COMPLEX NONCONTACT PIPELINES INSPECTION

OM TECHNICAL SOLUTIONS

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MAIN ACTIVITIES:

- Providing environmental safety,
- Industrial construction,
- Industrial safety expertise.

- 7 doctors of sciences,
- Up to 200 professional employees,
- Own scientific and industrial equipment,
- Own scientific labs,
- Headquarter in Saint-Petersburg (Russia).

- Mahrukat (Syria); Beijing Gas, Sinopec (China); Dragon Oil (UAE), Chevron Pacific, ConocoPhillips (Indonesia), Saudi Aramco (Saudi Arabia), Shell Petroleum Development Company (Nigeria);
- "Lukoil" Oil Company; "Transneft"; "Diamonds of Russia -Sakha"; "TNK-BP"; "Moscow Oil Refinery"; "Rosneft"; ROS "United Power Systems of Russia"; "Russian Railways"; Ministry of the Natural Resources.

INDUSTRIAL SAFETY PROVIDING

Full range of services on pipelines and tanks inspection:

- **Noncontact magnetometric inspection and electrometry,**
- Visual and dimensional inspection,
- Ultrasonic thickness tests and hardness measurement,
- Eddy-current and magnetic particle tests.

PROBLEM

Pipeline monitoring is a **matter of safety!**

Existing inspection methods are **costly and labor-intensive.**

No current effective solution for inspection of underwater pipelines.

SOLUTION

OM TECHNICAL SOLUTIONS has developed a magnetometric inspection system for the non-contact inspection of steel pipelines.

ADVANTAGES:

- **Remote** (up to 10-15 diameters of the pipe) diagnostics of pipelines state,
- **No preparations, no stop or disruption is required** – no production loss,
- Detects anomalies from stress, tension or corrosion in **real time,**
- **Reliability** for sever flaw **reaches 93 %,**
- **High speed -** up to 20 km a day per 1 crew,
- **Digital mapping** with GPS coordinates of anomalies,
- Inspection of **non-piggable** sections,
- Possible to install software filters for extra metal influence compensation.

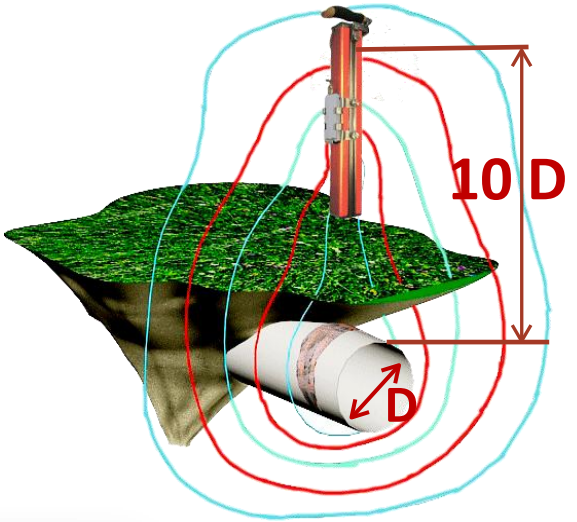
LIMITATIONS:

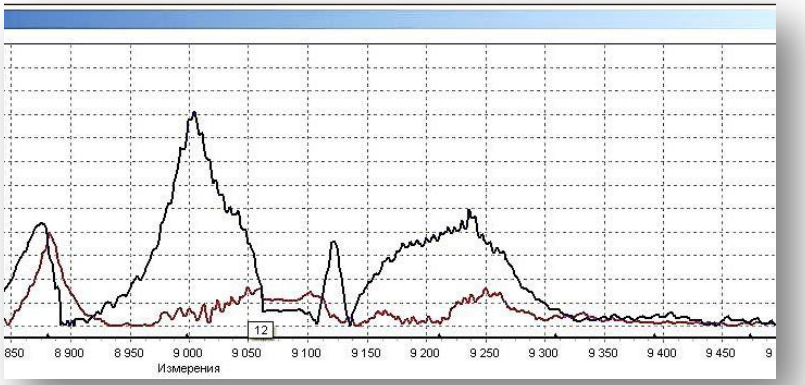
- **Inside pressure at least 1 MPa is required (without a pressure only stress-deformed state could be detected),**
- **The technology is applicable for steel (ferro-magnetic) materials only.**

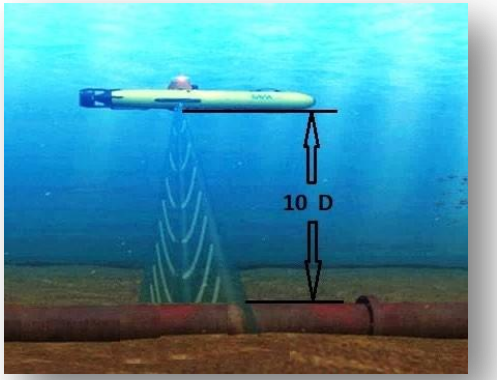
TECHNOLOGY

Hardware-software magnetometric systems KMD series:

- Using magneto-elastic (Villari Effect) KMD series devices detect changes in the pipelines magnetic field caused by various flaws, including stress, tension or corrosion,
- From the surface or under water, without excavation,
- Received data is visualized as magnetograms showing the location of anomalies with links to a digital map.

