The development of high automated control systems in hydrocarbons production for operating without the constant presence of operating staff

Chief engineer of “Gazprom Avtomatizatsiya” PJSC
Bobrikov Nikolai
The relevance of the work on the development of technologies of minimal manned operations

**THE MAIN GOAL OF THE WORK ON THE DEVELOPMENT OF TECHNOLOGIES OF MINIMAL MANNED OPERATIONS**

INCREASING THE EFFICIENCY OF PRODUCTION ACTIVITIES OF GAZPROM PJSC DUE:
- REDUCE OPERATING COSTS
- PROLONGATION OF NATURAL PRESSURE OPERATION

**PROBLEMS**

- THE REMOTENESS OF TECHNOLOGICAL OBJECTS FROM INFRASTRUCTURE
- DIFFICULT CLIMATIC, GEOLOGICAL AND GEOGRAPHICAL CONDITIONS

**CONSEQUENT**

- HIGH OPERATING COSTS
- THE HIGH COST ON SUPPORT OF SOCIAL SPHERE

**SOLUTION**

CREATION OF AUTOMATED TECHNOLOGICAL COMPLEXES (ATC) OF GAS PRODUCTION ON THE PRINCIPLES OF MINIMAL MANNED OPERATIONS
The experience and achievements in creating the process control systems of gas production facilities

The scope of works on creation of automated process control systems (APCS) at the facilities of gas production in the period from 2003 to 2016

The MAIN RESULTS

1. Was accumulated experience of creating automation systems with higher performance on the principles of minimal manned operations

2. Was formed competence to perform the work at all stages of the life cycle of automation – from conceptual design and survey work to commissioning and subsequent technical support APCS

3. Was formalized approach to the creation of systems of automation requirements - designed STO Gazprom "Automated gas field. Technical requirements for production equipment and volume of automation in the design and arrangement of fields on the principles of minimal manned operations"

4. According to the results of the tests was made the transition to the Russian components (HW and SW) for automation systems

Implemented projects in the field of automation of gas production facilities:

- Zapolyarnoe field
- Bovanenkovo field
- Kirinskoe field
- Urengoyskoe field
- En-Yahinskoe field
- Vyngoyahinskoe field
- Ety-Purovskoe field
- Muravlenkovoe field
- Medvezhie field
- Zapadno Tarkasolinskoe field
- Ubileinoe field
- etc.

Total produced more than 350 systems on the 52 gas treatment units (GTU)

Automated utilities control systems (AUCS) 15%

Fire and gas systems (FGS) 20%

Process control systems (PCS) 60%

The development of high automated control systems
The history of the development of APCS of the gas production facilities

From "manual control" to the minimal manned operations

The task of creating ATC of production, preparation and transportation of gas on the principles of minimal manned operations were formulated at a series of meetings of Gazprom PJSC (MoM from 29.05.2008 №03/0700/4-5277, from 06.11.2008 №03/0700-177). As a pilot project for the creation of the ATC built on the principles of minimal manned operations were used to determine the project "Development of Cenomanian gas deposits of Muravlenko field".

The main signs development of ACS :

- Uniformity HW&SW
- The degree of development of complex algorithms(CA)
- Integrated operator interface
- United control panel

Systems with united control panel, working on automated modes (AM)

Chayandinskoe field*

* for the Chayandinskoe field the parameters are given in accordance with the Concept of automation and implemented design decisions

The development of high automated control systems
The main signs of evolution of APCS: *Uniform components (HW&SW)*

### Comparison of the degree of technical unity of the subsystems

<table>
<thead>
<tr>
<th>Unit</th>
<th>Zapolyarnoe field. GTU-1C</th>
<th>Bovanenkovo field. GTU-2</th>
<th>Chayandinskoe field</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGW</td>
<td>ControlWave</td>
<td>GE-IP</td>
<td>Russian HW&amp;SW</td>
</tr>
<tr>
<td>GGP</td>
<td>ControlWave + Foxboro</td>
<td>GE-IP</td>
<td></td>
</tr>
<tr>
<td>BCS-2</td>
<td>Siemens + Tecon</td>
<td>GE-IP + Allen-Bradley</td>
<td></td>
</tr>
<tr>
<td>GTT</td>
<td>Foxboro + GE-IP</td>
<td>GE-IP</td>
<td></td>
</tr>
<tr>
<td>CGT</td>
<td>Foxboro + GE-IP</td>
<td>GE-IP</td>
<td></td>
</tr>
<tr>
<td>BCS-1</td>
<td>None</td>
<td>GE-IP + Allen-Bradley</td>
<td></td>
</tr>
</tbody>
</table>

### MAIN RESULTS

1. Have provided a high level of reliability of functioning of control systems. Developed standard technical solutions for all field subsystems.

2. Have minimized development costs and commissioning costs.

3. Have reduced operating costs for staff training, acquisition of spare parts, software update. The extended the intervals between maintenance and have minimized procedures for periodic maintenance and repair.

