В СОСТАВЕ ИЗДАНИЯ:
Second edition, Monograph,30
MINERAL RESOURCE AND ORE RESERVE ESTIMATION
THE AUSIMM GUIDE TO GOOD PRACTICE

Австралийский Институт: AusIMM The Minerals Institute

Resource and Reserve Valuation Practices in CIS Countries

H Arden and A Tverdov

Contact author:

Full name:	Hakan Arden
Position title:	Principal Geologist, Project Manager
Organisation Name:	IMC Group Consulting Ltd
Address:	10 Grosvenor Gardens, London SW1W 0DH, United Kingdom
Phone:	+44 20 7824 1925
Fax:	+44 1623 729 359
Mobile:	+44 7870 689076
Email:	Hakan.Arden@imcgcl.com

Contributing authors:

Full name:	Andrey Tverdov
Position title:	Head of mining development, Project Manager
Organisation Name:	IMC-Montan, Russia
Address:	Moscow, Chayanova St 22 Build 4, Russia
Phone:	+7 499 250 67 17
Fax:	+7 499 251 59 62
Mobile:	+7 910 458 77 28
Email:	Andrey.Tverdov@imcgroup.ru

Resource and Reserve Valuation Practices in Russia and CIS Countries

ABSTRACT

Russia has increasingly become one of the most important centres for the activities on raw commodity assessments in the recent years due to its enormous resources spread out over a huge territory. As Russia is rapidly closing the gap between the requirements of the internationally accepted codes and its own resource assessment standard, the practical reality is that the legacy of the Soviet Union for the assessment of resources is still active and alive today. However, this does not mean the requirements of the old Soviet system, now the Russian system, are redundant or unacceptable to the codes seen in the international scenery; but it is rather a descriptive and useful tool which guides the competent persons and practitioners in a well prescribed way when they are assessing the mineral resources in Russia. As the old Soviet standard has also been adopted into the national legislations in the other former Soviet Union countries similar to the current Russian system, the Russian code has become an important element in reconciliation of the resources in accordance with the criteria defined in the internationally recognised codes for Reporting Mineral Resources and Ore Reserves such as JORC. This article reviews the experience of IMC in resource estimation in both Russia and neighbouring CIS countries in compliance with both the national code and international codes, and the related issues and obstacles faced and dealt by the competent persons.

INTRODUCTION

The raw commodities in Russia have always been treated as strategic national assets owned collectively by the people and its legal representative by the State. This is also due to both the development history of the Russian system of mineral resource estimation and the Russian Constitution that specifies state monopoly of sub-surface ownership. For this reason, very strict rules and controls have been in place to ensure that resources have been beneficiated in a maximum way for the benefit of the nation. A set of standards under the Russian National Standards (GOST), as well as many state regulations, were allocated for this purpose on how the resource characterisation should be conducted according to the prescribed methodology at every level. This means that the system is based on well defined criteria for every activity in the assessment process leading into the final outcome for the allocation of resources and reserves into appropriate category without any subjectivity.

As the current resource and reserve assessment system has been inherited from the Soviet Union, many of its fundamentals are still resonating this legacy. This means that the companies interested in extracting raw materials have to go through a well described system which is tiered into several layers of assessment process to delineate and beneficiate the mineralisation in the ground. Each of these layers is controlled by independent state organisations to ensure that the mineralisation boundaries are well defined and the use of resources is maximised to its optimum.

As the Russian economy is effectively providing a significant portion of the raw commodities into the world economy, it is important for the western companies to understand how Russian resource system operates and what the similarities and differences are between the Russian system and internationally accepted codes such as JORC.

It must also be noted that Russia too has become a member of CRIRSCO (Combined Reserves International Reporting Standards Committee) in 2011 which is the umbrella organisation for well known standards such as JORC and NI43-101. The Russian national code (the "NAEN Code") has now been developed by the Society of Experts on Mineral Resources (OERN, a component body of NAEN), in close co-operation with the State Commission on Reserves (GKZ) and with members of CRIRSCO (CRIRSCO - NAEN, 2011). The NAEN Code is modelled very closely upon the CRIRSCO Public Reporting Template.

STAGES OF GEOLOGICAL AND ECONOMIC EVALUATION OF RESOURCES IN RUSSIA AND CIS COUNTRIES

Russia and other CIS countries use, by law, the classification system and estimation methods for reserves and resources established by the former Soviet Union. In practice, this means that the statements of reserves and resources developed by the mines and the mining plans to which they relate must be submitted for approval to the corresponding committees of the Government Authorities. Adherence to the standardised national system of reserves and resources estimation is mandatory.

Geological exploration and development of mineral deposits in Russia and CIS countries is licence-based that grants the private sub-surface users the exploration and mining rights within the concession areas. The licences are generally issued for 20-25 years (subject to extension) based on open-tender or auction results. There are three types of licences: geological exploration, production of minerals, and both production and sub-soil exploration. Geological and economic evaluation of sub-surface should be in compliance with criteria and requirements set by the federal agency for management of the State subsurface fund regulating procedure and methodology of evaluation work.

Regulatory documents in this system provide clear criteria for borehole grid spacing and deposit complexity to classify the deposits. These detailed procedures are also extended to technical and economic evaluation of the deposits. The latest edition of the Russian classification system specifies even the numerical values of requirements for possible confidence levels in estimation of geological parameters characterising a reserve.

