

**Main research and experimental test works, performed by  
ZAO “Mekhanobr Engineering” in 2004-2009**

#	Description of work	Customer	Accomplished results
<b>1. Base and noble metals ores</b>			
1	Pilot-scale and laboratory scale testing of semiautogenous and ball grinding processes on samples of the Gaiskoye deposit currently-mined and prospective ores, as well as the Letnee deposit copper-zinc ore	OAO “Gaisky MCC”	As a result of the semiautogenous grinding process pilot-scale testing and ball grinding laboratory-scale testing, conducted on samples of the Gaiskoye and Letnee deposits ores, Bond Work Index was determined with regard to semiautogenous and ball grinding of the ores in question. Bond Work Index values were used in calculations and choice of semiautogenous and ball grinding mills.
2	Development of the Process Regulation for the Feasibility Study, aimed at increasing the Gaiskiy MCC Concentrating Plant production capacity, based on the studies, performed by different organizations on the Gaiskoye deposit currently-mined ores and the Letnee deposit copper-zinc ores	OAO “Gaisky MCC”	Based on the studies, performed by different organizations, the Process Regulation for processing the Letnee deposit copper-zinc ores and the Gaiskoye deposit currently-mined ores has been developed. The flow sheets, processing regimes and metallurgical results have been proposed with respect to the both deposits ores dressing, the recommendations for the processing equipment installation have been given.
3	The flow sheet and reagents’ regime for processing the Gaiskoye deposit lower horizon ores have been made more specific for the purpose to develop the Process Regulation for the Concentrating Plant expansion Feasibility Study	OAO “Gaisky MCC”	As a result of the studies, performed on the 1.45% copper and 0.58% zinc ore sample, the Gaiskoye deposit ores processing flow sheet and reagents’ regime have been made more specific. With ore grinding to 80% -0.074 mm size, and applying sodium sulfide and zinc sulfate as depressors in bulk-selective flotation flow sheet with bulk concentrate regrinding to 90% -0.074 mm size, 15% copper concentrate with 85% copper recovery and 45% zinc concentrate with 32% zinc recovery were produced. Based on the obtained results, the Process Regulation for the Concentrating Plant Expansion to 8 million t/yr Feasibility Study has been developed.

4	Development of technology for processing the East Fyodorovo-Pansky massif (the East Chuarva area) low-sulfide platinum-metal ores	OOO "Central Kola Expedition "	The ores dressability studies were conducted based on only flotation and gravity-flotation flow sheets, the latter providing for higher results. With ore grinding to 50% -0.074 mm size, total recoveries were achieved: platinum – 86%, palladium – 85%, gold – 55%, copper – 81%, nickel – 50%. The produced joint gravity-flotation concentrate contained over 160 g/t of noble metals and over 3% of total copper and nickel content, and was suitable for pyrometallurgical treatment. On the basis of the studies, main processing equipment was chosen and tentative technical-economic estimate of capital investments was accomplished.
5	Development of technology for processing the Samarskoye (Nurkazgan) deposit copper ore with preparation of the Process Regulation for Design of the Concentrating Plant	TOO "Corporation Kazakhmys", Republic of Kazakhstan	Based on two copper-porphyrific ore samples, with copper represented by chalcopyrite, bornite and chalcocite, the technology has been developed, including grinding to 57-60% -0.074 mm size, copper sulfides flotation in limy medium with application of butyl xanthate and MIBC, with 1 <sup>st</sup> cleaner concentrate regrinding to 95% -0.074 mm size, followed by 2 cleanings. With that, copper recovery into 23-27% copper concentrate was 93%, recovery of gold – 60-62%, that of silver – 60-70%. On the basis of accomplished studies, the Process Regulation has been developed for Design of the Concentrating Plant.
6	The Process Regulation for the Talnakh Concentrating Plant Upgrade and Technical re-equipment Project	The "Norilsk Nickel Mine-and-Mill Complex" Transpolar Operation Unit	<p>The Process Regulation for the Talnakh Concentrating Plant Upgrade and Technical re-equipment Project was developed for the production complex processing blended high-grade Talnakh ores and the "Oktyabrsky" Mine cuprous ores (1<sup>st</sup> process flow); and for the production complex processing the "Komsomolsky" and "Skalistsy" Mines cuprous ores, as well as Talnakh disseminated ores (2<sup>nd</sup> process flow). The Process Regulation for the 1<sup>st</sup> process flow is based on the currently operating technology of the Talnakh Concentrating Plant. Based on the ore sample, provided by the "Norilsk Nickel Mine-and-Mill Complex" Transpolar Operation Unit, ZAO "Mekhanobr Engineering" conducted semiautogenous grinding process pilot-scale testing and ball grinding laboratory-scale testing with determination of respective Bond Work Index values. Regarding copper processing cycle, aeration parameters were revised, copper "head" flotation operation and 2<sup>nd</sup> copper concentrate cleaning were introduced; regarding nickel-pyrrhotine cycle, nickel "head" flotation operation was introduced and tailings gravity concentration by means of centrifugal concentrators was provided.</p> <p>In order to revise the 2<sup>nd</sup> process flow technology, the "Norilsk Nickel Mine-and-Mill Complex" Transpolar Operation Unit provided an ore sample from the "Mayak" underground mine of the "Komsomolsky" Mine for ZAO "Mekhanobr Engineering". This sample was used for semiautogenous</p>

