NDT TECHNOLOGIES, Inc.

Wire Rope Nondestructive Evaluation

Know Your Ropes. Know What. Know Where. Know Why.

New Generation
MRT Systems
MRT (Magnetic Wire Rope Testing)

RopeGuardian™
Continuous Rope Monitoring System (CRMS)

RopeGuardian™

Continuous Wire Rope Monitoring

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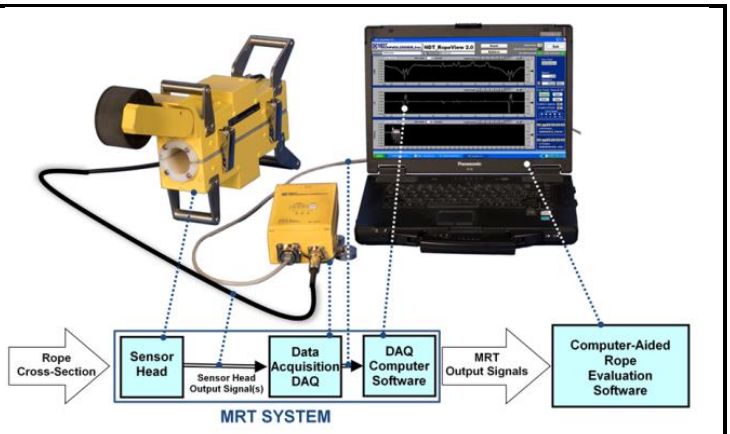
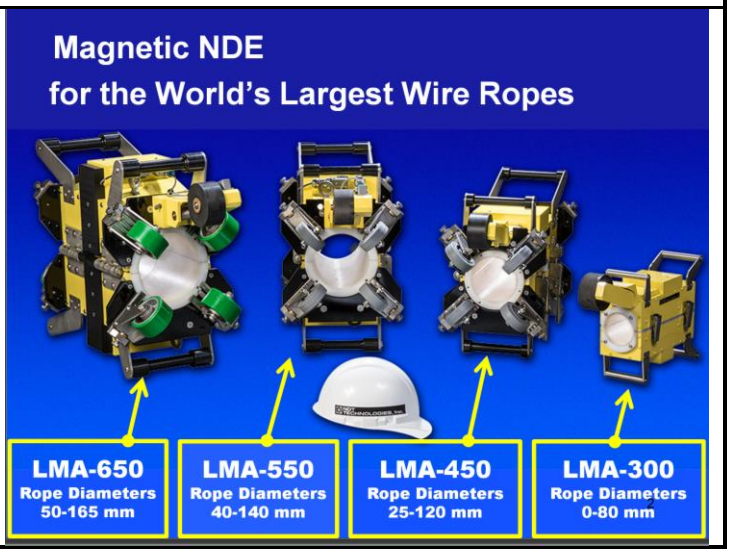
New Generation **Data Acquisition (DAQ) System**	
New Generation **MRT (Magnetic Wire Rope Test) Sensor Heads for Wire Ropes Φ 0-120 mm**	
New Generation **MRT (Magnetic Wire Rope Test) Sensor Heads for Wire Ropes Φ 0-165 mm**	

DAQ-05
New Generation Data Acquisition System

A *New Generation Wire Rope Nondestructive Examination (NDE) System* typically consists of the following major hardware items (Figure 1):

- Sensor Head,
- DAQ-05 Signal Acquisition Unit ("DAQ Box") (see Figure 2),
- Host Computer,
- Various accessories.

