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Case studies and testing of the United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009

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Case study – application of the United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009 to solid minerals

Note by the secretariat

I. Introduction

1. This study is based on the work undertaken by Stephen Henley in his capacity as a representative of the Committee for Mineral Reserves International Reporting Standards (CRIRSCO) and Deputy Chairman of the Pan-European Reserves & Resources Reporting Committee (PERC). The purpose of this study is to illustrate the mapping of minerals data from reports using CRIRSCO-aligned standards to the United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009 (UNFC-2009). Published data from a range of different companies and types of company have been used, to provide examples covering a variety of different circumstances, project types, and to show how the specifications and bridging documents may be used.

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A. Terms of Reference

2. The objectives and targets defined in the Terms of Reference for the study are as follows:

(a) The Specifications for the Application of the United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009 (UNFC-2009) were finalized by the Expert Group on Resource Classification at its fourth session in April 2013. The Specifications make UNFC-2009 operational. The Specifications include bridging documents to the two key aligned systems for solid minerals (CRIRSCO Template) and for petroleum (Petroleum Resource Management System (PRMS)). The bridging documents explain the relationship between UNFC-2009 and the CRIRSCO Template and PRMS, including instructions and guidelines on how to classify estimates generated by application of each system using the UNFC-2009 Numerical Codes;

(b) It is essential that UNFC-2009 is now tested to identify: (i) how well the system works in practice; (ii) areas for improvement in both the framework and the specifications (including the bridging documents with the aligned systems); (iii) areas where guidelines are needed to assist users; (iv) recommendations for potential users. Pilot and case studies are critical, particularly for the application of UNFC-2009 to solid minerals since a number of countries around the world are still working with the 1997 version of UNFC (which applies to solid minerals only). The changes made to the 2009 version, in order to achieve alignment with the CRIRSCO Template and PRMS, mean that it is not possible to map directly from the 1997 to the 2009 version of UNFC hence case studies will provide detailed instructions on how UNFC-2009 can be used for application to solid minerals;

(c) Through identification of a suitable pilot, a detailed study could test if the data relating to the mines in a single country can be mapped or transferred into UNFC-2009 (incorporating the generic specifications and using the CRIRSCO bridging document). This would identify if UNFC-2009 meets the needs of Governments in the area of minerals reporting, as well as any challenges or additional guidance that would need to be given to users.

B. Source Documentation

3. The source documentation used is as follows:

(a) Published reports from companies selected to be used as case studies;

(b) UNFC-2009: ECE Energy Series No. 39 (ECE/ENERGY/85);

(c) Specifications for the Application of UNFC-2009 finalized in April 2013, including Annex III, the Bridging Document for CRIRSCO, now published as ECE Energy Series No. 42 (ECE/ENERGY/94);

(d) CRIRSCO Template (2006) and updated CRIRSCO Template (November 2013);

(e) CRIRSCO Position Paper on Mineralisation Beyond Inferred Resources;

(f) Joint Ore Reserves Committee (JORC) Code (2004) and 2012 update;

(g) PERC Reporting Code (2008) and 2013 update.

4. The JORC Code and the PERC Reporting Code are both CRIRSCO-aligned reporting standards, developed for use in Australasian and European jurisdictions respectively.

Together with the versions of the CRIRSCO Template, they can be downloaded from the CRIRSCO website[1].

5. It should be noted that this report contains a number of references to the updated CRIRSCO Template (November 2013). Significant relevant changes include:

(a) New agreed standard definitions to be used in new versions of all CRIRSCO standards;

(b) Effective Date and Reference Point definitions added, to harmonise with UNFC-2009;

(c) Exploration Target definition added, to harmonize with some of the existing CRIRSCO standards; and

(d) Feasibility Study, Pre-feasibility Study, and Scoping Study definitions added.

C. Underlying principles

6. These will be discussed further in section IV below, but it should be noted that the various CRIRSCO-aligned reporting standards define rules and guidelines for the public reporting by companies of Exploration Results, estimates of Mineral Resources, and estimates of Mineral Reserves, all of which must be approved by an appropriately qualified and experienced Competent Person (or 'Qualified Person' in Canada, 'Qualified Competent Person' in Chile, both with the same meaning). UNFC-2009 was developed as a classification rather than a reporting standard and its definition therefore does not include any specifications for methods or standards of disclosure, which are a matter purely for agreement between users of the classification. As noted in the introduction to Annex III of the UNFC-2009 Specifications (the Bridging Document between the CRIRSCO Template and UNFC-2009):

- "A long-standing agreement is in place for CRIRSCO to provide the commodity specific specifications for solid minerals. In accordance with this agreement, CRIRSCO has provided commodity-specific specifications via the CRIRSCO Template of 2006 (hereinafter referred to as the "Template"). Along with the Generic Specifications, these provide the foundation and keystones for consistent application of UNFC-2009 for solid minerals."

7. The definition of UNFC-2009 allows the recording of more detail ('granularity') than is in the CRIRSCO classification, and in some company reports there is sufficient information to allow the mapping of data recorded using the CRIRSCO classification into sub-classes of UNFC-2009. Some of the case studies selected for this report illustrate how this can be achieved.

II. Identification of case studies

8. In order to provide a broad test of the conversion to UNFC-2009 of data presented using reporting standards aligned with the CRIRSCO Template, data are used from published annual reports of several companies, with examples of metals, coal, uranium, and industrial minerals, as well as unpublished data from one construction minerals company.

(a) Data are selected from the Rio Tinto annual report for 2012, reported using the JORC 2004 Code, for gold, coal, and uranium, both from operating mines and development

[1] www.crirsco.com

projects. The coal data include both 'coal reserves' and 'marketable coal reserves'. For gold and uranium there are also some data from stockpiles and partially processed mineral inventories which can be mapped to UNFC sub-classes and test the granularity definitions, while for gold there are data from both operating mines and development projects. Data from the Newcrest annual report illustrate the reporting of polymetallic deposits (in this example, just gold and copper) as well as attributable resource/reserve figures for joint venture projects. Unlike Rio Tinto which report resource estimates exclusive of reserves, Newcrest report their resource estimates inclusive of reserves.

(b) Data are selected from the **Imerys** annual report for 2012, reported using the PERC 2008 reporting code, for a range of industrial minerals, and an internationally operating construction minerals company has supplied real example data from a number of sites that produce cement raw materials and aggregates.

(c) Data are also included from companies primarily concerned with mineral exploration rather than mining, to test the handling of data on Exploration Results and Exploration Targets. These companies include **Newera Resources Ltd** (coal in Mongolia), **Oz Minerals** (copper, Australia), and **Carpentaria Exploration Ltd** (iron ore, Australia). Although for many years reporting of Exploration Targets has been allowed by the CRIRSCO-aligned JORC Code, they are the subject of a new definition in the 2013 update of the CRIRSCO Template, and these examples are selected to test the way in which the UNFC-2009 granularity is defined for exploration data.

III. Mapping of solid minerals resources and reserves data

A. Coal Resources and Reserves (example: Rio Tinto)

9. The Rio Tinto annual report for 2012 includes tables of data on coal reserves and resources, together with some explanatory notes. Extracts from these tables and notes are presented in Table 1 and Table 2.

(a) Reserves

10. A simple mapping of the principal reserves classes would allocate the entire column of Proved Reserves to E1-F1-G1 and Probable Reserves to E1-F1-G2. However, within these classes there are also identified Marketable Reserves.

11. From the CRIRSCO Template (2006, clause 39, identical wording in 2013 update, clause 44):

- ‘Marketable Coal Reserves’, representing beneficiated or otherwise enhanced coal product where modifications due to processing have been considered in addition to mining factors such as dilution, may be publicly reported in conjunction with, but not instead of, reports of Coal Reserves. The basis of the predicted yield to achieve Marketable Coal Reserves should be stated.

12. In other words, within the CRIRSCO standards it is mandatory to quote Coal Reserves, but it is not mandatory to quote Marketable Coal Reserves. If they are quoted, then the (pre-processing) Coal Reserves must also be reported and the yield factor should also be stated.

13. On a 'feasibility' basis these reserves could be allocated to a higher sub-class: E1.1-F1.1-G1 and E1.1-F1.1-G2 respectively as they represent more detailed knowledge of both marketability and processing feasibility. The F1.1 sub-class implies "on production", which is appropriate as these records represent reserves in currently operating mines.

14. No information is supplied for the difference in tonnage between the total Coal Reserves and the Marketable Coal Reserves. The reason for this is that this difference represents losses in the processing plant. The Reference Point for reporting Coal Reserves is the point of delivery to the processing plant, while the Reference Point for reporting Marketable Coal Reserves is the output from the processing plant.

Table 1.
Rio Tinto reported coal reserves

			Reserves		*Marketable reserves*		*Marketable coal quality*		*Avg % yield to give mktable reserves*	*Interest %*	*Rio Tinto share Marketable reserves*
	Type of mine(a)	*Coal type (f)*	*Proved at end 2012*	*Probable at end 2012*	*Proved at end 2012*	*Probable at end 2012*	*Calorific value MJ/kg*	*Sulphur content %*			
COAL (h)			millions of tonnes	millions of tonnes	millions of tonnes	millions of tonnes	(g)	(g)			millions of tonnes
Reserves at operating mines											
Bengalla	O/C	SC	161	10	121	7.2	27.86	0.48	75	32	41
Blair Athol (i)	O/C	SC				71.2					
Clermont	O/C	SC	168	4.6	160	4.2	27.9	0.33	96	50.1	82
Hail Creek	O/C	MC	84	44	43	23	32.2	0.35	52	82	54
Hunter Valley Operations	O/C	SC+MC	270	47	184	33	28.99	0.58	68	80	173
Kestrel Coal	U/G	MC	45	95	37	79	31.6	0.59	83	80	93
Mount Thorley Operations	O/C	SC+MC	30	7.4	20	4.7	29.8	0.45	66	64	16
Warkworth	O/C	SC+MC	217	155	141	101	29.8	0.45	65	44.5	108
Other undeveloped reserves (k)											
Mount Pleasant	O/C	SC		399		326	26.92	0.48	82	80	261

Notes include:
(k) The term “other undeveloped reserves” is used here to describe material that is economically viable on the basis of technical and economic studies but for which mining and processing permits may have yet to be requested or obtained. There is a reasonable, but not absolute, certainty that the necessary permits will be issued and that mining can proceed when required.