			grinding process pilot-scale testing and ball grinding laboratory-scale testing with determination of respective Bond Work Index values. The stage-wise gravity-flotation ore processing technology was proposed, providing for bulk gravity-flotation concentrate production, followed by its separation into copper and nickel concentrates by the developed non-steaming technology, and with gravity concentrate separation from tailings by means of centrifugal concentrators. On the basis of the obtained data, the Process Regulation has been developed for the ores of the 1 <sup>st</sup> and 2 <sup>nd</sup> process flows.
7	Laboratory development of a processing technology for different ore types, providing for nickel content in copper concentrate within 0.5 % and maximum removal of sulfur and iron with dump tailings products	The “Norilsk Nickel Mine-and-Mill Complex” Transpolar Operation Unit	The studies were performed on the samples, provided by the “Norilsk Nickel Mine-and-Mill Complex” Transpolar Operation Unit with the view to develop the Process Regulation for the Talnakh Concentrating Plant Upgrade and Technical re-equipment Project. So, based on the ore sample from the 1 <sup>st</sup> process flow, with the purpose to produce copper concentrate with nickel content within 0.5%, the copper cycle flow sheet number of aeration operations was changed from two to five, number of cleanings was increased from two to four, dithionite and sodium sulfite mix was used instead of sodium bisulfite, and other improvements were introduced into the flow sheet. As a result, copper concentrate was produced with nickel content of 0.36% and copper content of 31.24%, copper recovery being 82.1%. These results were obtained on ore with nickel content of 1.93% and copper content of 3.63% (in the Process Regulation: 2.25 and 3.63%), and exceed the indicators, set in the Process Regulation (the metals’ content in concentrate being 1.02 and 28.6%, with copper recovery being 76.52%). In order to provide maximum removal of sulfur and iron with dump tailings’ products by increasing the rate of pyrrhotine depression, a combination of polyamine and sodium sulfite was used instead of reagent DMDK. Nickel concentrate was produced with nickel content of 10.05%, recovery being 78.08% (in the Process Regulation: 9.81 and 76.31%, respectively). Dump tailings yield was 71.58% (in the Process Regulation: 66.05%), with copper and iron recovery being 53.27 and 66.02% (in the Process Regulation: 47.28 and 55.3%). In total, based on the ore samples from the 1 <sup>st</sup> and 2 <sup>nd</sup> process flows, ultimate copper concentrate was produced with 0.45% nickel content.
8	Laboratory testing of blended high-grade Talnakh ores and the “Oktyabrsky” Mine cuprous ores processing technology, developed by	The “Norilsk Nickel Mine-and-Mill Complex” Transpolar Operation Unit	Laboratory testing of the processing technology, developed by ZAO “Mekhanobr Engineering” for production of copper concentrate with nickel content within 0.5% and maximum possible removal of sulfur and iron with dump tailings products, were conducted at the Talnakh Concentrating Plant laboratory on the ore sample from the 1 <sup>st</sup> process flow. Copper

	ZAO "Mekhanobr Engineering", conducted at the "Norilsk Nickel Mine-and-Mill Complex" Transpolar Operation Unit		concentrate was produced with nickel content of 0.45% and copper content of ~ 30%, copper recovery being 83%. Dump tailings yield was 75.13%, with sulfur recovery ~ 59% and that of iron ~ 71.2%. So, the earlier obtained indicators were verified.
9	Supplements to the Process Regulation for the Talnakh Concentrating Plant Upgrade and Technical re-equipment Project	The "Norilsk Nickel Mine-and-Mill Complex" Transpolar Operation Unit	On the basis of the performed studies with the view to produce copper concentrate with nickel content within 0.5% and maximum possible removal of sulfur and iron with dump tailings products, the Supplement to the Process Regulation for the Talnakh Concentrating Plant Upgrade and Technical re-equipment Project has been prepared.
10	Laboratory studies on blended high-grade Talnakh ores and the "Oktyabrsky" Mine cuprous ores processing technology improvement	ZAO "Mekhanobr Engineering"	Based on the ore samples from the 1 <sup>st</sup> process flow, studies were conducted with the view to increase nickel concentrate grade from 10 to 15%. The flow sheet was simplified in the copper flotation cycle, number of cleanings was reduced to two, rougher concentrate regrinding operation was introduced, a combination of dithionite, polyamine and sodium sulfite was used to increase the rate of pyrrhotine and pentlandite depression in copper sulfides flotation by butyl aerofloat. Copper concentrate was produced, containing 0.46% nickel and 30.2% copper, copper recovery being 86% (with nickel content of 0.8%, copper recovery is increased to 90-91%). An optimum ratio of "polyamine - sodium sulfite" was determined in nickel-pyrrhotine flotation cycle, nickel-pyrrhotine flotation feed regrinding was introduced, permitting to produce ~15% grade nickel concentrate, recovery being 76-77%, from ore, containing ~ 2% nickel. With that, dump tailings were produced with yield of 74-75%, sulfur recovery being 56-58%, that of iron – 70-72%.
11	Laboratory development of flotation technology for the Mikheevskoye deposit primary and supergene ore samples for PFS program	ZAO "Mikheevsky MCC"	Jointly with Eureka Mining company, studies were conducted with the view to develop processing technologies for primary ore, containing 0.62% copper, and supergene ore, containing 0.42% copper. The samples' material composition and grindability were studied. In the primary ore sample, copper is represented mostly by chalcopyrite, in supergene ore sample – with chalcopyrite by 67%, with secondary sulfides – by 5.7%, with malachite – by 20.5%, with allophone – by 7.1%. Primary ore one- and two-stage grinding flow sheets were studied, and, on the basis of scaled-up technical-economic estimate, one-stage grinding flow sheet was adopted, with grinding to 80% -0.15 mm, with rougher concentrate regrinding to 80% -0.053 mm size, and 2 <sup>nd</sup> cleaning concentrate – to 80% - 0.02 mm size. Primary ore flotation is conducted with application of amyl xanthate and modified thiocarbamate combination in limy medium and dosing frothers – pine oil and MIBC. Liquid glass and CMC (carboxymethyl