The Russian system serves a number of purposes ranging from taking mineral resource inventories, to statistical reporting and estimation of mineral extraction taxes, to some other state regulatory objectives. Due to its transparent and unambiguous nature in categorising the reserves, the Russian system in many respects is particularly an ideal one for a geologist as it clearly characterises both resource and economic potential of the deposits from the Russian perspective. In essence, it is a package of documents collected at various stages of geological and economic study of the deposit

which describes and evaluates the deposit's geological features and mining characteristics thoroughly in detail.

Each stage of geological exploration is related to a certain technical and economic evaluation describing the most efficient and safe mining methods and corresponding production of optimum saleable products. General framework of the geological characterisation for any mineral deposit is given in Table 1.

Table 1 General framework of Geological Characterisation of Mineral Deposits

Study stage	General Task	Scope of work and deliverables
Stage I - Common geological and mineralogical work	Regional geological study of sub-surface and prediction of mineralisation	Regional geological and geophysical survey. Identification of promising sites for prospecting
Stage II - Prospecting and evaluation of deposits	Greenfield exploration	Exploration of basins, ore districts, fields etc. through geophysical surveys, single boreholes and workings. Estimation of prognostic P_1, P_2, P_3 resources. Technical and economic considerations of ore occurrence prospects.
	Prospecting (including preliminary exploration)	Geological survey of a prospective deposit at a far-spaced grid of boreholes and workings. Evaluation of general parameters of the deposit, configuration and size of ore bodies, technological properties of ore, hydrogeological conditions etc. Qualitative and quantitative evaluation of prognostic P_1 resources, C_1 and C_2 resources. Technical and economic report or technical and economic proposals. Technical and Economic study (TEO) of provisional cut-off parameters and recording reserves on the state balance.
Stage III - Deposit exploration and development	Detailed exploration	Drilling of a closely-spaced borehole grid sufficient for the most detailed study of geological and technological properties of ore and the most accurate estimation of the economic potential of the deposit. Classification of A, B, C_1 and C_2 reserves. Technical and Economic Study (TEO) of final cut-off parameters with GKZ re-approval of reserves on the state balance.
	Mine operations	Operational exploration in the process of mining operations aimed at detailed study of the sub-surface required for current mine planning. Development of operational cut-off parameters.

Some stages of geological and economic evaluation of the deposit in the above table are not mandatory and can be by-passed in certain circumstances. In particular, development of operational cut-off parameters is at the initiative of the sub-surface user due to the reasons related to the general circumstances, for example significant changes in general economic conditions, important change in original geological information based on advanced operational exploration and deposit development or the need to introduce new machinery and technology for the operations. In some cases provisional cut-off parameters may also be adopted by analogy with neighbouring deposits without a tailored technical and economic analysis due to similarities present.

HISTORICAL DEVELOPMENT OF RESOURCE AND RESERVE ASSESSMENT IN RUSSIA AND ITS GENERAL PRINCIPLES

In pre-revolutionary period and until the 1930s of the last century, Russia/Soviet Union used a system of reserve classification based on explicit verbal expression of the categories broken down into actual, probable and potential classes. Division into these categories was not accompanied by clear-cut criteria for classification of reserves, which brought about arbitrary interpretation of available reserves. For this reason in the early 1920s, a special commission at the USSR Geological Committee started work aimed at development of criteria describing the deposits more clearly, both in terms of precise geological information and their economic significance. As a result of discussions in 1928, the Geological Committee adopted a reserve evaluation system based on using letters. In this system, the reserves were classified into letter categories on the basis of geological knowledge and their economic use: A_1, A_2, B, C_1, C_2. It should be noted that substitution of verbal categories for letter-base classes was proposed as early as 1910 at the 11^{th} session of the International Geological Committee in Sweden.

Later the Russian system of classification was repeatedly revised with a view to improve reference to geological knowledge and economic significance of deposits. Alongside with refining and improving the system of reserve classification, the work was undertaken to develop regulatory and legal documents, instructions and guidelines for estimation of reserves for deposits of various types and complexities.

As a result of these revisions, the basic principles of the reserve classification system currently in operation in Russia had been formed by 1981. The latest revision of the classification took place in 2008. According to this system, a mineral deposit is defined as natural or man-made concentration of a mineral, development of which may bring about economic benefits. In its turn the term “reserve” covers “identified quantity of a mineral”, part of which may be extracted economically into six categories: explored (solid mineral reserves of categories A, B, C_1) and pre-evaluated reserves (C_2), and prognostic resources (P_1, P_2, P_3) based on the degree of reliability of exploration data. A brief description of the categories is given in Table 2. In addition, every ore deposit in Russia and CIS countries is also grouped according to their complexity in a numbering system ranging from I to IV (III for coal deposits) (Table 3).

Under this classification system and current reporting regime, reserve categories are allocated based on a set of Conditions for Estimation of Reserves prepared as part of the exploitation licence for each mineral deposit by the corresponding special professional organisations (institutes, engineering organisations, etc.) and are approved by the State supervisory authorities.

Table 2 Reserve Categories in Russian and CIS Systems

Category	Description
A	Deposit is known in detail, boundaries of the deposit have been outlined by trenching, drilling, or underground workings. Quality and properties of the mineral are known in sufficient detail to ensure the reliability of the projected exploitation.

