Case Study on Bridging from the China National Standard of Classifications for Petroleum Resources and Reserves (GB/T 19492-2020) to the United Nations Framework Classification for Resources (UNFC Update 2019): Gas Field A

Prepared by the Research Institute of Petroleum Exploration and Development of China National Petroleum Corporation, in cooperation with the Technical Advisory Group of the Expert Group on Resource Management

I. Introduction

1. This case study was prepared by Research Institute of Petroleum Exploration and Development of China National Petroleum Corporation, in cooperation with the Technical Advisory Group of the Expert Group on Resource Management. Major contributors are YANG Hua, XIA Mingjun, SHAO Xinjun, YUAN Ruie, YI Yanjing, Alistair JONES, Satinder PUREWAL, Olga TROFIMOVA and Jan BYGDEVOLL.

2. This case study is based on the supporting information provided by a Chinese national oil company. Through the Bridging Document between the China National Standard of Classifications for Petroleum Resources and Reserves (GB/T19492-2020) and the United Nations Framework Classification for Resources (UNFC Update 2019), hereinafter referred to as the China Petroleum Bridging Document[1], the petroleum resources and reserves of Gas Field A, estimated per GB/T 19492-2020 at three Exploration and Development Stages within its whole life-cycle, are mapped to UNFC numerical codes.

3. This case study is intended to provide demonstration and application guidelines for the global interconnection among resources management systems and application of the China Petroleum Bridging Document in practice.

II. Basic Information

A. Introduction

4. The Rationale for resource classification and evaluation in this case study includes: the China National Standard of Classifications for Petroleum Resources and Reserves (GB/T 19492-2020); the Industrial Standards of Regulation of Petroleum Reserves Estimation (DZ/T 0217-2020); the Estimation Methods of Natural Gas Recoverable Reserves (SY/T 6098-2010), the Petroleum

[1] Please refer to the UNECE website: https://unece.org/sustainable-energy/sustainable-resource-management/unfc-documents#accordion_1, or https://unece.org/sed/documents/2024/03/reports/updated-chinese-petroleum-bridging-document-october-2022-chinese

Resources Management System (SPE-PRMS2018)[2], the United Nations Framework Classification for Resources (UNFC Update 2019); and, the Bridging Document between the National Standard of the People's Republic of China Classifications for Petroleum Resources and Reserves (GB/T 19492-2020) and the United Nations Framework Classification for Resources (UNFC Update 2019).

5. Through a look-back process, this case study is intended to illustrate the mapping scenarios at three Exploration and Development Stages of Gas Field A, including the Exploration and Appraisal Stage, Initial Development Stage, and Late Production Stage.

B. Overview of Estimates per GB/T 19492-2020

1. Background of Gas Field A

6. Gas Field A is a fractured-vuggy type stratified carbonate gas reservoir, located in a mature petroliferous basin. It was discovered by the Wildcat E1 based on 2D seismic data. After being acidized, well E1 achieved commercial production of $736\times10^3 m^3/d$. Subsequently, 3D seismic acquisition and interpretation were performed in this area and two appraisal wells, A2 and A3, were drilled. The 3D seismic defined a structural spill point at 4,810 metres true vertical depth sub-sea (mTVDSS) with a trap acreage of 35.95 km^2. By logging interpretation, the net pay in wells A2 and A3 are estimated as 21.3 m and 35.8 m respectively. After being acidized, the productivity of well A3 was tested as $872.2\times10^3 m^3/d$ and well A2 failed due to a casing fish. So far, no gas-water contact has been penetrated. According to the approved field development plan, Gas Field A was put into progressive development in two phases. After 18 years depletion, this field is now in its late production stage with declined production close to the economic limit.

7. The example field has experienced almost a full life cycle from discovery to abandonment. According to the applicable Chinese standards for resource classification and evaluation, the estimates in the Exploration and Development stages of the example field were derived based on its maturity, the certainty on geological knowledge, productivity verification with the geological and engineering data available, and the company's technical and economic conditions.

2. Exploration and Appraisal Stage

8. **Status description**: In the Exploration and Appraisal Stage of Gas Field A, after the wells E1, A2 and A3 were drilled, data available for resource estimation included structural maps demonstrated by 3D seismic data, rock and fluid properties based on lab analysis, the lowest known gas of 4,740 mTVDSS identified by well A3, and recovery factor by depletion of 68.2% from analogous reservoirs. The economic analysis was conducted in the feasibility study.

