Girassol: The Biggest FPSO in the World: As Seen by Its Contractor
Bernard Loez, Stolt Offshore

Abstract
This paper describes the engineering, procurement, construction and installation (EPCI) issues encountered during the construction and assembly of the floating production, storage and offloading (FPSO) system chosen for the Girassol development, offshore Angola. This presentation is from the contractor’s point of view and includes general remarks on the management of big projects.

Finally the paper addresses contractual aspects of the client-contractor relationship, which have been carried out in a unique manner at Girassol.

Introduction
The Girassol project has been quite exceptional and it is true to say that it is greater than the sum of its parts. No matter how difficult the construction program was, however, the tale would seem banal if all of the details were recounted.

In order to avoid a tedious cascade of figures designed to demonstrate the merits of Mar Profundo Girassol, the Bouygues Offshore/Stolt Offshore joint venture, in their management of this complex project affair, it has been decided to provide the “inside story”, presenting the major problems encountered and the way in which they were resolved.

Many of these problems are of a general, rather than a technical, nature and are common to the management of all major projects. In order to make this presentation more interesting, a number of famous authors have been quoted - entirely out of context, of course - in order to throw a humorous light on the matter.

In the beginning
The problems with the Girassol project began with the preparation of the tender at the end of 1997. Those in the industry are familiar with the haste with which TotalFinaElf E&P Angola decided to proceed with this development. The questions at that moment were: which type of contract for which scope of work and what type of facility was to be built and on what basis?

It was to be an FPSO, a floating unit for the production, storage and offloading of oil. It is best described as a hull with a vast production complex on its deck for the processing of oil, water and gas; storage of crude oil; re-injection of water and gas and export and metering of the crude oil.

Slide 1: Slide BFD3
The simplest and most striking way to define an FPSO is as a refinery on a super-tanker. This over-simplification masks the major difficulties on the project. It is a combination of an oil processing platform and a ship - two different cultures, different objectives, specifications, safety regulations, functions, methodologies, different contractors and construction sites. What brings them together is a bundle of interfaces and the absolute necessity for strict planning and coordination.

The objectives on such a project are so divergent that certain oil companies separate them at the contract stage. TotalFinaElf E&P Angola decided against this and one hopes that at the end of the day they are satisfied with this choice. If the economics of this decision are not apparent at first sight, the long term benefits are considerable. There is considerable value in concentrating the interfaces in the same place in order to avoid difficulties, both contractual and technical, that would generate inefficiency and wasting of time. In this theory, this project has is a famous ally:

“I consider that there is often much less perfection to be found in works made up of several parts, crafted by the hands of different masters, than in those upon which a single hand has laboured”.

DESCARTES

The same remark may be applied with equal emphasis to the interfaces between the FPSO and the flowlines and riser package, the treatment of which was greatly simplified by employing the same groups, BOS and Stolt.

The construction of the hull
For MPG, circumstances dictated that the order for
construction of the hull went to the South Korean shipbuilder Hyundai Heavy Industries (HHI). It operates the biggest shipyards in the world: 15% of the world fleet of oil tankers, LNG carriers and container ships are launched from the HHI yards. They are excellent in this field, provided that one is prepared to bend to their discipline.

HHI make all the decisions - planning, specifications, subcontractors, etc. and the client has to accept a hull virtually “off the shelf”. It is extremely difficult to make any kind of variation order before the start of construction and practically impossible afterwards. Once one accepts the requirement to adapt to HHI rather than the other way round, its performance is as good as its reputation.

But one should not underestmate the powers of persuasion necessary to obtain delivery of a product as evolutionary as an FPSO. This contract was awarded by TotalFinaElf E&P Angola to MPG on a fixed price, lump sum basis. This form of contract is perfectly acceptable for the hull for which the basic design and functions were sufficiently well defined.

Slide 2: 2 plans

The topsides contract

The topsides of the FPSO is another story altogether. The definition of the scope was limited to the basic outline from the front-end engineering and design (FEED) study and it was nearly impossible to define in the contract what the contractor would actually be required to deliver. This definition was to be one of the tasks to be executed under the contract on the basis of functional specifications. The choice by TotalFinaElf E&P Angola was for a “target” contract under which the amount and scope of work would be defined after a period of design engineering. In July 1998 MPG signed a contract which provided for a revision stage. As you know: “The more a contract provides for every eventuality, the greater are the risks in the event of the unexpected.”