			cellulose) are dosed to cleaning operations. In supergene ore sample flotation, soda, liquid glass and sodium sulfide are additionally applied in rougher operations, sodium sulfide – in concentrate cleanings. On primary ore sample, copper concentrate was produced with 23-25% grade, copper recovery being ~ 84-86%, that of gold – 64-70%. On supergene ore sample, copper concentrate was produced with 25% grade, copper recovery being 50%, that of gold ~ 39%.
12	The Galmoenan deposit solid ore processing technology development	ZAO “KoryakGeolDobycha”	The ore gravity concentration flow sheet has been developed under pilot-scale conditions, using diaphragm-type jigs, Russian-made centrifugal concentrators ITOMAK and concentrating tables. Platinum recovery into high-grade concentrate (2%Pt) reached 87%, into low-grade (200 g/t Pt) – 5%. The facility technical-and-economic assessment was performed, showing its high profitableness.
13	The Yantarnoye and Zvyozdnoye deposits tin-complex ore material composition study and dressability determination	ZAO “Primorsky MCC”	The Yantarnoye and Zvyozdnoye deposits’ ore material composition was studied and dressability was determined. The Yantarnoye deposit ore sample, containing 0.4% copper and 0.42% zinc, less than 0.01% lead and tin, was processed by selective flotation flowsheet, producing copper concentrate with ~ 19% grade, recovery being ~ 86%, and zinc middling, containing 35% zinc, recovery being 33%. The Zvyozdnoye deposit ore sample, containing 0.25% copper and 1.24% lead, 2.32% zinc and 0.33% tin, was processed by bulk-selective flotation and selective flotation flowsheets, producing lead concentrate with ~ 40% grade, lead recovery being ~ 45%, zinc concentrate with 46% grade, zinc recovery being ~75%, and tin concentrate with ~ 6% grade, tin recovery being ~ 20%.
14	Development of recommendations for changing-over the Nikolayevskaya Concentrating Plant wet autogenous grinding mills WAG 70x23 to semiautogenous grinding regime	TOO “Corporation Kazakhmys”, Republic of Kazakhstan	Mills’ drums liners with overlay lifters, suitable only for operation in pure autogenous grinding regime, were replaced with special moulded liner elements with integrated plate and lifter parts. After installation of the above-mentioned liners on wet autogenous grinding mills WAG 70x23, the mills’ operating regime was changed and balls 100 mm in diameter were added. An optimum semiautogenous grinding regime with addition of 6% balls from the mills’ working volume was recommended. With that, the mills’ throughput rate was increased by 18% for the softest Yubileyno-Snegirikhinskaya ore and be 30% for the hardest Artemyevskaya ore, balls consumption being 0.5 kg/t of ore.
15	Development of copper-zinc ores processing technology and the Process Regulation for Design of Concentrating Plant of the Levikhinsky	ZAO “Russian Copper Company”	The Levikhinskoye deposit ore sample, containing 4.8% copper, 3.1% zinc and 41.7% sulfur, was studied with the view to develop ore processing technology. The ore sample material composition and grindability were studied by the methodology developed by Mekhanobr Engineering. The bulk-selective flotation and selective flotation technologies were

