CHAPTER X - PROJECT SCHEDULE, PERSONNEL AND COSTS

1. CONSTRUCTION COSTS

The construction costs of the reference project - i.e. all the costs during the 5-year construction period of the SPIRAL 2 facility amount to 135 million euros, including contingencies, at 2004 prices. They are exclusive of value-added tax (VAT) and customs duties. They are based on the assumption that SPIRAL 2 is free to choose "best value for money" for offers meeting the technical requirements.

This figure includes not only capital investments for all components necessary for the facility (as listed in Table 1), but also all the manpower required (in-house and subcontracted staff) at the various stages of the project, i.e. detailed design, procurement, construction, testing, installation and commissioning.

Table 1: Breakdown of the reference project into major subsystems.

Linac – driver accelerator	**200-kW deuteron** source & associated LEBT 1 / RFQ 1 systems – **intermediate ion source** & associated LEBT 2 – MEBT – SCL systems – HEBT to one production station & to beam dump – beam dump – RF systems – power supply systems – cryogenic plant & distribution – diagnostics systems – vacuum systems – test lab equipment
Target/ion-iource itation	**One** production station – **two** converter/target/source plugs (ECR-type) – t**wo** low-energy plugs – o**ne** hot-cell & equipment – test bench for plugs, targets & ion sources – one site for a possible material irradiation station
Secondary beam transfer lines	**One** 2-channel separator – o**ne** charge breeder – o**ne** identification station – separator-to-charge-breeder beam line – charge-breeder-to-CIME beam line – separator-to-identification-station beam line – direct beam line to G1/G2 caves
Conventional facilities	Industrial architect & insurances – site preparation, roads & footpath – accelerator building with crane & concrete shielding – production building with cranes & concrete shielding (for **one** target station & **one** separator station, **one** hot-cell infrastructure, charge breeder, identification station room) – service buildings (chillers & water distribution, cryogenic building, switchyard & electrical substations, nuclear ventilation & HVAC, 'hot' gas storage, nuclear waste treatment) – workshops & general laboratory infrastructure
Integrated control systems and networks	Integration – global systems controls (linac & cryogenic plant controls, target/ion-source controls, secondary beam transfer line controls) – building & infrastructure control systems – safety & interlock systems safety control systems
In-house manpower	Management & administrative support (project leaders, task leaders, project planning & control, configuration management, quality assurance, information & documentation management, safety & environment) – all manpower required during the construction phase of the project for design, procurement, contract monitoring, quality assurance, acceptance testing, assembly, installation, tests and commissioning for each section of the project

Possible future options which have been considered are not taken into account, e.g. a new high-performance ion source (A/q=3), a second heavy-ion injector (A/q=6), a fast chopper in the MEBT line, and an irradiation station using the 14 MeV neutrons. For additional confirmation, parts of the costing have been cross-checked independently. Examples are:

- the linac RF power systems (high voltage power supplies, tube amplifiers, solid state amplifiers, isolators/combiners, electronics & direct control systems, etc.), the RFQ, cavities and cryomodules, checked from industrial quotations;
- the cryogenic plant, control network and computer systems, checked by experts running similar large-scale facilities elsewhere.

However, at this stage of the project, the following assumptions were made for the cost estimation:

- For the existing GANIL facility: the only assumed modifications concern the CIME hall (nuclear ventilation and reliability improvement ~1 M€) but do not take into account the possible modifications which could result from the Safety Authorities' reports.

- For the SPIRAL 2 extension: assumptions have been made about the maintenance system, but are waiting for the results of the nuclear engineering studies.

Apart from the accelerator studies, an extra-cost of 20% has been added for the detailed studies of the components within the production hall (i.e. the irradiation station, hot-cell, separator, charge breeder, etc.) which will be subcontracted by specialized companies.

The cost breakdown, as well as the distribution of the capital cost among the subsystems, are shown in Table 2 and Figure 1.

Table 2 : Cost breakdown of the SPIRAL 2 project.

