Management Best Practices Optimizing Gas Sales in Campos Basin – Brazil

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a. Introduction / Background

Campos Basin is located offshore Rio de Janeiro state, on the southeast region of Brazil, and is the main petroleum province in Brazil. Campos Basin has been producing since 1977 from shallow waters, and nowadays comprises 54 productions units, with almost 800 wells in operation. The first pre-salt well started to produce in 2011 from a deep water field, keeping the expansion tendency.

The organizational model with Two Operating Units, "UO-Rio" and "UO-BC", take care of these 57 fields, that achieve almost 1,6 millions barrels per day (representing 70% of the domestic production) and 23 million cubic meters of gas daily. This gas is exported to shore via 2,900 km of gas pipelines. With such amount of production coming from such different systems as old fixed platforms and new deep water FPSOs, the challenge was how to improve the gas process in such complex installations.

During the last ten years, natural gas has been achieving a greater role in the Brazilian Energy Matrix, growing from a 5% share in 2000 to a 10% share of the matrix in 2010. This growing importance of natural gas, together with the Companies' environmental concerns, led Petrobras to search further opportunities to change flare gas to sales gas.

A gas flaring reduction Corporate Program was created, with many initiatives, such as a partnership program with the main suppliers, monthly operating meetings to share experience and compare results, a training program preparing the company to the "Big Crew Change" in the next future, Capital Spare policy focusing in "Pool" of similar equipments, turbomachinery and compressors remote monitoring diagnostics, best practices Assets meetings, Improving installations investment program and other actions.

b. Aims

This paper describes the initiatives of this Program from 2009 to the middle of 2011. Coming from a benchmarking level achieved during these three decades of experience, the result is a representative increase of efficiency in the production process, achieving a new standard of operational practices. Many of these opportunities didn't need intensive capital, but demanded management efforts to continuously improve the process and the communication among the company sectors. This way, these initiatives managed to increase the gas supply to the market

at lower costs than the development of new gas projects, showing the best cost benefits results.

c. Methods

The first discoveries and the recognition of the high petroleum potential of Campos Basin occurred in 1974. This good news to a country with strong dependence on imported oil, after the 1973 oil crisis, had created a government effort for the Brazilian petroleum company to accelerate the production of this new offshore province.

Using a simplified Floating Production System, named Early Production System (EPS), Enchova Field started to produce in 1977. Several others EPS were installed, relocated and demobilized during the following years, and naturally many improvements were introduced. Some of these units move towards permanent systems, keeping these technological innovations.

In 1983 another step forward was taken, when seven fixed platforms were installed at a maximum of 170 meters water depth. These units were equipped with complete process production plants, gas compression and treatment systems. The gas started to be sent to shore through rigid pipelines and these new platforms became a hub for the existing and the new floating production systems. Other 5 satellite platforms linked to a central system with 2 twin platforms were installed in 1989, these fixed units, producing 120 wells by electrical submersible pumps, ended this shallow water phase.

Many giant deepwater production developments started the production in the nineties. At that point in time, there were no wells producing beyond 400 meters, so the company created a research program to support this development. Floating Production Systems with one hundred thousands barrels per day process capacity, or even more, producing fields under two thousands water depth, with complex equipments and technology to avoid problems like hydrate in the gas pipelines, just to mention one example, consolidated the future of this prolific basin. Fraga et al, 2003 and Ribeiro et al, 2011 describes such complexity development and the near future developments very well.

In the beginning of the basin production, the gas used to be flared in the Early Production Systems, and one of the main concerns of the organization has been how to maximize the use of the produced gas. After the fixed platforms were installed with the capacity to export gas through a gas pipeline network, all the old floating units were connected to this network and many processes improvements, like the installation of high pressure compressors to export produced gas, were installed to avoid flare gas.

There are in the literature some case studies about oil operators companies concerned about gas flaring, Cramer *et al*, 2011, Labeyrie, H. and Rocher, A., 2010 and Al-Otaibi *et al*., 2007 are examples. As some others companies, Petrobras has been doing a lot of work to reduce gas flaring during Campos Basin deployment and often is compares its results using an external benchmarking research. So it was possible to confirm that our production units had achieved a high level of energy efficiency in its operations.

But during 2009 the company decided to implement a corporate program to reduce even more gas flaring. Considering that during these three decades the old production systems adjusted the facilities capacity to process all the gas produced, and that the news projects have these considerations the from the beginning, the organization knew that it had a hard task to cope with.