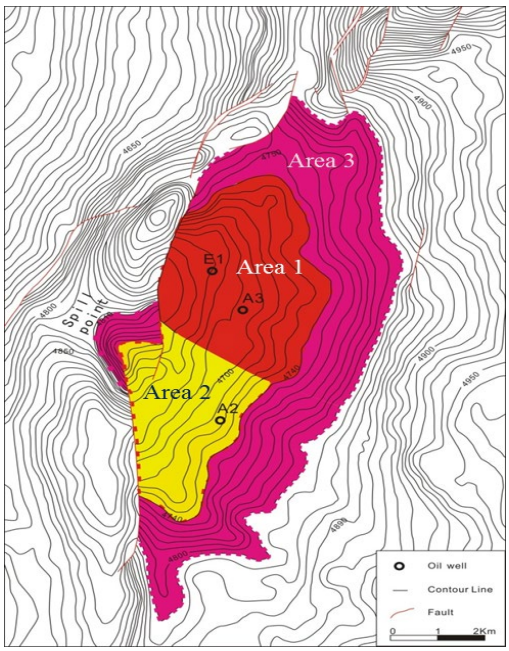
9. **Resource classification**: As shown in Figure I, according to the lowest known gas and the identified spill point of 4,740 mTVDSS, the whole gas-bearing area was divided into three parts: **Area 1** with an acreage of 9.96 km^2 above the lowest known gas, classified as **Proved** considering

[2] https://www.spe.org/media/filer_public/b9/a1/b9a14c08-4116-49c9-aaf5-a2c47720f391/prms_2018_english-chinese_feb_2024.pdf

that there is a high level of confidence in gas bearing volumes for Area 1 and a final investment decision is expected; **Area 2** with an acreage of 6.94 km^2 above the lowest known gas, classified as **Probable** considering that there is a moderate level of confidence in gas bearing volumes for Area 2; and **Area 3**, delineated by contour lines of 4,740 mTVDSS and 4,810 mTVDSS, classified as **Possible** considering that there is a low level of confidence in gas bearing volumes and more data needs to be acquired.

Figure I

Resource Classification at the Exploration and Appraisal Stage: Gas Field A



10. **Resources estimation outcomes**: According to Chinese standards for resource classification and evaluation[3], using volumetric and analogy methods, the resource estimates of three Areas of Gas Field A are derived and summarized in Table 1.

Table 1:

Summary of Estimates at the Exploration and Appraisal Stage: Gas Field A

Categories	Acreage（km^2）	Discovered PIIP（10^9m^3）	Technical Recoverable Reserves (TRR) (10^9m^3)	Commercial Recoverable Reserves (CRR) (10^9m^3)	Sub-Commercial Recoverable (SCR)（10^9m^3）	Unrecoverable Quantity（10^9m^3）
Proved	9.96	3.12	2.13	1.28	0.85	0.99
Probable	6.94	2.17	1.48	1.15	0.33	0.69
Possible	19.05	5.96	4.07	not defined	not defined	1.89
Total	35.95	11.25	7.68	2.43	1.18	3.57

[3] Refer to the Figure 1 and Figure 2 of the China Petroleum Bridging Document.

Note: Discovered PIIP refers to Discovered Petroleum Initially-In-Place (i.e. Geological Reserves, as defined in the Bridging Document).

