TECHNICAL REPORT
on implemented work and obtained results
on the Sub-Project: «Automated on-line monitoring system of incoming ore flows for mining and processing plants»
in the second half of 2017

1. General data.

1.1. This report is made according to schedule and compiled in accordance with the reporting regulations approved by the International Council for commercialization of innovative developments for World Bank borrowers, certain fiduciary guidelines and other regulatory documents of this organization.

The report includes information on all major works and organizational and technical measures implemented for realization of the concept of innovation commercialization: **«Automated on-line monitoring system of incoming ore flows for mining and processing plants» (AS OMQO).** Commercialization project is carried out based on request № APP-SSG-16/0330P– SSG / JRG and financed in accordance with the grant agreement No. 46 dated November 30, 2016. To better clarify the presentation of material on substance of work performed and results obtained further described in this technical report, we hereby give a brief reference on the essence of this innovative technology and the problem that it solves.

1.1.1. Problem. Practically applied technologies of online measurement of processed ore quality are oriented to fine fractional ore flows and are used in scheme of single-flow ore supply for enrichment. However, a scheme of single-flow ore supply for enrichment does not ensure maximum utilization of equipment of concentrating plants. In a multi-flow ore supply for enrichment scheme, fine fractional ore flows are obtained after crushing, when it is already difficult to distinguish in ore flow which ore came from which mine. Thus, there is a problem: it is difficult to quickly measure the quality of ore from mines before crushing, and after crushing it is difficult to distinguish which ore came from which mine. This problem of online monitoring of input ore flows in a multi-flow scheme of ore supply for enrichment has not yet been solved.

1.1.2. Essence of technology. In order to determine the quality and quantity characteristics of ore flows in real time regime, quality and conveyor weight of input fine-fraction ore-flow of crushing section shall be measured, and then reverse on time (temporal) projection of measured ore quality and weight is made to discrete flows of transport units (dump cars) from mines. The objects of monitoring and the scheme for collecting information in the AS OMQO are presented in Fig. 1.1 and 1.2.

1.1.3. The main idea of considered innovative technology is illustrated in figure 1.3.

Figure 1.1 - Objects of monitoring

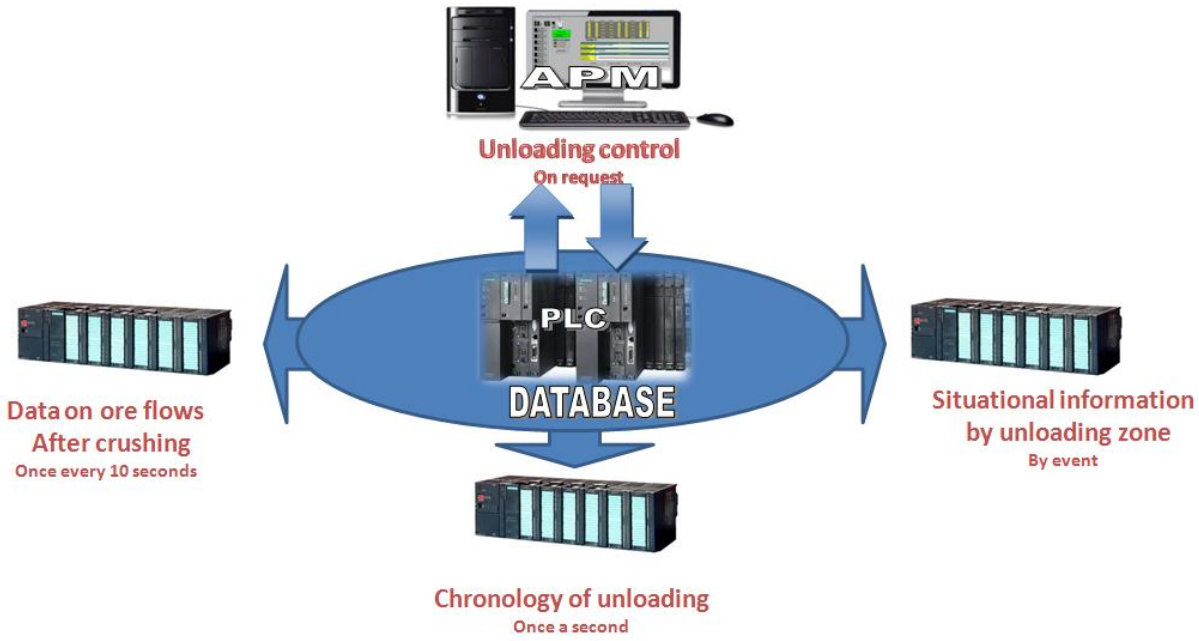


Figure 1.2 - The scheme for collecting information in the AS OMQO

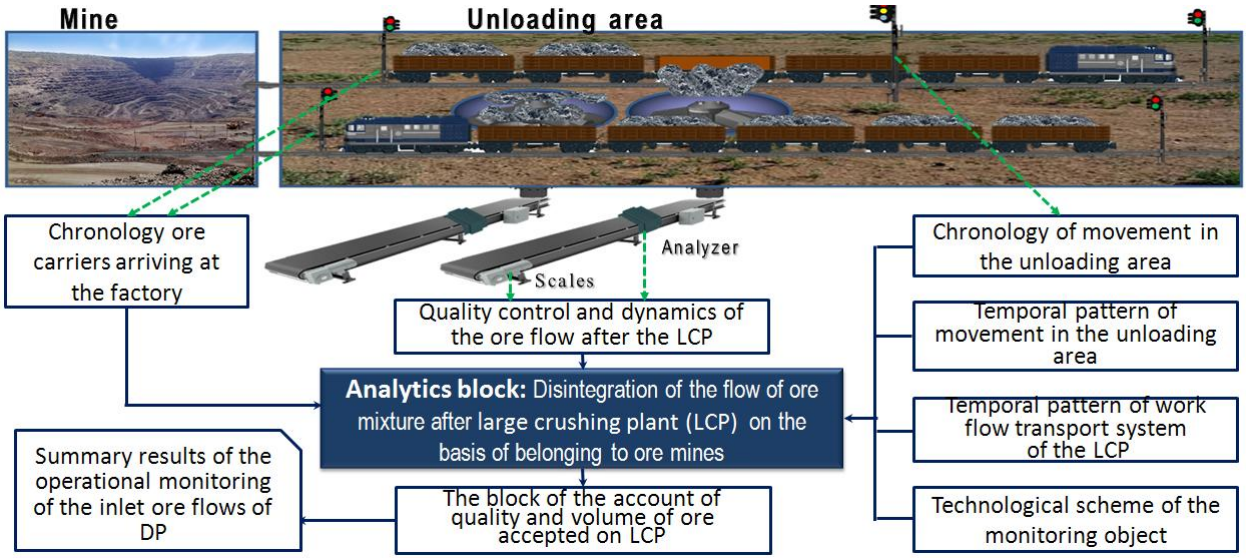


Figure 1.3 - Functional - technological structure of AS OMQO

2. Content and scope of work in the first half of 2017

Scope of work of the Grant Project under consideration in the first half of the year includes:

- Clarification of methodological and scientific-technical solutions for creation of AS OMQO;
- Development of system-wide decisions of AS OMQO;
- Development of information support (IS) of AS OMQO;
- Correction of system-wide solutions in terms of structure and functionality of automated system for online monitoring of input ore flow quality at concentrators;
- Justification of selection of specialized measuring equipment for measuring the quality of ore in inlet ore flows of concentrator.

They are presented in sufficient detail in the previous technical report prepared for the ISCB on 21.06.2017 and are further mentioned only when required.

3. Content of work and activities of the second half of 2017

Further, the report describes the main results of work and activities carried out in the second half of 2017. Detailed description of all scope of work performed and results obtained, please see on the website: aosyst.kz in the section «tst-16».

3.1. Brief summary of all works and events of the second half of the year

Brief summary of all the works and activities of the second half of the year is given below in Table 1.

