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GAS ALLOCATION PLANS BASED ON FAILURES SCENARIOS – PETROBRAS – GAS& POWER SECTOR

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Abstract

The purpose of this paper is to present gas allocation plans developed for Petrobras Gas & Power Sector, considering failure to supply scenarios that could occur along gas supply network. Those scenarios, as well as the associated contingency plans, were identified and validated by an experienced team, composed by engineers and operators from different PETROBRAS sectors. The key issue of concern was the anticipation of possible undesired scenarios that could imply on contract shortfalls, the evaluation of possible maneuvers, taking into account best gas delivery allocation. Different softwares were used for the simulation of best gas supply allocation and for the verification of delivery pressure and conditions for final consumers. The ability of being capable of dealing with undesired or crisis scenarios, based on suitable anticipation levels, is, nowadays, a highly valuable attribute to be presented by competitive corporations, for best crisis management and prompt recovery response. Those plans are being used by Gas & Power Gas operation Control Centre and as an input for reliability modeling of gas supply chain.

1. Introduction

Gas allocation plans were built with the purpose of providing ways of dealing with undesired scenarios that could occur due to equipment failures in general, to gas processing plants, compression station, pipelines and gas sources failures, resulting on contract shortfalls, revenue losses and penalties.

There is the need of anticipating those scenarios, so that, as propagated by crisis management literature and best practice, the corporation could be able to face those situations, based on suitable planning of investments, procedures and training.

That ability of being capable of dealing with undesired scenarios, in an efficient and prompt manner is, nowadays, a key issue of concern and a highly valuable attribute to be presented by competitive corporations. That feature that is influenced by adopted management systems, will express the level of '*resilience*' that the corporation organization presents.

At present, when looking at national and international context, considering severe fines imposed when shortfalls occur, possible damage impinged to safety or environment, company image, etc., makes those capabilities essential attributes to be addressed to socio technical organizational systems.

Corporations should be able to respond properly to crisis scenarios with promptness, efficiency and quick recovery.

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That anticipation approach consists on the basic support to be used when dealing with crisis scenarios, considering that men create mental strategies and paths, when submitted to decision making processes that involve, each day, higher levels of complexity and stress. Those mental paths are built, based on suitable levels of knowledge, experience and continuous training, and they will compose the source that will be used when degraded situations occur.

2. Assumptions

The following assumptions were made and used:

- Failure scenarios were analyzed for Petrobras Northeast gas supply network configuration, that was conceived for December 2009;
- Offer and demand profiles, issued by Petrobras for December 2009;
- Minimum level of water reservoir for hydroelectric energy sources, therefore, maximum demand forecast for thermo generation units;
- Shedding priority defined according to Petrobras rules (mentioned below on section 3.2)
- Shedding priorities among thermo generation units based on their efficiency;
- Gas commodity prices and costs from different gas sources collected and considered;
- Contract shortfalls and penalties considered;
- GNL costs for December 2009 were used;
- E&P gas costs considered.

3. Methodology

3.1. Gas Network Configuration

The first step to elaborate contingency plans was to obtain necessary information concerning Petrobras NE gas supply network 2009, so that the complete gas chain could be suitably depicted (it was based on whatever has been conceived for December 2009).

All information related to new enterprises, supposed to be operating on December 2009, the related documentation, flow diagrams, information and technical data were raised, compiled and analyzed, in order to have the whole gas supply chain properly drawn.

The whole gas supply chain representation requires the involvement of different sectors from Petrobras: - Gas & Power, Exploration and Production, Refineries, and Transportation an Operation (Transpetro) (including gas processing plants, compressor stations, city-gates and pipelines).

The NE gas supply chain was also modeled together with engineers from Brazilian University (Pontífice Universidade Católica - PUC), using a thermo fluid hydraulic software, named Pipeline Studio – TGNET (developed by Energy Solutions), so that steady state and transients state scenarios could be simulated and delivery conditions verified. TGNET modeling will be mentioned in a further step in this text.

