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### **SOFTWARE SUPPORT FOR INDUSTRIAL CONTROLS CONTRACT**

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#### **Abstract**

The contract covers the development and the operation and maintenance (O&M) of the monitoring and control systems used for supervising CERN's technical infrastructure. The contract involves those responsible for equipment in any current or future technical installation. We are outsourcing a complex activity which will require efforts on both preparing the specifications for new projects and setting clear definitions of tasks and procedures for O&M. It is a result-oriented contract in which performance will be continually evaluated by different methods and tools: project management plan and project follow-up, and CAMMS (Computerised Assets and Maintenance Management system). To be used effectively, this approach requires complete traceability of activities and documentation of the systems. Based on the analysis of the results measured and the shared (CERN and contractor) experience, the O&M activities will be reviewed and reorganised and operational procedures will be changed according to needs. A key issue of this contract is the challenge of establishing a good partnership with the contractor in order to reach the goals.

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## **1 INTRODUCTION**

The 'Software Support for Industrial control' contract will come into force on 1<sup>st</sup> January 2001 and be valid until 31<sup>st</sup> December 2003. After this date, the contract may be renewed by CERN for two further one-year periods. The specifications for this contract were prepared one year ago and we presented the scope and services to be supplied as well as our objectives at the 3<sup>rd</sup> ST Workshop. Now, after having completed the tender process, adjudication and contract start-up preparation, we have gained some useful experience in both specifying and preparing the execution of a contract.

The purpose of this paper is to show the experience gained, present several potentially troublesome issues which we would like to point out as sensitive and need special care when outsourcing software support and development. This might lead to an open discussion and the sharing of experience with other contract managers in the Division.

## **2 CONTRACT OBJECTIVES**

The contract concerns the maintenance and development of the monitoring and control systems used for supervising CERN's technical infrastructure.

The equipment groups (Alarm and Access, Cooling and Ventilation, Electrical Engineering) of the Division will mainly require the development and maintenance of systems related to process control. The Monitoring and Operation group will, on the other hand, require the maintenance and development of monitoring systems. The process control and monitoring systems are, however, closely linked by the data that flows from the process control to the Technical Control Room (TCR) and Safety Control Room (SCR). All the monitored equipment is defined in reference databases, which are used for configuration or maintenance purposes.

### **2.1 General Strategy**

Our challenge is to improve the quality of the monitoring and control systems by using industrial solutions and methodologies. We focus on the rationalization of the monitoring and control architecture, applying CERN's recommendations (fieldbuses, PLCs, SCADA systems, ...) and favoring software reusability of proven solutions and modules. The contractor will be asked to follow this strategy.

### **2.2 Support to the Operation**

The support to the operation of the CERN Safety and Technical infrastructure shall have the highest priority. Failure by the contractor to do so will entitle CERN to terminate the contract by giving the contractor one month's notice [1].

## **3 CONTRACT EXECUTION**

In this section are presented the main principles and key issues of the contract, extracted directly from the Technical Specification [2].

### **3.1 Types of Services Covered**

The services covered by the contract are divided in two groups:

- Projects. This covers activities limited in time and devoted to the development of new systems or to the implementation of major modifications to existing systems.
- Operation and Maintenance. This covers on-going operation and maintenance activities required for operating the systems and keeping them in optimal operating conditions.

During the first year of the contract, 70% of the activities will be for projects and, the remaining 30% for operation and maintenance (O&M) activities. However, it is foreseen that the O&M volume will increase with the integration of new systems and when projects developed under the contract and no longer covered by the warranty period will have to be maintained.

## 3.2 Operation and Maintenance Service

### 3.2.1 O&M Transition Period: Knowledge Acquisition

The execution of the contract will start with a six months transition period where the contractor will gradually acquire the knowledge required to perform the O&M Service. He shall analyse the existing documentation and update it if necessary. He shall also maximize the experience obtained during the execution of the corrective maintenance with the support of CERN staff members.

After this period, the contractor is supposed to have acquired the necessary knowledge to carry out the O&M Service to CERN's full satisfaction. Any subsequent transfer of knowledge within its team (in case of replacement of personnel for example) will be the contractor's sole responsibility and at his cost.