The goal was to reduce as much as reasonably practical the gas flaring, as Ritter *et al*, 2010, explained that Flare is important in offshore production operations, because it consists of a rapid combustion of hydrocarbon gas streams, and is necessary to prevent uncontrolled release to the atmosphere and to relieve dangerous equipment overpressure conditions. Flaring is generally preferable, in terms of both safety and greenhouse gas (GHG) emissions considerations, to venting or releasing clouds of hydrocarbon gas to the atmosphere

The Campos Basin organization model has a matrix format, allowing the Assets Managers to focus on the fields/concessions results, and leaving to the functional leaders the responsibility of taking care of technical issues. The Assets turbomachinery managers plus the functional turbomachinery manager compose the "turbomachinery functional team"; this team is in charge of solving these issues and started to seek "out of the box" initiatives to achieve the expected results.

This paper listed above the main actions developed to reduce the gas flaring. Some initiatives were already on going as corporate programs, hence the work was just to give special attention and try to improve their results, and others were new, created specifically to help achieve this company objective.

c.1 Training Program

All the industry had heard about the "Big Crew Change", defined by Labastie, 2011, as "the retirement of a large number of experienced professionals and their replacement by a younger generation". So the decision to improve the knowledge of the work force was strategic, the challenge was to do in an effective way before starting to loose the majority of experienced technicians.

The first step was to guarantee that all the turbomachinery managers became part of the program, they agreed that each course would have a manager sponsorship, after that the resources had started to flow.

A selected team, composed by consultants and other experts improved the old training program, and the result was a new "course schedule" formatted by a) speciality (mechanical, electrical and instrumentation & automation), b) technicians and engineers c) experienced and new employees (younger professional with less than 5 years or experience). The vision was a long term program, where each employee might attend some courses per year, considering that he would finalize his training program during the next five or eight years. Tinchon *et al* – 2008 described a similar proposal.

After that, each manager defined two instructors for each course, one experience and other called "new instructor, with less than 5 years in the company. So, the

knowledge will be transferred to the younger employee and they will start to be a reference in this topic.

The human resource training sector supports the program, taking care of all the logistic. They created one kind of curriculum where it became easy for all the team to understand the courses that they already done and which ones they would still have to do, as some courses changed from the old training program for the new one. Then the managers negotiated with each employee and defined the courses to be done in the next years.

Analysing the demand a schedule was created for the next year courses, as many employees works offshore, each manager could adjust in advance the period that this employee would be onboard and confirming that he would be available onshore during the course period.

Each month the training sector presented at the "monthly turbomachinery functional team meeting" how the program was going and defined any improvements needed. With this initiative all the work force realized that the company wanted to improve the gas process and that they were one of the most important success key in this strategy, 200 persons was trained in 2011, some came even from others company areas.

c.2 Partnership program with the main suppliers

When we talk about compressors and turbines in big offshore platforms, there are just a few big companies in the market. So is strategic establish a partnership with these suppliers. May be not easy to have a "Win & Win" game between two big companies, the bureaucracy and the lack of long term relationship point of view can happen and it would be dangerous for the business.

Having this in mind, the Director of E&P create a program, called HOA – Head of Agreement, that consisted in an agenda treating the problems that could not be solved in the Asset' level and that represent great opportunities for both companies. Each company had a HOA coordinator, which promoted at least a monthly teleconference between the managers and technicians involved in the HOA "pending points", in which each item would have a written evaluation. Four meetings were held during the year with the both sides' Executive Managers, and the E&P Director and the CEO of the supplier would have once a year a high level organizational meeting to find solutions to all the pending points that had not been solved in the others meetings.

As everybody knows that both companies wants a long term relationship, all the teams works hard to solve the problems and implement the opportunities with a "Win X Win" point of view. Just few points goes up to the second level meeting to be solved, the idea is to save time and create a space for the E&P Director and the CEO to discuss about news big opportunities during this yearly meeting.

This program is a good example of success, the number of problems that need to go to the HOA decreased significantly. It means that the two teams, operator and suppliers, are finding a way to work together putting energy to solve the problems

instead of spending time discussing. With this the reliability of the compressors and turbines tends to increase.

c.3 Monthly operating meetings to share experience and compare results

Campos Basin is divided in two Operational Units, one takes care of the new projects and newest fields and the other of the mature fields. Both units have the same organizational model and its specific "monthly turbomachinery functional team meeting". Both teams detected that during these meetings many subjects needed to be discussed, and the time to talk about technical problems and solutions might not be enough.

