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Design for Operation and Maintenance of the Johan Sverdrup oil and gas field

Lecturer

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Key Concepts: Phases of Johan Sverdrup field, Challenges (Power Network System, Pipeline Net installation, Process Control and Monitoring, and HSE), Reliability, Quantitative Risk Assessments, FMECA Analysis, FTA, ETA, and LCC Analysis.

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PROBLEM DESCRIPTION

The Johan Sverdrup field was discovered in 2010, formed by three blocks (PL 501, PL 265 and PL 502) on the North Sea, with an estimated of reserves between 1.8 billion to 2.8 billion Barrels of Oil, so assessing the total risk for this huge field development is crucial, as well as the understanding of the development of each phase. The launched Project, is structured by the consortium Group (Statoil ASA, Lundin Norway ASA, Maersk Oil ASA, Petoro AS and DNV GL AS).

From Operation and Maintenance perspective, the Project carries critical operations and challenges in the long term (Interfaces, Power Network system, Pipeline Net Installation….etc) to be cover up through appropriate preventive maintenance management and control, during the estimated entered Life Cycle of the field(50 years).

ABSTRACT

The present report describes challenges and forward developments to face up, at the Johan Sverdrup field, on the current Phases (Concept and Design, Construction and Hook-up, Commissioning, Operations and Maintenance, and Recycling) between the partners/players involved on this joined adventure. Has been explained the main critical issues during and between the phases, as well as an identification and explanation of the main challenges, listed bellow:

- Power Network System (From shore Grid to Offshore Facilities)
- Compromises and Interfaces of the whole Project.
- Corrosion and Erosion.
- Process Control and Monitoring.
- HSE.

The framework of the report, has been to carry out an appropriate selection of technical components (as example, the HIPPS system), established analyzed through failure modes effects and criticality tools:

- FMECA
- FTA
- ETA

Which ones, has contributed for better assessment and identification of the risks (failure causes and consequences) that carries at a crucial component on the subsea installation (HIPPS= High Integrity Pressure Protection System).

In addiction, a discussion of the Life Cycle Cost (LCC) analysis, or also called "Cost Benefit Analysis" has been described. As well as stated, the key of a good LCC analysis roots on the right identification of all "Cost Items" (Cost Drivers) that the Project carries, and achieved a Profitable Concept Development. The aim is to monitor the actual costs against predicted LCC and to calculate the cumulative costs throughout a product's Life Cycle (LC).

Therefore, LCC practices will demand more "case studies" before we will know enough about the effective implementation and the utilizations of LCC between the partners (More Number Cases Studies = Less Uncertainties!).

Spare parts logistics, has been classified through on table 1("Critically vs. Lead Time") where we can find the importance of an effective availability. Regarding to the inventory management on items can be well observed on figure 10 (Pareto's Law of Investments distribution) which express total spares vs. cost. Although, computerization of Inventory control during LC and bar coding systems, shall make our space parts maintenance more profitable and likely given a better accuracy and performance level.

To reach up a better management of data and information during operations and maintenance management, will be the key to set up Computerized Maintenance Management Systems (CMMS) as ideal model showed on figure 11. Due to, the CMMS will increase the reliability of Life Cycle at long term.

Lastly, has been showed on the figure 12*("Methodology and Understanding of the report"*), how this work presented was conducted, where the essential parameters on the Project starts from Phases of the Field Development (Identification Factors & Cost Drivers) and ending up, overcoming the challenges through analysis of their failure modes effects and criticality.

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The Johan Sverdrup field is placed on the North Sea, the field consist of two discoveries (Avaldsnes and Aldous) and former with a production license of; PL501, PL265 and PL502.
The discovery was made on 2010, with an estimated to hold between 1.8 billion and 2.8 billion barrels of oil, so assessing the total risk for this huge field development is crucial, as well as the understanding of the development of each phases. The discoveries are located in 110m deeps and 140 km off the cost of Stavanger (to the West) in the Norwegian North Sea. The reservoir target point depth is at 1,900m, field reservoir is made of lower Cretaceous/Jurassic age high porosity and permeability sandstones.

Moreover, the quality of the oil presents is highly mobile with low viscosity. It has an API of 28º and has a low gas/ oil ratio.

The partners involve and their corresponding share distribution, are showed bellow;

PL 501: Lundin Norway(40%), Statoil (40%) and Maersk Oil (20%).
PL 265: Statoil(40%), Petoro (30%) and Det norske oljeselskap(20%), Lundin Norway(10%).
PL 502: Statoil(44.44%), Petoro (33.33%) and Det norske oljeselskap(22.22%).

The representation of each block, and their distribution boundaries can be observed in the next images;

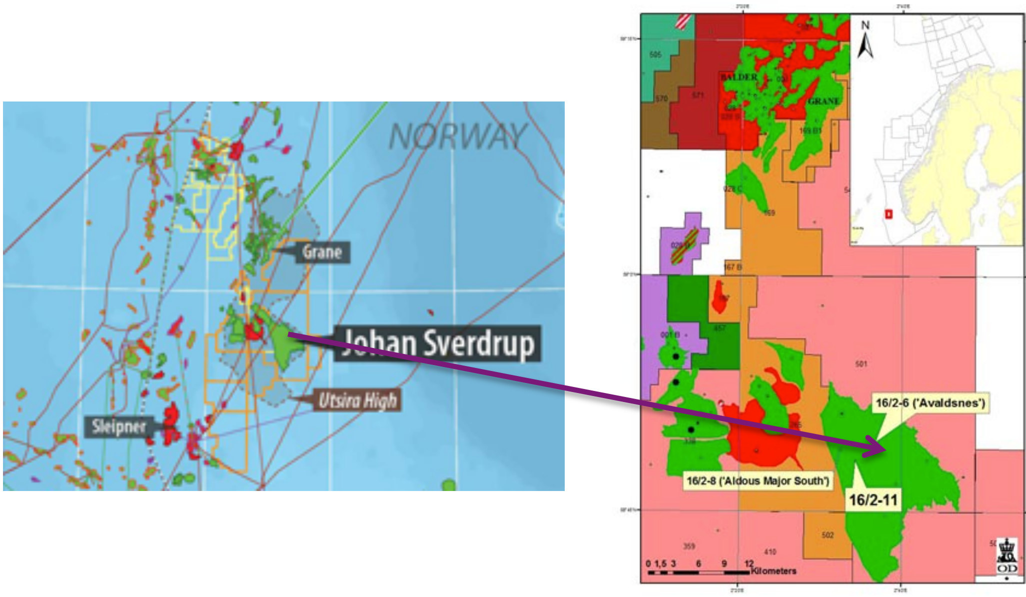


Figure 1. Johan Sverdrup field blocks divisions and location on North Sea.

Production start up is expected at the end of 2019 with a forecasted production until 2050, with a Plateau production seen at 550,000 – 650,000 boe/d.