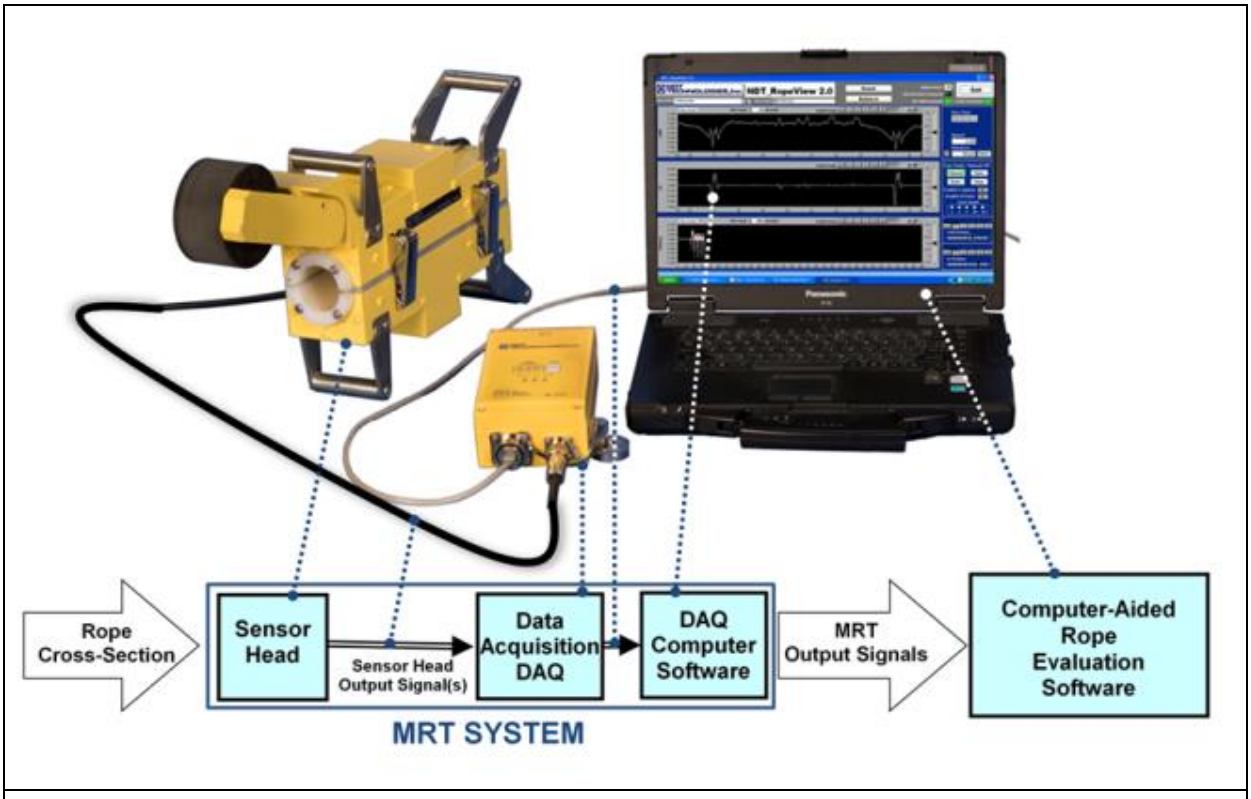
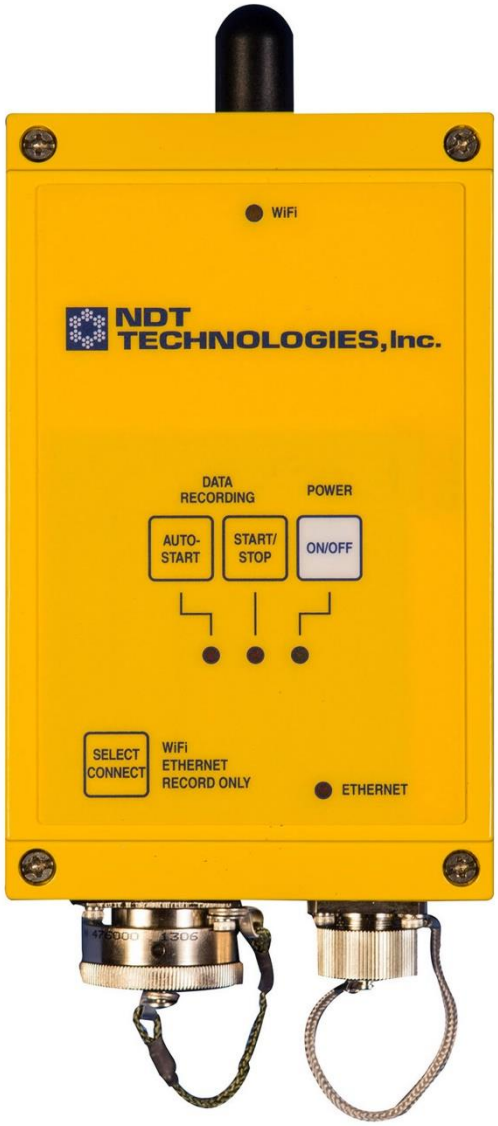


Figure 1: ***New Generation Wire Rope NDE System***

DAQ-05

New Generation Data Acquisition System



Specifications

- Size 160 x 100 x 55 mm
- Weight 0.9 kg
- Memory capacity 1 GB
- 18 hours of continuous data collection
- Rechargeable batteries (Li-ion)
- Battery life 8-15+ hours (depending on operating mode)
- Battery charger 120/240 V
- Environmental protection IP 65
- Ambient temperature -10°…+50°C
- Download to Host Computer via wired Ethernet or Wi-Fi
- CE marking

Software:

- NDT_RopeView™
- NDT_CARE™ (**C**omputer **A**ided **R**ope **E**valuation)
- MS Office compatible

Figure 2: DAQ-05 Signal Acquisition Unit ("DAQ Box")

DAQ-05
New Generation Data Acquisition System

DAQ-05 "DAQ Box" Operation

1. **Online.**

   This type of operation supports situations where the sensor head is stationary, and the wire rope moves through the sensor head. Examples include mine hoist and crane rope inspections.