The contract with TotalFinaElf E&P Angola did not fall into this trap. At the time of signing, even the definition of the target was not possible and if this type of contract - “risk and reward” - has merits, it also has pitfalls. Too high a target can to introduce an element of laxity, whereas a low target can result in a budget soon exceeded.

The contractor, having already lost a great deal of money, can become discouraged and lose all incentive to defend the interests of his client. In the case of MPG, the revised target price and final schedule were know in spring 1999 with the final contract signed in July 1999, equivalent to a lump sum with a “risk and reward” mechanism around the jointly agreed target price. This form of contract proved to be both satisfactory and efficient, as a result of a considerable level of cooperation between the two contracting parties. It proved that when engineering is reasonably well advanced - at least on basic design – an FPSO contract on a lump sum basis is workable.

Getting organized

Once a contract is signed, it is time to get organised. The creating an organisation for a big project is an essential task, extremely complex and unique to each project. The difficulty lies in the fact that a project organisation, unlike that of a large corporation, has to be nimble and reactive. A major project can often have more personnel than the parent company and, contrary to the parent which is involved in multiple activities, the project has one single product to deliver.

What is necessary is to get several hundred people to work on one single end-product, which is not necessarily divisible into simpler tasks. Project control is essential, if one is to have reliable decision-making tools at one’s disposal. Just as super-tankers have to continue on their course for several tens of kilometres before coming to a halt or changing direction, a major project can very easily stray for a long time in the wrong direction through lack of information or warning signals indicating a wrong turning.

It is project control which should know everything, check every detail and communicate everything to the project management team. A military style (pyramid) organisation is preferable to an administrative type of organisation (matrix). All the players in the project team must know for whom they are working, what they are expected to do and have a real sense of responsibility.

It is advisable to avoid interfaces. When these are necessary, they should be given close attention as they can be a source of problems. Coordinators and functional and administrative departments bring prosperity to their own activity, but they bring none to the project. A project should be organised like a battleground where absolutely everything is directed towards achieving a sole, precise objective and where total vigilance is constantly required. Here it is advisable to refer to a reasonably good project manager whom many of you may have heard:

“The art of war is to deploy one’s troops in such a way that they are everywhere at the same time, all the time.”

- NAPOLEON

The same is true of an FPSO project. One has to be everywhere at the same time. And the battle to be fought is all the harder for the enemy is ill-defined. The enemy is not, as one might think, the client. Quite the opposite, it is better to consider the client as the main ally. The enemy is disorder, inefficiency, internal friction or, to use a term from thermodynamics, “entropy”.

This evil can take diverse forms: interminable impromptu un-minuted meetings, individuals working in splendid isolation on a minor problem the purpose of which escapes everyone else, procedures for managing procedures, oversight committees which have lost sight of what they were meant to oversee, specialists brought in to support the team who introduce new areas of technology at the expense of the project. The list is endless!

An appropriate analogy comes from Dr Bichat, a famous Parisian medical man, who said:

“Life is a collection of vital functions resisting death”
which, translated to our profession might be re-phrased:

“Project management is the collection of functions resisting chaos.”

Head on the engineering

Once the organisation is established, the first task is to attack the engineering. At the time the Girassol project began, the two parent companies of MPG did not have sufficient design engineering capacity to able to handle a problem of the magnitude of the FPSO. It was necessary to bring in subcontractors, some friendly companies and some competitors, which is not a minor cause for concern in an association of this nature.

To assemble a workforce of 600 from different disciplines and with different motivations and get them to work together under the same banner is nothing short of a nightmare for a project director. They to be given new habits, methods and a common language during an intense eight month period and then they have to be demobilised.

The beginning is the most difficult. It is when the project team, relatively inexperienced with its own problems with internal communication, is confronted with the design phase when important decisions have to be taken. It is often at the beginning and at the end of a project when the most time is lost and it is precisely at these moments when the project teams need to be at its most efficient.

Since the beginning of this project, Bouygues - through the takeover of Sofresid and Doris - and Stolt - by the acquisition of Paragon and Litwin - have demonstrated that they have learned the lesson of Girassol by providing themselves with the necessary engineering resources to take on projects of all kinds.

There is a general rule related to engineering, which applies to all projects:

“Every major project has three problems: engineering, engineering and engineering.”

It is a fact that everything depends on the engineering, which is the beginning and the end, the alpha and omega of every major project.