B	Deposit has been explored but is only known in fair detail, boundaries of the deposit have been outlined by trenching, drilling, or underground workings. Quality and properties of the mineral are known in sufficient detail to ensure the basic reliability of the projected exploitation.
C_1	Deposit has been estimated by a sparse grid of trenches, boreholes or underground workings. The quality and properties of the deposit are known tentatively by analogy with known deposits of the same type and the general conditions for exploitation are known tentatively. This category includes resources peripheral to the boundaries of the A and B category and also reserves allocated in complex deposits in which the mineral distribution cannot be reliably determined even by a very dense grid.
C_2	Extent of the deposit has been extrapolated from limited data. This category includes resources adjoining areas designated as A, B, and C_1 in the same deposit.
P_1	Resources in the P_1 category may extend outside the actual limits of the mineral reserves defined in the C_2 category. The outer limits of P_1 type resources are determined indirectly by extrapolating from similar known mineral deposits in the area. P_1 is the main source from which C_2 reserves can be increased
P_2	These resources represent possible mineral structures in known mineral deposits. They are estimated based on geophysical and geochemical data. Morphology, mineral composition and size of the mineralisation is estimated by analogy with similar mineralised geological structures in the area.
P_3	Potential for discovery of a deposit of any type of mineral on the basis of favourable geological and indicative pre-conditions found in the prospective area by undertaking medium to small scale geological and geophysical surveying, satellite image interpretation and analysis of geophysical and geochemical survey results.

Table 3 Classification of Deposits According to Their Complexity

Complexity Type	Description
I	Large deposits, simple in form with uniform distribution of minerals. The highest confidence classes of reserves, A + B reserves, can be established on the basis of boreholes, trenches and trial pits.
II	Large deposits with variable and sometimes complicated forms and an uneven distribution of minerals. Only B and C_1 reserves may be defined based on exploration data, such as boreholes, trenches and pits, and higher confidence reserves classes can be established only by a combination of closely spaced boreholes and active exploitation.
III	Deposits are smaller in size with uneven distribution of minerals (examples include vein-hosted or pegmatite deposits, skarns and dykes). Only C_1 and C_2 reserves may be defined based on exploration data and higher confidence reserves classes can be established only on the evidence of operational experience.
IV	Complex geological structure with small or rarely medium-sized ore bodies with exceptionally uneven mineralisation or characterised by sharp variations in thickness and internal structure, extremely uneven mineral quality or grade, and intermittent concentrations of the main useful constituents. Deposits of this group are explored primarily to Russian Resource category C_2, with confirmation of reliability of their estimation, in areas of detailed study, at category C_1.

Upgrade to C classes from P requires additional data (typical “modifying factors” such as geotechnical, economic, pit design, etc.) whilst C_1, B, and A classes require completion of a prefeasibility/feasibility study which is generally called the TEO of “conditions” (technico-

economicheskoye obosnovaniye kondicy = technical-economic justification of minimum parameters). The publication of data in the above classes requires audit and registration by an independent organisation i.e. GKZ (Gosudarstvenaya Komisiya po Zapasam) = State Commission on Reserves at national level or TKZ (Teritotorialnaya Komosiya po Zapasam) = Territorial Commission on Reserves at regional level. Experts' opinion from these organisations will be completed by a group of highly qualified specialists in various disciplines including geology, mining, environment, processing, hydrogeology, economics etc. In the course of preparation of GKZ experts' opinion, experts may introduce changes into the TEO of "conditions" related to mining technology, processing solutions as mistakes may be found in interpretation of geological data, projection of the cash flow model etc. As a result, the changes may touch upon both the reserves classified into a different category hence their balance status being re-calculated.

The TEO document is a very comprehensive and detailed one and covers not only the geological and technical/technological assessment and economical evaluation of the deposit in question for different cut-off parameters, but also checking the suitability of the various aspects of the chosen mining methodology for the current health and safety legislations and procedures in place. Economic assessment typically investigates the different cut-off parameter options defined from the geological and technological perspectives under the headings of: analysis of market and economic environment and taxation issues, operational cost and production cost and product sales, capital costs, floating capital investments, profitability, discount rate, net cash flow and net present value, internal rate of return as well as indicators of the commercial effectiveness of the project.

The main distinctions between these documents are what they are aimed at. If the main criterion in development of Pre-feasibility and Feasibility Studies is investment attractiveness of the deposit, in some cases even to the detriment of the reserve quantity, a TEO of "conditions" shall justify solutions implying maximum full recovery of reserves with a view to satisfy the balance of interests of the state and of the sub-surface user.

With reference to these conditions, the reserves stated for each deposit are further categorised as "balance reserves", which means they meet the pre-determined criteria for economically justifiable extraction, or are "out-of-balance resources" considered to be uneconomic to exploit at the moment, but can be economic in the future potentially. Another category of reserves under the current system is the "industrial resources/reserves" which are the "balance reserves" after adjustments for all operational losses. In their turn industrial reserves taking account of dilution (contamination) form exploitation reserves characterising commercial significance of the deposit fully. Estimation of both industrial and exploitation reserves is made at the TEO of "conditions" stage and at more "Detailed Engineering" phase.

It is important that any resource must be approved by GKZ or TKZ before any mining is allowed. Therefore, the cut-off parameters document plays a crucial step in the finalisation of the approval of the reserves. GKZ/TKZ approval also includes transfer of reserves to the national mineral inventory or the state "balance" of reserves. The former Soviet system places all the available mineralisation in

the ground as a reserve based on the cut-off parameters defined and does not make any distinction between the resource and reserves.

Typical flow of exploration and deposit characterisation as well as the related technical and economic studies in relation to exploitation of the reserves in Russia and CIS countries is given in Figure 1.

