KUALA LUMPUR 2012 WORLD GAS CONFERENCE

25th world gas conference

"Gas: Sustaining Future Global Growth"

"APPLICATION OF ADVANCED TECHNOLOGIES FOR EVALUATION OF UNDERGROUND NATURAL GAS STORAGE WELLS` INTEGRITY AND OPERATIONAL SAFETY AT "LATVIJAS GAZE" JSC FACILITIES"

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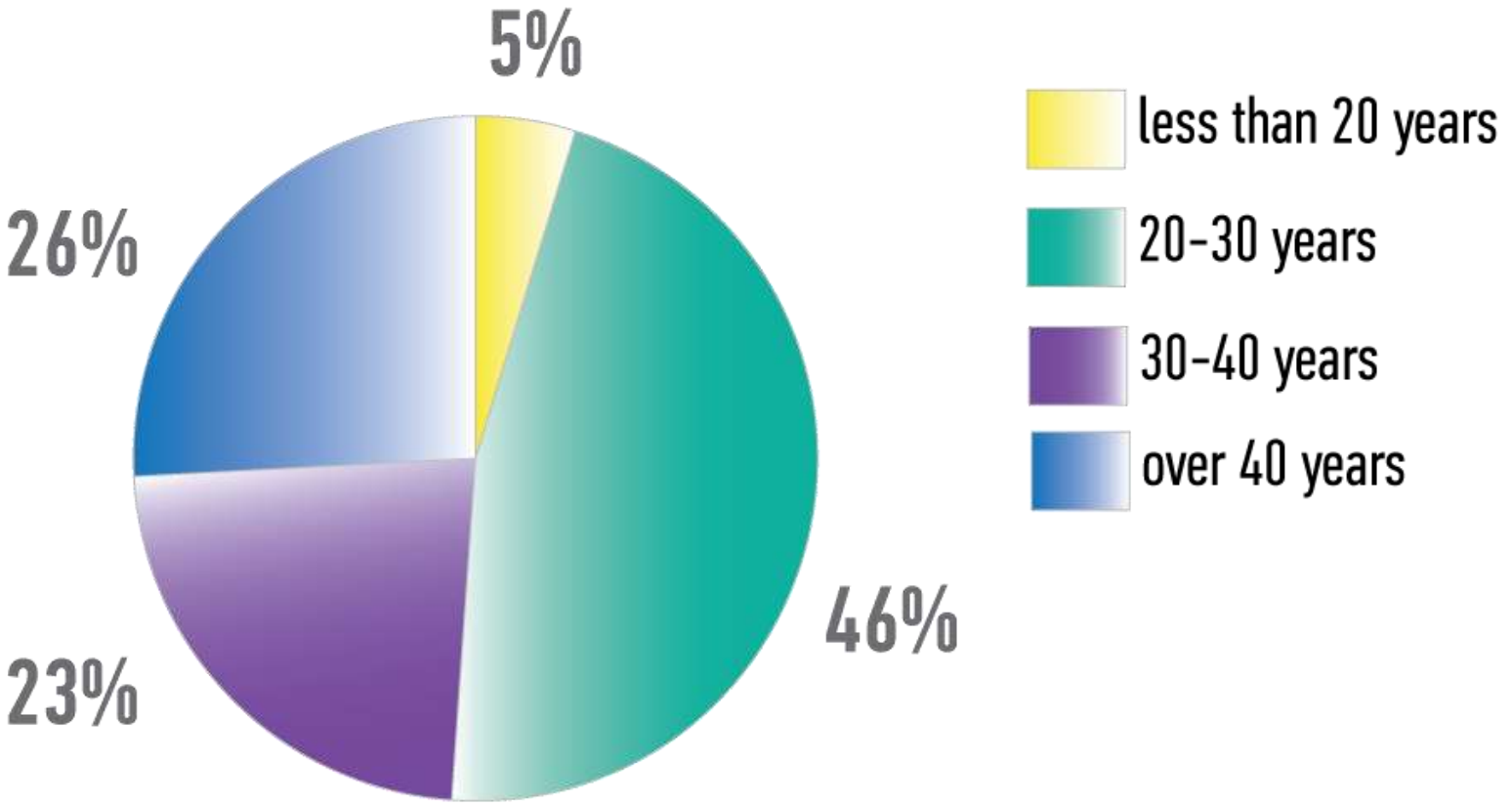
General information about IUGS and wells' functional safety status.