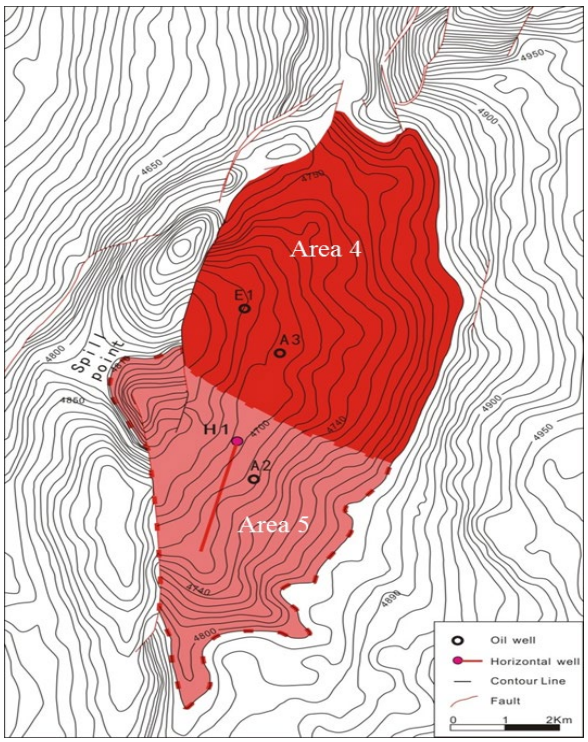
3. Initial Development Stage

11. **Status description**: In the Initial Development Stage of Gas Field A, based on in-depth regional geological research, 3D seismic inversion data, geological modeling and reservoir numerical simulation, a two-phase progressive field development plan (FDP) of Gas Field A was adopted. In Phase I, the field was planned to be depleted by wells E1 and A3 using the existing facilities and infrastructure; and in Phase II, one more horizontal well H1 was to be drilled with production start-up through new facilities in the third year. According to this FDP, the recovery factor of Gas Field A was increased to 70.5%.

12. **Resource classification**: According to data available and integrated studies, the whole acreage of the structure trap was demonstrated to be gas-bearing, and classified as **Proved** (see Figure II), in which, as wells E1 and A3 were put into production in the first year, Area 4 is categorized as **Proved Developed** CRR. Area 5, with the planned well H1 still in the process of construction, categorized as **Proved Undeveloped** CRR.

Figure II

Resource Classification at the Initial Development Stage: Gas Field A



13. **Resources estimation outcomes**: Entering the development period, Gas Field A has measured categories in its inventory. With more data, integrated studies, a committed FDP available, and after

the first year of production, the associated resource estimates of Gas Field A in the Initial Development Stage are updated and summarized in Table 2.

Table 2:

Summary of Estimates at the Initial Development Stage: Gas Field A

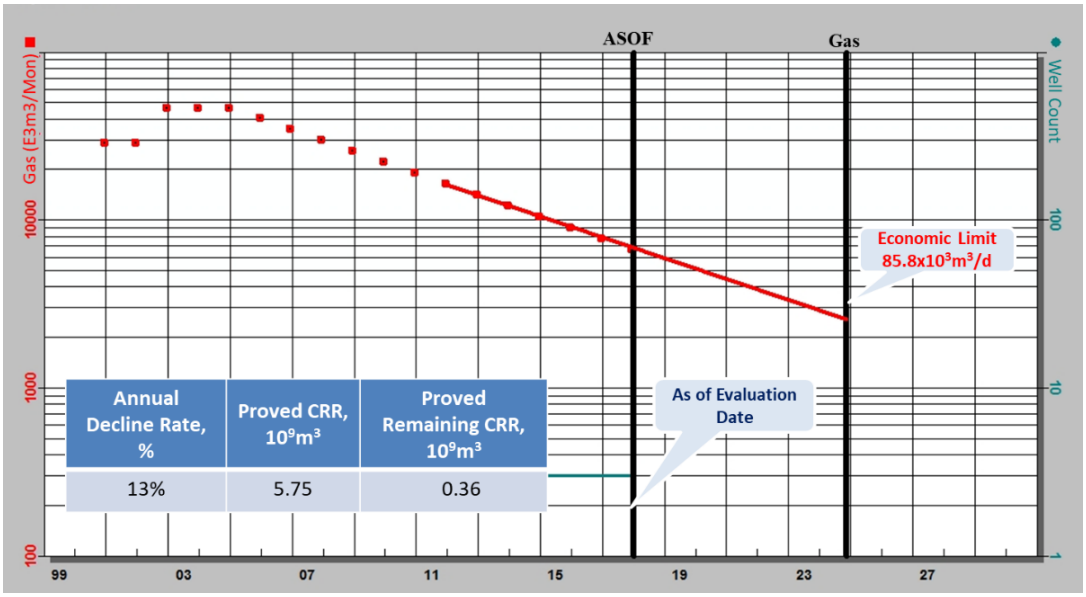
Category	Acreage (km^2)	Discovered PIIP (10^9m^3)	Technical Recoverable Reserves (10^9m^3)	Commercial Recoverable Reserves (10^9m^3)		Remaining Commercial Recoverable Reserves (10^9m^3)	Sub-Commercial Recoverable (10^9m^3)	Unrecoverable Quantity (10^9m^3)
				Developed	Undeveloped			
Proved	36.2	9.16	6.46	3.56	1.81	3.22	1.09	2.7

4. Late Production Stage

14. Status Description: After being in operation for 18 years, the cumulative gas production of the example field reached 5.39×10^9 m^3. The field is in the period of late stage of decline. See Figure III.