The history and timeline of the field so far, are statement bellow;

- 2010 - Johan Sverdrup Oil Field discovered.
- 2012 - Successful Johan Sverdrup appraisal well drilled.(By Transocean)
- 2013 - Further appraisals
- 2013 - Front-end engineering design (FEED) work, as well as an engineering services, procurement and management assistance (EPma) option for the development's first phase. (By AkerSolutions)
- 2014 - Concept selection completed

As part of the Design basis for the field, was decided early in 2013 that the field will be developed in phases. The phases that the field compromises, which are;

- Phase 1: Concept and Design.
- Phase 2: Construction and Hook-up.
- Phase 3: Commissioning.
- Phase 4: Operations and Maintenance.
- Phase 5: Recycling.

The main critical issues, to be expected during the phases might be classified as bellow;

1. Establish a Field Centre: ***(Production rates, Compromises and Cost issues!)***

The Concept Selection will have a direct bearing on both production rates and CAPEX profiles. Ambition horizon of the recovery up to 70%, for the full field. Investment costs during the first phase, are estimated around 100-120 billion NOK by the consortium of operators partners involve: Lundin Petroleum, Statoil, Maersk, state oil firm Petoro and Maersk. As compromises during the same phase:

- Process platform.
- Drilling platform.
- Riser platform and Living quarter.
- Installations Jackets linked by bridges.

The cost of future phases of the project is still to be negotiated by the firms involved, although the project designs have met with approval by the partners.

2. Power from Shore: ***(Powered from Shore, to reduce the CO_2 emissions!)***

At phase 1 will be supplied with power from shore with a transformer on Kårstø outing source current to the Riser platform (around 80MW), onward phases must be updates power requirements.
See more details on the next figure;

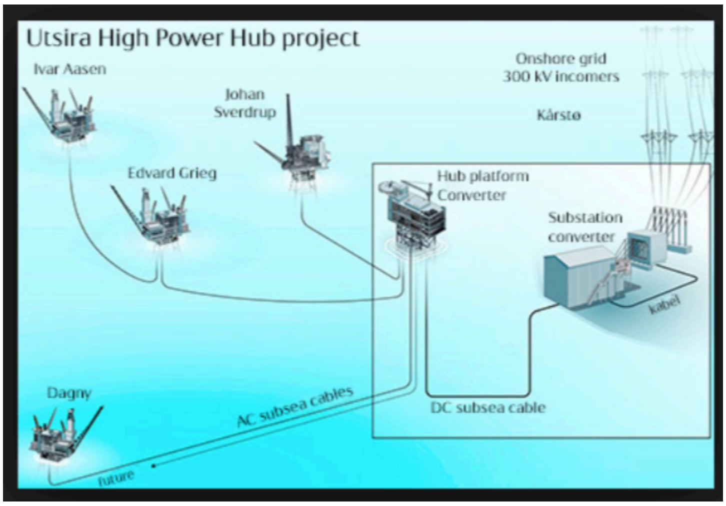


Figure 2. Utsira High Power Hub project.

These electrification from shore could imply CAPEX way above of the total CAPEX estimate of 11$/boe. Therefore, the goal to capture more than 90% of the total CO_2 emissions, the frame of network Power supply system is essential.

3. Export Solutions: ***(Pipeline installation)***

The export solution for oil and gas, is based on transport to shore through pipelines.
Export distribution at Johan Sverdrup;

- Oil pipelines to the Mongstad terminal.
- Gas pipeline through Statpipe via Kårstø for processing and transport onward.

As great uncertainty that this field presents, it's one of the largest discoveries made in the NCS. Also, the maintenance strategy, plan and management in the long term will be the key to reduce business risks.

2.IDENTIFY AND DISCUSS BRIEFLY THE MANY CHALLENGES THE COMPANY WILL FACE IN THE OPERATIONS AND MAINTENANCE MANAGEMENT OF THE ASSET.

The partners in the joining a venture will face up the next challenges;

2.1. Production Rates.

High ambition horizon established by the consortium, is to recover at least the 70%, for the full field. Being the resource estimate for the field is between 1.8 – 2.9 billion barrels of Oil Equivalent. As well as, the field will produce between 550.000 and 650.000 boe/day.

Plateau production now seen at 550.000 – 650.000 boe/day. This high ambition, at the first phase is larger 200-300kboepd, and should mean some production is accelerated in the development, originating an uplift to the initial estimations made it.

2.2. Compromises and Interfaces.

As well was stated on the previous section, the consortium of operators partners involve: Lundin Petroleum, Statoil, Maersk, state oil firm Petoro and Maersk.
Has compromises during the first phase; Process platform, Drilling platform, Riser platform and Living quarter and Installations Jackets linked by bridges.
Therefore, these compromises can create easily interfaces between services companies that are involved in the same Project. See next hierarchy services companies at Statoil ASA:

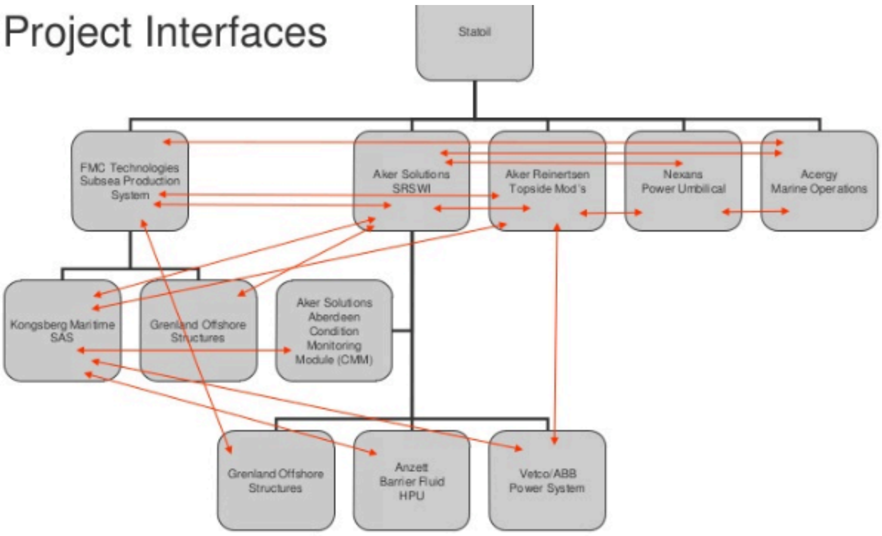


Figure 3. Project Interfaces example.

2.3. Cost and Investment issues.

Investment costs during the first phase, are estimated around $16.4 - $19.7 billion by the consortium of operators partners, below DNV guidance and under analysts' estimate for $22 billion from production initially seen at 315.000 to 380.000 boe/day. According to the main Operator (Statoil ASA) this initial development cost will be bellow forecasts.

Johan Sverdrup field is among the largest oilfields on the North Sea, which one is going to demand well management Cost investment distribution between the players during this join a venture, during each phase of the project.

Might be the main cost challenge, could be the cost of future phases due to is still to be negotiated by the firms involved, although the project designs have met with approval between the partners.

Or even, to meet on time the schedule needs for the Production and oil sales into the market. As well as satisfy the need's previously set up on the initial Technical Scope agreement document.

2.4. Power Network System from Shore to Offshore facilities.

The phase 1 was designed to supply with power from shore with a transformer on Kårstø delivering direct current to the riser platform (see figure 2 on section one), ensuring average an estimated of 80MW.

