COST AND SCHEDULE REVIEW COMMITTEE REPORT

15 December 2003

Introduction

The second meeting of the Cost and Schedule Review Committee (CSRC) was held at CERN from the morning of 27 October through mid-morning on 29 October. The Committee was charged to examine the following: the project management tools used by the LHC project, including the CERN implementation of an Earned Value System (EVM); the Project cost and schedule in the light of progress to date; and the over-costs that the Project Leader proposes to charge to contingency between December 2003 and December 2004.

In view of the vast scope of the LHC project the Committee chose to examine cost and schedule issues in only four areas that it deemed especially critical as follows: .Superconducting Magnet Fabrication; Superconducting Magnet Testing, the QRL Cryoline, and the Underground Civil Works at Point 5. It chose these areas because it was aware that they presented difficult challenges to the Project Management. Prior to the meeting it studied the project status through reporting tools that were accessible from the LHC Project website and through the documents that the Project Leader provided the Committee. The latter included copies of the June 2003 LHC Project Status Report and the Earned Value Management Status Report of the LHC Project on 1 September 2003 and the former included the LHC Dashboard. During the meeting the Committee received excellent and thorough presentations of the critical areas from the Project staff and it had extensive discussion with the Project Leadership. The Agenda for the Second Meeting is attached to this report as Appendix 1. The report is organized as follows: The summary of the Committee's findings and major recommendations is presented first. Then further details are presented along with the recommendations in the remaining sections. The Committee notes that the Summary and Major Recommendations section was presented to the Director General, the Director General Designate, and the Project Leader during the closeout meeting on October 29 as Power Point slides. The Committee has edited the text of those slides in order to include the oral comments that were made on the general state of the project and to improve the clarity of the text.

Summary and Major Recommendations

The Committee is very pleased to note the considerable progress that has been made on all aspects of the LHC project during the past year. Most of the problems that Project Management was grappling with a year ago have either been solved or have solutions that are being implemented. While new problems have arisen in the past year Project Management is already addressing these problems. This rate of progress gives the Committee confidence that the Project can meet the demanding technical performance requirements without either a significant cost overrun or a significant delay in the start of commissioning. Nevertheless, Project Management still faces a daunting task. The

Committee addresses the most critical issues that Project Management must address in the remainder of this section.

The Committee has reconciled the September 2003 Cost to Complete of 2924 MCHF with the December 2002 baseline estimate of 3220 MCHF, contained in LHC Project: Cost to Completion (AC-DI/BP (2002-2009)). The Committee notes that the apparent reduction is a consequence of moving the cost of the special contributions to another accounts. This is as noted in Table 1 in the Section on Cost to Completion, which follows this section. There has been a small overrun during the past year and this is presented in the next paragraph.

The Committee recommends that Council approve the increases to the Cost to Completion, which amount to 41.3MCHF, that were presented to the Committee by the Project Leader since the baseline Cost to Completion was prepared. The overrun is composed of 16.4MCHF that was reported at the October 2002 CSRC meeting and 24.9 MCHF reported at this meeting. The Committee requests that the Cost to Completion be increased by this amount. Further details of these increases are presented in the remaining sections of this report. However, the Committee notes that these increases may not cover all of the currently known increases. The Committee has informally discussed these with the Project Management. The Committee believes that these increases will be of a similar scale to those already experienced. These increases will probably not be realized until after 2004. The Committee also believes that Project will encounter cost increases associated with the delays in starting QRL installation.

The Committee is pleased that the cost tracking systems are in agreement and are being used widely throughout the Project. The tracking and EVM management tools are excellent and the Committee believes the output of these tools reflects reality to a commendable degree.