After drawing the whole supply chain, considering detailed configuration, facilities, interfaces between different Petrobras asset owners, a draft configuration for the basic case (steady state one – no failures scenarios) is depicted.

Then, considering gas offer and demand profiles and delivery priority, a certain ‘optimized’ gas allocation for consumers was defined.

All possible maneuvers that could be carried out, after the occurrence of failure scenarios, were analyzed by an experienced team, composed by operators and engineers.

3.2. Allocation Software

The second step is concerned with the utilization of an optimization software, developed in house (named PLANAGE), which provides the best possible allocation for gas delivery, based on the maximization of revenues, considering financial aspects and logistic restrictions.

As input, the offer profile, the logistics configuration and restrictions, volumes to be delivered to thermo generation units (with priority levels previously defined), commodity prices, gas production costs, GNL costs, contracts and penalties due to contract shortfalls were taken into account.

The first run is related to the basic case configuration and the best allocation of demand for consumers. Different consumers have different types of agreement for gas delivery. Most of the contracts include a percentage of gas delivery quantity (volume) well established, that has been negotiated, according to the following three categories: interruptive, flexible, and inflexible.

In case of the occurrence of shortfalls, the first parcel of gas consumption to be shed will be the one associated with the interruptive percentage, as the contract agreement prescribes, implying on no penalties for Petrobras.

The second parcel of gas consumption to be shed will be the flexible one, which allows the replacement of gas by other available products (diesel oil, etc.); the third one does not allow any possible maneuver, and, therefore, penalties will be imposed.

Considering the exposition above, the building of a basic case scenario is carried out, representing the steady state best allocation gas delivery, but still should be validated by TGNET simulation (shown further).

For each failure scenario (gas sources, processing units, compressor stations failures, etc.), best allocation for gas delivery is made, considering all possible maneuvers, contract shortfalls, penalties, gas prices and the experience of the operational team.

The basic case configuration is shown on Figures 1 and 2, as shown below.