### 3.2.2 Planned and Unplanned O&M Services

There are two types of O&M Services:

- Planned O&M Services
- Unplanned O&M Services

#### Unplanned O&M Services

Consists of corrective maintenance activities, minor modifications and user support activities that cannot be planned in advance.

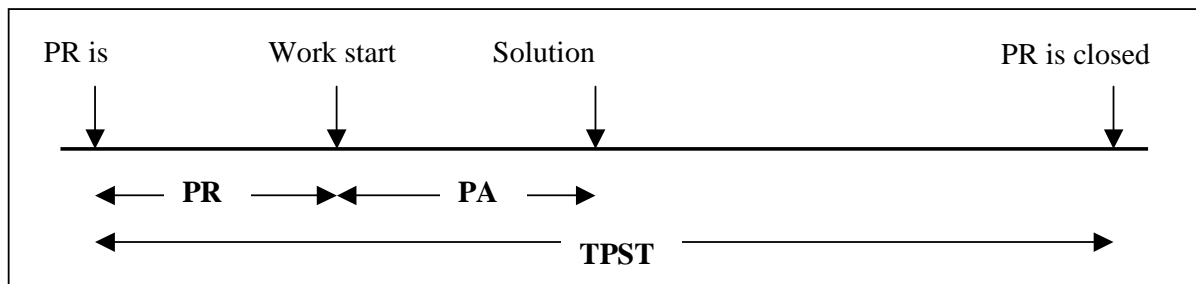
This service includes an *on-call service* and will be supported by a *Problem Report System*. The triggering events, also called problems, will be introduced by CERN in the Problem Report System using a *Problem Report (PR)*. The type of problem determines the type of service:

- A *fault* or a failure in the industrial control infrastructure identified by the TCR: *support to the operation service*.
- A *change request* issued by a user: *minor modification service*.
- An *information request* issued by a user: *helpdesk service*

The execution of the Unplanned O&M Service is characterised by the following time intervals:

- *Problem Reaction Time (PRT)*: Time elapsed between the introduction of a problem in the Problem Report System using a PR and the time at which the contractor starts working.
- *Problem Analysis Time (PAT)*: Time to understand the problem and to identify (a) solution(s).
- *Total Problem Solving Time (TPST)*: The total time required to solve a problem (life duration of a Problem Report).

These intervention times are illustrated in **Figure 1**.



**Figure 1:** Intervention times for Unplanned O&M activities

### 3.2.3 Maximum intervention times required for the Unplanned O&M Services

During the transition period, Unplanned O&M Service will be executed with the support of CERN staff members. After the transition period, the contractor shall perform the Unplanned O&M Service alone, at least as quickly as during the transition period with the support of CERN staff.

The maximum intervention times for the unplanned O&M services are given in Table 1. The support to the operation shall have the highest priority.

**Table 1**  
Maximum intervention times required

<b>Unplanned O&amp;M services</b>			
	<b>Support to the operation</b>	<b>Minor modifications</b>	<b>Help desk</b>
Problem Reaction Time	1 hour	4 hours	2 hours
Problem Analysis Time	1 hour	4 hours	2 hours
Total Problem Solving Time (during the transition period)	Best effort		
Total Problem Solving Time (after the transition period)	Based on intervention times measured during the transition period		

### 3.2.4 O&M Service Monitoring

An Operation weekly meeting will be organized with the contractor to monitor the status of all the problems reported and the action taken to solve them. The contractor shall provide a service performance report covering at least the parameters given in the Table 1.

This meeting will also ensure that the cause of the problems are analysed and well understood, and long-lasting solutions eliminating the cause of the problems are implemented.

The Maintenance Management System, MP5 [3], used in the Division will be used in this contract to follow-up the O&M service.

### 3.2.5 O&M Service review and volume change

Bi-annual O&M Service reviews will be organized by CERN.

The contractor shall make recommendations to improve the O&M Services, taking into account the feedback of the O&M experience. He shall also make recommendations to improve the re-use approach and to improve the maintainability of the systems. The implementation of these recommendations will need the prior approval by CERN.

During these reviews, CERN may request the introduction of new control and monitoring systems in the O&M Service. For each of these requests, the contractor shall make a technical and financial offer. Prices for the additional services required shall be based on prices for comparable activities stated in the tender. In case the contractor's offer seems unreasonable, CERN may decide not to include the additional service in the contract.

