working surface of the EMAT-block is protected by a special ceramic layer.

Active zone of the probe is covered by a protector made of a special resistant material preventing rubbing and a negative influence of a high temperature.

There are two nozzles at the bottom of the probe. They allow compressed air to create an “Air-Cushion”-gap of 0.1~0.7mm between the probe and plate (size of gap depends on pressure of compressed air). Because of the “Air-Cushion” EMAT-blocks do not even touch the plate during the test.

“Air- Cushion” is the main instrument to keep the EMAT-block in a good shape for a long-long time. One set of EMAT-blocks can test at least 1.000.000 tons of plates without decreasing its parameters. Long operation is another great advantage of the EMAT-technology in terms of plates ultrasonic examination.

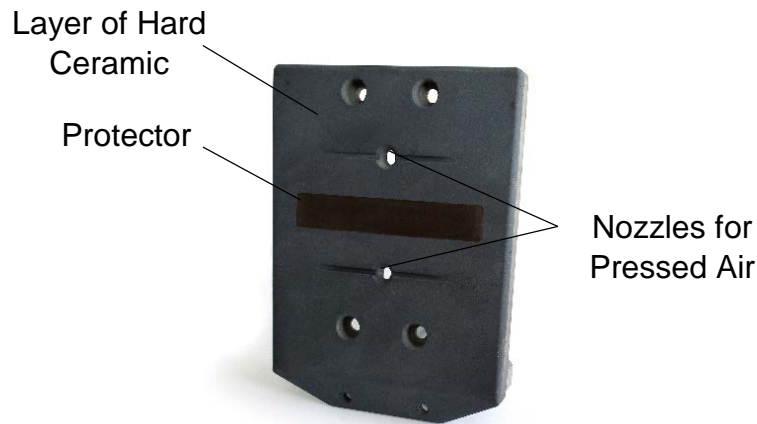


Fig. 4 – EMAT – block design.

Application of “Air-Cushion” is one of the most important patents related to the technology of Nordinkraft and makes an industrial examination of plates with EMAT very effective.

The basic idea of air cushion is simple and understandable:

Pressed air is feeding air cushion by means of special nozzles in the EMAT-block. It creates a small gap between the probe and plate. Due to the gap, EMAT is easily floating over the plate surface, just like an air-cushion ship.

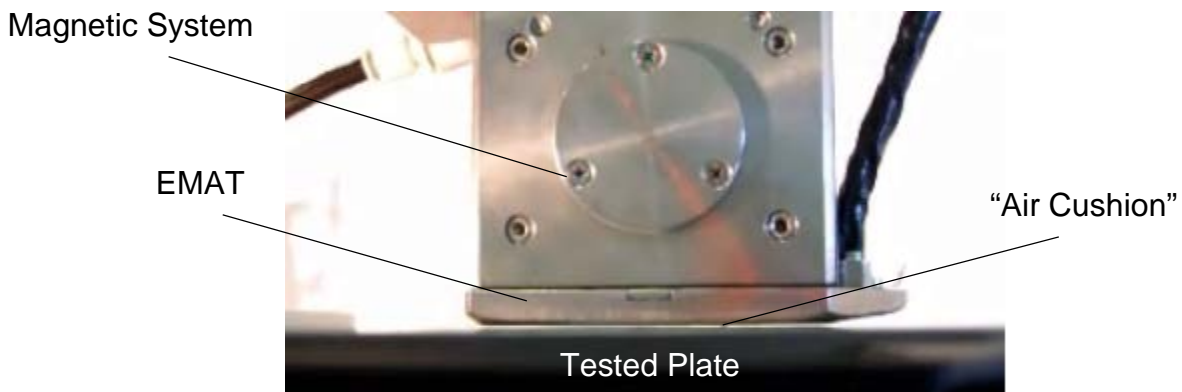


Fig. 5 – “Air Cushion”

The main functions of the “Air-Cushion” are:

- Protection of probes in order to avoid or minimize their direct mechanical contact with plates;
- Protection against high temperature.