The Committee is pleased to note the very significant progress with the main dipole production and notes that during the past 12 months the production rate has increased five fold. The dipole technical quality looks good and collared coil production rate is 80% of the desired rate, a significant leading indicator. While a further increase of a factor of two is needed to reach the required rate of dipole production the Committee believes that this will be achieved soon. Collared coil production for the main quadrupole has been initiated and is proceeding smoothly. Unfortunately the production of correction dipole magnets is significantly behind schedule because of an under-performing vendor and this has limited the full start up of quadrupole cold mass production. The production of trim quadrupole magnets have also not met the schedule and are also close to delaying the fabrication of main quadrupole cold masses. The Committee recommends increased oversight of the poorly performing vendors. With adequate vendor oversight the Committee recommends initiating correction dipole production as soon as possible even if some need for retraining occurs in these magnets. Since the main quadrupoles and the correction magnets are integrated into a Short Straight Section (SSS) prior to their installation the low production rate of the correction magnets and main quadrupole cold masses have significantly slowed the production of these units. Since the complete SSS is

an installation unit the delivery of tested SSS to the LHC tunnel is close to the critical path.

The Committee is pleased to note the significant increase in testing capability since the October 2002 CSRC meeting and agrees with the Project Management that the full testing capability will be in place by late Spring 2004. The current test schedule is extremely aggressive in light of the extent of the proposed testing plan. The Committee believes that some compromise must be made between the scope of the test plan and the time on the test stand in order to deliver tested magnets to the LHC tunnel on schedule. The Committee recommends that the magnet test plan be reviewed after July 2004 with a goal of achieving an appropriate set of quality control tests consistent with the production and installation schedule.

The Committee notes that the initial installation of tunnel services has been completed as scheduled. However, the Committee also notes that a significant delay has already been incurred in the implementation of the QRL contract. The availability of the QRL components and their installation has introduced a significant risk to the on-time installation of the superconducting magnets. The Committee believes that nearly the entire float in the baseline schedule that was presented to the Committee a year ago has disappeared. QRL delays will require a restructuring of the installation plan in mid 2004. The QRL contractor and the CERN team will have to invest a considerable effort in order to complete the QRL installation in time for the Spring 2007 commissioning date. The plan will have to rely heavily on a carefully coordinated and well-communicated effort of all of the teams participating in the installation since they will have to do their work simultaneously in the same sectors of the LHC ring in order to meet the schedule. The Committee agrees with the Project Management that the Spring 2007 date is still achievable.

Cost to Completion

A year ago the Committee recommended that CERN Management adopt the Cost to Completion estimate of 3220 MCH, contained in LHC Project: Cost to Completion (AC-DI/BP/(2002-09), as the CERN materials budget for the LHC project. The Committee refers to this as the baseline cost elsewhere in the report. CERN Management accepted this recommendation with the understanding that during the course of the year small revisions would be presented to Council for their consideration. CERN Management subsequently revised the baseline cost and the changes are noted in the June 2003 LHC Project Status Report (CC/2443) and Earned Value Management Status Report of the LHC Project on 1st September 2003 (FC/4727), both of which were issued during the last six months. The Committee has reconciled the revised estimate of 2923.7 MCH contained in FC/4727 with the baseline estimate and its reconciliation analysis is presented in Table 1:

Table 1: Reconciliation analysis

Baseline Cost of 1st December 2002		3220.0
Less	special contribution, moved to another account group	- 408.0
Plus	approved cost overrun, debited to Contingency account*	+ 16.4
Plus	compensation of price escalation 1996-2002	+ 16.3
Less	CERN materials index adjustment	- 17.3
Less	transfer from materials budget to personnel budget	- 1.9
Plus	price escalation second half of 2003	+ 3.4
Plus	infrastructure and supplementary exploitation (IES)	+ 94.7
1st September 2003 Cost to Completion		2923.7

*This increase was presented to the CSRC at its October 2002 meeting, was noted in its report, and subsequently reported to Council.

During our meetings with LHC Management, Division Leaders and Group Leaders we were presented with the justification of further increases that were needed to cover cost overruns that have already identified by the Project Leader. He presented these cost overruns, which sum to 24.9 MCHF, to the Committee and he plans to add them to the Cost to Completion during 2004 with the approval of CERN Management. These are enumerated in Table 2.

Table 2: Summary of the requested increases to the Cost to Completion in MCH

Extension of the duration of the ACCEL contract by one year (AT-MAS)	5.7
Tunnel piping-warm (ST-CV)	4.2
Tunnel piping-cold (AT-ACR)	0.8
Beam Screen Shields (AT-VAC)	1.3
Extra cost for cryogenics piping in accelerator enclosure (AT-ACR)	2.9
Civil Works (ST-CE)	10.0
Total increase in the Cost to Completion in 2004	24.9

In the opinion of the Committee, this calculation is a moderate and cautious estimate of the current cost increases. The Committee believes that it is likely that additional increases will be identified during 2004. The Committee also believes that increases in the QRL and other installation costs associated with the current delays will be encountered after 2004.