INCHUKALNSKOE GAS STORAGE (IUGS) — is the third largest gas storage in Europe and the most important structural subdivision of "LATVIJAS GAZE" which deals with natural gas importing, transportation, storage and utilization in the territory of Latvia.

IUGS technical parameters:

- Reservoir – Sandstone at the depth of 680 – 760 m;
  Reservoir thickness (capacity) is 50 m.
- Storage capacity: total volume - 4,5 bln m^3, active gas –
  2,30 bln m^3,buffer gas - 2,2 bln m^3.
- Design capacity: gas injection - 16 mln m^3/day, gas topping - 24 mln m^3/day.
- Working pressure: minimum –24 kgf/cm^2, maximum –
  105 kgf/cm^2.
- Compressor station output– 33,8 megawatt (45 500 horse power).
- Number of wells – 183 (93 development wells)
- Number of gas-gathering stations – 3.
- Gas deposit zone– 25 кm^2.

Age of IUGS wells and main process equipment before the beginning of UGS reconstruction



- Field equipment:

  Gas-gathering stations (GGS):

  30% over 40 years old;

  70% over 25 years old;

  Well pipelines:

  30% over 40 years old;

  20% from 30 to 40 years old;

  50 % from 20 to 30 years old;

- Gas treatment unit – 25 years old;
- Gas-pumping units:

  5 units - 25 years old;
  13 units – over 40 years old;

- Interdepartment gas main and Compressor Department 2 hookup – over 25 years old;

Reasons for UGS wells' integrity evaluation

- Ageing of wells' equipment operating in severe environment, in the conditions of mechanical effects and cyclic loads
- Exclusive ecological safety standards for operation of gas storage facilities located in the vicinity of human settlements and infrastructure facilities
- Exclusive standards for environment protection and subsurface resources

What indicates well integrity

- **Production string (PS) and tubing integrity**

  - absence of mechanical damage (cracks, cuts, breaks, etc)

  - absence of geometrical deformation (ellipse form, local crumpling, etc)

  - absence of string walls' thinning intervals caused by corrosive and erosive wear in the course of UGS wells operation

- **Technical condition of cement stone behind the production string**

  - absence of voids in cement stone (packing of voids, saturation, etc.)

  - absence of caving formation intervals in well bore zone

- **Technical condition of X-mas tree and well bore zone**

  - absence of inter-string pressure

  - absence of defects in metal of X-mas tree process components

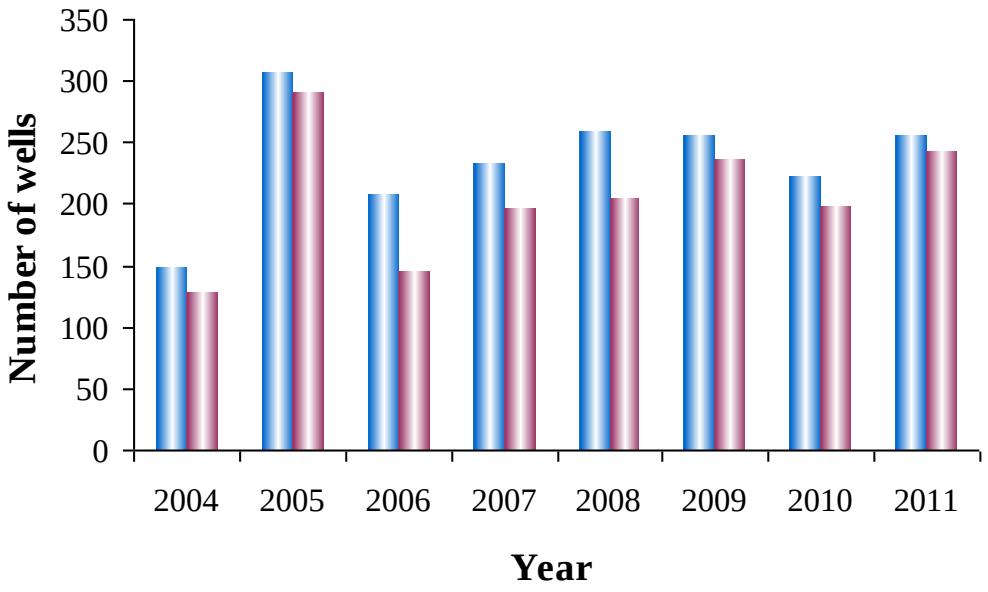
  - absence of undersealing in X-mas tree components

All the abovementioned defects can be detected by means of the proposed techniques