As well was explained on section one, forward alternative power solutions on the future phases will be key share between partners due to incremental of the initial CAPEX estimates will be expected. (CO_2 emissions vs. Power Requirements)

2.5. Pipeline Net installation.

The export solutions for Oil and Gas from Johan Sverdrup, is based on transport to shore through pipelines distribution. As was described on section one, the pipeline distribution is divided by;

- Oil pipelines to the Mongstad terminal.
- Gas pipeline through Statpipe via Kårstø processing plant.

The pipeline network distribution, can lead a great impact in the result of 40 years of development and activities on the Norwegian Shelf. Corrosion and Erosion will trigger to damage in the pipelines and in the entire equipment, which likely lead to higher repair and maintenance cost.
Therefore, advance well decision made steps by the partners is essential.

2.6. Process Control and Monitoring.

This sub-section is the most important part of the Life Cycle in the project and operate it in the most effective way.
Each process has to be motorized ensuring the risk of failures in the entire system is limited. Every part of the process system must be functioning, as it should, as well as the process safety system.
The aim of process control and monitoring may prevent the failure of escalating to other parts of the platforms, and then preventing a whole shutdown.

2.7. HSE and Process Safety.

The government has pushed oil firms to power platforms from the shore, where hydro generation energy is in abundance, to stop them burning fuel offshore.
Decision made by the partners, powering from shore the entire field in the first phase, witch will reduce the total CO_2 emissions from Utsire High area.
To capture range of 90% for the total CO_2 emissions, the frame of network Power supply system is essential.

Hence, a buckling of challenges between Parliament and Companies need's, still in a struggle debate due to looking for the approval of the Plan for development and operation (PDO).

3.AMONG THE CHALLENGES IDENTIFY IN THE TASK 2, RANK THE TOP 5 MOST CRITICAL OPERATIONS AND MAINTENANCE CHALLENGES.

The next challenges selected bellow, have been choose and classified according to the grade of risk severity and cost survey, which are:

1. **HSE and Process safety.**

As main requirement of a project, is the whole process must be safe, for the personal involve and the environment. To accomplish this two need's (People + Environment), there are regulations for process safety and monitoring that needs to meet and follow up.
Therefore, the installations to be installed must be satisfice well the standards and regulations goals on safe protocols, in order to achieve the best safety degree. For example, good drainage systems, ventilations and so on.

As matter of fact, at any stage of the project, Safe come first.

2. **Process control and monitoring.**

Have a control on the parameters of process, equipment, or other problems that can cause unexpected events(explosions, accidents, and losses). If unexpected downtime occurs, at any stage of the working process of the platform, the whole downtime for the platform will lead to decline production, may be no production at all, consequently, a huge economic losses impact.

3. **Corrosion and Erosion.**

As I mention on the sub-section (Pipeline Net installation), the corrosion and erosion shall lead a diversity of damages into the pipelines and equipment, as consequence a higher maintenance cost and repair management. Some of damages can be lead by sand, gas hydrates or high concentration of oxygen.
Also, a lead front line of the Design Basis and Requirements, must satisfy a long life of field production (2019 to 2050) of Johan Sverdrup field, where in shallow waters can lead a consider buckling effect along the pipeline. Roughness and friction issues on seabed properties, have to be considering before to carry out the installation of pipelines.

So, the Life Cycle Evaluation of pipe and risers under consideration will be the key of the field development.

4. **Power Network System from Shore to Offshore facilities.**

The power grid from shore to offshore during the phase 1, will power an average of consuming energy of 80MW.

In addition, the lay-out of network power lines, shall play a important role for the future phase, due to the consumption on energy from offshore facilities must be orientated to reduce CO_2 emissions and power requirements, which ones might be lead a variety of uncertainties (cut off energy supply, failure of topside transformers, lack of energy source by the Tower of Power, …etc).

5. **Compromises and Interfaces.**

On this section the compromises of challenges (Process platform, Drilling platform, … etc) that the consortium of operators partners can face up, could be to meet the Technical Scope expectations stated on the agreement document between them.

Beside that, the interfaces into the project can be multiple between services companies provide to the operators or even the Standardization's issues can lead the major problem, due to loses of the total budget.

4.DISCUSS VARIOUS ALTERNATIVE SOLUTIONS TO OVERCOME THE TOP 5 CHALLENGES.

1. **HSE and Process safety.**

To overcome the challenges on this sub-section involves (HSE + Process safety). First at all, having really good detection systems (gas detection, fire detection, ventilation system…etc), due to installing sensors on each element and motorized them to the "control room" and exchanging this data in real time to shore based facilities. This technique will ensure safely the entire offshore installation. In order to ensure, the employee's activities along the installations, a mapping of positioning and tracking data on each one is need it, to log on the activities management. As well as, is well established a record system on each action and decision made.

Beside that, to assure that all the PSV are functioning at all times, as other security valves to minimize the risk by unexpected hazards (overpressure, fire, explosions….etc).

Good insolation of each cable through the facilities attached along the platform is crucial. In addition to a good drainage valves are relevant such that dangerous fluids and chemicals are running away from the personal and the platform.

2. **Process control and monitoring.**

To solve this challenge a preventive maintenance plan can be made it, data in advance on the equipment and onshore support team, which help up if any problem arises to the platform facilities.
Environmental damages and economical consequences induced by health and safety risk to men and machinery must be removed. In order to achieve this, methods like FMEC, FTA, ETA and HAZOP analysis, are important to be implemented, to approach better the risk challenges.

By carrying out risk analysis techniques and make failure classification outline over the process and equipment, together with monitoring control system's over the entered cycle of the process the risk of unexpected scenarios and the unknown uncertainties are limited.

3. **Corrosion and Erosion.**

Currently exist a several techniques to overcome this problem, and decrease considerable the risk originated. Sand control device will be implemented at different locations and points along the pipeline. As well as swell packers will be installed. Gas hydrated formation can be reduced by increasing flow rate at temperature levels or even using like glycol. High formation of Oxygen may originate to corrosion, as solution is the produced water can go through degassing towers to vanish the Oxygen.

4. **Power Network System from Shore to Offshore facilities.**

Most of the challenges that power supply distribution in offshore platforms, come from cut off energy supply, failure of topside transformers, lack of energy source by the Tower of Power or even explosion of the Transformers.

The design basis for the energy supply during entire life cycle (LC) of the field lay-out will be lead by successful development link between the Tower of Power (offshore) and the Power of Grid onshore. That mean's, the dimensioning procedures of energy source input to the Tower of Power must be satisfy the need's of energy source output of the entire field during life (2019-2050).

Therefore, a protocol of measures for energy supply and power, management and distribution must be well made previously in order to cover the challenges described above. Back up of energy will be indispensable, in case of the worse scenario happens (shutdown), for instance installing a second Tower of Power (as back up!) beside the main one, can prevent future surprises in future.

5. Compromises and Interfaces.

As I stated on the previous section above the challenges that this section demands are various. But may be the main solution that could solve Cost, Time consuming and Energy by human resources can be through putting a side the individual interest of the benefits by Operators and Services Companies, and focus an anger of competition for a common goal of the project ("**Safe, Profitable and Reliable**") in proportional way of sharing between all the players involve.