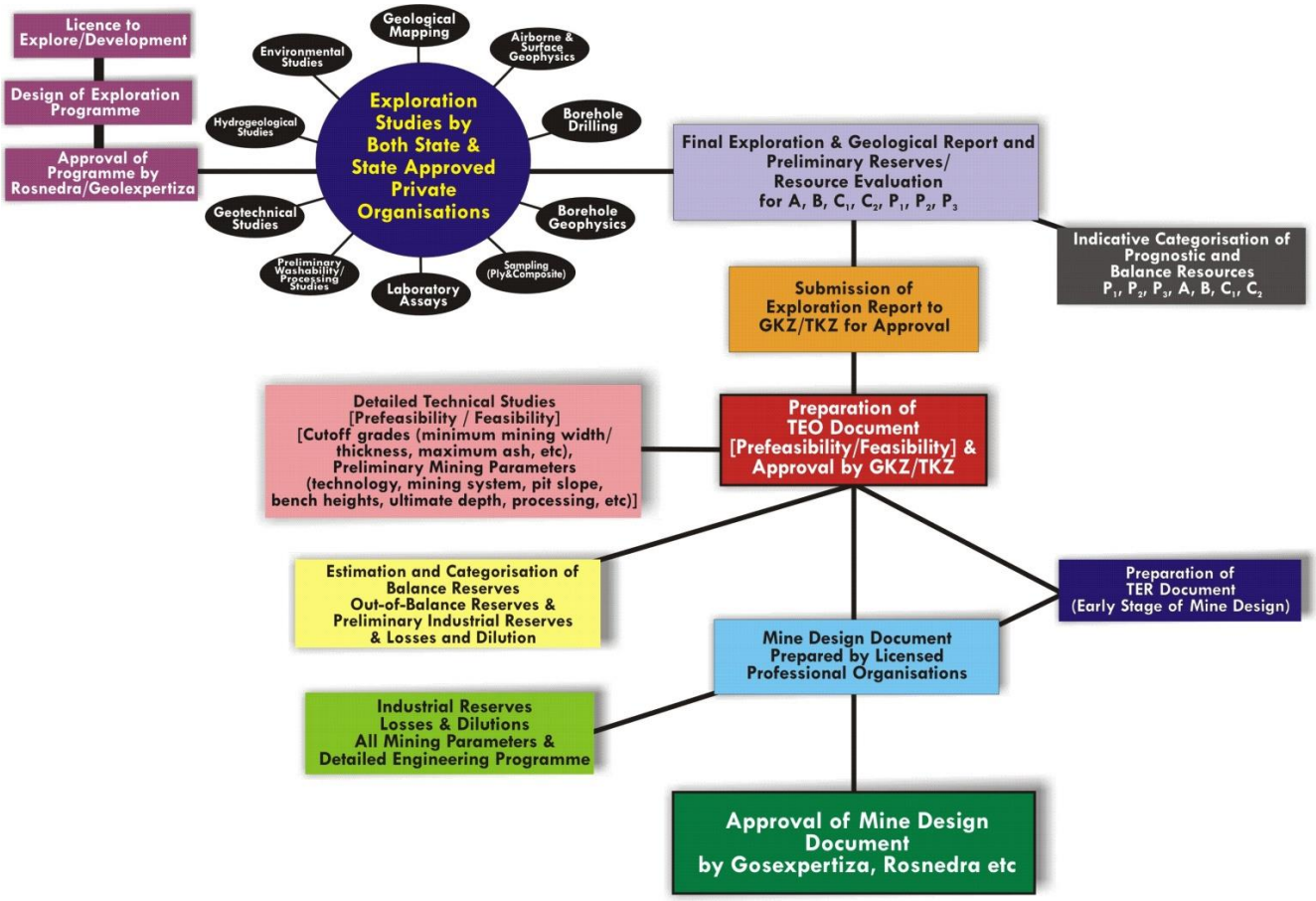

Figure 1 Simplified Framework of Resource/Reserve Assessment in Russia and CIS Countries

CONVERSION OF RUSSIAN CATEGORIES TO CRIRSCO TEMPLATE

There were many attempts to convert Russian resource/reserve categories to those defined by CRIRSCO-aligned standards in the past.

In 2010, a working group of experts from FGU (Federalnoye Gosudarstvenoye Uchrezhdeniye), “GKZ”, CRIRSCO, mining and other companies and Russian and international universities finalised its work and prepared a clear and detailed guideline on converting the Russian minerals reporting standards into the CRIRSCO Template directly.

The final version of this document (FGU – CRIRSCO, 2011) indicated that the general assumption in the recent past was that in order to produce a CRIRSCO aligned report on a Russian mineral project it was necessary to work from the base raw data and carry out a completely separate modelling and estimation exercise. As the fundamentals can be significantly different in allocating the resource and reserve categories in each system i.e. Russian and CRIRSCO based templates, this could produce a

set of estimates for resources and reserves which cannot be easily reconciled with the Russian estimates leading to many problems for companies both with the authorities in Russia and with the stock markets around the world.

However, it is important to emphasize the fact that non-Russian specialists will still need to have a high level of understanding of the Russian classification system in this conversion process. These guidelines have been developed primarily on the basis of the respective definitions (rather than on individual experiences on different projects) and are applicable to all types of solid mineral deposits. The working group guideline document also emphasis that every deposit is different, and these are only guidelines, not instructions, and that therefore the Competent Person should not apply the mapping mechanically but must provide the same degree of justification for the resulting classification as in producing any other CRIRSCO-compatible report.

