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PRACTICAL APPLICATION OF THE UNITED NATIONS INTERNATIONAL FRAMEWORK CLASSIFICATION FOR RESERVES/RESOURCES

COMPATIBILITY OF INDIAN RESOURCE CLASSIFICATION WITH THE UNITED NATIONS FRAMEWORK CLASSIFICATION

(Submitted by the Government of India) *

1. Introduction

Since the liberalisation of the Indian mineral sector in 1993, sincere efforts are being made to attract private investment – domestic as well as foreign. However, sincere efforts notwithstanding, investment in mining can take place only when there is a geological prospectivity to warrant investment in mineral exploration which is the *sine qua non* for going into mining. The Indian Precambrian shield is known to host a wide array of geological formations with exciting mineralogical possibilities. This has generated tremendous interest in multi-national mining companies all over the world. In the last three years, 49 prospecting licences covering an area of 68757 sq. km. have been granted. Aerial prospecting in a large part of this area has been completed and the data is under process. Preliminary indications are that these companies are very upbeat about the anomalies found so far.

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With intense prospecting with state-of-the-art techniques, more and more resources of various minerals, including many new discoveries, are bound to be found and added to the present reserves. In India, there already exists a comprehensive scheme of classification of ore and mineral reserves. It is against this backdrop that an effort has been made in this paper to analyse how far the Indian resource classifications are compatible with the UN Framework Classification so that investment decisions by the international mining companies are made easy.

2. Classification system in India.

The Report of the Committee on Standardisation of Terminology and Classification of Ore and Mineral Reserves brought out by Geological Survey of India (GSI) deals comprehensively with the objective of providing a uniform code of reserve classification for all minerals, a somewhat different classification for coal, but excluding atomic minerals for nation-wide application. The Report categorised the mineral reserves under four headings - *developed*, *proved*, *probable* and *possible* and also brought out their equivalency with A,B,C_1, C_2 categories of USSR classification. New error limits were specified in the Report. In the coal sector, the then prevalent Indian standard practice considered classifications under three categories of *proved*, *indicated* and *inferred* mainly on stipulation of areas of influence. It is interesting to note that in the coal sector, the reserve classification scheme adopted combined the terminology of USA and Western Europe (Proved, Probable and Possible) with the modified terminology of USA and Canada ('measured', 'indicated' and 'inferred'). Beside the Russian and East European terminology (A,B,C_1 and C_2) which has almost the same meaning as their Western equivalent with an additional feature in the scheme involving specification of ratios between A,B and C category reserves before mines are designed and investments allowed. This system was also followed in some public sector units in India notably the Central Mine Planning and Development Institute (CMPDI) – the planning and development arm of Coal India Ltd. These comparisons as tabulated in the GSI report are reproduced in Figure 1.