Here in chronological order, not necessarily by order of importance, are some of the engineering elements of a project: the date and precision of the purchase orders, the weight of the construction, the price of the construction and the commencement of the works, the quantity of changes brought in before, during and after construction, the final delivery date, ease of maintenance, the quality of the operation and service life of the construction.

Baron Louis, Minister of Finance under the Restoration of the Monarchy said:

“Give me good politics and I will make good finance of them”.

To paraphrase this:

“Give me good Engineering, and I will deliver a good project”.

Engineering is usually the first victim of staff reductions, cost savings and accelerated short cuts and yet “short cuts” in engineering are at best pure fiction and, at worst, a grave mistake. Engineering is an iterative process which requires the results of one phase in order to progress to the next.

Doubling up on personnel is not of great use either as the thought process is both individual and collective at the same time and often involves suppliers or subcontractors. There is an inevitable period of gestation which one cannot hope to reduce in any spectacular fashion.

“It takes nine months for one woman to have a baby. But if you took nine women, you wouldn’t have a baby in one month.”

Essentially it is not true of the construction process that one can begin by attacking on all fronts and, with unlimited resources, hopefully gain time.

Having highlighted the importance of engineering and the length of this phase, one should not take a lax view. If there is one discipline to which strict control should be applied, it is engineering. For a project, the engineering is a means to an end and not an end in itself. In order to see an end, it is important to know, by a reliable means, the status of progress, which requires tracking, in meticulous detail, thousands of documents which are connected. The availability of specialised software for the follow-up of engineering and procurement documents - from the first strokes of the pencil up to the purchase order, delivery and integration into the structure - is fundamental to ensure speedy action and total traceability.

In addition to indispensable software, the human element of control is necessary since, for each document, the degree of completion has to be estimated. This estimate is highly subjective and is the source of numerous errors, giving rise to disillusion. This is very well expressed in one of Murphy’s famous laws:

“If the first 90% of the engineering takes 9 months, the remaining 10% will take the same amount of time.”

Taking into account everything that has been said and, in particular, the iterative aspect of engineering, it is essential to know when to stop. Engineers are perfectionists and one repetition too many can be fatal. If there is one thing more difficult than getting engineers started, it is to get them to stop.

Under the threat of being, as the English say, “engineered to death”, it is necessary at any given time, to declare, decree, often in the face of stiff opposition, that the engineering is completed, finished. As with the super tankers, the engineering will continue on its course under its own steam.
for a length of time after this energetic decision. The decision should not be put off.

For Girassol, there were 1,000,000 manhours of engineering and procurement assistance, spread over a period of 24 months. It might have been possible to have worked more quickly and used up fewer hours. And yet, the structure produced reflects the amount of effort invested.

One should not underestimate the importance of time spent on procurement, supervision, control of suppliers, factory testing, pre-commissioning and taking delivery of the various components of the project. It is a highly delicate phase and one factor which contributes to the success of a project.

**Slide 3: Overall Engineering**

**Hands-on procurement**

Compared with engineering, the impact of procurement on the overall duration of a project is overestimated, notably on the well-known “long lead items”. These items are often easy to define and should not significantly impact project cost which would enable them to be ordered fairly early on.

But in later phases, more time will be spent on valves, electric cables and the items called “the small goodies” than on large items. A review of Girassol scheduling would shows that the project took 36 months, evenly split into 18 months of engineering and 18 months of construction. The procurement, although spread over the whole project, was done practically in hidden time and when an item of equipment was missed, it was not one of the “long lead items”.

**Slide 4: Overall Procurement / Planning**

**The results of the engineering**

The FPSO was finally fully defined. During those 18 months of work, what choices were finally made?

**Slide 5: General Technical Data of Girassol Topsides**

On the deck, the main functions share the space almost equally with 15% each for power generation, gas compression, oil processing, water processing, manifolds, offloading and metering with the remaining space taken up by utilities.

**Slide 6: Overall plan, level 107 (5 drawings)**

After 12 months of work, the engineering advanced by approximately 60%. There was a general view that it would be possible to award a subcontract for construction at this stage with the product being sufficiently well defined both in form and degree of complexity. Moreover, the weight of the topsides, which is an important indicator of the progress of the structure, remained stable for several months. This indicator is essential in the management of a project, ie a structure which “puts on weight” is an unhealthy structure.