Table 1 - Summary of engineering developments, organizational and technical measures implemented by "TST-16" LLP in the second half of the year as of 07.11.2017

№	Period	Nameofmeasures / works	Results	Execution
1	**July-Sept-17**	Development of working design document for AS OMIOQ "technical support" (TS) was completed	TSdocumentfor AS OMIOQ workingdesignwas developed	Implemented in accordance with work schedule of the Grant Agreement
2	**July-Sept-17**	Development of working design document for AS OMIOQ«Mathematical support» (MS) was completed	MSdocumentfor AS OMIOQ workingdesignwas developed	Implemented in accordance with work schedule of the Grant Agreement

№	Period	Nameofmeasures / works	Results	Execution
3	**июль-дек-17**	Work on creation of application software was completed.	Appliedsoftwaredocumentfor AS OMIOQ workingdesignwas developed	Implemented earlier than given at work schedule of the Grant Agreement.
4	**July-Sept-17**	Correction of hardware and software platform	Based on developed TS design, solutions of content of hardware-software platform of AS OMIOQ were corrected	Implemented in accordance with work schedule of the Grant Agreement
5	Sep-17 - Dec.-17	Works and measures for organization of a tender for purchase of equipment: Switchboard of workstation assembly based on industrial computer; Switchboard of central controller (CPU) assembly; Switchboard of controller communication station with the object (CPI) assembly Switchboard of controller communication station with object (CPI) assembly external OnSup-project “Automated system for online monitoring of input ore flow quality at mining-processing enterprise” (AS OMIOQ), including.	1. Development of technical specifications for purchased equipment in accordance with requirements 2. TS are prepared for publication on the portal www.fpip.kz. together with a letter-expression of interest. 3. Ready to conduct tender for purchase of equipment (board constructions) for "TST-16" LLP to create industrial sample of " Automated system for online monitoring of input ore flow quality at mining-processing enterprise " (AS OMIOQ) 4. Results of tender shall be published on the portalwww.fpip.kz.	Works shalll be fully implemented after signing of supplementary agreement with alterations of procurement plan, approved by the ISCB and agreed with the SC.
7	Sep-17 - Dec.-17	Kitting and installation of switchboard structures of basic sample of system of ore flows online monitoring of concentrators.	In accordance with design results of TS AS OMIOQ, an additional agreement was prepared with adjustment of procurement plan for Switchboard structures without changing the final cost. Changes in procurement plan have been approved by theISCB and agreed with the SC.	Works shalll be fully implemented after signing of supplementary agreement with alterations of procurement plan, approved by the ISCB and agreed with the SC.
8	Sep-17 - Dec.-17	Set of system software platform	Additional agreement was prepared with adjustment of procurement plan for Switchboard structures without changing the final cost. Changes in procurement plan have been approved by theISCB and agreed with the SC.	Works shalll be fully implemented after signing of supplementary agreement with alterations of procurement plan, approved by the

№	Period	Nameofmeasures / works	Results	Execution
				ISCB and agreed with the SC.
9	Sep-17 - Dec.-17	Installation of basic software on workstations of technologists	Installation of basic software on workstations of technologists shall be completed on the second half of the year	Works shalll be fully implemented after signing of supplementary agreement with alterations of procurement plan, approved by the ISCB and agreed with the SC.
10	July 17 - Dec. 2017	Preparation of application for obtaining a patent of the Republic of Kazakhstan on invention: "system of online automatic monitoring of ore flow characteristics in preparation for enrichment". Working with experts of the National Institute of Intellectual Property of the Ministry of Justice of the Republic of Kazakhstan	Application for obtaining a patent of the Republic of Kazakhstan on invention: "system of online automatic monitoring of ore flow characteristics in preparation for enrichment"is accepted for examination by the NIIP MJ RK.	Implemented in accordance with Procurement plan See Annex 1
11	July 17 – Dec2017	Development of application software complex for computer "Automated system for online monitoring of input ore flow quality at mining-processing enterprise" - as an object of copyright.	Application to the Ministry of Justice of the RKwas prepared and sent for registration of rights to copyright object: application software complex for computer "Automated system for online monitoring of input ore flow quality at mining-processing enterprise"	Implemented in accordance with work schedule of the Grant Agreement.

3.2. Characteristics of implementation of work plan for the second half of the year

3.2.1.In accordance with implementation plan for AS OMQO Subproject, functional-technological structure of which is shown in Figure 1.3, along with organizational and technical measures mentioned in Table 1 of this document, in the second half of 2017 it was planned to perform scientific and technological, engineering and installation-commissioning activities as well as work to improve and enhance protection of innovative basis of the Grant Project.

3.2.2. Scope of engineering works envisaged by the AS OMIOQ creation plan for the second half of 2017 envisaged completion of development of AS OMIOQ working documentation. These works are fully completed. As a result, the following working documentation was developed:

- Technical support

- Mathematical support
- Application software
- Adjustment of software and hardware platform.

3.2.3. Mounting and adjustment works envisaged:

- Completion and installation of swtichboard structures of basic sample of system of ore flows online monitoring at concentrators.
- Set of system software platform.
- Installation of basic software on production engineers' workstations.

At the time of submission of this technical report theseworkshave been partially implemented (estimated 20%). Estimated duration of planned timeframes for these works shall be over 50% due to delay in signing by the Science Committee of the additional agreement on adjustment of procurement plan for the Grant Agreement. The need for such adjustment arose based on TS development design. In this regard it should be noted that the design was carried out with assistance of a consulting firm. We sent relevant application to the Project management team, ISCB and the Science Committee on 22.08.2017 г. (reference No. 06/08-17) and although the Grant Agreement procurement plan adjustment was agreed with the ISCB and Science Committee (reference No. 142-2071.16-6,, Annex 1 to this report) the mentioned additional agreement has not yet been signed. After signing of the above-mentioned additional agreement, installation-commissioning works shall be completed within the period stipulated in the Grant work schedule.

3.2.4. Works on development of improvement and enhancement of protection measures for innovation basis of the Grant Project carried out during the reporting period correspond to the following list:

- Measures to protect intellectual property (IP), which is the basis of the AS OMQO. In the second half of the year within these activities, the license agreement was prepared for transfer of exclusive use rights for invention "Automatic complex for monitoring of quality and quantity of ore flow in preparation for enrichment" under patent No. 31642 from our business partner (Systemotechnika LLP) to our organization - "TST-16" LLP. Under this agreement "TST-16" LLP acquires the exclusive license right for the right to use this invention in the territory of the Republic of Kazakhstan for 5 years. Applicant for registration of the license contract is the Licensor - Systemotechnika LLP. Within the measures to protect AS OMIOQ project intellectual property rights, exhaustive measures have been taken to extend the term of validity of the patent of the Republic of Kazakhstan No. 31642 for the period of 2018-2020. On this matter we would like to clarify that the abovementioned patent for invention of the Republic of Kazakhstan No. 31642 was received on 04.10.2016 on application filed on November 19, 2014, where the patent owner is Systemotechnika LLP, and one of the authors - employee of"TST-16"LLP.

- Measures to expand the scientific and patent protection of ore flows online monitoring technology. In the fourth quarter of 2017 within these activities "TST-16" LLP carried out the following:
  - prepared and registered at RSE NIIP MJ RK the application for obtaining a patent of the Republic of Kazakhstan for invention: "System for automatic online monitoring of ore flow characteristics in preparation for enrichment". At the moment, the formal examination of application is completed and its substantive examination has been started (Annex 2 to this report). In addition, during the same period, personnel of "TST-16" LLP prepared and sent a publication "Online monitoring system of the enrichment factory input ore flows quality on the base of temporal model" to the journal ACIIDS 2018.
  - filed an application for the registration of copyright on the developed software in the Ministry of Justice of the Republic of Kazakhstan (Annex 3 to this report).

3.2.5. In conclusion of this section, it is appropriate to note the following:

- Development of design solutions for creation of automated system for online monitoring of input ore flow quality at mining-processing enterprise wasfully completed in the second half of 2017.
- After completion of kitting and purchase of equipment of the AS OMIOQ, according to the technical specification, it will be project-linked to the technological schemes of the SSGPO JSC, adjusted for operation and industrially tested within 2018.

3.3. Contents and results of the second half of the year

One of large-scale works on implementation of AS OMQO in the reporting period was development of technical, mathematical and software support for techno-working project to create automated system for online monitoring of input ore flow quality at mining-processing enterprise (AS OMIOQ). In accordance with accepted commercialization strategy, these types of support, along with the types of security created in the first half of the year, are the material basis of the copyright object: - "Computer software for online monitoring of input ore flow quality at mining-processing enterprise". As already been noted earlier in this report, the draft of the relevant legal documents was submitted to the competent registration authority.

3.3.1. Completion of the development of technical support.

Development of technical support of AS OMQO was completed in the third quarter of 2017. The central initial premise for development of technical support was requirement to implement the basic analytical functions of AS OMQO on programmable logic controllers, which is associated with a large volume of logical

analysis in real time, and also with the need to satisfy a large number of technical and economic indicators: - reliability, accuracy, high speed of reaction, modification and maintainability convenience, and so on.

In this connection, AS OMQO was designed as a three-level automation system with hardware protection and implementation of fast automatic non-shock switching from working controllers to standby ones.

The full description of the technical support of the AS OMQO is given in the document, a brief reference about which is given in the annex 4 of this technical report.

Level I (Basic Automation) –As the basis of hardware platform, Siemens' programmable logic controllers were used since they are widely used in the industry. Unified interfaces and powerful proprietary software of these controllers allow modular expansion of the system and use of new technical means, providing expansion and modernization of the system in the future.

For AS OMQO, a redundant Simatic S7 417-5H CPU controller is used with ET 200M remote I / O stations.

It implements the following main functions of monitoring:

- control and measurement of values of ore mixture flow characteristics after coarse crushing
- logic of temporal analysis of chronology and situational environment at unloading zone
- formation of information model of quality and volume of ore mass flow after coarse crushing operation, its segmentation and linking of model segment to time interval of input ore-flow
- warning and alarm signaling.