Main advantages of the advanced techniques

- no need in special well's preparation
- considerable cost savings in well's integrity evaluation
- possibility of studying the process taking place only in the running well (inter-string flow)
- simultaneous integrity evaluation of two strings (tubing and production string) when working through tubing
- absence of gravity solution impact effects on the pay section when killing a well

“Gazpromenergodiagnostika” LLC experience in wells’ integrity evaluation



Number of inspected wells (incl. 2011) :

	without killing	total number
Russia	**1418**	**1681**
Hungary	**12**	**14**
Germany	**39**	**46**
Kazakhstan	**196**	**227**
China	**63**	**73**
Latvia	**87**	**101**

Works performed in a well

1. **Geophysical survey of strings and annulus**

– Gas-dynamic complex (highly sensitive temperature logging, barometry, noise level metering, etc.)
– Magnetic pulse flaw detection
– Scanning magnetic pulse flaw detection
– Gamma and neutron-gamma ray logging
– Spectrometric methods of gamma, neutron-gamma, neutron – neutron logging
– Pulse methods of neutron-gamma, neutron – neutron logging

2. **Wellhead gas-dynamic survey of annular space**

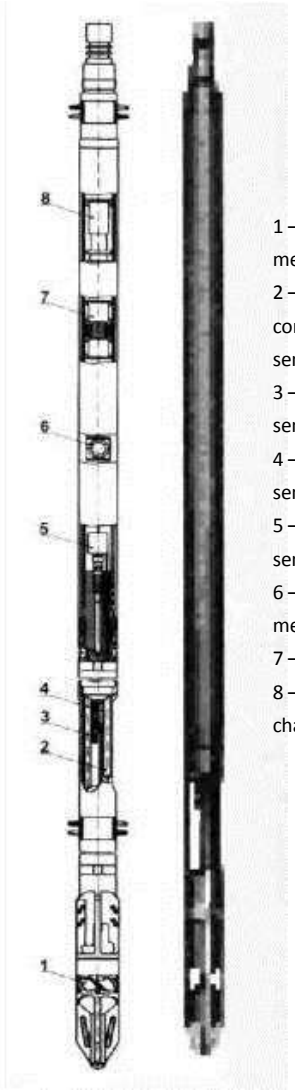
– Wellhead measurement of pressure, temperature, humidity level and mechanical impurity lifting

3. **Wellhead area and equipment examination**

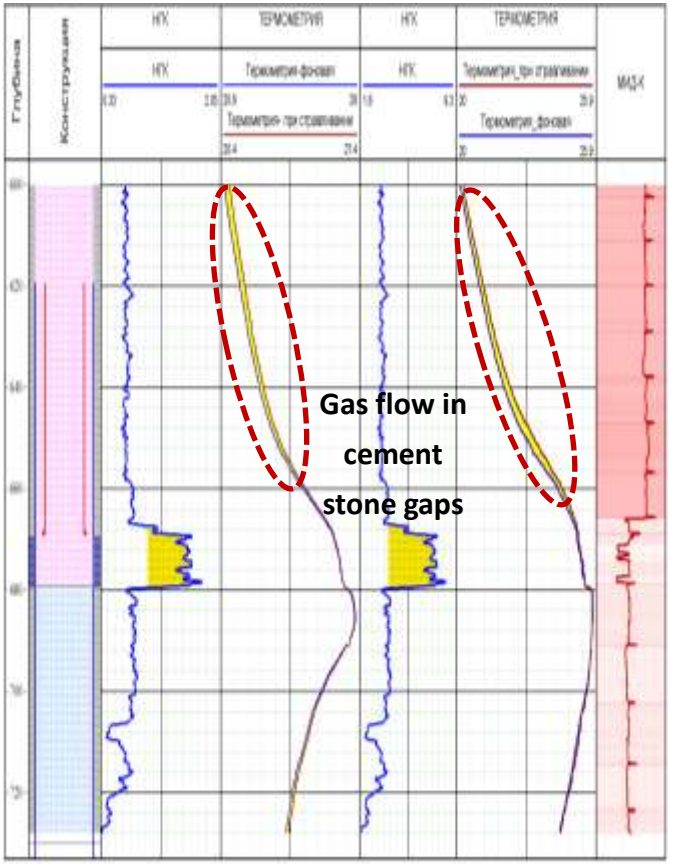
– Visual inspection, thickness measuring, hardness measuring, non-destructive examination, etc.