   Sensor head signals are digitized by the DAQ-05 "DAQ Box" and transferred to the Host Computer in real-time via wired Ethernet.

   Using *NDT_ RopeView*™ software, signals are displayed on the computer screen. They are simultaneously written to a disk file.

   After the inspection, signals can be analyzed offline with the *NDT_CARE (**C**omputer **A**ided **R**ope **E**valuation)*™ software.

2. **Offline.**

   This type of operation supports situations where the wire rope is stationary and the sensor head moves along the rope. Examples include guy-wire, stay-cable or zip-line nondestructive examinations.

   In batch mode, the DAQ-05 "DAQ Box" operates as an autonomous data collection unit – not connected to the Host Computer. In this mode, the DAQ Box can be attached to the sensor head. Inspection data from the sensor head is stored in the DAQ Box onboard memory in the form of time and date stamped files, which allows data from multiple inspections to be collected and organized.

   After the inspection, when reconnected to the Host Computer, *NDT_RopeView* software presents a file directory that can be used to select, download, display, and analyze the desired inspection results. Data can be transferred to the Host Computer via wired Ethernet or Wi-Fi.

   It can then be printed and analyzed offline with the *NDT_CARE*™ *(**C**omputer **A**ided **R**ope **E**valuation)* software.

LMA-125 WIRE ROPE INSPECTION SYSTEM

SPECIFICATION SHEET

LMA-125 Sensor Head

Features

For the Nondestructive Inspection of wire ropes with diameters 0 to 1¼ inch (0-32 mm).
Speed and Distance wheel assembly: Calibrated for Meters.

LMA-125 Sensor Head

- Dimensions: (LxWxH) (without handles) 10” x 3” x 6” (254 x 76 x 152 mm)
- Weight: 17 lbs. (8 kg)

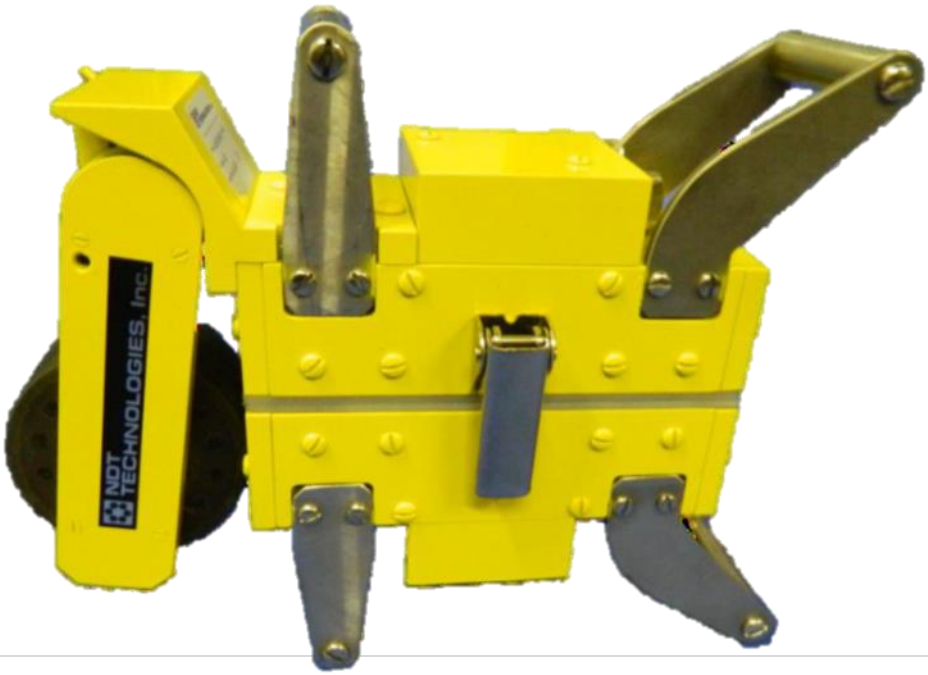
Environmental Protection: IP 67

Performance

- Rope Sizes: Φ 0 - 1¼ inch (0 - 32 mm)
- Rope Speed: 0.03 to 3 m/sec (0.5 to 600 feet per minute)
- Test Signals: LF and LMA Signal, amplitudes independent of rope speed.