Use of H-system provides the following technical advantages:

- High reliability;
- Wide range scaling;
- Reduction of operating costs;
- Minimum demand for cable products;
- Reduced installation costs.

All control equipment and ET200M stations shall be mounted in metal cabinets of IP 55 version (manufactured by Rittal) and connected to the industrial network 220V.

Input-output stations are arranged on the basis of the following signal modules:

- digital input module SM321;
- digital output module SM322;
- analogue input module SM331;

Level II (HMI/SCADA). Data server and workstations of users shall be installed at the upper level II of the system and combined with the Industrial

Ethernet LAN at 100Mb data transfer rate and with possibility to enter the enterprise's automated dispatch control system.

The Industrial Ethernet network is built on base of SCALANCE X208 switch, installed in PLC cabinet. SCALANCE X208 module has 8 ports for connecting copper network cables with RJ45 plug. Connecting to users shall be by a standard TP-cord.

As workstations and database server are used specialized personal computers of industrial design SIMATIC IPC847C with RAM of at least 8GB optical discs with capacity of at least 1TB.

As workstation of unloading operator, specialized embedded SIMATIC IPC627D personal computer with RAM of at least 8GB optical disk with a capacity of at least 500GB is used.

At the operator control level the following interface shall be provided:

- display information on the mnemonic diagrams of workstations;
- light signals of process failures and faults
- technical tools of system;
- changes in control settings and monitored parameters;
- source of information for archiving process parameters;
- authorizing of access to system functions using passwords.

Structural and functional scheme of input ore flow quality control at concentrator is shown in Figure 3.1.

Structural diagram of technical tools package is shown in Figure 3.2.

System software AS OMQO for level II

As system software basis for data server and automated workstations of AS OMIOQ are used means of Siemens and Microsoft. In particular, technical specification of AS OMIOQ software platform includes the following set of proprietary software products:

- SIMATIC PCS 7, system development environment package (V8.2) with floating license for 1 user.
- SIMATIC WINCC V7.3, RT 2048 (2048 external variables), system software of SCADA-systems, executable software, single license;
- As operating system, there is OS Windows 7 64-bit SP1on the data server and workstations.

Reliable, uninterrupted, non-stop operation of the system is provided by the following solutions:

- optimal architecture of system, rational decoupling of subsystems;
- redundancy (duplication) of controllers;
- use of uninterruptible power supplies;
- Development of extensive subsystem for system elements diagnosing.

Proposed solutions will allow replacing the failed units on the move without stopping the system and without stopping the technological mechanisms.

To connect to the Industrial Ethernet network, controllers implementing the functions of "Input Quality Control" system will be equipped with communication modules CP 443-1.

Project uses the following software:

- SIMATIC PCS 7, system development environment package engineering V8.2 with floating license for 1 user.
    - SIMATIC WINCC V7.3, RT 2048 (2048 external variables), system software ofSCADA-systems, executable software, single license;
    - workstationsshall be equipped with OS Windows 7 64-bit SP1.

Currently, according to the AS OMIOQ projectimplementation plan, development of documentation for technical support of this system has been completed, including working drawings for switchboard structures and workstations measuring instruments, etc. List of basic drawings is presented below in the table 2.

Table 2 - List of basic hardware platform drawings of AS OMQO

Sheet	Title	Note
1	List of project documents	Developed in the 1st half of the year
2	General information	
3	Structural scheme of technical tools package	Developed in the 1st half of the year
4	Diagram of interface connections	Developed in the 1st half of the year
5	PC cabinet. Principal power supply diagram	Developed in the 1st half of the year
6	PC cabinet. External wiring connection diagram	Developed in the 1st half of the year
7	PLC cabinet Principal power supply diagram	Developed in the 1st half of the year
8	PLC cabinet. External wiring connection diagram	Developed in the 1st half of the year
9	CPI cabinet. Principal power supply diagram	Developed in the 2 half of the year
10	CPI cabinet. Input of analog signals	Developed in the 2 half of the year
	Electric schematic diagram	
11.1-11.3	CPI cabinet. Input of discrete signals	Developed in the 2 half of the year
	Electric schematic diagram	
12	CPI cabinet. Output ofanalog signals	Developed in the 2 half of the year
	Electric schematic diagram	
13	CPI cabinet. Output of discrete signals	Developed in the 2 half of the year
	Electric schematic diagram	
14	CPI cabinet. External wiring connection diagram	Developed in the 2 half of the year
15	CPI MS-5cabinet. Principal power supply diagram	Developed in the 2 half of the year
16	CPI MS-5 cabinet. Output of analog signals	Developed in the 2 half of the year
17	CPI MS-5 cabinet. External wiring connection diagram	Developed in the 2

Sheet	Title	Note
		half of the year
18	External wiring connection diagram	Developed in the 2 half of the year
19	Layout of Profibus optical cables	Developed in the 2 half of the year
20.1-20.4	List of cables	Developed in the 2 half of the year

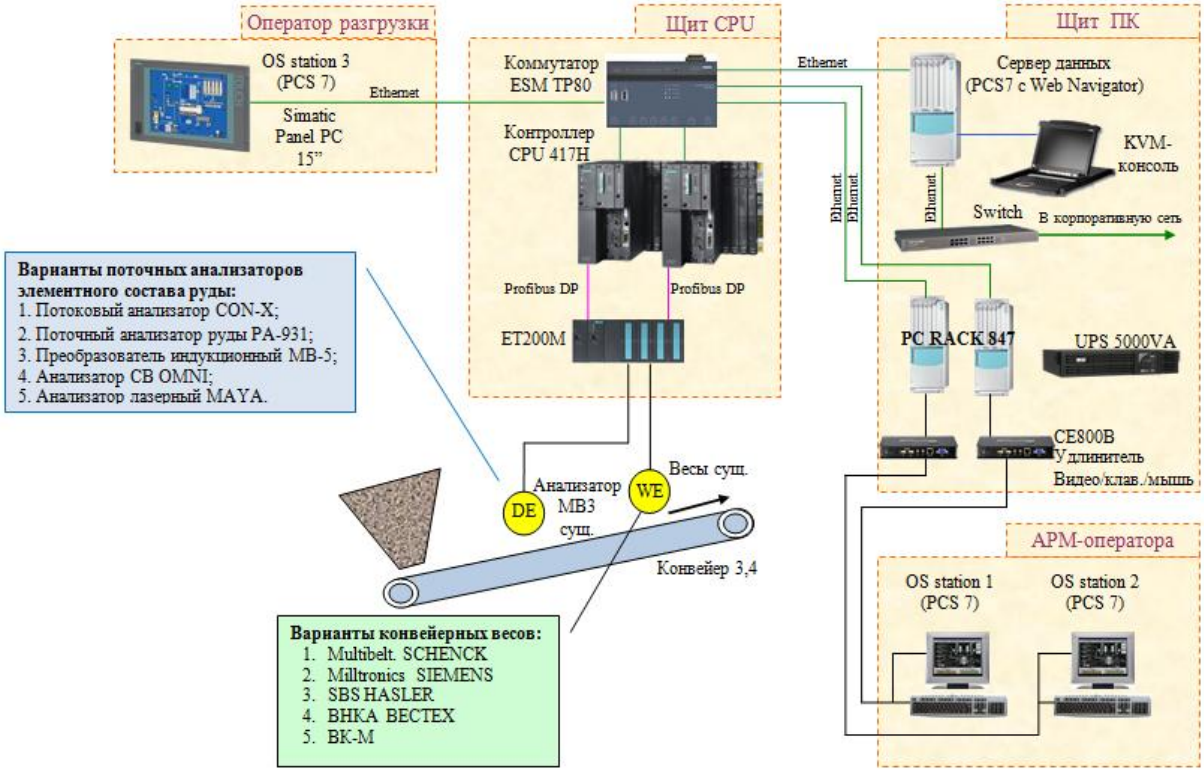


Figure 3.1 - Structural - functional scheme of system of input ore flow quality control at concentrator