**Slide 7: The evolution of the weight of the topsides and the final estimated weight compared with the final measured weight**

**The Construction**

Problem: How and where to build the 25,000t of topsides? After having considered onshore construction with the whole topsides structure skidded onto the hull, it was finally decided to opt for the “piecemeal” approach, that is, install the topsides module by module. This part of the construction was awarded to the offshore division of HHI, as a result of its equipment and manpower in the yard than rather than its adaptability to the western management habits which could be the subject of another paper.

The selection of the “piecemeal” method does not imply that other methods are unacceptable or less efficient. This decision was the result of economic rather than technical considerations, ie the state of the construction market, availability of yards, marine heavylifting equipment, the locations of the offshore field, the site of the hull construction, et al.

The fundamental decision which had to be taken prior to or at the beginning of engineering, was what would be the amount of pre-fabrication required. In other words, should we build modules? If so, what size: 300t, 1,000t, 5,000t? or one or more skids of 15,000t, 20,000t or 25,000t?

All of these options were possible, based on the equipment available: onshore or floating cranes, lifting winches, skidding apparatus, etc. The choice of equipment available is what determines the basic structural orientations and outline, ie how the modules are split, the interfaces, et al. and in particular, the electrical system. As this discipline comes last in project chronology, it will certainly be on the critical path in the construction program.

One would assume that it would be necessary at this point in the project to proceed with the wiring - close on 1,000km - or to connect the junction boxes of pre-wired modules. This scenario mitigates in favour of “heavy” modules, which imposes certain constraints on design, but gives greater flexibility in planning and affords greater commercial freedom as it would fabrication at a number of construction sites.

Once this decision was taken, how did the construction method work on Girassol?

**Slide 8: The quantities to be included in construction**

Girassol involved a vast amount of work, but it was not basically different from smaller projects. It represented a problem of procurement and organisation rather than an original design.

But as with the engineering, control over progress is of paramount importance. A construction program as complex and widely dispersed as Girassol cannot be compared with a linear project, such as a pipeline or highway construction, where progress can be measured by advances along a straight line. Even the all-seeing construction superintendent could not gauge the progress in his yard without an accurate instrument
and would find it impossible to decide which discipline to accelerate or which resources to reinforce.

For this task, the project team set up the most complex and most refined control indicators ever used. Even an abridged list will give some idea of the work involved which required the production each week of several dozen “S”–curves.

**Slide 9: Indicators of construction progress**

All of these tasks required the mobilisation of as many as 2,000 people during a peak period with over 3,500,000 man-hours expended. The organization of the HHI offshore construction yard, similar to the shipyard structure as it was created by the same culture, had advantages and disadvantages, often being the reverse of each other.

On the plus side, there is a considerable assortment of resources. There could be as many as 5,000 people at work in the yard at one time, their mechanical equipment is exceptional and the organisation of the pre-fabrication without fault. Despite this fine organisation, there is no room for alterations and even less for initiative. Should this be criticized, though? Where would an army be if the soldiers displayed initiative?

As a result, the slightest variation in design took at least a month to implement. Even changes identified at the engineering stage, such as the clash between piping and structure, are the mortal enemies of great projects and of Korean yards in particular. One can never be too attentive in controlling them nor deploy enough effort in avoiding them. Once again, rigorous, well orchestrated engineering is one of the keys to success.

**Conclusion**

At the end of March 2001, the FPSO sailed away from the HHI’s Ulsan yard, virtually finished and commissioned. A hundred days later, on 10 July, the vessel arrived in Angola, three years almost to the day after the contract was signed. Since that date, the FPSO has been moored on site, connected to the the riser towers by flexible pipes and umbilicals installed by the combined vessels of Bouygues Offshore and Stolt Offshore. First oil was achieved on December 4.

The FPSO project was completed on time and within the defined target budget. It might have been possible to have done a little better and a little more quickly. With the experience gained from Girassol, this would be the intention on future such projects.

It is not possible to say whether TotalFinaElf and its partners are satisfied with the contractors, but it is possible, if somewhat unusual, to say what the contractors think of their client. A project of this magnitude and a contract of this nature cannot be completed as a solo effort or by generating antagonisms. The project team could only work together and succeed together. That is exactly what has been achieved with TotalFinaElf.