For the first time was provided the development of a fully unified control system for the oil and gas part of the Chayandinskoe field.
The main signs of evolution of APCS: complex algorithms

Control algorithms: the intellectual maintenance of the state of a difficult system

<table>
<thead>
<tr>
<th>Field</th>
<th>Zapolyarnoe field. GTU-1C</th>
<th>Bovanenkovo field. GTU-2</th>
<th>Chayandinskoe field</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGW</td>
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<td>BCS-2</td>
<td>BCS-2</td>
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<tr>
<td>GTT</td>
<td>GTT</td>
<td>GTT</td>
<td>GTT</td>
</tr>
<tr>
<td>CGT</td>
<td>CGT</td>
<td>CGT</td>
<td>CGT</td>
</tr>
<tr>
<td>BCS-1</td>
<td>BCS-1</td>
<td>BCS-1</td>
<td>BCS-1</td>
</tr>
</tbody>
</table>

- The distribution of gas field performance between GTU in accordance with the operation modes of the interfield manifold
- Control of wells performance
- The monitoring system of the underground part of the well
- Maintenance of a given technological performance of threads and the unit as a whole
- Automatic regulation of the flow of methanol into plumes pad and gas wells
- Optimal redistribution gas flow for process lines
- Automatic loading/unloading Boost Compressor Station (BCS)
- Automatic translation technological lines in the reserve and withdrawal of thread from the reserve
- Localization of ruptures of the pipeline (well, Bush, GTU, IM, GMU)
- Graphs of the process modes

The relevance
Experience and achievements
The history
Signs of development
Import substitution
ATC Chayandinskoe gas condensate field
Perspective
The main signs of evolution of APCS: complex algorithms

- **The relevance**
- **Experience and achievements**
- **The history**
- **Signs of development**
- **Import substitution**
- **ATC Chayandinskoe gas condensate field**
- **Perspective**

The results of the implementation of complex control algorithms

- Minimized the number of permutations of valves
- Reduced the reaction time to disturbance
- Regulatory quality increased 5 times

**COMPLEX CONTROL ALGORITHMS** are:

- a key element in creating ATC on the principles of minimal manned operations and provide control of technological processes of production in a fully automatic mode without constant presence of staff (start, stop, change modes, regulation and control of technological equipment)
- providing adaptive regulation, and prevention of development of emergency situations on the entire process chain (from wells to the shipment of commercial products) minimization of the human factor

The development of high automated control systems
The main signs of evolution of APCS: **Operator interface**

- The relevance
- Experience and achievements
- The history
- Signs of development
- Import substitution
- ATC Chayandinskoe gas condensate field
- Perspective

**Unified operator interface**

- **The gas gathering network**
- **Primary separation unit**
- **Complex algorithms**

**The principles of creation**

- The minimum number of Operator actions for the access to target screen
- Providing for integrated information on the process and complex security
- All interface elements are designed on a unified solutions

The development of high automated control systems
The main signs of evolution of APCS:
*Unified control panel (as an example Bovanekovo)*

- **Unified control panel (as an example Bovanekovo)**
  - Gas field -1
  - Gas field -2
  - Gas field -3 (as perspective)

<table>
<thead>
<tr>
<th></th>
<th>Gas field -1</th>
<th>Gas field -2</th>
<th>Gas field -3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wells</td>
<td>152</td>
<td>270</td>
<td>-</td>
</tr>
<tr>
<td>Bushes</td>
<td>15</td>
<td>22</td>
<td>-</td>
</tr>
<tr>
<td>BCS</td>
<td>2</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>GTU</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

- **The development of high automated control systems**
  - Complex automatization of the gas field
  - **Unified control center**
  - Process chain “Formation-Well-Bush-BCS-GTU-BCS” as control object
The results of the analysis of the market of manufacturers of Russia, their testing with subsequent testing of ACS

<table>
<thead>
<tr>
<th>Feature</th>
<th>Import components</th>
<th>Russian components</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reliability (availability factor of not less than 0.99)</td>
<td>✓ yes</td>
<td>✓ yes</td>
</tr>
<tr>
<td>Functional compliance</td>
<td>✓ yes</td>
<td>✓ yes</td>
</tr>
<tr>
<td>Scalability</td>
<td>✓ yes</td>
<td>✓ yes</td>
</tr>
<tr>
<td>Certifications</td>
<td>✓ yes</td>
<td>✓ yes</td>
</tr>
</tbody>
</table>

- SELECTED RUSSIAN MANUFACTURERS and performed work with factories on technical improvement under the requirements of the ATC on the principles of minimal manned operations
- MINIMIZED RISKS INCREASING THE COST OF PROJECTS BY ELIMINATING THE IMPACT OF CURRENCY EXCHANGE RATE DIFFERENCES. Project risks are assessed more than 1.2 billion rubles for Chayandinskoe field.
- RUSSIAN HW&SW ARE APPLIED TO ALL GAS PRODUCTION PROJECTS
ATC of Chayandinskoe field

Specifications
- 99 bushes with 335 gas wells
- GTU-3, GTU-2, GTU-4, HRU
- 4 BCS (15 GCU, 12 GCU)
- 1 CBCS (10 GCU)

- Monitoring and control of the production process without staff presence at remote processing facilities
- The unified information space of the field

Legend:
- Gas moving direction
- Helium concentrate
- Data transfer
- Control parameter
- Control action
- Measurement
- Control
- Distribution of unit performance

The development of high automated control systems
Prospects of development

The concept of the organization of the control scheme

Chayandinskoe field (implementation)

Unified control panel of the field (for all facilities)

Concept (suggestion)

The virtual group of experts

Operational-analytical group (subsidiary company)

Field

Gas field

Gas-condensate field

Targets the development of new generation should be oriented on:

- increasing the reliability
- reducing capital and operating costs
- minimization of the human factor at all control levels

The relevant field

Experience and achievements

The history

Signs of development

Import substitution

ATC Chayandinskoe gas condensate field

Perspective

Without the constant presence of operating staff

With the constant presence of operating staff

Bovanenkovo field

Gas field -1

Unified control panel of the gas field -2

Gas field -3

Bovanenkovo field (implemented)

The development of high automated control systems
Thank You for Your attention!