

27 March 2002

MEMORANDUM

To: Members of the RRB via R. Cashmore / DG-DI, Chair

From: C&I Scrutiny Group¹

Subject: C&I Scrutiny Group Report (April 2002 RRB)

1. Introduction

The C&I Scrutiny Group was formed early in February to review in detail the “Commissioning and Integration” costs of ATLAS and CMS. It consists of a subset of the M&O scrutiny group and the CORE committee. Its mandate has been:

- to check the reasons for the costs
- to scrutinize the cost level
- to review carefully the spending profile
- to spot accidental double counting (M&O/C&I/CORE)

C&I costs were first identified by carefully scrutinizing the spending profile of the “Maintenance and Operation” estimates made by the LHC experiments. The M&O scrutiny group set up two simple guidelines in order to obtain a uniform approach to the cost separation:

- M&O consists of (recurrent) work in assembly and active storage areas or work in or close to the underground cavern.
- C&I consist of (non-recurrent) work in assembly and test areas, away from the underground cavern.

Several M&O sub-groups were formed to identify and separate C&I cost from the M&O exercise. The results of this (partial) exercise were published in the RRB report D-2001-8 that concentrated on eight particular items. C&I costs in these items were separated out and were thoroughly scrutinized with respect to both the overall amounts and the time profiles. The resulting spending profile of the C&I expenses showed the urgency of finding means to cover these costs. ATLAS and CMS were asked to finalize their C&I costs for further scrutiny.

The reasons for the substantial extra C&I costs were identified to be: underestimates of the complexity of detector commissioning and integration that led to oversights in the construction cost estimates, unforeseeable

¹⁾ W. Bartel, P. Lazeyras, and K. Potter (from CORE); P. Giubellino, D. Plane, and J. Yeck (from M&O SG); E.M. Rimmer (Secretary), D. Schinzel (Chair)

circumstances, e.g. delays in civil engineering (CMS) leading to additional commissioning and integration work on the surface and reductions of services associated with both decreasing budget and staff numbers at CERN. In the era up to the end of construction time of the LEP experiments, infrastructure costs were covered by the CERN groups' exploitation budgets and general services were CERN-managed and centrally budgeted. To a great extent, these services are now provided by Industrial Services personnel (outsourced) and have to be paid by the collaborations.

Necessary changes in integration strategy aiming at a more safe and more maintainable detector were also identified as cost factors for both experiments.

The C&I Scrutiny Group met once at CERN for a full day meeting to review the C&I cost estimates of CMS and ATLAS. In several pre-meetings, the CERN resident Scrutiny Group members interacted with representatives of the experiments to scan through their cost estimates.

2. CMS Scrutiny

The CMS C&I costs consist of three entries, a) additional facilities for commissioning on the surface, b) detector installation, opening and access facilities and c) general services. The spending profile of these costs peaks in 2003. In its original planning, the CMS detector was to be entirely assembled, cabled and commissioned in the underground area. In order to meet the schedule of the LHC, foreseeing commissioning in April 2007, the technical coordination of CMS had to completely change its installation strategy. Delays in civil engineering of the CMS underground area were the trigger for this change, but the new strategy has many advantages and clearly lowers the risk of unforeseen problems. The five barrel-wheels and two end-caps are in the new scenario completely independent of each other. They are pre-assembled, cabled and commissioned on the surface and then prepared for lowering into the underground cavern. This change of strategy, with the resultant need for provision of additional services for system tests at the level of sub-assemblies is one of the reasons for C&I costs. The second reason is that the complexity and difficulty of maintaining and operating the detector were not fully appreciated. C&I spending now will help to prevent damage to detector elements (in particular to their cabling) during maintenance shut-downs in the future. The third reason for C&I costs is the above-mentioned outsourcing of general services, such as crane operators/riggers, survey and support teams.

The C&I Scrutiny group concluded that spending profile, cost justification and cost level were correct. No double counting was discovered. In particular the group remarked that the spending profile indicates urgency to endorse these costs.