SUB-SYTEMS	CEILING COST (k€)
LINAC - DRIVER	26 671
TARGET ION SOURCE STATION	6 649
SECONDARY BEAM LINES	9 540
CONVENTIONAL FACILITIES	35 139
INTEGRATED CONTROL SYSTEMS	2 206
DIRECT LINES G1/G2	2 640
TOTAL CAPITAL COST	82 844
STAFF COST	35 000
CONSTRUCTION COST	117 844
CONTINGENCY (15%)	17 677
TOTAL CONSTRUCTION	135 521

The 15% contingency factor – which has nothing to do with the error bars on cost estimates – is provided in order to cover unforeseen requirements, so that the overall project scope and specifications can be achieved. The contingency reserve is included, pro-rata according to the capital cost profile, in the annual construction budget. At the end of the construction programme, the funding authorities should decide on the assignment of any remaining contingency reserve.

It is worthwhile noting that the cost of the conventional facilities accounts for more than 40% of the total capital cost, higher than the usual cost for accelerator facilities but smaller than the usual cost for nuclear facilities.

Figure 2 shows the expected profile of expenditure over the 5 years of construction.

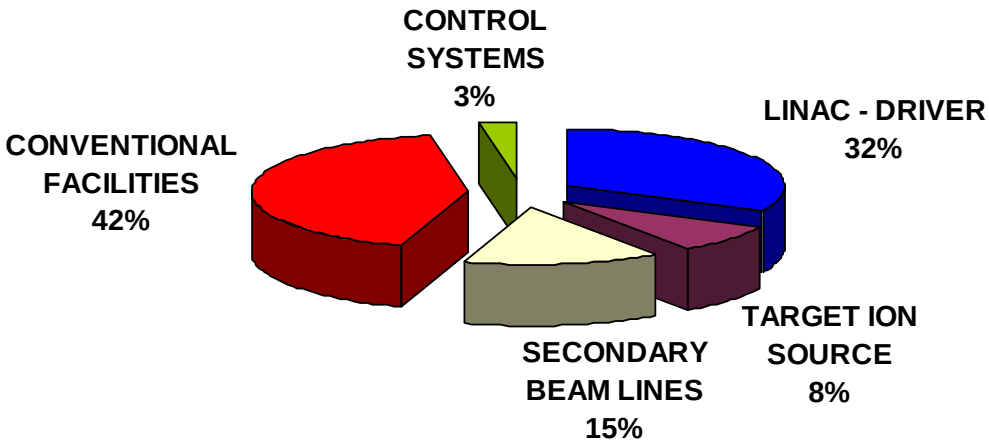

Figure 1: Distribution of the capital cost.

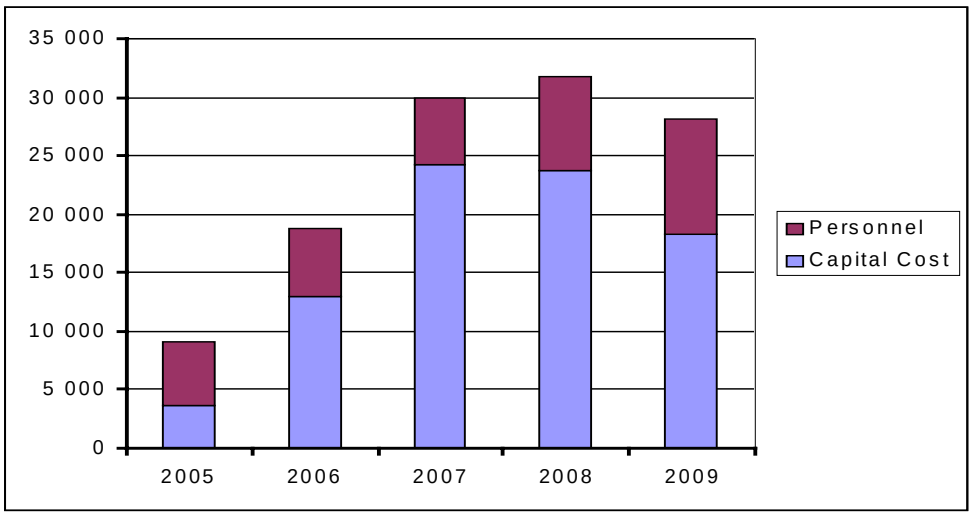

Figure 2: Profile of the expenses.