Flaw Detection:

- **Loss of metallic cross-sectional area (LMA):**
  Quantitative Characterization: external and internal corrosion including corrosion pitting, wear, broken wires, broken cores, various changes of rope structure.
- **Localized flaws (LF):**
  Qualitative Characterization only: broken wires, corrosion pitting.
- **Wire Rope Roughness (WRR):**
  Quantitative Characterization: external and internal corrosion including corrosion pitting, interstrand nicking, broken wires (single or in clusters).



LMA-175L WIRE ROPE INSPECTION SYSTEM

SPECIFICATION SHEET

LMA-175L Sensor Head

Features

For the Nondestructive Inspection of wire ropes with diameters 0 to1¾ inch (0 - 45 mm).
Speed and Distance wheel assembly: Calibrated for Meters.

LMA-175L Sensor Head

- Dimensions: (LxWxH) (without handles) 9.3"x 3.26 "x 6.9” (490 x 83 x 175 mm)
- Weight: 50 lbs. (23 kg)

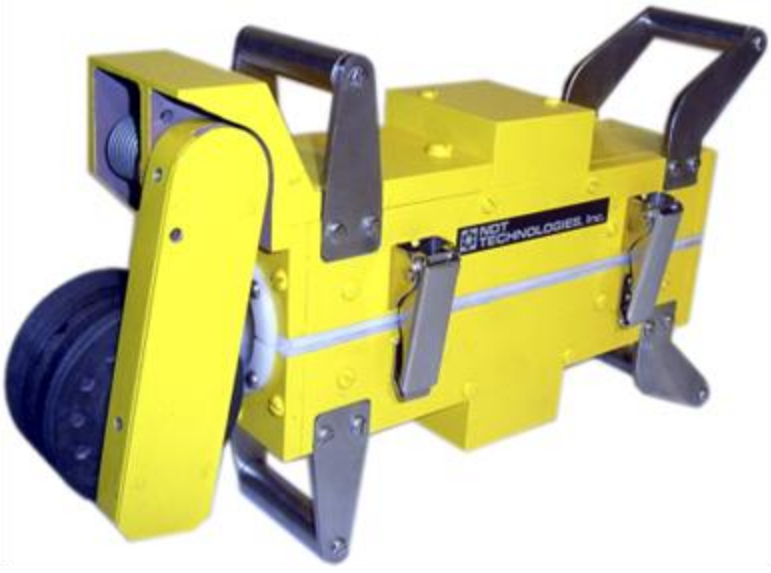
Environmental Protection: IP 67

Performance

- Rope Sizes: Φ 0 - 1¾ inch (0 - 45 mm)
- Rope Speed: 0.03 to 3 m/sec (0.5 to 600 feet per minute)
- Test Signals: LF and LMA Signal, amplitudes independent of rope speed.

Flaw Detection:

- **Loss of metallic cross-sectional area (LMA):**
  Quantitative Characterization: external and internal corrosion including corrosion pitting, wear, broken wires, broken cores, various changes of rope structure.
- **Localized flaws (LF):**
  Qualitative Characterization only: broken wires, corrosion pitting.
- **Wire Rope Roughness (WRR):**
  Quantitative Characterization: external and internal corrosion including corrosion pitting, interstrand nicking, broken wires (single or in clusters).



LMA-250S WIRE ROPE INSPECTION SYSTEM

SPECIFICATION SHEET

LMA-250S Sensor Head

Features

For the Nondestructive Inspection of wire ropes Φ 0 to 2½” (0 - 63 mm).
Speed and Distance wheel assembly: Calibrated for Meters.

LMA-250S Sensor Head

- Dimensions: (LxWxH) (without handles) 9¾ "x 4½ "x 9” (250 x 115 x 220 mm)
- Weight: 40 lbs. (18 kg)

Environmental Protection: IP 67

Performance

- Rope Sizes: Φ 0 – 2½ inch (0 - 63 mm)
- Rope Speed: 0.03 to 3 m/sec (0.5 to 600 feet per minute)
- Test Signals: LF and LMA Signal, amplitudes independent of rope speed.