Figure III

Production Performance Analysis at the Late Production Stage: Gas Field A



15. **Resource classification**: The whole gas-bearing area of the structural trap is classified as **Proved**, with Proved Remaining CRR, Proved SCR, and Proved Unrecoverable Quantity in the gas inventory.

16. **Resources estimation outcomes**: According to the Decline Curve Analysis, the Technical Recoverable Reserves (TRR) of the field was estimated as 6.64×10^9 m^3. Under current economic conditions, the economic limit was 85.8×10^3 m^3/d, which resulted in in the Commercial

Recoverable Reserves (CRR) of 5.75 $\times 10^9$ m^3 and Proved Remaining CRR of 0.36 $\times 10^9$ m^3 with a recovery factor accounting for 72.5%. Estimation outcomes are summarized in Table 3.

Table 3

Summary of Estimates at the Late Production Stage: Gas Field A

Category	Acreage (km^2)	Discovered PIIP (10^9m^3)	Technical Recoverable Reserves (10^9m^3)	Commercial Recoverable Reserves (10^9m^3)	Remaining Commercial Recoverable Reserves (10^9m^3)	Sub-Commercial Recoverable (10^9m^3)	Unrecoverable Quantity (10^9m^3)
Proved	36.2	9.16	6.64	5.75	0.36	0.89	2.52

III. Key Highlights in the Bridging Document

17. The National Standard of Classification for Petroleum Resources/Reserves (GB/T 19492-2020) is an Aligned System of UNFC as demonstrated by the existence of a bridging document that has been endorsed by the Expert Group on Resource Management. The Bridging Document explains the mapping scheme between the reserves and resources by categories of the China Classification (GB/T 19492-2020) and UNFC's Classes and Categories, and is intended to guide stakeholders who are reporting petroleum resource estimates under Chinese standards with UNFC codes.

18. The correspondence of E and F Axes is shown in Figure IV.

Figure IV

Mapping of UNFC E-F Matrix to GB/T 19492-2020[4]

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

Classes	*Sub-classes*	*Code*	*GB/T 19492-2020 Classes/Categories*
Viable Projects	On Production	1	Proved Remaining Developed CRR
	Approved for Development	2	Proved Undeveloped CRR
	Justified for Development	3	Proved Undeveloped CRR
Potentially Viable Projects	Development Pending	4	Proved SCR, Probable Remaining CRR, Probable SCR, Possible TRR

[4] Source from the Figures 4 and Figure 5 of the China Petroleum Bridging Document.

	Development on Hold	5	Proved SCR, Probable Remaining CRR, Probable SCR, Possible TRR
Non-Viable Projects	Development Unclarified	6	Probable SCR, Possible TRR
	Development Not Viable	7	Probable SCR, Possible TRR
Remaining products not developed from identified projects		9	Proved, Probable and Possible UQs
Prospective Projects	No Sub-classes defined	8	Recoverable Resources
Remaining products not developed from prospective projects		9	Undiscovered UQ
Production which is unused or consumed in operations		10	Not defined

19. The correspondence of G Axis is shown in Table 4.

Table 4

Mapping GB/T 19492-2020 categories to UNFC G Axis [5]

GB/T 19492-2020 Classes and Categories					*UNFC Category*
Discovered	Proved PIIP	Proved TRR	Proved CRR	Production	
				Proved Remaining CRR	G1
			Proved SCR		
		Proved UQ			
	Probable PIIP	Probable TRR	Probable CRR	Production	
				Probable Remaining CRR	G1+G2
			Probable SCR		
		Probable UQ			
	Possible PIIP	Possible TRR			G1+G2+G3
		Possible UQ			
Undiscovered	Resources	Recoverable Resources			G4
		Undiscovered UQ			

[5] Source from the Figure 3 of the China Petroleum Bridging Document.

IV. Correspondence of Axes for the Example Case

A. Mapping Summary

20. According to the Bridging Document, the resource estimates in the Exploration and Appraisal Stage, Initial Development Stage, and Late Production Stage of Gas Field A are mapped to UNFC numerical codes as summarized in Table 5.

