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Response to Request for Review – 6818 Daegu Metro 3th Urban Railroad

Dear Members of the CDM Executive Board,

Please find the summary of the responses to the issues raised and the action taken to correct the project-related documentation as part of the request for review for requesting registration for the No. 6818 project. The response is in accordance with para 9 a) in the Procedures for Review of Requests for Registration (EB55, Annex 40).

1) The DOE is requested to further substantiate the following input values:
a) the discount rate of 5.57 %, considering that two other metro projects (Incheon Line 2, Busan Line 1 extension) with similar financing structure (60% federal and 40% municipal budget) validated by the same DOE have applied 0% discount rate;

DOE's response:
The document used for the entire financial analysis is the economic and financial analysis realized by the Ministry of Land, Transport and Maritime Affairs, 2008. In Chapter 4, assumptions, the financial discount rate is included as standard. The discount rate used is 5.5% and not 5.57% as cited by the EB. This is conservative. EB 62 Annex 5 has in its Appendix as default return on equity for transport projects in Korea 11.8%. Long-term (10-year) government bond rates also had in the year 2008 (year prior investment decision and year in which financial analysis was made) an average interest rate of 5.57% whilst the project used the rate of 5.50%.
The other 2 metro projects had in their financial analysis no discount rate explicitly mentioned and therefore the PP took a very conservative stance of taking 0%. However it would also have been justified to take for the other 2 projects a higher rate idem to Daegu. Taking a higher rate for the other projects would have made them even less financially attractive.

b) the total investment: how it has considered the range of 35-89 million USD for metro lines worldwide (Bus-systems for the future, IEA, 2002) comparable, considering that: i) the project activity is a mono-rail; and ii) there are several metro projects in the host country and neighbouring countries;

DOE's response:
The investment cost is based on the Ministry of Land, Transport and Maritime Affairs, a 3rd Party. To assess the plausibility of the value independent and well known international sources are taken being the IEA and a published report by B Flyvberg, Comparison of Capital Costs per Route-Kilometre in Urban Rail, EJTIR, 8, no. 1 (2008) which show that the investment cost of the project with 36 million USD/km (elevated metro) is at the lower end of international estimates. The Article of Flyvberg includes thereby also the investment cost of Seoul metro network (117km) which is stated to be 65.8 million USD/km in 2002 (File 47,

Table 3, p.23). The IEA comparison is for elevated metros. Not all elevated metros are monorails but most monorails, including the project one, are elevated. Thus elevated metros (including monorails and others) are the most comparable rail-based MRTS. GTZ on p.14, SQS ref. [38] states also: "… monorail and maglev train technologies could be considered a form of elevated rail transit…". In fact Korea has at the moment only 2 monorail systems operating (in theme-parks Lotte World and site of Taejon expo 1993) and thus this system could be determined "first of its kind" as a MRTS. However, albeit having some unique technological features, basically it's an elevated MRTS and therefore compared to the latter.

Park and Han (2003) estimate the cost of building metros in Korea by 80-100 million USD/km (see cited in J. Pucher et.al., Public Transport Reforms in Seoul, p.56; The study for the state of construction and improvement policy of advanced transit system of Korea, 2003,) in addition, Annex 1: Public Transport Reforms in Seoul: Innovations Motivated by Funding Crisis, Journal of Public Transportation, Vol. 8, No. 5, 2005, SQS ref. [85])
The cost of other fully elevated MRTs under construction is shown in the table below:

Daegu	Gurgaon, India	Metro Mumbai 1	Metro Mumbai 2
36 million USD/km	46 million USD/km	46 million USD/km	72 million USD/km

Data based on finance documents as included in the respective PDD published on the UNFCCC website.
See also about the difficulty of comparing investments in metro: http://www.railway-technical.com/finance.shtml.
The project is at the lower end of cost estimates compared to other projects. In terms of projected construction investment the Monorail system is less expensive than other rail alternatives studied with 22-31% lower construction investment required as determined in the FSR[1]. Taking the investment of the other systems and reducing it by 20-30% we can see that the Daegu project is in the range of other projects and thus the investment cost is plausible.
Above figures including other elevated metros, Seoul metro data, IEA and Flyvberg all show that the investment for an elevated metro as planned in Daegu are plausible. The dataset is deemed as comparable as based on elevated MRTS.