2. RUNNING COSTS

As SPIRAL 2 is considered as an extension of GANIL, the running of this new facility has to be integrated into that of the present one. The impact of SPIRAL 2 has been analysed in terms of strategy for financing (e.g. recurrent expenditure, complementary developments), organisation of operation, extra manpower needed, and running costs.

With the capability of delivering multiple beams at the same time, different physics experiences scenarios have been analysed. For example, by running the linac for some 44 weeks a year, about 100 weeks of physics can be achieved at GANIL overall.

In these conditions, the additional manpower required is about 30 people. This extra manpower can be provided by a redeployment of the present GANIL staff, but also by a participation of European partners.

With regard to the annual operating budget (9 M€ for the present GANIL facilities), the estimated extra cost is 2.2 M€, assuming full running of both the existing facilities and the SPIRAL 2 facility, and is mainly due to the cost of electricity.

With regard to the dismantling cost, the estimated extra cost is 10 M€ (about 15% of the SPIRAL 2 capital cost) compared to about 15 M€ for the present facilities. These dismantling costs will not be provided in the construction phase. However, a dismantling provision should be proposed within the framework of the long-term operational budget beyond the first ten years.

3. PERSONNEL AND ORGANISATION PROPOSAL

The required manpower has been estimated for each of the activities: administration (including management, safety and quality control), accelerator, converter-target/ion-source, secondary beam lines, buildings and infrastructures.

Technical and administrative support is assumed to be provided by GANIL staff during all of the construction phase.

Manpower required during the construction phase of the project for design, procurement, contract monitoring, quality assurance, acceptance testing, installation, system testing and commissioning has been estimated for each of the following activities: administration (including management, safety and quality control), accelerator, converter-target/ion-source, secondary beam lines, buildings and infrastructures.

Approximately 390 person-years of in-house staff are required for the construction phase. It is assumed that all in-house human resources will come from the DSM and IN2P3 institutes. Figure 3 shows the profile of the manpower required during the construction phase.

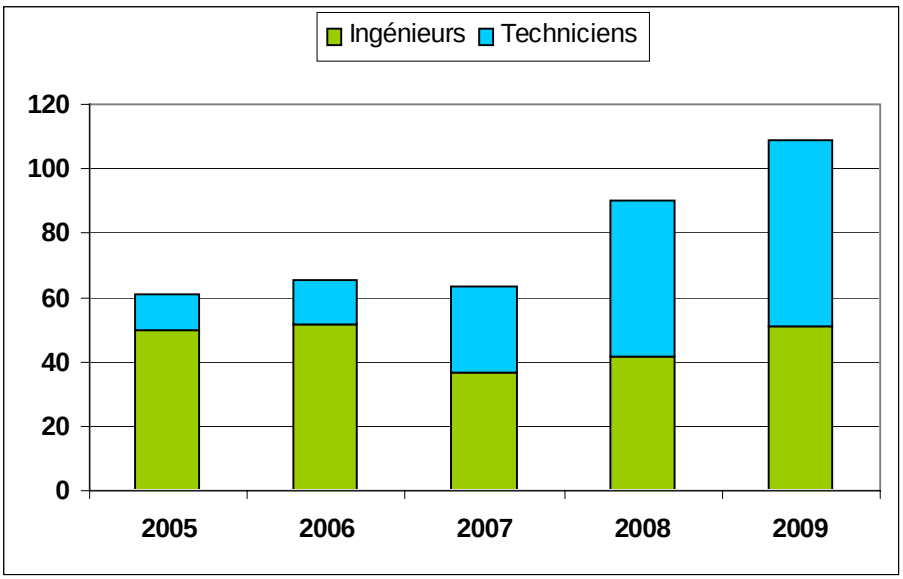

Figure 3: Profile of the in-house manpower required for the construction phase.