Device for gas-dynamic logging SKAT– К 8 and results of its application

Description	Value	
Thermometer channel		
Measurement range	from -10 to +150 °C	From 14 to °F
Absolute error admissible values limits	±0,5 °C	±0,9° F
Sensitivity threshold	0,001 °C	0,0018 °F
Manometer channel		
Measurement range	от 0 до 100 МПа	от 0 до 14504 psi
Absolute error admissible values limits	±0,25 %	±0,25 %
Sensitivity threshold	0,0005 МПа	0,072 psi



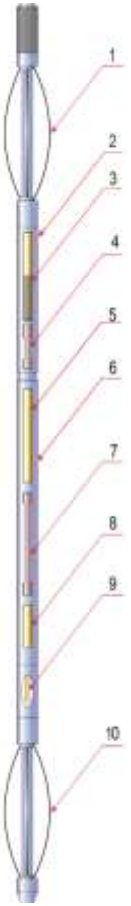
1 – Tubing flow-meter sensor
2 – Dielectric constant meter sensor
3 – Anemometer sensor
4 – Thermometer sensor
5 – Pressure sensor
6 – Noise-level meter sensor
7 – Collar locator
8 – Gamma-ray channel



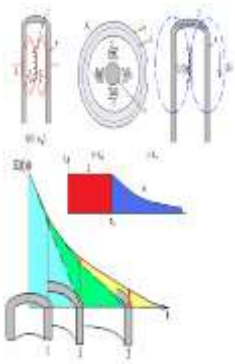
Magnetic pulse flaw detectors
MID-K и MIDS-K

MID-K-GR
1 – upper centralizer
2 – protective housing
3 – GR log sonde
4 – cartridge
5 – protective housing
6 – cartridge
7 – lateral log sonde
8, 9 – transverse log sondes
10 – temperature sensor
11 – lower centralizer

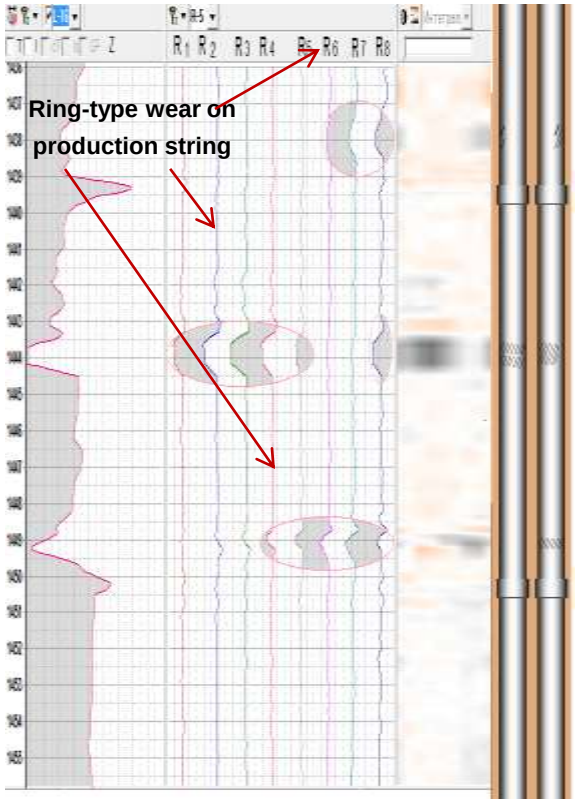
Technical parameters	MID – K - GR	MIDS - K - GR
Precise dimensions of logging tool Diameter, mm Length (without centralizers), mm weight, kg	 42 1500 9	 42 2300 13
Number of log sondes	3	6-10
Diameter of strings under consideration, mm	62÷324	62÷324
Total thickness of two strings' walls , mm	30	30
Srtings walls' thickness measurement range, mm	3÷15	3÷15
Basic error in measuring string wall, mm For one-string structure For casing string measuring through tubing	 ± 0.5 ± 0.7	 ± 0.3 ± 0.7
Min. length of detected defect of a crack type along the string axis, mm for a string diameter 73 mm for a string diameter 146 mm Across the string axis	 30 50 1/6 of circumference	 15 30 1/12 of circumference
Max. operating temperature, °C	150	120
Max.hydrodinamic pressure, MPa	100	100