	Mining and Concentrating Complex		developed. The best results were obtained with selective flotation technology, including intercycle flotation of copper sulfides with 45% -0.074 mm size fraction, copper and zinc cycles rougher operations – with 70% - 0.074 mm size fraction, copper scavenging flotation concentrate re-grinding to 90% -0,074 mm size fraction. With regard to copper cycle, butyldithiophosphinate is used as collector, sodium sulfide and zinc sulfate – as depressors in limy medium; butyl xanthate, copper vitriol and lime are used in zinc cycle. Copper concentrate with 23.7% grade was produced, copper recovery being 92.6%, that of gold – 47%, and zinc concentrate with 47% grade, zinc recovery being 77%. On the basis of the obtained data, the Process Regulation for Concentrating Plant Design was developed.
16	Development of the Process Regulation for the Mikheevskoye deposit ore dressing	ZAO “Russian Copper Company”	In order to develop the Process Regulation, primary ore composite sample was studied, including pilot-scale testing of semiautogenous grinding process and laboratory testing with the view to develop the ore processing technology. The ore sample material composition was studied; copper content was 0.41%, represented essentially by chalcopyrite. On the basis of the pilot-scale testing data, Bond Work Index was determined with regard to semiautogenous grinding, and in laboratory testing of semiautogenous grinding products’ grindability – Bond Work Index was determined with regard to ball grinding. The developed technology includes semiautogenous grinding of primarily-crushed ore, ball grinding to 80% -0.013 mm, rougher concentrate regrinding to 80% -0.028 mm, 1 <sup>st</sup> cleaner concentrate regrinding to 80% -0.02 mm, application of amyl xanthate and modified thiocarbamate combination in limy medium, dosing of liquid glass into rougher concentrate cleaning operations. Copper concentrate with 20% grade was produced, copper recovery being 78%, that of gold – 55%. On the basis of the obtained results, the Process Regulation for the Mikheevskoye deposit primary ore dressing was developed.
17	Studies aimed at production of 20% grade copper and 50% grade zinc concentrates with maximum gold recovery from the Gaiskoye deposit ores. Development of the Process Regulation for Concentrating Plant Design correction	OAO “Gaisky MCC”	As a result of the studies performed on a representative ore sample, the Concentrating Plant Upgrade Feasibility Study flow sheet was enlarged, adding the operations of copper “head” concentrate cleaning, re-flotation of bulk concentrate cleaning tailings and removal of re-flotation tailings to dump; re-flotation of bulk flotation tailings sands fraction following its regrinding to 75-80% -0.074 mm; application of butyl xanthate and aerofloat IMA-414-1 combination. Using this flow sheet, copper concentrate with ~ 20% grade was produced, copper recovery being 83.8%; as well as zinc concentrate with 50% grade, zinc recovery being 42%. The flow sheet was assumed as a basis for the developed Process

			Regulation for Concentrating Plant Expansion Design correction.
18	Consulting services on the fundamentals of the state-of-the-art mineralogical analysis of ores and ore-dressing products	OOO "Sorsky ferromolybdenum plant"	A theoretical and practical training course was conducted, dedicated to determination of textural and structural specialties of different ores, macro- and micro-diagnostics of minerals, liberation of valuable minerals in ore processing, computerized quantitative mineralogical analysis of ores and ore-dressing products by means of the state-of-the-art microimage analyzer of Karl Zeiss (Germany). The trained specialists were acquainted with the present-day physical-chemical methods of ore studies: X-ray spectrum microanalysis and X-ray phase analysis.
19	Development of the Vostok-2 deposit North flank complex ore processing technology	OAO "Primorsky MCC"	Studies were conducted on the ore sample containing 0.93% copper, 1.15% zinc and < 0.1% tin, using bulk-selective flotation and selective flotation flow sheets. Copper concentrate was produced with ~ 20% grade, recovery being ~ 75%, and zinc concentrate with 46% grade, recovery being 40%.
20	Laboratory trial testing of technology, providing arsenic content decrease in copper concentrate produced at the Primorskiy MCC Concentrating Plant	OAO "AIR" Mining Company"	In order to decrease arsenic (represented by arsenopyrite) content in copper concentrate, a technology has been proposed, including concentrate regrinding to 90-95% -0.08 mm, arsenopyrite depression by combination of iron vitriol with sodium sulfite or sodium dithionite and depressor, possessing oxidizing properties; as well as rougher and scavenging flotation. With that, arsenic content decreases from 0.43 to 0.12-0.2%, with copper recovery being 97-98% from operation.
21	Development of the Process Regulation for construction of the Khandiza deposit complex ores Concentrating Plant	OAO "Almalyksky MCC" Republic of Uzbekistan	The ore sample material composition was studied, the sample contained 0.52% copper, 3.2% lead and 7.1% zinc. Copper was essentially represented by chalcopyrite, lead – by galenite, zinc – by sphalerite. As a result of performed studies, the flow sheet was developed, including copper-lead flotation, non-cyanide separation of copper-lead concentrate and flotation of sphalerite from copper-lead flotation tailings. Copper concentrate was produced with ~ 23% grade, recovery being ~ 77%, as well as lead concentrate with 45% grade, recovery being 72%, and zinc concentrate with 53% grade, recovery being 82%. On the basis of the performed studies, the Process Regulation for construction of the Concentrating Plant was developed.
22	The Fyodorova Tundra deposit ores floatability studies results analysis, and development of recommendations for the ore processing flow sheet	ZAO "Fyodorovo Resources"	The results of studies, performed by the Mining Institute of the Kola Regional Scientific Center of the Russian Academy of Sciences, the Chita laboratory SGS, OOO "PC+" and Cabri Consulting Inc. were reviewed. The insufficient scope of laboratory studies and pilot-scale testing, performed by the Mining Institute of the Kola Regional Scientific Center of the Russian Academy of Sciences, as well as poor reproducibility of experiments and the methodology imperfection of locked-cycle

