Bridging Document between National Standard of the People's Republic of China "Classification for Resources/Reserves of Solid Fuels and Mineral Commodities" (GB/T 17766-1999) and "United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009"

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I. Foreword

1. This bridging document between "Classification for Resources/Reserves of Solid Fuels and Mineral Commodities" (GB/T 17766-1999) (hereinafter referred to as "GB/T 17766-1999") and "United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009" (hereinafter referred to as "UNFC-2009") [1] details the correspondence between GB/T 17766-1999 and UNFC-2009.

2. GB/T 17766-1999 is independent of UNFC-2009. This bridging document does not affect the independent application of GB/T 17766-1999.

3. The application of GB/T 17766-1999 does not affect any component of UNFC-2009.

II. Overview of GB/T 17766-1999

II.1 Brief introduction of GB/T 17766-1999

4. GB/T 17766-1999, a national standard issued in 1999, applies to mineral exploration planning and deployment, mineral resources and reserves estimation, preparation of reports of mineral resources and reserves for each stage of exploration and development of mineral resources and reserves. It is not only applicable to the evaluation of mineral resources and reserves, registration, statistics, scheduling, planning, formulation of policies on mineral resources and reserves, and the development of mineral exploration rules, standards and guidelines, but can also serve as the basis

[1]The United Nations Framework Classification for Resources (UNFC) changed its name in April 2017. Prior to this, UNFC was known as the United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009 (UNFC-2009).

for mineral rights transfers and financing for mineral exploration and development.

5. GB/T 17766-1999 classifies Identified Mineral Resources and Undiscovered Resources. Identified Mineral Resources are divided into three classes: Mineral Resources, Basic Reserves and Reserves. GB/T 17766-1999 applies three-dimensional numerical coding scheme in which quantities are classified based on the three fundamental criteria: Degree of Economic Viability (E), Stage of Feasibility Assessment (F) and Degree of Geological Assurance (G). Combinations of these criteria form a three-dimensional system. Figure 1 shows the entire classification and codification of GB/T 17766-1999.

Figure 1

Classification of GB/T 17766-1999

Degree of Geological Assurance / Classification Category / Degree of Economic Viability	Identified Mineral Resources			Undiscovered Resources
	Measured	Indicated	Inferred	Pre-Prospected
Economic	Proved Reserves (111)			
	Basic Reserves (111b)			
	Probable Reserves (121)	Probable Reserves (122)		
	Basic Reserves (121b)	Basic Reserves (122b)		
Marginal Economic	Basic Reserves (2M11)			
	Basic Reserves (2M21)	Basic Reserves (2M22)		
Sub-Marginal Economic	Mineral Resources (2S11)			
	Mineral Resources (2S21)	Mineral Resources (2S22)		
Intrinsic Economic	Mineral Resources (331)	Mineral Resources (332)	Mineral Resources (333)	(334)?

Notes: Codes used in Figure (111－334)

The 1st digit refers to economic viability: 1=Economic; 2M=Marginal Economic; 2S=Sub-Marginal Economic; 3=Intrinsic Economic; ?=Economic-Interest Undefined.

The 2nd digit refers to stage of Feasibility Assessment: 1=Feasibility Study; 2=Pre-Feasibility Study; 3=Scoping Study.

The 3rd digit refers to Degrees of Geological Assurance: 1=Measured; 2=Indicated; 3=Inferred; 4=Pre-Prospected. b= Reserves without deducting any design or mining losses.

II.2 Characteristics of GB/T 17766-1999

6. As a Chinese national standard, GB/T 17766-1999 together with all related technique specifications and guidelines for exploration, constitute a complete standard system for mineral resources in China. It can ensure the orderly, high-quality exploration of mineral resources in China.

7. In the field of estimation and management of mineral resources and reserves, China has outstanding characteristics.

8. The process of mineral exploration and development is divided into three phases: mineral exploration, mine design and construction, and mine production. Mineral exploration is divided into four stages: pre-prospecting, prospecting, general exploration, and detailed exploration.

9. Application of industrial indexes is one of the outstanding characteristics of GB/T 17766-1999. The industrial indexes proposed for the mineral quality and mining technical conditions under technical and economic conditions during a certain period shall serve as the basis for delineation of an ore body and the estimation of mineral resources and reserves. They generally comprise general industrial indexes and verified industrial indexes of a specific ore deposit. The general industrial indexes are derived from the experience accumulated by the industry in the long-term mineral exploration, technical and economic verification and mining activities. They are generally used in pre-prospecting and prospecting stages. The verified industrial indexes of a specific ore deposit come from the technical and economic verification through normative procedures and upon comprehensive consideration of geological, mining, metallurgy, comprehensive utilization, economy, environmental protection, laws and regulations, society and government and other factors by technical personnel of different professions. They are generally used for the general exploration, detailed exploration stages, mine design and construction, mine production phases. The verification of industrial indexes is essentially a process of pre-feasibility study or feasibility study.