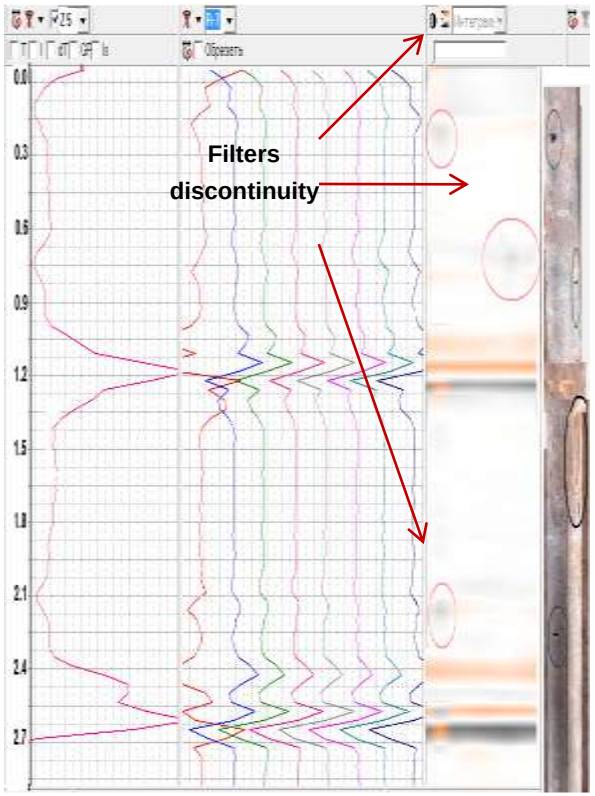


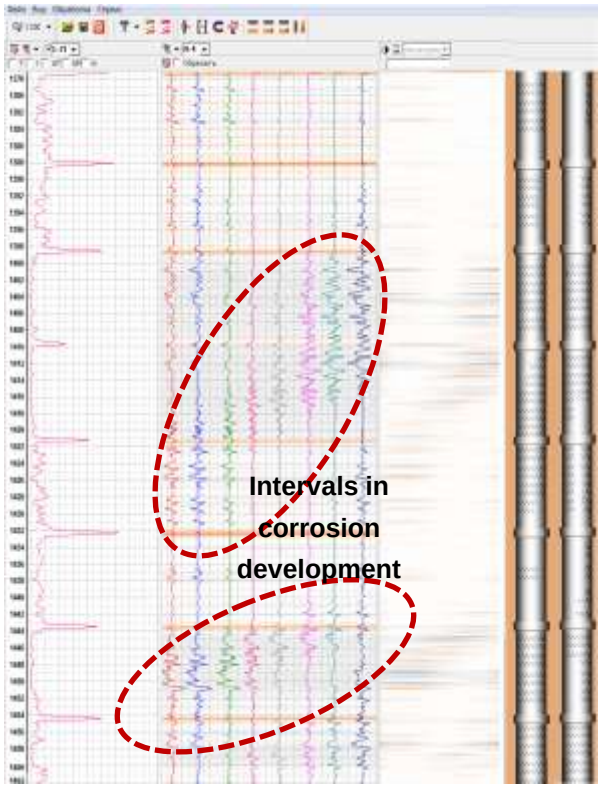
MIDS-K-GR
1 – upper centralizer
2 – protective housing
3 – GR log sonde
4 – cartridge
5 – axial big and small sondes
6 – protective housing
7 – cartridge
8 – axial and radial sondes
9 – temperature sensor
10 – lower centralizer



Examples of technical condition evaluation of casing strings and bottomhole equipment by magnetic pulse methods



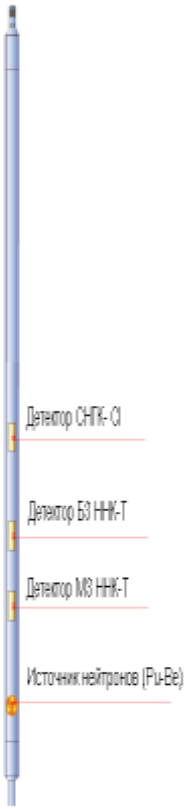




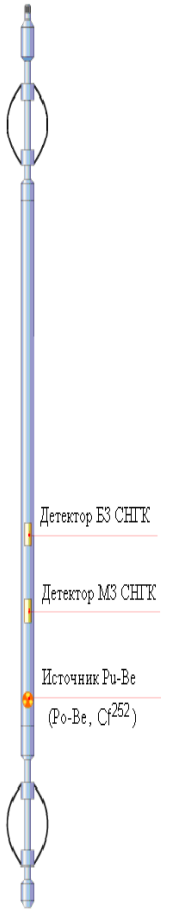
Induced spectral gamma-ray logging (SNGK) applied for evaluating cement stone technical condition in gas medium