Table 5:

Mapping Estimates Summary per GB/T 19492-2020 to UNFC: Gas Field A

GB/T 19492-2020 Categories						Estimates ($10^9 m^3$)	UNFC Codes
Exploration and Appraisal Stage	Proved PIIP	Proved TRR	Proved Undeveloped CRR			1.28	E1.1F1.3G1
			Proved SCR			0.85	E2F1.3G1
		Proved UQ				0.99	E3.3F4G1
	Probable PIIP	Probable TRR	Probable CRR			1.15	E1.1F2.1(G1+G2)
			Probable SCR			0.33	E2F2.1(G1+G2)
		Probable UQ				0.69	E3.3F4(G1+G2)
	Possible PIIP	Possible TRR				4.07	E2F2.1(G1+G2+G3)
		Possible UQ				1.89	E3.3F4(G1+G2+G3)
Initial Development Stage	Proved PIIP	Proved TRR	Proved CRR	Proved Developed CRR	Cum. Production	0.34	
					Proved Developed Remaining CRR	3.22	E1.1F1.1G1
				Proved Undeveloped CRR		1.81	E1.1F1.2G1
			Proved SCR			1.09	E2F1.1G1
		Proved UQ				2.70	E3.3F4G1
Late Production Stage	Proved PIIP	Proved TRR	Proved CRR	Proved Developed CRR	Cum. Production	5.39	
					Proved Developed Remaining CRR	0.36	E1.1F1.1G1
			Proved SCR			0.89	E3.3F2.3G1
		Proved UQ				2.52	E3.3F4G1

B. Mapping Description

21. **Exploration and Appraisal Stage.** Per Chinese standards system, Gas Field A was booked with Proved Undeveloped CRR, Proved SCR, Probable CRR, Probable SCR, Possible TRR, and Proved, Probable and Possible UQs. According to the Bridging Document, the mapping correspondence can be identified, and then further verified by matching the status of Gas Field A with UNFC definitions.

1. E Axis

(a) Proved Undeveloped CRR: Based on production test and feasibility study in Exploration and Appraisal Stage, it was economic to produce both wells E1 and A3, hence the estimates for Area 1 should be assigned as E1.1.

(b) Proved SCR: According to the mapping scheme of the Bridging Document, potential digital codes are 4, 5, 6 and 7, corresponding to E1.1, E2, E3.2 and E3.3 respectively. The

additional production is sub-economic under current conditions, however there is a reasonable expectation of socio-economic viability in the foreseeable future. As verified with UNFC definitions, it should be mapped to E2.

(c) Probable CRR: According to the pre-feasibility study for Area 2, its future development is economic and should be assigned as E1.1.

(d) Probable SCR: Like the Proved SER, potential codes are 4, 5, 6 and 7, corresponding to E1.1, E2, E3.2 and E3.3 respectively. Under current conditions, the additional production is sub-economic, however there is a reasonable expectation of socio-economic viability in the foreseeable future. As verified with UNFC definitions, the most appropriate code is E2.

(e) Possible TRR: Similarly, according to the Bridging Document, possible codes are 4, 5, 6 and 7, corresponding to E1.1, E2, E3.2 and E3.3 respectively. Through analogy, it is expected to be socio-economically viable in the foreseeable future. As verified with UNFC definitions, the appropriate code is E2.

(f) Proved, Probable and Possible UQs: According to the Bridging Document, should be assigned as E3.3.

2. F Axis

(a) Proved Undeveloped CRR and Proved SCR: For Area 1 with wells E1 and A3, as it is in a mature region with facilities available, 3D seismic interpretation, production tests and the development feasibility study for depletion have been achieved, there are reasonable expectations of a final investment decision. At this stage, the project has been demonstrated to be technically feasible and corresponds to Code F1.3[6]. There is a reasonable expectation that all necessary approvals/contracts for the project to proceed to development will be forthcoming.

(b) Probable CRR and Probable SCR: For Area 2, well A2 failed in the production test. By analogy, it is expected to be potentially economic in the foreseeable future. In this stage, project activities are ongoing to further justify its development, and the most appropriate F axis code is F2.1.

(c) Possible TRR: Area 3 in the gas field is actively being appraised to promote full delineation and development, and thus should be classified as F2.1.

(d) Proved, Probable and Possible UQs: According to the mapping scheme of the Bridging Document, this should be classified as F4 since no development has been identified to produce these volumes.

3. G Axis

[6] Refer to the Paragraph 44 of the China Petroleum Bridging Document.

(a) Proved categories, corresponding to G1.

(b) Probable categories, corresponding to G1+G2.

