PETROBRAS	**TECHNICAL SPECIFICATION**	N° I-ET-3010.00-1200-901-P4X-001	
	CLIENT:		SHEET: 1 de 6
	JOB:		
	AREA:		
DENGE-SRGE	TITLE: **RELIABILITY AVAILABILITY AND MAINTENABILITY (RAM) ANALYSIS REQUIREMENTS – BOT/BOOT**		INTERNA
			ESUP

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FORM OWNED TO PETROBRAS N-381 REV. L

SUMMARY

1 SCOPE

SELLER or an independent supplier shall develop the Reliability, Availability, and Maintainability (RAM) analysis in accordance with the principles and criteria outlined in this Technical Specification. The study shall be presented during the development of the project, after the signature of the agreement. Minimum redundancies and plant equipment configuration defined in the agreement must be fulfilled.

The study should be used to determine the availability of the facility, identify key equipment that contributes to the downtime of the system, then use sensitivity analysis (scenarios simulations) to quantify the impact of alternative design configurations.

Using sensitivity analysis to quantify the impact of:

- Alternative configurations (e.g. equipment sparing).
- Alternative failure data (e.g. reliability improvement programs).
- Alternative maintenance schedules.

2 NORMATIVE REFERENCES

- ISO-14224:2016 - Petroleum, petrochemical and natural gas industries - Collection and exchange of reliability and maintenance data for equipment.
- ANP - National Agency of Petroleum, Natural Gas and Biofuels.

3 KPIs AND DEFINITIONS

3.1 Project Productive Efficiency – IEP:

$$IEP[\%] = \frac{Volume\ processed}{Expected\ production} * 100\%$$

3.2 Associated Gas Usage – IUGA:

$$IUGA[\%] = \frac{Produced\ gas\ - Flared\ gas}{Produced\ Gas} * 100\%$$

3.3 Project Injection Efficiency – IEI:

$$IEI[\%] = \frac{Injected\ volume}{Injection\ planed\ volume} * 100\%$$

4 TECHNICAL REQUIREMENTS

The RAM modeling of the plant shall be created using a state-of-the-art market proven and commercial simulation software. The model must be able to quantify the oil, water and gas production as well as the water and gas injections and gas flaring in the entire life of the plant.

The plant model must comprise the production and utilities systems, subsystems, equipment, and critical failure modes and rates, as well as reliability and maintenance data of the elements of the plant, in accordance with ISO-14224 Standard.

All failure and repair data shall be obtained from latest version of OREDA databank:

- Data shall be segmented by lowest main function: design and equipment class, level 6 from ISO-14224.

- For each production critical equipment item, the model shall include one or more failure modes depending on the utilized data source. The equipment will be characterized through the frequency and duration of equipment outages and the effects in the KPIs.

- Other sources shall be submitted for BUYER´s approval.

The expected products flowrates shall be conceived by the SELLER considering a linear interpolation in time between the flowrates of the streams and conditions from maximum oil to maximum water design cases scenarios as simulation input.

A list of the assumptions that will be considered for the RAM analysis must be presented within 60 days after the agreement´s signature. This list should contain, but not limited to, the following minimum information, for each equipment that will be considered in the analysis:

- Systems modeled and systems not modeled.

- Planned (scheduled) maintenances, within equipment life-cycle.

The analysis may consider the achievement of the minimum operational efficiency specified in the agreement through sensitivity analysis providing that the presented solutions (logistics and installed, on board or on shore spare parts) are approved by BUYER.

The RAM modeling of the plant shall be submitted before the HazOp event.

4.1 Model Requirements

The model must be capable of:

- Accounting for variations in oil, water, and gas flow rates.
- Evaluating the usage of spare parts, labor, and logistics.
- Assessing product storage.
- Analyzing production delays as a result of production losses.
- Estimating the values for the required study KPIs.

When the following streams are anticipated, the model must consider their flow rates throughout the plant's lifetime:

-Oil.
-Gas lift.
-High-pressure gas.
-Low-pressure gas.
-Injected gas.
-Exported gas.
-Flared gas.
-Fuel gas consumption.
-Produced water.
- Heavy Hydrocarbon Rich Stream (C3+)
-Injected water.

The model shall be able to calculate the productive efficiency throughout the plant´s lifetime.

The model shall consider:

- the full lifetime of the plant.
- The necessary frequency and duration of plant turnarounds as defined by agreement.
- The effects of the associated production of oil, water, and gas and consequent interdependencies.
- The impacts of the gas lift, injection gas and injection water unavailability.
- Both the physical and legal limitations for gas flaring and their impacts on oil and gas production.
- Preventive maintenance plans for critical rotating equipment (including all gas compressors, gas turbines, turbogenerators, main water injection pumps, booster water injection pumps, sea water lift pumps, cooling water pumps for classified areas, MEG injection pump, Heavy Hydrocarbon Rich Stream Pump and Refrigeration Unit Compressors) according to equipment suppliers.
- The critical failure of equipment (failures that cause the equipment to stop or that cause production losses).
- The repair and mobilization time necessary to restore the critical equipment failures.
- The effect of the electrical generation failures over the availability of the equipment and overall production efficiency.
- The different operation modes and flexibilities of the production plant.
- The ramp-up time for the systems

4.2 Deliverables

4.2.1 Report Requirements

The reliability report must contain, at minimum:

- The average lifetime KPIs with respective standard deviation.
- The definition of plant turnaround strategies.
- The definition of maintenance strategies.
- The policy for the return of main equipment after repair.

- The expected frequency of emergency shutdowns.
- The plant downtime.
- The annual unavailability as well as for the full lifetime of the plant.
- The lifetime availability curve.
- The main bad actors (equipment / systems) in each system.
- Calculated monthly production losses as well as lifetime average.
- Calculated monthly IEP as well as lifetime average.
- Calculated monthly IUGA as well as lifetime average.
- Calculated monthly IEI as well as lifetime average.
- Produced volumes.
- Flared gas volumes.
- Injected water volumes.
- Description of the critical equipment bad actor responsible for the losses.
- The schematic block diagrams or considered flow diagram.
- Failure repair person-hour consumption.
- Preventive maintenance person-hour consumption.
- Reliability Block Diagrams.

4.2.2 Electronic Files - Model

- Final version of the electronic files for the detailed model and data.