



EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH
ORGANISATION EUROPÉENNE POUR LA RECHERCHE NUCLÉAIRE

CERN - ST Division

ST-Note-2003-040

4 April 2003

**OUTSOURCED DESIGN SERVICES
LESSONS LEARNED FROM LHC CIVIL ENGINEERING**

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Abstract

In April 1996 CERN awarded three contracts for the provision of civil engineering design and site supervision services associated with the LHC Project. These three contracts with an average value at signature of 12MCHF were placed using the “two envelope” award system. Eight firms from six member states were integrated into three Joint Ventures. For Projects prior to the LHC, CERN would have carried out the design and supervision using in-house staff. The change to out-sourced services represented a major step for CERN. After seven years, the contracts are now coming to their conclusion. This paper aims to discuss the reasons why these contracts were originally implemented, the lessons than have been learnt over the last seven years and conclusions on how CERN could approach the need for civil engineering design services in the future.

Presented at the 6th ST Workshop
Thoiry, France, April 1 – April 3, 2003

1 INTRODUCTION

In 1996, the goal with respect to staffing at CERN was to reduce numbers by some 33% over the following 10 years. As such, the policy that was adopted in order to undertake the civil engineering required for the LHC project consisted of using CERN staff to undertake only a limited amount of preliminary design work, leaving the bulk of the detailed design to external consultancy firms. This approach was intended to continue throughout the design and construction phase with the external consultants also ensuring the supervision of the construction works. The main role of ST-CE was to manage the contracts and act as interface between CERN clients and the external consultants.

This approach was completely different to that taken on previous large CERN civil engineering projects and it was not universally accepted as being the best way to carry out the project.

As the LHC civil engineering is now coming to an end with over 80% of construction work complete, it is a worthwhile looking back at the development of the civil engineering aspects of the LHC project and in particular the reasons why external consultants were chosen to play such a major role, a review of the performance of these consultants and finally some lesson for the future.

2 PRINCIPAL MOTIVATING FACTORS FOR USING EXTERNAL CONSULTANTS

2.1 Staffing levels

The most overwhelming reason why outsourcing was the best approach to take was simply the number of man-hours required to complete the design tasks. It was estimated that for each of the three design phases, the number of man hours required would be as given in table 1.

| Design Phase | Total man hours required |
|---------------------|---------------------------------|
| Phase 1 | 10,000 |
| Phase 2 | 20,000 |
| Phase 3 | 20,000 |
| Total | 55,000 |

Table 1. Estimated resource requirement design

Given the timescale of the project, the above figures equate to an average size design team of 30 people. Clearly it would not have been economical for CERN to employ such numbers of people for the short duration of time during which the designs would be completed. In addition, the actual resource requirements fluctuated quite substantially and it is a fact that at least one of the external design companies had over 50 people working on the designs at one particular critical stage. Clearly CERN would not have been able to accommodate these kinds of requirements.

2.2 Design Skills Required

Even if CERN could have employed directly the required staff, much of the design work required specialist skills, which would be difficult to find. The design of underground structures is, even today, undertaken by only a few specialized firms. The designs themselves require bespoke software that CERN would have had to purchase. To learn how to use such software would probably take several months, time which was not available on the fast-track civil engineering design schedule.

2.3 Fair Return

Just prior to the letting of the civil engineering contracts, CERN purchasing policy had changed in order to adopt the "fair return" policy. These high value service contracts were ideal for spreading amongst member states since the design work could be done in the offices of the firm, regardless of their distance from CERN. Six different member state nationalities were involved in the main design work, only one of which was a local firm.

2.4 Flexibility

One of the greatest advantages of using three joint ventures of external consultants was their flexibility in terms of bringing on more or less resources as required. This has greatly benefited CERN in cases where users have made requirement changes at short notice. This flexibility was possible because of the relatively large pool of skilled resources that were available “in-house” to the consultants.

2.5 Performance and problems during the design phase

Whilst there is no doubt that the use of external consultants was necessary for the LHC civil engineering, it would certainly not be true to say that everything was always running smoothly. One of the most difficult problems to overcome, at least for CERN, was that the consultants primary business was to make money for their shareholders. This they were striving to do having put in the lowest price to undertake some reasonably well defined services. As long as the actual services remained within the scope as defined in the tender then the consultants were obliged to carry them out within the contract cost. However, once changes were made the inevitable discussions and arguments ensued on the correct cost for these changes.

Another major problem that had not been considered prior to contract award was the difference in perception of required service level by the respective consultants. In particular, consultants from different countries had different ideas of what was required of them. By way of example, it transpired after contract signature that one company was intending to produce all detailed reinforcement drawings, as was the standard practice in his country, whilst another was not intending to produce any drawings since in his country it would normally be the contractor who would carry out this task. This kind of problem can only be avoided by writing very detailed specifications and leaving nothing that could be open to interpretation. On long duration contracts such as these civil engineering consultants, to foresee all possible events in advance is of course extremely difficult.

Another serious problem that affected the contracts included the fluctuating exchange rates (up to 40%), which whilst benefiting CERN, caused immense problems for two of the three consultants since their income basically reduced by 40%. At one stage, one of the consultants seriously considered pulling out from his contract with CERN due to the large losses he was making on the contract.

The problem of working with unfamiliar regulations and design rules also caused some problem. Although CERN had specified that the structural design of the buildings and other structures could follow any recognized design codes, the issue of safety had to be covered by the codes of the host states (i.e. France and Switzerland). It was certainly an advantage that there was a French or Swiss partner in two of the joint venture companies.