CERN may also request modifications to the O&M process, procedures and systems.

## 3.3 Projects Service

The Projects service requested from the contractor is to execute and manage development of projects related to control and monitoring systems.

### 3.3.1 Project classification

Projects are characterized by the effort required to execute the work:

- *small-size projects*: effort required is less than 6 man/months
- *medium-size projects*: effort required is between 6 and 12 man/months
- *large-size projects*: effort required is between 6 and 12 man/months.

Small- and medium-size projects will be developed on the site, and the large-size ones at the contractor's premises.

### 3.3.2 Project life cycle

The typical project life cycle is given in **Figure 2**.

Requirements and Planning Phase	Product Design Phase	Detailed Design Phase	Transfer of Product Phase	Operation and Maintenance Phase
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**Figure 2:** Life cycle for the development of a new system

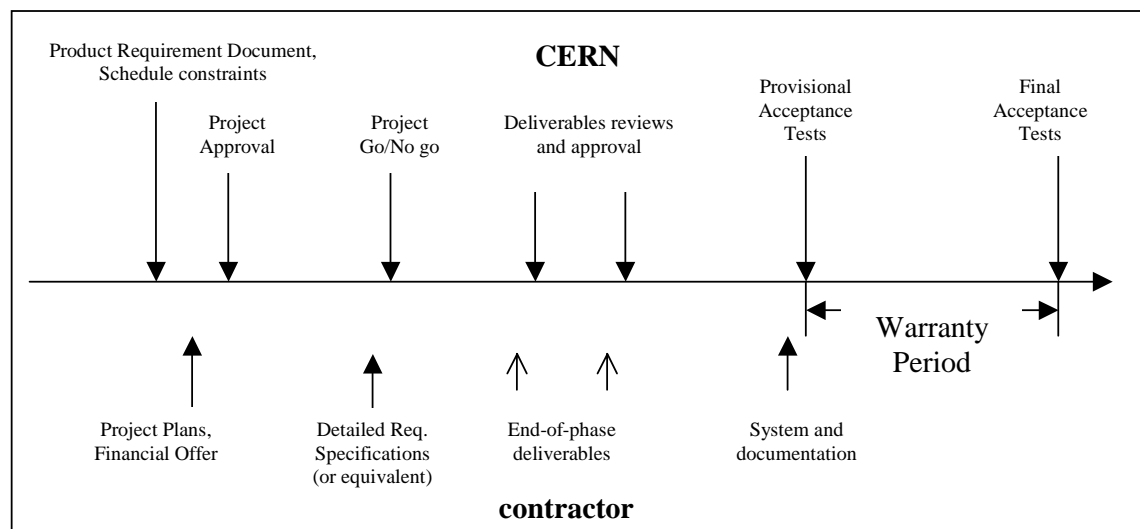
The Requirement and Planning Phase may be performed either by CERN or by the contractor.

For the projects where the Requirement and Planning Phase is performed by CERN, CERN will produce a *Product Requirement Document* (PRD) specifying the product to be developed or the major changes to be implemented. The PRD will usually be a User Requirements Document (URD) or a Software Requirements Document (SRD) as defined by the ESA Software Engineering standards [4]. CERN will also specify the constraints for the execution of the project and in particular the schedule constraints.

The contractor shall adopt a suitable project development methodology. CERN recommends the use of the ESA PSS-05 Software Engineering standards [4] with relevant methodologies and tools (e.g. SASD, UML).

### 3.3.3 Project follow-up

Each project phase shall have associated deliverables (**Figure 3**). Each end-of-phase will be object of a formal review meeting between CERN and the contractor. During these meetings, the deliverables will be reviewed and approved by CERN. CERN will approve or reject the deliverables and will authorize or not authorize the execution of the next phase of the project.



**Figure 3:** Project milestones – Requirements and Planning Phase performed by CERN.

CERN's approval of the phase deliverables does not release the contractor from his responsibilities with respect to the correct performance of the final system.

CERN reserves the right to organise audits at the contractor's premises to review progress and/or compliance of the development activities with the plans.

Roles and responsibilities shall clearly be defined in the various management plans. CERN strongly recommends the use of the Goal Directed Project Management method (GDPM) [5].