Due to its design and physical properties, EMAT probes do not need maintenance, adjustments, or calibrations. Calibration of the whole test system is performed automatically during the testing process, regardless plates thickness variations. Therefore, the Customer may test plates having different dimensions in a random order.

For example, the first plate may have a wall thickness of 5 mm, the next one to be tested has a wall thickness of 50 mm thick, the next one is 22 mm thick, and so on. The system

obtains information about the next plate (like its wall thickness and width) from the upper level PC automatically before the test starts.

Due to the EMAT's special design, the actual sensitivity (within a defined range) is not influenced by thickness, attenuation factor of the material, temperature, or gap between probe and plate.

EMAT-block Specification

Parameter	Value
Type of the probe	ET 5.3-8-2.5-10-83-26-BT-K66
Number of active elements in one probe	8
Effective length of every active element	10 mm
Effective width of every active element:	3 mm
Width of the track covered by each probe:	65 mm
Detection Sensitivity:	FBH-3 mm
Geometrical overlap rate	10mm x 8 / 65mm \approx 1.23;
Modes of waves transmit/receive	Each element transmits and receives ultrasonic waves independently
Direction of transmitting and receiving of ultrasound:	normal to the surface
Adjustable Working Frequency range:	3~6 MHz
Type of protector:	ceramic or composite material plate
Main protection	"Air Cushion"
Nominal gap provided by "air gap"	0.1 – 0.7 mm (depends on the compressed air supply)
Typical range of the plate temperature:	-25°C ~ +450°C;
Maintenance, adjustments, and calibrations.	Not required

3. Suspension System

Suspension System is intended for providing a reliable and safe on-line examination of plates by means of the EMAT Units.

Suspension System contains the following main components:

- Magnetic System in assembly;
- A Set of Executive Levers;
- Pneumatic Drive Cylinder and Spring;
- Protective Shield.

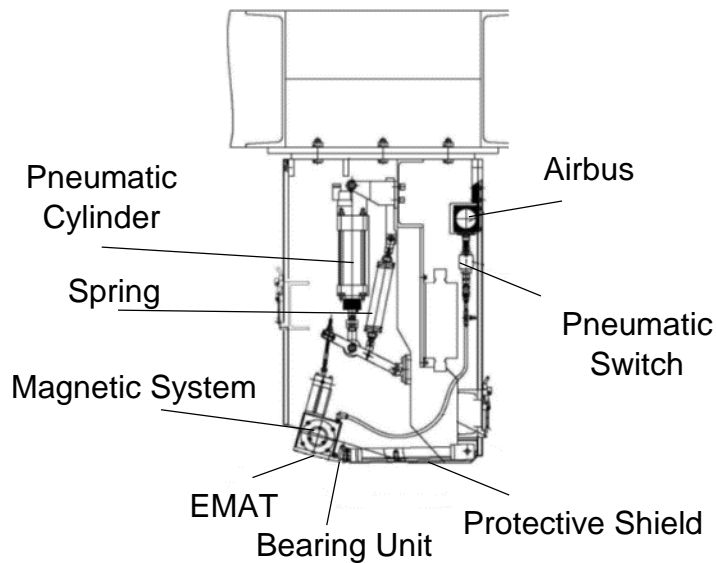


Fig. 6 – EMAT Suspension System

Magnetic System is intended for providing a permanent magnetic field in the area of coils.