Therefore, agreements, standards and regulations following during each phase, will be the fundamental to a successful field development and with appropriate long-term maintenance strategy.

5.SELECT SOME TECHNICAL SYSTEM COMPONENTS AND ANALYZE THEIR FAILURE MODES EFFECTS AND CRITICALITY, FAILURE CAUSES, AND FAILURE CONSEQUENCES. OUTLINE POSSIBLE ALTERNATIVES FOR ELIMINATING/REDUCING/MITIGATING THE RISK.

I have selected the High Integrity Pressure Protection System (HIPPS) to carry out Failure Mode and Effect Criticality Analysis (FMECA), Fault Tree Analysis (FTA), and Event Tree Analysis(ETA).

5.1. System Definition[1]

The HIPPS is a highly reliable system that is needed to maintain protection against overpressures, and manage shutdowns (Safety System).

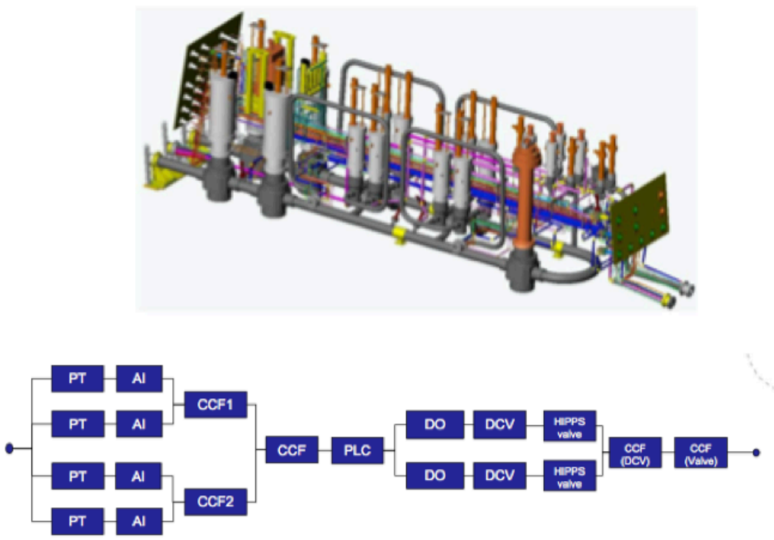


Figure 4. High Integrity Pressure Protection System (HIPPS).

[1] See example on the Annexes: *"A single well subsea production system for high pressure"*.

5.2. Main Functionality the System

Act as Safety System to ensure that the systems shut down in case of malfunctions and out-of bounds conditions. Isolate and depressurize, or simply fail to safe condition mode. Allow the flow line to be designed for a lower pressure than the wellhead pressure.
Such as, simply opening or closing a valve would potentially cause overpressure conditions or overload safety devices such as flares HIPPS monitors and executes these responses in a specific sequence mode.

- Operational Functionality and Procedures of HIPPS:

    - Reset and restart after an autonomous shutdown.
    - Execution of sensor, logic controller, and leak tests.
    - Chemical supply to ensure flow assurance for shutdown and start-up.

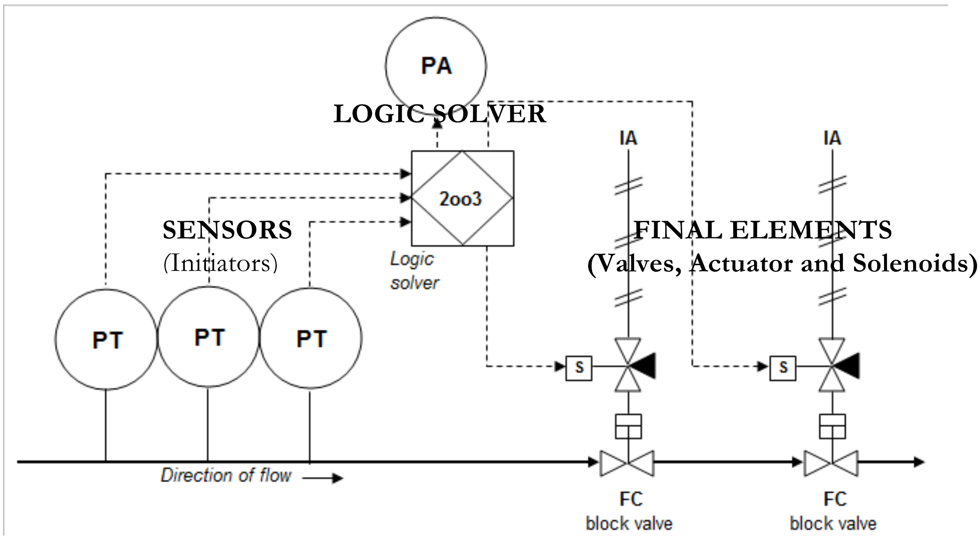


Figure 5. Diagram distribution of HIPPS.

5.3. System breakdown into subsystems:

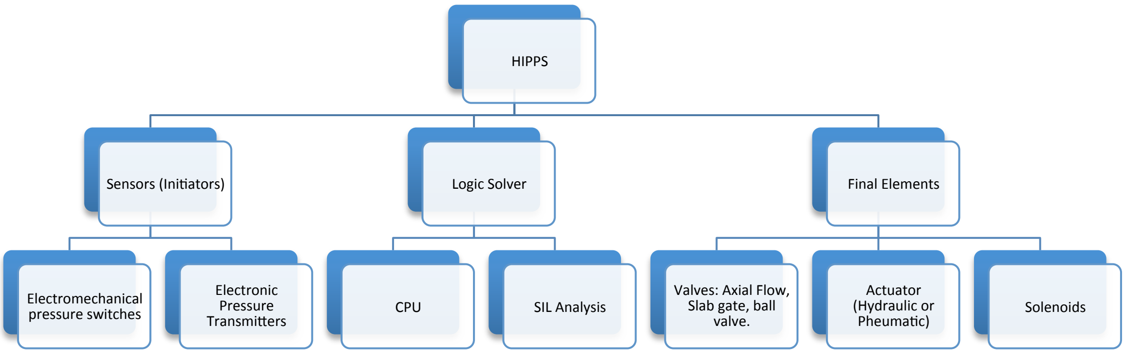


Figure 6. System breakdown hierarchy.