Figure 1

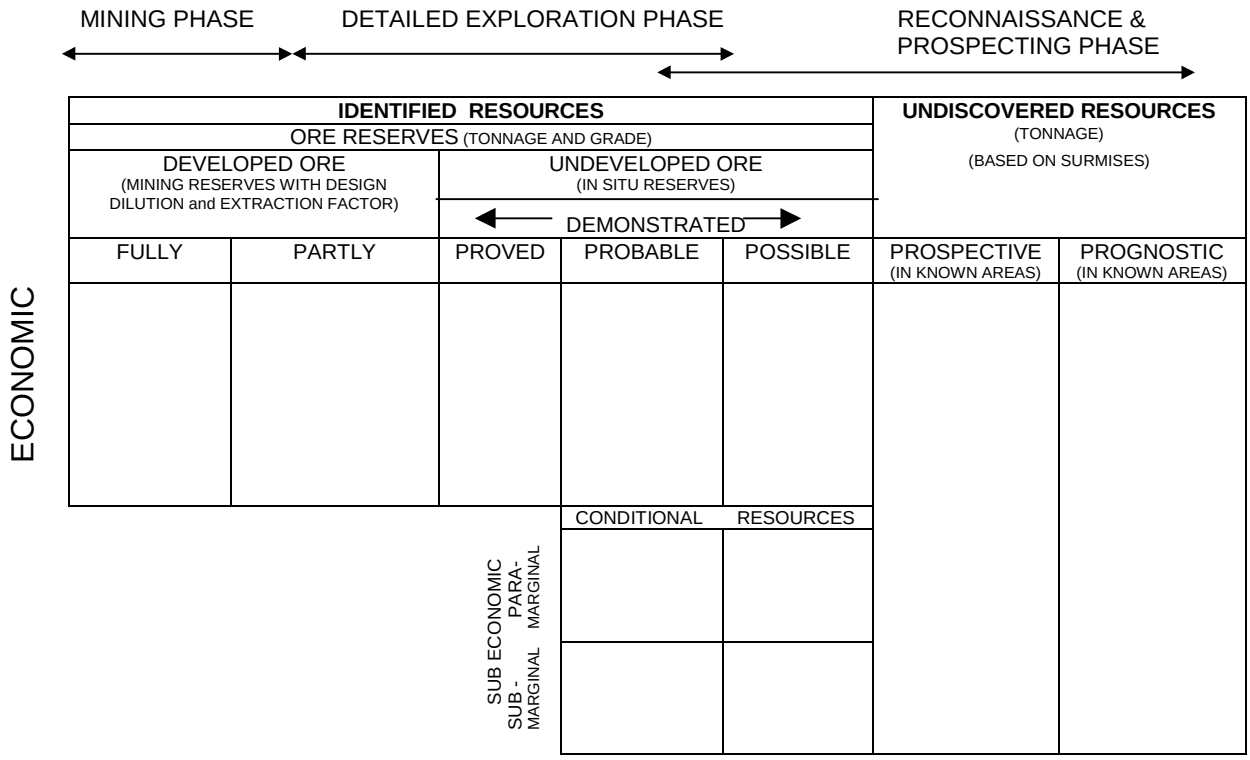
COMPARISON OF PREVAILING INTERNATIONAL AND PROPOSED NATIONAL CLASSIFICATION SYSTEM (1980)

U.S.G.S./U.S.B.M. CLASSIFICATION			U.S.S.R CLASSIFICATION			PROPOSED INDIAN CLASSIFICATION		
Category	Purpose	Permissible Error	Category	Purpose	Permissible Error	Category	Purpose	Permissible Error
			A	Production planning mine projection	15-20%	Developed	Production planning and ready for mining	0-10%
Measured		0-20%	B	Estimating mining investment and planning of development of the deposit	20-30%	Proved	Investment decision mine planning	10-20%
Indicated		20-40%	C_1	Long term development plans for projecting exploration needs	30-60%	Probable	Back up tonnage to proved reserves for investment decision for mine development likely geological reserve to decide on detailed exploration	20-50%
Inferred	Planning for further exploration		C_2	Planning further prospecting	60-90%	Possible	First quantitative approximation for planning for national resources survey	

The formulation of the classification of the Committee was propelled by the requirement of long term planning and immediate requirement. Further, the above classification was pivoted primarily against two basic approaches of (a) probability dealing with assurances of appraisal and (b) feasibility, concerning economic and technological viability.

The relevance of evolving a universal classification was also touched upon in the same Report and it was felt desirable not to complicate the single classification through accommodation of all the attributes—physical and techno-economic appraisal—in a single classification. Quite objectively, the Committee attached profound emphasis primarily to tonnages and grades aspects of classification. In addition to proposing a framework of reserve classification, the Committee suggested a scheme of national ore / mineral resource classification and also diagramatically represented the proposed resource classification (Figure 2).

Figure 2
DIAGRAMMATIC REPRESENTATION OF SUGGESTED NATIONAL ORE/MINERAL RESOURCES CLASSIFICATION



In the proposition of the national scheme of reserve and resource classification, the main objective was to keep the classification system as simple as possible to enable easy understanding by all concerned — the exploration geologist, mining community, the policy makers and the entrepreneurs.