15. If aggregating coal reserves from more than one company and across multiple sites, it is incorrect to combine "Coal Reserves" estimates from some sites with "Marketable Coal Reserves" estimates from others, because some will include and others will exclude processing losses.

16. When aggregating data from multiple sources, a decision must be made on which of the two sets of numbers should be used. Since it is not mandatory to report Marketable Coal Reserves or the associated yield factors, it is likely that using the point-of-sale Reference Point would lead to an incomplete total.

17. For all sites there should be figures for Coal Reserves (i.e the Reference Point is at delivery to the processing plant) and these are the numbers that should be used.

18. It should be noted that for most other types of mineral, the reference point normally assumed and used in CRIRSCO standards is delivery to the processing plant, not point of sale. It is usually only the point of sale for direct-shipping material which needs no processing - such as some iron ore, some building materials, etc.

19. The "other undeveloped reserves" at Mount Pleasant, referred to in note (k) of Table 1, consist of Probable Reserves which would map to E1-F1-G2, but because mining and processing permits were not available at the effective date these would be allocated to a lower sub-class E1.1-F1.3-G2.

20. It should be noted that the final columns in the reserves table are headed "Interest %" and "Rio Tinto Share". These indicate that the quoted reserves are not wholly owned by Rio Tinto, and therefore, when making a compilation of reserves from different companies, care must be taken to avoid double-counting.

21. Item E “Basis for estimate” of the UNFC-2009 Specifications (ECE Energy Series No. 42 (ECE/ENERGY/94), Part II, Section VI) is relevant:

- *Reported quantities may be those quantities attributable to the mine/development project as a whole, or may reflect the proportion of those quantities that is attributable to the reporting entity’s economic interest in the mining operation or development project. The reporting basis shall be clearly stated in conjunction with the reported quantities.*

Table 2.
Rio Tinto reported coal resources

		Coal type (e)	*Coal resources at end 2012*			*Rio Tinto Interest %*
			Measured	*Indicated*	*Inferred*	
COAL (f)			*millions of tonnes*	*millions of tonnes*	*millions of tonnes*	
Rio Tinto Coal Australia						
Bengalla (h)	O/C + U/G	SC + MC	68	112	66	32
Blair Athol (i)	O/C	SC	10	0.2		71.2
Clermont	O/C	SC	11		3.7	50.1
Hail Creek	O/C	MC	60	79	36	82
Hunter Valley Operations	O/C + U/G	SC + MC	201	428	368	80
Kestrel West	O/C	SC		106	33	80
Lake Elphinstone	O/C	MC		120	42	82
Mount Pleasant	O/C + U/G	SC + MC	162	245	205	80
Mount Thorley Operations (j)	O/C + U/G	SC + MC		19	94	64
Oaklands	O/C	SC	596	584	90	80
Valeria	O/C	SC		698	64	71.2
Warkworth	O/C + U/G	SC + MC	6.2	125	343	44.5
Winchester South	O/C	MC		17	175	75

Notes include:

(i) All remaining reserves at Blair Athol have been converted to resources following the cessation of mining in November 2012.

22. This is discussed in more detail below, in the section on gold data.

(b) Resources

23. From the Rio Tinto 2012 annual report, page 55:

Resources are stated as additional to the reserves reported earlier. Where operations are not managed by Rio Tinto the resources are published as received from the managing company. Where new project resources or reserves are footnoted as being reported for the first time, additional information about them can be viewed on the Rio Tinto website.

24. Thus although CRIRSCO standards optionally allow Resources to be reported *inclusive* of material used to derive the Reserves, for Rio Tinto there is no risk of double counting if considering Resources and Reserves separately.

25. A simple mapping of the principal classes of Resources estimates shown in Figure 2 would allocate the Measured Resources to class E2-F2-G1, the Indicated Resources to E2-F2-G2, and the Inferred Resources to E2-F2-G3.

26. The note (i) in Table 2 referring to Blair Athol, recording the downgrading of Reserves to Resources following cessation of mining, suggests that it might be appropriate to allocate these resources to lower sub-classes. However, no information is supplied to indicate the reason for cessation of mining - whether technical (F axis) or socio-economic (E axis) - so it is probably safest simply to use the full classes for these Measured and Indicated Resources. Additional information would be required in order to establish the correct class or sub-class using UNFC-2009.

B. Gold and Uranium Resources and Reserves (example: Rio Tinto)

(a) Gold

27. Tables 3 and 4 show extracts from the gold reserves and resources tables in the Rio Tinto annual report for 2012, with explanatory notes.

(b) Reserves

28. As with the coal reserves, the Proved and Probable Mineral Reserves will map respectively to E1-F1-G1 and E1-F1-G2. For the "Reserves at Operating Mines", according to the guidelines in Specifications for the Application of UNFC-2009 (ECE Energy Series No. 42 (ECE/ENERGY/94), Part II, Annex V), these are "On Production" and the reserves may be allocated to higher sub-classes E1.1-F1.1-G1 and E1.1-F1.1-G2 respectively.

29. For the "Reserves at Development Projects", these are justified for development (there is no evidence in the Notes that all approvals have been received, to start mining and processing), and the appropriate sub-classes would be E1.1-F1.2-G1 and E1.1-F1.2-G2 respectively for the reported Proved Reserves and Probable Reserves ('Capital funds have been committed and implementation … is underway').

Table 3

Rio Tinto reported gold reserves

GOLD	*Type of mine (a)*	*Proved ore reserves at end 2012*		*Probable ore reserves at end 2012*		*Average mill recovery %*	*Rio Tinto share*	
		Tonnage	*Grade*	*Tonnage*	*Grade*		Interest %	*Recoverable metal*
		Millions of tonnes	*grammes per tonne*	*millions of tonnes*	*grammes per tonne*			*millions of ounces*
Reserves at operating mines								
Bingham Canyon (US)								
– open pit (l)	O/P	417	0.21	287	0.18	64	100	2.875
– stockpiles		40	0.14	41	0.14	64	100	0.232
Grasberg (Indonesia)	OP+UG	800	1.03	1624	0.74	68	(q)	12.227
Northparkes (Australia)								
– open pit and stockpiles		8.2	0.24			67	80	0.035
– underground	U/G			66	0.28	68	80	0.328
Oyu Tolgoi (Mongolia)								
– South Oyu open pit (r) (y)	O/P	426	0.42	614	0.24	74	33.5	2.581
– South Oyu stockpiles (s) (r)		9	0.33			74	33.5	0.024
Reserves at development projects								
Eagle (US) (u)	U/G			5.2	0.25	55	100	0.023
Oyu Tolgoi (Mongolia)								
– Hugo Dummett N (v)	U/G			460	0.37	83	33.5	1.544
– Hugo Dummett N Ext(w)	U/G			31	0.62	83	30.5	0.159

Notes include:

(q) Under the terms of a joint venture agreement between Rio Tinto and FCX, Rio Tinto is entitled to a direct 40 per cent share in reserves discovered after 31 December 1994 and it is this entitlement that is shown.

Table 4
Rio Tinto reported gold resources

GOLD	Likely mining method (a)	Measured resources at end 2012		Indicated resources at end 2012		Inferred resources at end 2012		Rio Tinto Interest %
		Tonnage	Grade	Tonnage	Grade	Tonnage	Grade	
		millions of tonnes	grammes per tonne	millions of tonnes	grammes per tonne	millions of tonnes	grammes per tonne	
Bingham Canyon (US)								
– Open Pit (l)	O/P					2.7	0.13	100
– North Rim Skarn	U/G	1	2.1	9	1.7	10	1.5	100
Eagle (US) (m)	U/G			0.4	0.18	0.1	0.12	100
Grasberg (Indonesia)	OP+UG	490	0.63	1851	0.53	94	0.46	(r)
Northparkes (Australia)	U/G	14	0.3	3.7	0.13	271	0.26	80
Oyu Tolgoi (Mongolia)								
– Heruga ETG (s)	U/G					910	0.49	30.5
– Heruga IVN (t)	U/G					60	0.37	33.5
– Hugo Dummett North (u)	U/G			292	0.31	574	0.31	33.5
– Hugo Dummett North Extension (v)	U/G			90	0.57	100	0.3	30.5
– Hugo Dummett South (w)	U/G					490	0.09	33.5
– South Oyu (x)	O/P	22	0.65	150	0.5	453	0.23	33.5
Wabu (Indonesia)	O/P					44	2.47	(r)

Notes include:
(r) Under the terms of a joint venture agreement between Rio Tinto and FCX, Rio Tinto is entitled to a direct 40 per cent share in resources discovered after 31 December 1994.

(c) Resources

30. The Measured, Indicated, and Inferred Resources, as reported, will map respectively to UNFC classes E2-F2-G1, E2-F2-G2, and E2-F2-G3. This is the simplest mapping as defined in the Bridging Document: in the absence of additional information (which was not available for this study), the minimum allowed categories under UNFC-2009 have been adopted.

31. It should be noted that (as with the coal data), where the Rio Tinto interest shown is less than 100%, the total reserves or resources are partly owned by another company or companies, and may also be included in their reports.

32. As mentioned above in the discussion on coal resources, Item E “Basis for estimate” of the UNFC-2009 Specifications (ECE Energy Series No. 42 (ECE/ENERGY/94), Part II, Section VI) is relevant:

- *Reported quantities may be those quantities attributable to the mine/development project as a whole, or may reflect the proportion of those quantities that is*

attributable to the reporting entity's economic interest in the mining operation or development project. The reporting basis shall be clearly stated in conjunction with the reported quantities. ...