10. The content of mineral exploration in China not only includes achieving knowledge of regional geology and ore body geology through geochemical and geophysical surveys and prospecting, mapping, trenching, drilling, down-hole geophysics etc., but also comprises doing appraisal and research of hydrogeology, engineering, environmental geology related to mining technical conditions, and doing research of mineralogy, mineral processing and smelting finally to meet mine design and mine production.

11. GB/T 17766-1999 categories correspond directly to mineral exploration and development stages and level of feasibility assessment as show in Figure 2.

Figure 2

Correspondence among Mineral Exploration and Development Stages, Level of Feasibility Assessment and Categories

Mineral Exploration and Development Stages	Target	Feasibility assessment	Application of industrial indexes	Categories
Pre-Prospecting	Find an area with greater potential for mineralization	Quite simple technical and economic assessment	General industrial index	(334)?sometime a small part of (333)
Prospecting	Find a deposit	Scoping study	General industrial indexes	Main part of (333) and a small part of (334)?
General Exploration	Make a judgement whether the project has any commercial value or not	Prefeasibility study or scoping study	Verified industrial indexes	If the deposit has potentially commercial value, the resources classes are mainly (332),(333) ,with a few (334)? If it has no commercial value, the exploration project will be finished, but no resources are registered into national resources and reserve base.
Detailed Exploration	Do detail exploration to provide grounds for a feasibility Study or mine design and development.	Feasibility study, prefeasibility study or scoping study	Verified industrial indexes	Scoping study: (331),(332) and (333). Prefeasibility study: (121b),(122b), (333),(121),(122). Feasibility study: (111b),(122b),(333),(111),(122).
Mine Design and Construction	Complete mine development and construction on schedule.	Mine Design	Verified industrial indexes	(111b),(122b),(333),(111),(122).
Mine Production	Achieve commercial production on schedule and meet cash flow requirement and quality specification.	Production plan	Verified industrial indexes	(111b),(122b),(333),(111),(122).

III. Overview of UNFC-2009

12. UNFC-2009 was developed by experts organized by the United Nations Economic Commission for Europe (UNECE) and was published with the approval of the UNECE. UNFC-2009 applies to international energy and mineral research, government resource management as well as the industrial process planning and efficient capital allocation of enterprises.

13. UNFC-2009 is a generic principle-based system in which quantities are classified based on the three fundamental criteria: economic and social viability (E), field project status and feasibility (F), and geological

knowledge (G), using a three-dimensional numerical independent coding scheme. Combinations of these criteria form a three-dimensional system.

14. Each criterion (axis) is divided into various categories. For instance, the F axis is divided into three categories: F1, F2 and F3, and each category is further divided into a few sub-categories (for example, F1 is further divided into F1.1, F1.2 and F1.3). The specific classification is shown in Figure 3.

Figure 3

UNFC-2009 Classes and Sub-classes defined by Categories and Sub-categories

UNFC Classes defined by Categories and Sub-categories						
Total commodity initially in place	Extracted	Sales Production				
		Non-sales Production				
	Class		Sub-class	Categories		
				E	F	G
	Known Deposit	Commercial Projects	On Production	1	1.1	1,2,3
			Approved for Development	1	1.2	1,2,3
			Justified for Development	1	1.3	1,2,3
		Potentially Commercial Projects	Development Pending	2	2.1	1,2,3
			Development On Hold	2	2.2	1,2,3
		Non-Commercial Projects	Development Unclarified	3.2	2.2	1,2,3
			Development Not Viable	3.3	2.3	1,2,3
		Additional Quantities in place		3.3	4	1,2,3
	Potential Deposit	Exploration Projects	No sub-classes defined	3.2	3	4
		Additional quantities in place		3.3	4	4

IV. Axis correspondence

IV.1 Correspondence of G axis

15. In GB/T 17766-1999, the G axis represents the degrees of geological assurance, representing the confidence in exploration results, and is

divided into four categories: 1. Measured; 2. Indicated; 3. Inferred; 4. Pre-prospected.

16. In UNFC-2009, the G axis represents geological knowledge and is divided into four categories.

17. The categories of the G axis of GB/T 17766-1999 and UNFC-2009 essentially correspond to each other as shown in the gray area in Figure 4.