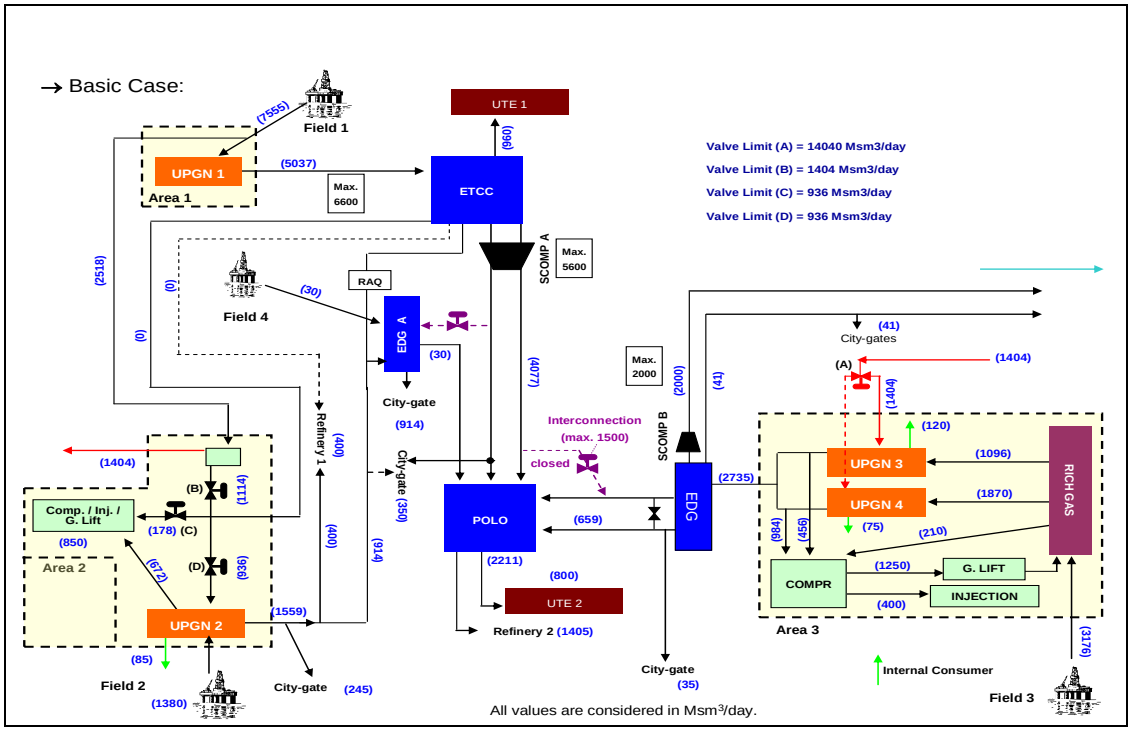

Figure 1 – NE Gas Supply Chain 2009 – Basic Case

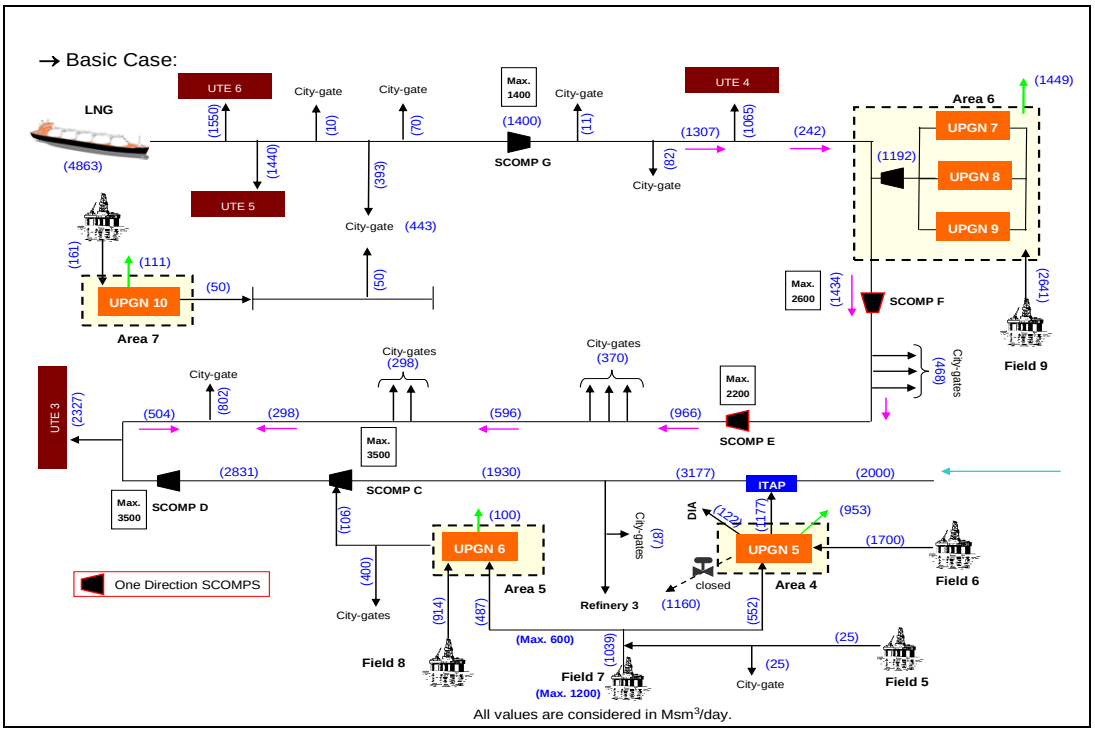

Figure 2 – NE Gas Supply Chain 2009 – Basic Case (cont.)