5.4. FMECA and FTA flow diagrams for HIPPS:

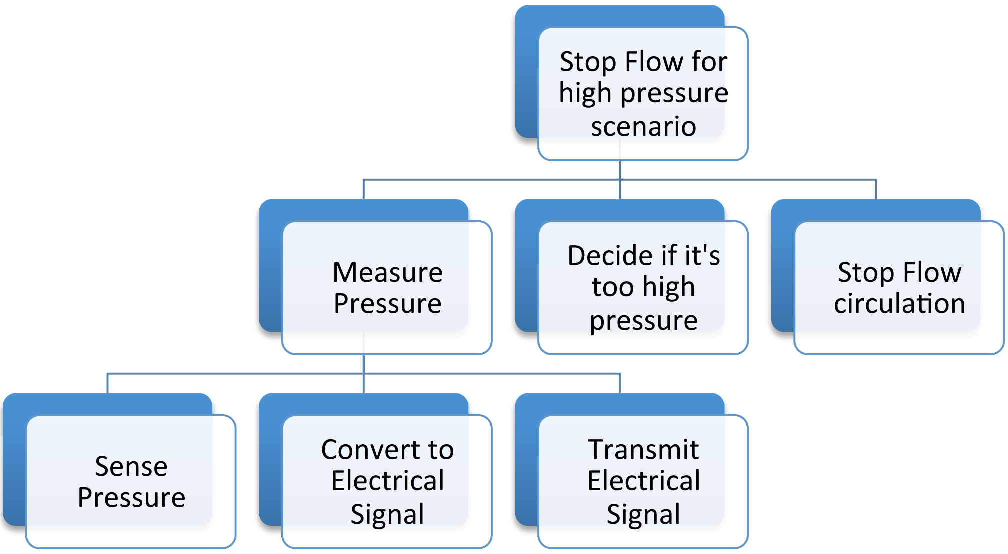
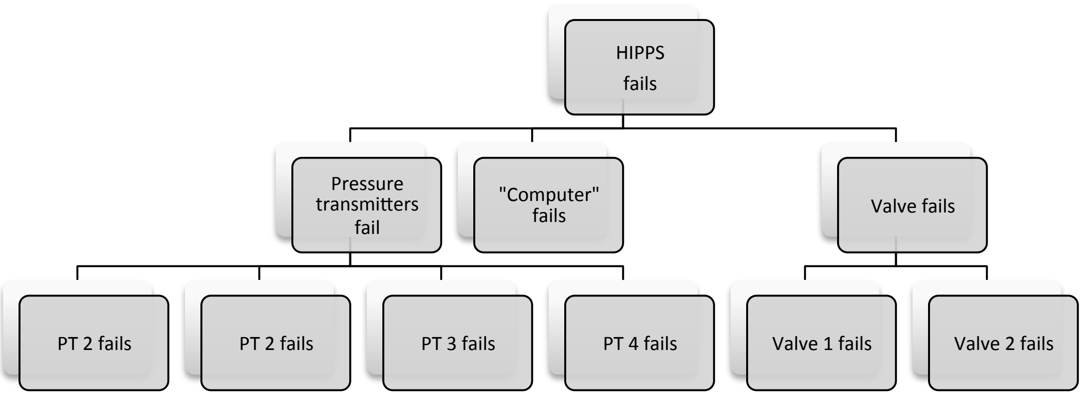


Figure 7. Failure Mode and Effect Criticality Analysis (FMECA)



Minimal <u>Cut</u> Sets	**Minimal <u>Path</u> Sets**
{PC}	{PT1, PC, V1}
{PT1,PT2, PT3, PT4, PT5}	{PT1, PC, V2}
{V1, V2}	{PT2, PC, V1}
	{PT2, PC, V2}
	{PT3, PC, V1}

Figure 8. Fault Tree Analysis (FTA)

5.5. FMECA Table for HIPPS:

See on the **Annexes** section attached.

5.6. Event Tree Analysis for HIPPS:

Let's assume that we have a situation with **Over-Pressure**, and the output is an **Explosion**. See bellow the Event Tree Analysis (ETA):

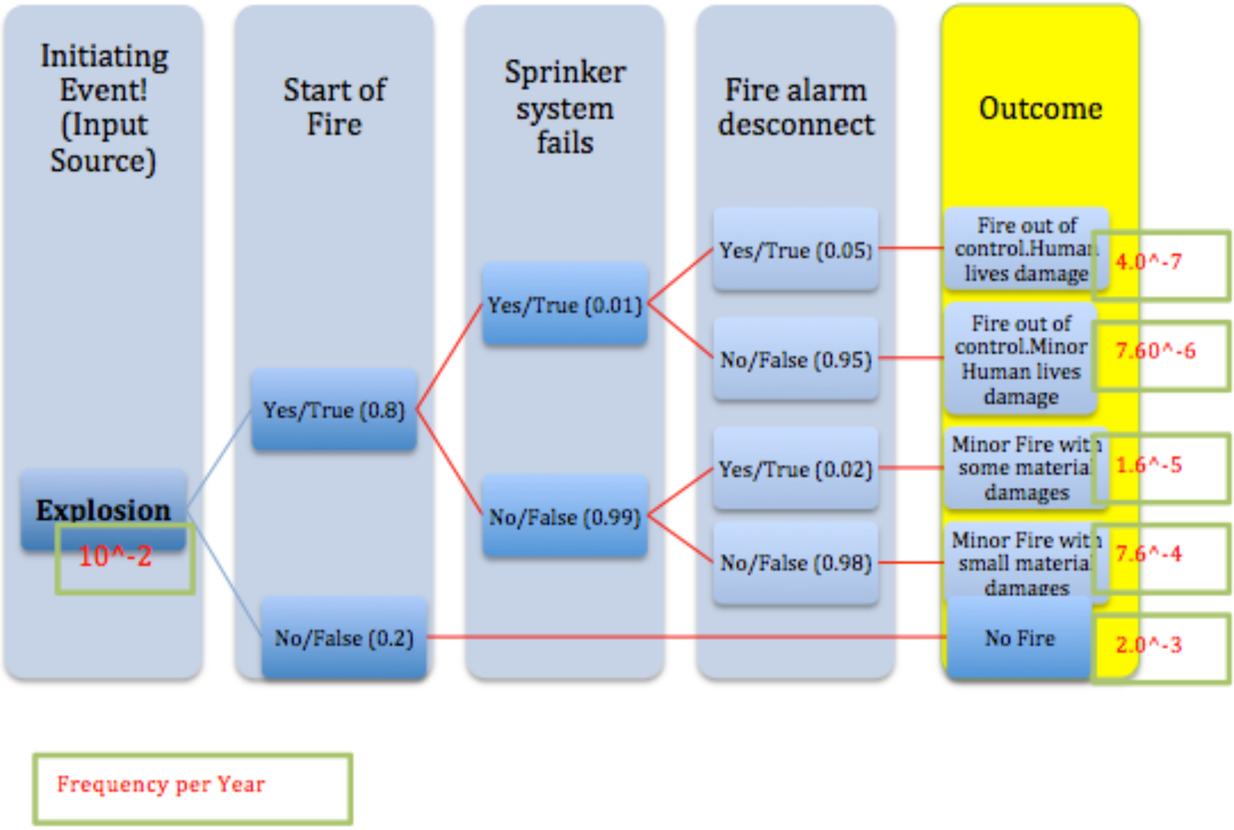


Figure 9. ETA

6.DISCUSS HOW TO USE A "LCC ANALYSIS" TO COMPARE SELECTION OF COMPONENTS/EQUIPMENT/MACHINES/SYSTEMS FROM DIFFERENT SUPPLIERS

LLC Analysis is an affordability analysis, considering long term financial planning and assets, where the cost profile over the Life Cycle itself is key information. LCC also called "Cost Benefit Analysis", is a tool for decision making when several alternatives are under consideration and select the best investment of the alternative chosen.

