DRAFT v5: 6/18/2004

To: NOT FOR DISTRIBUTION!! (Eventually for Barry Barish, ITRP Chair)
From: Yoji Totsuka, KEK Director General
Subject: KEK Response on "Operating Cost information for ITRP"

1. Summary Table

Table 1 summarizes the estimated FTE and M&S costs for operating GLC in the format that has been provided in your email of June 5, 2004.

Description	Head count (FTE)	M&S (Unit = 1BY = 10 oku-yen ~ 8M$)
Accelerator Physics	20	0.05
Simulation	20	0.05
Survey and Alignment	20	0.05
Diagnostics	30	0.075
Controls including PPS	30	0.075
Mechanical Eng + Vacuum	60	0.15
Electrical Eng.	30	0.075
RF + Modulators	50	0.125
Cryogenics	-	-
Workshops	40	0.1
ES & H / Safety	30	0.075
Administrative	80	0.2
Klystrons		9
Replacement Spares		2
Upgrades / Services		4
Cryogens		
Electrical Power	Based on 10,000Y $/MWh	16
Water generation/disposal		0.3

Table 1.

2. Head-count

We for now quote the human resource numbers in a model which closely mimics that of KEK Accelerator Laboratory. Our estimate is based on the following two inputs:

1. The distribution of existing human resources at KEK on accelerator activities.
2. The human resources requirements during the construction phase of GLC that is quoted in GLC Project Report (KEK Report 2003-7), p.311.

For operation of GLC we are quoting ~ 330 on-site staff members in academic, engineering and technical areas and ~80 for administrative areas, both to be employed by the GLC laboratory organization. The total human resources is 410FTE. This does not include visitors and contract workers.

We would like to draw your attention to the fact that the details of this type of studies are dependent on the model of laboratory organization and machine operation. At KEK, the majority of maintenance and repair work of hardware equipment is done by the contractors. Thus, the amount of human resources for "maintenance technical work", hired on-site, is substantially smaller than that at laboratories in US or in Europe. It should be also noted that the groups within the KEK Accelerator Laboratory is significantly less clearly divided than laboratories in US or in Europe. For instance, the members of the "Magnet Mechanical Engineering Group" typically also work on "Survey and Alignment"; it is not uncommon for members of the "Vacuum Engineering" or "Instrumentation Engineering" to work also on "Commissioning and Operation", and so on.

For reference,
- The present total head-count of KEK Accelerator Laboratory is ~190, who are operating KEKB, electron-positron injectors, PS, ATF and are constructing J-PARC.
- The present total head-count of the KEK Administration Division is ~140.

3. Operating Cost

The annual electric power bill for operating accelerator facilities in Japan can be estimated by using the following empirical formula:

$$C_{AC}\,[\text{oku yen}] = 0.5 \times P_{AC}\,[\text{MW}],$$

where the estimated annual power bill, C_{AC} is in units of oku-yen (100Myen), and P_{AC} the site power in units of MW. This is equivalent to assuming the annual operation time to be on average 5000 hours, and the electric power cost as 10 yen /kWh.. If we assume the total site power to be 313MW, as quoted in the GLC response to ITRP Q28, C_{AC} is estimated to be ~ 160 oku-yen = 16Byen ~ 145M$.

There is an on-going discussion within the Japanese government for allowing a significant discount in the electric power bill for large scientific projects such as ITER. If this applies to GLC, its electric power bill may be substantially lower.

The rate at which the klystrons need to be replaced depends on the expected lifetime and the yearly operation hours. The estimate in the table assumes a yearly operation time of 5000 hours and the lifetime of 20,000 hours.

The expenses for maintaining the work group activities and for replacement components, upgrades and services, amount to 16.325 BY = 163.25 oku-yen ~ 148M$. If put together

with the electric power bill, the entire operating budget is estimated to be 32.325BY = 323.25 oku-yen ~ 294M$. This does not include employee salaries.