Over the long contract duration, loss of key staff was also a problem. Although CERN included a contract clause forbidding key staff to be removed without CERN authorization, this was difficult to implement, particularly when the staff left the company at short notice. The main problem when this occurred was the time needed for a new member of the design team to become fully familiar with the Project.

2.6 Performance and problems during the supervision phase

The site supervision phase was the most critical and expensive phase for CERN. Each of the three consultancy firms had on average about 10 people on site with a peak of around 15. These numbers which may appear large were required in order to maintain a minimum on-site presence during the 24 hours per day operations of the contractor. The cost for the site management teams was on average 10 kCHF per man-month, with the Senior Project Managers costing CERN about 15 kCHF per month. Total expenditure by CERN on the site supervision will be about 27 MCHF by the time the project is complete.

The performance of each site supervision team varied significantly depending on the particular circumstances. In general CERN has been satisfied with the overall performance but as during the design phase, it was clear that whilst the consultants wanted to do their best for CERN, they also have to take into account the financial situation of their respective companies.

As during the design phases, one of the most critical issues was that of exchange rates. For the reasons explained earlier, the companies were losing substantial sums of money. This has caused two major problems during the supervision phase of the project.

Firstly, during the normal contract period, CERN has insisted, despite objections from the consultants, that the contract prices must be maintained. This had led the consultants to put forward cheaper people to fill the positions in the site supervision teams. Generally speaking, the cheaper people are less experienced than would otherwise be the case and this has certainly caused many arguments between CERN and the consultants. CERN included within the contracts a clause stating that the experience of any replacements must be at least as good as those included within the original offer. Nonetheless it is certain that the financial problems caused by the exchange rate fluctuations did have an adverse effect on the composition of the site supervision teams.

Secondly, the problem of exchange rate has required CERN to re-negotiate unit costs with two of the three consultants. This is due to the fact that contractually the consultants are only obliged to maintain their unit rates for the construction period as estimated in 1996 when the tender were made. Unfortunately the construction period for all contracts have extended by about 1 year (due to the late DUP and delays during construction) that means that unit rates had to be re-evaluated. It is estimated that an additional cost of around 600 kCHF will have to be paid.

The most difficult problem that have arisen for CERN have been issues relating to design responsibility and how to deal with issues within which the consultants are implicated. The contracts are written on the basis that the consultants manage the projects with minimal input from CERN. This puts CERN in a position where we rely heavily on the consultants. This causes a problem when situations arise that may be the fault of the consultant since CERN is left in the position with no one to assist in defending their case. The very limited internal resources available compound this problem. Even worse is the potential scenario whereby a costly problem arises that all three parties consider to be the fault of one of the other parties. In this situation CERN may find itself fighting not only against the contractor but also the consultant.

3 LESSONS LEARNT FOR THE FUTURE

There are several important lessons that can be learnt from the experience CERN has gained over the last 7 years in working with external consultants. These are briefly summarized below.

3.1 Specification

It is important to be very detailed in the specification and other documentation that sets out the scope of work. In particular the issue of design codes and “best practice” needs to be carefully laid out in order to avoid that companies make offers based on their own national practices that may not necessarily apply at CERN. The most important rules and regulations to clarify are those where CERN themselves have a particular regulation that may differ even from the host state regulations. A bidders conference is absolutely imperative although it must be carefully controlled with all questions being summarized in written form with both questions and answers being circulated to all bidders.

3.2 Staffing

It is impossible to ensure 100% that the same staff will be available throughout the duration of the contract. However it is necessary to ensure through the wording of the contract that all changes are authorized by CERN and that all replacements must have a certain defined level of experience and/or qualifications. It may even be possible in certain cases to penalize a consultant should a certain key person no longer be available to the CERN project. In all cases, a suitable “overlap” period with the replacement should be made at the consultant’s own cost to ensure continuity.

3.3 Currency

Although the problem of exchange rate problems are not specifically related to the provision of consultancy services, the long duration of such services does make them more susceptible. To avoid such problems, it should be ensured that the consultants are paid in the currencies in which they will have major expenditure. This may mean offering the possibility of payments in more than one

currency. To avoid the problem of re-negotiation of rates, it may be useful to include a contract clause that fixes rates for a specified period of time should the contract need to be extended in time.

3.4 Disputes

The problem of disputes with the consultants is not one that can be easily overcome. Unfortunately with the commercial pressures on the consultants and CERN, disputes are more or less inevitable on such long running contracts. By passing over so much responsibility to the consultants, CERN was perhaps putting itself at risk should disputes arise. On the other hand it would not be economical to maintain staff simply in case disputes do arise. Unfortunately there is no obvious solution to this problem other than to either maintain a team of sufficient size to defend CERN in case of disputes or to employ another set of consultants to defend CERN against the first set!

4 CONCLUSIONS

In 1995 when the recruitment of external consultants for the LHC project began, it was considered that this would certainly be the best way forward in order to complete the LHC civil engineering works. Whilst this remains true today, it is also true that the use of external consultants has not been without problems. The root of these problems lies in the fact that the consultant's primary goal is to make money for their shareholders. Some of these problems can be avoided by careful drafting of tender documentation and contract documentation. When problems do arise, it is important that the client has the right people available to deal with them and that the client does not become too dependant on the consultants.