Flaw Detection:

- **Loss of metallic cross-sectional area (LMA):**
  Quantitative Characterization: external and internal corrosion including corrosion pitting, wear, broken wires, broken cores, various changes of rope structure.
- **Localized flaws (LF):**
  Qualitative Characterization only: broken wires, corrosion pitting.
- **Wire Rope Roughness (WRR):**
  Quantitative Characterization: external and internal corrosion including corrosion pitting, interstrand nicking, broken wires (single or in clusters).

LMA-300 WIRE ROPE INSPECTION SYSTEM

SPECIFICATION SHEET

LMA-300 Sensor Head

Features

For the Nondestructive Inspection of wire ropes Φ 0 – 3¼” (0 - 83 mm).
Speed and Distance wheel assembly: Calibrated for Meters.

LMA-300 Sensor Head

- Dimensions: (LxWxH) (without handles) 13” x 5” x 10” (330 x 127 x 254mm)
- Weight: 75 lbs. (34 kg)

Environmental Protection: IP 67

Performance

- Rope Sizes: Φ 0 – 3¼” (0 - 83 mm)
- Rope Speed: 0.03 to 3 m/sec (0.5 to 600 feet per minute)
- Test Signals: LF and LMA Signal, amplitudes independent of rope speed.

Flaw Detection:

- **Loss of metallic cross-sectional area (LMA):**
  Quantitative Characterization: external and internal corrosion including corrosion pitting, wear, broken wires, broken cores, various changes of rope structure.
- **Localized flaws (LF):**
  Qualitative Characterization only: broken wires, corrosion pitting.
- **Wire Rope Roughness (WRR):**
  Quantitative Characterization: external and internal corrosion including corrosion pitting, interstrand nicking, broken wires (single or in clusters).

LMA-450 WIRE ROPE INSPECTION SYSTEM

SPECIFICATION SHEET

LMA-450 Sensor Head

Features

For the Nondestructive Inspection of wire ropes Φ 1” to 4¾” (25 - 120 mm).
Speed and Distance wheel assembly: Calibrated for Meters.

LMA-450 Sensor Head

- Dimensions: (LxWxH) (without handles and wheels) 16" x 9 1/4" x 8" (406 x 234 x 203 mm)
- Weight: 165 lbs. (75 kg)

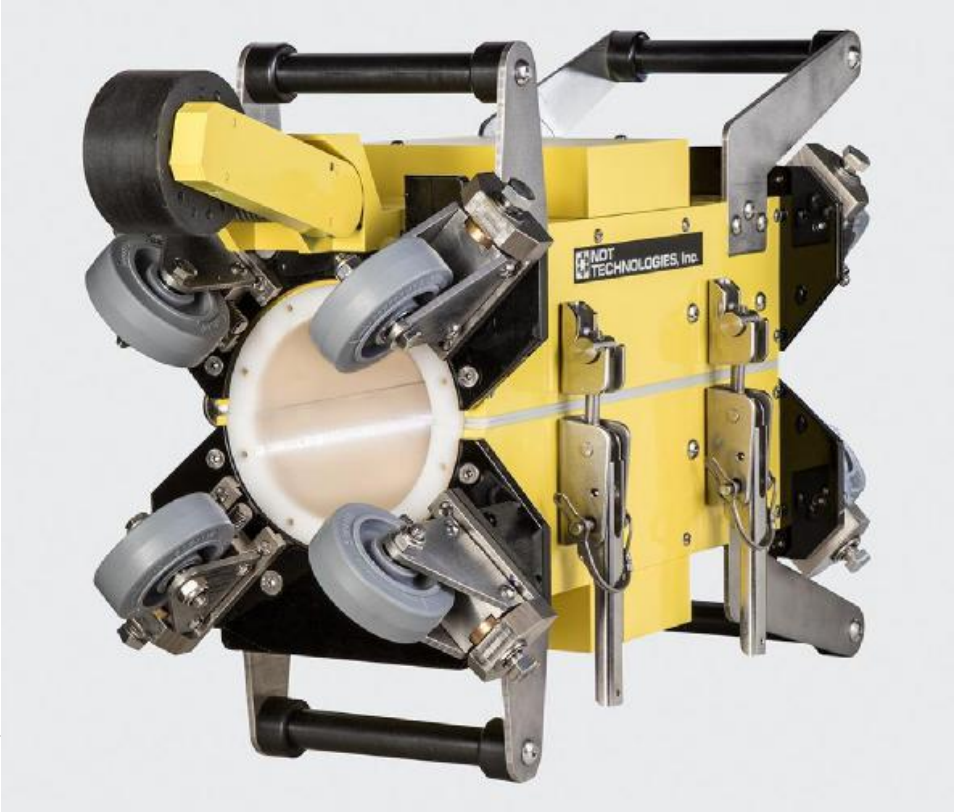
Environmental Protection: IP 67

Performance

- Rope Sizes: Φ 1 – 4¾ inch (25 - 120 mm)
- Rope Speed: 0.03 to 3 m/sec (0.5 to 600 feet per minute)
- Test Signals: LF and LMA Signal, amplitudes independent of rope speed.