As for those who think that during the course of this exposé, all secrets have been revealed and that others could do as well or better with these few hints and dispense with the services of this consortium, a final quotation, from an author of not inconsiderable talent, should suffice to answer this:

*If it were as easy to do as to know what must be done, the chapels would all be cathedrals and the cottages palaces.*

- **SHAKESPEARE**

**ACKNOWLEDGEMENT**

The Girassol project is a development operated by TotalFinaElf E&P Angola under a production sharing agreement awarded by Sonangol to a contractor group including TotalFinaElf, ExxonMobil, BP, Statoil and Norsk Hydro. The consortium Mar Profundo Girassol and Saibos who the authors work for would like to thank TotalFinaElf E&P Angola, Sonangol and all of the partners for their support in the preparation of this paper and their permission to publish.
2.5.2 Main capacity requirements

The requirements for the main systems capacities are derived from the base case reservoir simulation GIR 282. In the following table, provision for extra capacity has been included above the reservoir simulation data to cover their uncertainties and to provide some flexibility.

<table>
<thead>
<tr>
<th>Design capacity data</th>
<th>Value</th>
<th>Unit</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average liquid production per well (1)</td>
<td>15 000</td>
<td>bpd</td>
<td>range: 5000 - 40 000</td>
</tr>
<tr>
<td>Maximum oil production flowrate (field) *</td>
<td>200</td>
<td>10^3 bpd</td>
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</tr>
<tr>
<td>Maximum liquid flowrate (field)</td>
<td>300</td>
<td>10^3 bpd</td>
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<tr>
<td>BSW (1)</td>
<td>up to 80</td>
<td>%</td>
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<tr>
<td>Production water treatment capacity</td>
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<td></td>
<td>Operating range: about 8 MSM3/d from 200 to 285 b, to be finalised according to available equipment</td>
</tr>
<tr>
<td>2000 to 2007</td>
<td>130</td>
<td>10^3 bpd</td>
<td></td>
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<tr>
<td>2007 to end field life</td>
<td>180</td>
<td>10^3 bpd</td>
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<tr>
<td>Total gas injection capacity</td>
<td>8</td>
<td>10^6 Sm3/d</td>
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<tr>
<td>Max gas injection rate per well</td>
<td>3</td>
<td>10^6 Sm3/d</td>
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<tr>
<td>Max Gas injection pressure</td>
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<td>285 bars at wellhead level 285 bars top riser</td>
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<td>Water injection capacity</td>
<td></td>
<td></td>
<td>includes a 95% availability factor</td>
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<td>9/2000 to 1/2004</td>
<td>270</td>
<td>10^3 bwpd</td>
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<td>1/2004 to 2008</td>
<td>390</td>
<td>10^3 bwpd</td>
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<tr>
<td>Average water injection per well (1)</td>
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<td>bwpd</td>
<td>Range: 10 000 - 40 000</td>
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<td>Max water injection pressure</td>
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<td>bar</td>
<td>maximum operating pressure for pump design.</td>
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<tr>
<td>Oil storage</td>
<td>2</td>
<td>10^6 bbl</td>
<td>note (2)</td>
</tr>
<tr>
<td>Oil commercial specification</td>
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<td>BSW 0.5 %</td>
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<tr>
<td></td>
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<td></td>
<td>Salt content 60 mg/l</td>
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<td>RVP 10 psi (ASTM D 323-73)</td>
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<tr>
<td>Offloading capacity</td>
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<td>tandem offloading</td>
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<tr>
<td>Loading points are not used simultaneously</td>
<td>8000</td>
<td>m3/h</td>
<td>loading buoy</td>
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<tr>
<td></td>
<td>6000</td>
<td>m3/h</td>
<td>VLCC tankers of opportunity, by parcels of 1 million bbl</td>
</tr>
</tbody>
</table>

Note (1): some values in this table are advised for information. The actual system sizing criteria are more complex (e.g. rates must be defined with definition of fluid composition, inlet and outlet pressure, temperature etc...) and are defined in technical specifications, with the detail of a verification case.