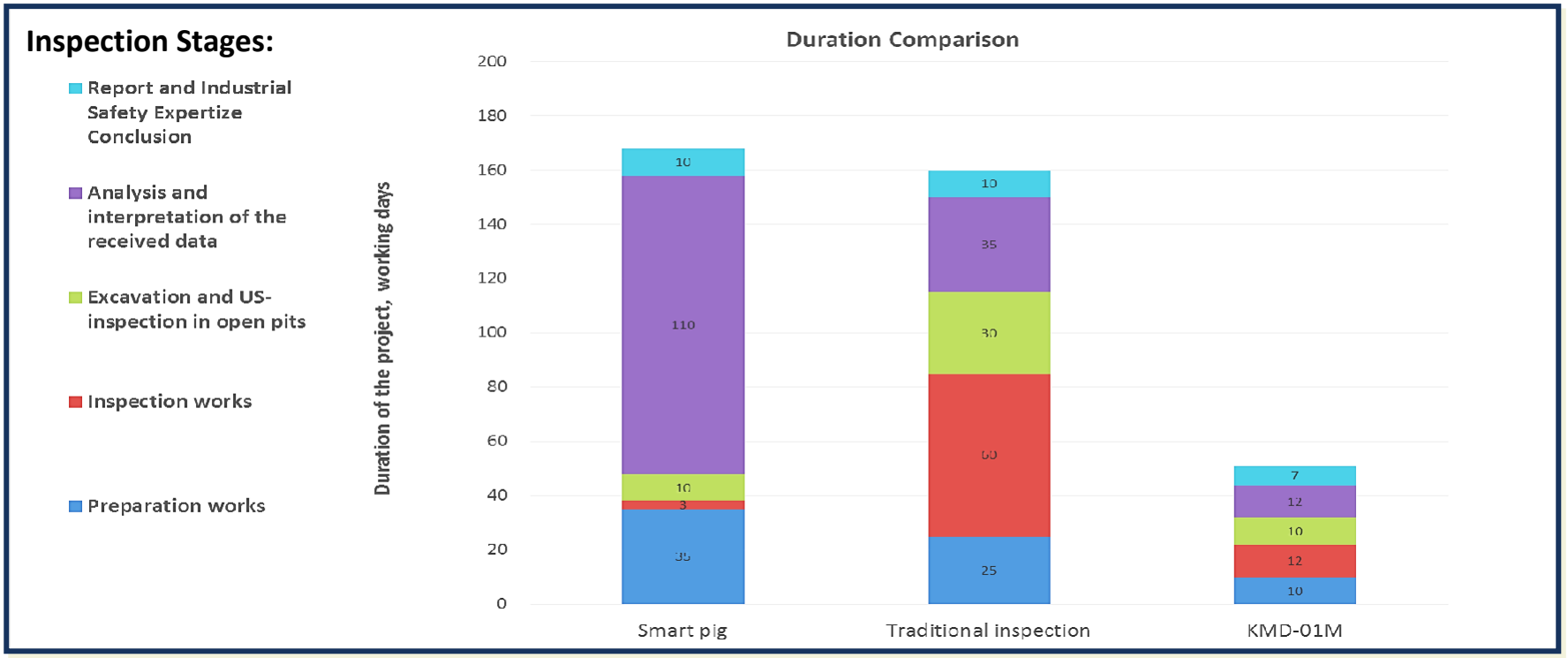






SPEED: INSPECTION PERFORMANCE PER 100 KM

Average speed of inspection performance per 100 km



* Traditional inspection - Ultrasonic and similar contact tests in the pits excavated each 500 m.

REDUCE COSTS

PIPELINES INSPECTION BY MEANS OF KMD SERIES DEVICES:

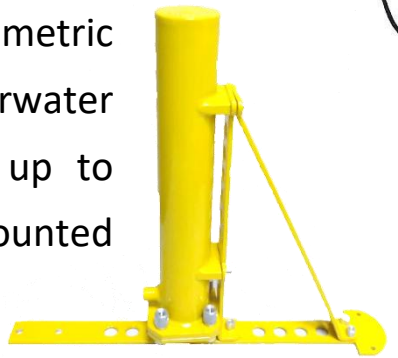
- *No need* to equip the pipeline with a pig launch or trap,
- *No need* for a pipeline cleanout,
- *No need* for inner surface preparation,
- *No need* to open a section of pipeline to recover a trapped Pig and therefore,
- *NO LOST PRODUCTION*,
- Cost significantly less than in line surveys.

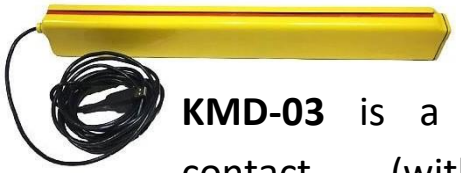
KMD PRODUCT LINE

KMD-01 is a mobile system for underground pipelines inspection.

KMD-02D-Octopus is a diver-operated system for underwater pipelines non-contact magnetometric inspection at the depth of 20 – 60 m.

KMD-02GR-Dolphin and **KMD-02R-Barracuda** are systems for non-contact magnetometric inspection of underwater pipelines at the depth up to 300 m/2000 m, to be mounted on ROV.

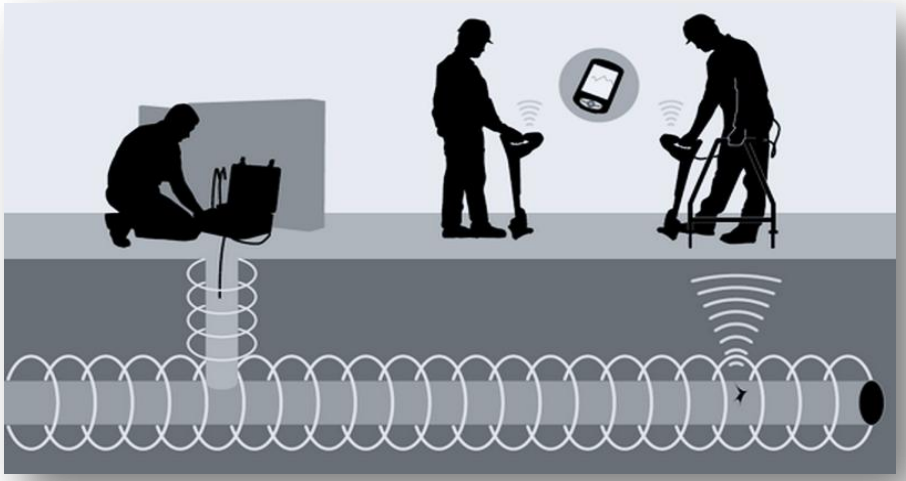


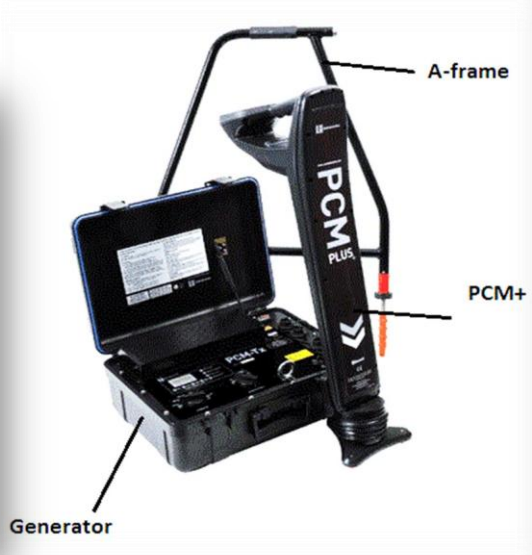


KMD-03 is a system for sub-contact (without insulation removal) location of stress concentrators, connected with flaws, designed for inspection of pipelines in pits and tank walls.

ADDITIONAL SENSORS: ELECTROMETRIC TOOL

- Accurately find buried pipes,
- Establish center-line depth,
- Troubleshoot coating defects,
- Minimizes unnecessary excavations.





GPS COORDINATES LINKING

For defining of each measurement GPS coordinates the high-accuracy geo-positioning system

TRIMBLE R10 is used.