33. **In such cases, the numbers actually quoted in different company reports for reserves and resources of the same deposit are not necessarily the same, because different companies participating in a project may rely upon different Competent Persons for the estimates.**

34. In a similar way there may be other non-intuitive effects related to government take. This could be in kind, in cash and linked to taxes with or without non-linear relations to profit, and potentially could make an impact on the quantities a company is allowed to report (in other words, the data are dependent upon the "governmental" Modifying Factor of the CRIRSCO reporting standards).

35. The only numbers which should be guaranteed to match are the percentage ownerships recorded by the different companies in a joint venture, and as directed in Item E "Basis for estimate" of the UNFC-2009 Specifications (ECE Energy Series No. 42 (ECE/ENERGY/94), Part II, Section VI) these should be stated in any report.

(d) Uranium

36. Uranium reserves and resources from the Rio Tinto 2012 report are shown in Tables 5 and 6.

37. The default mappings of the reserves and resources classes are just as for the gold data. However, there is an item in both tables for "Ranger #3 stockpiles" with explanatory notes for reserves and for resources, indicating that after completion of open-cut mining, there were still stockpiles remaining.

Table 5.

Rio Tinto reported uranium reserves

Uranium	*Likely mining method*	*Proved ore reserves at end 2012*		*Probable ore reserves at end 2012*		*Rio Tinto Interest*
		Tonnage	Grade	Tonnage	Grade	%
		Millions of tonnes	U_3O_8 %	Millions of tonnes	U_3O_8 %	
Energy Resources of Australia (Australia)						
– Ranger #3 stockpiles (oo)				7.3	0.132	68.4
Rössing (Namibia) (pp)	O/P	29	0.031	102	0.035	68.6

Notes include:
(oo) Following completion of open cut mining, Ranger #3 reserves are reported as stockpiles only, with reduced tonnes and grade.

Table 6.
Rio Tinto reported uranium resources

Uranium	*Likely mining method*	*Measured resources at end 2012*		*Indicated resources at end 2012*		*Inferred resources at end 2012*		*Rio Tinto interest*
		Tonnage	Grade	Tonnage	Grade	Tonnage	Grade	%
		millions of tonnes	U_3O_8 %	millions of tonnes	U_3O_8 %	millions of tonnes	U_3O_8 %	
Energy Resources of Australia (Australia)								
– Jabiluka	U/G	1.2	0.887	14	0.52	10	0.545	68.4
– Ranger#3 mine (nn)	U/G			9.5	0.325	0.6	0.383	68.4
– Ranger #3 stockpiles (oo)				69	0.043			68.4
Rössing (Namibia) (pp)	O/P	15	0.026	148	0.024	173	0.026	68.6

Notes include:

(nn) Ranger open cut resource tonnes have decreased following the completion of open cut mining. Underground resources at a significantly higher grade are now reported.

(oo) Following completion of open cut mining, Ranger stockpile resources are reported as a separate entity for the first time.

38. Usually it would be expected that material in stockpiles would be considered as Proved Mineral Reserves, because all geological factors are known (the material has been mined) and all Modifying Factors are taken fully into account. However, the Ranger#3 mine stockpiles are listed as partly Probable Mineral Reserves and partly Indicated Mineral Resources. If the material has already been mined and is located in stockpiles then the degree of geological knowledge should be at a maximum, so the material should be classified as G1 on the G axis. This may represent a case where CRIRSCO Proved Reserves have been downgraded to Probable Reserves, and further to Indicated Resources, not because of lack of geological knowledge but because of uncertainty in one or more of the Modifying Factors. In such a case it is likely that the material should be allocated to lower sub-classes, such as E1-F2.2-G2 (or perhaps more accurately G1) for the Probable Reserves and E2-F2.2-G2 (or G1) for the Indicated Resources. F2.2 represents "project on hold" status. In such a case, further information and explanation might be sought in the full text of the report.

39. The Ranger#3 mine resources quoted in the table are for the underground mine, not the open-pit mine which has ceased operation, and the allocation of these to appropriate UNFC-2009 classes is unaffected by the above discussion.

40. The actual allocation of sub-classes in such cases should be made with reference to more detailed information in the company report or by reference to the company itself for further information on the reasons for mine closure and the status of the stockpiles - for example, closure of the processing plant would evidently affect both the technical and economic feasibility of processing stockpiled ore.

C. Polymetallic resources and reserves (example: Newcrest, gold/copper)

41. The Newcrest 2012 annual report includes data in a slightly different format, as shown in Table 7. Among other projects for which reserves and resources are tabulated in the report, the Telfer mining area produces both gold and copper. The tonnage of ore produced for both metals is the same, but grades are quoted for both metals.

Table 7

Resources and Reserves Data for the Telfer province from the Newcrest 2012 annual report

Dec-12 Mineral Resources	*Measured Resource*			*Indicated Resource*			*Inferred Resource*		
Gold and Copper Resources (# = includes stockpiles)	*Dry Tonnes (million)*	*Gold Grade (g/t Au)*	*Copper Grade (% Cu)*	*Dry Tonnes (million)*	*Gold Grade (g/t Au)*	*Copper Grade (% Cu)*	*Dry Tonnes (million)*	*Gold Grade (g/t Au)*	*Copper Grade (% Cu)*
Main Dome Open Pit #	28	0.43	0.07	380	0.65	0.08	50	0.57	0.07
West Dome Open Pit	-	-	-	390	0.53	0.06	27	0.54	0.07
Telfer Underground	-	-	-	78	1.3	0.32	21	0.76	0.25
Other	-	-	-	0.57	4.2	0.03	16	0.28	0.34
O'Callaghans	-	-	-	69	-	0.29	9	-	0.24

Dec-12 Ore Reserves	**Proved Reserve**			**Probable Reserve**		
Gold and Copper Reserves (# = includes stockpiles)	*Dry Tonnes (million)*	*Gold Grade (g/t Au)*	*Copper Grade (% Cu)*	*Dry Tonnes (million)*	*Gold Grade (g/t Au)*	*Copper Grade (% Cu)*
Main Dome Open Pit #	28	0.43	0.07	240	0.76	0.09
West Dome Open Pit	-	-	-	180	0.61	0.06
Telfer Underground	-	-	-	45	1.1	0.3
O'Callaghans	-	-	-	59	-	0.29

42. From the introduction to the Newcrest resource/reserves tables:

- ***Mineral Resources are quoted inclusive of Ore Reserves***. *Metal price assumptions used for all Newcrest Mineral Resources are US$1350/oz for gold, US$3.10/lb for copper and US$23/oz for silver. Price assumptions for Ore Reserves are US$1250/oz for gold, US$2.70/lb for copper and US$20.00/oz for silver. In the case of Gosowong, a gold price of US$1400/oz has been used to estimate Mineral Resources and Ore Reserves, acknowledging the shorter life of the currently known deposits.* ***Where appropriate, resources are also constrained spatially by a notional pit shell based on US$1400/oz for gold and US$4.00/lb for copper or, for underground mining, by a shape based on the marginal cut-off grade used as a conservative measure to remove non-contiguous mineralisation.*** *Cost assumptions are based on the latest approved study for each deposit.[our* ***bold****]*

43. As seen in Table 7, because Resources are *inclusive* of Reserves, the Measured Resource is represented in its entirety by Proved Reserves, and must not be counted separately. For the Indicated Resource, the tonnage and grade must be recast to remove the material recognised as Probable Reserves. It is not clear from the table whether any allowance has been made for dilution or loss in the Probable Reserves figures. Even if the

dilution and loss factors are reported it will not in general be possible to back-calculate the correct Resource figures as some Resource is likely to have been excluded from the mine design used for the Reserve estimation.

44. No general rule can be stated for the classification of such excluded Resource material. The mine design may make it inaccessible (so it would then become 'unrecoverable'), or it may simply be uneconomic to mine at the Effective Date but potentially mineable with change in economic parameters at some later date.

45. In any report where Resources are quoted inclusive of material used to estimate the Reserves, care must be taken to avoid double counting of the same material.

46. It should be noted, from the second passage marked in bold in the quoted section from the Newcrest report, that this company takes a conservative approach to reporting of Resources. They are not considered to be all of the material that has "reasonable prospects for eventual economic extraction" (CRIRSCO Template 2006, clause 19, CRIRSCO Template 2013; clause 21), but are restricted to material within notional pit shells defined on the basis of specified metal prices, or similar constraints for underground mines. For governmental reporting purposes, this could lead to biased (under-estimated) data summaries, although it is a fair representation of what the mining company itself expects to be able to mine.

47 Other than these calculations to separate Resources from the included Reserves, assigning the data to UNFC classes is straightforward and will use the default mappings as defined in the bridging guidelines, but there is one further point to note concerning the first line of the table (Main Dome Open Pit). The reserves and resources for this open pit mine, according to the title, include stockpiles. It seems unlikely that there will be material of all resource and reserve classes within the stockpiles. This is an operating mine, so it would usually be expected that the material quantities and attributes (metal grades) of stockpiles will be known more accurately than any of the un-mined material. The stockpiles are therefore usually considered as Proved Reserves. If there is stockpile material of other CRIRSCO classes, it may imply that there is some doubt over socio-economic or technical Modifying Factors (i.e. the E and F axes of UNFC-2009) rather than geological, as noted above in the context of the Rio Tinto uranium data.

48. In reporting the resources and reserves of gold and copper as in this example, or of several metals (e.g. Cu, Ni, Co) in the case of a polymetallic mine, the economic justification for mining is likely to be derived from consideration of all the different saleable products taken together. In some cases, there may be a principal product used for economic justification and one or more by-products which simply modify the financial forecasts. In any of these cases, however, for reporting each separate metal it is necessary to report the total ore tonnage and the grade of that metal.

49. **Care must then be taken if aggregating data for different metals (such as cobalt and nickel) that the same ore tonnage is not double counted, though of course there is no problem in aggregating the data for the individual contained metal quantities.**

50. It should be noted always that the contained metal as derived using CRIRSCO standards relates to quantities delivered to the defined Reference Point, and for metal mines this is usually at the point of supply to the processing plant, so contained metal quantities do not allow for the processing yield factors and thus do not reflect the amounts ultimately sold.