3.3. Thermo fluid hydraulic modeling (Pipeline Studio software)

The whole gas supply chain steady state configuration was modeled, using thermo fluid hydraulic software TGNET and basic case established, as mentioned above.

Next step consists on the simulation of failure scenarios: - main processing units, compression stations and pipelines, in order to validate the allocation carried out, checking if pressure conditions can be achieved, as defined on contract agreements.

Shedding priorities were considered, as well as logistics specifications and restrictions. The failures are simulated, considering line-packing, so that the time until shedding could be properly evaluated.

Failure scenarios and the best allocation, based on several assumptions, are illustrated on Figures 3 and 4 below.

Failure impacts are evaluated from TGNET simulations in terms of time and volumes to be shed, allowing losses (gas reduction or total shed to consumers) to be quantified and evaluated.

Those results are used as input, not only for an anticipated planning for the operational team, but also as input for reliability studies that are being developed by Petrobras for gas supply chain.

3.4. Gas Allocation Plans as Input for Reliability Studies

Allocation plans, elaborated for failure scenarios, provide among other issues, time and volumes to be shed. Those parameters compose input formally used for gas network reliability studies.

Those studies are being developed by Petrobras, in order to evaluate gas chain security of supply, pointing out its vulnerable points (´bottle-necks´) and proposing optimization measures to be adopted.