Used to quantify the Total cost of a product throughout its full life cycle, so knowing the life cycle costs of the product is one of the basic requirements when one is considering for instance, one wants to offer one's capacity for use by the other organizations in the supply chain.

The crucial thing in LCC is to comprehend the interaction of the "cost items" "(Cost Drivers) that cumulate among the relevant stakeholders during the different life cycle stages.

Besides that, it's important to identify all "cost items", that have a major impact on the total LCC of the oil facilities, to find the Cost-Effective improvements and to select the most desirable alternative in the Economic perspective (Profitable Concept Development!).

Furthermore to the estimation of future costs, an essential feature of LCC is cost monitoring during a product's life cycle (Taylor 1981; Woodward 1997). It's essential point to know the cost incurred for a particular product or service and to understand the behavior of different cost elements in the different phases of the LC.
The aim is to monitor the actual costs against predicted LCC and to calculate the cumulative costs throughout a product's life cycle.

As such, the cost monitoring is not consistent regarding different cost factors since costs related to maintenance and operation are often monitored accurately than other cost factors such as indirect costs.

Collecting data can indicate the link between Cost drivers and the way of using or maintaining products life. LCC data are utilized to select factors affecting product reliability and as a basic data for future supplies in the Oil&Gas Industry.
Beside that, Suppliers possibilities to use empirical data rely on the information they obtain from customers during a product's life cycle and often the provision of information is perceived to be insufficient. This lack of communication between suppliers and customers, likely will decrease in the future, due to the full implementation of monitoring of life cycle cost.

To illustrate the evolving focus in the LCC approach over the time, see the next figure;

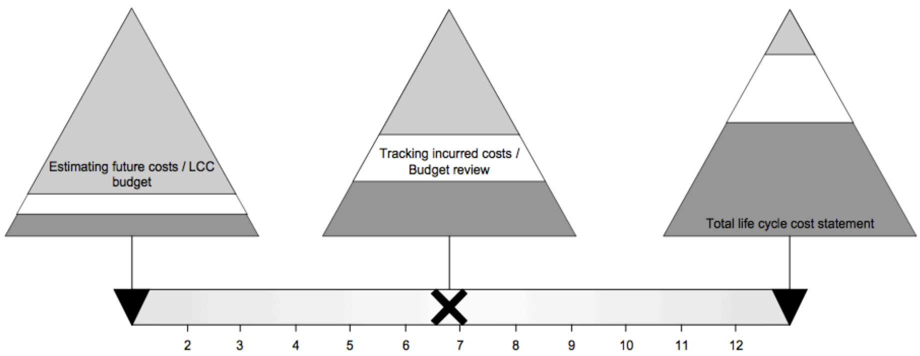


Figure 10. The changing focus in life cycle costing during a product's life cycle (Adopted from Suomala et al.2004)

The data information predicted in advance with LCC, are useful in decision making, purchasing a product, scheduling maintenance steps or even optimizing design. To make better decisions based by the partners (Operators!) available information, knowledge and intelligence is vital. The decision making is often solely based on a combination of Tacit Knowledge gained and achieved over the years and/or recommendations from the original equipment manufacturer (OEM)/supplier. They are also able to make critical decisions more robust, faster and more reliable.
The Life Cycle Cost technique implicates six steps, are:

1. Problem description.
2. Cost elements definition.
3. System modeling.
4. Collection & Analysis of Operational Data.
5. Cost development.

By another side, the identification of Cost Drivers it is essential to identify and survey in detail the Causes and Consequences on the total Life Cycle period (Causes vs. Consequences Analysis). LCC includes evaluation of alternative products, system design layouts, operational and maintenance solutions. As we observed on the previous figure above (figure 9) is analyzed the cumulative cost of a product through its entire life cycle.

The factors ('Cost Drivers') that need to be taken into account beforehand, when accomplishing a Risk and LCC analysis, is to identify the major cost drivers, which part of them are;

- Weather Conditions
- Materials and Liquids
- Procurement Cost
- Operating personnel
- Equipment
- Operational Facilities
- Energy/Utilities
- Spare parts/repair of these parts
- Maintenance Cost
- Maintenance personnel
- Maintenance Support

During the LCC Analysis, the identification of potential areas of Economic Risks may be help to reduce Cost, Lead time, and to avoid unnecessary or unexpected Hazards and Accidents.

Problems and Lack of expertise in the LCC Analysis

Identification of problematic issues are crucial, for further development of life cycle costing. As well as, most of problems seem to be connected with the application of LCC in practice.
The most often problem list, are bellow;

- The lack of uniform practices.
- Evaluation of the effects of the changes in a product's operational conditions, during this LC.
- The unavailability of suitable and reliable input data.
- Uncertainty factors existence.
- Long life cycles of products, made life cycle costing difficult.
- Total Cost Analysis (TCO) approach, lack of input data and not standard approach between companies.

In addition, a need of increasing cooperation in LCC between suppliers and customers, in order to improve the quality of communication from suppliers in the purchase phase. Due to, the quality of LCC information obtained one's own suppliers and the obtaining of LCC data from customers in the operating phase will demand development.

By another side, during the last decade the lack of expertise in LCC analysis becomes a boundary, the oil prices cycled between very low to high, in periods with low prices originates the companies to reduce their activities, and many of the "LCC Specialist" changed jobs. But, during periods of high prices the companies were in a hurry to invest in a "Competitive Market" and did not always have time to perform time-consuming LCC assessments. Therefore, much of the LCC assessment competence has disappeared.

Conclusion on the LCC Analysis

The need for LCC Management becomes evident when studying the longitudinal cost structure of investment product: The sum of LCC of products often significantly exceeds the initial purchase price set up.

Challenges in evaluations, for instance future cost and dealing with the uncertainties of different implication factors affecting directly to the LCC may been among the factors that have hindered the practical applications of LCC. Or even, the lack of adequate costing data was considered to be one of the main problematic issues in LCC. Improvement of these situations, demands for accurate product-specific data collection systems, analysis into the companies and active collaboration between supply chain organizations. Meaning to learn more connection between Product Cost, Operating conditions and Practices.

Beside that, a connection between costing practice and decision-making criteria: the users of LCC tend to emphasize the role of LCC as a decision criterion when assessing investment alternatives.

The homework of LCC practices, will be more "case studies" is needed before we will know enough about the effective implementation and the utilizations of LCC in companies (More NºCase Studies = Less Uncertainties!!). Through this work, hence, it could be possible to construct feasible costing systems that can produce cost information that corresponds to existing Long-Term Cost Management needs.

7.DISCUSS HOW YOU WILL MANAGE SPARE PARTS LOGISTICS AND INVENTARY. WHAT ARE THE ISSUES INVOLVED IN DECIDING WHICH PARTS TO BUY, HOW TO STORE THE PARTS, WHERE TO STORE THEM, ETC.?

Spare parts logistics and inventory management, are a key part of the modern engineering maintenance program, during the LC of the product.
In order to reach the maximum availability of spare parts and avoid stock-outs while reducing total investment in inventory.
The Total Investment includes costs of ordering, ownership and transportation.