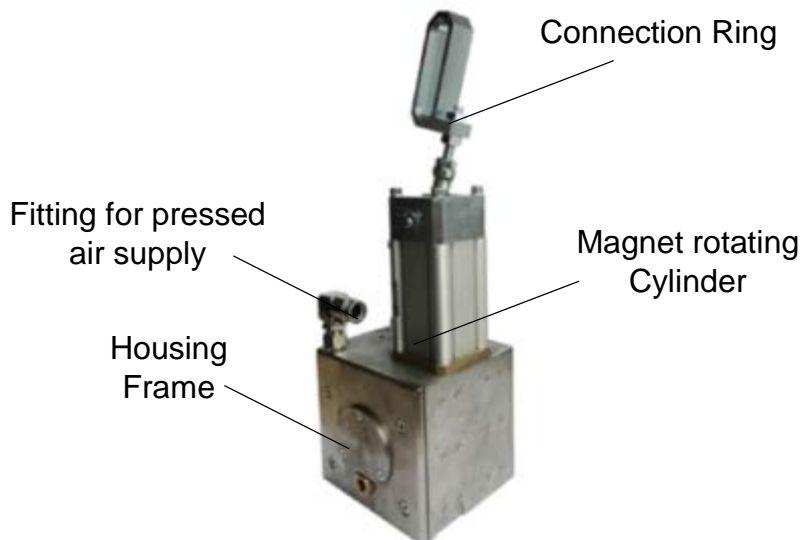


Fig. 7 – Magnetic System in Assembly

Design an principle of the **Magnetic System** operation can be described as follows:

- Strong permanent magnet is located inside of the **Magnetic System** housing;
- A permanent magnet can travel to/out of the coils area by means of a lever connected to a pneumatic cylinder;
- Therefore, it is possible to switch the magnetic field “ON” and/or “OFF” by activating/de-activating the cylinder.

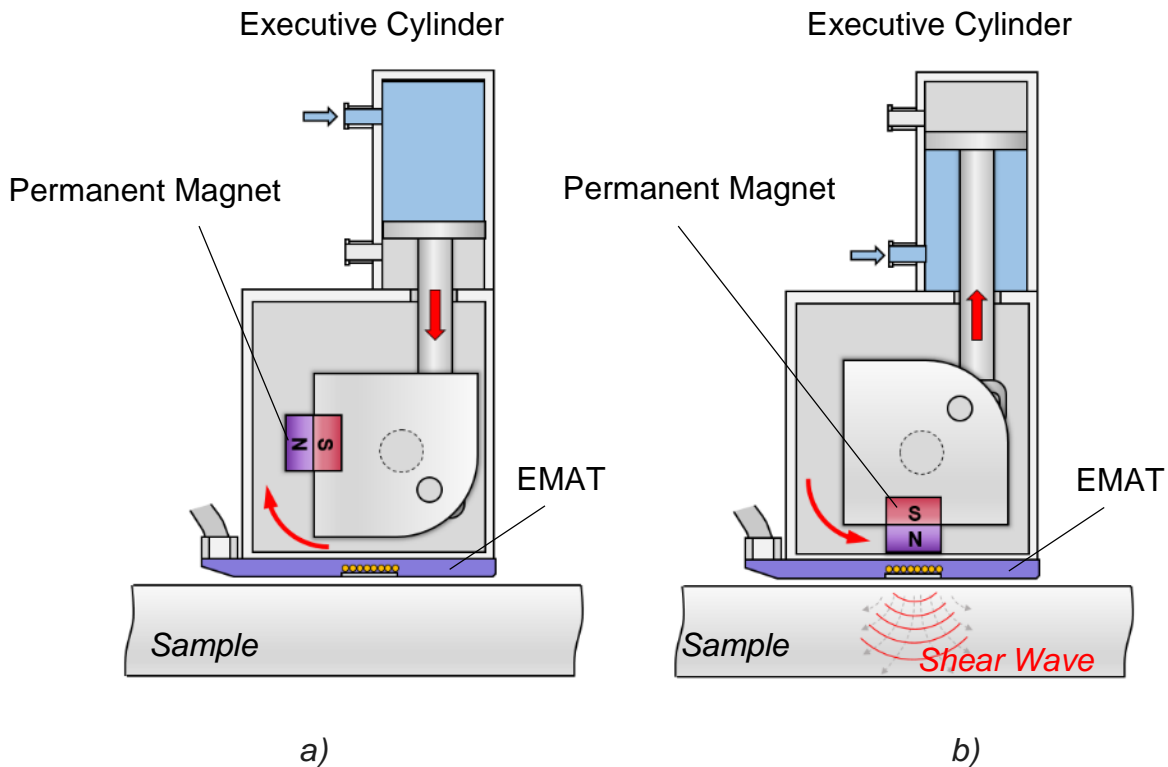


Fig. 8 – The Magnetic Field is “Off” (a) and “On” (b)

EMAT-block is fixed into the **Magnetic System** of four screws.