So another meeting was created to discuss only about the equipments of the two bigger suppliers. The focus was not the organization, so the teams for both Operational Units would participate, depending only on which kind of equipment / supplier that they had.

These meetings had two parts, one called "process overview" with the manager's participation, where these fixed points were covered:
A) Turbomachinery and Compressor failures during the previous month per platform, with duration and the basic causes of the problems;
B) How many hours each machine had run and any specific problem, to get an idea about the next overhauls and interventions to fix or change a machine;
C) An overview about the schedule of the machines that were under overhaul or other kind of maintenance, focusing what could be done to anticipate the end of the service and increase the number of spare machines available;
D) Unifying the company position before a discussion with the partner.

Just the technicians participated in the second part, where they discussed specific problems, trying to help other Assets and share best practices and experiences. Many actions needed some months to be solved, so an action plan was created to the managers to understand what were going on in these initiatives and put resources to help when it was necessary.

Lessons have been learned and many opportunities have been created during this Forum.

c.4 Capital Spare policy focusing in "Pool" of similar equipments

When we talk about equipments used in the gas process, it is very usual need to wait almost a year to receive a motor spare, or even a compressor rotor.

Taking this in account, the turbomachinery area defines which spare parts are economical to have in stock in order to avoid a turbine or a compressor out of operations conditions.

With an Assets integrated overview, the costs involved might be shared and the solution enabled, this is good example how to have benefits in a bigger scale point of view.

c.5 Turbomachinery and compressors remote monitoring diagnostics

It's always very important to be updated with the new technologies, and remote monitoring for turbines and compressors is a good example. Parknison, A. 2011, gave some case studies in North Sea mature fields. This remote control can ensure safety and simplify maintenance and repair, so it can be concluded that the condition of monitoring may enhance the performance and machinery protection.

There are many tools available in the market, and the challenge is to define the best for each area, besides install and develop the competence to use all the potential of each tool. To guarantee the success of this initiative, one group called "Machinery Condition Team", with members from all the Assets, was created. They are in charge of define which tools will be used, share the best practices and experience and send a monthly report about the results to the high manager's level of the Operations Units.

Another initiative was the installation of a "Turbomachinery Monitoring Service" to keep the Assets informed about alarms or dangerous tendencies in any variable of the main machines. This "in house" service was created to do a "double check" at the system, as the turbomachineries sector did similar service to their Assets. The results proved that the cost of this service were not high, when compared the benefits obtained were compared to the fails avoided and the improvements shared between all Assets.

c.6 Best practices Assets meetings

Once a year, a one day meeting is promoted to present the best practices developed and to compare the Assets results. This big event highlights the main advances and recognizes the teams with the best results. The focus is always to share best practices and this workshop can mobilize a great number of employees. This is a good method to recognize the best results and create a competitive behaviour between the Assets teams.

c.7 Improving installations investment program

All the investments, like a panel retrofit, a new technology to be installed or even the necessity to fix a compressor with corrosion problems, need to be proposed in the budget plan. These opportunities linked to gas process are classified as a special category, called "Gas Process Enhancement" where the company gives special attention and fast-track procedures to have the budget approval.

c.8 Benchmarking Program

Learn how to do internal benchmarking is the first step in this process, the organization need to learn how to standardized and compare data on a consistent basis, to objectively identify and measure the performance gaps and use the best practices where the "opportunities" are detected. The last part is the most important and the hardest to execute.

External benchmarking, described by Kilchirst, J. and Alba, J.C. – 2011, as a confidential and independent third-party analysis of the detailed operating costs and efficiency of selected "like kind" producing properties among operators, may provides valuable information from all phases of fields life and support Operations Excellence programs to implement improvement opportunities such as well operations, maintenance practices, chemical consumption, staffing and logistics.

Some great opportunities to reduce the gas flaring come first, from the internal benchmarking, and the "second wave", from the external. This movement is very interesting, because with this methodology it is possible to discover simple ideas that the teams could not detect.

c.9 GIOP

A new operational philosophy, called "GIOP – Gerenciamento Integrado das Operações", "Integrated Operations Management" in a free translation, has been implemented in the company. The implementation of GIOp follows a project development approach, in which opportunities are devised and developed after a deeper and thorough business analysis. Some pilots have already been implemented, such as the integration of small teams of technicians, working functionally, to take care and improve the platforms operations on a daily basis. These groups have specialists from the areas listed below:
- Reservoir, with the focus on the ratio between oil and gas produced (GOR), evaluating the injection flow to avoid impact to the reservoir internal pressure;
- Operations, taking care of all the topsides processes;
- Flow Assurance and Multiphase Well Flow Behaviour, in charge of optimizing the wells flow to maximize the oil production and avoid problems such as water and gas fingers. This function takes care of the oil and gas pipelines too, measuring pressures and avoiding problems of hydrate and paraffin plugging.
- Turbomachinery, responsible for all the compressors and energy generator packages, always aiming at enhancing the availability of these machines.