c) the operational cost: how it has validated: i) the Operational Cost per Passenger for the project activity, the validation report does not include this information, ii) the selected domestic metro line and overseas metro lines for comparison, and iii) the suitability of the number of employees, salary, electricity cost, electricity consumption and maintenance cost;

DOE's response:
The operational cost is based on the Ministry of Land, Transport and Maritime Affairs, a 3rd party. Since Korea and especially Daegu already have operating metros the operational costs can be estimated fairly well depending on train frequency and demand projections. Whilst operational costs might be lower if passenger numbers are lower than projected this has been included in the finance model as the operational costs have been reduced proportionally to the reduction in passenger numbers, which is very conservative as this assumes that all operational costs are variable whilst in practice some are fixed costs (e.g. station maintenance; also electricity consumption is not strictly proportional to passenger numbers).

The metro lines are compared to recently established metro lines or such under construction. The data from the Daegu PDD has not been included as latter is a short line extension and not a full line thus not making costs comparable. The table below shows the operational costs of all elevated metros for which data was available on a comparable base i.e. FSR were available for a same year to make cost data per passenger comparable:

[1] File 20 SQS ref. [20] Chapter 1.3., Table 1.3.7.

Table: Comparison of Projected Operational Costs per Passenger (USD per km and passenger; year 2020)[2]

Metro Daegu	Metro Mumbai 1	Metro Mumbai 2	Metro Seoul Line 9	Metro Gurgaon	Metro Mexico Line 12	Metro Delhi Phase II
0.22	0.13	0.12	0.19	0.11	0.29	0.23[3]

Metro Incheon is underground and has thus significantly higher costs and has therefore not been included. Metro Buenos Aires is to a large part underground and has thus not been included.
Metro Seoul Line 9 is double-tracked which means much more passengers but using the same stations and thus reducing the cost per passenger transported. Metro Mumbai 1 and 2 and Metro Gurgaon have passenger numbers which are 2-4x higher than DMRC and Metro Mexico are partially elevated, partially underground and partially at level.
In terms of operational costs the monorail is more expensive than other metro systems basically due to higher electricity and maintenance costs. Operational costs are between 4 and 25% higher than for other rail-based systems – see FSR[4]. Taking this data the Metro Daegu operational costs are idem to Metro Seoul, which is the most comparable for operational costs due to being in the same country with similar staff and electricity costs.
The number of employees, their salaries, the electricity costs and the maintenance costs (divided in station-, train- and system-maintenance costs) have been taken from the 'Master plan of Daegu Metro 3th Urban Railroad' edited by Saman Engineering, an independent 3rd Party (SQS ref. [69]), which was sent to SQS in responding to CL 14. These figures were discussed in detail and crosschecked during the on-site visit by the SQS' validation team and the local expert Mr Ko (KFQ). Furthermore the performed assessment is confirmed in writing on 09/11/2012 by the Korean Foundation for Quality (KFQ), regarding the assessment on operational costs analysis for Daegu Metro, in which Mr Ko confirms that the background data for operational costs for Daegu Metro is duly reasonable and correct (see Annex 2: File Daegu Operational Cost Evaluation (09. Nov. 12)_1.xls).

Based on checks and information above, SQS considers the validation approach as appropriate and expected operational costs of Daegu as plausible in the international context.

d) the revenue: how it has validated i) the passenger projection, ii) the average fare, in particular, whether the population share of each fare group is likely to represent the passenger share, and iii) whether the non-fare box revenue is included in the revenue, and if so, whether it is subject to the risk rate.

DOE's response:
(i) Passenger projections and revenue projections were performed by Saman Engineering, an independent 3rd Party (SQS ref. [66]). The fare-box revenues are calculated based on passenger projections (based again on demand forecast models) multiplied with the average actual fare paid.

(ii) the average fare is based on the population shares and the fare rates respectively discounts per passenger group as summarized below:

Table 6-6 of Saman Eng. report
Population ratio for Daegu metropolitan city (30th June 2007)

[2] Based on Feasibility reports for all i.e. projections for all cases; for all based on projection year 2020 to have a fully operational and comparable data year. Exchange rates to USD based on financial assessment report per project; all data based on published PDDs for the respective metros.