The Committee recommends that the Cost to Completion be increased by 24.9 MCHF and recommends further that the LHC Project Director calculate a new estimate of likely cost overruns and that he incorporate them into the Cost to Complete as of 1st July 2004.

Examination of LHC Project Management Tools

It is the opinion of the Committee that the present, recently developed and installed management tools are excellent applications that provide powerful analyses of the project status. Together with previously developed tools they facilitate project monitoring and progress tracking. The integration of tools used to track progress, costs, contracts and

schedules meet the challenges of a large-scale project such as LHC with its numerous contracts and thousands of work units. The Earned Value Management system (EVM) has already after only a few months use given the project management early indicators of areas with slower than desired progress or possible cost overruns. The combined information that can be derived from the CERN Expenditure Tracking, CET, and EVM allows the project management to go further in analyzing cost and schedule variances. The Committee notes that some of the small variances will be a result of delays in work unit reporting or delays in invoice processing. These can generally be identified by additional follow-up using other project tools such as CET or Contract Follow Up, CPU.

Engineering Change Request System

A revised Engineering Change Request (ECR) and approval system was introduced in October 1999 to provide a unified mechanism for considering proposed changes to the engineering baseline design that is maintained within the Engineering Data Management System (EDMS). A major beneficial feature of the new system was a requirement to address the effects of the requested change on project cost and schedule in addition to its effects on technical performance. The Cost & Schedule Review Committee at its 2002 meeting thought that the system was very good but requested that the LHC Project Leader should consider setting up a system to explicitly record the cost and the source of funding associated with any approved ECRs. This has been done in a fully satisfactory manner by establishing Project Leader's Office Authorisation (PLOA) forms, which summarise in one document the consequences to scope, cost and funding, and the actions required to adjust the project budgets and estimates.

Schedule and Cost Issues for Superconducting Magnet Fabrication

During the past 12 months significant progress is evident in the main dipole production program. The dipole cold mass production rate has increased from ~3 per month to ~15 per month during 2003. While this is still a factor of 2 short of the baseline schedule, the Committee believes that dipole production will soon reach the necessary rate for the following reasons: Collared coil assemblies, a leading indicator, are now within 80% of the baseline rate and continuing efforts are in progress at the manufacturers to further improve the rate. Cable production rate in support of the dipole program is steady and has essentially reached the required level. The re-allocation of quantities among vendors has maximized production efficiency. Correctors for the main dipole units are available. Technically the dipoles are of high quality, with satisfactory field quality and quench levels. While the occasional rejected or damaged element needs to be watched, in principle the rejects will not increase CERN costs. This welcome situation is slightly tempered by the fact that the slower than anticipated ramp-up of main dipole production has used essentially all of the available schedule contingency. Dipole production from this point on will be "just in time" and with ~ 90% of the production quantity remaining continued vigilance of vendors is required. Nonetheless, the Committee believes that the schedule risk to the project from dipole fabrication has diminished significantly from what it was a year ago. The dipole costs have remained relatively stable during this

period with some cost pressures arising from changes in quantities rather than unit costs. These potential cost changes are modest in relation to the overall production program. The Committee does not anticipate any cost changes during 2004 in the dipole program.