- *High accuracy of inspected objects' coordinates binding,*
- *Automatic tracing of pipelines.*

NON-CONTACT PIPELIES INSPECTION WORKFLOW

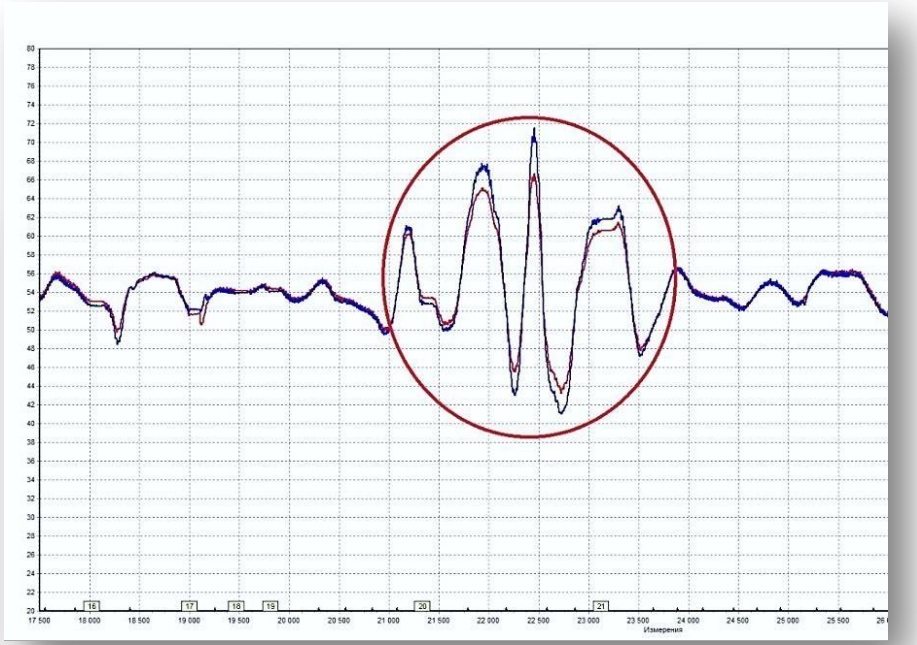
I. PREPARATION	Collecting all necessary information about the pipeline and preparing the measuring equipment.
II. FIELD DEPLOYMENT	Field inspection with KMD-01M system – magnetometric non-contact detection with the simultaneous data visualization and GPS coordinates linking and electrometric inspection.
III. EXPRESS ANALYSIS	Express analysis of the magnetograms, choosing the places for reconnaissance* pits.
IV. ADDITIONAL CONTROL	The request of a customer, the excavation of the reconnaissance pit for the NDT - additional control by non-destructive methods (measuring of thickness and hardness).
V. DATA PROCESSING	The processing and interpretation of the received data is held in the Analytic Center.
VI. REPORT	The report and the final condition conclusion on the technical state of the pipeline including the digital maps of the discovered anomalies is made.

**** Reconnaissance pit* is required for comparing of the magnetic characteristics of the pipeline with the NDT data.**

NON CONTACT & REMOTE INSPECTION METHOD

OPERATION PROCEDURE

1. Non-Contact and Remote Inspection with NMC



2. Express-analysis of the contactless data

OPERATION PROCEDURE (CONTINUATION)

3. Marking of the magnetic anomaly's center at the site.

4. Additional control measuring in the test pit.

DETECTABLE DEFECTS

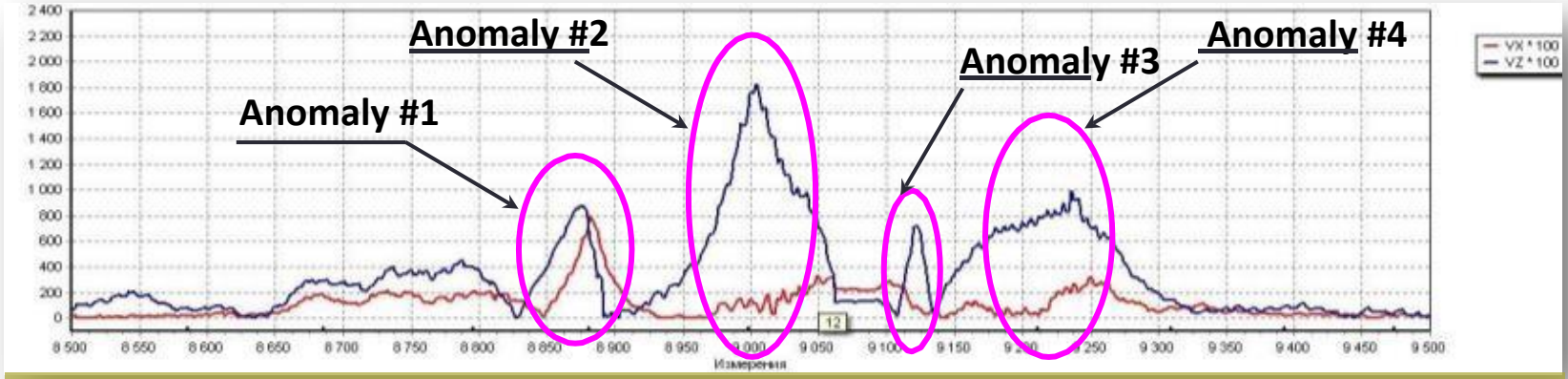
KMD series devices detect anomalies of the magnetic field caused by various types of defects:

- Stress-deformed state – SDS,
- Corrosion fatigue,
- Defects related with loss of metal* and failure of metal's solidity, changes the pipelines geometry, unauthorized inserts as well as repair locations – “local damage”.