(c) Possible categories, corresponding to G1+G2+G3.

22. **Initial Development Stage.** Per Chinese standards system, Gas Field A was booked with Proved Developed Remaining CRR, Proved Undeveloped CRR, Proved SCR, and Proved UQ. According to the Bridging Document, the mapping correspondence can be identified, and then further verified by matching Gas Field A's status with UNFC definitions.

1. E Axis

(a) Proved Developed Remaining CRR: Per the Bridging Document, it should be classified as E1.1.

(b) Proved Undeveloped CRR: According to the mapping scheme of the Bridging Document, corresponds to code 3. As its feasibility study is economic, it should be classified as E1.1.

(c) Proved SCR: Mapping check with the E-F matrix of the Bridging Document, shows that potential corresponding codes are 4, 5, 6 and 7, associated with E1.1, E2, E3.2 and E3.3 respectively. Under the conditions of the evaluation date, the estimate is sub-economic, however there is a reasonable expectation of socio-economic viability in the foreseeable future. As verified with UNFC definitions, the most appropriate code is E2.

(d) Proved UQ: In the E-F matrix of the Bridging Document, it is mapped to E3.3.

2. F Axis

(a) Proved Developed Remaining CRR: Field development is under way and this category should be classified as F1.1.

(b) Proved Undeveloped CRR: In the initial development stage, the two-phase FDP has been approved and the capital funds have been committed. According to UNFC definitions, the corresponding code is F1.2.

(c) Proved SCR: As the FDP of Gas Field A has been approved and implemented, for the Proved Developed volume, F1.1 should be assigned; while for the Proved Undeveloped volume, F1.2 should be assigned.

(d) Proved UQ: According to the Bridging Document, it should be assigned as F4.

3. G Axis

(a) In the initial development stage, the whole gas field was classified as **Proved**, related categories correspond to G1 in UNFC per the Bridging Document.

23. **Late Production Stage.** Per Chinese standards system, Gas Field A was booked with Proved Developed Remaining CRR, Proved SCR, and Proved UQ. According to the Bridging Document, the mapping correspondence can be identified, and then further verified by matching the status of Gas Field A with UNFC definitions.

1. **E Axis**
   (a) Proved Developed Remaining CRR are economic, as the production rate exceeds the economic limit under current economic conditions. It should be mapped to E1.1 in UNFC.
   (b) Proved SCR. According to the Bridging Document, optional codes are 4, 5, 6 and 7, associated with E1.1, E2, E3.2 and E3.3 respectively. As this field is close to abandonment and it is currently considered that there are not reasonable prospects for economic development and sale in the foreseeable future, its corresponding code is E3.3.
   (c) Proved UQ. In the E-F matrix of the Bridging Document, it is mapped to E3.3.
2. **F Axis**
   (a) Proved Developed Remaining CRR, should be assigned to F1.1 in UNFC per the Bridging Document.
   (b) Proved SCR. Due to E3.3 identified; the possible code is 7. As there is no additional adjustment plan available for this volume in the foreseeable future, it should be mapped to F2.3.
   (c) Proved UQ. According to the Bridging Document, it should be assigned as F4.
3. **G Axis**
   (a) In the Late Production Stage, the Proved categories in GB/T 19492-2020 should be mapped to G1 in UNFC.

V. Discussion

24. A Bridging Document is a document that explains the relationship between UNFC and another classification system, including instructions and guidelines on how to classify estimates generated by application of that system using the UNFC Numerical Codes. Bridging Documents are hence of significance to promote global communication in both resource evaluation and administrative management.

25. China has developed an integrated petroleum resource classification and evaluation standard system to support the full life cycle petroleum resources/reserves management and estimation,

serving the demand of both the sovereign and company's business.

26. According to the Bridging Document, it was found that the mapping between GB/T 19492-2020 and UNFC categories does not always give a one-to-one correspondence. It would be helpful to further verify the corresponding relationship by cross checking with UNFC definitions or direct categorization per UNFC [7].

27. UNFC is a classification framework system, whose code-characterized estimates cannot yet be directly mapped to the China's classification and evaluation system yet. Further checks are needed with underlying resources management system and rules.

VI. CONCLUSION

28. In this case study, using the Bridging Document between GB/T 19492-2020 and UNFC, resource estimates in full life cycle of a typical gas field can be successfully mapped to UNFC with its numerical codes.

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[7] This exercise will be addressed in a subsequent case study.