For reference,

- The present total electric power bill for all accelerators put together on KEK Tsukuba campus is 5BY (= 50 oku-yen ~ 45M$) / year.
- The present operating budget, excluding the power bill, for all accelerators put together on KEK Tsukuba campus is 4.4BY (= 45 oku-yen ~ 41M$) / year. The employee salaries are not included.

4. Comments on the ITRP Statement

4.1 Warm-Cold Comparison of the Construction Cost

Table 2 summarizes the status of cost studies of Warm and Cold LC cases that have been conducted so far by the GLC group (June, 2004).

	Warm		Cold	
	In-house studies	Industry studies	In-house studies	Industry stides
Main Linac hardware	Yes	RF only	Cavity only	Yes
Injectors / Beam Delivery hardware	Yes	No	No	No
Conventional Facilities	Yes (GLC-style, two-tunnel)	Yes (GLC-style, two-tunnel)	No	Yes (TESLA-style, single-tunnel)

Table 2.

The cost numbers that are quoted from the industry studies are currently considered not adequate for use in comparative discussions. It is because many, if not all, the companies who participated in these studies did not have a sufficient amount of time to examine thoroughly the mass production and cost reduction issues. Their numbers should be taken as of a strongly preliminary nature. Thus, we are left with in-house studies for possibly discussing cost comparisons between the Warm and Cold cases. However, Table 3 indicates that with the cost data that have been acquired so far in GLC group's studies, we cannot quite make remarks on the "total construction cost" for the Cold LC. Consequently, we cannot make statements on comparisons between the total construction cost for the Warm and Cold LC cases on the basis of our own data. In addition, since the GLC study of the Cold case assumes a TESLA-style, single-tunnel configuration with the maximum E_{CM} of 800GeV, an issue of "what constitutes a fair comparison?" remains unresolved.

As for the Warm case (GLC), as reported in A.Enomoto's presentation in a closed session during ITRP visit to KEK, the in-house studies of the total construction cost presently has a variation of ±8%. The total construction cost of the Warm machine may be reduced as more aggressive industrialization studies ensue.

As for the Cold case, as reported in M.Yoshioka's presentation, the in-house studies of the preparation cost for superconducting cavities has a variation of ±20%, and it may be higher than the corresponding TESLA TDR number by ~30%. The cost of cavities may also be reduced as more aggressive industrialization studies ensue. However, the contributions of other components to the construction cost of the Cold LC are subjects of forthcoming studies.

4.2 Warm-Cold Comparison of the Total Project Cost

The yearly operating cost of GLC with E_{CM} = 500GeV is estimated to be approximately 5% of its initial construction cost, as discussed in Sections 1 and 2 of this memorandum. The NLC estimation of the operating cost, as quoted in the response to ITRP Question 21, seems to be approximately the same, when differing accounting systems are taken into account.

With these inputs, impacts of variations of the GLC/NLC operating cost, accumulated over some number of years of operation, can be estimated. For instance, if the site power consumption of the LC were 140MW (like TESLA) rather than 313MW (like GLC), the expected reduction of the electric power bill would be approximately 8.7BYen (= 87 oku-yen ~ 79M$) per year, meaning a reduction by 7.3 BYen (=73 oku-yen ~ 66.4M$). Then, over 10 years of operation, it will have an impact of 8% in terms of the total project cost (i.e. construction and operation costs put together). The same impact on the total project cost can arise, if the initial construction cost happens to have a variation of ~12%.

These exercises indicate the relative orders of magnitudes of impacts of variations in the present construction cost estimates and operation cost estimates.

4.3 GLC Summary

In summary, we recognize certain amounts of variations or ambiguities in both the construction and operating costs of LCs now. The estimated ranges of the construction cost and the possible variations of the operating cost appear to impact the total project cost by a similar magnitude. We cannot make a quantitative statement on relative differences between the construction costs for the Warm and Cold LCs on the basis of our own present data. From this standpoint we agree with the conclusion of ITRP who stated, "Therefore, for the purpose of the ITRP technology decision, we have concluded that the costs differences between the two technologies cannot be considered to be an important discriminator in making the ITRP technology recommendation."