Beside formulation of codified terminology and definition of terms, the Committee also made sincere efforts in quantification of exploratory parameters for the standard terms of classification in which stages of exploration, purpose, type of activity and resultant status of

resource evaluation were dealt with comprehensively and each set of activities at different stages of exploration were detailed out in a tabular form. Additionally, efforts were also made to define the exploration practices to be adopted in different types of deposits taking into consideration the characteristics of deposit types as well as the principal kind of mineral association.

In so far as the classification of coal resources and reserves were concerned, the Committee felt it desirable to introduce a refined resource classification in place of the then prevalent classification entitled Indian Standard for Coal Reserve Estimation adopted since 1956. The proposed coal resource classification system put due emphasis on geological identification, the nature of sampling, the level of assurance or reliability, technological feasibility of recovery and economic viability. New terms like *joint probability* to define reserves of higher category were emphasised in relation to resource categories of lower order — *assured reserves* — to define that part of reserves which have a high level of assurance commensurate with the requirement of highly mechanised mines in addition to the conventional, proved, probable and possible categories of reserve.

The ash content in coal and thickness of the seams and the structural impress on the coal seams were the main yardstick in defining the *joint probability* estimate. The level of assurance under the banner of assured, proved, probable and possible criteria were defined under the sub-headings of geology, geo-technology, estimated level of assurance and mining and economic objective.

The classification scheme evolved for Indian coal and lignite by the Committee *prima facie* were objective in a sense that they were resource / reserve endowment specific, irrespective of their compatibility aspects with internationally accepted broad scheme of general classification of resource / reserve, in which both solid fuels and mineral commodities were clubbed together in a single classification framework.

3. United Nations Framework Classification – Solid Fuels and Mineral Commodities

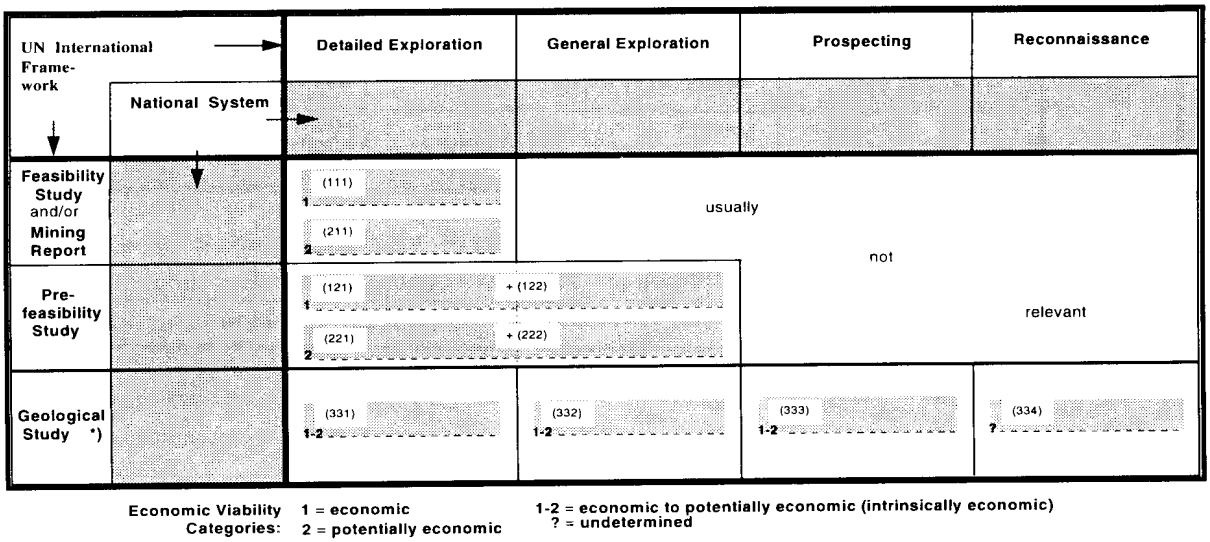
The United Nations Framework Classification for Reserves/Resources - Solid Fuels and Mineral Commodities (abbreviated : UN Framework Classification) is the latest effort to develop a universally and internationally accepted scheme for assessing both the solid fuels and mineral deposits under market economy conditions. (Figure 3).