[3] See Annex 3: File 47 finance vers. 1.1 DMRC SQS ref.[78] operational cost (9,645 million INR) exchange rate 44 INR/USD (http://www.oanda.com/currency/converter/ for 1.9.2005); see Annex 4: File 2 Passengers and OP costs DMRC.xls, SQS ref.[79] project with growth rate 5.8% per annum (960 million); all 2020.

[4] File 20 SQS ref. [20] Chapter 1.3., Section 2 p.23

	infant	Child	Student	Adult	Senior (65 or Older)	Total
Population	132,572	238,838	224,197	1,686,483	214,183	2,496,273
Population Ratio	5.31%	9.57%	8.98%	67.56%	8.58%	100%

Table 6-7 of Saman Eng. report Discount rates and free of charge					
	Child	Student	Adult (Card etc)	Adult (General)	Senior and infant
Discount Rate	55%	39.10%	13.60%	-	100%

The average resultant fare rate is 800 Won based on a standard tariff of Won 1,100 applicable as of time of FSR (calculated as 1,100-discount rate per category x population ratio per category summarized over all categories)
The discount rates for metro line 1 and 2 have considered to be setting the discount rates for line 3 and it has been assumed that the 50% of adult passengers would get fare discount by using traffic card or commuter pass.
(iii) Revenue is based on fare box and non-fare-box revenue.
Non-fare box revenue is estimated as 10% of fare-box revenue based on experience in Daegu. This rate is comparable to other metros. Metro Seoul Line 9 has e.g. 8%[5]. The non-fare box revenue is subject to the risk rate. This is justified as the FSR assumes that the non-fare box revenue is correlated to the passenger number. Based on the FSR with lower passenger number the non-fare box revenue also drops (this is also quite logic as a core non-fare box revenue is publicity and rates of latter are dependent on number of persons which can be reached). Also non-fare box revenue only accounts for 10% and with a risk rate of 70% the non-fare-box is reduced by 7 percentage points. The sensitivity analysis shows however that the total revenues would need to increase by 62% to achieve the benchmark. Therefore even if no risk rate would be applied to the non-fare box revenue the result of the financial exercise of a negative NPV would not be affected.

e) the risk rates of 30%, whether all lines in the host country were considered; and

DOE's response:
Yes, in accordance with the methodology p.6: "…project participants should evaluate the cost overruns or reduced revenues of former MRTS that were implemented in the same host country in the last 20 years at the time of project start. Information on originally projected and actually observed costs/revenues should be based on official and public data…".
All lines as published in a 3rd party independent report were included. See table below:

Table: Relation Expected to Actual Passenger Numbers of Korean Metros (1,000 passenger/day)

City/Line		Expected	Actual	%
Seoul	Line 5	2,410(2001)	827(2001)	34.3
	Line 6	1,319(2001)	284(2001)	21.5
	Line 7	2,363(2001)	703(2001)	29.8
	Line 8	557(2001)	222(2001)	39.9
	Total	6,649	2,036	
Busan	Line 1	1,932(2001)	544(2001)	28.2
	Line 2	1,782(2006)	230(2006)	12.9
	Line 3	276(2006)	65(2006)	23.6

[5] File Seoul, SQS ref [86] (93,650 million Won / 288.1 million passengers; exchange rate 0.00059)

	Total	3,990	839	
Daegu	Line 1	347 (2001)	138 (2001)	39.8
	Line 2	912 (2006)	125 (2006)	13.7
	Total	1,259	263	
Incheon		1,441(2003)	204(2003)	14.2
Gwangju		187(2004)	305(2004)	16.3
Daegjeon		91(2006)	42(2006)	46.2
Average relation actual to projected passenger numbers				**27 %**
Median relation actual to projected passenger numbers				**26 %**

Source: All cities/lines except Daegu Line 2 based on Inha University, 2006, Table 17 (File 37 SQS ref. [37]); Daegu Line 2 for expected passenger number based on Daegu Metropolitan City Railroad Construction Headquarters and Daegu Metropolitan Transit Corporation for actual passenger numbers (SQS ref. [40]); median and average of all lines calculated by Grütter Consulting validated by SQS and deemed correct.