While the main quadrupole magnets present less technical risk than the main dipoles, the production of Short Straight Sections (SSS), the unit that integrates the quadrupoles and the quadrupole correctors, does present a serious schedule risk. The quadrupole collared coil assemblies are well into production. However, quadrupole cold mass production was delayed by the lack of correction dipoles needed for the sextupole/dipole correctors that are an integral part of each SSS. The stretch out of the ACCEL quadrupole contract resulted in a 5.7 MCHF increase in the contract cost as noted in Table 2. These correction dipoles, which have an innovative design with a multi-layer ribbon coil and a vacuum impregnated epoxy-cured coil, are well behind the original production schedule and recently they have demonstrated erratic re-training behaviour after thermal cycling. The below-specifications technical performance and associated schedule delays are a consequence of poor vendor performance. Since these dipoles are individually powered and the vast majority of correction dipoles will run at much lower excitation than the maximum, the Committee believes that the schedule risk is much greater than the technical risk and urges that full production of these devices be initiated promptly. Potential problems caused by the lack of trim quadrupoles for the SSS's have been addressed with a work around. However they present a looming schedule issue and the trim quadrupoles need to be brought into production soon to avoid a similar situation from re-occurring several months from now. Finally, the lack of quadrupole cold masses is rapidly becoming a critical risk to the overall Project schedule. The Committee believes however, that once full production has been reached on all of these magnets, it will be possible to recover some schedule float through the use of additional CERN supplied tooling thereby allowing a faster than baseline production rate.

Schedule and cost issues for superconducting magnet testing

Considerable progress has been made toward bringing the magnet testing facility up to full capacity during the past year. When the committee met last year there were only two older type test benches in operation. These are now being phased out. Today six new test benches, which were all delivered after November 2002, are in operation and an additional two benches have been delivered and are being prepared for commissioning. The remaining four test benches will be delivered before the end of the year and Project Management expects that all will be in operation by May. Project Management believes that it will be possible to test two magnets per day with nine benches and this rate will make it possible to test 1370 cold masses between 1 July 2004 and 1 October 2006 and thus complete the main magnet testing by October 2006. The Committee notes that it will also be necessary to test 150 dipoles and 50 SSS between 1 January and 1 July 2004 in order to meet the schedule for magnet installation at sector 7-8. The three additional benches will be used to test the 116 special SSS and to provide for 110 tests for second runs of non-conforming magnets. The additional capacity will also allow the additional testing of magnets that require more than two quenches to qualify for installation. Project Management believes that the three additional test benches will permit the testing of an

additional 0.5 magnets/day. The scope of the testing program has been scaled back somewhat from what was foreseen a year ago in order to achieve these goals. The Committee notes that the goals are extremely aggressive and will require continuous 24-hour/day operations after 1 January 2004. Moreover it may be necessary to scale back the scope of the tests for each magnet even further. The Committee agrees with this assessment. The ability to meet this demanding testing schedule will not be known until after July 2004, when the full facility will have been in operation for several months. If connection and removal of magnets can be done with full efficiency the testing rate will ultimately be limited by the capacity of the cryogenic plant and the reliability of the equipment. The schedule does not appear to have any allowance for downtime. Since the ability to meet the testing schedule remains to be demonstrated it presents a significant risk to the Project schedule.

The budget at completion for this task seems adequate and there is no indication of an over-cost.

Schedule and Cost Issues for the QRL

The cryogenic distribution line (QRL) is a central element in the LHC tunnel installation. It is constructed, delivered and installed "just-in-time" by a single contractor that is one of the European market-leaders and is supported by four sub-contractors located in other countries in Western Europe. As part of the contract CERN is responsible for delivering specialized parts to the QRL contractor, providing the integration studies of the QRL modules (3D-model) in order to assure a proper fit with the other LHC tunnel equipment and transporting the QRL modules into the tunnel. The contract for the QRL was awarded to a single vendor because of an excellent price in the summer 2002 and CERN management was aware of the potential risk for increased costs and schedule delays that this arrangement might create.

The Committee acknowledges the clear and thorough presentation by the responsible CERN engineer from which it learned that the start of the QRL installation in sector 7-8 was delayed beyond the contract start date of June 2003 and that CERN had fulfilled its duties prior to installation to the extent that no installation delays had been occurred. Since the results of the integration studies were not delivered in time and a number of Engineering Change Requests (ECR) were issued by both parties that were subsequently approved or are presently negotiated there is a risk that that QRL contractor will make claims. To date CERN has kept the cost limit within the agreed cost-to-completion baseline of 2002.