	optimization		experiments, performed by the Chita laboratory SGS, were noted. The recommendations were given for the Fyodorova Tundra deposit ores processing technology optimization.
23	The Skrytoye deposit ore processing technology development	ОАО "AIR" Mining Company"	The studies for the Skrytoye deposit ores processing technology development were performed on the two ore samples: scheelite-carbonate and scheelite-quartz-amphibole. The samples were subjected to preliminary radiometric separation at ООО "Rados" with production of final dump tailings. The radiometric separation products' material composition and physical-chemical properties, crushability and grindability were studied, Bond Work Index values were determined. The radiometric separation products were processed by gravity-flotation flow sheet. In flotation, rougher concentrate, produced with application of oleic acid and depressors, was subjected to steaming with liquid glass, and to cleanings. In locked-circuit experiments with return water, run on scheelite-carbonate ore sample, that contained 0.47% of WO <sub>3</sub> after radiometric separation, scheelite concentrate was produced, containing ~ 57% WO <sub>3</sub> , recovery being ~ 62.7%; from scheelite-quartz-amphibole sample, that contained 0.43% of WO <sub>3</sub> after radiometric separation, scheelite concentrate was produced, containing ~ 60% WO <sub>3</sub> , recovery being 75.5%.
24	The Amurskoye deposit (the Chelyabinsk Region) East and West flanks zinc ores dressability studies on technological samples 1 and 2	ООО "Uralmedsoyuz"	The deposit East and West flanks ores' samples material composition was studied; the samples contained 4.23 and 1.38% zinc, respectively, essentially represented by sphalerite. The ores processing technologies were developed. The technologies' specific feature consists in addition of crushed ore desliming operations into flowsheets. From West flank ore samples, concentrate was produced with zinc grade ~ 54%, recovery being ~ 82.5%, from the East flank ore sample – concentrate, containing ~ 53% zinc, recovery being 69%. The produced concentrates met the requirements with regard to impurities content, except the concentrate from the West flank ore sample in which mercury content, as isomorphic component of sphalerite, was 1800 g/t.
25	Consulting services on application of the state-of-the-art research methods in mineralogical analysis of ores and ore-dressing products	ОАО "Uchalinsky MCC"	A theoretical and practical training course was conducted, dedicated to determination of textural and structural specialties of different ores, macro- and micro-diagnostics of minerals, liberation of valuable minerals in ore processing, computerized quantitative mineralogical analysis of ores and ore-dressing products by means of the state-of-the-art microimage analyzer of Karl Zeiss (Germany). The trained specialists were acquainted with the present-day physical-chemical methods of ore studies: X-ray spectrum microanalysis and X-ray phase analysis.

26	Laboratory-scale testing of Zhezkazgan Concentrating Plant-2 improved sulfide copper ore processing flow sheet with grinding to 60-70% -0.074 mm	TOO "Corporation Kazakhmys", Republic of Kazakhstan	The relationship between copper recovery and feed ore grinding size has been verified for different alternative flow sheets, with the optimum being close to 70% -0.074 mm. It was established that difference in copper recovery, with ore grinding size varying over the range from 52 to 70% - 0.074 mm size fraction, is 1.0-1.5%. This relationship is of linear character and may be used in calculations. The data, obtained by the technological research, are recommended to be taken into consideration in corrections of Concentrating Plant-2 flow sheets and regimes Upgrade Project. It is shown, that re-flotation of 2 <sup>nd</sup> cleaning tailings with addition of sodium sulfide and butyl xanthate permits to re-recover 70-85% copper into froth product per operation and increase copper recovery into final concentrate by 2%.
27	The Process Regulation for the Severny Katpar deposit ore processing	TOO "Severny Katpar", Republic of Kazakhstan	On the basis of the studies performed by the Kazakhstan Chemical-and-Technological Institute, KazIMS, the Kazakhstan Academy of Sciences Chemical-and-Metallurgical Institute, SredazNIProtsvetmet and Mekhanobr Engineering, the Process Regulation for the Severny Katpar deposit ores processing was developed with application of gravity-flotation flowsheet, the choice of main processing equipment was determined, the design-engineering aspects of water-supply, sampling, automatic process control, environmental protection and tailings disposal were finalized.
28	The Eruvayamsky gold-ore area gold-silver ores dressability studies on the ore samples 1 and 2	OAO "Kamchatgeologiya"	The gravity-flotation flow sheet has been developed for high-grade ores processing with application of jigs and centrifugal concentrators, permitting to produce gold "head" with gold content up to 27 kg/t, gravity concentrate (500 g/t Au) and flotation concentrate, containing 220-340 g/t Au. Total gold recovery – 95%, that of silver – 85%.
<b>2. Ferrous metals ores and industrial minerals</b>			
1	The Kostomuksha deposit ore overall iron re-recovery expediency estimate	OAO "Karelsky Okatysh"	The recommendations were given with regard to iron losses decrease by 1.5-2% per operation of the existing technology, including change of magnetic field intensity in wet magnetic separation stages, changes in desliming and demagnetizing regimes prior to classification operations, re-arrangement of the flow sheet units.
2	Pilot-scale testing at the thickening module with a view to determine the OAO "Karelsky Okatysh" Concentrating Plant tailings slurry clarification loads	OAO "Karelsky Okatysh"	Pilot-scale testing of Concentrating Plant tailings slurry thickening was performed at the thickening module. The testing results permitted to recommend Supaflo thickeners as most efficient in tailings thickening, permitting to decrease slurry flow rate, discharged into Tailings Storage Pond, by the factor of 8, and decrease the tailings disposal and return water costs by the factor of 2.