#### *3.3.4 Warranty period.*

During the two years warranty period, the system supplied is Operated and Maintained by the contractor (price of this service is included in the project price).

#### *3.3.5 Tender Reference Projects*

Five projects, one large-size, one medium-size and three small-size projects, referred to as *Reference Projects*, were specified at the tender and were used for the adjudication.

#### *3.3.6 Project approval and Go/No-go decision*

The contractor shall provide a proposal containing the project plan and a financial offer. CERN will approve or reject the proposal after a careful evaluation. The proposals for the Reference Projects provided by the contractor at the tender, will be used to benchmark the new proposals.

CERN will reject incorrect proposals and reserves the right to contract the project execution to another contractor or to execute the project in-house.

### **3.4 Remedies in case of non compliant service**

The contractor shall at all times provide a service in compliance with the contract and the highest professional standards. He shall at all times ensure CERN's full satisfaction.

In case the service does not comply with the above requirements, CERN shall advise the contractor in writing, providing all necessary details concerning the non-conformity or the reason of its dissatisfaction. Upon receipt of such notice, the contractor shall inform CERN about the measures that he is going to take in order to remedy the situation. CERN shall in good faith examine such proposals.

In case such measures are deemed satisfactory, CERN shall instruct the contractor to implement his proposal.

In case such measures are not deemed satisfactory, CERN shall so inform the contractor who shall then submit an alternative proposal.

In case the contractor cannot propose satisfactory remedial measures, or does not implement the measures proposed and accepted by CERN, or in case of recurrent and/or serious problems and dissatisfaction by CERN regarding the contractor's performance of the contract, CERN reserves the right to terminate the contract by giving the contractor one month's notice. It is being understood that no compensation shall be due to the contractor with regard to such premature termination.

## **4 CONTRACT START-UP PREPARATION**

### **4.1 Contract Users Organization: roles and responsibilities**

There is a representative (helped by a deputy) of every group (AA, CV, EL, MO) participating in the contract, these persons are in charge of presenting the needs of their groups to the Contract manager and at the same time, they are responsible for ensuring that the CERN strategy and general recommendations are followed within their groups.

For each of the two services of the Contract, Projects and Operation & Maintenance, there is a responsible person helped by a deputy. This distribution of responsibilities will help the Contract manager in running the contract successfully.

## **4.2 Software Tools**

The different software tools (MP5, EDMS) that will be used have been adapted to meet the contract requirements.

## **5 REVIEW OF EXPERIENCE**

### **5.1 Tender Evaluation and Adjudication**

When the tender offers were opened, we found the “lowest bid” technically correct and compliant with the Technical Specification, but rather low.

If our doubts are correct, and during the execution of the contract, the contractor does not make an adequate return on his investment, he will not be “willing” to provide the services in compliance with the contract at the highest professional standards.

We should be wary of this and if possible find the right compromise between quality of services required and the price paid to the contractor.

### **5.2 Contract start-up**

In order to ensure a successful beginning of the contract, some preparation work is required by both CERN and the contractor.

We correctly prepared the software tools, which will be used. From the point of view of organization and management, a dedicated team of CERN staff has been set up whose roles and responsibilities have been defined (ref. section 3.1).

A few weeks before the start of the contract, we asked the contractor to provide us details on their organization and, in particular, the specific organization of the O&M team assigned to work on the site. The contractor provided such information, but we found that the team’s knowledge covered only a small part (10-15%) of the domains of activity we need (“Industrial control infrastructure technologies”, point 1.4.3 of the Technical Specification [2]), and therefore were not able to start the contract effectively.

We decided to postpone the signature and the start of the contract in order to give the contractor additional time to set up a proper team having the competence specified in the Technical Specification of the tender. We proposed to the contractor to test the competence of the new O&M team assigned by measuring their performance in two specific tasks which had to be completed successfully, after the appropriate training by CERN staff, within 30 days. These two tasks served to validate the knowledge and experience of the O&M team members in ORACLE and UNIX which are used in 95% of the CERN technical installations scope of this contract.

The result of the validation test was positive and CERN agreed to start the contract. We appreciate the effort put by the contractor during this validation process that also showed its capacity to mobilize resources when required.