The proposed UN Framework Classification has been designed in such a way as to render it simple and easily understandable by all concerned. While retaining the existing terms by and large used globally, the UN Framework Classification provides information about the stages of geological and feasibility assessment as well as the degree of economic viability.

It will be seen from Figure 3 that the geological study has been divided into four consecutive stages of geological assessment in order of their increasing details, consequently reflecting the increasing degree of geological assurance from the initial stages of reconnaissance through the stages of prospecting, general exploration and detailed exploration

Figure 3 Matrix

United Nations International Framework Classification for Reserves/Resources
- Solid Fuels and Mineral Commodities -



* Code (123) (see codification in figure 4)

The feasibility assessment similarly has been subdivided into three consecutive stages in order of increasing details viz. geological study, pre-feasibility study and feasibility study / mining report reflecting degree of assurance of economic viability.

The economic viability, corresponding to the reserve, resource figures as obtained from the feasibility assessment is reported in the third dimension, using the individual boxes in the matrix or the individual column in the table.

4. Compatibility between Indian and UN framework classification

From the elaboration of the two classification systems, i.e. Indian and UN Framework Classification mentioned above, the elements of convergence and divergence have been briefly summarised in the succeeding paragraphs.

The UN Framework Classification system has been purported to incorporate both solid fuel and minerals - which is not the case with the Indian classification system. Two separate systems exist in the Indian classification system with the coal resource classification system introducing such terms as *joint probability* (with differential emphasis on reserves of higher category and resources of lower category) and *assured reserve*. Further, the phrase *joint probability* calculation is reliant on such attributes as quality considerations on the basis of ash percentage in Gondwana and ash/sulphur percentage in tertiary coals, thickness of coal seams and the degree of structural disturbance effecting the coal seams.

The term *assured reserve* for coal has been considered apparently in a manner analogous to the term *developed reserve* used in the Indian classification of minerals. Incidentally, the use of the term *developed reserve* in the Indian classification has apparently been retained after the USSR classification, representing a category of reserve for production planning and mining purpose. The UN Framework Classification on the other hand has been reliant on the USGS/USBM classification system retaining the categories of measured (proved), indicated (probable) and inferred (possible) only.

In addition to the marginal variance mentioned above, the Indian classification scheme has proposed the permissible limit of error of 0-10% for 'A' category of reserve as against 15-20% error limit assumed for 'A' category reserve in the USSR classification. In the USGS/USBM classification, the error limit prescribed for measured category of reserve has been 0-20% (for investment as well as planning and development purposes). Similarly for indicated reserve, the USGS/USBM classification assumes an error limit at 20-40%. For the corresponding probable reserve, an error limit of 20-50% has been assumed in the Indian classification. No error limit has been prescribed either for an inferred / possible reserve. It will be seen that the Indian classification of reserve has inherited some of the terms used both by USGS/USSR for classification of reserves, albeit in a slightly modified form.

In the UN Framework Classification system, the error limit has been proposed at ±10% in case of feasibility and ± 25% for pre-feasibility assessment stage. The basic difference between the two classifications mentioned above therefore is one of approach—the Indian classification prescribing error limit primarily on the assurance of appraisal of the reserve. There is no error limit on the various stages of feasibility assessment (Refer Figure 1). In the UN Framework Classification, as already mentioned, the four stages of geological assessment reflecting the order of increasing details have been defined.