Problems which can be solved by SNGK :

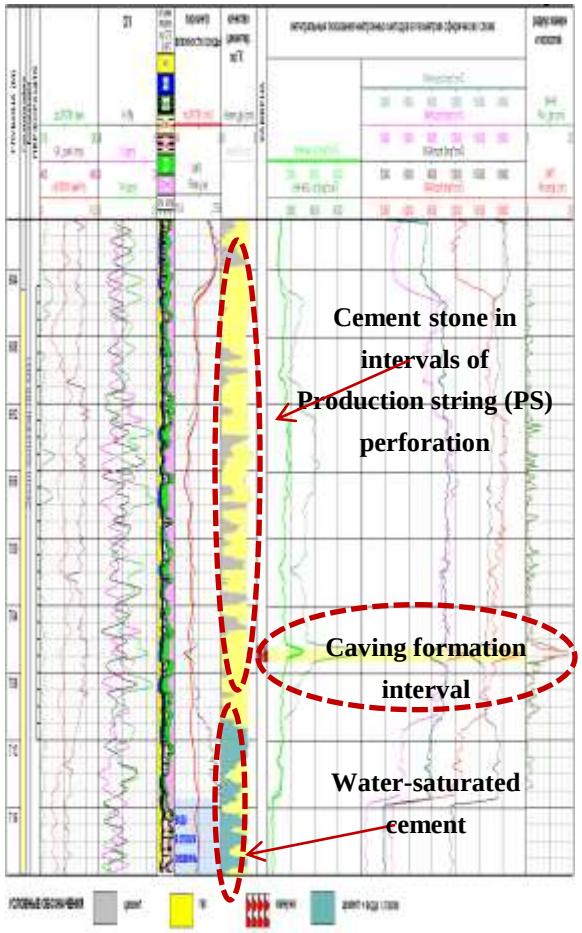
- Evaluation of cementing quality behind production (PS), technical strings (TS) and conductor
- Detection of voids and cavities in cement stone
- Determination of cement stone voids and cavities' filling character
- Detection of zones of production-induced gas accumulation in inter-string area and in the annulus of wells
- Detection of caving formation intervals in well bore zone
- Determination of cavity radius (from 5 to 50 cm), their quantitative estimation