With regard to the organisation of the construction of SPIRAL 2 facility, we propose to follow the SPIRAL 2 APD model, to renew the agreement between CEA, IN2P3 and the Basse-Normandie Region, as well as the collaboration agreements with the associated laboratories, and to rely on the existing technical and administrative support of GANIL. An example of organisation for the construction phase is shown in Figure 4.

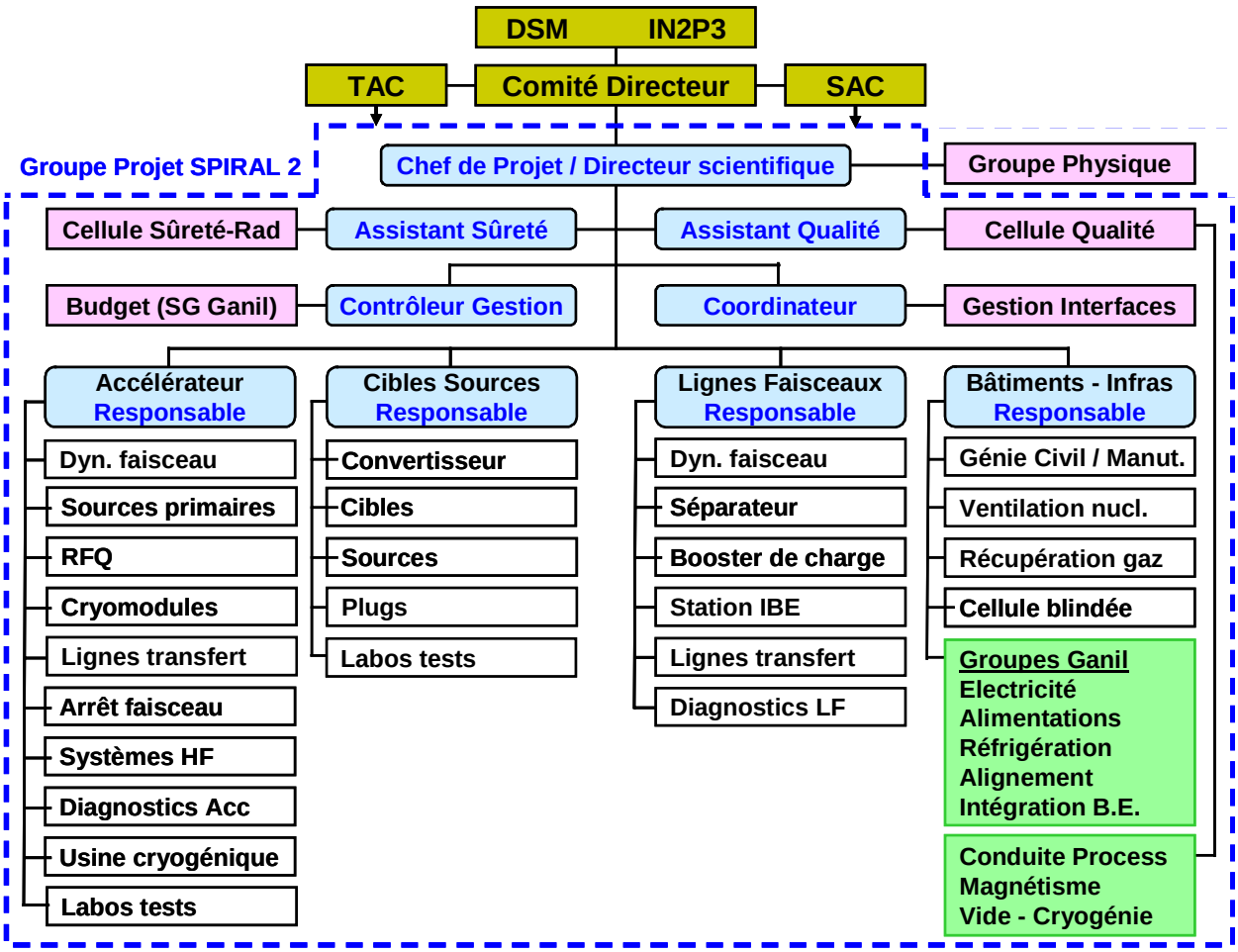

Figure 4: Organisation proposal for the construction phase.