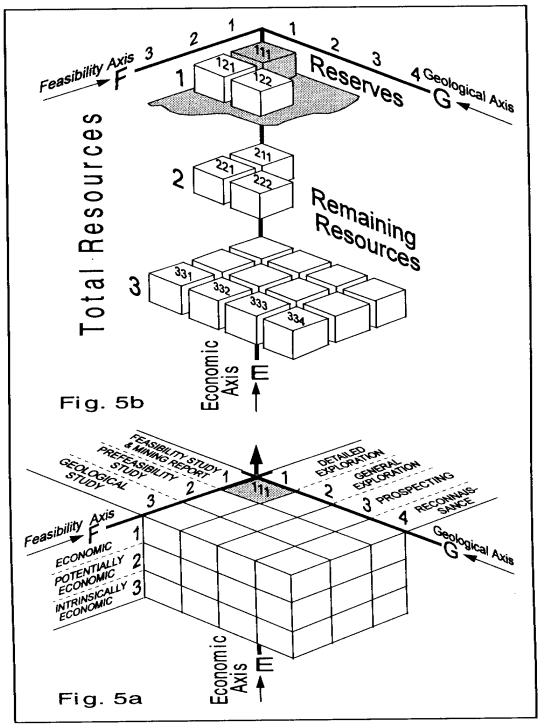
In the Indian classification, an additional category - namely *Developed* category -- has been introduced to reflect such reserves which can be considered for production, planning and ready for mining (corresponding to A category of the USSR classification). Incidentally it was J.D. Forrester, who originally suggested the term developed reserve for that part of proved / measured / material that is available for immediate withdrawal.

The UN Framework Classification provides information about the (1) stages of geological assessment, (2) stage of feasibility assessment, and (3) degree of economic viability. The principle behind the UN Framework Classification and methodology of classifying reserve and resources has been shown in Figure 4.

In addition to the geological and feasibility assessment, the UN Framework Classification also added the third dimension - the economic viability corresponding to the reserve resource figures as obtained from the feasibility assessment using the individual boxes in the matrix (Figure 4 (a) and (b)) or in the individual column in the table of the UN Framework Classification. Three categories of economic viability have been proposed in the UN Framework Classification : economic, potentially economic and intrinsically economic.

Figure – 4 (a) and (b)