MAIN CHALLENGES

There are many challenges encountered during the application of both the Russian system and internationally accepted codes in Russia. The following list is a small sample based on IMC's past and recent experience in both Russia and other CIS countries.

Borehole Co-ordinates and Other GIS Information

As the mineral resources in Russia and other CIS countries have traditionally been treated as strategic assets, the secrecy on GIS information still continues today. Many mines in Russia and other CIS countries still operate with the false co-ordinates for topographic maps at 1:50,000 and smaller scales dictated and regulated by the national laws and local regulations; and only few people at the mines like the mine director, mine geologist and chief surveyor can access to the true co-ordinates. However, the false co-ordinates can be converted back to the true co-ordinates through specially issued codes by the chief surveyor if necessary for official documentations such as licensing details. In some isolated cases, the mine management would still be reluctant to release even the false co-ordinates to the outside world. This is especially true for the foreign experts operating in Russia as releasing the data to the foreigners can be a punishable offence.

IMC's experience with the Clients is both to respect the local rules and regulations and to accommodate the requirements of the JORC based assessment at the same time by satisfying that all the information in the documents (maps, plans, cross sections etc) based on false or true co-ordinates are truly represented by checking them. This means that the foreign experts are usually given full access to the original records for inspection but without making any copies of them. It should be noted that Vladimir Putin, the President of Russia, set forward an initiative in 2013 to make preparation of reserve and resource estimates under international standards easier, specifically in the area of revealing the secrecy on GIS.

Data Availability and Access

In many cases, the known mineral deposits in Russia and other CIS countries are investigated in detail through the well documented exploration programmes and technical studies. The amount of

information accumulated over the decades is sometimes so overwhelming that reviewing or inspecting the volumes of data and reports can easily take weeks and months. However, in many instances the original data would not be kept at the mine site as the original data is state owned and looked after by the State Geological Trusts spread around the country. The data held by these institutions include all the necessary documents on any deposit under their jurisdiction such as original borehole log books, the exploration reports, and other technical pre-feasibility and feasibility documents usually in paper format. The mining companies purchase this data from the trusts or the "Rosgeofund" if they need the original data on the deposits for further evaluation. Then the copies are made from the originals, and preserved at the mine sites and the headquarters of the companies generally again in paper format and sometimes in digital format as scanned copies. The plans, maps as well as cross sections from the previous studies are sometimes digitised and stored as picture files and utilised as rasters (images) in appropriate software if necessary. Some of the data also is available for storage purpose in spreadsheet format.

In some instances, IMC competent persons visit the geological trusts and consult the original reports and other technical experts who would know the specific issues on that particular deposit.

The borehole drilling from the Soviet times consisted of both open hole and core drilling with some geophysical logging in the later phases of investigations. Borehole deviation measurements were also standard. Borehole geophysical logging (e.g. at least natural gamma, density, sonic, and caliper), was undertaken in majority of boreholes, for example, to determine the coal seam thickness and their continuity. According to the existing technical documentation on many sites, the core recovery in the majority of cases is more than 80% which was acceptable under the Soviet standards. However, the teams during Soviet times were still encouraged to provide higher core recovery rates by offering bonuses. Borehole core photography was not a common practice in the Soviet times, and is still not implemented in many current exploration projects. Therefore, for old geological studies, the chance of finding any trace of core photography in the projects is pretty low.

IMC's experience with the local mine expertise and management is that full co-operation is generally provided to the consultant and open discussions on the geological and mining issues are held without any problems. The local teams at the mine operations can be very honest about their issues, difficulties and are always eager to hear different solutions and approaches. However, in some remote locations, the mine personnel can be less accommodating if the purpose of the visit is not explained to the local teams by their headquarters of the company who wanted the JORC based assessment in the first place. However, this can be rectified by through consultation process with various parties at the headquarters and the data access is later provided without any problems.

Manual Estimation vs Automated Estimation

In many cases, the manual estimation of the resources is still the only methodology used to estimate mineral resources. In this manual methodology, every individual block is delineated and coded on the basis of their geological characteristics which are all well documented.

The conditions defined by the GKZ for estimation of reserves for each deposit specify the method of computation of reserve blocks, cross-sections etc, the minimum geometry parameters for exploitation of the minerals (e.g. minimum coal thickness) and cut-off parameters (e.g. maximum ash content for coal grades), plus special considerations which may apply where the conditions for mineral extraction are exceptional or present difficulties.

For example, mineral deposit volumes can be estimated by the determination of the areas at specific levels and the multiplication of this area by the average thickness estimated from sections through the applicable area. The estimate of resource tonnage is obtained by multiplication of the estimated volume by the assumed or determined specific gravity (SG) defined in the Conditions for Estimation of Reserves for each deposit for specific mineral type and grade.

The use of geological and other mining packages has recently been finding more acceptance at the mine sites although there is still a long way to go for a full recognition of the benefits of these packages. One of the reasons for this could also be that only the state registered and approved computer packages are allowed to be used in resource and reserve estimations. The process of approval for these packages through the official channels can be tedious and lengthy.

However, as in-house expertise at GKZ institutions is rapidly catching up in using these software, the materials of geological exploration prepared using 3D geological and mining modelling and estimation of resources prepared in pre-approved packages after verification have been finding more acceptance.