### **5.3 Integration of new O&M services and development of new projects**

The integration of new O&M services and development of new projects can occur at any time, but a dedicated treatment and study will be done during the bi-annual O&M Review meetings and specific Projects meetings organized for that purpose.

Prices for additional O&M services shall be based on prices for comparable activities stated in the tender. In case the contractor’s offer is deemed unreasonable, CERN may decide not to include the additional services in the contract (point 4.4.4.9 of the Technical Specification [2]).

For new projects, the Project Evaluation Sheet provided by the contractor in the tender for the Reference Projects, will be used to benchmark the new proposals. CERN will reject incorrect proposals and reserves the right to give the project execution to another contractor or to execute the project in-house (point 4.3.4.2 of the Technical Specification [2]).

Even within the contract, offers by the contractor should not be 'unreasonable' financially speaking: we have to be ready to reject inappropriate offers and to negotiate and discuss both financial or technical offers.

## 6 CONCLUSIONS

We are outsourcing a complex activity that requires effort on both preparing the specifications for new projects and clear definition of tasks and procedures for O&M.

For the development of new projects, the correct and appropriate use of software engineering methods (ESA PSS-05) and project follow-up methods requires a bigger effort during the specification phase but reduces the effort required later (project follow-up, design, deployment and O&M).

Concerning the O&M activities, the complete traceability of the O&M interventions and solutions applied possible with MP5, and their posterior analysis will give a better understanding of the cause and importance of the problems. The information gathered will allow redefining the O&M tasks and procedures accordingly, together with a rationalization of the work and establishment of priorities. It will also allow the implementation of solutions that eliminate the cause of the problems.

During the first six months of the contract (transition period), O&M tasks and procedures will be revised together with the contractor, and registered in the MP5 database. This process should improve the operation of the systems concerned. The final aim is the rationalization of the systems and their re-usability, which will improve the quality of the control and monitoring systems and ease their operation and maintenance.

We asked the bidders to include in the price for the O&M Service, the cost for the initial knowledge acquisition of the existing control & monitoring systems (18, at the start-up of the contract). The contractor did not quote any cost at all for the *Knowledge Acquisition* of the systems to be O&M, thus making their offer the lowest. It must be noted that after the transition period, it is the contractor's sole responsibility to assure the *knowledge transfer* of the totality of the O&M systems.

However, we have to be aware that it is mandatory for us to keep an "expert cell" because of the following reasons:

1. We have to be able to check and evaluate the service provided by the contractor. And, in case of major problems, we have to be able to rapidly point out bugs and their possible causes and solutions. Last year there were several major problems with the TCR operation, the contractor did not manage to fix the bugs within a reasonable delay. The CERN experts intervened and finally solved the problems.
2. Even if it is the contractor's sole responsibility to assure the *knowledge transfer* of the totality of the O&M systems, if he fails to do so, it will not be a major problem for the contractor but for CERN who shall have to handle the situation.

We are aware of the fact that the contractor faces the same problem of recruitment as CERN, namely to find competent computer technicians.

During the first months of the contract, the type of tasks to be executed by the O&M team will be less than foreseen and the easiest. Our expectations are low; we will monitor their performance and its evolution, and based on it we might give them more complex tasks to execute. We will certainly have to follow-up their activities very closely.

CERN will have to give special care to the integration of new systems to the O&M Service and development of new projects. Prices for new projects will be negotiated, but the contractor's offers must be based on prices quoted for the tender Reference Projects and the O&M Service (points 4.3.4.2 and 4.4.4.9 of Technical Specification [2]) placed in the past. We should be careful, negotiate the best (most convenient) technical implementation!

The ST Division has set up this contract for its own systems. Other Divisions (SL, LHC) have also shown an interest and could join at a later stage. In fact, the SL/CO group is already a user, the Management of the CERN alarm database has been integrated in the O&M service of this contract.



Finally, we hope this contract will increase and improve the communication between the ST groups, and generally establish a good partnership with the contractor.

#### **ACKNOWLEDGEMENTS**

The elaboration of the contract has been the result of the efforts of several representatives from the ST/AA, ST/CV, ST/MO and ST/EL groups, with the very effective support of P. Ciriani and our SPL colleagues, M. Picchioli, B. Denis and V. Hatton.

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