EFG CLASSIFICATION OF UN INTERNATIONAL FRAMEWORK CLASSIFICATION – SOLID FUEL AND MINERAL COMMODITIES

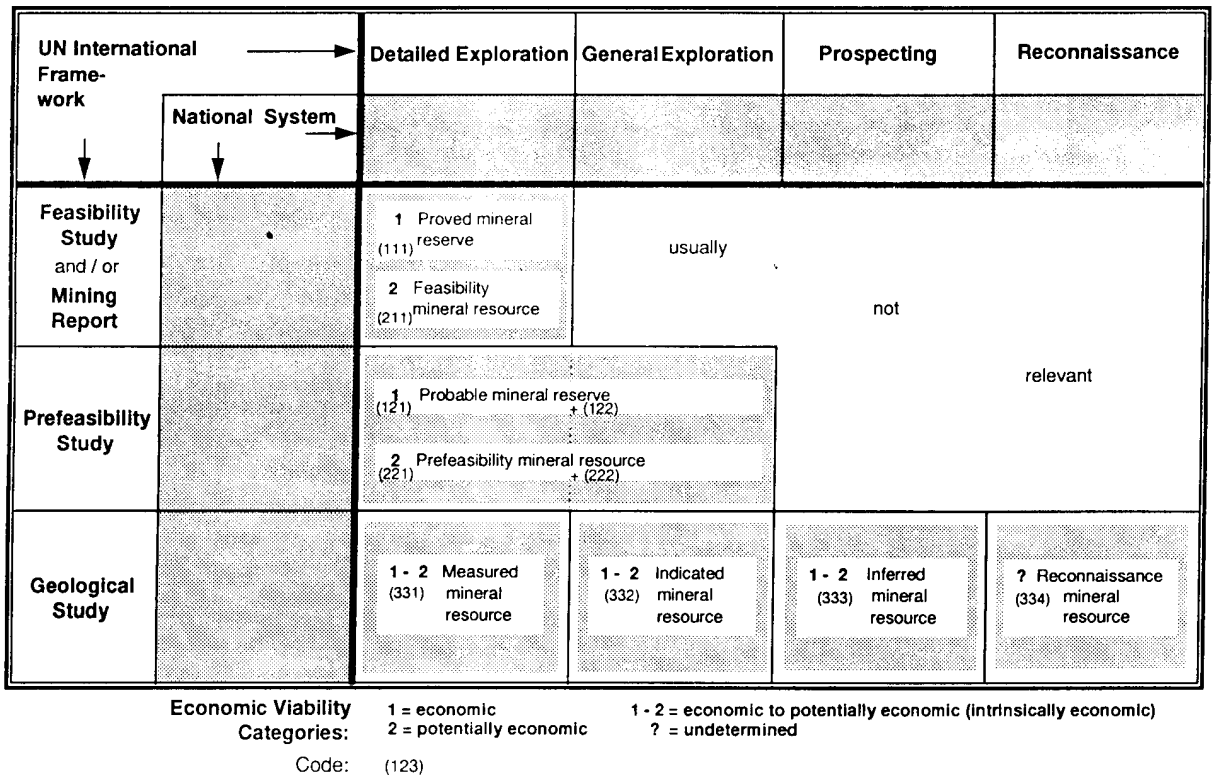


In the proposed UN terminology, some terms like feasibility resource and prefeasibility resources (Refer Figure 5) have been proposed as preliminary working terms. It has been reckoned that the terms ‘reserve’ and ‘resource’ have different meanings in the various national classification systems throughout the world, most of which have a long history and India being no exception.

One of the most important features of the proposed UN Framework Classification has been the incorporation of the existing classification by means of a simplified numerical codification acting as an interface. It is expected that the proposed codification will immensely facilitate computer processing of data and exchange of information.

Each codified class has a set of assessment stages and economic viability degree as arranged in Figure 6 which renders it possible to codify any kind of reserve and resource and transfer any class from one system to another.

Figure 5
Proposed UN Mineral Reserve/Resource Terminology



(Note: the terms Feasibility Mineral Resource and Prefeasibility Mineral Resource are proposed as preliminary working terms)

Figure 6
Codification of Classes
(Codification of suggested classes as provided in UN International framework classification)

ECONOMIC AXIS	FEASIBILITY AXIS	GEOLOGICAL AXIS	CODE
Economic	Feasib.St. & Min. Rep.	Detailed Exploration	111
Economic	Prefeasibility Study	Detailed Exploration	121
Economic	Prefeasibility Study	General Exploration	122
Potentially Economic	Feasib.St. & Min. Rep.	Detailed Exploration	211
Potentially Economic	Prefeasibility Study	Detailed Exploration	221
Potentially Economic	Prefeasibility Study	General Exploration	222
Intrinsically Economic[1]	Geological Study	Detailed Exploration	331
Intrinsically Economic[1]	Geological Study	General Exploration	332
Intrinsically Economic[1]	Geological Study	Prospecting	333
Undetermined Economic	Geological Study	Reconnaissance	334

[1] Economic to potentially economic

5. Conclusion

The exercise involving standardisation of terminology and classification of ore and mineral reserves comprehensively conducted by the Committee set up by the Government of India is almost two decades old. Yet it made a sincere attempt to bring an element of harmony into the terminology used in preference to the use of the multitude of terminologies that were being used by the different public, private sector agencies and Government departments. The effort itself was a vast improvement in standardizing the terminology on classification.

The Indian classification did not intentionally attempt to accommodate all the attributes in a single classification scheme. The approach was clearly borne out of the consideration to keep the scheme of classification easily comprehensible to all concerned. Judged from the above perception, the newly proposed UN Framework Classification portrays a scheme which not only accommodates all the attributes in a single classification for all minerals but also the solid fuels. The UN Framework Classification at the same time *prima facie* is simple, easily comprehensible and not cumbersome. It has been able to link the category of reserve to indicate the feasibility of utilisation success reasonably well.

The measured (proved), indicated (probable), inferred (possible) terminologies are too well established both nationally and internationally to permit change. The presently accepted and broadly adopted Indian scheme of classification is significantly compatible (see Annex I) with the UN Framework Classification when viewed in two dimensional matrix. Whatever the existing differences, they are of marginal nature and fringes to some extent on the subjective perception of the specialists engaged on the issue. Such differences are bound to be there and are understandable.