3	Study of flotation technology for production of magnetite concentrates with silica content within 3%, performed at the OAO "Mikhailovsky MCC" pilot-scale installation	OAO "Mikhailovsky MCC"	For the first time in Russia, pilot-scale testing were performed with the view to produce high-grade iron concentrates for sintered pellets with application of SRT Cominco column flotation machines. The Process Regulation for Design of production section with capacity of 8 million t /yr of high-grade concentrate was developed. At present time, the developed technology has been introduced at the OAO "Mikhailovsky MCC" with the view to produce high-grade iron concentrates for sintered pellets.
4	Laboratory and pilot-scale development and testing of technology for hematite concentrate production from the OAO "Mikhailovsky MCC" Concentrating Plant wet magnetic separation tailings	OAO "Mikhailovsky MCC"	The OAO "Mikhailovsky MCC" Concentrating Plant tailings magnetic-flotation processing flow sheet was developed and tested at pilot-scale installation. Magnetic separation was conducted on high-gradient magnetic separator 6ERM-70M, flotation – in SRT Cominco column flotation machine, classification – on fine screens. Concentrates with 62.7% iron grade were produced from the Concentrating Plant tailings with 28.2% iron grade. Additional recovery of iron into the Plant concentrate (without re-processing of middlings) was 6.6-7.0% from feed ore.
5	The AO "Sokolov-Sarbay Mining-and-Production Amalgamation" raw-material base development scheme for 20-year period	"RGP "The Republic of Kazakhstan National Center for minerals all-round utilization""	The AO "Sokolov-Sarbay Mining-and-Production Amalgamation" raw-material base development scheme for 20-year period has been worked out, showing real long-term perspective for the Mining Complex operation with profitability and product range increase (production of concentrates with 68.5-70% iron grade, sintered pellets and briquettes). The required scope of the existing operations upgrade and technical-and-economic performance indicators, with regard to the upgrade stages and years of operation with the Mining Complex capacity of 35-40 million t /yr by ore, were determined.
6	Study of the Tha-Khe (Vietnam) deposit iron ore dressing on 3 samples for preparation to metallurgical process stage	OAO "Giproruda Institute"	Studies were performed with the view to decrease zinc content in ore (0.06-0.067%) by physico-mechanical, chemical methods, sintering and oxidizing roasting of pellets. High-grade iron concentrates production technology was developed with the view to produce sintered pellets (with non-limited zinc content), followed by direct reduction of sintered pellets to sponge iron by Midrex or Corex methods. An Alternative was also proposed to use Tha-Khe iron ore in blast furnace, when "mixed" with iron ore with low zinc grade from other Vietnamese deposits or with imported ore. The Process Regulations were developed with respect to the above alternatives, providing for Tha-Khe iron ore preparation to metallurgical process stage.

7	Technical appraisal (audit) of the OAO "Korshunovsky MCC" with development of technical proposals for the processing flow sheet improvement	OAO "Mechel Steel Group "	Shortcomings were revealed, decreasing the Plant operating efficiency, and two Stages were developed for the Plant technical re-equipment and upgrade. The first Stage includes equipment upgrade and stage-wise production of concentrates with application of fine screening; the second Stage – autogenous grinding, due to high content of clay in feed ore. At present time, the Plant is implementing the recommendations of the first Stage.
8	Development of flow sheet for nepheline concentrate production from the Umbozerskaya Concentrating Plant dumped tailings	OAO "Sevzapprom"	Based on the sample, selected from the Plant Tailings Storage Pond, and containing ~33% nepheline, 41% feldspar and 21% aegirite, the technology was developed, with the view to produce nepheline concentrate with soluble Al <sub>2</sub> O <sub>3</sub> content of 28.5-29.0%. The technology includes cation flotation or cation flotation in combination with high-intensity magnetic separation. Al <sub>2</sub> O <sub>3</sub> recovery was ~51-53%.
9	Study of two iron ore samples with the view to obtain data for designing crushing-and-sizing plant in the Union of Myanmar (Burma)	GP "Tyazhpromexport"	Ore-preparation flow sheets were developed and calculated with subsequent application of Romelt technology at metallurgical processing stage, with preparation of Design documentation
10	Development and testing of improved flow sheet for hematite concentrate production at OAO "Olkon"	OAO "Olkon"	Two technologies of hematite concentrate production have been developed: one providing for hematite concentrate production from wet magnetic separation tailings after separation of magnetite, this technology includes wet magnetic separation in weak and strong field, as well as gravity concentration in screw-type apparatuses; the other technology provides for hematite recovery from tailings of jigging machines that separate hematite by the presently operating technology. The technical-and-economic assessment showed that the second technology is more economically sound, providing for 14.4% increase of hematite iron recovery into concentrate that contains 59.5% iron.
11	Laboratory studies with the view to develop technology for processing the Krupeli deposit quartz sand to produce grade VS-040 product, as well as to prepare background data for Design development	ZAO "Rosin"	The studies were conducted on the quartz sand sample, taken from the Luzhsky MCC cell. Sand processing technologies with application of dry and wet methods were developed. The technical-and-economic assessment showed that the "dry" technology is more economically sound, permitting to produce sands of grade VS-040-1 with iron content of 0.036%, product yield being 86.8%. The technology is based on -0.5+0.1 mm size fraction removal by pneumatic classification and screening, and removal of iron-containing ingredients by means of magnetic separation in weak and strong field. Input data were prepared for designing quartz sand