Also if the average of the 2 Daegu lines would be taken the risk rate would be lower than 30%.

f) the cost of the trial run of 15,600 million KRW, accounted as cash outflow in 2014. Please refer to VVM version 1.2 paragraph 111.

DOE's response:
Trial run expenses are put as expenses and not investment. Therefore the risk rate of minus 70% is also applied to this expenditure. The NPV with the expense trial run (base case with risk factor) is – 176,000 million Won and without the trial run cost this number would change to 172,700 million Won i.e. a change of 1.9%. This means that this expense is completely irrelevant in financial terms to determine the NPV. This is logical as the expense is only incurred in once. Total expenses over the observation period are 856,400 million Won whilst trial run expenses are 15,600 million Won i.e. 1.8% of total expenses. As the incidence of this expense is marginal and insignificant an in-depth review, (as was made for other relevant operational expenses such as staff, maintenance or power consumption, which have 10-30x higher expenditures) is not required when applying a risk based approach during validation.

2) The DOE is requested to further substantiate how it has validated the common practice analysis as: a) the set of cities used for comparison includes cities with population less than 1 million while the methodology (page 6) states "If the larger urban zone (LUZ) of the city of the project activity contains more than one million inhabitants, then the set of cities for comparison includes all cities (including the city of the project activity) in the host country with a LUZ that contains more than 1 million inhabitants"; and b) excluding the cities with less than 1 million at the time of the investment decision, there would be 7 cities for comparison out of which 5 cities already have MRTS in place while the methodology states "The proposed project activity is regarded as common practice if MRTS have already been implemented in 50% of the cities in the set of cities for comparison". Please refer to VVM version 1.2 paragraph 120.

DOE's response:
The methodology states that the LUZ needs to be taken (which is often larger than the official number of city inhabitants).
A. Eurostat, the European Union's statistical agency, has created the concept of Larger Urban Zone (LUZ) in an effort to harmonise definitions of urbanisation in the European Union and in countries outside the European Union. These definitions were agreed upon between Eurostat and the National Statistics Offices of the different countries of the European Union at the European Commission's Urban Audit of 2004. Eurostat's objective was to have an area from a significant share of residents commuting into the city, a concept known as the "functional urban region." To ensure a good data availability, Eurostat adjusts the LUZ boundaries to administrative boundaries which approximate the functional urban region.

B. The concept of LUZ needs to be transformed to the traditional concept of city inhabitants. The functional area is therefore taken for the cities for which no metropolitan area statistics are available. The result is depicted in Table 1 below:

Table 1: Metropolitan Population (year 2009) of Korean Cities

Urban Area based on functional area idem to LUZ	Population in millions
SNCA	24.38
Busan Metropolitan City	3.54
Daegu Metropolitan City	2.49
Daejeon Metropolitan City	1.48
Gwangju Metropolitan City	1.43
Ulsan Metropolitan City	1.11
Changwon (only city, 2010)	1.09
Cheongju	1.15
Jeonju	1.39
Cheonan	1.25
Pohang	1.30

File 70b SQS ref. [77][6]

Therefore we have 11 cities with > 1 million of which 5 have a MRTS (highlighted in yellow) i.e. less than 50%.

In detail for the below cities which as metropolitan or functional area have > 1 million but less than 1 million when taking only the city population data which is however NOT in line with LUZ as used by the methodology depicted in Table 2 below:

Table 2:

			Total population in the metropolitan area
Cheongju (LUZ)	Cheongju city	643,161	1,153,443
	Cheongwon	149,783	
	Boeun	34,845	
	Okcheon	54,117	
	Yeongdong	50,426	
	Jeungpyeong	33,164	
	Jincheon	61,456	
	Goesan	36,775	
	Eumseong	89,716	
Jeonju (LUZ)	Jeonju city	635,007	1,387,253
	Iksan	306,669	
	Gimje	94,770	

[6] File 70b was erroneously mentioned as File 26b in the validation report, this is corrected in the new VR

