



MAGNETIC TOMOGRAPHY METHOD (MTM)

NON-CONTACT INSPECTION OF PIPELINE CONDITION





In terms of transported volumes, pipelines are the most busy means of transportation on the planet.

The total length of pipeline network in Russia is over 1 million km, where over 80% cannot be inspected by ILLI.

Monitoring pipeline condition is within responsibility of respective industry companies, as they are the owners of dangerous industrial plants, and it is an important element of state safety.





Monitoring pipe metal all over the pipeline length by means of conventional methods is difficult, expensive and inefficient, because it requires full access to the pipeline, surface preparation, etc.

Less than 30% of pipelines are subject to inline inspection.

The digs (current "Guidelines for operation, audit, repairs and rejection of oil-transferring pipelines ПД 39-132-94" issued in 1994, for instance, specify selective non-destructive testing in digs with a frequency of 2 digs per one kilometer of a pipeline) can only provide metal monitoring over 2% of pipeline length, and this does not and can not ensure the real integrity evaluation.





Transkor introduces a complex solution for defect detection, technical examination and evaluation of integrity of surface pipelines, underground pipelines, offshore pipelines, that are subject of not subject of inline inspection.

THE LATTER INCLUDE:

Field pipelines, offshoot gas lines, offshore gas and oil pipelines;

Pipelines of gas compressor stations, pump stations, gas and oil chemical plants, underground gas storage facilities;

Mainlines that are not fitted with pig launch and trap areas, including underwater "streams" - (Blue Stream, North Stream, etc);

Utility pipelines of all sorts.



MTM ADVANTAGES

NO BLIND SPOTS all over the pipeline length.

NO INTERRUPTIONS at pipeline bends, turns etc.

SPEED of scanning is up to 5 km/h.

OMNI-APPLICABLE for all types of pipelines.

DETECTS all types of anomalies inside and outside of the pipe.

INTEGRITY EVALUATION is performed for all defect types and stress concentrations in actual work conditions, that makes safe operation term prediction more accurate, taking actual loads into consideration.

INDICATES stress concentration at locations of "insignificantly small" defect that cannot be figured out by other non-destructive testing methods and that in turn appear to be high-risk anomalies (experimentally proven).

PRECISION of MTM evaluations has a 90-97% correspondence with conventional methods of СНИП, DNV, ASME, API FEM, wherever the respective standards are applicable.



MTM ADVANTAGE

- NO** interruption of pipeline operation.
- NO** special pipeline preparation.
- NO** necessary contact with pipeline surface or changing mode of operation.
- NO** launch and trap areas for pigs (or searching in case of a stuck pig).
- NO** pipeline cleaning.
- NO** special preparation of internal surface.
- EFFICIENT** for micro crack search in welds at high-load areas in new pipelines.



MTM BASICS

MTM is based on Villari effect (magneto-elasticity, of inverse magnetostriction).

When subject to mechanical deformation (or stress), metal changes its magnetization.

The basis of MTM integrity concept is the fact that it is not defects themselves that are dangerous for metal and constructions, but local combination of defects and high stress is. MTM is capable of remote detection of stress concentration spots in pipe metal by analyzing its magnetic field. It detects areas with stress concentrators (defects and locally applies forces) and determines the danger degree of these areas.



MTM RELIABILITY AND EFFICIENCY

AS THE MTM QUALIFICATION RESULTS SHOW:

- probability of detection of defective areas..... **POD = $(1-1/10)*100 = 90\%$**
- probability of correct interpretation of danger degree.... **POI = $7,75/10*100 = 77,5\%$**
- probability of missing a critical defect..... **POE = $(1-POD)*(1-POI) = 2,25\%$**
- probability of false calls POFC is in between 0 and 17% (the largest value is for pipelines layed in environment with high amount of metal debris).

At the same time, conventional methods used all over the world were involved to calculate local stress values in defective areas – DNV, ASME, API, FEM – wherever the respective standards are applicable.