Flaw Detection:

- **Loss of metallic cross-sectional area (LMA):**
  Quantitative Characterization
- **Localized flaws (LF):**
  Qualitative Characterization only
- **Wire Rope Roughness (WRR):**
  Quantitative Characterization



LMA-550 WIRE ROPE INSPECTION SYSTEM

SPECIFICATION SHEET

LMA-550 Sensor Head

Features

For the Nondestructive Inspection of wire ropes Φ 1½”- 5 1/2” (38 - 140 mm).
Speed and Distance wheel assembly: Calibrated for Meters.

LMA-550 Sensor Head

- Dimensions: (LxWxH) (without handles and wheels) 16" x 8" x 14" (406 x 203 x 355 mm)
- Weight: 242 lbs. (110 kg)

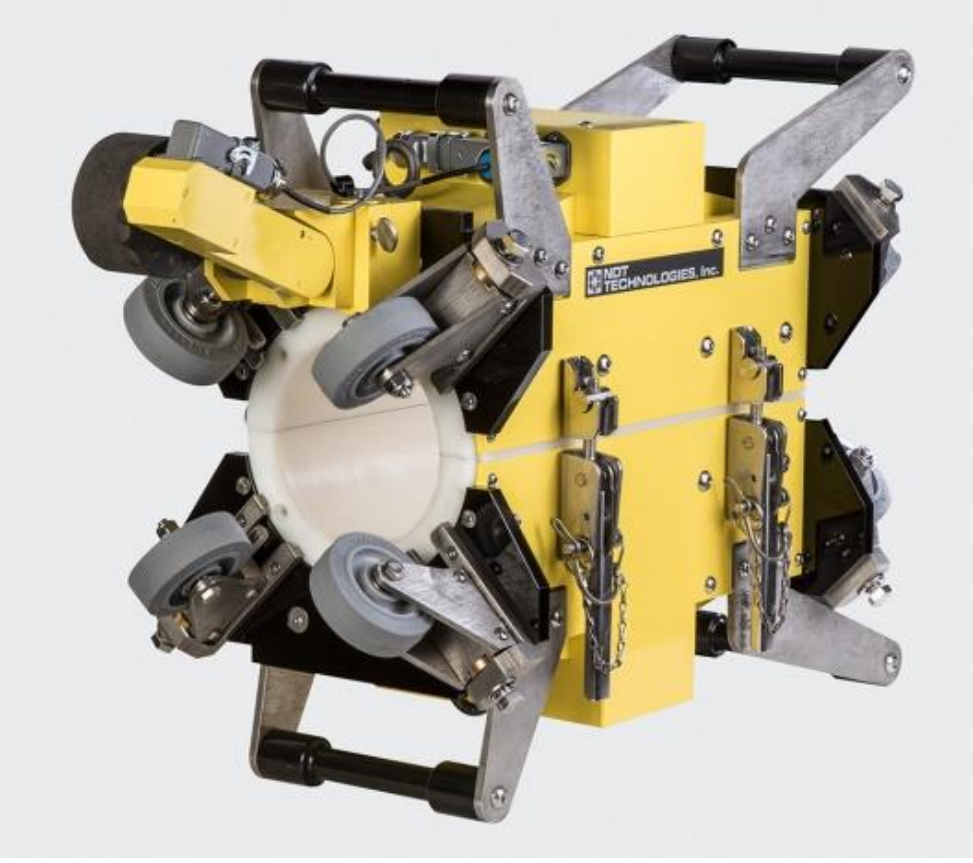
Environmental Protection: IP 67

Performance

- Rope Sizes: Φ1½ – 5½ inch (38 - 140 mm)
- Rope Speed: 0.03 to 3 m/sec (0.5 to 600 feet per minute)
- Test Signals: LF and LMA Signal, amplitudes independent of rope speed.

Flaw Detection and Characterization:

- **Loss of metallic cross-sectional area (LMA)**
- **Localized flaws (LF)**
- **Wire Rope Roughness (WRR)**



LMA-650 WIRE ROPE INSPECTION SYSTEM

SPECIFICATION SHEET

LMA-650 Sensor Head

Features

For the Nondestructive Inspection of wire ropes Φ 2”- 6½” (50 – 165 mm).
Speed and Distance wheel assembly: Calibrated for Meters.