	Gunsan	266,922	
	Wanju	83,885	
Cheonan (LUZ)	Cheonan city	540,832	1,245,560
	Gongju	124,172	
	Boryeong	106,754	
	Nonsan	127,097	
	Gyeryong	42,760	
	Geumsan	56,220	
	Yeongi	79,482	
	Buyeo	75,564	
	Seocheon	60,066	
	Cheongyang	32,613	
Pohang (LUZ)	Pohang city	509,475	1,300,503
	Geongju	267,466	
	Youngcheon	103,115	
	Cheongsong	26,917	
	Yeongyang	18,553	
	Yeongdeok	41,710	
	Uljin	52,529	
	Geongsan	236,459	
	Cheongdo	44,279	

File 70b SQS ref. [77][7]

C. To assess the plausibility a check was performed with the EU LUZ empirical calculations. The plausibility is done by comparing LUZ calculations done in the EU with official city population data, and thereby determining an expansion factor to determine LUZ based on city inhabitant data. All cities of the Eurostat database are taken for this purpose. The figures in the Eurostat database are an attempt to reach a compromise between harmonised data for all of the European Union, and with availability of statistical data, making comparisons more accurate. The data used is from the 2006 Urban Audit III, which uses information collected for 2004[8]. The database was made for all cities with > 500,000 inhabitants for which data was available. Eurostat published thereby data for 128 cities. The population of each city is based on national statistics (city population data). The expansion factor is defined as LUZ, namely the population/city population. The average expansion factor taking the lower 95% confidence interval for the entire database was 2.1 i.e. to determine the LUZ population the city population number must be multiplied with the factor 2.1. This is based on the empirical relationship of all Eurostat cities between LUZ and city population taking the lower 95% confidence level (File 70b SQS ref. [77][9]).

D. The metropolitan data calculated in the first table is thereafter compared with the LUZ population based on the LUZ expansion factor as determined in point C. The table below shows for the relevant cities the population data based on the metropolitan population and a calculated LUZ based on empirical EU data for cities where no metropolitan area information is directly available by the National Statistical Authority, and where the core city population is less than 1 million.

[7] See Footnote 6

[8] See Annex 5: Population information all cities.xls

[9] See Footnote 6

Population (year 2009) of Korean Cities

Urban Area	Population in millions metropolitan area	Population in millions LUZ
SNCA	24.38	Not determined
Busan Metropolitan City	3.54	Not determined
Daegu Metropolitan City	2.49	Not determined
Daejeon Metropolitan City	1.48	Not determined
Gwangju Metropolitan City	1.43	Not determined
Ulsan Metropolitan City	1.11	Not determined
Changwon (only city, 2010)	1.09	Not determined
Cheongju	1.15	1.38
Jeonju	1.39	1.35
Cheonan	1.25	1.20
Pohang	1.30	1.08

File 70b SQS ref. [77][10]

As can be seen with both approaches all included urban areas have a population of > 1 million. Therefore, using 2 different approaches both coincide that the cities listed in the PDD have a population of > 1million in the larger urban area. Thus 11 cities in Korea have a LUZ of > 1 million of which 5 have a MRTS i.e. less than 50% thus proving that the project is not common practice in accordance with the methodology.

SQS concludes that the given common practice analysis is correct because it is based on the population of the LUZ at the time of the investment decision.

3) The DOE is requested to further substantiate how it has validated the identification of the baseline scenario as the DOE has validated only the baseline scenario as per "Step 2: Investment analysis" of the applied methodology while the methodology (page 5) requires to "conduct an investment comparison analysis for all alternatives that are remaining after Step 1" i.e. "realistic and credible alternative scenario(s) to the project activity that are in compliance with mandatory legislation and regulations. Please refer to VVM version 1.2 paragraphs 83-86, Tool for the demonstration and assessment of additionality version 05.2. Step 1 and 2.

DOE's response:

In Chapter B5 of the PDD the following alternatives are listed:

1. The establishment of a BRT (Bus Rapid Transit);
2. The establishment of another rail-based MRTS:
3. The continuation of the current public and individual transport systems, including (future) investments in road based infrastructure if applicable;
4. The proposed project activity being implemented at a later date in the future, without being registered as a CDM project activity;
5. The project proposal not implemented as a CDM project activity.