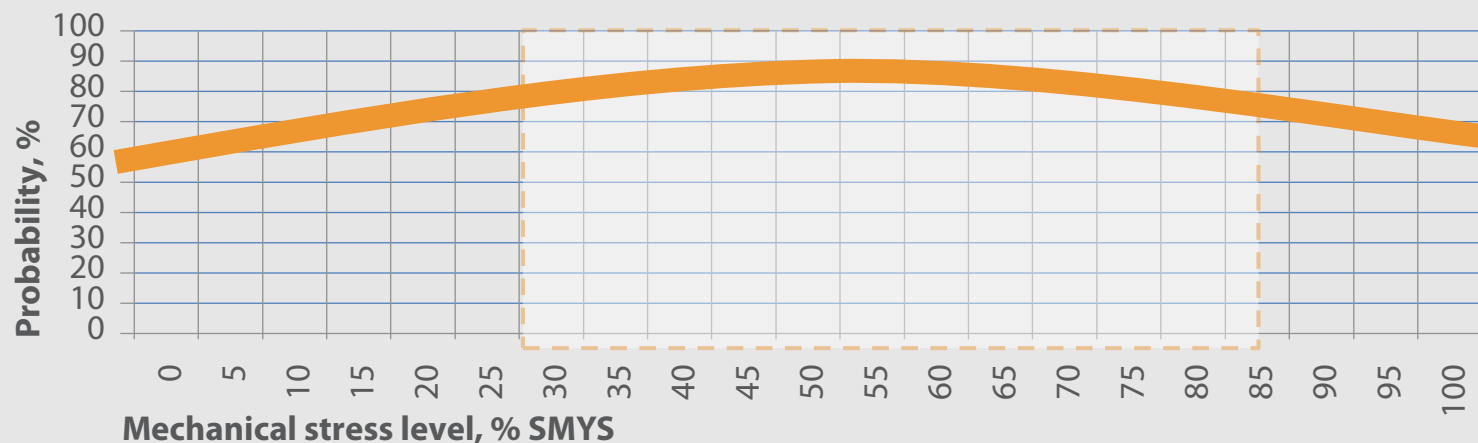
Comparing the results of stress calculation by means of MTM (AQUA-MTM), it was determined that they match by 90% to 97% the results obtained by conventional approaches – DNV, ASME, API, FEM.




MTM has undergone a successful industrial approbation at pipelines, including those not subject to inline inspection – the total length of over 20 thousand kilometers buried at depths up to 8 meters, with high rate of anomaly detection.

RELIABILITY OF MAGNETIC TOMOGRAPHY METHOD

Client	Country	Кол-во контрольных точек	Достоверность %
ПАО		137	>83
ОАО «ТНК-ВР»	Россия	39	90
ПАО «Транснефть»	Россия	8	87
Sinorep Corp.	Китай	29	95
ПАО «Лукойл»	Россия	43	95
Chevron Corp.	Индонезия	45	92
National Greed	Великобритания	39	89
PETRONAS	Малайзия	145	>87



SCANNING AND CALIBRATION

 – anomaly areas



SCANNING AND CALIBRATION

1. Determining the pipeline axis position under the ground surface.
2. Pipeline scanning using a portable magnetometer СКИФ МБС that automatically records magnetic data and GPS tracks.
3. Preliminary processing and choosing 1-2 points for calibration.
4. Additional non-destructive testing is performed in the digs, involving contact methods, after that the calibration of the data is done.
5. Preparation of the final report, that includes a list of dangerous (anomalous) areas of the pipeline, matched with the map and having their respective danger degree reported.

INFORMATION FOR PIPELINE INTEGRITY MANAGEMENT:

- 1. The locations of all detected stress-deformed state anomalies.**
- 2. Parameters for analyzing safety of all detected defect areas:**
 - safe operation term T_{safe}
 - safe operation pressure P_{safe}
 - estimated repair factor ERF
 - local internal stress values S_i



MTM REQUIREMENTS AND LIMITATIONS

- Maximal inspection distance between the pipe and the magnetometer – 15D
- Minimal diameter of a pipeline subject to MTM inspection - 80 mm
- Minimal length of a pipeline section to be inspected by MTM – 100 m
- A clear path is required for an operator to be able to walk above the pipeline, minimal width is 1 m