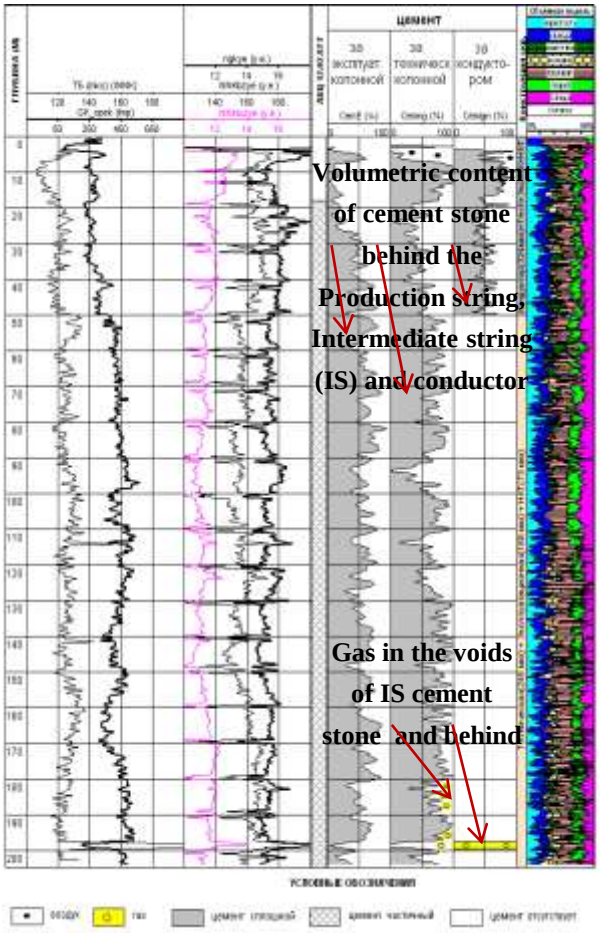


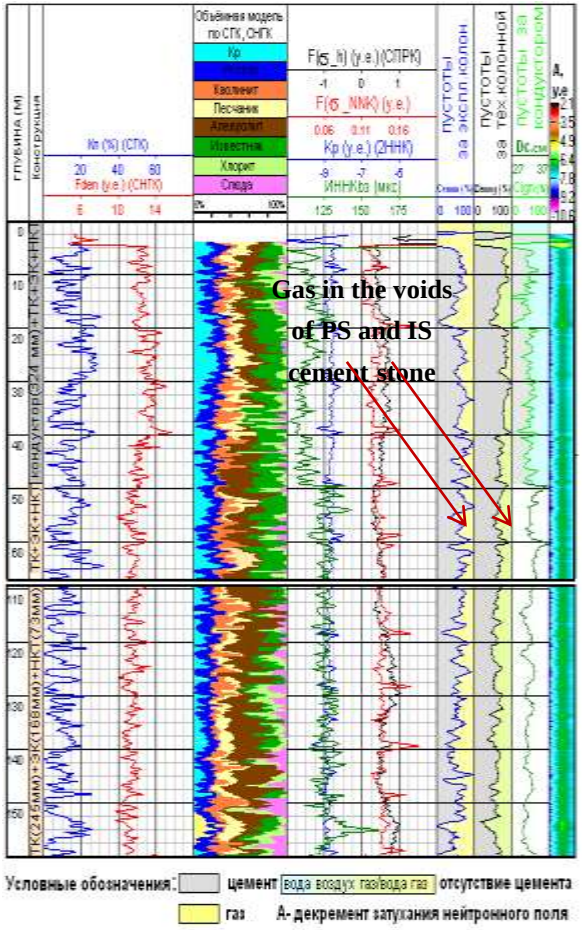
Method:	SNGK-Sh	SNGK-Sl + 2NNK	SGK	2INGK	2INNK
device:	**SNGK-Sh 48**	**SPRK-45**	**TsGK-48**	**TsSP-2INGK-43M**	**AINK-43**
Design: - diameter, mm - Sonde spacing , cm	 48 30 и 55	 45 28, 48(2NNK), 65(SNGK-Sl)	 48 -	 43 40 and 60	 43 32 and 59
Detecting block - detectors: type size - FEU (type)	 NaI(Tl) 24x70 158	 NaI(Tl), CHM-56 20x40 102	 NaI(Tl) 24x160 74-A	 NaI(Tl) 16x40,18x150 102	 CHM65,CHM18
Number of measured channels / pass of timing channel	256x4	128 +2	128	2x64/40мкс	2
Position in a well	centre	Not in the centre	Not in the centre	Not in the centre	Not in the centre
Max. temperature, °C	+120	+120	+120	+120	+120
Max. pressure, MPa	60	60	60	100	100



Results of cement stone evaluation in the UGS running wells







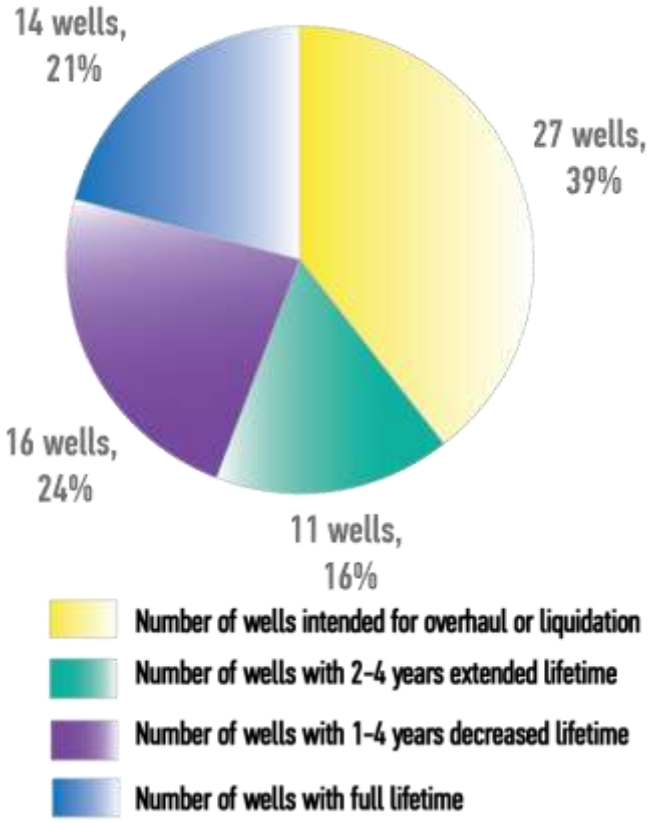
Wells' industrial safety expert appraisal