Figure 4

Axis correspondence of GB/T 17766-1999 and UNFC-2009

<table>
<tr><th colspan="2" rowspan="2">GB/T 17766-1999</th><th colspan="3">UNFC-2009</th></tr>
<tr><th>Category</th><th>Sub-Category</th><th></th></tr>
<tr><td rowspan="8">Economic Viability</td><td rowspan="2">1</td><td rowspan="2">E1</td><td>E1.1</td><td rowspan="8">Economic and Social Viability</td></tr>
<tr><td>E1.2</td></tr>
<tr><td>2M</td><td rowspan="3">E2</td><td rowspan="3"></td></tr>
<tr><td>2S</td></tr>
<tr><td>3</td></tr>
<tr><td></td><td rowspan="3">E3</td><td>E3.1</td></tr>
<tr><td>3</td><td>E3.2</td></tr>
<tr><td></td><td>E3.3</td></tr>
<tr><td rowspan="4">Stage of Fesibility Study</td><td>1</td><td rowspan="2">F1/F2</td><td></td><td rowspan="4">Field Project Status and Feasibility</td></tr>
<tr><td>2</td><td></td></tr>
<tr><td rowspan="2">3</td><td>F2</td><td></td></tr>
<tr><td>F3</td><td></td></tr>
<tr><td></td><td>F4</td><td></td><td></td></tr>
<tr><td rowspan="4">Degrees of Geological Assurance</td><td>1</td><td>G1</td><td></td><td rowspan="4">Geological Knowledge</td></tr>
<tr><td>2</td><td>G2</td><td></td></tr>
<tr><td>3</td><td>G3</td><td></td></tr>
<tr><td>4</td><td>G4</td><td></td></tr>
</table>

IV.2 Correspondence of F axis

18. In GB/T 17766-1999, the F axis represents the stage of feasibility assessment and is divided into three categories: 1. Feasibility study, 2. Pre-Feasibility study and 3. Scoping study. No sub-category is defined.

19. In UNFC-2009, the F axis represents the field project status and feasibility and is divided into four categories: F1, F2, F3 and F4, in which

F1 and F2 can be divided into sub-categories. The correspondence of the F axis is shown in the blue area in Figure 4.

20. GB/T 17766-1999 emphasizes the level of the feasibility assessment, and UNFC-2009 emphasizes field project status and technical feasibility. Their categories do not correspond to each other. Generally, a feasibility study or pre-feasibility study on the technical factors may have two results: one is that the current technical condition can meet the requirement of a mine development or production; another is that the technical feasibility of the project needs to be confirmed further. Therefore, both categories "1" and "2" of the F axis in GB/T 17766-1999 may correspond to F1 or F2 in UNFC-2009.

21. Scoping study that is a preliminary assessment of the technical and economic viability for the development of mineral resources may apply to all stages of mineral exploration activities. The conclusions of the scoping study in the prospecting stage have a relatively low degree of confidence. The conclusions of the scoping study during general exploration and detailed exploration and have a higher degree of confidence, especially with verification of industrial index. The scoping study corresponds to F2 in UNFC-2009.

22. At the pre-prospecting stage in GB/T 17766-1999, it is required that local geological studies and exploration activities, site-specific geological studies and exploration activities should be done and Undiscovered Resources may be estimated. The level of the feasibility assessment at this stage is actually lower than Scoping Study although its GB/T 17766-1999 classification of F3 is the same as Scoping Study. In this case, the level of the technical feasibility in GB/T 17766-1999 corresponds to F3 in UNFC-2009 as shown in Figure 4.

23. F4 in UNFC-2009 is not defined in GB/T 17766-1999.

IV.3 Correspondence of E axis

24. In GB/T 17766-1999, the E axis represents the evaluation of the economic rationality at that time, and is divided into 4 categories: Economic, Marginal Economic (2M), Sub-Marginal Economic (2S) and Intrinsic Economic. No sub-categories are defined.

25. In UNFC-2009, the E axis represents economic and social viability, and is divided into E1, E2 and E3 categories. E1 and E3 can be divided into sub-categories.

26. In GB/T 17766-1999, "Economic" represents the fact that the pre-feasibility or feasibility study shows that extraction at the time is economically reasonable under the market conditions, or it is possible to

develop with assistance from government subsidies and other forms of assistance. It corresponds to E1.1, E1.2 sub-category in UNFC-2009;

27. “Marginal Economic” represents the fact that the pre-feasibility or feasibility study shows that extraction at the time is uneconomic , but may become economic as a result of improved conditions or through other supportive measures of governments in the future. It corresponds to E2 in UNFC-2009.

28. “Sub-Marginal Economic” represents the fact that the pre-feasibility or feasibility study shows that extraction at the time is not economic or is not technically feasible and would require substantially higher commodity prices or a major cost-reducing advance in technology before it becomes economic. Generally, it corresponds to E2 in UNFC-2009.