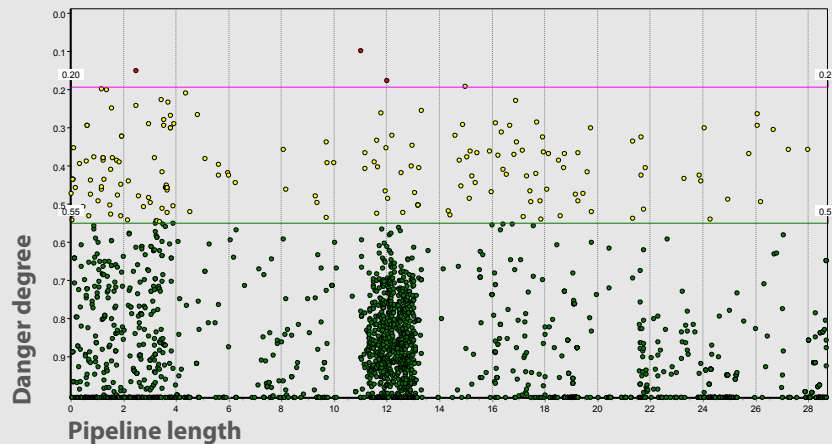


MTM REPORT

МГ Средняя Азия-Центр 2 н.Ду-1220 мм
MTM ANOMALY LOG WITH GROUND REFERENCES



Density of anomaly distribution
ООО "ЛУКОЙЛ-Западная Сибирь", ДНС-ЦПС,

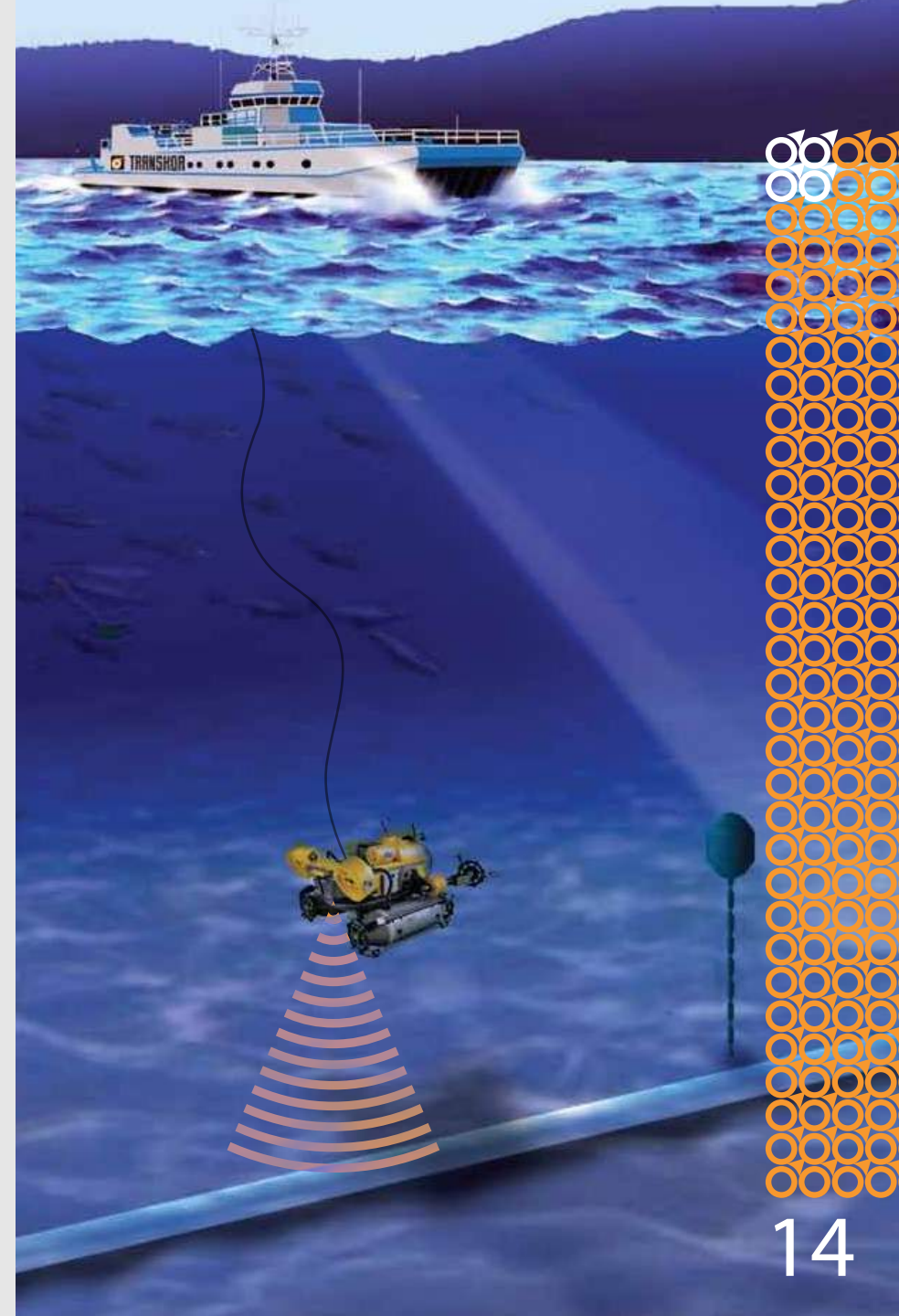


ИНФОРМАЦИЯ ПО НАЗЕМНЫМ ПРИВЯЗКАМ			ИНФОРМАЦИЯ ПО АНОМАЛИИ							
Pipe length м	Reference	Notes	GPS-координаты		Anomaly No	Condition of metal	Risk factor F	Begin, м	End, м	Length, м
			Longitude	Latitude						
1	2	3	4	5	6	7	8	9	10	11
00,2	Дорога Ж/д	насыпь начало	N39°24'673"	E54°43'626"						
5,00	Дорога Ж/д	насыпь конец	N54°43'629"	E39°24'672"						
26,00	КИК	маркер	N54°43'639"	E39°24'665"						
39,00	КИК	маркер	N54°43'643"	E39°24'663"	2	3	0,7206	36,3	39,4	3,1
50,00	Свеча	слева	N54°43'647"	E39°24'661"	4	3	0,6395	48,1	52,4	4,3
100,00	Общая	маркер	N54°43'650"	E39°24'660"						
199,00	КИК	маркер	N39°24'646"	E54°43'678"						
			N54°43'736"	E39°24'638"	5	2	0,3581	215,3	230,4	15,2
			N54°43'776"	E39°24'612"	6	2	0,2351	292,6	291,4	1,4
293,00	начало лесополосы		N39°24'612"	E54°43'778"						
			N54°43'786"	E39°24'610"	7	3	0,8797	307,3	308,0	0,7
			N54°43'789"	E39°24'608"	8	3	0,8742	313,5	314,5	1,0
324,00	конец лесополосы		N39°24'599"	E54°43'797"						
			N54°43'822"	E39°24'578"	9	3	0,6425	387,9	391,3	3,4
600,00	Общая	маркер	N39°24'509"	E54°43'931"						
716,00	Общая	маркер. КИК справа	N39°24'471"	E54°43'991"						
			N54°43'991"	E39°24'471"	10	1	0,1892	717,2	714,4	0,2
818,00	опора ЛЕП №125		N39°24'436"	E54°44'044"						

AQUA MTM

Aqua MTM (Magnetic tomography method) – ,
a technology developed by RDC «Transkor-K» (Russia)
in frame of a joint development agreement with
PETRONAS (Malaysia)

**designed for remote evaluation of
stress-defomed state of offshore
underwater steel pipelines of any purpose
intended to be used with an underwater remotely
operated vehicles (ROV).**



AQUA MTM