Many problems were identified during preparations at the workshops of the QRL contractor and its sub-contractors for the start-up of the QRL component production and the preparation of the LHC tunnel for installation. Further problems were encountered during the beginning of the installation of the QRL modules in sector 7-8. Examples that required ECR's are unexpected engineering problems, non-conformant production and installation procedures due to missing specifications, missing documents and assembly tools, insufficient training of workshop personnel, lack of communication or missing

knowledge of the unique CERN site. These problems reflect the fact, that the manufacturer had drastically underestimated the amount of work needed to set-up continuous production and installation of QRL modules with the required quality. As a consequence, the installation of QRL modules in sector 7-8 was suspended and many actions have been started to thoroughly solve these problems. It is not expected to resume the installation before week 46 resulting in a delay of at least 13 weeks for the completion of the QRL installation in sector 7-8.

The Committee notes that the Project Management is well aware of the organizational and technical problems and the consequences of the delays in the QRL installation. Furthermore they recognize that the over-all installation schedule and plan will have to be extensively re-adjusted to accommodate the delays without jeopardizing the Spring 2007 commissioning date. The Committee believes that adequate actions have been launched to solve the problems and that the resulting adapted learning curve will allow an installation of the QRL at the required quality level in the remaining sectors. The Committee understands, that the installation procedure for the other sectors cannot be finally specified until significant experience has been gained in sector 7-8. However, even in the case of a smooth future QRL installation at the rate specified in the contract the accumulated, unrecoverable start-up delays will push the dates of final completion of sectors 5-6, 6-7 and 1-2 strongly towards the anticipated date of the first beam injection into LHC in Spring 2007. The Committee would like to focus the attention onto the fact that due to the resulting delays the commissioning of components in sector 8-1 that are required for the local beam test scheduled in sector 7-8 in spring 2006 is already on a critical path.

The Committee is concerned that these schedule delays will have unfavorable consequences for the project costs. It is convinced that the contractor will try to push any cost increases due to these delays onto CERN, including the delays that were a consequence of the slow start up of the QRL installation. For example, claims could arise from modifying the installation scheme in sector 7-8 in order to allow QRL installation and magnet transport and magnet installation in parallel or from installation schemes that could potentially recover the start-up delays during the later stage of the contract. Additional costs could grow out of the need for more intense supervision of the ongoing QRL installation by CERN personnel in other sectors. The Committee notes that additional costs of 3.7 MCHF, which are not related to this contract, have been accumulated for general cryogenic piping work as noted in Table 2

The Committee recommends that the contractual constraint that prohibits parallel work in the tunnel during QRL installation be removed, even though it may increase the likelihood of contractor claims. Given that each sector is several kilometres long it should be possible for the QRL contractor and CERN to do their work concurrently in separate locations in each sector. This change will provide the Project Management the flexibility to organize the remaining work in order to minimize further schedule delays.

Schedule and Cost Issues for Civil Works

The long and difficult effort to complete the underground civil works is drawing to an end. Nearly all of the remaining underground construction is at point 5, the location of CMS. The Committee notes that the final cost of the civil works (ST-CE), as obtained from the Earned Value Report of September 2003, is estimated to be 453 MCHF. Project Management estimates that the value of the uncompleted, but planned work is approximately 20 MCHF. The technical problems created by the difficult site conditions noted in the CSRC report of October 2002 have been successfully solved, although the solutions required an increase in cost. There is a risk of further cost increases because of potential claims that will be a consequence of the redesign of the two large caverns after work had started. The redesign was initiated when large, unforeseen movement of the rock occurred during the pillar excavation. The redesign introduced massive steel beams in the cavern crowns and floors and required substantially more steel reinforcing and concrete in the load bearing walls, crowns and floors than the original design. The current and previously forecast displacements of the rock show that the revised design was the appropriate way to solve the problem. The Committee learned that there are significant water leaks in the main shaft at point 5 and that these leaks will be repaired through a separate contract that will be issued after the completion of the planned work at point 5. Project Management believes that the grouting of the leaks can be done without delaying the installation of the CMS detector and related infrastructure. However, during the ten-week window for installation in the second quarter of 2004 the contractor and CERN will need joint occupancy of the shafts at point 5 and that could result in additional claims by the contractor, since it could delay the contractor ‘s work. The Committee agrees with Project Management that this is an acceptable cost risk that will mitigate a serious schedule problem.