The companies which use and realise the benefits of these software packages can also argue and present their cases to the appropriate authorities to modify some of the cut-off parameters conditions dictated on them earlier by the State organisations. For this, they develop parallel resource estimation for internal usage and demonstrate the benefits of the use of the geological and mining package to the official authorities. Due to IMC's strong background in modelling packages, IMC has been asked by many of its clients either to create a model for the client's needs or to verify the company created models whether the general modelling principles are applied correctly.

Mind-set between Resources and Reserves

In Russia and CIS countries all resources are technically regarded as reserves with different level of categories attached to them such as balance reserves (economic reserves), out-of-balance reserves (potentially economic reserves), industrial and exploitation reserves (extractable tonnages after losses and dilutions). If some portions of the balance reserves cannot be extracted from the ground, then the companies have to prepare very detailed technical and economical justification reports for the authorities to demonstrate why these portions of the mine site cannot be mined. This could sometimes be relatively costly exercise to undertake.

Since the Soviet system has effectively dictated that everything under the balance reserves category within the defined cut-off parameter conditions should be extracted from the ground, this has become

one of the main difficulties to communicate with the local Russian and CIS experts on the differences between resources and reserves.

For this reason, there are always constant discussions between the western experts and the local Russian teams for the amount of reserves available from the mine sites. This can be especially important when some deposits have huge amounts of balance reserves which could be extracted. For example, a "reserve" classified under the Russia/CIS system may have a mine plan covering the next two hundred years, but an assessment under JORC code on the same resource classifies the reserve within realistically foreseeable economical projections under a business plan covering only about a 20 to 30 year period.

This, i.e. minimising the evaluation period to 20-30 years, can sometimes be a difficult concept for the Russian experts to grasp and it can be a monumental task to convince the clients that their resources/reserves did not disappear, but the reserves assessed under the international system covers only for the reliable business plan period; and at the end of this period, further resources will be converted into reserves.

Re-allocating Resource Categories

Although it is a well prescribed system, one of the major issues with the Russian system is its rigidity on allocating the resources from one category to another. These are usually defined at the beginning of the projects which can be a long time ago, and reviewed later on if any of these categories need to be upgraded into one of the upper and more certain categories once the deposit is accessed.

There are lengthy statistical methods and reasons to undertake further exploration studies to convert the categories from one to another which can sometimes be relatively costly exercise to undertake. However, the companies still have to implement these exploration studies in lesser (i.e. C_1 and C_2) category areas and prove that they have executed them before they are allowed to mine these sections as part of their mine licensing conditions.

In addition, extreme caution must be exercised when considering the old estimates. Once approved by the state authorities, the reserves estimates may remain in the State balance indefinitely, until or unless updated or replaced by new estimates. This is especially important as such approval may be based on cut-off grades and other controlling parameters deemed no longer to be appropriate due to changes in technical conditions.

In addition, as the system is based on the scrutiny and approval of an independent organisation (GKZ/TKZ). The certain complexity of the procedures in preparing the "conditions" and their defence at the various committees, and the re-approval procedure at GKZ/TKZ, may take a considerable length of time. This is also applicable to the old deposits, which means that bringing these historical resources up to date with the current conditions, preparation of documentation on them and with the additional compulsory geological and mining work may take between six to twelve months or even longer. The approval procedure at GKZ/TKZ used to be a very lengthy period too, but this has now been limited to three months but which could be extended up to five months if further documentation

is required. In a number of cases, however, the licence owner may still prefer carrying out mining according to the old “conditions” defined many decades ago and not satisfying the current economic conditions to avoid the bureaucratic procedures which could involve additional exploration and technical work as well as additional time for approval processes.

Trust in Assessments Conducted by State Organisations

The Soviet system has been built in a mechanism which controlled every aspect of the geological investigations and mining activity. There were many committees which checked and re-checked the results and controlled the decision making. Anecdotal evidence is that the mistakes were punished by sending the technical personnel into exile. Therefore there is significant amount of confidence on the past studies undertaken in the Soviet times.

Although the Soviet system was indeed based on a robust system, there were occasions that the mistakes or errors were certainly made. This is especially true towards the mid eighties in the last century when the Soviet Union was in need of financing and was on the brink of collapse. The quality of work around this time deteriorated due to lack of cash and morale which was consequently reflected in the results.

IMC’s experience is that the clients accept many of the results from these past investigations without questioning for their validity, or without undertaking any further tests or studies to confirm the findings. This can be accentuated if the base data is no longer traceable or found anywhere, despite the Geological Trusts being the custodian of the original data. Therefore, IMC always check the data to ensure that the fundamentals of the reserve estimations are in place.

Selecting Cut-off Parameters through State Approval Procedure

As a rule, a TEO of “conditions” reviews different systems of mining sub-surface areas and mining boundaries with a view to justify the optimum solutions. A TEO of “conditions” normally reviews several options of a set of minimum parameters (conditions). Each of the options is accompanied by a corresponding technical and economic evaluation and assessment of “potential” balance reserves.

As a rule, GKZ approves an option of “conditions” that is characterised by a maximum reserve tonnage while mining being still profitable. The state, as a sub-surface owner, is interested not only in royalties, tax charges and creation of new jobs in the project area, but also in maximising the utilisation of processing and machine-tool industries, and efficient use of transport companies too. In some cases this results in minimisation of the economic indicators related directly to the mining of the deposit; and mining at the minimum acceptable level from investor’s point of view. Macroeconomic effect due to the deposit development has also to be illustrated by the so-called State Budget efficiency – an indicator of economic impact at the regional and state level included into the TEO of “conditions” which is also dictated by law.