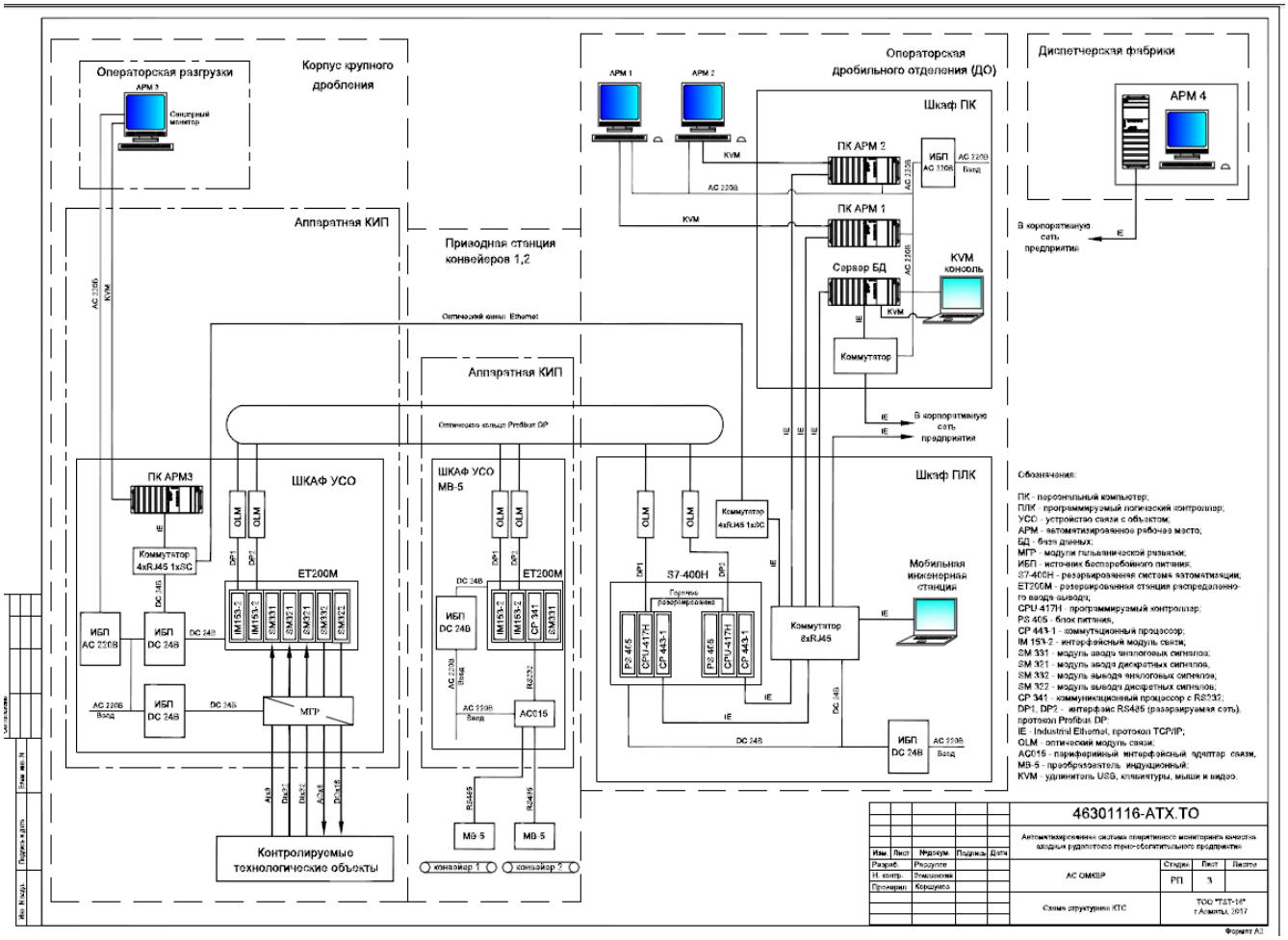


Figure 3.2 - Structural diagram of AS OMQO technical tools package

3.3.2. Development of mathematical support.

3.3.2.1Documentation on mathematical support of AS OMIOQ regulates a set of mathematical methods, models and algorithms. It was developed in the third quarter of 2017 according to the Grant Project work schedule. Content of this documentation fully complies with requirements of Section-7 RD 50-34.698-90 and includes a general (enlarged) and block (detailed) description of algorithms for solving the task of online monitoring ofinput ore flowsquality.

3.3.2.2. Mathematical support of AS OMIOQ is a set of formalizations describing the functions of data collection subsystems, situational analysis and calculation of qualitative and quantitative characteristics of ore flows from supplied by railway transport from various warehouses of mining enterprise. All formalizations are built on a modular basis and executed in the form of specialized algorithmic blocks. Content and functional specifics of algorithmic base are selected based on technological completeness of operations of input ore control process and also considering ideas and positions of object-oriented approach for constructing of corresponding software based on this algorithmic basis.

3.3.2.3. Functionally, algorithms complex for solving the input control problem allows you to determine the weight of selected ore flow passing through the conveyor scales for each coarse crushing stream and identify the point (warehouse) where this ore was uploaded. In addition, based on these results and indications of ore quality sensor, the content of useful component in ore is calculated from regression models predetermined for each ore stock and productivity of discharge queues is calculated.

Algorithmic structure of task of online monitoring of input ore-flows quality includes six basic algorithms, namely:

- Algorithm for formation of object - "dump-scalesstream ".
- Algorithm for adding a car to "dump-scalesstream ".
- Algorithm for controlling the passage of ore car through scales.
- Algorithms for determining the unloading process characteristics:
  - Algorithm for determining the iron content in each ware house ore
  - Algorithm for determining queue performance.
  - Algorithm for determining the unloading process characteristics.

3.3.2.4. Result of model decomposition into algorithmic blocks and their interaction are presented in the diagram (Figure 3.3). Below we consider the functional specifics of each block from perspective of their implementation by means of object-oriented programming in the form of program modules.

List of tasks implemented by functional blocks includes the following:

1) Collection and primary processing of signals from the object.
2) Determination of ore weight to be supplied in each train and for each ore loading point.
3) Determination of iron content in medium-crushed ore from the beginning of the shift, control of weight of accepted ore from the beginning of the shift.

4) Formation of information for supply to corporate network for monitoring the operation of the 3rd receiving hopper by operational personnel.

List of functional blocks of AS OMIOQ and description of their main functions are given below:

1 Functionalblock(FB) «Railway»:
- Identification of train entrace.
- Identification of train exit.
- Entering data on specific train.
- Mergingoftrains.
- Separationoftrains.

2. Functionalblock(FB) «Train»:
- Recalculation of number of wagons.

3. Functional block (FB) «Identification of dump (fall)»:
- Identification of wagon dump moment.
- Creating a new data block «Wagon».

4. Functionalblock(FB) «Bunker»:
- Calculation of the current mass in bunker.
- capacity rating of crusheroutput.
- Determining of start time of wagon exit from bunker.
- Determining end time of wagon exit from bunker.
- Determining of DB of the first wagon in bunker.

5. Functionalblock(FB) «Scales»:
- Calculation of zero level of scale.
- Identification of beginning and end of the stream
- Calculating of total weight of the current stream.
- Archiving of weight and magnetic susceptibility in cyclic archives.
- Identification of wagon passage through scales.
- Handling of "Orphan ore" contingency.

Example of algorithms description in the form of graphic schemes is shown in Figure 3.4.

6 Functional block (FB) «StreamWork»:
- Function call(FC) «Determination of number of wagons in stream».
- Function call (FC) «Initial correction of wagon boundaries in stream».
- Functional block call (FB) «Extremum seeking ».
- Function call (FC) «Secondary correction of wagon boundaries in stream».

7. Function (FC) «Determiningnumber of wagons in stream»:
- Determiningnumber of wagons in stream.
- Calculation of coefficient «discrepancy».
- Determiningthe actual last wagon in stream.

8. Function (FC) «Initial correction of wagon boundaries in stream»:

- Allowance to expected mass of wagons by "discrepancy" coefficient.
- Recalculation of end time of wagon passage of scales (and start time of next wagonpassage of scales) in accordance with the received wagon mass based on weight values array.

9. Functional block (FB) «Extremum seeking»:

- Define the extreme value in values array, i.e. limit values for wagons.
- Formation of indices array of extreme weight values.

10. Function (FC) «Secondary correction of wagon boundaries in stream»:

- Recalculationstarandendtimeofwagon passage of scalesin accordance with indices array of extreme weight values.

11. Functional block (FB) «Summary»- forming of summary lines:

- Filling in fields: declaredweight of train, time of train entry onto Railway, time of exit, quantity of wagons in train, railwaynumber, warehousenumber, locomotivenumber.
- Calculation and filling of fields: actual weight of train, average iron content in train.

12. Functionalblock(FB) «Remover»:

- Identifying "extra" data blocks (DB).
- Removing "extra" data blocks (DB).