Pressed air is supplied to the EMAT-block through special channels inside of the **Magnetic System** housing.

Hoses for pressed air supply are connected via a pressed **air supply connector** to a **Pneumatic Switch**; thus the Air-Cushion could be switched “ON” or “OFF” - individually for each EMAT Unit.

Permanent magnet is in connection with the executive **Air Cylinder** and **Spring** - by means of the set of levers and bearings. Due to specifics of the suspension system, the EMAT Unit has several degrees of freedom; it is able to float over the plate surface following its curvature.

Pneumatic Cylinder is intended for descending/retraction of the EMAT to/from the plate. Each EMAT Unit is driven by an individual cylinder; thus, it is possible to control descending/retracting of every EMAT Unit on an individual way.

All the **Pneumatic Cylinders** are provided by **Springs**. Such concept developed for the equipment safe operation: in case if the pressed air supply is not sufficient the **Springs** will immediately lift the respective EMAT Units up to their initial (safe) position.

Every EMAT block is connected to the **Protective Shield** trough the **Bearing Unit**. The **Protective Shield** and **Bearing Unit** are intended for an additional protection of the EMAT Units.

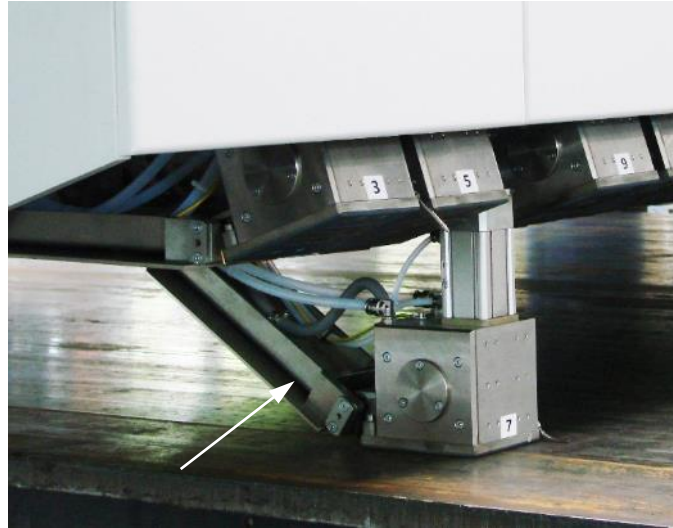


Fig. 9 – Protective Shield

Even in case of an extreme plate curvature or foreign objects on it, the EMAT Unit will keep on testing without a risk to be damaged.

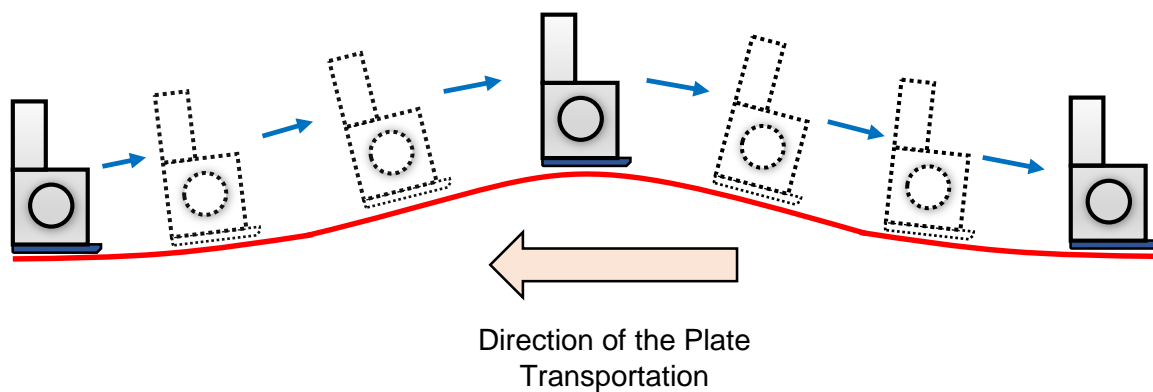


Fig. 10 – Principle of Plate Curvature Tracking