If there are high reserve tonnages in place, the sub-surface user is interested in maximising profit focusing on areas requiring smaller investment and characterised by higher profitability. This often initially results in elimination of areas with most complicated geological structure and of more

complicated mining conditions. In a number of cases, this brings about loss of these resource tonnages. Thus, preparation of technical and economic evaluation made in the framework of "ground conditions" may consider different options, for example a set of minimum coal seam thickness accepted for estimates: 1, 1.5, 2m etc. Even if the total project efficiency (IRR, NPV) turns out to be higher with 2-metre seam thickness, an option with thinner seam thickness may be approved by the State authority that is characterised by higher reserve tonnage, which is subject to the condition that mine is still profitable with this seam thickness selected.

Yearly Re-conciliation of Reserves through State Approval Procedure

The movement of resources and reserves in mine operations are still controlled by the State Authorities making the whole procedure effectively an inventory system allowing the State to know how much of a specific mineral is present and how much tax and royalties would be applicable to these reserves. Mine inspectors appointed by the state can visit the operations in regular intervals and in some cases even reside at the mine site and work alongside with the local mine teams. Their role is to ensure that the operation is safely conducted according to the accepted rules and regulations and the amount of reserves extracted from the ground is undertaken according to prescribed mine design plans. They also check the final production figures to reconcile the remaining reserves left in the ground. Therefore, the statement of the reserves prepared from the mine is approved in an official form called 5GR on this basis annually by the state authorities. This final figure will be the base for royalties, taxes, and fees payable to the state. This involvement by the state gives extra confidence to the competent person that the movement of the reserves are checked and approved by the third parties independently.

Suitability of Selected Mine Methodology and Equipment

The TEO of "conditions" contains comprehensive substantiation of rational deposit access and mining method and systems, annual production and life of mine, planned quality of produced minerals, and mechanisation of mining operations as well as other design solutions ensuring the ultimate, complete economical recovery of reserves.

The typical mining options including the open-pit mining, underground mining or combined system have to be assessed when choosing a mining method.

Choice of the mining system and their key elements, mineral access methodology and location of the main openings, optimum open-pit envelope, including slope angles and other parameters is made on the basis of geological and mining conditions of the deposit. As a rule, choice of the optimum deposit opening scheme is based on assessing several options followed by selection of the best one.

Long-Term Mine Planning and Life of Mine

Production schedules are normally developed year-by-year basis for the first twenty years of mining and in some cases further in stages.

Cash flow of the mine is projected for the period (estimation horizon) of life of reserve (but normally not more than 20 years) or the term of the license.

Estimation of the mine optimum annual production considers dependence of capital investment and operating expenditures on life of mine. For example, estimation of reserve tonnages for various cut-off (economic cut-off) grades is made by assessing several options. Firstly, one or two reserve options are accepted as the base ones, and then estimates of their capital investment are assessed. After this, a detailed analysis follows demonstrating how changes in reserve tonnages (and correspondingly potential annual production of the mine) and the life of mine influence the capital investment amount.

Economic Parameters

Economic justification and estimates used in defining parameters of “conditions” and estimation of economic efficiency of the project implementation are deliverables of all geological exploration, processing and environmental studies carried out at the deposit.

In general, standard economic tools are used for economic valuation: modelling of product, resource and cash flows within the estimation period (planning horizon); defining economic effect by comparison of expected total results and costs; analysis of mineral market development trends; consideration of uncertainties and risks related to the project implementation.

The main economic parameters used in the deposit valuation and determination of its reserve balance status are standard, and are the same ones used in standard, international, best practice and include: Cash Flow (CF); Net Present Value (NPV), Profitability Index (PI); Internal Rate of Return (IRR). There is one exception - the state budget efficiency that is “NPV of the state”, where the overall contribution to the state and local economy is assessed with this additional investment.

Technical and economic justification of “conditions” is based on consideration of economic parameters, with cost estimates including all real taxes, payment and collection applicable in conformity with the current federal and local laws and conditions of the license agreement.

The amount of capital investment is to a maximum extent estimated by direct calculation. Operating expenditures are estimated using norms based on solutions of the TEO technological part or by cost items or elements.

The project’s economic valuation is usually carried out at different discount rate options ranging from 0 to 15%.

Vertical Integration of Companies and Transparency

Some organisations in Russia as similar to the other parts of the world can own not only mines but also other enterprises such as coke and steel plants, chemical industries which are vertically integrated into the entire structure. This can sometimes pose its own challenges since the relationship between these organisations cannot easily be explained economically. Although the benefits can include the lower transaction costs, synchronization of supply and demand along the chain of products, lower uncertainty and higher investment, ability to secure the supply of the raw material and monopolise/manipulate the market throughout the chain, there could still be problems

with the higher co-ordination costs, higher monetary and organizational costs of switching to other suppliers/buyers and weaker motivation for good performance at the start of the supply chain since sales are guaranteed and poor quality may be blended into other inputs at later manufacturing stages.

In other cases, the company structure is designed in a way that the parent company may be registered outside Russia or CIS and the productions units may be reporting to these departments outside the country which make the data accessibility difficult for the competent person.

IMC's experience with such situations i.e. understanding such relationships is a mixture of both co-operation and resistance within the company due to some commercial sensitivity involved. However, in many cases the information is generally provided in a transparent manner to at least satisfy the competent person's audit requirements.