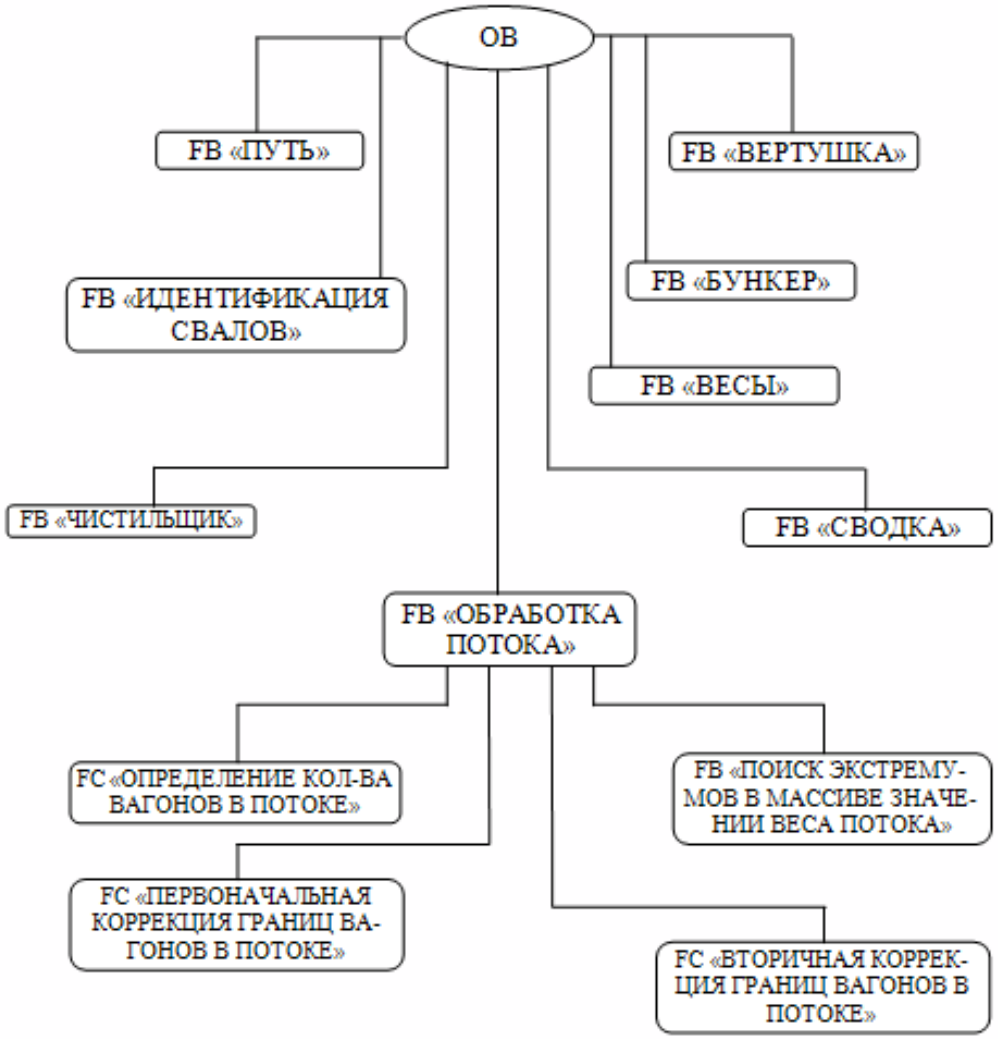


Figure 3.3 - Structure of AS OMQO construction on the basis of function blocks

Full description of mathematical support of AS OMQO is given in the document indicated in the annex 5 to this report.

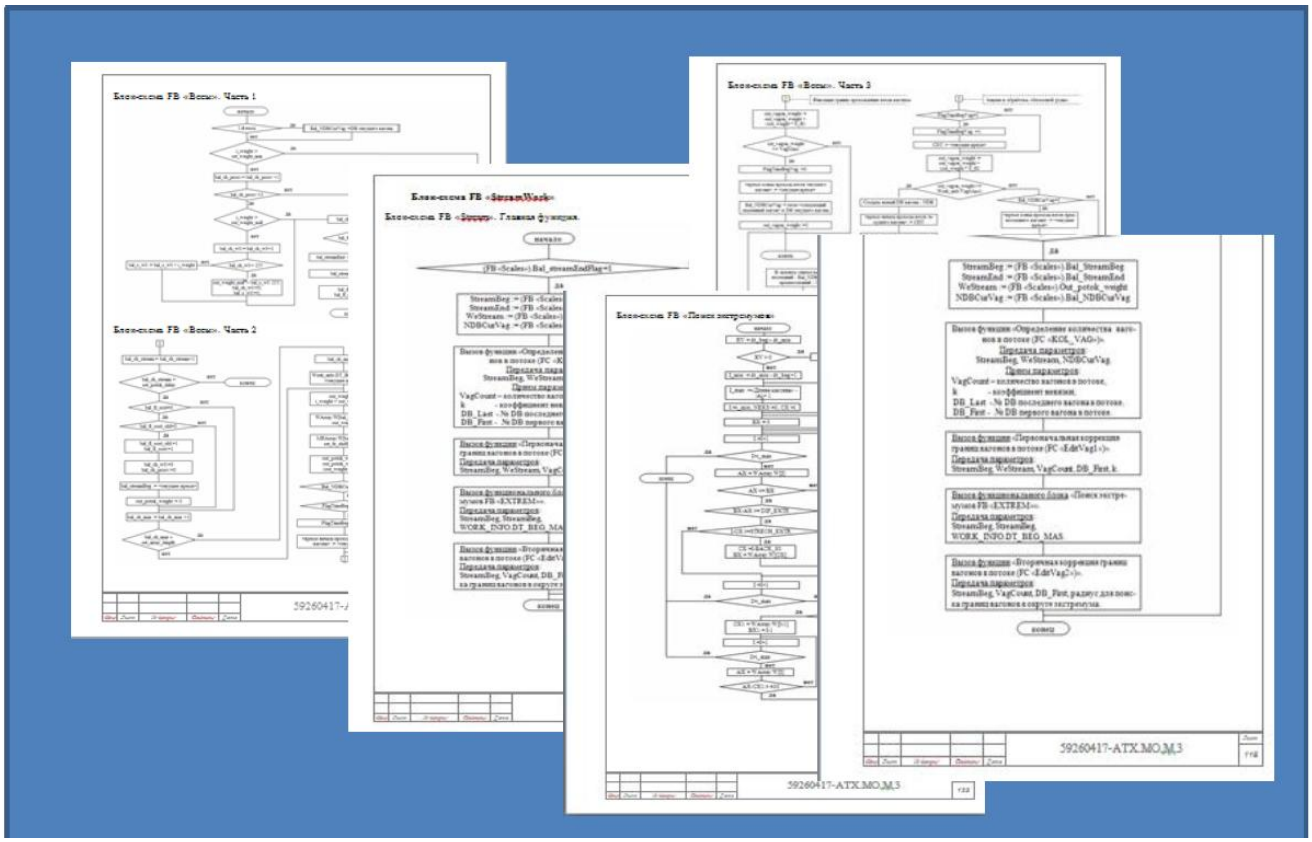


Figure 3.4 - Example of description of AS OMQO algorithms in the form of block diagram

3.4.Development of application software.

3.4. 1. This section of Project work was carried out ahead of the Grant Project schedule in the middle of the 4th quarter of 2017.

3.4.2. Application software for data servers and workstations has been developed for execution in Run-time WinCC version 7.3 environment which is part of PCS7 system from the Siemens software product line

Application software of controller stations is implemented in the SCL language of visual software environment STEP 7, which is part of PCS7 system toolset.

As additional tools for development of controller and technological levels software, a set of extensions for PCS7 system and Delphi V7 visual programming tool environment were also used. The Delphi V7 tool system is used only to implement individual utilities in generating original operational summaries. In other cases, programming is carried out within the instrumental and language capabilities of PCS7 system and its extensions.

In particular, programming of application logic at technological (controller) level is carried out in the SCL language using the tools and libraries of the above mentioned Siemens STEP 7 branded tool product.

Software of the upper (dispatching) level II is implemented using principles and approaches of the client-server architecture considering capabilities of

application server and database technologies. For programming, tools of the WinCC package of PCS-7 system and Delphi visual programming environment are used. At this level, the required functionality of automated workstations (AWS) of specialists is implemented, including:

- interfaces for monitoring and control of "input control" processes,
- procedures for data input on weight, number and loading point of compound,
- service for storing and adjusting the coefficients of regression equations for recalculating the signals of MS-5 sensors into the values of magnetic and total iron content, accumulating the archival information about operation of hardware-software,
- software for generating messages and reports on monitoring results, as well as data transfer through the corporate network to servers of adjacent systems and seniorsystems.

To exchange data between system components at technological level, Industrial Ethernet and OPCtechnologies, as well as communications based on formats, interfaces and protocols adopted for Profibus, Profibus-DP networks are used.