51. Estimates of the sale quantities could be made if the report contains information on processing yield factors, but it should be noted that it is not mandatory in CRIRSCO standards to supply this information, merely a strongly worded guideline.

D. Industrial and Construction Minerals Resources and Reserves (examples: 'an internationally operating construction materials producer', Imerys)

(a) Construction Minerals

52. An internationally operating construction minerals producer has supplied real sample data as shown in Table 8.

Table 8
Reserves and Resources Data from a construction minerals company

	Reserves (Mt)		*Resources (Mt)*		
Cement Quarry A (note 1)	**Proved**	**Probable**	**Measured**	**Indicated**	**Inferred**
Clay 1	1.43	2.94	0.00	5.46	0.00
Clay 2	0.89	1.14	0.00	3.51	0.00
Limestone 1	1.61	18.25	0.00	27.25	0.00
Limestone 2	0.00	0.00	1.75	2.61	0.00
Limestone 3	1.18	4.26	0.00	8.23	0.00
Cement Quarry B (note 2)					
Limestone 1	2.37	0.00	0.00	0.00	0.00
Limestone 2	32.18	0.00	2.37	0.00	0.00
Cement Quarry C (note 2)					
Limestone 1	0.57	4.50	0.00	5.23	0.00
Limestone 2	24.00	0.00	0.00	1.07	0.00
Aggregate Quarry A (note 3)					
Unit 1	3.35	0.00	16.05	0.00	0.00
Unit 2	46.96	0.00	4.19	0.00	0.00
Aggregate Quarry B (note 4)					
Unit 1	141.05	0.00	8.92	38.96	0.00

Notes:
1. Reserves and resources comprise the materials to be used in the kiln feed. Materials in the Resources classes include, amongst other things, that tonnage beyond the ratio necessary for the current recipe but which are expected to be worked in the future by additional blending or use of imported additives.
2. Reserves and resources are stated for those tonnages only that will be recovered based on the current kiln recipe. Other materials are available at the site, but for which there is currently no proposal for recovery hence are not reported.
3. Two different materials are present in the quarry suitable for the production of aggregates. Additional permits are necessary to recover the resources stated.
4. Additional investment is necessary to recover the resources stated (currently beneath the plant and stock areas).

53. The default mappings will apply to the data in this table, but it is also possible to use sub-classes.

54. In Cement Quarry A (see Note 1), the resources include material which cannot be used by the 'current recipe' but may become usable in future with different blending or additives. However, the relative proportion of such material is not specified, so it is not possible to identify tonnages to different sub-classes.

55. In Cement Quarries B and C (see Note 2), technology has not been defined for other mineral that exists at the sites, and which therefore is not reported (as it does not have reasonable prospects for eventual economic recovery). Such mineral could notionally be classified in UNFC-2009 if estimates are available but it should be noted that listed companies are usually not allowed by the market regulators to report publicly any mineral 'assets' other than within the CRIRSCO classes.

56. In Aggregate Quarry A (Note 3), the reported reserves cannot be extracted yet because the permits are not in place. These reserves therefore qualify for the sub-class 'Justified for Development', F1.3, and thus, as Proved Reserves, would map to E1.1-F1.3-G1.

57. The Resources identified for Aggregate Quarry B (Note 4) are not currently accessible. These would be identified as 'development on hold', with a corresponding sub-class on the F axis of F2.2, so the Measured Resources would map to E2-F2.2-G1 and the Indicated Resources to E2-F2.2-G2.

58. **It should be noted that when data on construction minerals are reported to stock exchanges, they are often aggregated over a number of sites (see European Securities and Markets Authority (ESMA) Letter relating to requirements on European Union stock exchanges) and assignment to UNFC-2009 sub-classes may not be possible.**

(b) Industrial Minerals

59. Data from Imerys are aggregated across multiple sites, and extracts from their Reserves and Resources tables for 2012 are presented in Tables 9 and 10.

Table 9
Mineral Reserves: extracted from table in Imerys annual report for 2012

Product	*Region*	*Proven*	*Probable*	*Total*
		2012 (kt)	2012 (kt)	2012 (kt)
Ball clays				
	Asia/Pacific	899		899
	Europe incl. Africa	8304	4415	12719
	North America	4687	1695	6382
	Total	13890	6110	20000
Carbonates (calcite, marble, chalk, limestone, dolomite & dimension stone)				
	Asia/Pacific	1589	37426	39015
	Europe incl. Africa	5824	24278	30102
	North America	116482	41686	158168
	South America	610	6800	7410
	Total	124505	110190	234695
Clays (brick & roof tile raw materials)				
	Europe	85343	1959	87302
	Total	85343	1959	87302

Table 10
Mineral Resources: extracted from table in Imerys annual report for 2012

Product	*Region*	*Measured*	*Indicated*	*Inferred*	*Total*
		2012 (kt)	2012 (kt)	2012 (kt)	2012 (kt)
Ball clays					
	Asia/Pacific	61	-	-	61
	Europe incl. Africa	9113	2336	270	11719
	North America	8743	11775	11932	32450
	Total	17917	14111	12202	44230
Carbonates (calcite, marble, chalk, limestone, dolomite & dimension stone)					
	Asia/Pacific	-	30451	11101	41552
	Europe incl. Africa	2226	3518	57213	62957
	North America	57036	122409	92732	272177
	South America	-	12855	4800	17655
	Total	59262	169233	165846	394341
Clays (brick & roof tile raw materials)					
	Europe	24521	25265	-	49786
	Total	24521	25265	-	49786

60. It is seen that these data are aggregated across supra-national regions. Such aggregation of data is allowed in the CRIRSCO-aligned PERC Standard 2013, for consistency with the ESMA regulations for European stock exchanges, provided that the company retains full Competent Person reports for each site or each geographical group of sites.

61. The mapping of these data into UNFC-2009 does not present a problem - all will follow the default mapping guidelines as defined in the Bridging Document between the CRIRSCO Template and UNFC-2009. However, for governmental reporting it is likely that the company would have to be asked for detail relating to individual countries or regions.

62. Another feature of these tables is that there is also aggregation over different minerals. In the example tables quoted, the carbonate minerals are presented as combined estimates. These would not necessarily match mineral classifications required in governmental reporting, so in such a case the company would need to be requested to provide separate tabulation of reserves and resources for each mineral type, especially where they are intended for different target markets.

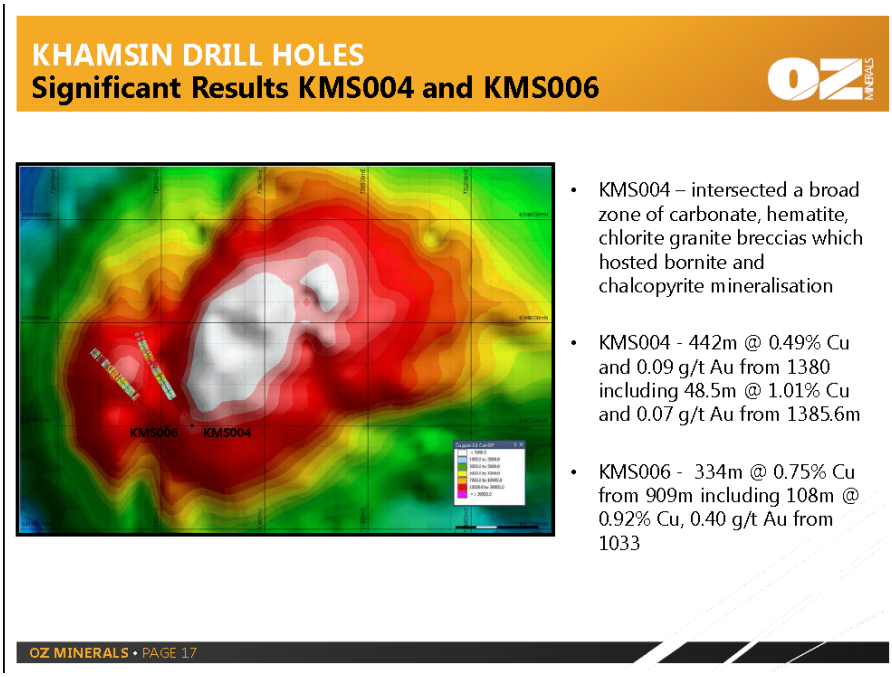
63. This may also not be coherent with statistical information tracking stocks and flows in the economy downstream of the reference points. Such coherence requires the quantities that enter the economy, i.e. sales, and such information generally will be available only for those minerals which require no processing so that the Reference Point will be the point of sale.

E. Exploration data (examples: Oz Minerals, Newera Resources, Carpentaria Exploration)

(a) Exploration Results

64. These are clearly defined in the CRIRSCO Template and their mapping to E3-F3-G4 in UNFC-2009 has been established. An example is shown in Figure 1:

Figure 1:
A slide from a presentation by Oz Minerals showing Exploration Results



65. Of the three items on the slide in Figure 1, the first is purely descriptive and normally would not be considered as 'Exploration Results', though as "information" it falls within the CRIRSCO definition of Exploration Results. The second and third items contain quantitative data which would constitute Exploration Results and would map to the UNFC-2009 class E3-F3-G4. It must be noted that these are purely drill hole data, and cannot be related to any estimated tonnage or any estimate of average grade. They do not represent any estimate of resources or even of exploration potential, but are merely publication of preliminary data which might (or might not) subsequently be used to estimate a mineral resource.