** Except pinhole corrosion*

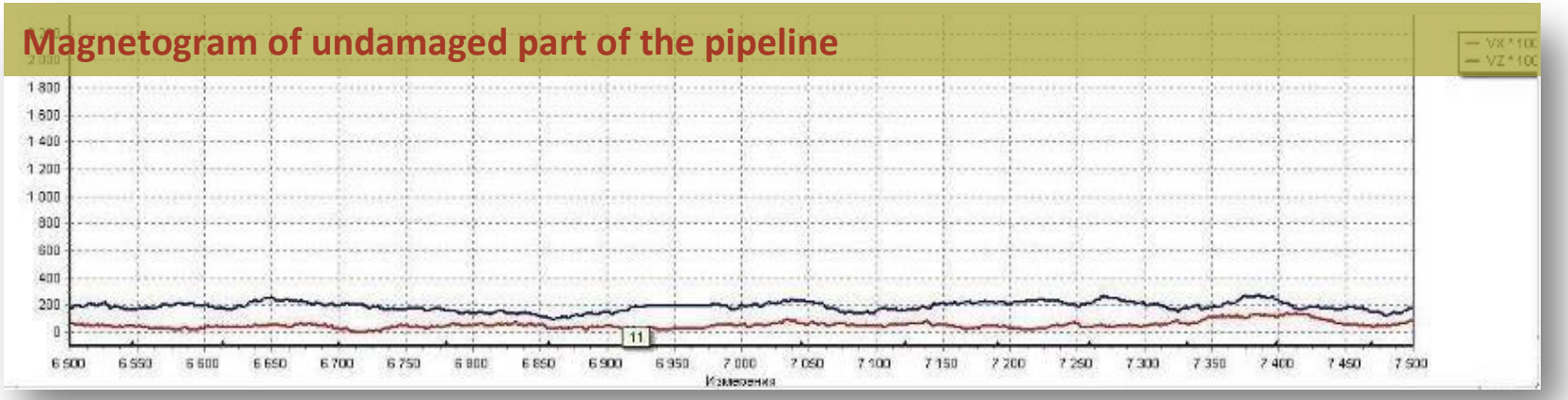
MAGNETOGRAMS: VISUALIZATION OF THE MAGNETIC FIELD

During the process of express-analysis the received magnetometric data is proceed and the experts select the locations for reconnaissance and control excavations.



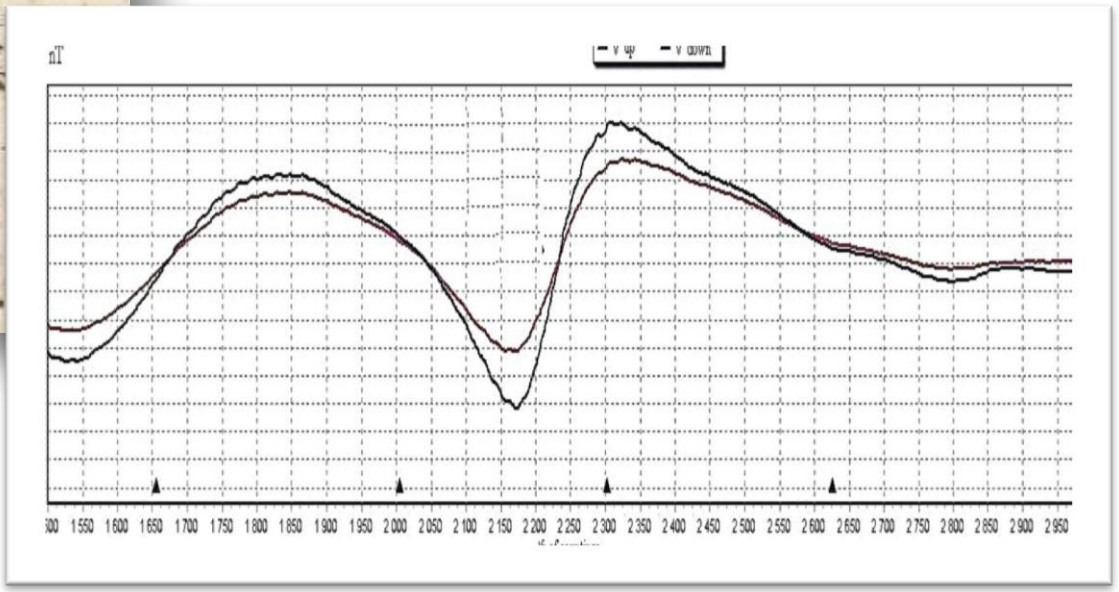
Magnetogram of the damaged sections of the pipeline

Magnetogram of undamaged part of the pipeline



EXAMPLE OF FLAWS – STRESSED-DEFORMED STATE (1)

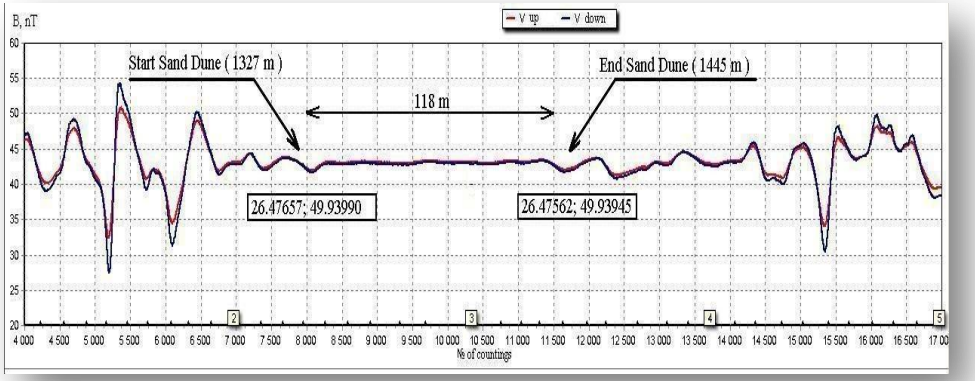
The magnetogram of changing of the full vector of magnetic induction shows significant stress (bending moment), caused by curving of the pipeline due to the pressure of sand. ILI made a few months before defined the pipeline as “no problems”.



EXAMPLE OF FLAWS – STRESSED-DEFORMED STATE (2)

The magnetogram shows the changing of the full vector of magnetic induction of the pipeline, covered by the sand dune.

At 118 meters long section the high of the dune is more than 10 diameters of the pipe, so the data of the pipeline can not be read.



At places where the pipeline enters and exits the dune the stressed-deformed state of high level are detected, caused by the pressure of large amount of sand.

No local defects associated with the loss of metal were detected at the inspected area.

EXAMPLE OF FLAWS – CORROSION (1)

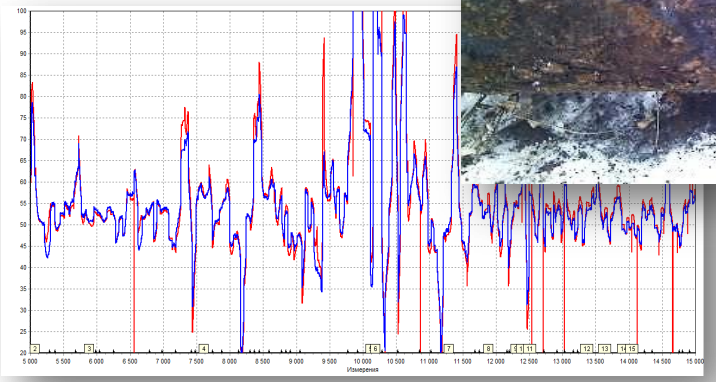
SAUDI ARABIA PROJECT

- Corrosion of underground pipeline was detected and marked,
- Excavation confirmed precise location of the anomaly within ± 0.5 m.