4. PROJECT SCHEDULE

The construction of the SPIRAL 2 facility is planned to take place over 5 years, including 6 months for sequential commissioning of the deuteron chain of accelerators, one target/ion-source station and the complete chain of beam transport lines up to the experimental areas.

Therefore, assuming that all required authorisations will been obtained at the right time (i.e. a building licence by May 2007, a decree of authorisation of modification and a Departmental order of authorisation on the effluent discharge before the beginning of 2009), the first beams to the experimental area could be delivered at beginning of 2010.

During the last year of the construction period, the beam power would increase in steps, up to the specified 200 kW for deuterons to be delivered to the target/ion-source station.

After two years of feasibility studies, the construction of SPIRAL 2 facility is planned to take 5 years from the decision for the project go-ahead to the start of operations.

The conventional facility programme is one of the most critical ones, with respect to the technical risks, schedule and costs (more than 40% of overall capital costs). Machine parts can generally be ready for installation well before the buildings are completed. Therefore, the conventional facilities dictate the overall construction schedule.

The industrial architect (INA) contract will be placed only once the infrastructure and building programmes for both conventional buildings and production buildings are ready. Owing to specific studies needed for the production hall, the production-building programme turns out to be on the critical path. However, the critical path for obtaining the building licence also depends on the writing delays in parallel with the request for the nuclear facility modification (DAM) and the request of the effluent discharge authorisation (DARPE), followed by the safety authority analysis

and public enquiry led by the Prefecture. Figure 5 summarises the projected time schedule for the safety authorities in connection with the major building tasks for SPIRAL 2.