3. ATLAS Scrutiny

In contrast to CMS, ATLAS has subdivided its C&I costs into category "A" and "B". The scrutiny group concluded at first that sub-detector specific

C&I B costs are in reality costs to the completion of individual sub-systems. Whereas CMS commissions and integrates the complete detector on the surface for reason described above, ATLAS commissions sub-systems individually at various places in CERN. The integration of these sub-systems takes place in the pit where the complete detector will be system-tested. This “decentralized” approach was initially adopted to save civil engineering costs for large surface buildings close to the ATLAS pit. It consequently now leads to higher costs for provision of infrastructure and manpower.

For these reasons the ATLAS C&I “A” and “B” costs were eventually scrutinized on the same basis.

The ATLAS C&I “A” costs can be combined into two entries, a) commissioning and integration facilities for magnets and cryogenics and b) general services. The spending profile peaking in 2004 is in good agreement with the ATLAS schedule that shows a working detector ready in the last quarter of 2006. For a long time ATLAS underestimated the complexity and scale of the detector partly due to the lack, in EP Division of senior project engineers with relevant LEP experiment experience. Recent changes in the project engineering team of ATLAS have resulted in these essential extra integration costs being identified. The outsourcing of general services is another non-negligible cost factor.

The C&I Scrutiny group concluded that the spending profile, cost justification and cost level were correct. No double counting of costs between M&O, C&I and CORE was observed. However, the scrutiny group remarked that the estimate of manpower, in particular as far as crane-drivers/riggers are concerned, seems to be rather on the low side.

The ATLAS C&I “B” costs are sub-detector specific. Nonetheless, the scrutiny group reviewed carefully each sub-detector entry checking the spending profile, reasons for costs and cost levels. One cost entry was transferred into the CORE cost to completion. The spending profile agrees well with the ATLAS schedule. Since manpower is again one of the visible cost factors, the ratio between hired manpower at CERN and technical manpower (measured in FTE) sent by collaborating institutions was carefully reviewed. Technicians sent by collaborating institutions can be credited once agreement on a common conversion factor is reached. However, the Scrutiny Group remarked repeatedly that technicians sent by collaborating institutes, as “in kind” contributions are as welcome as “hired” manpower at CERN.

The C&I Scrutiny group concluded that the spending profile, cost justification and cost level of the ATLAS C&I “B” costs remaining after scrutiny are reasonable.

4. Concluding remark

The C&I cost profiles and the integrated costs are obviously dependent on the commissioning schedule of the LHC machine. Further delays in the LHC

schedule would increase the total costs but would not have a significant impact on the C&I costs for the next two years. It should be noted that the C&I cost estimates do not include explicit contingency and there was no attempt by the C&I Scrutiny Group to assess the remaining cost risk or the degree of flexibility available to the collaborations for addressing additional C&I costs.

Dietrich Schinzel

Appendices:

ATLAS C&I “A” and “B” costs

CMS C&I costs

C&I Cost Estimates in kCHF		ATLAS C&I (A) ESTIMATES (kCHF)						
EP-ATO/mn/080302	2002	2003	2004	2005	2006	2007	TOTAL	
Commissioning+Integration facilities								
Magnet	25	25	25	0	0	0	75	
Magnet controls	30	45	50	0	0	0	125	
Cryogenics	0	350	495	110	0	0	955	
Common electronics	30	30	130	510	0	0	700	
Workshops	40	60	125	125	0	0	350	
Cryogenics 180	50	220	150	0	0	0	420	
TOTALS	175	730	975	745	0	0	2,625	
General services								
Heavy transport	0	90	440	250	0	0	780	
Cranes	120	300	300	300	0	0	1,020	
Magnet	60	60	60	0	0	0	180	
Magnet controls	150	150	150	0	0	0	450	
External cryogenics	0	640	1,060	400	0	0	2,100	
External cryogenics 180	0	265	100	0	0	0	365	
Detector integration & survey	200	300	500	500	0	0	1,500	
General Technical support	160	240	320	320	0	0	1,040	
TOTALS	690	2,045	2,930	1,770	0	0	7,435	
GRAND TOTAL	865	2,775	3,905	2,515	0	0	10,060	

ATLAS C&I “A”