LMA-650 Sensor Head

- Dimensions: (LxWxH) (without handles and wheels) 16" x 10" x 21" (406 x 254 x 533 mm)
- Weight: 447 lbs. (203 kg)

Environmental Protection: IP 67

Performance

- Rope Sizes: Φ 2 – 6½ inch (50 - 165 mm)
- Rope Speed: 0.03 to 3 m/sec (0.5 to 600 feet per minute)
- Test Signals: LF and LMA Signal, amplitudes independent of rope speed.

Flaw Detection and Characterization:

- **Loss of metallic cross-sectional area (LMA)**
- **Localized flaws (LF)**
- **Wire Rope Roughness (WRR)**

RopeGuardian™

Continuous Rope Monitoring System (CRMS)

RopeGuardian™
Continuous Wire Rope Monitoring

RopeGuardian™

Continuous Rope Monitoring System (CRMS)

Hardware and Software

Introduction

High-value ropes for offshore cranes and winches are expensive and safety critical. Each one of these ropes represents a multimillion dollar investment. To protect the integrity of these ropes, the most sophisticated inspection and maintenance equipment and procedures available should be used. Any additional expense for more advanced inspection and monitoring methods is well justified and offers a considerable return on investment.

For example, the condition of these ropes should be continuously monitored in order to extend rope life while, at the same time, maintaining safe operating conditions.

Realistically, a continuous rope monitoring system (CRMS) can extend the life of these ropes by several years, and possibly double their useful service life[1].

Under these conditions, a Continuous Rope Monitoring System (CRMS) represents a low-cost/high-return investment with a rather small technical risk.

A permanently installed rope monitoring system will allow constant observation and data logging of the wire rope condition, which will help to establish maintenance schedules. This process will eliminate downtime for unexpected activities such as rope replacement, and it promises considerable savings by replacing the wire rope only when necessary and/or on planned maintenance schedules.

A CRMS also serves as an effective preventive maintenance tool. To illustrate, here are some practical examples.

- The early detection of corrosion allows immediate corrective action through improved lubrication.
- Accelerating wear and inter strand nicking can indicate a need to reline sheaves to stop further degradation.
- Careful inspections can monitor the development of local damage at the crossover points of the rope on a winch drum. This way, the operator can determine the optimum time for repositioning the rope on the drum.

The following are examples of preventative operation and maintenance procedures that could be implemented by using CRM Systems:

1. For offshore cranes equipped with a heave compensation unit. The heave compensation system can quickly reduce the lifetime of the wire rope due to the large number of bending cycles over a short length of wire rope. A CRM System could monitor the status of the rope and give a warning when its condition is no longer acceptable. Or a CRM System could detect that a certain area of wire rope is almost worn out, and that heave compensation in this wire rope area should be avoided.
2. For conventional drilling rigs equipped with one hoist winch a ‘cut and slip’ practice can be used. Here, a large amount of spare wire rope can be stored on the drum. After a certain ton-mileage, the used section of wire rope is cut off, and a new unused wire rope section is slipped through the reeving.

   Other drilling rigs contain dual winch systems. Here, the travelling block is driven by two draw works at both ends of the wire rope. This is a fast, reliable and redundant drive system. By slowly spooling the wire rope from one drum to the other, the bend fatigue load is spread over the complete wire rope length.

Presently, it is a very conservative practice to replace the wire rope every year. However, a CRMS could allow much longer intervals between rope replacements.

[1] Based on a comment by Mr. Sandy Steven, Subsea 7, at the IMCA Workshop “Rope assurance through NDE systems,” Amsterdam, January 2013.

Furthermore, if the condition of the wire rope is monitored by a CRMS, its exchange can be planned in a timely fashion.

A CRMS will assess rope health and required safety margins on a continuous basis. This will allow optimum operation over the serviceable life of the rope.

Another benefit of a CRMS is to detect unexpected damage or corrosion. Then limits could be set within which all rope measurements must remain to ensure safe usage. Exceeding these limits would trigger an alarm that is distributed to responsible personnel for appropriate action.

Moreover, online rope monitoring equipment must be non-contacting. This is necessary in order to avoid damage to the rope and/or to the rope monitoring sensor head. Magnetic wire rope NDE equipment from NDT Technologies, Inc. has the unique capability of measuring the rope condition across a considerable air gap (lift-off) as required for a non-contacting rope monitoring system.

RopeGuardian™ CRMS from NDT Technologies

Our recent R&D efforts on Magnetic Wire Rope Testing (MRT) concern especially the inspection of so-called *High-Value Offshore Wire Ropes*.