Coming to managing spare parts and inventory offshore, the excess limitation onboard are additional because lack of storage space and high cost of possession.
By another side, must be keep it in mind the unexpected downtime issues due to a lack of Inventory would cause to enormous consequences and risks. Hence, the decision made must to come up with proper trade-off(decision and consequences).

Moreover, we should take into account using the latest technological achievements predictive maintenance and wireless technologies connectivity (Monitoring!). Hence, by monitoring equipment behave during the LC trends we find out a prediction of equipment is going to fail and where, and replace it in economically way during due to reducing the entered LCC.

Regarding to future critical components should be stored onboard into special rooms in the platforms utilities areas. Rest of the components might be accumulated in onshore base. To avoid mistakes for classification spares parts/components, following seller's catalogues will help out.

So as to set up Optimization and Priorities on spare part and inventory management, well established the next order bellow:

1. Spare parts classification factors according to importance of effect in availability of spare part:
    - Geographical location of system.
    - Criticality of part.
    - Spare parts Lead-Time
    - Etc.

Criticality / Lead time	Low	Moderate	High
Short	S_{SL}^{*}	S_{SM}^{*}	S_{SH}^{*}
Moderate	S_{ML}^{**}	S_{MM}^{**}	S_{MH}^{***}
Long	S_{LL}^{**}	S_{LM}^{***}	S_{LH}^{***}

Table 1. Criticality vs. Lead Time on spare parts

2. Classification of all the inventoried items, according to the Pareto's law:
   - Class A: 10 to 15% of the total spares parts yet their monetary value (cost) would be between 70 and 80% of the total investment in inventory.
   - Class B: 20 to 30% of the total spares demands with their cost about 25% of the total investment.
   - Class C: 60 to 70% of the total spares demands with their cost about 10% of the total investment.

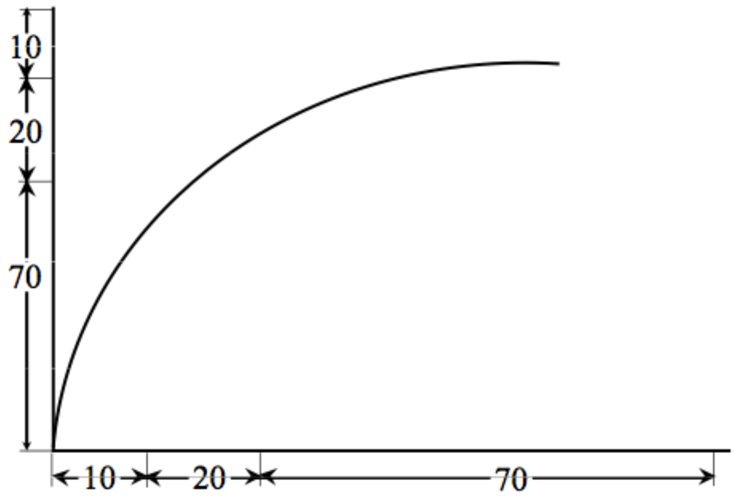


Figure 11. Pareto's Law of Investments distribution.

As well as, to protect inventory from steal value cost, ensure the required quantity and identify physical records should be carried out periodically with. Class A and critical spares are frequently due to their high values and importance.

Computerization Inventory control during LC and bar coding systems, will make our spare parts maintenance more profitable and likely given more accuracy and performance level.

8.DISCUSS THE USAGE AND MANAGEMENT OF DATA AND INFORMATION IN AN OPERATIONS AND MAINTENANCE MANAGEMENT PERSPECTIVE.WHAT KIND OF TECHNOLOGY WOULD YOU RECOMMEND IMPLEMENTED FOR THE INFORMATION MANAGEMENT? WHY?

The recent technology has had a positive impact on the Oil & Gas industries from an operation and maintenance perspective. The rapid change development of computers, software solutions and communications has resulted in a huge reduction of time consuming and costs, hence, more efficient industrial asset management.

Nowadays, exist a spread variety of software's solutions, which ones helps us to performer better planning, spare parts and inventory management, condition monitoring and so on. But being the key, to use appropriate tool solutions, in order to reach the best performance to be achieved.

One of the problems is the quality of the report data and information. Often maintenance work orders consume more time and resources than projected.
In this situation the actual time and resources used may be under reported to show higher performance. Moreover, some activity experiences are not reported and documented at all. Ending up may be a lost opportunity to optimize maintenance and to arrive at a more precise prediction of cost.

Oil platform could be see as complex dynamic system, where a variety of subsystems, techniques and process, are interacting between themselves (Equipment, Managers, Workers, Operations, Maintenance and Inspections). In order to trace out and understand the relationship between all them, must be through **Computerized Maintenance Management Systems (CMMS)** explained on next section number nine.

The software packages designed to support our operation and maintenance management during LC, so these applications provide the next main functions:

- Remote assistance.
- Order optimization
- Condition monitoring and preventive maintenance issues.

As benefits that we obtain, are:

- Increase of the overall performance almost on real time.
- Cut off cost for the Operation and Maintenance issues.

9.BASED ON THE DISCUSSION ABOVE, ESTABLISH THE MAIN O&M GOAL(S) AND DISCUSS HOW YOU WILL SET UP A STRUCTURED MAINTENANCE MANAGEMENT PROGRAM TO ACHIEVE YOUR GOALS AND FOR IMPROVING YOUR MAINTENANCE ACTIVITIES

The operation and maintenance goals, I established them as fellow;

1. Life Time Cycle (LTC)/Reliability Objectives:
   - Maximize Reliability and availability of the system.
   - Stop, reduce or management Downtime

2. Economical Achievement's:
   - Extension of Asset Optimization.
   - Decrease Cost of maintenance support and production
   - Keep uninterrupted production.

3. Health, Environmental and Safety (HSE):
   - Mitigation of Hazards related to operation and maintenance issues.
   - Decrease the CO_2 emissions.
   - Satisfy safety set up agreements with government regulations and international standards.

In order to carried out and achieve the previous goals stated above, an asset optimization (AO) and maintenance support is need it.

It records the maintenance history of an asset and identifies potential problems to avert unscheduled shutdowns, maximize up-time and operate closer to plant production prognoses.
This functionality supports maintenance workflow as the AO system communicates with a maintenance system, often denoted as a computerized maintenance management system (CMMS). See figure fellow;

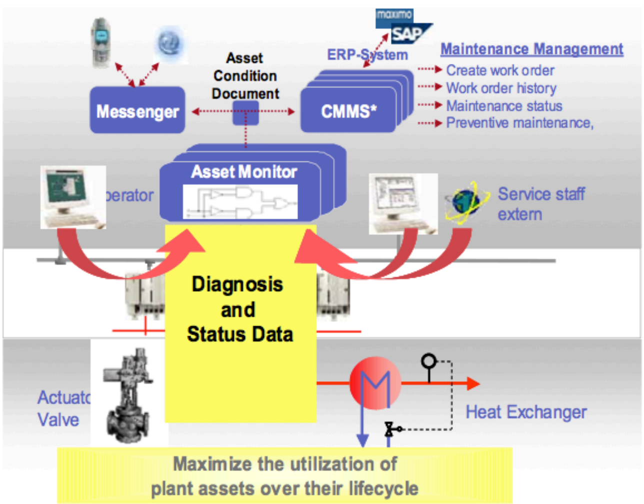


Figure 12. Computerized Maintenance Management System (CMMS)

As we saw on the previous representation on the distribution CMMS, the condition monitoring is formed;

- Structural Monitoring:
    - Corrosion meters devices.
    - Tension force meters.
    - Free swinging strings.
- Condition monitoring: (for large rotating apparatus)
    - Turbines.
    - Compressors.
    - Generators.
    - Large Pumps.