(b) Exploration Targets

66. Exploration Targets were defined in JORC 2004, but a definition was not included in the 2006 Template, which mentions them only in a Guideline in clause 17:

- *Descriptions of exploration targets or exploration potential given in Public Reports, should be expressed so as not to misrepresent them as an estimate of Mineral Resources or Mineral Reserves.*

67. There is now an agreed definition of Exploration Target in the November 2013 updated CRIRSCO Template, in a new clause 17, and this definition is progressively being

added to all of the CRIRSCO standards (it is already in the JORC, PERC, and NAEN[2] standards):

- **An Exploration Target is a statement or estimate of the exploration potential of a mineral deposit in a defined geological setting where the statement or estimate, quoted as a range of tonnes and a range of grade or quality, relates to mineralisation for which there has been insufficient exploration to estimate Mineral Resources.**

68. There are two contexts in which an Exploration Target may be reported:

(a) Where there is no direct information about mineralization within a project (lease or licence area, etc.) – which (for explanation see Item R "Classification of quantities associated with Exploration Projects of the UNFC-2009 Specifications (ECE Energy Series No. 42 (ECE/ENERGY/94), Part II, Section VI(R) (a) to (c)) would be represented by E3.2-F3.3-G4 (though see recommendations in IV(A) below); and

(b) Where there is some data such as from geophysical or geochemical surveys or from preliminary drilling programmes, represented by UNFC-2009 class E3.2-F3.1-G4 or E3.2-F3.2-G4 (though see recommendations in IV(A) below), depending on whether the data were specific to one deposit or used to justify a group of possible deposits.

69. **Newera Resources** published a statement on 18 March 2013 concerning its Shanagan Coal Project in Mongolia, as follows:

- **Newera Resources Limited (ASX: NRU)** is pleased to advise that work over the last month to calculate an Exploration Target – as defined under Section 17 of the updated JORC Code - has now been completed.

Highlights:

- A determination that an Exploration Target of 64 to 111 million tonnes of coal can currently be attributed to Newera's Shanagan coal project, based on exploration to-date, including Newera's recently completed phase 1 and phase 2 drilling programs.
- …

70. In this particular example, there exists some drilling data, and therefore the Exploration Target is of type (b) identified above and would map to E3.2-F3.1-G4 or E3.2-F3.2-G4 depending on the quantity and specificity of the geological data (though see recommendations in IV(A) below).

71. It must be noted that Exploration Targets as defined by the CRIRSCO Template are always quoted as ranges of possible values. When aggregating sets of data compiled from Exploration Targets, a view must be taken for each one whether the range should be preserved (for example by adding all the minima together, and separately adding all the maxima together) or whether some mid-point estimate should be used. Combining all the minima and all the maxima separately is likely to lead to large over-estimates of an aggregated range of possible values. Great caution should always be exercised in using Exploration Target data.

72. **Carpentaria Exploration** published a statement on 29th November 2013. This statement includes the following two paragraphs:

[2] The NAEN Code is the Russian Code for public reporting of exploration results, reserves and resources of solid minerals.

- *At the Braemar JV (CAP earning in) and contiguous South Dam project (100% CAP), independent geologists H&S Consultants Pty Ltd (H&SC) have estimated an* ***Exploration Target of 1.7 to 3.1 billion tonnes, with an estimated magnetite mass recovery (Davis Tube Recovery, "DTR") of 12 to 27% for between 200 million tonnes and 850 million tonnes of iron concentrate at 63-67% iron (Table 1).***
- *The potential quantity and grade of the Exploration Target is conceptual in nature and there is insufficient exploration to define a mineral resource. It is uncertain if further exploration will result in determination of a mineral resource.*

Table 11
"**Table 1" from the Carpentaria Exploration report showing aggregation of Exploration Target estimates**

Target Area	*Strike (km)*	*Thickness (m)*	*Down Dip (m)*	*Volume (Mm3)*	*Density (t/m3)*	*In situ Tonnes (Mt)*	*Concentrate (Mt)*
South Dam	9.5-10.5	80-120	250	190-320	3.05	580-960	70-260
Braemar W	8.5-9.5	80-120	250	170-290	3.05	520-870	60-230
Braemar C	8.0-9.0	80-120	250	160-270	3.05	490-820	60-220
Braemar E	2.0-4.5	100-150	250	50-170	3.05	150-515	20-140
Totals	28.0-33.5	80-150	250	570-1040		1740-3170	210-850

73. The supporting evidence for this Exploration Target consists of three reverse-circulation drill holes and some geophysical exploration (airborne and ground magnetic data), so it might therefore be considered to be of type (b) identified above and would possibly fall within the UNFC-2009 class E3.2-F3.1-G4 (though see recommendations in IV(A) below). Since, however, only three drill holes have been used to justify five separate exploration targets, it would probably be more reasonable to use sub-class E3.2-F3.2-G4 – the data are 'local' rather than 'site-specific'.

74. The "Table 1" referred to in the text and shown in Table 11 above is a compilation of exploration targets for four separate exploration areas, and aggregation into a single overall Exploration target range was done by adding all the minima together and adding all the maxima together. This is not considered best practice and may result in an over estimation of the Exploration Target.

75. Allocation of sub-classes on the G axis is problematic. As currently defined, the G4.1, G4.2, and G4.3 sub-classes allow codification of ranges of a single parameter (such as tonnage). Where there are multiple parameters, this simple classification cannot be used. Simply coding all of the lowest values into G4.1 and all of the highest into G4.3 could be taken to imply perfect positive correlation between the parameters. Furthermore, use of the increment concept, as defined in UNFC-2009 Specification P (ECE Energy Series No. 42, Part II, Section VI), implies that the parameters are recorded on additive scales. While this is clearly true for tonnages and simple grade information such as iron or gold grades, it is not true for quality parameters of many industrial minerals (e.g. 'brightness' of clays). For the Carpentaria Exploration data, therefore, it is safest not to use G4 sub-classes as currently defined.

IV. Discussion of issues arising from the mapping exercises

76. This section analyses issues and problems arising from the case studies identified above, and includes recommendations for modifications or clarifications that might improve

the Bridging Document between the CRIRSCO Template and UNFC-209, the Specifications for the Application of UNFC-2009, and the CRIRSCO Template.

A. Granularity and sub-divisions of classes

77. Discussion below is concerned with issues arising from the identification of sub-classes in UNFC.

78. In most cases, no problems were encountered in applying the sub-divisions of classes as defined in the UNFC-2009 Definition and Specifications for the Application of UNFC-2009. The only significant problems were found with exploration data.

79. For CRIRSCO Exploration Results and Exploration Targets, the default mapping is to E3-F3-G4.

80. Exploration Results are defined in the CRIRSCO Template as reports of actual data from exploration projects, and do not include estimates of tonnage and grade or mineral quality.

81. Exploration Targets are mentioned but not defined in the CRIRSCO Template 2006, but a definition is given in the CRIRSCO Template November 2013 update, consistent with previous usage in JORC and other CRIRSCO aligned standards:

- **An Exploration Target is a statement or estimate of the exploration potential of a mineral deposit in a defined geological setting where the statement or estimate, quoted as a range of tonnes and a range of grade or quality, relates to mineralisation for which there has been insufficient exploration to estimate Mineral Resources.**

82. Although this definition was not included in the version of the CRIRSCO Template used in preparing the UNFC-2009 Specifications, it ought to be possible to map such information to UNFC-2009. However, in attempting to use the granularity available in UNFC-2009, some difficulty was encountered. It is possible to identify different types of Exploration Target depending on whether or not there is any supporting data.

83. The sub-classes of F3 are not included in the UNFC-2009 Definition (ECE Energy Series No.39), nor are any sub-classes for any of the G classes.

84. Item R “Classification of quantities associated with Exploration Projects” of the UNFC-2009 Specifications (ECE Energy Series No. 42 (ECE/ENERGY/94), Part II, Section VI) defines sub-divisions of F3 (F3.3, F3.2, and F3.1) that actually represent differing relative amounts of geological data – and therefore which should logically be expected to lead to sub-divisions on the G axis. Although there is obviously a correlation with the 'project maturity' concept, these are not in fact sub-divisions that primarily express relative 'project maturity' (a concept which is not used for solid minerals) but are clearly dependent purely on the amount of geological information that is available – and should therefore be sub-divisions on the G axis.

85. At the same time, Item P “Expansion of G4 to account for uncertainty” of the UNFC-2009 Specifications (ECE Energy Series No. 42 (ECE/ENERGY/94), Part II, Section VI) defines sub-divisions on the G axis to be used for a range of quantities with separate sub-classes for 'low estimate', increment to 'best estimate' and additional increment to 'high estimate'. These might possibly be used for CRIRSCO Exploration Targets which are always quoted as a range of estimates: thus in the Shanagan coal example in section III(E) above, the Exploration Target of 64-111 million tonnes could be mapped to

- E3.2-F3.1-G4.1 = 64 million tonnes

- E3.2-F3.1-G4.2 = ? (there is no 'best estimate' in the CRIRSCO definition for Exploration Targets)
- E3.2-F3.1-G4.3 = 47 million tonnes (as the high estimate is 64 + 47 = 111 million tonnes)

however it is clear that even this mapping is problematic, as CRIRSCO Exploration Targets do not include any 'best estimate' – they are expressed just as a range.

86. It seems inappropriate for the G axis to be used in this way, as the axis itself represents relative degrees of uncertainty in the geological data, and not a codification of the individual numbers in estimates. Data allocated to the E3-F3-G4 class may be quoted in at least three (and potentially many) different ways:

- as raw data - drill hole intercepts, geochemical survey data, geophysical data, etc. (with a huge variety of formats and types of data content)
- as ranges with low case, best estimate, and high case (as in PRMS exploration targets)
- as ranges with low and high limits (as in CRIRSCO exploration targets)

87. It should be noted that CRIRSCO ranges are not simply ranges of tonnage, but also of grades of one or more contained minerals, and that these ranges are quoted separately for the same material (for example "1.7 to 3.1 billion tonnes, with an estimated magnetite mass recovery of 12 to 27 per cent") which does not map neatly to the defined UNFC-2009 sub-classes as the low cases (1.7 billion tonnes, and 12 per cent magnetite) and high cases (3.1 million tonnes and 27 per cent magnetite) are not necessarily correlated in that way. Quality parameters, especially for many industrial minerals, may not be recorded on linear, additive, scales and in such cases the use of increments for coding them is inappropriate.