28-Mar-02		SUMMARY OF C&I (B) kCHF								
ATLAS	2002	2003	2004	2005	2006	2007	2008	2009	2010	TOTALS
ID&TileCal&LAR&Muons										
Mechanics	30	35	113	60	0	0	0	0	0	238
Gas-system	50	120	245	125	0	0	0	0	0	540
Cryo-system	0	70	70	120	0	0	0	0	0	260
Cooling system	40	185	345	275	0	0	0	0	0	845
FE electronics	20	50	120	100	0	0	0	0	0	290
Standard electronics, PS (LV, HV)	0	0	70	100	0	0	0	0	0	170
Standard electronics, Crates	20	120	230	140	0	0	0	0	0	510
Standard electronics, RO Modules	0	0	0	30	0	0	0	0	0	30
Controls, (DCS, DSS)	30	75	70	25	0	0	0	0	0	200
Sub-Detector Spares	0	0	0	0	0	0	0	0	0	0
Areas	472	494	426	265	0	0	0	0	0	1657
Communications	20	20	20	20	0	0	0	0	0	80
Store Items	106	209	209	55	0	0	0	0	0	579
Hired Manpower @ CERN (CHF)	765	1060	1070	585	0	0	0	0	0	3480
Technical Manpower @CERN (FTE)	34	53	48	26	0	0	0	0	0	161
TOTALS (excl. FTEs)	1553	2438	2988	1900	0	0	0	0	0	8879

ATLAS C&I “B”

CMS C&I COST ESTIMATE								A. Herve
CMS C&I		COSTS [kCHF]						
No.	Item	2002	2003	2004	2005	2006	2007	TOTAL
9.1	Additional facilities for commissioning on surface							
9.1.1	Mixed water cooling	270	30	0	0	0	0	300
9.1.2	Gas distribution	90	10	0	0	0	0	100
9.1.3	Control room (barrack) refurbishment	32	40	8	0	0	0	80
9.1.4	Smoke detection	0	75	75	0	0	0	150
9.1.5	LV system (1 generator)	0	120	30	0	0	0	150
9.1.6	Temporary 10 tons lifting gear in SDX	0	0	160	40	0	0	200
9.1.7	Electrical and fiber optical cabling in SX5	0	160	40	0	0	0	200
9.1.8	Common Electronics	80	560	160	0	0	0	800
9.1.9	Pre-cabling, pre-testing facilities	100	600	200	100	0	0	1000
9.1.10	Basic DSS for equipment protection	0	64	16	0	0	0	80
9.1.11	Semi clean-room	20	60	20	0	0	0	100
	TOTALS	592	1719	709	140	0	0	3160
9.2	Detector installation, opening and access facilities							
9.2.1	Duplication of tooling	0	0	0	36	84	0	120
9.2.2	Dummy end flanges (EB, EE, SE)	0	60	140	0	0	0	200
9.2.3.1	Magnet closing system (grease pads)	0	280	120	0	0	0	400
9.2.3.2	Magnet closing system (corner&closing pieces)	525	225	0	0	0	0	750
9.2.3.3	Magnet closing system (hydraulic winches in UX)	0	170	595	85	0	0	850
9.2.4	Controls for magnet and magnet power supply	0	126	126	126	42	0	420
9.2.5	Beampipe and vacuum tooling, beam pipe support	0	0	32	224	64	0	320
9.2.6	Floor plates in SX 5	96	336	48	0	0	0	480
9.2.7	Cherry pickers and access platforms	0	300	0	0	0	0	300
	TOTALS	621	1497	1061	471	190	0	3840
9.3	General services							
9.3.1	Workshops	90	150	150	120	90	0	600
9.3.2	Heavy transport	290	412	508	726	484	0	2420
9.3.3	Survey	86	86	86	86	86	0	430
9.3.4	Infrastructure for storage	60	210	30	0	0	0	300
9.3.5	Extra engineering design for integration and cabling	196	406	602	196	0	0	1400
9.3.6	CMS technical support team	300	500	600	600	500	0	2500
	TOTALS	1022	1764	1976	1728	1160	0	7650
	GRAND TOTAL	2235	4980	3746	2339	1350	0	14650

CMS C&I costs