			processing plant.
12	Technical proposals for crushed stone production at OAO "Karelsky Okatysh" operations	OAO "Karelsky Okatysh"	The flow sheets and List of main equipment (Russian-made and produced by Sandvik) were prepared with respect to crushing-and-screening plants producing cube-shaped crushed stone of -60+20 mm and -20+10 mm size fractions with capacity of 318000 t/yr.
13	Studies on the OAO "Kachkanarsky MCC" "Vanadiy" thickeners overflow clarification	OAO "Kachkanarsky MCC" "Vanadiy"	Three operating thickeners were subject to study and analyses. The recommendations were given for distribution of water-wash from Sinter plant and Pellet plant between the thickeners, as well as improvement of operating regimes of hydrocyclones and classifiers, treating Pellet plant water-wash prior to thickening. The possibility to reduce losses in thickeners overflow by the factor of 3 was demonstrated.
14	The Kovdorsky MCC processing flow sheet performance indicators' corrections related to joint processing of ore and dumped tailings	OAO "Kovdorsky MCC"	As a result of the processing technology upgrade and reduction in number of equipment items, if compared with the Design flow sheet, power inputs were reduced by ~ 20% and marketable products quality was improved. Iron fraction of total mass is 64%, that of phosphorus – within 0.12%, iron recovery being over 90%. Apatite flotation reagent regime improvement permitted to increase concentrate grade to 38% P <sub>2</sub> O <sub>5</sub> .
15	Ore-preparation and concentration processes upgrade with the view to increase production, improve performance indicators and reduce concentrate production cost at OAO "Karelsky Okatysh"	OAO "Karelsky Okatysh"	The proposals were developed with the view to increase crushing, grinding and concentrating stages efficiency, raising the plant capacity to 30-33 million tons of ore per year and improving concentrate grade to 71% Fe, with reduction of concentrate production cost by 10%. The technology for dumped tailings and currently produced tailings processing with additional production of 1 million tons of concentrate per year was proposed.
16	Development of crushed ore dry magnetic separation technology and flotation technology, aimed at OAO "Karelsky Okatysh" concentrate grade improvement, with estimate of investments required for realization of these technologies	OAO "Karelsky Okatysh"	The obtained results demonstrated advisability of dry magnetic separation integration into the operating technology at material size of 70-16 mm or 20-0 mm with separation of 10-15% dumped tailings, permitting to decrease operating costs at the Plant and increase concentrate grade by at least 0.5% Fe.
17	The Process Regulation for OAO "Karelsky Okatysh" crushing-and-concentrating	OAO "Karelsky Okatysh"	The Process Regulation of 2008 was developed on the basis of multi-alternative try-out of technology for processing Kostomuksha quartzite with consideration of this mineral dressability and physico-mechanical

	Complex Design		<p>characteristics, and application of a new-generation processing equipment.</p> <p>The Process Regulation provides for capacity increase to 33 million tons of ore per year, concentrate grade increase to 68.5-71%, reduction of the Plant power consumption by 15 %.</p>
18	Preliminary estimate of expediency of high-grade concentrate production for subsequent production of DR pellets from the Kostomuksha deposit ore	ОАО "Karelsky Okatysh"	<p>High-grade concentrates production Alternatives were considered, suitable for production of sintered pellets of DR grade from the Korpanga deposit ore, as well as by means of final concentration stage of current ore blend with application of fine screening, reduction of final grinding size, gravity processing and flotation. It is shown that the least capital-intensive are the Alternatives with application of fine screening and local processing of the Korpanga deposit ore.</p>
19	Full-scale testing at ОАО "Karelsky Okatysh" Plant sections with the purpose of achieving the planned flowsheet Upgrade performance indicators	ОАО "Karelsky Okatysh"	<p>Full-scale testing, conducted at the Plant in 2009, permitted to determine the operating technology potential and showed the possibility of producing concentrates with iron grade 69.5-70.5% by means of the currently operating magnetic flow sheet, without flotation, annual capacity being 33 million tons of ore.</p> <p>The concentrate qualitative characteristics meet the Customer's requirements, metal losses in tailings do not exceed 2.25%.</p> <p>The optimal Alternative is production of concentrate with iron grade 70.5% through correction of the currently operating technology regimes, the section throughput rate being 297 t/hr. Pay-back period of capital investments is 1.4 years.</p>
20	Ore-preparation processes upgrade at ОАО "Olkon" with the view to decrease concentrate, power inputs and main materials costs, increase marketable concentrate grade and produce additional marketable product from dumped tailings.	ОАО "Karelsky Okatysh"	<p>Jointly with the plant specialists, the plant operating production flow sheet was subjected to technical appraisal (processing audit) from feed ore to marketable concentrate, the flow sheet "bottle-neck" points were determined, concrete concepts for the flow sheet upgrade were developed, including ore blend grade control, new arrangement-and-layout solutions, introduction of fine screening operation with the view to increase concentrate grade to 67.5-70%, re-processing and the plant tailings thickening.</p>
21	The Bakalskoye deposit siderite ore dressability pilot-scale testing with comparative analysis of different preliminary processing methods'	ООО "Bakalskoye Operation"	<p>The extensive ore dressability pilot-scale testing were performed on different flow sheets with application of X-ray radiometric separators, jigging machines, DMS, table concentrators, screw separators, as well as dry and wet magnetic separators with different field intensity. The technical and economic assessment of six alternative flow sheets permitted to recommend the Alternative flow sheet with DMS processing of -100+6 mm</p>