Retaining all advantages of the onshore MTM, the Aqua MTM is capable of remote inspection, **without interruption of operation**, safely, not incurring risks to personnel, or damage to property or to the environment, in order to detect integrity parameters of an underwater pipeline by detecting metal defects (metal loss due to internal or external corrosion, change of geometry, etc.), and stress concentration areas (free spans, loss of stability, etc).

Additional analytical and integrity assessment capabilities can be gained by applying a seismic activity map used together with MTM anomaly map.

This technology can be used to inspect offshore pipelines along their entire span at depths up to 200 m with POD > 80%.



COMPARING METHODS

Efficient Not efficient Average

+ **-** **+/-**

The most efficient of all compared methods of inspection in terms of detecting various types of defects and anomalies is MTM

Damage defects	Visual inspection	Hydrotest inspection	Acoustic inspection	Geotechnical inspection	CP inspection	Inline inspection	Magnetic method (MTM)
Vandalism	+	-	-	-	-	-	+/-
External damage (ECDA)	-	+	+	-	-	+	+
Internal damage (ICDA)	-	+	+/-	-	-	+	+
Fatigue of metal	-	+/-	-	-	-	+	+
Coating damage	-	-	-	-	+	-	-
Manufacturing defects	-	+	+	-	-	+	+
Soil movement	-	-	-	+	-	-	+

INSPECTION GEOGRAPHY

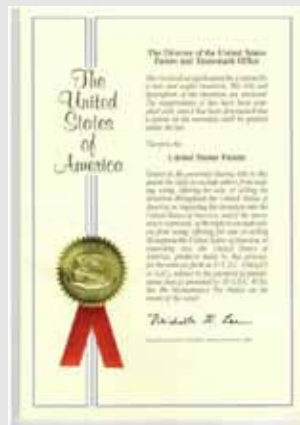
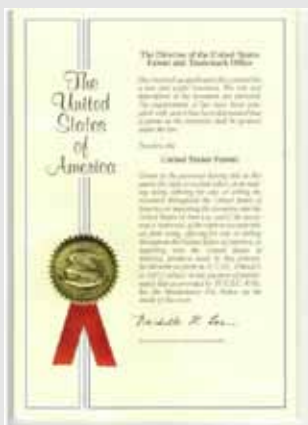
Since 2002 TRANSKOR has inspected over 17 000 km of underground pipelines and over 500 km of offshore pipelines



- | | | | |
|---|---------------|---|------------|
|  | Russia |  | Brazil |
|  | China |  | Malaysia |
|  | Germany |  | Armenia |
|  | Canada |  | Croatia |
|  | Great Britain |  | Ukraine |
|  | USA |  | Columbia |
|  | Australia |  | Sudan |
|  | France |  | Indonesia |
|  | Italy |  | Uzbekistan |
|  | Argentina |  | Azerbaijan |



CERTIFICATES AND PATENTS





TRANSKOR

THANKS FOR YOUR ATTENTION