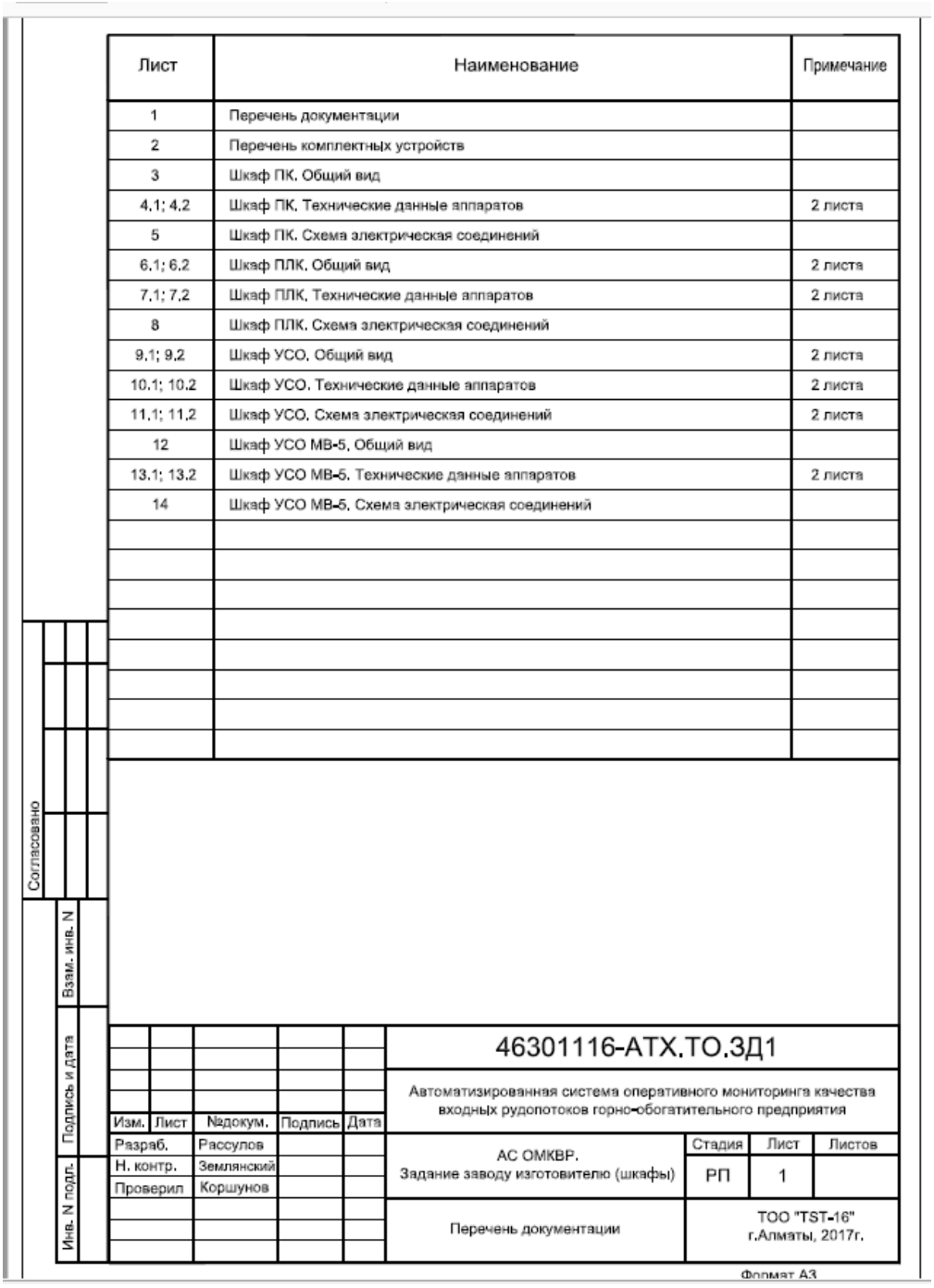
Full description of application software, including instructions and manuals for its installation on computers, controllers and AS OMIOQ data server is given in the corresponding document. Monitoring system distribution kit itself, intended for installation, is recorded on a magnetic medium and is attached to this document. Brief information about the document is given in the Annex 6 to this Technical report.

3.5. Kitting and installation of cabinet structures of AS OMQO

3.5.1. Kitting and installation of cabinet structures of basic sample of system for ore flows online monitoring was carried out based on documentation for technical support of AS OMQO and "Assignment to manufacturer" document for supply of cabinet structures in accordance with given specification.

The set of specifications regulated content and technical characteristics of equipment for the following cabinet structures: - PC cabinet, PLC cabinet, PCI cabinet and PCI MS-5 cabinet. This document shows all the data including both general view of cabinet structures and technical data of their components and wiring diagrams, which allow assembling and mounting of AS cabinets.

List of necessary documentation for this section is shown in Figure 3.5.



Лист	Наименование	Примечание
1	Перечень документации	
2	Перечень комплектных устройств	
3	Шкаф ПК. Общий вид	
4.1; 4.2	Шкаф ПК. Технические данные аппаратов	2 листа
5	Шкаф ПК. Схема электрическая соединений	
6.1; 6.2	Шкаф ПЛК. Общий вид	2 листа
7.1; 7.2	Шкаф ПЛК. Технические данные аппаратов	2 листа
8	Шкаф ПЛК. Схема электрическая соединений	
9.1; 9.2	Шкаф УСО. Общий вид	2 листа
10.1; 10.2	Шкаф УСО. Технические данные аппаратов	2 листа
11.1; 11.2	Шкаф УСО. Схема электрическая соединений	2 листа
12	Шкаф УСО МВ-5. Общий вид	
13.1; 13.2	Шкаф УСО МВ-5. Технические данные аппаратов	2 листа
14	Шкаф УСО МВ-5. Схема электрическая соединений	

Согласовано

Взам. инв. N

Подпись и дата

Инв. N подл.

Изм.	Лист	№докум.	Подпись	Дата	46301116-АТХ.ТО.ЗД1			
					Автоматизированная система оперативного мониторинга качества входных рудопотоков горно-обогатительного предприятия			
Разраб.		Рассулов			АС ОМКВР. Задание заводу изготовителю (шкафы)	Стадия	Лист	Листов
Н. контр.		Землянский				РП	1	
Проверил		Коршунов						
					Перечень документации	ТОО "TST-16" г.Алматы, 2017г.		

Формат А3

Figure 3.5 - Assign the factory to the manufacturer. List of documents

3.5.2. Analyzing results of the work on this stage we would like to note that design solutions for technical support of AS OMIOQ obtained by "TST-16" LLP

with participation of "SCADA LTD" firm who provided consulting services for design of the AS, envisage setting of system's hardware in four cabinet units structure which is not fully consistent with procurement plan for the Grant Agreement No. 46 dated November 30, 2016, in terms of the quantity and value of each of cabinet. The proposed design solutions fully ensure implementation of all planned functions and the total cost of panel structures does not exceed the cost of cabinets under the procurement plan. In this case, in accordance with article 42 of the Grant Agreement, we prepared for registration an additional agreement with adjustment of the procurement plan, which was approved by members of the ISCB and the Science Committee of the Ministry of Education and Science of the Republic of Kazakhstan. However, due to the fact that the additional agreement has not been signed to date, the work on kitting and installation of cabinet structures will continue after signing of this agreement. The letter of the Science Committee is given in Annex 6 to this report.

Conclusion

The main engineering results obtained as a result of the works are presented in Table 3.

Table 3 - Current status by technology

Results of works for the second half of 2017				
Works	QUARTER		Status	RESULTS
	3	4		
• Development of technical support (TS)			Done 100%	Technical documentation for the level of basic automation, based on programmable logic controllers
• Development of mathematical support			Done 100%	Models and algorithms of the subsystems for data collection and situational analysis
• Development of application software (software)			Done 100%	Application software for the basic control level and technological level
• Correction of the hardware and software platform			Done 100%	The specifications for the purchase of equipment have been developed
• Acquisition and installation of cabinet designs sample base-line monitoring of DP production intensity systems			Done 20%	The market was investigated. The potential supplier of cabinet designs of the system of the AS ICQO - LLP "EnergyAutomation" is defined
• Completion of the system software platform			Done 20%	The analysis of the market is carried out. A range of potential suppliers has been identified.
• Installing software on the base of technologists workstations			Done 15%	Trial installation and autonomous testing of the main components of distribution package of the developed AS OMQO application software was conducted on AS OMQO hardware model under the field conditions of TST-16 LLP Installation will be made after completion of the work on the assembly and installation of cabinet structures

The current status of the market can be summarized as follows:

- We have conducted consultations with potential technology purchaser - SSGPO JSC about providing an industrial site for pilot testing of the system in 2018. We received positive decision on this issue as well as confirmation of intention to purchase and introduce the technology in the period of 2018-2019 which was previously declared in the relevant memorandum between "TST-16" LLP and "SSGPO"JSC.

The current status of activities related to the protection of intellectual property rights can be described as follows:

- We have filed an application and paid services for prolongation of the patent term of the Republic of Kazakhstan No. 31642 for the period of 2018-2020, which is the basis of the technology and where one of the authors is a member of team of the Project APP-SSG-16/0330P- SSG/JRG implemented by “TST-16" LLP.
- License agreement for transfer of exclusive rights to use the invention "Automatic complex for monitoring of ore flow quality and quantity in preparation for enrichment" has been signed and submitted to the RK Justice Authorities under the RK patent No. 31642. Under this agreement "TST-16"

LLP shall acquire the exclusive license right for this invention use right in the territory of the Republic of Kazakhstan for 5 years.

- We have prepared and registered in the RSE NIIP of the Ministry of Justice of the Republic of Kazakhstan the application for obtaining the patent of the Republic of Kazakhstan for invention: "System of online automatic monitoring of ore flow characteristics in preparation for enrichment". At the moment, the formal examination of the application is completed and its substantive examination has been started.
- Publication was prepared and sent.
- Filed an application for the registration of copyright on the developed software in the Ministry of Justice of the Republic of Kazakhstan.