	technical and economic effectiveness.		size fraction and magnetic separation of -6+0 mm size fraction, providing for total recovery into concentrate at the level of 93%, with minimal water consumption and Tailings Storage Pond holding capacity.
22	Studies with the view to produce nepheline concentrate with Al <sub>2</sub> O <sub>3</sub> grade at least 28.5% from apatite flotation cell product with increased feldspar content	OAo "Apatite"	A combination technology has been developed for apatite flotation tailings processing, including high-intensity magnetic separation with the purpose to remove aegirite, and cation flotation for the purpose to decrease feldspar content in nepheline concentrate. The technology permits to produce nepheline concentrate with Al <sub>2</sub> O <sub>3</sub> grade at least 28.5%, recovery being 45.2%, with a high feldspar content (13.1%) in run-of-mine ore.
23	The "Lebedinsky MCC" magnetite concentrates production technology development, providing for 71.5% iron and 1.0% silica content in concentrates.	OAo "Lebedinsky MCC "	A technology has been developed for production of magnetite concentrate with 71.5% iron grade and 1.0% silica, iron recovery from starting concentrate being 94.6%. The recommended flow sheet includes reverse cation flotation, regrinding and wet magnetic separation of middlings with magnetic product recirculation to rougher flotation. The studies were conducted on the "Lebedinsky MCC" reclaim water.
<b>3. Diamond ores</b>			
1	DMS technology development for diamond ores of the deposit named after V.Grib	ZAO "Arkhangelskgeologorazvedka"	The laboratory and pilot-scale dense medium testing of diamond ores dressability permitted to develop an efficient processing flow sheet, to choose main processing equipment and perform the technical and economic assessment of the ore processing stage. With the ore final grinding size of 3 mm, diamonds recovery at level of 98% was achieved, with gravity concentrates yield being about 1.2%.
2	The OAo "Severalmaz" pilot-scale testing of tailings slurry thickening and the Tailings Storage Pond return water clarification with application of flocculants	OAo "Severalmaz"	As a result of conducted pilot-scale testing, it was recommended to add flocculants to -0.2 mm size slime fraction of tailings slurry immediately prior to slimes discharge into the Tailings Storage Pond, providing for slurry thickening from 17 to 30% solids and return water clarification to solids content below 5 g/l.
3	Jigging machine operation study and the Process Regulation development with recommendations for provision of on-stream control and jigging process control	Catoca Operation, Angola	MO-212 jigging machines operation specialties were studied at commercial-scale level. The machines maximum throughput rate and optimal operating regime were determined, permitting to develop the Process Regulation for the jigging section. The recommendations for provision of on-stream control and MO-212 jigging machines control were given, providing for diamonds recovery into jigging concentrate at the level of at least 99%.
4	The V.Grib deposit three main ore types disintegration processes study in scrubber	ZAO "Arkhangelskgeoldobycha"	The three main ore types were subjected to pilot-scale testing on "scrubber-autogenous grinding" and "autogenous grinding" flow sheets. The equipment operating parameters, specific energy consumption per

	and autogenous mill with subsequent determination of washed -1 mm size fraction thickening conditions and tailings disposal design parameters.		operations and Bond Work Index for autogenous grinding process were determined. Preliminary calculations of grinding equipment and washing equipment were carried out. Laboratory thickening experiments were performed on -1 and -0.2 mm products, obtained at the pilot-scale installation, regarding all ore types, with and without flocculants. It was established, that the best thickening results were achieved with -1 mm size with application of flocculants. The recommendations are given with regard to flocculants types and dosage, providing ~ 50% solids content in thickened product and < 0.5 g/l in overflow with respect to different ore types. Tailings disposal design parameters were determined.
5	The V.Grib deposit ore types dressability and physical-mechanical characteristics study with the view to obtain data for the Process Regulation development	ZAO "Arkhangelskgeoldobycha"	The extensive studies were performed under laboratory conditions on 300 core material samples and pilot-scale conditions on more than 500 large samples of 8.3 ton each, disintegrated in scrubber, jaw and roll crushers with production of -15+1 mm product size fraction and -3+0 mm final dump tailings. By means of DMS, concentrate with yield of 1% of feed ore was produced, and subsequently processed on XRF separators, rougher XRF concentrates were subject to hand sorting. All data required for development of the Process Regulation for processing the three different ore types were obtained. Diamonds recovery at the level of 98-99% was achieved.