Purpose: wells technical condition evaluation, estimation of their further lifetime

WORK PROCEDURE:

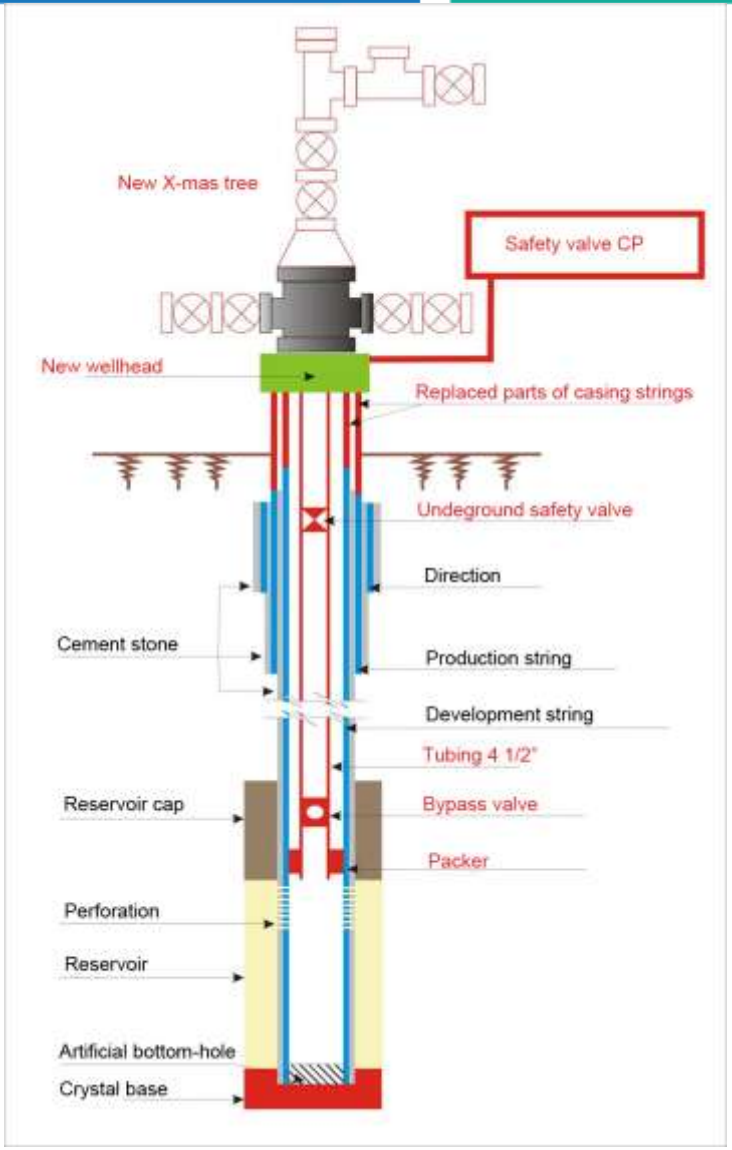
- Analysis of documentation including results of geophysical survey;
- Hookup technical condition evaluation;
- X-mas tree and wellhead equipment technical condition evaluation;
- gas-dynamic survey;
- calculation of strength and estimation of residual lifetime.

INSPECTION RESULTS



After considering the results of the inspection Inchukalnskoe UGS:

- Has performed the overhaul of 26 wells;
- Has updated a 5-year program of wells' overhaul.



Immediate tasks in the field of IUGS diagnostics and reconstruction

- Developing program of technical diagnostics of UGS depreciated processing facilities;
- Decision-making on GGS reconstruction progress;
- Wells overhaul;
- Upgrading normative base with the aim of improving the quality of diagnostics and extending the lifetime of UGS wells' processing facilities.

Techniques of UGS wells' integrity evaluation without killing a well allow specialists

- to perform simultaneous non-destructive examination and thickness measuring of two strings;
- to evaluate technical condition of cement stone;
- to avoid special preparation of the strings before non-destructive examination;
- to study the reasons of inter-string flows and pressures;
- to avoid using reducing productive reservoir characteristics gravity solutions for killing the well;
- to radically decrease the time, expenses and labor costs for wells geophysical survey;

Thus, the technique allows specialists to obtain all the required data for UGS wells integrity evaluation without killing a well and removing the tubing, which gives a sound economic effect.

The results obtained are comparable in accuracy with the results obtained by means of traditional inspection in killed wells.

THANK YOU FOR YOUR ATTENTION!