The work carried out by the project team for the reporting period includes the following planned development:

- development of working documentation of project for technical, mathematical and software support of AS OMQO, in particular:
- development and adjustment of software and working documentation of AS OMQO in volume sufficient for hardware package manufacturing and installing on it of system and developed application software.

In addition, work has begun and is being carried out on the following items of the work plan:

- Completion and installation of cabinet structures: - development of technical specifications for potential suppliers for manufacture and supply of automation cabinets with equipment of AS OMIOQ
- Kitting of system software platform: - development of technical tasks for potential suppliers for supply of AS OMIOQ system software platform
- Installation of basic software of AS OMIOQ for workstations: - trial installation and autonomous testing of the main components of distribution package of the developed AS OMIOQ application software was conducted on AS OMIOQ hardware model under the field conditions of TST-16 LLP.

In conclusion, it can be stated that all the works and activities defined by the project work plan for the second half of the year have been generally fulfilled.

ANNEX 1 Letter of authorization to adopt changes in the procurement plan

«ҚАЗАҚСТАН РЕСПУБЛИКАСЫ
БІЛІМ ЖӘНЕ ҒЫЛЫМ
МИНИСТРЛІГІНІҢ ҒЫЛЫМ КОМИТЕТІ»
МЕМЛЕКЕТТІК МЕКЕМЕСІ

ГОСУДАРСТВЕННОЕ УЧРЕЖДЕНИЕ
«КОМИТЕТ НАУКИ МИНИСТЕРСТВА
ОБРАЗОВАНИЯ И НАУКИ
РЕСПУБЛИКИ КАЗАХСТАН»

010000, Астана қ., Есіл ауд., Мәңгілік Ел даңғылы, 8-үй, 11-қ.
Тел.: 8 (7172) 74-24-59, 74-16-58 (қабылдау)
sc.edu.gov.kz

010000, г. Астана, Есильский р-он, проспект Мәңгілік Ел, д. 8, п. 11
Тел.: 8 (7172) 74-24-59, 74-16-58 (приемная)
sc.edu.gov.kz

№
2017 ж. 04.10 №442-2071/16-6

Осіз жарамсыз болып табылады. Жауап қайтарарда міндетті түрде біздің № және күні көрсетілу керек.
С серийного номера не действителен. При ответе обязательно ссылаться на наш № и дату.

ТОО «TST-16»

050000, г. Алматы,
ул. Амангельды, 40/112

На № 06/08-17 от 22 августа 2017 года

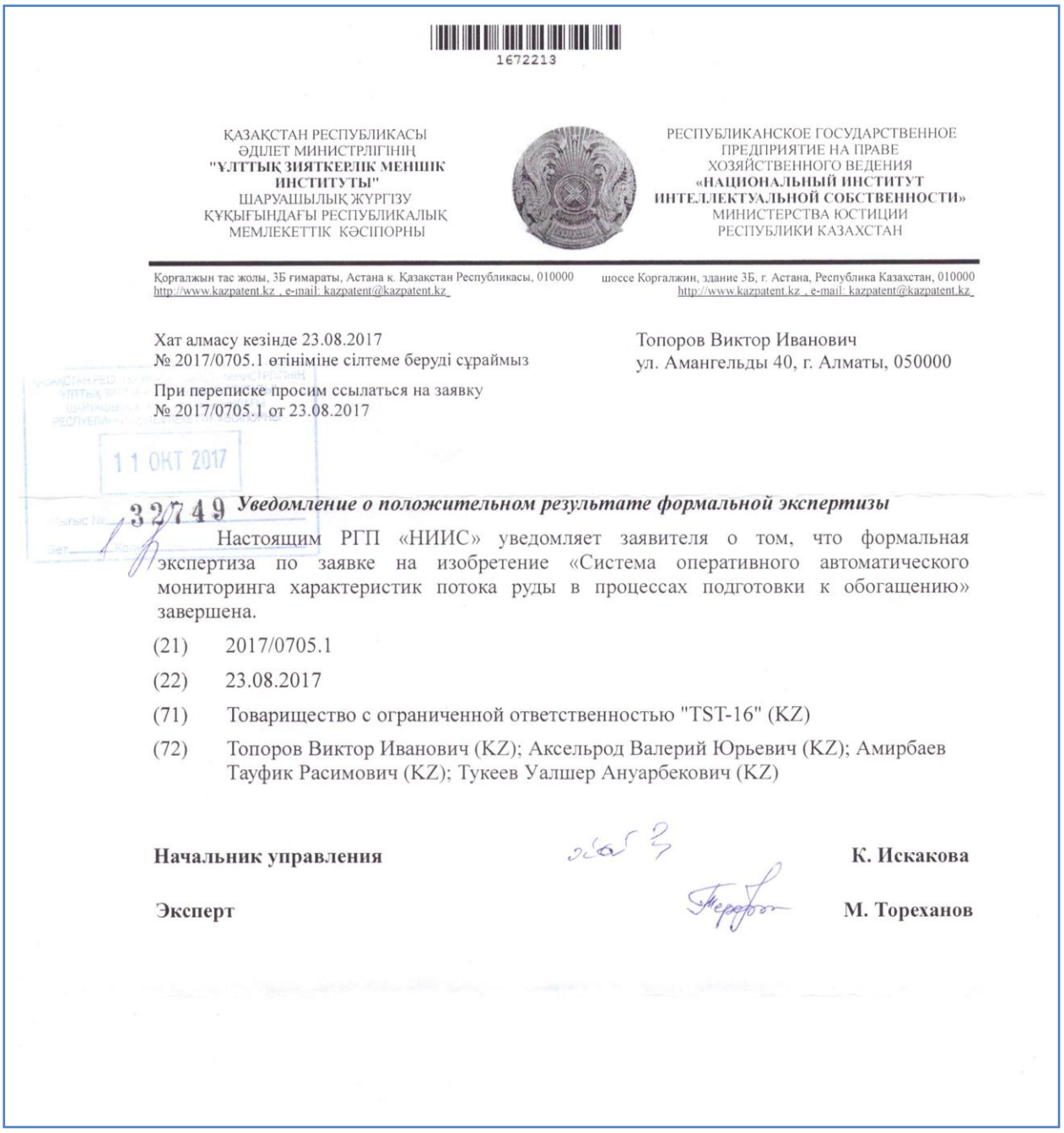
Комитет науки Министерства образования и науки Республики Казахстан (далее – Комитет), рассмотрев Ваше письмо касательно внесения изменений в План закупок по подпроекту «Автоматизированная система оперативного мониторинга качества входных рудопотоков горно-обогатительного предприятия», сообщает следующее.

Комитет, принимая во внимание одобрение членов Международного совета по науке и коммерциализации, считает возможным принятие изменений в план закупок после подписания Дополнительного соглашения к Соглашению о гранте № 46 от 30 ноября 2016 года.

Председатель **Б. Абдрасилов**

ANNEX 2

Notification of a positive result of a formal examination of an application for a patent of the Republic of Kazakhstan for an invention: "A system for operative automatic monitoring of ore flow characteristics in preparation for enrichment"



1672213

ҚАЗАҚСТАН РЕСПУБЛИКАСЫ
ӘДІЛЕТ МИНИСТРЛІГІНІҢ
"ҰЛТТЫҚ ЗИЯТКЕРЛІК МЕНШІК ИНСТИТУТЫ"
ШАРУАШЫЛЫҚ ЖҮРГІЗУ
ҚҰҚЫҒЫНДАҒЫ РЕСПУБЛИКАЛЫҚ
МЕМЛЕКЕТТІК КӘСІПОРНЫ

РЕСПУБЛИКАНСКОЕ ГОСУДАРСТВЕННОЕ
ПРЕДПРИЯТИЕ НА ПРАВЕ
ХОЗЯЙСТВЕННОГО ВЕДЕНИЯ
«НАЦИОНАЛЬНЫЙ ИНСТИТУТ ИНТЕЛЛЕКТУАЛЬНОЙ СОБСТВЕННОСТИ»
МИНИСТЕРСТВА ЮСТИЦИИ
РЕСПУБЛИКИ КАЗАХСТАН

Қорғалжын тас жолы, 3Б ғимараты, Астана қ. Қазақстан Республикасы, 010000
http://www.kazpatent.kz , e-mail: kazpatent@kazpatent.kz

шоссе Коргалжин, здание 3Б, г. Астана, Республика Казахстан, 010000
http://www.kazpatent.kz , e-mail: kazpatent@kazpatent.kz

Хат алмасу кезінде 23.08.2017
№ 2017/0705.1 өтініміне сілтеме беруді сұраймыз

При переписке просим ссылаться на заявку
№ 2017/0705.1 от 23.08.2017

Топоров Виктор Иванович
ул. Амангельды 40, г. Алматы, 050000

11 ОКТ 2017

32749

Уведомление о положительном результате формальной экспертизы

Настоящим РГП «НИИС» уведомляет заявителя о том, что формальная экспертиза по заявке на изобретение «Система оперативного автоматического мониторинга характеристик потока руды в процессах подготовки к обогащению» завершена.