Note (2): the overall net oil storage capacity is 2 M bbl at reference conditions, and represents 98 % of the total oil cargo tank gross volume.
STOCKAGE DE L’HUILE
(CAPACITE 2 MILLIONS DE BARILS)
<table>
<thead>
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<th>1998</th>
<th>1999</th>
<th>2000</th>
<th>2001</th>
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<td></td>
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</tr>
<tr>
<td>MPG- Procurement</td>
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<td></td>
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<tr>
<td>AMG - Interfaces</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>HHI - HULL subcontract</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>McDERMOTT - MSF Fabrication subcontract</td>
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<tr>
<td>HHI - Topsides construction - Engineering</td>
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<tr>
<td>HHI - Topsides construction - Procurement</td>
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<tr>
<td>HHI - Topsides construction - Construction</td>
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<tr>
<td>HHI - Topsides construction - Precommissioning</td>
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<td>EEA - FPSO at shore Commissioning</td>
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<tr>
<td>SBM - Buoy/Mooring subcontract - Engineering</td>
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</tr>
<tr>
<td>SBM - Buoy/Mooring subcontract - Procurement</td>
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<tr>
<td>SBM - Buoy/Mooring subcontract - Buoy</td>
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<tr>
<td>SBM - Buoy/Mooring subcontract - Anchors fab.</td>
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<td>MPG - FPSO tow to site</td>
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<td>MPG - Moorings installation</td>
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<tr>
<td>MPG - Buoy installation</td>
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<tr>
<td>MPG - FPSO Hook-Up / Mechanical Completion</td>
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<tr>
<td>EEA - Offshore commissioning</td>
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General Technical Data of Girassol Topsides

- One separation unit including three separators, one test separator, two desalters, two hydrocyclons, a degassing drum and a coalescer.

- One deshydratation unit with glycol regeneration skid.

- Three turbogenerators of 26 MW each one equipped with one WHRU.

- Two gas compressors of 25 MW each one with pressure of 285 bar in 3 stages.

- Three crude offloading pumps of 2000 m³/hr under 14 bar.

- One water treatment unit producing 390 000 BWPD of desulphated water and including:
  - 16 multimedia filters
  - 2 vacuum towers
  - 5 feed booster pumps
  - 9 cartridge filters
  - 8 SRU banks equipped each one with 360 membranes

- Three desulphated water injection pumps with a flowrate equal to 860 m³/hr with a discharge pressure of 150 bar.

- One methanol injection unit for the wells preservation.

- One fuel gas unit.

- One compressed air unit.

- One chemical injection unit.

- One inert gas unit.

- One nitrogen production unit.

- Two diesel generators each one able to produce 2,2 MW with a third one in the Hull.
Slide 6:
MAINTIEN DE LA PRESSION DU GISEMENT PAR INJECTION D’EAU DE MER (CAPACITÉ 400,000 bbls PAR JOUR)
Slide 8:

**Quantity for the Construction**

<table>
<thead>
<tr>
<th>Component</th>
<th>Quantity/Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hull</strong></td>
<td></td>
</tr>
<tr>
<td>Hull</td>
<td>300 X 60 X 32m</td>
</tr>
<tr>
<td>Living Quarters</td>
<td></td>
</tr>
<tr>
<td><strong>Topsides</strong></td>
<td></td>
</tr>
<tr>
<td>MSF Structure</td>
<td>4500T</td>
</tr>
<tr>
<td>Topsides Structure</td>
<td>4500T</td>
</tr>
<tr>
<td>Topsides Piping</td>
<td>6000T</td>
</tr>
<tr>
<td>Equipment</td>
<td>7500T</td>
</tr>
<tr>
<td>Electricity / Instrumentation</td>
<td>1500T</td>
</tr>
<tr>
<td>Carbon Steel Spools</td>
<td>2500</td>
</tr>
<tr>
<td>GRP Spools</td>
<td>6500</td>
</tr>
<tr>
<td>Electrical Cables</td>
<td>980km</td>
</tr>
<tr>
<td>Cables Trays</td>
<td>47km</td>
</tr>
<tr>
<td>Piping Supports</td>
<td>7000</td>
</tr>
<tr>
<td>Instrumentation Supports</td>
<td>40 000</td>
</tr>
</tbody>
</table>
Slide 9:

**Indicators of Construction Progress**

Shop drawings (structure, piping E&I) à 20%, 50%, 90%

*Valves procurement (5969 vannes)*

Cables procurement (980 000 m)

Structural fabrication (6800T) & sub-assembly

Piping pre-fabrication (11596 largebore) & installations

Equipment installation (7500T)

Cables trays (47km) procured, installed

Cables cutting (22000 cables)

Cables ends (44000)

Pipe supports (7000)

Instrument supports (40000)

Valves installation

Lines tested, flushed …

Total: More than 20 indicators followed weekly