SIBERIA PROJECT

The damaged part of the pipeline and corresponding magnetogram.

The loss of metal - over 50%.



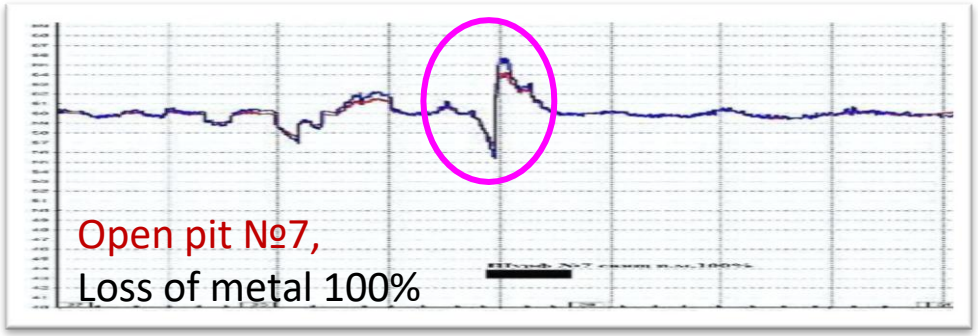
EXAMPLE OF FLAWS – LOSS OF METAL

AZERBAIJAN PROJECT

- Pit #2 finding: the loss of metal 100% - hole,
- Pits #1 and #3 finding: lots of corrosion over 70%

SIBERIA PROJECT

- The loss of metal 100% - hole



The fragment of the magnetogram at the part of the pipeline that has metal loss

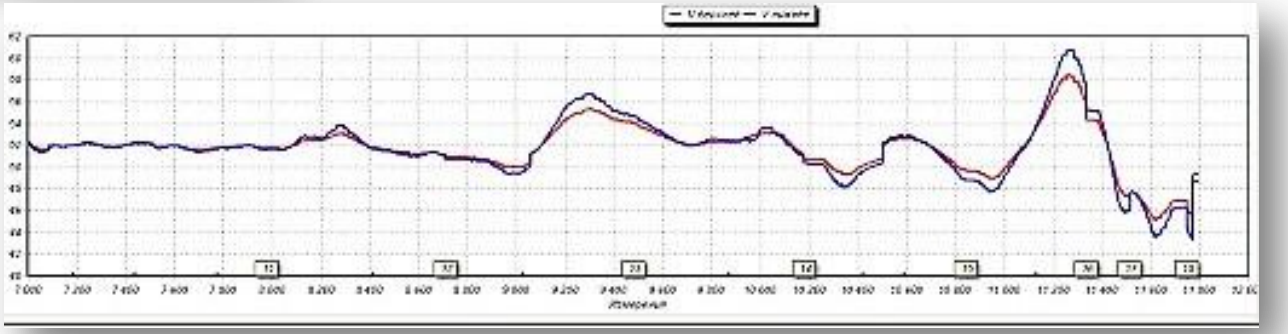
EXAMPLE OF FLAWS – LOCAL DAMAGE

PROJECT: **gas pipeline in Beijing (China)**
Excavation at the location of the magnetic anomaly.

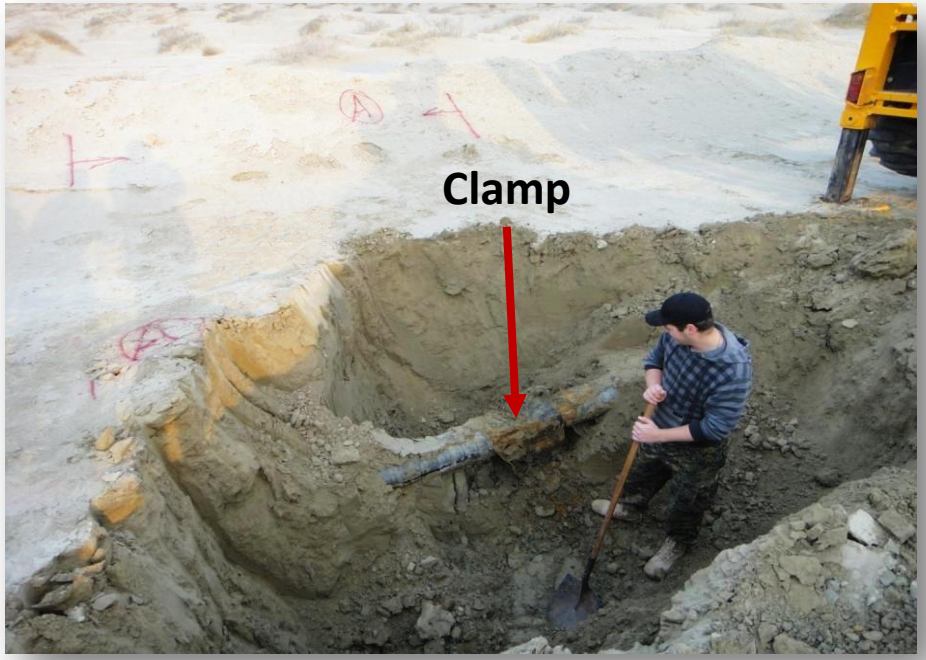
ADDITIONAL FLAW DETECTING TESTS (AFDT) – ultrasonic thickness and eddy-current tests.

FINDING: stress corrosion cracking.

Example of the magnetogram, the loss of metal was over 30%.