29. “Intrinsic Economic” refers to the mineral resources which have been through a scoping study. It represents the fact that extraction of the mineral resources is expected to become economically viable in the foreseeable future. Category “Intrinsic Economic” corresponds to E2 in UNFC-2009.

30. “Economic-Interest Undefined”, where it is impossible to determine its degree of economic viability due to insufficient information, only corresponds to undiscovered resources achieved at the pre-prospecting stage in GB/T 17766-1999. It corresponds to E3.2 in UNFC-2009.

31. E3.1and E3.3 in UNFC-2009 are not defined in GB/T 17766-1999.

V. Correspondence of classes and categories

32. GB/T 17766-1999 and UNFC-2009 do not correspond to each other very well for the E and F axis, but they may correspond between classes as shown in Figure 5 and Figure 6.

33. “Reserves” in GB/T 17766-1999 correspond to the “Commercial Projects” class in UNFC-2009.

34. “Basic Reserves” with “b” in GB/T 17766-1999 generally equal to “Reserves” plus relevant design or mining losses. For example, (111b) equal to (111) plus (design or mining losses). They are not defined in UNFC-2009.

35. “Basic Reserves” beginning with “2M” corresponds to the “Potentially Commercial Projects” class in UNFC-2009.

36. “Mineral Resources” beginning with 2S in CCMR-199 correspond to the “Potentially Commercial Projects” class in UNFC-2009.

37. “Intrinsic Economic Mineral Resources” correspond to “Potentially Commercial Projects” class in UNFC-2009.

38. “Economic-Interest Undefined Undiscovered Resources”, that is (334)? corresponds to “Exploration projects” class in UNFC-2009.

Figure 5

Mapping of GB/T 17766-1999 to UNFC-2009 Classes and Categories.

<table>
<tr><th colspan="2">CCMR-1999Class</th><th colspan="4">CCMR-1999Categories</th><th>UNFC-2009Class</th><th>UNFC-2009"minimum"Categories</th><th></th><th></th></tr>
<tr><td rowspan="2">Economic</td><td rowspan="2">Reserves</td><td>(111)</td><td></td><td></td><td></td><td rowspan="2">commercial projects</td><td rowspan="2">E1</td><td rowspan="2">F1</td><td rowspan="2">G1,G2</td></tr>
<tr><td>(121)</td><td>(122)</td><td></td><td></td></tr>
<tr><td rowspan="4">Marginal Economic
Sub-Marginal</td><td rowspan="4">Basic Reserves</td><td>(111b)</td><td></td><td></td><td></td><td colspan="4" rowspan="2">Not defined in UNFC-2009</td></tr>
<tr><td>(121b)</td><td>(122b)</td><td></td><td></td></tr>
<tr><td>(2M11)</td><td></td><td></td><td></td><td rowspan="4">Potentially commercial projects</td><td rowspan="4">E2</td><td rowspan="4">F2</td><td rowspan="4">G1,G2,G3</td></tr>
<tr><td>(2M21)</td><td>(2M22)</td><td></td><td></td></tr>
<tr><td rowspan="2">Sub-Marginal</td><td rowspan="3">Mineral Resources</td><td>(2S11)</td><td></td><td></td><td></td></tr>
<tr><td>(2S21)</td><td>(2S22)</td><td></td><td></td></tr>
<tr><td>Intrinsic Economic</td><td>(331)</td><td>(332)</td><td>(333)</td><td></td></tr>
<tr><td>Economic -Interest Undefined</td><td>Undiscovered Resources</td><td></td><td></td><td></td><td>(334)?</td><td>Exploration projects</td><td>E3</td><td>F3</td><td>G4</td></tr>
</table>

Figure 6

Mapping of GB/T 17766-1999 to UNFC-2009 by E-F Axes.

	F1.1	F1.2	F1.3	F2.1	F2.2	F2.3	F3	F4
E1.1	1	2	3	4				
E1.2	1	2	3					
E2			4	4	5			
E3.1	10	10	10	10	10	10		
E3.2			6	6	6		9	
E3.3			7	7	7	7		8

			UNFC-2009 Sub-Class
Economic	Reserves	1	On production
		2	Approved for Develepment
		3	Justified for Development
	Basic Reserves	Not defined in UNFC-2009	
Marginal Economic	Basic Reserves	4	Development Pending
		5	Development On hold
Sub-Marginal Economic	Mineral Resources	4	Development Pending
		5	Development On hold
Intrinsic Economic	Mineral Resources	4	Development Pending
		5	Development On hold
Not defined in CCMR-1999		6	Development Unclarified
		7	Development Not Viable
		8	Additional Quantities in Place
Economic-Interest Undefined	Undiscovered Resources	9	Exploration Project
Not defined in CCMR-1999		10	Quantities forecast to be extracted but not available for sale
Less common mappings			