88. UNFC-2009, including any defined sub-divisions of classes, should be sufficiently general to handle any of these cases. What it should not attempt to do is allocate sub-classes for the purpose of codifying data in a way that is specific to any one case, because this would compromise the intended generality and neutrality of the classification.

89. It should be noted that use of different G4 sub-classes for the 'low', 'best' and 'high' cases could be seen by users as implying different degrees of confidence for the three numbers if plotted along the G axis, which is clearly incorrect.

90. There is no reason why the numbers in a range should not ALL be quoted within the same sub-class, and there are good reasons why they should – they all relate to the same degree of geological knowledge and are all effectively part of the same data item.

91. The very specific use of sub-classes to encode data on the G axis, as proposed in Item P "Expansion of G4 to account for uncertainty" of the UNFC-2009 Specifications (ECE Energy Series No. 42 (ECE/ENERGY/94), Part II, Section VI) is inconsistent with the way in which sub-classes are defined elsewhere in UNFC-2009. It is recommended that the use of such sub-division of the G4 classes be deleted, and replaced by the sub-division that was used in Item R "Classification of quantities associated with Exploration Projects" of the UNFC-2009 Specifications (ECE Energy Series No. 42 (ECE/ENERGY/94), Part II, Section VI) for F3 to be used instead of sub-dividing G4. The Shanagan coal data above would perhaps then be represented by

- E3.2-F3-G4.1 = "64 million tonnes (low case) to 111 million tonnes (high case)"

and the Carpentaria data by

- E3.2-F3-G4.1 = "1.7 to 3.1 billion tonnes, with an estimated magnetite mass recovery of 12 to 27 per cent"

92. Proposals for replacement paragraphs for the UNFC-2009 Specifications are presented in section D below.

93. **It should be noted that this recommendation leaves possible sub-division on the F axis available if it is required to include more detailed 'project maturity' considerations related to technical feasibility, other than those dependent on geological knowledge.**

B. Potential issues in dealing with early stage exploration data

94. There are questions concerning granularity in mapping the CRIRSCO Template to UNFC-2009 which are discussed in section IV(A) above. However, there is also a more general point to be noted.

95. The CRIRSCO Template 2006 does not include any definition of Exploration Target, merely a mention in a guidelines paragraph within clause 17. In the updated CRIRSCO Template (November 2013) there is a definition of Exploration Target in a new clause 17. A definition of the mapping of this to UNFC-2009 should be added as a revision to the Bridging Document. It is recommended that the mapping should be the same as for Exploration Results, i.e. E3-F3-G4, and that sub-divisions be used as suggested above – replace the current G4.1-G4.3 definitions (Section VI(P) of ECE Energy Series No. 42, Part II) by new definitions for G4.1-G4.3 replacing F3.1-F3.3 in section VI(R) of ECE Energy Series No. 42, Part II, and do not at this stage define any sub-divisions on the F axis. Proposals for replacement clauses to modify the sub-classes are presented in Section D below.

C. Recommendations and guidelines on format and content of reports containing data mapped from CRIRSCO to UNFC-2009

(a) General recommendations for governmental reporting

96. For data collected from minerals companies, it is recommended that CRIRSCO classes be used: they can be mapped direct to UNFC-2009 main classes and, as this report has demonstrated, in some cases to sub-classes.

97. The CRIRSCO reporting standards include validation by Competent Persons. For companies listed on stock exchanges data on reserves and resources estimates are already compiled and reported in this way. There is a cost issue for unlisted companies, especially small private companies, but it may be that this could be resolved by Competent Person validation of submitted data by the relevant governmental agency.

98. For types of estimate that are not covered by CRIRSCO standards (undiscovered, uneconomic, or unrecoverable minerals), such data would not be recorded or held consistently (if at all) by minerals companies even when they may use them for their own planning purposes. Therefore, for such types of information, estimates should preferably be obtained from national or regional geological surveys or similar organisations which have the broader overview and the defined remit to make such estimates, without distortions of commercial bias. These could then be recorded directly into UNFC-2009 classes. It is recommended, furthermore, that for more consistent data quality these estimates should be validated by Competent Persons in the same way that CRIRSCO estimates are validated.

(b) Presentation formats

99. The UNFC-2009 definition (ECE Energy Series No. 39) and the UNFC-2009 Specifications (ECE Energy Series No. 42, Part II) include little guidance on the presentation of data, whether as free text or as tabulations. However, there are some relevant specifications:

- In ECE Energy Series No. 42, Part II, Section VI(A), it is specified that the numerical codes shall be used, such as 111, 111+112, 1.1;1.2;1 as appropriate. (In this report, the numeric codes are prefixed by the axis letters to make the classes even more explicit, thus E1-F2-G1 or E1.1-F1.2-G1).
- In ECE Energy Series No. 42, Part II, Section VI(D), it is specified that for aggregated data for different commodities or product types, an accompanying explanatory statement shall be provided. It is not specified how this statement should be included, whether as a footnote or in some other form.
- Section VI(K) of ECE Energy Series No. 42, Part II, indicates that it is permissible to aggregate different classes, with explanation provided in a footnote as appropriate
- Section VI(N) of ECE Energy Series No. 42, Part II, requires the use of SI units where relevant, or inclusion of conversion factors where other units are used.

(c) Reference Point

100. As noted in section III(A) above, care must be taken when identifying the **Reference Point**. This is a concept which has identical meanings in CRIRSCO (definition included in 2013 update) and in UNFC-2009. It is the point at which reserves estimates are recorded, whether (as in most cases in the solid minerals sector) delivery to a processing plant, or delivery to point of sale (as commonly in the hydrocarbons sector), or some other point which may be defined. For Coal Reserves in particular, two different Reference Points are allowed in the CRIRSCO standards: delivery to the processing plant (e.g. a coal washing plant) or point of sale. Where reserves are reported at point of sale, they are referred to as Marketable Coal Reserves; at delivery to the processing plant, simply as Coal Reserves. During the processing there will always be some losses so that the figure for Marketable Coal Reserves will always be the lower of the two.

101. CRIRSCO standards require that whenever Marketable Coal Reserves are reported, the Coal Reserves from which they are derived must also be reported.

102. Care must be taken not to aggregate data of these two types. Only one of them should be recorded for statistical purposes, and that should be the Coal Reserves - NOT the Marketable Coal Reserves. The reason for this is that data for Marketable Coal Reserves may be incomplete.

103. The CRIRSCO Template includes a Guideline:

- *In reporting Mineral Reserves, information on estimated mineral processing recovery factors is very important, and should always be included in Public Reports.*

104. Compliance with this would enable the derivation of figures for a point-of-sale Reference Point, this is only a guideline and not mandatory, so its inclusion in every report cannot be relied upon.

105. Possible standardization on a point-of-sale Reference Point has been discussed before in CRIRSCO, but it is recommended that the question should be given further consideration, though there are some known problems in requiring it to be used. One problem is that it would entail mandatory inclusion of processing yield factors, something which many companies do not currently quote, and which could be a particular problem for industrial minerals companies where the same source mineral can lead to several alternative end-products as a result of blending or different processing paths.

(d) Codification of Data

106. Nowhere is it specified that within any one class or sub-class (other than in the sub-divisions of G4) there should be a particular format or content of data. Each class or sub-class

may contain a single number (e.g. tonnage) or a set of associated numbers (tonnage and grade, or tonnage and a vector of mineral quality estimates, or the same sets of numbers with estimated error, standard deviations, etc). UNFC-2009 Definition and Specifications do not and cannot prescribe the way in which such data should be presented.

(e) Precision

107. It is also strongly recommended that the CRIRSCO convention be followed, that data be quoted only to as many significant digits as represent the confidence attached to the data:

- (CRIRSCO Template 2006, clause 24, and CRIRSCO Template 2013, clause 26) ... Reporting of tonnage and grade figures should reflect the relative uncertainty of the estimate by rounding off to appropriately significant figures and, in the case of Inferred Mineral Resources, by qualification with terms such as 'approximately'.

108. Data will vary greatly in both form and content. For polymetallic resources or reserves data, it may often be most appropriate to present the data for multiple elements in a single table, while for exploration data there may either be a large volume of Exploration Results in the form of raw drill hole data, or a range of values for Exploration Targets, and in such cases the data type will dictate the most appropriate storage and presentation formats.

(f) Tabulations

109. Where data are simply mapped from CRIRSCO aligned reports and presented without aggregation, the simplest approach would be to add another header line which gives the UNFC-2009 classes. An example of this, using the Rio Tinto uranium resources table, is presented in Table 12. Note that in this case the data are presented as tonnage and grade. For coal data there is commonly only tonnage, while for other minerals there may be more than one grade or quality parameter. In this example an explanatory footnote has been added to make it explicit that in this instance the data presented are for the whole project.

Table 12
Uranium resources data with UNFC-2009 classes added

Uranium	*Likely mining method*	*Measured resources at end 2012*		*Indicated resources at end 2012*		*Inferred resources at end 2012*		*Rio Tinto interest*
UNFC-2009 class		**E2-F2-G1***		**E2-F2-G2***		**E2-F2-G3***		
		Tonnage	Grade	Tonnage	Grade	Tonnage	Grade	%
		millions of tonnes	U_3O_8 %	millions of tonnes	U_3O_8 %	millions of tonnes	U_3O_8 %	
Energy Resources of Australia (Australia)								
– Jabiluka	U/G	1.2	0.887	14	0.52	10	0.545	68.4
– Ranger#3 mine (nn)	U/G			9.5	0.325	0.6	0.383	68.4
– Ranger #3 stockpiles (oo)				69	0.043			68.4
Rössing (Namibia) (pp)	O/P	15	0.026	148	0.024	173	0.026	68.6

***** Data presented are for the whole project, not the Rio Tinto interest in the project.

110. If both the UNFC numerical class (and sub-class where appropriate) and the CRIRSCO class for the data are presented together, the mapping is explicit and unambiguous.

111. Where data from multiple tables are combined, associated text in the table header or in footnotes should also identify the degree and methods of aggregation of data.

112. Where data are obtained from public reports, it would be useful also to include identification of the relevant Competent Persons.