The Project Leader has recommended increasing the cost to complete the civil works (ST-CE) by 10 MCHF, exclusive of indexation, in order to provide sufficient funds to meet the bills that will come due in 2004 as shown in Table 2. However, as with any civil engineering contracts of such magnitude, the project is vulnerable to further claims until the termination of the work. The Committee recommends that Council approve the proposed increase.

Installation Schedule Issues

Installation of General Services and cabling has been ongoing for some time, generally at the planned rate. The only small areas of significant slippage compared to the baseline schedule occurred when the operation of SPS prevented access. This will be rapidly resolved at the end of the present SPS run. The installation programme has now reached the point where significant parts of the LHC machine systems are about to be installed. Consequently the scale of activities is about to take a step upwards and the timely availability of LHC components will become a critical schedule issue for the first time.

The installation of the LHC components requires a careful choreography of a number of separate contractor and CERN teams to ensure that the waves of activity around the tunnel can proceed with minimal interference. The original plan gives each team almost unencumbered access to the sectors in which they are working by phasing the work so that the QRL installation is completed before the installation of magnets begins in each sector. This ideal situation could only be sustained if the delivery of components ready for installation keeps pace with the requirements of the installation teams. It was already clear at the CSRC meeting of 2002 that the delivery of some components was time critical. This was most pronounced for the QRL components and the superconducting magnets for the Short Straight Sections (SSS). The delivery and installation of the QRL plays a pivotal role in the overall installation planning.

This summer it became clear that the QRL contractor could not ramp up production to meet the installation requirements because of teething troubles arose at its manufacturing sub-contractors and the contractor was not properly prepared to set-up its on-site effort with its installation sub-contractor. The contractor had to stop work at the site while the necessary documentation was produced and adequate supervision of the on-site sub-contractor was established. Whilst this delay is regrettable, the pause will almost certainly provide a quicker resolution of the problems than would have happened if the work had continued without appropriate specifications, training and supervision. The contractor must fully resolve the initial production and quality control problems with its off-site sub-contractors that supply QRL components so that these components will be available to meet the installation schedule. It is expected that the installation contract will recommence in earnest in the next few weeks. Project Management estimates that the delays associated with these problems have delayed the QRL installation by approximately 13 weeks relative to the baseline schedule.

Even if the problems with the QRL installation are resolved quickly the overall installation schedule can only be recovered if the magnets can be transported through ring sectors in which the QRL is being installed. Given that the sectors are several kilometers long the interference between such activities should be minimal if properly planned. This could be achieved, for example, by transporting magnets at night or during weekends and requiring that the QRL installation contractor does not leave components or equipment that obstructs the transport route through the tunnel outside of its working hours (which will soon become double day shifts). Project Management proposes to negotiate contract changes that will allow concurrent installation of the QRL and magnets in a sector as part of the discussions to resolve the breach of contract that the recent cessation of work constitutes. The Committee strongly supports the intention of Project Management to use this opportunity to gain planning flexibility without incurring significant cost penalties. The feasibility of Saturday working for QRL installation should also be explored.

Delays in supplying some types of corrector magnets are also expected to force a revision to the baseline installation schedule in order to keep the magnet installation teams fully occupied. It may prove necessary to delay the installation of some magnets in a certain sector in order to complete the testing and commissioning of the QRL in the same sector. The precise optimisation of the overall installation schedule will depend on the exact

timing of the availability the magnets required and the exact durations of the QRL activities in the various sectors. It is, therefore, premature to re-optimise the whole installation schedule in detail until the QRL contractor achieves acceptable performance. Nevertheless, it will be beneficial for Project Management to continue and extend the studies that they have already started to identify the opportunities for re-optimising the schedule since this will allow them to quickly determine the optimum plan as the situation unfolds.