Parallel Reporting for Resource and Reserve Statements

For a number of reasons, reporting procedures in compliance with the Russian resource and reserve classification system are not currently recognised by the international financial institutes. Therefore, the Russian producers often resort to preparing a parallel reporting of resources and reserves in compliance with one of the international standards, usually JORC, by using independent international mining consultancy organisations, such as IMC, to establish a greater confidence in the estimations.

The Russian producers' interest in compliance with the international standards may be influenced or necessitated by

- attraction of a foreign investor,
- obtaining a credit facility,
- IPO procedure and/or uplifting the company to the international level,
- changes of owners,
- internal audit and keeping pace with the international financial reporting practice.

Despite this parallel reporting, this does not cancel the necessity of keeping the reporting compliant with the Russian system of classification, due to the well grounded objections raised by the main advocates of the current system i.e. the Russian geologists and specialists who will face a monumental task to reconcile or marry both the local and international systems into the national system.

The JORC Code is one of the most popular in Russia and is used by the most of the major mining companies in Russia to keep double reporting. It should be noted that in 2013 Vladimir Putin, the President of Russia, set forward the initiative to make preparation of reserve and resource estimates under international standards easier and more transparent especially in the area of revealing the secrecy on GIS.

To achieve the task of reporting mineral resources in compliance with requirements of the international financial institutes, the sub-surface user may consider two main approaches:

- Independent re-working of the original geological information containing ***resource*** estimates into the JORC Code or other international standards followed by ***reserve*** estimates in the course of technical and economic evaluation at least at the Pre-Feasibility Study, etc. level), with a Competent Person in charge of reserve estimates considering all specifics of the Russian legal environment. All mining losses and other mining indicators shall be accordingly adopted with consideration of the legal and regulatory bases in force.

- Reclassification (conversion) of the available data on estimation of "balance reserves" under the Russian system of classification into resources and reserves under the JORC Code or other international standards, with experts' verification of the available results of geological studies and technical and economic evaluations made in compliance with the Russian standards.

It should be noted that conversion of "balance reserves" into international categories of resources and reserves is not a straightforward process, and requires a competent person's input and verification. This can sometimes be a daunting task especially when the available TEO of cut-off parameters and the Russian project studies are more complicated than typical. In such circumstances, the direct conversion of industrial reserves into international reserve categories may not always be possible. In a number of cases "conditions", that the balance reserve estimates were based on, are out-of-date and may therefore require additional studies. In addition, the market dynamics, the actual conditions of the company's fixed assets and the status of mining operations may require new analysis of all the factors influencing technical feasibility and economic viability of the deposit mining. This necessitates quite a complex technical and economic analysis and involvement in the audit of a wide range of specialists qualified both in mining, geology and economics, law, environment, processing and other fields.

It should be stressed that in recent years there has been significant positive dynamics in the growth of interest on the part of the Russian mining companies to public offerings at Stock Exchanges particularly in London, New-York, Hong-Kong and Toronto.

The London Stock Exchange especially enjoys the highest popularity among the Russian issuers by using the JORC Code with the assistance of IMC and other international consultants. A number of companies prefer starting preparation well ahead of their IPO with independent resource and reserve audits some years before the offering. The early resource and reserve estimation in compliance with international standards identifies potential non-compliance in company's financial reporting and technical and economic documentation, which, when rectified, ensures preparation of the company for listing in a more favourable light.

IMC has prepared about 25 MERs since the company started its operation in Russia. The experience of IMC demonstrates a significant positive growth of assignments in Russia including reporting of resources and reserves in compliance with international standards.

CONCLUSIONS

Recent demand for the raw material from both the major and developing economies around the world has put Russia back in the map for the development of its vast mineral resources and their supply to the market. This has resulted in a renewed interest from both the investor and mining community to develop these commodities in an efficient manner.

It is important to remember that the current legislation in Russia and similarly in the other former Soviet Union countries dictates that the reserves and resources must be evaluated in a well prescribed system where the underlying principles for resource assessment can be fundamentally different compared to the internationally accepted codes such as JORC. This has been the legacy of the Soviet Union where the resources were seen as national commodities that belong to the people of the country. Therefore, it is important for the western companies to understand how the Russian resource system operates and what the similarities and differences are between this system and internationally accepted codes.

Although there are many strict rules and controls in place to ensure that the resources have been recovered in the most efficient way for the benefit of the nation, the Russian system, due to its rather descriptive nature, has become an important element in reconciliation of the resources in accordance with the criteria defined in the internationally recognised reporting codes such as JORC. The Russian code is a useful tool and gives a clear guidance to the competent persons and practitioners in a methodical way when they are assessing the mineral resources in Russia; and should be seen a practical complimentary instrument to assist them.

ACKNOWLEDGEMENTS

The authors would like to express their sincere thanks to IMC personnel for their kind and constructive comments and IMC management for its permission to publish this paper.

REFERENCES

CRIRSCO - NAEN, 2011. Russian Code for the Public Reporting of Exploration Results, Mineral Resources and Mineral Reserves (NAEN Code). http://www.crirsco.com/news_items/naen_code.pdf [Accessed: 11 March 2012]

FGU - CRIRSCO, 2010. Guidelines on Alignment of Russian Minerals Reporting Standards and the CRIRSCO Template. http://www.crirsco.com/conversion_guidelines_2010_9.pdf [Accessed: 11 March 2012]