(g) Reporting outside CRIRSCO classes

113. For collection of government inventory statistics, it is strongly recommended that data are not compiled *from minerals company sources* beyond those classes defined in the CRIRSCO Template and CRIRSCO aligned reporting standards. There are a number of reasons for this recommendation.

(a) Companies do not commonly hold information on uneconomic mineral quantities, and those exploration companies which wish to record estimates of undiscovered mineral will generally do so within the 'Exploration Target' class. For planning purposes, most companies use the same numbers in their external public reporting as for their financial modelling and business planning purposes: the CRIRSCO classification, and are able to maintain just one set of reserves and resources information, serving multiple users;

(b) If companies are required to supply estimates for mineral quantities beyond the CRIRSCO classes, for which they may not even have the relevant information, it is likely that some 'zero' returns will be made, and the quality of any governmental planning based on such incomplete data will necessarily be compromised;

(c) Any requirement for companies to make estimates of mineral which they have not found or which would be uneconomic to mine would be a requirement to do additional work which is of no benefit to them and they would rightly see this as a hidden tax.

114. For 'undiscovered', 'uneconomic', or 'unrecoverable' mineral inventory estimates, it is more appropriate and would lead to more consistent estimates, to use data compiled by national or regional geological surveys or similar organisations. It is recognised that existing governmental regulations in some jurisdictions may require minerals companies to supply data beyond the CRIRSCO classes, but in such cases it is recommended, in view of the points identified above, that the requirements ideally should be modified to collect the data in other ways.

(h) Aggregation of Different Classes

115. For a number of reasons, great care should be taken in aggregating different classes of data.

116. For historical reasons, in reports prepared under some CRIRSCO aligned standards, Mineral Resources may sometimes be reported ***inclusive*** of material that is used to estimate Mineral Reserves. In other words, the same material may be listed in two classes in the same report. Whenever this is done, it should always be clearly stated in the report, and best practice is also to report the quantity of Mineral Resources that was used for conversion to Mineral Reserves.

117. It is important when using data from CRIRSCO reports to be aware of this possibility. In UNFC-2009 mineralization reported in any class is always ***exclusive*** of other classes, so CRIRSCO data expressed in this way cannot be converted directly, but the quantity of Resource used to define a Reserve must first be subtracted from the Resource estimate (see section III(B) of the Bridging Document between the PRMS and UNFC-2009 (ECE Energy Series No. 42 (ECE/ENERGY/94) Part II, Annex III).

118. In conversion of Mineral Resources to Mineral Reserves estimates, allowance is made for diluting material and for mining losses, so both tonnages and grades are likely to be changed. Commonly also some Resources will be excluded from the mine design used to estimate Reserves, and if the mine design makes this material inaccessible they could well be omitted from public reports as they have no "prospects for eventual economic extraction". It is therefore not admissible in public reporting by companies to aggregate data from these two sets of classes. While reserves classes (E1-F1-G1 and E1-F1-G2) may be aggregated with each other, and resources classes may similarly be aggregated among themselves, **under no circumstances should E1-F1-Gx numbers be combined with E2-F2-Gx numbers (where 'x' in the 'Gx' is either 1 or 2)** – that is, E1-F1-G1 and E1-F1-G2 can be aggregated with each other but cannot be aggregated with E2-F2-G1 and E2-F2-G2. In practice this should not be a problem, as the Bridging Document gives another reason why these numbers should not be combined: Mineral Resources and Mineral Reserves are considered in UNFC-2009 as separate projects ('Potentially Commercial' and 'Commercial' respectively). Such aggregation of different projects is allowed under Item K "Aggregation of quantities" (ECE Energy Series No. 42, Part II, Section VI) but it is recommended in section IV(D) below that this specification be modified to prohibit such aggregation in situations where the numbers in the different classes are not directly comparable.

119. It should also be noted that minerals companies may aggregate different types of mineral in their published reports. Where this aggregation does not match the minerals classification required for compilation of statistics or for minerals planning purposes, it will of course be necessary to obtain the un-aggregated data from the company concerned. Where data have been reported using CRIRSCO standards, the separate estimates should always be available even if they are not included in the published summary reports.

(i) Joint Ventures

120. As noted above, estimates of Mineral Resources and Mineral Reserves may be presented in different public reports by different partners in a joint venture operation. In all cases the share of ownership by the company preparing each report should be clearly stated. Great care must be taken to avoid double counting of such estimates.

121. Ideally only the proportion actually owned by the reporting company should be converted into UNFC-2009. This would avoid the risk of double-counting - but it should be noted that there is a complementary risk of under-counting if data are not received from all JV participants.

122. Item E "Basis for Estimate" (ECE Energy Series No. 42, Part II, Section VI) of the UNFC-2009 Specifications states:

- *Reported quantities may be those quantities attributable to the mine/development project as a whole, or may reflect the proportion of those quantities that is attributable to the reporting entity's economic interest in the mining operation or development project. The reporting basis shall be clearly stated in conjunction with the reported quantities. ...*

123. However, it is recognized that recording of data in UNFC-2009 is normally expected to be on a project basis, therefore the 100% project estimates would be used (as illustrated in Table 12 above). This should eliminate the under-counting risk, provided that data for a project is captured from at least one of the project's participants. Double counting must then be avoided by unambiguous identification of the project.

124. In some cases it will be found that different partners in a joint venture publish different estimates of the resources and reserves. In these cases, it will be necessary for the government agency or other compiling organisation to apply professional judgement on which numbers to use for the project as a whole. This may require detailed discussion with

each of the companies concerned, as well as examination of the underlying data, deposit models, and estimation methods.

(j) Cut-off Grades

125. Although not explicitly identified in the case studies, cut-off grades can be an important source of uncertainty when aggregating data from multiple projects. The grade-tonnage curve, which is a fundamental feature of resource/reserve evaluation, will give lower tonnages of mineral (and higher average grades) as the cut-off grade is increased. The cut-off grade is not a fixed number, but will vary from one project to another depending upon mining costs, and will vary from time to time depending on fluctuating commodity prices. A mining company will also take its own view on an appropriate mining cut-off grade which will generally be above a theoretical 'break-even' cut-off, and will take into account the company's views on likely future pricing as well as the time horizon for the particular project - a large project will generally need longer-term planning than required for smaller projects.

126. For mapping of CRIRSCO estimates into UNFC-2009, the cut-off grade should probably be considered as just one among many Modifying Factors (on the E and F axes of UNFC) and usually will not impinge directly upon the choice of classes or sub-classes. The cut-off grade is just one input parameter for the mine design which is one of the key steps in converting a CRIRSCO Resource to a Reserve (i.e. moving from E2-F2-Gx to E1-F1-Gx in UNFC-2009).

(k) Exploration Targets

127. Where data are recorded from company reports on Exploration Targets, the likelihood of positive bias should always be considered. Ideally such data should not be used directly - as in any case the figures will be incomplete and should usually refer only to licensed exploration areas. More reliable and less biased estimates of undiscovered mineral potential should be available from geological surveys or similarly independent agencies.

(l) Use of sub-classes

128. In compiling data for statistical purposes, it is unlikely that numbers from all data providers (companies, etc.) will be available at the same level of granularity. Although sub-classes may be recorded for some data, it is strongly recommended that two fields be used for the UNFC-2009 classification in any database, one containing the main UNFC-2009 class (e.g. E1-F1-G1), the other containing the sub-class if defined (e.g. E1-F1.2-G1). This will allow correct aggregation of data using the main classes.

D. Comments on Specifications for the application of UNFC-2009

129. Minor updates are proposed in the Specifications including the CRIRSCO-UNFC-2009 Bridging Document to bring it into line with the updated CRIRSCO Template (November 2013).

130. There are three specific points which are identified: the aggregation of data on Reserves with data on Resources, the sub-division of exploration information in class E3-F3-G4, and a set of updates to Annex III.

(a) Aggregation of Reserves and Resources

131. The CRIRSCO Template explicitly prohibits the aggregation of Reserves estimates with Resources estimates in public reporting by companies. One of the main reasons for this is that the numbers themselves are not comparable. Reserve estimates are derived from Resource estimates by consideration of a series of Modifying Factors. These include the

definition of a mine design (which is likely in most cases to exclude some of the identified Resources) as well as the application of factors for dilution (which will tend to increase the tonnage and reduce the grade) and mining losses (which will tend to reduce the tonnage).

132. **A Mineral Resource** is a quantity of mineral which has "reasonable prospects for eventual economic extraction."

133. **A Mineral Reserve** is "the economically mineable part of a Measured and/or Indicated Mineral Resource" on which assessments at feasibility or pre-feasibility level "demonstrate at the time of reporting that extraction could reasonably be justified".

134. It is not in general possible to derive estimates of Mineral Reserves from Mineral Resources estimates simply by application of the estimated dilution and loss factors - because the mine design process will define that part of the resource for which extraction could reasonably be justified, and quite commonly substantial parts of the Resource are excluded from a Reserve estimate.

135. It is therefore not valid to combine the figures for Resources and Reserves, because they are estimates of different quantities.

136. It is proposed that Item K "Aggregation of quantities" of the UNFC-2009 Specifications (ECE Energy Series No. 42, Part II, Section VI) be modified to reflect the intention of Annex III, the Bridging Document between the CRIRSCO Template and UNFC-2009, to make it clear that under no circumstances should material classified in CRIRSCO as Reserves and mapped into UNFC classes E1-F1-G1 or E1-F1-G2 be aggregated with material classified in CRIRSCO as Resources and mapped into E2-F2-G1, E2-F2-G2, or E2-F2-G3.

(b) Sub-division of Exploration Information

137. Modifications to the CRIRSCO Template in 2013 include the addition of a definition for Exploration Targets (in the 2006 version these are mentioned but not defined). There is also an existing CRIRSCO position paper on "Mineralisation beyond Inferred Resources" which discusses some of the issues.