EXAMPLE OF FLAWS - TENSION CONCENTRATOR

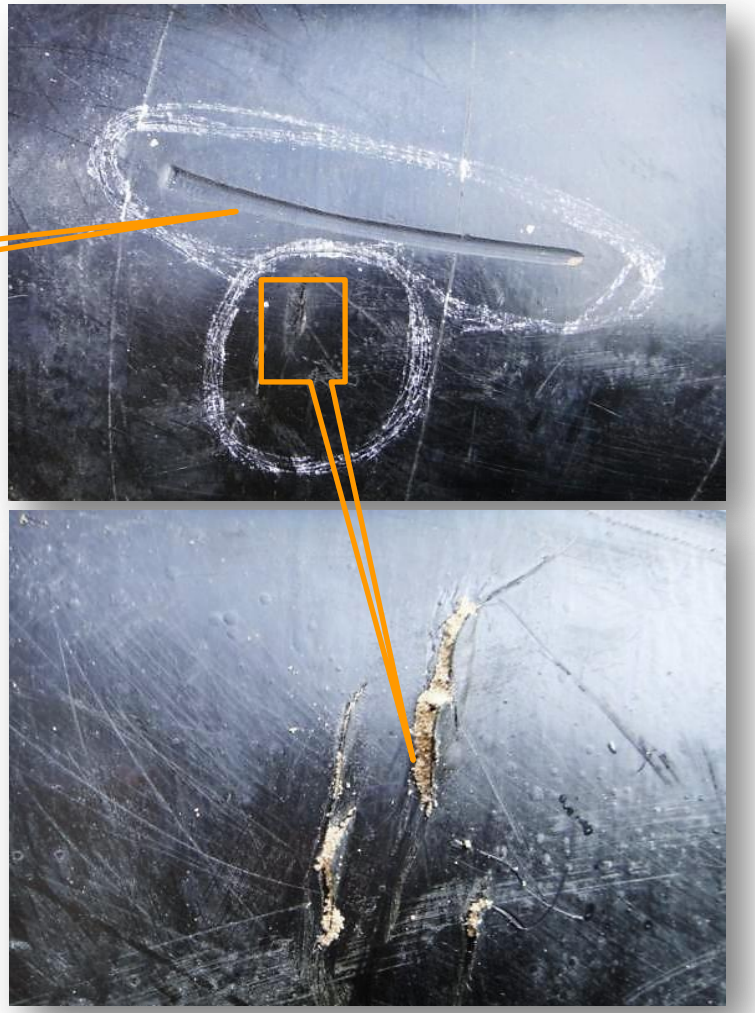


The excavated pit, made at the location of the magnetic anomaly the concentrator of the tensions (repair construction) was found.

DRAGON OIL PROJECT

The excavated clamp located at the point, marked according to the results of the contactless inspection.

EXAMPLE OF FLAWS - INSULATION DAMAGE



The excavated pit made at the location of the isolation cover damage, detected according to the results of the contactless inspection.

EXAMPLE OF MAP OF ANOMALIES (PART OF THE REPORT)

Examples of maps of anomalies caused by various defects with the geographical coordinates.

TRACK RECORDS

The diagnostics using the system KMD-01M has been carried out on the pipelines of different types, destinations and level of readiness for operation:

«Lukoil - West Siberia», Russia

- gas collecting pipeline «Yamalneftegaz», ø 260-400 mm,
- field oil pipelines «Kogalymneftegaz», «Pokachineftegaz», «Langepasneftegaz», «Urajneftegas», ø 159-400 mm.

«Bashneft», Russia

- field pipeline, ø 159-420 mm.

«Rosneft», Russia

- field pipeline «RN-Ugansknefteqas», ø 530 mm.

«KazMunayGaz», Kazakhstan

- main gas pipeline «Middle Asia - Center», ø 1220 mm.

«KazTransOil», Kazakhstan

- main oil pipeline, ø 1020 mm,
- main water pipeline, ø 1220 mm.

Dragon Oil (UAE) in Turkmenistan

- trunk oil pipeline, ø 30".

«Saudi Aramco», Saudi Arabia

- main pipeline, ø 31".

«CNPC», China

- main gas pipeline, ø 600 mm.

«PetroChina», China

- field oil pipelines «ShiXi Oil Field», ø 273 mm.

«Sinopec», China

- main oil pipeline, ø 426 mm,
- field gas pipelines, ø 8" – 16".

PT Chevron Pacific, Indonesia

- gas pipeline, ø 12".

Conoco Phillips, Indonesia

- gas pipelines, ø 6" – 12".

Star Energy, Indonesia

- subsea oil pipeline (90 m depth), ø 6".

Shell Petroleum Development Company, Nigeria - oil pipelines, ø 8".

Sonatrach, Algeria

- gas pipeline, ø 12".

TRACK RECORDS / ILLUSTRATIONS

OBJECT: «LUKOIL – West Siberia», 2010

main gas pipelines (ø 159-600 mm)

OBJECT: «PT CHEVRON PACIFIC» (Indonesia), 2015

main gas pipeline (ø 12 mm)

TRACK RECORDS/ILLUSTRATIONS

Using of the snowmobile for diagnostic.
The speed - 20 km/h.

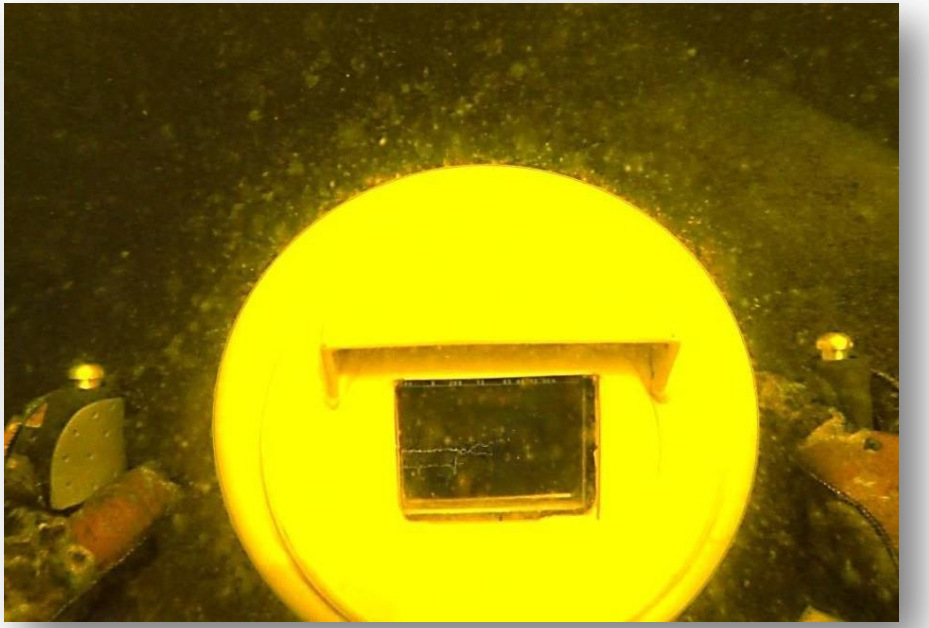
OBJECT: «LUKOIL – West Siberia», 2016

field oil pipeline «Langepasneftegaz» (ø 159-420 mm)

UNDERWATER PIPELINES INSPECTION - KMD-02D-OCTOPUS

Waterproof display allows the operator to monitor anomalies in real time.