We have made huge progress, unequalled in the industry.

Among other accomplishments, we have developed a magnetic ***Non Contacting Continuous Wire Rope Monitoring System (NC-CRMS)***

NDT Technologies has acquired some very unique experience that is required for such a project. This know-how is based on a CRMS for a Φ 78 mm nonrotating multistrand rope, 3.2 km long that is presently installed on an **A&R Winch** on the **Deep Energy**, a **Pipelay Vessel** that is owned and operated by **TechnipFMC**.

In the meantime, this CRMS has been successfully used during two pipelay campaigns in the Mediterranean and for spooling of a new rope during a rope replacement. It is currently used for pipelay operations in the Norwegian sector of the North Sea.

We also received a follow-on purchase order.

All our new systems are Ethernet based and compatible with any SCADA system. In other words, we are completely prepared for the so-called “digital transformation of the oil and gas technology market” including the IIoT.

Description

Here is a short description of this CRMS hardware and software.

There is an urgent need for suitable equipment and procedures for the accurate and reliable NDE inspection of densely packed, large high-value offshore ropes.

For example, a major problem is the fact that NDE is time consuming and requires considerable and costly vessel downtime. Therefore, more often than not, NDE inspections are considered prohibitively expensive, and it is frequently considered cheaper to scrap a rope early. While this rope discard philosophy might be acceptable for smaller ropes, it is

unjustifiably wasteful for large high-value ropes, which frequently represent seven figure investments.

Furthermore, this so-called *Statutory Retirement* approach is inherently unsafe and has caused all too many rope failures in the past.

To sidestep these problems, a permanently installed *continuous rope monitoring system* (CRMS) is the only feasible approach to making the NDE inspection of these high-value ropes possible.

NDT Technologies has the exclusive know-how for producing a non-contacting CRMS. This capability is not available from any competitor.

Continuous Rope Monitoring System (CRMS)

Click here for videos:

http://bit.ly/2TZzFC5

http://bit.ly/2VqOUVC

http://bit.ly/2VEYU2g

Sensor Head Weight

- The above CRMS sensor head for a Φ 78mm rope weighs 72kg.

NDT_CARE™ (Computer Aided Rope Evaluation) Software

In connection with our

- **New Generation Wire Rope Nondestructive Examination (NDE) Systems** and our
- **Continuous Wire Rope Monitoring System (CRMS)**

we developed our

- **NDT_CARE (Computer Aided Rope Evaluation) 3.0 "VISTA"** software. Please click on the link to watch a video demonstration.

Here is a description of this software.

NDT_CARE VISTA gives a complete record of an entire, possible very complex, rope examination, including

1. LMA, LF and WRR signals
2. Inspection time, distance along rope, total length of rope inspected, rope speed, and of start-stop operation.

For example, this software can be used for monitoring the rope condition, distance and speed, and time during complex rope maneuvers like

1. A&R operations of pipelay vessels,
2. Deep sea lifts.
3. Combined visual and MRT inspections when the rope is stopped during an MRT inspection and moved back forth for a visual examination, etc.

Shown in the video are

1. An experimental inspection performed on a test rope at NDT Technologies. Here, the ends of the rope are welded together to form an infinite loop. The rope is exactly 5 m long. The weld shows clearly on the LMA/LF traces, and it can be used as a 5 m distance marker.
2. Spooling of a Φ 78 mm A&R winch rope that is 3.2 km long and lasted about 10 hours with numerous lengthy stops for repositioning of the pipelay vessel and the supply barge.

For more illustrations of our recent software developments, please watch additional tutorial videos on our new **NDT_CARE™ 3.0** (**C**omputer **A**ided **R**ope **E**valuation) software. We uploaded them to YouTube and to our DropBox:

- **https://youtu.be/H3Cf37xEYoE and**
- **https://www.dropbox.com/s/l18vl7smrdc2ip3/14%20NDT%20CARE%203_0%20Stationary%20Calibration%20and%20Speed%20Signal.mp4?dl=0**.

Note that the example inspection discussed in the videos is well documented in several papers that you can download as follows:

- **Wire Rope Roughness (WRR), a new indicator for the quantitative characterization of wire rope deterioration** and
- **here**.

Our recently developed hardware and software tools offer powerful capabilities. They allow a rational interpretation of test results and will take the guesswork – educated or blind – out of making rope retirement decisions. They will profoundly transform inspection procedures for high-value offshore ropes, and they will finally make *condition-based rope retirement* possible