138. At the CRIRSCO 2013 meeting in Bogota, Colombia, it was agreed that this Position Paper on Mineralisation Beyond Inferred Resources should be updated to include further discussion of "Exploration Targets" which now have a standard definition included in the November 2013 update of the CRIRSCO Reporting Template:

- **An Exploration Target is a statement or estimate of the exploration potential of a mineral deposit in a defined geological setting where the statement or estimate, quoted as a range of tonnes and a range of grade or quality, relates to mineralisation for which there has been insufficient exploration to estimate Mineral Resources.**

139. It was identified during discussion at the meeting that there are two types of Exploration Target: those for which there are supporting data available (such as geophysical or geochemical surveys or limited drill hole data) and those for which there is only general regional geological information. An updated version of the position paper will be prepared which explains these, and appropriate mappings to classes of UNFC-2009 will be recommended.

140. This report includes suggestions for mapping, following the proposal for revised definitions of sub-classes below.

141. As identified above, it is strongly recommended that Item P "Expansion of G4 to account for uncertainty" of the UNFC-2009 Specifications (ECE Energy Series No. 42, Part II, Section VI), defining G axis sub-classes for exploration data which codify the presentation

of data, should be replaced in its entirety as it is inconsistent with the nature of UNFC-2009. Such detailed codification is not specified for any other classes. Data within any class or sub-class of UNFC may consist of more than a single number, with or without estimates of precision. This will then allow a more consistent use of sub-classes along the G axis to represent the relative amount of geological knowledge, specifically by replacing the F axis sub-divisions (of F3) in Item R "Classification of quantities associated with Exploration Projects" of Section VI of the UNFC-2009 Specifications (ECE Energy Series No. 42, Part II) by more appropriate G axis sub-divisions (of G4). The current Item P "Expansion of G4 to account for uncertainty" of Section VI of the UNFC-2009 Specifications (ECE Energy Series No. 42 (ECE/ENERGY/94), Part II) is not suitable for codifying the CRIRSCO 'Exploration Target' class. It provides for a range and best estimate of a single parameter; CRIRSCO Exploration Targets are normally expressed as ranges of multiple parameters (tonnage, grades, etc.) without a best estimate.

142. All the exploration target values in either a 'low, best, high case' form or the CRIRSCO range (lower, upper limits), are at the same relative level of geological knowledge so should not be assigned to different sub-divisions along the G axis.

143. In Item R "Classification of quantities associated with Exploration Projects" of Section VI of the UNFC-2009 Specifications (ECE Energy Series No. 42, Part II), the sub-division as defined is actually dependent directly upon the relative degree of geological knowledge. Although there may be a correlation with 'project maturity', the concept of project maturity is not useful for solid minerals projects - but the degree of geological knowledge is a concept applicable to all projects. Sub-division should therefore be along the G axis, not the F axis.

144. Project maturity as described in Annex V of the UNFC-2009 Specifications (ECE Energy Series No. 42 (ECE/ENERGY/94), Part II) involves progression along all three axes E, F, and G, and different aspects of this concept could lead to sub-divisions on any one of the three axes – but it seems clear that an aspect of project maturity that concerns only the degree of geological knowledge should sub-divide the G axis, not the F axis.

145. The proposed replacement paragraphs in the Specifications for the Application of UNFC-2009 are as follows:

(a) Item P "Expansion of G4 to account for uncertainty" (ECE Energy Series No. 42, Part II) Exploration data may be presented in a variety of different forms: as raw data, as ranges (low and high limits of one or more parameters), as ranges with low case, best estimate, and high case, or in other formats;

(b) Item Q "Optional labels for estimates (ECE Energy Series No. 42, Part II): It is not the purpose of UNFC-2009 to define the codification or form of presentation of such data, and it would be both impractical and inappropriate to define sub-classes to represent all possible variants;

(c) Item R "Classification of quantities associated with Exploration Projects" (ECE Energy Series No. 42, Part II): In some situations, it may be helpful to sub-classify data from Exploration Projects on the basis of the degree of geological knowledge. In such cases, the following specification shall apply:

(i) G4.1: where site-specific geological studies and exploration activities have identified the potential for an individual deposit with sufficient confidence to warrant drilling or testing that is designed to confirm the existence of that deposit in such form, quality and quantity that the feasibility of extraction can be evaluated;

(ii) G4.2: where local geological studies and exploration activities indicate the potential for one or more deposits in a specific part of a geological province, but requires more data acquisition and/or evaluation in order to have sufficient confidence

to warrant drilling or testing that is designed to confirm the existence of a deposit in such form, quality and quantity that the feasibility of extraction can be evaluated;

(ii) G4.3: where favourable conditions for the potential discovery of deposits in a geological province may be inferred from regional geological studies.

146. The CRIRSCO Exploration Target class would then be mapped to E3-F3-G4, into one or other sub-class depending on the extent of geological knowledge:

(a) Where there are supporting data available (such as geophysical or geochemical surveys or limited drill hole data): mapping to E3.2-F3-G4.1 or E3.2-F3-G4.2 depending on the relative amount of geological information available;

(b) Where there is only general regional geological information, mapping to E3.2-F3-G4.3.

147. It should be noted that if there is still a requirement to sub-divide the E3-F3-G4 class on the basis of project maturity, other than related to geological uncertainty, then this remains possible on the F axis, which the above proposal leaves undivided.

(c) Annex III: Bridging Document between the CRIRSCO Template and UNFC-2009

148. This should be updated to reflect the contents of the updated CRIRSCO Template (November 2013). Apart from addition of references to the Exploration Target, as discussed above, it should also include reference to the new CRIRSCO definitions of Reference Point and Effective Date. Figure III.1 should be replaced by the new standard CRIRSCO Figure 1 (which is essentially the same but has been redrafted and mentions additional Modifying Factors).

149. It is recommended that section III(B) paragraph 3 of the Bridging Document between the CRIRSCO Template and UNFC-2009 (ECE Energy Series No. 42, Part II, Annex III) be amended so that it explicitly excludes the option of aggregating classes E1-F1-G1-3 (Reserves) with E2-F2-G1-3 (Resources). A suitable example of aggregation to quote instead might perhaps be (221 + 222 + 223), which would represent all Resources (Measured + Indicated + Inferred).

150. In paragraph 4 of Section III(B) of the Bridging Document between the CRIRSCO Template and UNFC-2009 (ECE Energy Series No. 42, Part II, Annex III), "yield factors shall be provided" should be replaced by "yield factors should be provided" because although strongly recommended it is not mandatory to supply these in a CRIRSCO report.

E. Confidentiality and disclosure issues

151. Whilst the UNFC-2009 Definitions and Specifications are silent on confidentiality and disclosure, these considerations do not directly affect the mapping of the classifications, nonetheless these are issues that will need to be addressed by government or other users of the classification if using data supplied by either private or public companies.

152. For private companies, the confidentiality of their data will be constrained only by statutory requirements by government authorities. For public companies listed on stock exchanges, the form and content of disclosure will be controlled by the appropriate stock exchange regulator (for example in Europe by ESMA, in Australia by the Australian Securities and Investments Commission (ASIC), etc.) and there is thus a possibility of conflicting requirements of regulatory and other authorities.

153. Other than identifying that there is a potential issue to be addressed by government authorities in conjunction with market regulators, it is beyond the scope of this report to make any detailed recommendations.

F. Competence and Quality Assurance

154. For publicly listed minerals companies, stock exchange regulations in many jurisdictions require that statements of estimated reserves and resources be certified by a Competent Person ('Qualified Person' in Canada), with a minimum level of professional qualifications, membership of a recognised professional organisation, and sufficient relevant experience. This provides a degree of assurance of the veracity of the published estimates.
For private or unlisted companies, there is usually no such requirement, though many unlisted companies voluntarily follow the same rules. Particular care should be exercised to maintain consistency of data quality when recording data from a variety of sources. Within the context of the European Union 'Minventory' project (to create a metadata portal to resources and reserves data held by the governments of member states and other participating European countries) BRGM (Bureau de Recherches Géologiques et Minières) have concluded, as one result of a 'Gap Analysis' study, that there should perhaps be a recommendation that governments consider the employment of highly experienced 'Competent Persons' to validate mineral reserves and resources data submitted for national mineral inventories or statistical purposes.

155. If mapping company data to UNFC-2009, it will be important to record whether or not the data being used have been approved by a Competent Person and are fully compliant with CRIRSCO standards. It should be noted that frequently private and unlisted companies record their data using one of the CRIRSCO aligned standards, but do not enforce strict rules on Competent Person sign-off because the reports are not intended for market-sensitive publication and their content is not governed by stock exchange regulations.

V. Concluding comments

156. It was found possible to use the main classes of the UNFC-2009 classification to represent all example data reported under CRIRSCO reporting standards. No changes are recommended in either the UNFC-2009 Definitions or the CRIRSCO Template.

157. In many cases it was also possible to use UNFC-2009 sub-classes as defined in the Specifications, including the Bridging Document between the CRIRSCO Template and UNFC-2009. Only one problem was encountered, where the UNFC-2009 Specifications were found to be inappropriate, and this was for sub-classes of exploration data in the E3-F3-G4 class. Detailed proposals have been made in this report for replacement of the relevant paragraphs with a more logical and consistent sub-division.

158. There is also a more general question concerning data aggregation, where a CRIRSCO prohibition on aggregating Reserves estimates with Resources estimates is not reflected in UNFC-2009, and a small but significant modification to the Specifications is proposed.

159. It is recommended that, even though the matter has been discussed before, CRIRSCO should re-visit the question of requiring the use of a particular Reference Point (in particular the point of sale). This would be a departure from present normal practice (the point of delivery to the processing plant) and could be problematic for some companies, but at the same time could be of assistance both to investors (in their own financial modelling) and to agencies using published data for raw materials policy and planning purposes.

160. A number of practical issues have been identified, which could be extracted in a set of guidelines for government and other users of UNFC-2009. These issues are concerned with use of the classification for different types of data, not with the classification itself.

161. Acknowledgement is made of the helpful contributions in terms of comments, suggestions, and corrections from Jim Ross, Sigurd Heiberg, Roger Dixon, and Ferdi Camisani.