Given the current status of the various contracts and of the installation activities, it is clear that much of the schedule contingency that was explicitly available in the baseline installation schedule has been used. However, the Committee agrees with the Project Leader's assertion that the installation work can still be completed by the planned start of commissioning in Spring 2007. In order to meet this challenging date it will be necessary to frequently re-optimise the schedule to cater to the actual availability of components and to generate some additional schedule contingency to cover the unforeseen problems as they arise. Exploring whether tasks that assumed a learning curve can generate greater schedule savings than are presently assumed once the team gains experience could generate some contingency. For example, it is currently assumed that the installation time of 21 weeks for the first two sectors of the QRL can only be reduced to 19 weeks for the subsequent sectors. This seems to be a cautious assumption and the Committee urges that this assumption be reviewed. The Committee recommends that Project Management set challenging, but realistic, milestones in the next release of the installation schedule to encourage efficiency savings to be achieved sooner rather than later. Where possible the goals should also maximise the psychological benefits that can arise from setting targets to complete specific tasks by the end of a certain day or week.

In addition to these strategic aspects of the planning of the LHC installation there are a number of other important issues that should be given due attention to avoid losing time unnecessarily. In particular, Project Management should ensure that it:

- Supplies sufficient information and materials to installation contractors on time. The provision of installation drawings appears to only be just keeping up with the required rate of delivery. This is particularly true for the production of the integration models since the small number of experienced people that can produce these models determines the production rate.
- Actively monitors and supervises contractors to ensure that the preparations for on-site work are timely and sufficient, and points out where they are not.
- Provides early warning to contractors of problems occurring on other installation tasks that might affect them and, if possible, suggest measures to minimise their impact. It is particularly important to minimise possible 'waiting time' claims from contractors due to schedule delays on one contract causing cost over-runs on other contracts. These could be of significant given the large number of contract staff working on-site.

The need for frequent, effective communication with all parties involved cannot be overstated, and this can only be achieved if sufficient management effort is devoted to these tasks.

Concluding Comments

As a Committee we have intentionally retained the repetition of the discussion of the installation of the superconducting magnets and the QRL in the sections on Schedule and Cost Issues for the QRL and Installation Schedule Issues because they are presented from different perspectives. Moreover, the repetition highlights our concern for this issue. We know that the Project Management is also concerned and it is planning strong measures to resolve the problem. We support those measures. We wish to conclude our report by noting that the LHC is the most challenging project ever attempted by CERN and the accomplishments to date deserve great praise. In spite of the successes Project Management still has a tough job ahead to avoid major cost overruns and significant delays until the last day of the project. Project Management's vigilance of their contractors and the CERN staff must be sustained until there are collisions.

Submitted by the Cost and Schedule Review Committee

Reinhard Bacher / DESY, Hamburg
Martin Cox / UKAEA, Culham Science Centre
Michael Harrison / FNAL, Batavia
Jan-Otto Joranli / Riksrevisjonen, Oslo
John Peoples (Chair) / FNAL, Batavia

APPENDIX 1
DG/DI/LRE/jf 2003-10-27

Cost and Schedule Review of the LHC Machine and Experimental Areas
Second Meeting
CERN, Geneva, 27-29 October 2003
Agenda

Monday 27 October - Building 30 *(7th fl, room 012)*

08.30 Executive session
09.30 Status of LHC – L. Evans (40')
10.10 Engineering Data Management System (EDMS) – T. Pettersson (20')
10.30 Break
10.50 Project management tools:
- CET, CFU, EDH and EVM – J. de Jonghe, R. Martens, J. Purvis
- Engineering change control – P. Proudlock
- Project Leader's Office Authorisation (PLOA) – P. Bonnal, L. Esteveny

12.30 Lunch
14.00 Schedule and cost issues for magnet fabrication (L. Rossi) (30')
14.30 Schedule and cost issues for magnet testing (L. Walckiers) (30')
15.00 Schedule and cost issues for QRL cryoline (L. Tavian) (40')
15.40 Break
16.00 Visit to SM18 (60')

Tuesday 28 October – Building 30 *(7th fl, room 012)*

09.00 Civil works cost and schedule – J.L. Baldy (30')
09.30 Schedule issues, installation – S. Weisz (30')
10.00 Discussion
10.30 *Break*
10.50 Corrector magnets – K.H. Mess
11.20 Discussion
12.00 Executive session
12.30 Lunch
14.00 Cost issues – L. Evans (30')
16.00 Executive session

Wednesday 29 October - Bldg. 61, 1st fl , "Salle A" (-017)

09.00 Executive session
10.30 Close-out discussion with Management
12.00 Adjourn