(21) 2017/0705.1

(22) 23.08.2017

(71) Товарищество с ограниченной ответственностью "TST-16" (KZ)

(72) Топоров Виктор Иванович (KZ); Аксельрод Валерий Юрьевич (KZ); Амирбаев Тауфик Расимович (KZ); Тукеев Уалшер Ануарбекович (KZ)

Начальник управления **К. Искакова**

Эксперт **М. Тореханов**

ANNEX 3

Application for registration of copyright for the developed software to the Ministry of Justice of the Republic of Kazakhstan

Министерство юстиции
Республики Казахстан
от ТОО «TST-16»
по адресу: 050000, г. Алматы,
ул. Амангельды, дом 40/112
Тел. +7272796185, ф. -77272795582,
e-mail: gsns2016ruk.ut@gmail.com
справка о государственной регистрации
юридического лица от 15.11.2016 г.

ЗАЯВЛЕНИЕ
на регистрацию прав на произведения,
охраняемые авторским правом от правообладателя

ТОО «TST-16», БИН 161140015654, настоящим подтверждает, что является обладателем исключительных имущественных прав на программу для ЭВМ созданную Аксельродом Валерием Юрьевичем (УДЛ №022989861 от 20.11.2008 МЮ РК, ИИН 490314300989), Амирбаевым Тауфиком Расимовичем (УДЛ №023344656 от 21.11.2008 МЮ РК, ИИН 430207300430), Коршуновым Петром Петровичем (УДЛ №023788094 от 03.06.2009, ИИН 420303300212), Рассуловым Тимуром Мансуровичем (УДЛ №030050021 от 29.04.2010 МЮ РК, ИИН 850220300220), 12 августа 2017 года под названием «Автоматизированная система оперативного мониторинга качества входных рудопотоков горно-обогатительного предприятия» (сокращенное название «АС ОМКВР») и просит зарегистрировать исключительные имущественные права на данный объект авторского права в Министерстве юстиции Республики Казахстан.

Настоящим также подтверждаем, что при создании объекта авторами не были нарушены права других лиц.

Юридическое значение факта регистрации произведения в Министерстве юстиции Республики Казахстан и условия регистрации нам разъяснены.

«18» октября 2017 г.
Директор ТОО «TST-16» Уалшер Тукеев

TST-16

Согласен на использование сведений, составляющих охраняемую законом тайну, содержащихся в информационных системах, при оказании государственных услуг.

ANNEX 4 About technical support

"TST-16"
LIMITED LIABILITY PARTNERSHIP

Approved
Director of
"TST-16" LLP, D.Eng.

_____ U. Tukeyev
«____»_____ 2017.

SSG Program on realization of Fostering Productive Innovation Project

Subproject "Automated system for online monitoring of incoming ore flow quality at concentrator"
(AS OMQO)

TECHNICAL SUPPORT

Annex 4 to Technical report

2017

«TST-16» LLP

Automated system for online monitoring of incoming ore flow quality at concentrator

AS OMQO

TECHNICAL SUPPORT

46301116-ATX.TO

Book 1

CommercialDirector **V.Yu.Akselrod**

2017

Abstract

Keywords: structural diagram, interface connections, external wiring, power scheme, analog signals, discrete signals, external wiring connections.

Technical support of the project includes:

1. Working drawings of project:
   - Structural scheme of hardware package.
   - Schemes of switchboard equipment (Boards:PC, PLC, CPI, CPIMS-5):
     - Diagram of interface connections.
     - Schematic electrical diagram.
     - External wiring diagrams.
     - Electrical diagram of analogue signal input (for CPI).
     - Electrical diagram of analogue signal output (for CPI).
     - Electrical diagram of discrete signal input (for CPI).
     - Electrical diagram of discrete signal output (for CPI).
   - Layout of optical cables.
   - cable list.
2. Task for manufacturing plant for each switchboard equipment(Boards: PC, PLC, CPI, CPIMS-5):
   - General view of each switchboard..
   - Technical data of devices.
   - Wiring diagram.
3. Specification of equipment and materials:
   - Name and technical characteristics,
   - Type, brand,
   - Code of equipment, product, material,
   - manufacturer,
   - unitofmeasuremen,
   - quantity.

ANNEX 5 About mathematical support

“TST-16”
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Approved
Director of
"TST-16" LLP, D.Eng.

_____ U. Tukeyev
«____»_____ 2017.

SSG Program on realization of Fostering Productive Innovation Project

Subproject “Automated system for online monitoring of incoming ore flow quality at concentrator”
(AS OMQO)

MATHEMATICAL SUPPORT

Annex 5 to Technical report

2017

«TST-16» LLP

Automated system for online monitoring of incoming ore flow quality at concentrator

AS OMQO

MATHEMATICAL SUPPORT

46301116-ATX.MO.M.3

Book 3

CommercialDirector **V.Yu.Akselrod**

2017

№	Legend	Title	Number of pages	Note
1	46301116-ATX.ТП.М.3	Book 3 content list	1	
2	46301116-ATX.МО.М.3	Mathematical support	132	

					46301116-ATX.ТП.М.3			
Rev.	Sheet	Doc.№	Signature	Date	"SSGPO" JSC			
Developed by		RassulovT.			*Automated system for online monitoring of incoming ore flow quality at concentrator* AS OMQO	Letter	Sheet	Sheets
Checked by		Korshunov P.					1	1
Compl-ce check		ZemlianskiyV.						
Approved by		Akselrod V.			Book3 content list	"TST-16" LLP Almaty		

Abstract

Keywords: mathematical support (MS), automated system (AS), functional structure of AS, technical support of AS, information support of AS, software of AS, techno-working project, test program of AS.

This document regulates the set of mathematical methods, models and algorithms used in the automated system of online input ore-flows quality monitoring of concentrator (hereinafter referred to as "AS OMIOQ "). The document was developed in accordance with requirements for documents content including mathematical support solutions as given in Section 7 of РД 50-34.698-90 and includes a general (consolidated) and block (detailed) description of algorithm for solving the online input ore-flows quality monitoring.

Mathematical support is designed in a scope sufficient to develop software. Developed algorithms are the initial data necessary for development of application software

For algorithm description there are used legends of requisites, signals, arrays, variables in accordance with designations adopted in "Information Support" document.

CONTENT

ANNEX 6 About application software

“TST-16”
LIMITED LIABILITY PARTNERSHIP

Approved
Director of
"TST-16" LLP, D.Eng.

_____ U. Tukeyev
«____»_____ 2017.

SSG Program on realization of Fostering Productive Innovation Project

Subproject “Automated system for online monitoring of incoming ore flow quality at concentrator”
(AS OMQO)

APPLICATION SOFTWARE

Annex 6 to Technical report

2017

«TST-16» LLP

Automated system for online monitoring of incoming ore flow quality at concentrator

AS OMQO

APPLICATION SOFTWARE

46301116-АТХ.ПО.М.4

Book 4

CommercialDirector **V.Yu.Akselrod**

2017

№	Legend	Title	Number of pages	Note
1	46301116-АТХ.ТП.М.4	Book 4 content list	1	
2	46301116-АТХ.ПО.М.4	Application software	237	

					46301116-АТХ.ТП.М.4			
Rev.	Sheet	Doc.№	Signature	Date	"SSGPO" JSC			
Developed by		RassulovT.			*Automated system for online monitoring of incoming ore flow quality at concentrator* AS OMQO	Letter	Sheet	Sheets
Checked by		Korshunov P.					1	1
Compl-ce check		ZemlianskiyV.						
Approved by		Akselrod V.			Book 4 content list	"TST-16" LLP Almaty		

Abstract

Keywords: software, automated system (AS), functional structure of AS, technical support of AS, information support of AS, mathematical support of AS, crushing section (CS), ore-preparation complex of concentrator (OPCC).

Automated system for online monitoring of incoming ore flow quality at concentrator (hereinafter referred to as "AS OMQO") is designed to automate the online monitoring of volumes and quality of ore flows entering the crushing section of ore preparation complex of concentrator (hereinafter referred to as "OPCC"):

- for online, real-time monitoring of ore quality (iron weight content) in separate compositions, with simultaneous summation of quality and volume of deliveries according to receiving bunker, mines and loading points.
- for information support of operational-production personnel of OPCC and other interested subdivisions with information on volume and quality of ore supply for processing, as well as information on the time of unloading of compounds and separatedumpcars (through the corporate network).

This document describes the software of the AS subsystem for online monitoring of quality of input ore flows at OPCC along multi-flow scheme.

The following sections are descibed:

- general description of subsystem algorithm,
- main elements of structure,
- general description of system functioning,
- description of algorithms of program modules (function blocks, functions),
- overview of program code of modules,
- flow-chart of software modules**.**

Information on technical and information support of AS OMQO is given in "Technical Support" and "Information Support" documents, respectively.

Algorithms developed and presented in "Mathematical Support" document are the initial data necessary for software development.

Structural and functional features of the system software are described, the necessary information is given about methods and means of development, the most complicated program and block codes and functions are commented on from the logical and mathematical points of view.

CONTENT