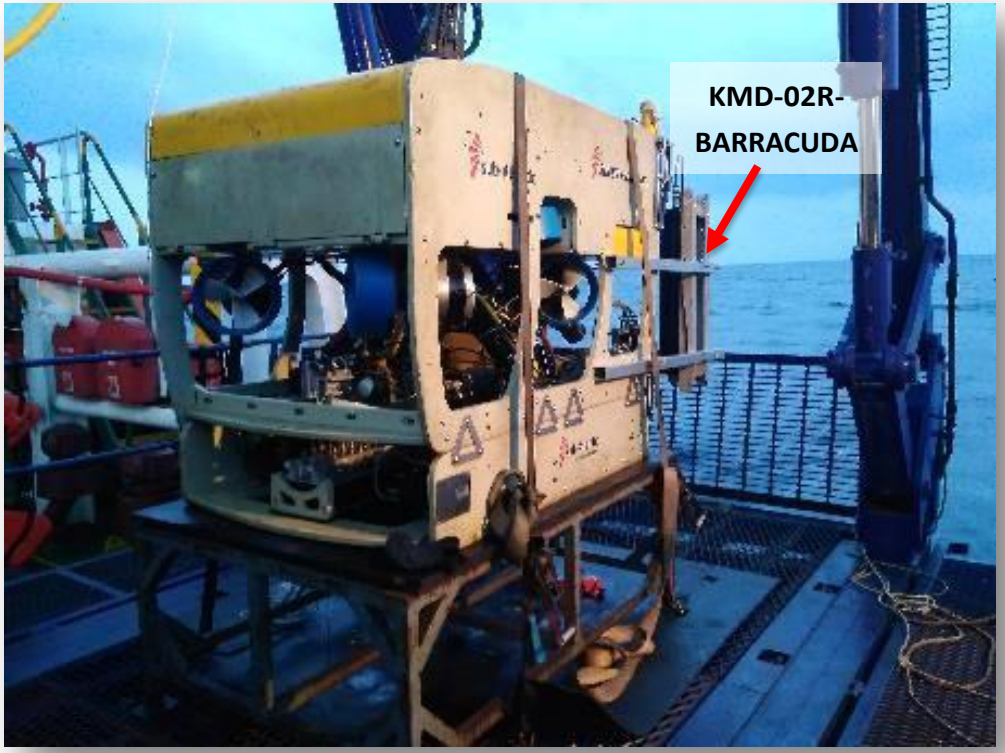
The device operated by a diver allows inspection at the depth of up to 40-60 m. The received data is written to the flash memory for further processing.

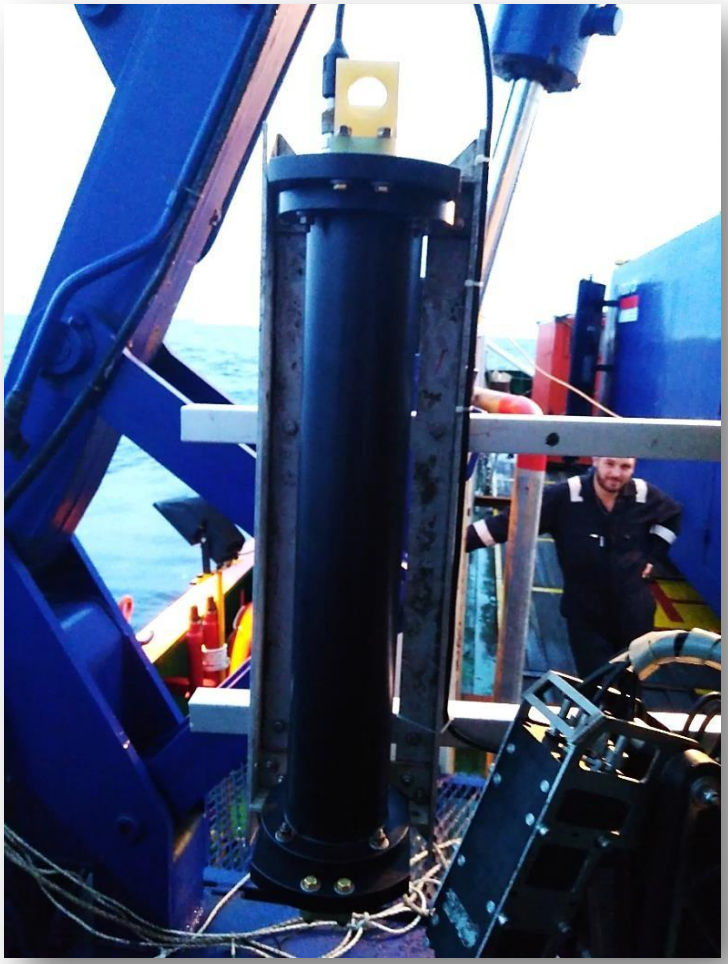


SUBSEA PIPELINES INSPECTION - KMD-02R-BARRACUDA

The device is designed for the non-contact inspection of subsea pipelines at the depth up to 2000 m

The data from KMD-02R-Barracuda is sent by the cable of ROV to the computer of the operator in the real time, it's also recorded into the computer memory.





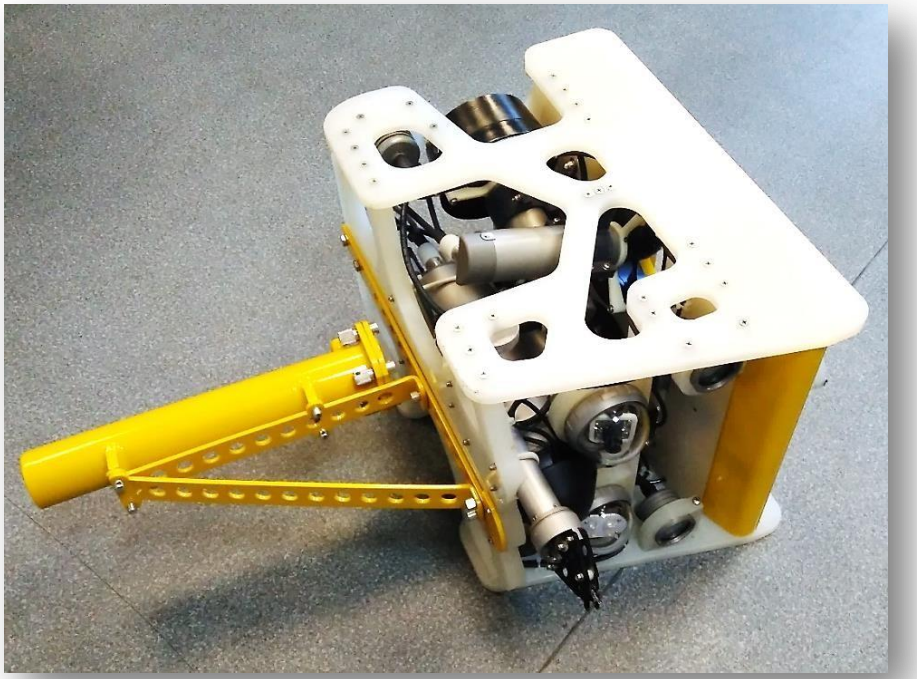
KMD-02R-Barracuda is mounted on an ROV.