It would be appropriate to mention in this context that besides the traditional way in which reserves and resources are expressed wherein 'resources' progressively become 'reserves' as they are delineated with greater precision and as their commercial extraction becomes more and more viable on account of improved technology or as a result of a rise in commodity price, it may now be necessary to deal with other issues like environmental considerations, quantity of the commodity for which the term "accessibility" has been added as the third access in McKelvey's box.

No two mineral deposits are akin and it is all the more difficult to find their economic analogy. Consequently, perception difference in a mineral classification scheme is bound to be there from country to country and regionally. We feel the worst thing to happen in the world with regard to mineral classification schemes is for everybody to follow the same model of classification. Even the terms, reserve and resource, have a variety of meanings in the various national classification systems throughout the world and it is well recognised that to use these terms for international communication within the UN Framework Classification would therefore mean partially redefining them. This could only be done if the exercise is fully supported by those countries that are affected.

This invariably brings in the attenuated questions - should one attempt to evolve an universal classification? What will be its relevance to national classification? To what event or extent will they be accepted? etc.

It is in the backdrop of the above complex situation, the relevance of the UN Framework Classification would merit in-depth and focused attention.

The proposed UN Framework Classification providing information about the stage of geological assessment, the stage of feasibility assessment and the degree of economic viability and having the flexibility of their being represented either in two dimensional matrix with in-built codification measures or in the three dimensional categorisation of all the three above referred attributes of Economic viability (E), Feasibility assessment (F) and Geological study (G) represented by the edges of a cube, mark a conspicuous refinement of over many of the prevalent classifications adopted all over the world. The digits are quoted in the order of EFG firstly because alphabetical order is easy to memorise and secondly because the first refers to the economic viability, which is of decisive interest to both mining company and investor. It is felt that on account of the simplicity of the scheme, the UN Framework Classification may soon otherwise be reckoned as "EFG" classification. This classification enables easy incorporation of most of the existing national classification systems. Beside their comparison with the "EFG" classification will be further simplified by means of codification acting as interface.

We are sure, India as a nation with the privilege of having geo-scientific institutions like the Geological Survey of India with more than 150 years of exhaustive history of achievement, the relatively newer institutions like the Indian Bureau of Mines, Mineral Exploration Corporation, various public as well as private sector companies, State Departments of Geology & Mining would like to address individually and collectively the scope of further dove-tailing the Indian classification system into the newly formulated UN Framework Classification.

India is slowly but surely trying to become a part of the global economy. The transition from the centrally controlled to market economy situation has made it necessary to open her mineral sector for foreign investment both in exploration and mining. This development will further reinforce the consideration of the scope of integrating the Indian classification to the UN Framework Classification. As the subject is too important to be overlooked, we feel it would be most appropriate to consider a workshop on the subject with the involvement of UN and all the concerned agencies not only for India but preferably for Indian Ocean rim countries.

Annex I

COMPATIBILITY OF UN FRAMEWORK TO INDIAN SYSTEM OF CLASSIFICATION

(AS ADOPTED IN NATIONAL MINERAL INVENTORY (NMI) DATABASE OF INDIAN BUREAU OF MINES)

S.No.	NMI Categories & Status	UN codes	Terminology as per UN classification
1.	Freehold reserves - proved	131,231	No term, corresponding to these codes.
2.	Freehold reserves - probable	132,232	- do -
3.	Freehold reserves - possible	133,233	- do -
4.	Leasehold reserves - proved	111,121	111 – proved mineral reserve. 121 – probable mineral reserve.
5.	Leasehold reserves - probable	112 & 122	122 – probable mineral reserve. No term corresponding to code 112.
6.	Leasehold reserves – possible	113, 123 & 133	No corresponding term.
7.	Conditional resource - proved	331	331 – measured mineral resource.
8	Conditional resource - probable	332	332 – indicated mineral resource.
9.	Conditional resource - possible	333	333 – inferred mineral resource
10.	Prospective	334	334 – reconnaissance mineral resource.
11.	Prognostic	--	--