Many gas flaring optimizations have already been done by these multi-disciplinary teams. This diversity of technical skills may help in detecting some processes improvements opportunities that may have great positive impacts in business results.

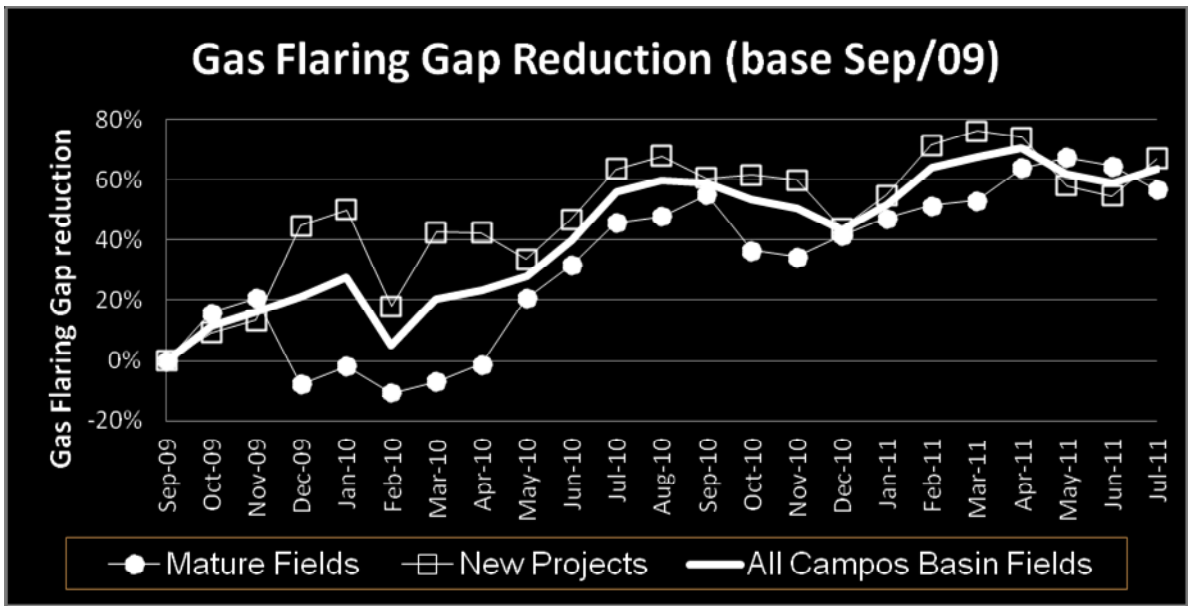
d. Results

The gas produced may have many utilities:
- Be exported and sold
- Re-injected in order to keep the reservoir pressure;
- Used as an artificial lift method called "gas lift", when injected in the well to improve the production;
- As fuel to the turbomachineries, and;
- A small quantity is flared to keep the security of the platform.

There are some key performances indicators (KPI) to measure the efficiency of the gas process, but to measure the result of all these initiatives will be used just:

Gas Flaring Gap Reduction = (Gas Flared in Sep/09 - Gas Flared in Month “n”)
Gas Flared in Sep/09

This KPI includes the gas flared for security reasons. Considering the gas flared in September 2009 as a basis for this analysis, the graphic “Gas Flared Gap Reduction” shows this gap evolution for almost two years period, achieving 60% gap reduction comparing the results between Sep/09 and July/2011. The Operational Unit that takes care of the mature fields produces less gas than the Operational unit with the new projects, but as the installations are older they had more difficulties to improve the results.



Although the development of each initiative listed in this paper was very important individually, but they were part of a big “puzzle”, when all the pieces had connected the result became much better than the sum of each initiative alone.

e. Summary/Conclusions

This paper summarizes how, after three decades of experience, Campos Basin Assets achieved a new benchmarking level reducing the percentage of gas flaring. Many of these opportunities didn’t need intensive investments and had the best cost benefits results; nevertheless they demanded efforts to continuously improve the process and the communication among the company and partners.

The gas flaring reduction in offshore operations created an immediate business value in a carbon constrained world, improving robustness in the sustainability and profitability of Campos Basin.

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