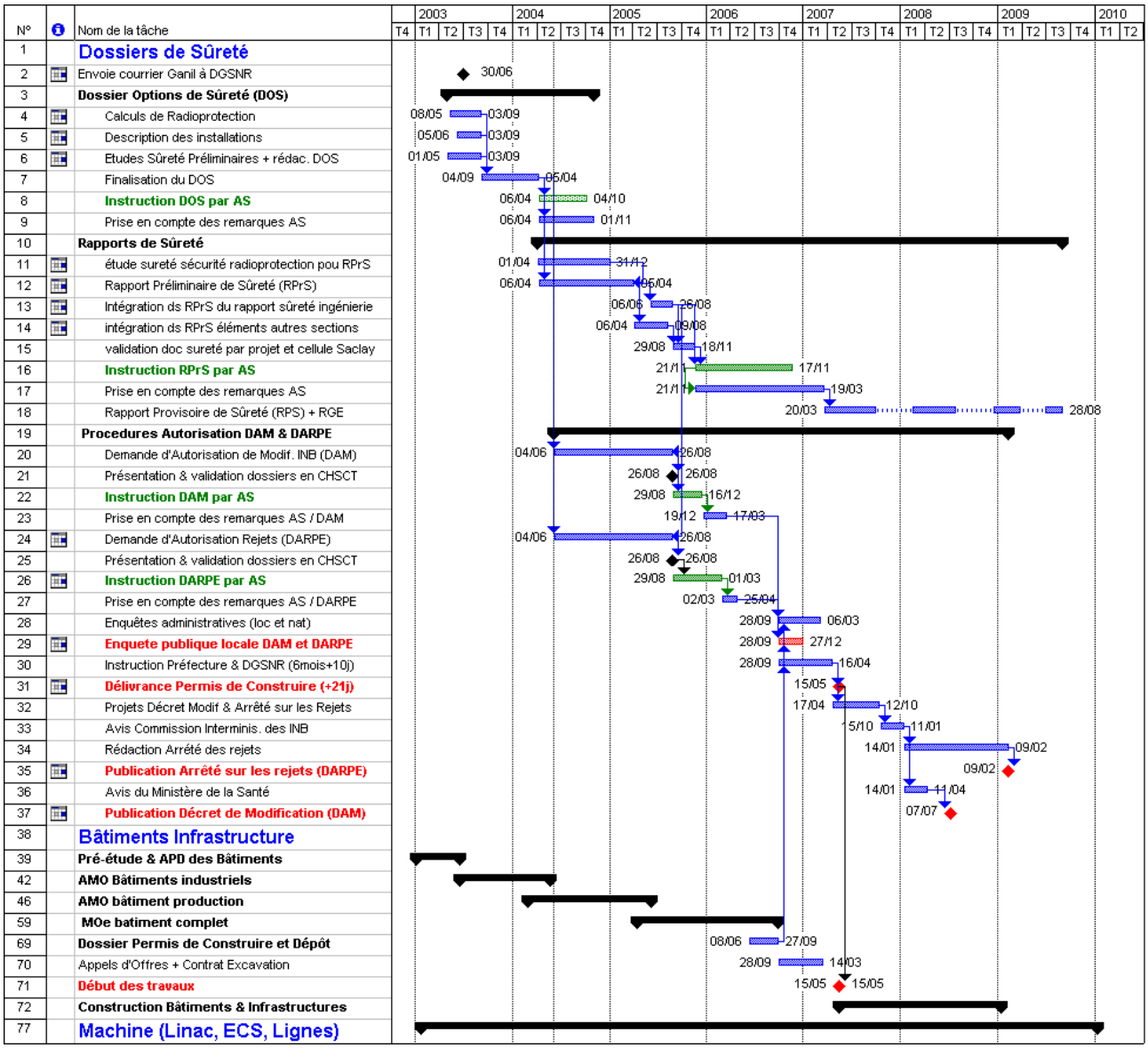

Figure 5: Safety authorisations time schedule for SPIRAL 2.

Publication of the decree for the modification of the nuclear facility (DAM) will only occur some two-and-a-half to three years after its request, following intensive investigation of the safety authorities and the advice of the inter-ministerial commission on nuclear facilities. The decree on effluent discharge (DARPE) will be published after additional advice is received from the Health Ministry. In principle, unless major difficulties arise, these publications are not on a critical path, provided that the dossiers for the civil engineering construction are in accordance with those of the preliminary safety report.

It is assumed that when the building licence is delivered, the contracts for civil engineering will already be set up in order to launch the ground-breaking work immediately, followed by the construction of the conventional facilities. Over the 1½-year period of construction, 6 months are dedicated to the preparation of the building site and ground-breaking, and 12 months to the construction and delivery of buildings, tests and acceptance of technical infrastructure providing electricity and fluids, and the HVAC systems.

Independently of all these procedures, studies, procurement, construction and delivery of the SPIRAL 2 components can be carried out, in order to start installation of the first elements within the accelerator buildings in mid-2008, i.e. 4 to 6 months prior to the final delivery of buildings. The full installation of the accelerator and related components is planned to take about one year.

Mid-2009 corresponds to the start of the commissioning period of the machine facilities. This period will be dedicated to sequential testing, commissioning of the accelerator, target subsystems and beam transfer lines and carrying out the “cold” tests for the safety procedures.

Assuming that all required decisions have been made at the beginning of 2005, and the building licence obtained before mid-2007, the construction period will end in December 2009. Thus, the first beams to the experimental areas could start in January 2010, marking the beginning of the operational period. The power delivered by the accelerator to the target will then increase step by step, until full performance is reached with 200-kW deuterons.

Figure 6 shows a preliminary construction schedule for the SPIRAL 2 baseline facility (buildings and accelerator-related components).