UNDERWATER PIPELINES KMD-02GD-DOLPHIN

KMD-02GR-Dolphin mounted on SuperGnom ROV and ready for the operation.

The device is designed for the non-contact magnetometric pipelines inspection at the depth of up to 300 m.

KMD-02GR-Dolphin should be mounted on an ROV SuperGnom type.



TECHNICAL INSPECTION OF INDUSTRIAL SITES

- Surface and above ground pipelines inspection,
- Leaks detection,
- Tanks inspection,
- Technical survey of metal constructions.

TECHNICAL INSPECTION OF INDUSTRIAL SITES

ADDITIONAL INSPECTION EQUIPMENT

ADDITIONAL DEFECTOSCOPY CONTROL

Gauss-meter
Walmag

Ultrasonic thickness measuring tool AKS A1210

Defectoscopy-scanner
DIO 1000

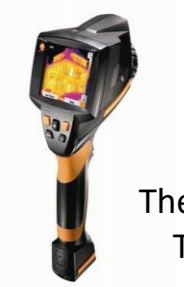
POSITIONING SYSTEM

GNSS Trimble

CONTROLLING TOOLS

Gas analyzer
Testo 316 ex

Electrometric system
PCM Plus



Thermal scope
Testo 875i

Acoustic leaks detector
Uspeh ATP-407H

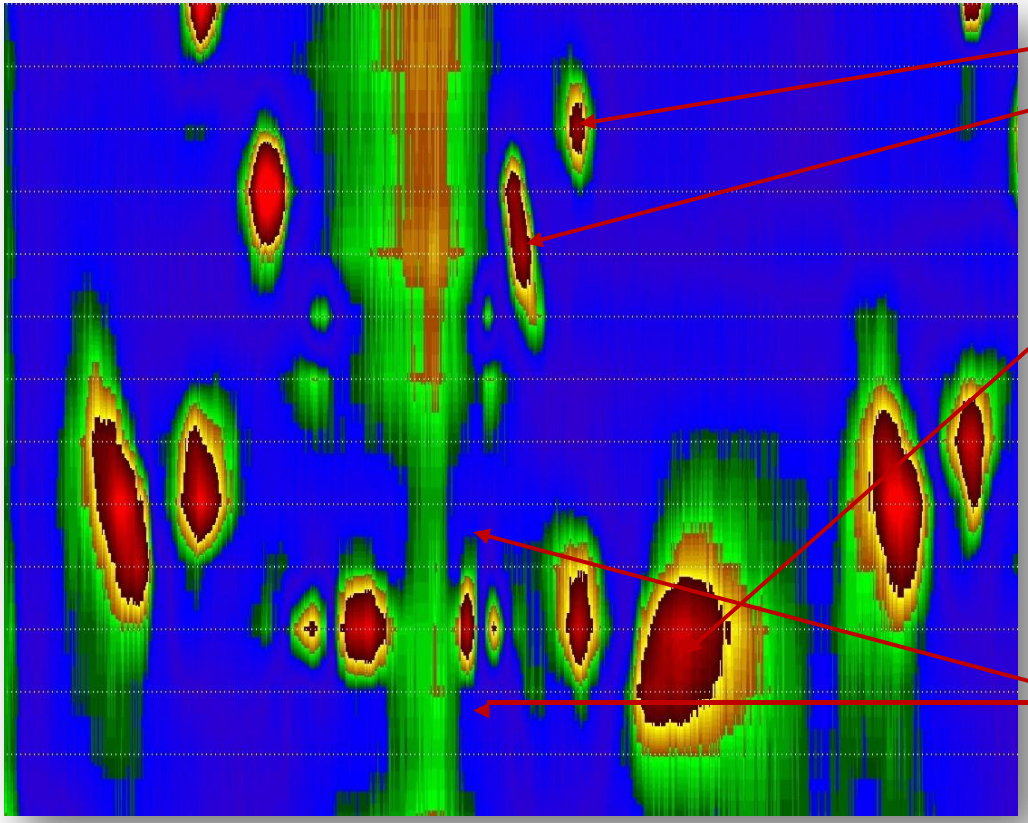
SUBCONTACT INSPECTION OF TANKS

Sub-contact (without insulation removing) inspection system allows location of the stress concentrators, appeared due to various flaw.

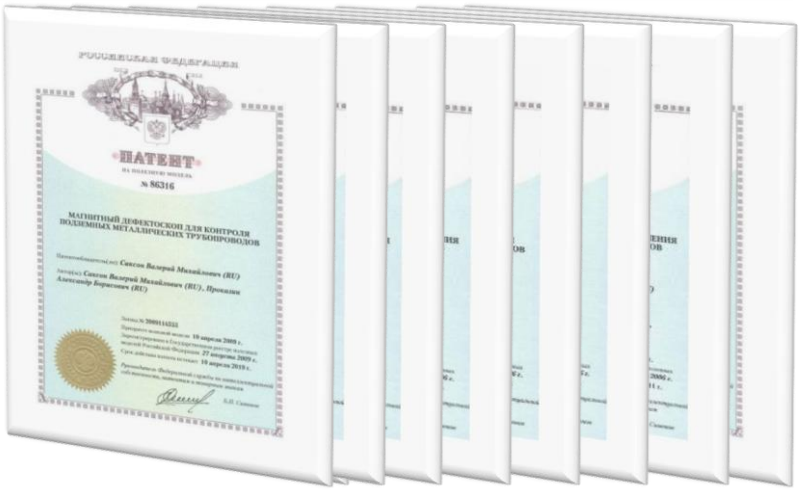
The system allows inspection of tanks even without a pressure.

SUBCONTACT INSPECTION OF TANKS

Received data is visualized as colored magnetograms showing the places of anomaly (flaw) as red spots and normal area as colored green and blue.



SCIENCE AND TECHNICAL APPROVAL



- New design, technological solutions and software developed for the diagnostic equipment are protected by 11 patents,
- Application for PCT #PCT/RU2014/000227 “Device for inspection of the technical state of steel pipelines“,

- The company processes the License on the activity on executing of expertise of industrial safety.

REFERENCES

Besides successful commercial projects KMD-01M system successfully passed through the arbitrage tests at the objects of “LUKOIL-West Siberia”, “Sibur neftehim”, “Bashneft-Dobycha”, “PetroChina” (China), “Dragon Oil” (UAE), “Sinopec” (China) and received positive expert conclusions from State Corporation “Rosnano” and “Skolkovo” Fund.

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