Alternatives 1 and 2 are assessed in Chapter B.4. of the PDD and have been discarded:

[10] See footnote 6

Alternative 1: as BRTs due to their limited phd capacity are also basically used for secondary lines in large metropolitan cities in which a rail-based MRTS have already been established. Also with Daegu already having a metro line the connectivity is easier if the same system can be used and buses are thereafter used for secondary routes. For the area in which the metro is planned a BRT system is also considered as non-optimal basically due to the required passenger per hour capacity. BRT or bus lane systems have typical carrying capacities of less than 10,000 passengers per hour per direction (phd) (proven in Table 4 of the PDD). The median value for all included BRTs is 7,000 phd which gives an indication that BRT are basically used for secondary lines in large metropolitan cities and as main lines in smaller and medium-sized cities. Also the only operational Korean BRT in Seoul has a capacity of 7,000 passengers per hour and direction only. The capacity of the proposed metro line is 16,000 passengers per hour per direction.
Alternative 2: Rail-based systems can be separated where they operate (underground, at level, elevated) or also based on criteria such as technology used. Various rail-based systems including LRT, monorail etc. were studied. The different rail systems can all comply with the expected passenger demand. In terms of projected construction investment the monorail system is by far less expensive than all other rail alternatives studied with a 22-31% lower construction investment required. The monorail was finally considered the most appropriate system based on environmental, financial and technical criteria (see FSR).
Alternative 3 is the baseline situation.
Alternative 4 has been discarded in Chapter B4 respectively is identical with the Alternative 5.
Following alternatives are thus credible, realistic and comparable:

1. Continuation of the current situation (A3)
2. Project without CDM(A5)

The options BRT (A1), other rail-systems (A2) and the option project in the future without CDM (A4) are not considered credible, realistic or comparable alternatives as outlined in Chapter B.4. of the PDD. They are thus eliminated in Step 1 and not further considered. Step 2 conducts an investment comparison analysis for all alternatives that are **remaining** after Step 1 in accordance with page 6 of ACM0016:

"Apply Step 2 of the latest approved version of the "Tool for the demonstration and assessment of additionality". Conduct an investment comparison analysis for all alternatives that are remaining after Step 1. Use the NPV as indicator."

Step 1 is performed in B.4. of the PDD and Chapter B.5. then resumes the result of Chapter B.4. As only 1 alternative to the baseline remains after step 1 only for this alternative the financial analysis is performed.

4) The DOE is requested to clarify the value used for the Occupancy Rate of the passenger cars, sourced from Korea Transport Institute, 2010, as it appears that two other similar projects validated by the same DOE have used the same reference but different values of 1.31 and 1.25. Please refer to VVM version 1.2 paragraph 91.

DOE's response:
Occupation rates are different for each city. National values should not be used.
The report of the Korea Transport Institute has data for various cities in the same table. Following cities are included:

Seoul
Busan
Daegu
Incheon
Gwangju
Daejeon

Ulan
Gyeonggi
Gangwon
Chungbok
Chungnam
Jeonbok
Jeonnam
Gyeongbok
Gyeongnam
Jeju

The data per city by logic is not the same, however the reference source or document is the same. See below the original table from the original document (see Annex 6: KOTI brief, 2010.xls)

Classification	OC
Seoul	1.2
Busan	1.3
Daegu	1.21
Incheon	1.25
Gwangju	1.2
Daejeon	1.27
Ulan	1.34
Gyeonggi	1.27
Gangwon	1.38
Chungbok	1.31
Chungnam	1.33
Jeonbok	1.26
Jeonnam	1.32
Gyeongbok	1.3
Gyeongnam	1.31
Jeju	1.43
Average	1.26

The Validation Report has been amended to reflect the issues raised. The document is re-submitted in both clean and tracked-changes versions as part of the RfR process. If further information is required, Hanspeter Graf will be the contact person for the review process. He is available to address any questions the Executive Board may wish to clarify during its considerations.

Thank you.

Yours sincerely,

Silvio Leonardi	Hanspeter Graf	Oliver Stankiewitz
Member of the Executive Board	Lead Auditor	Reviewer

Supporting documents:

Annex 1: Journal of Public Transportation, Vol. 8, No. 5, 2005.pdf
Annex 2: Daegu Operational Cost Evaluation (09.Nov.12)_1
Annex 3: File 47 finance version 1.1 DMRC.xlsx
Annex 4: File 2 Passengers and OP cost DMRC.xls
Annex 5: Population information all cities
Annex 6: KOTI brief, 2010.xls