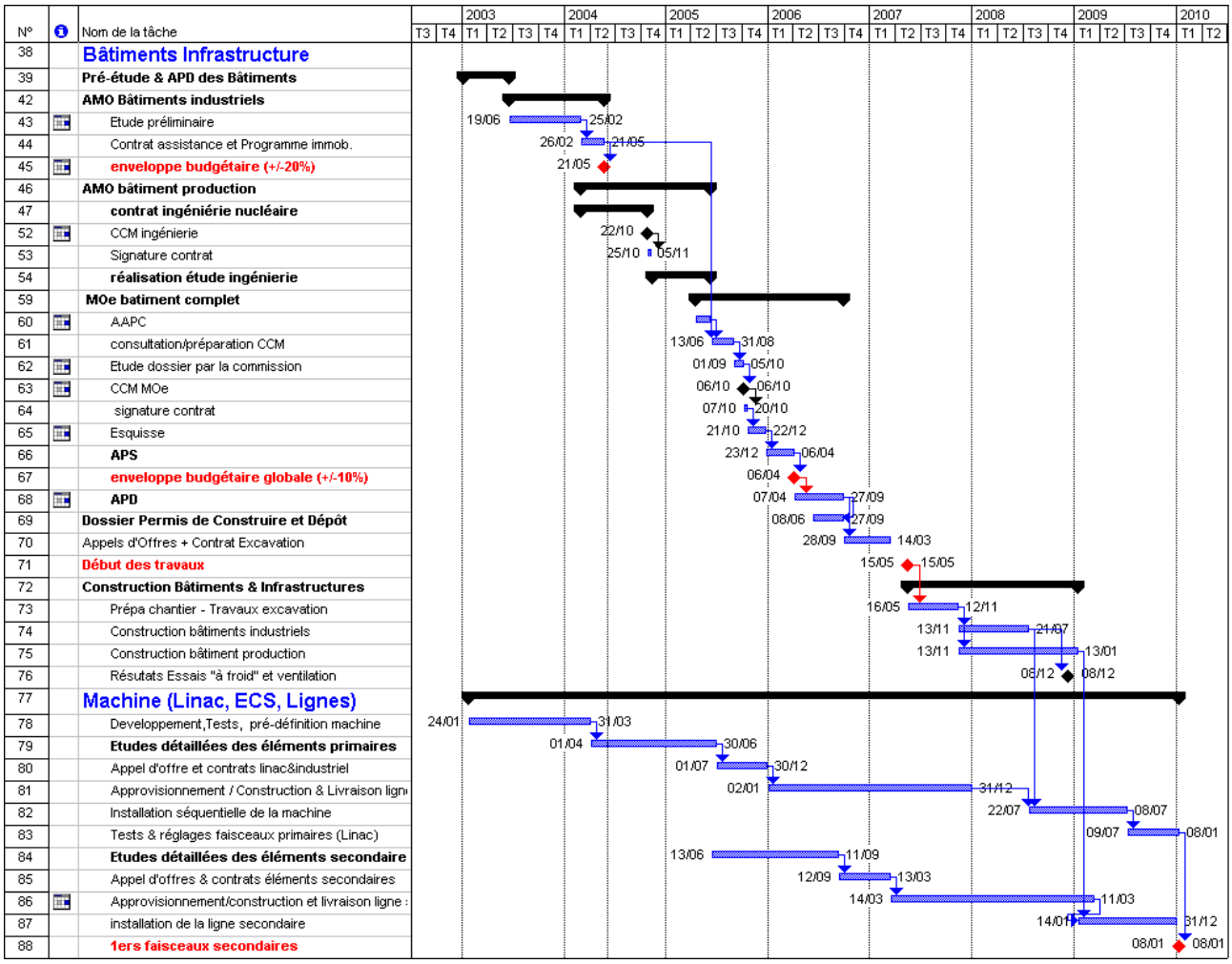

Figure 6: Preliminary construction time schedule for the SPIRAL 2 facility.

However, as the studies of the nuclear engineering company will only be complete about 6 months later than originally expected, the overall time-schedule should be shifted by approximately the same period.