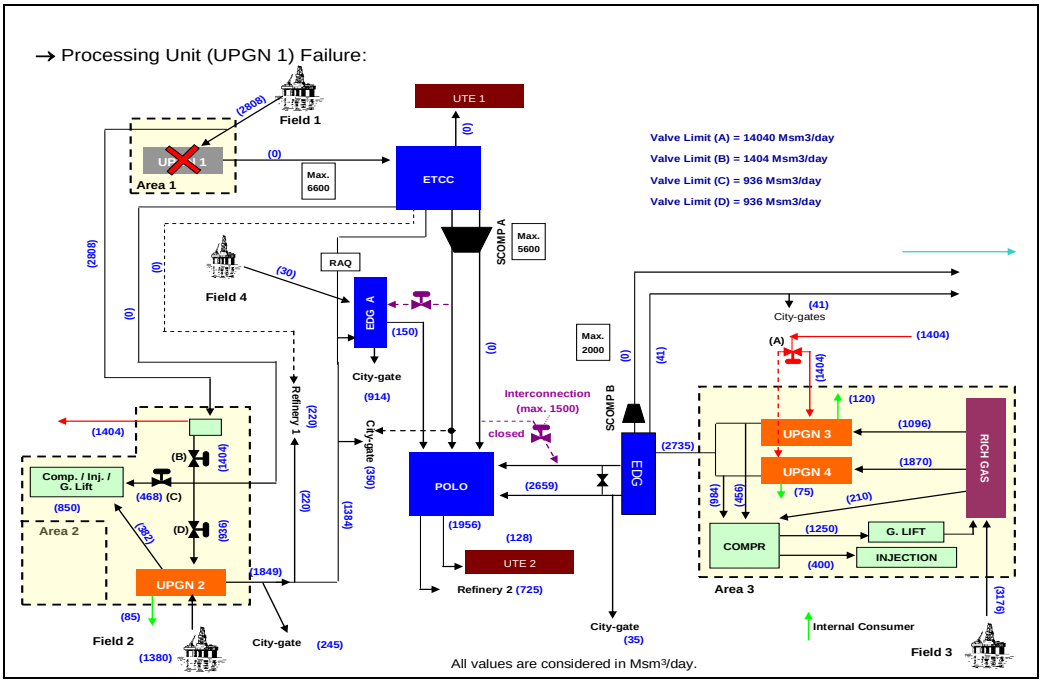

Figure 3. NE Gas Supply Chain 2009 – Processing Plant Unit Failure Scenario

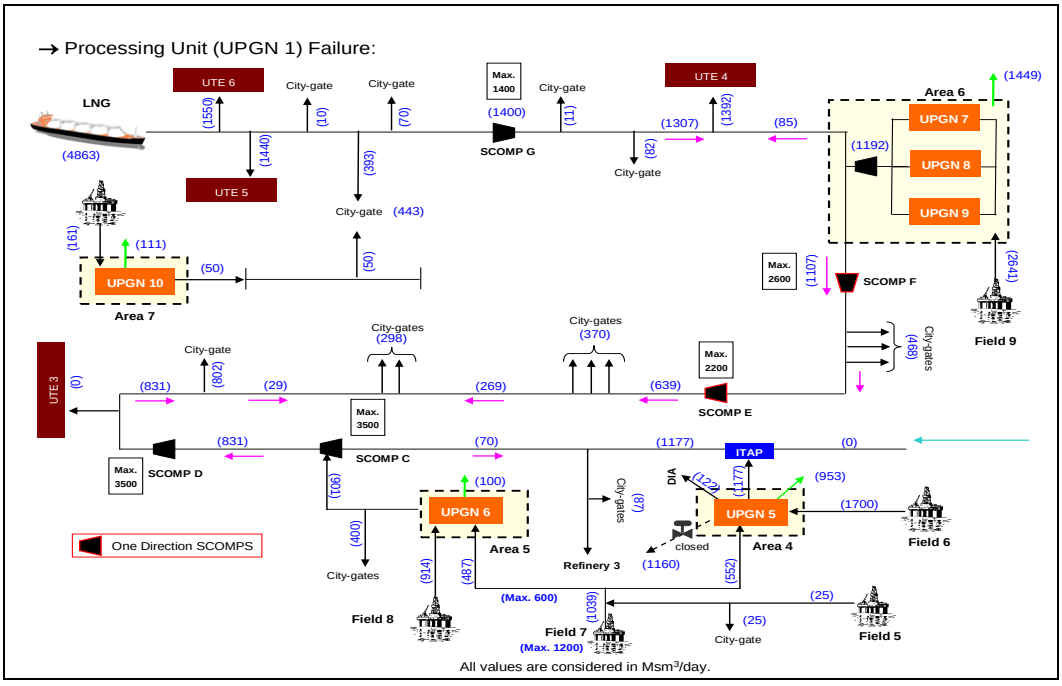

Figure 4. NE Gas Supply Chain 2009 – Processing Plant Unit Failure Scenario

Complex reliability models are used to model gas supply network, from gas sources to final consumers, tracking events or failures scenarios that could occur and result on undesired losses, contract shortfalls, and penalties.

For each identified failure mode, probability density functions are addressed, as well as time to repair distributions. Impacts, expressed in terms of gas volumes losses, were also evaluated.

That evaluation was made, considering, besides other variables, all possible operation maneuvers.

Loss estimations that have been previously foreseen, using TGNET simulations and contingency plans, compose essential information for reliability modeling.

Reliability study results provide a significant contribution for network optimization, highlighting main contributors to losses and the prioritization of investments, based on cost benefit analysis and expressed in terms of investment versus averted losses (averted income losses and penalties).

4. Results and Conclusions

The elaboration of gas allocation or contingency plans, based on failure or crisis scenarios, as shown in this paper, is a key issue for crisis management.

It is a highly valuable tool for the anticipation of failure or crisis scenarios, for training operators and decision making people on the ability to prompt respond.

It provides the possibility of exercising decisions and evaluating their possible impacts, helping to build and anticipate best solutions, procedures, as well as mental strategies.

It provides training for all company team, involved with the operation and management of systems that present, each day, higher complexity levels.

The concept of *'resilience': - the ability of recognizing and being capable of handling unexpected events, that impose the review of whatever has been conceived and established in terms of values and demand changes in terms of all management processes, strategies and policies that have been in use'(Woods, 2005; Hollnagel, 2004)* - has to be considered.

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