The maintenance support functionality will plan maintenance, based on input from condition monitoring systems, and a periodic maintenance plan. This will allow the system to schedule personnel for such tasks as lubrication or cleaning, and plan larger tasks such as turbine and compressor periodic maintenance. Due to, the CMMS will increase the reliability of Life Cycle at long term.

Therefore, the objectives have been to reduce the Risk (more Safe), increase availability and improve reliability of the entire system.

10.WRITE HALF A PAGE (MAX) ABOUT HOW THE GROUP WORK WAS CONDUCTED AND HOW THE GROUP PARTNERS WERE COOPERATING.

I hereby, that the whole integrity of the present Report Project submitted by Email, was carried out by myself, during the present semester as part-time Student beside my part-time Job.

The work conducted, methodology and understanding, can be summarized in next Flow Diagram;

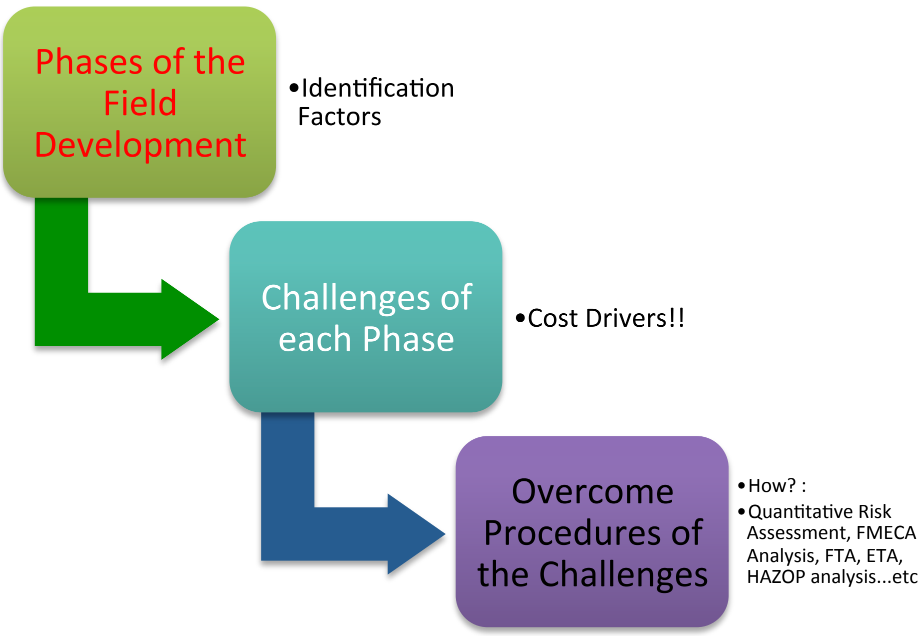
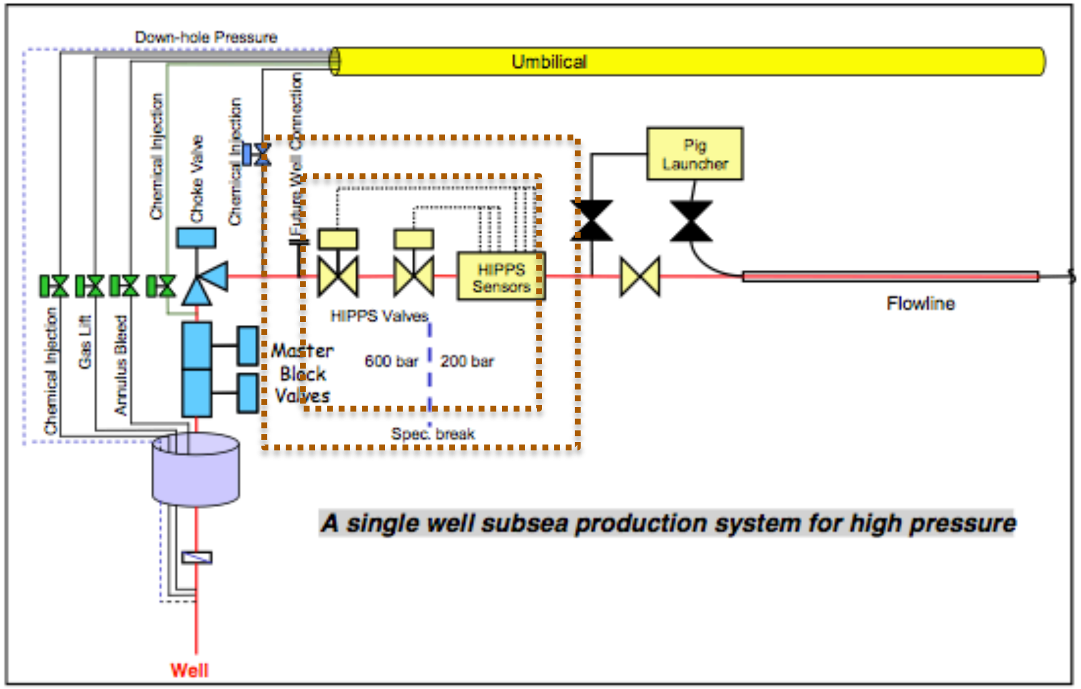


Figure 13. Methodology and Understanding of the report.

11.ANNEXES

HIPPS representation: "A single well subsea production system for high pressure".



FMECA Table for HIPPS: (for main components)

Description of Unit			Description of Failure			Effect of Failure		Failure Rate (per 10^6hrs)	Critically	Risk reducing measures/comments
Ref.No.	Function	Operational Mode	Failure Mode	Failure Cause	Detection of Failure	On the subsystem	On the system function			
PSH (Pressure Sensor)	Act as Pressure Transmitter, and send Input signal to Logic Solver	Running	Sensor failure	Mechanical damage	Running High Flow levels	Damage of sensor readings	System shutdown	2,5exp-03	critical	Backup Sensors on the Circuit
				Erosion	Originated by abrasive fluid	Damage of sensor functionality	May cause to shut down later			
Logic Solver (HIMA)	Responsible of activation of relevant signal outputs on the basis of the present applications and input from the initiators.	Running	CPU failure	Over Energy supply	Lack signal from the Initiators	Damage of the internal Circuit	Unavailable Management	3,0exp-04	critical	Regulator device of Energy Supply
		On hold	I/O system failure	Fail-safe redundant without Energy	Lack of output signal by initiators	Not Identify at this stage	Unavailable to work in Safety Mode			
QSV (Quick Shut-Off valve)	Act to Isolate the over pressure detected by the initiators	In Open position	Don't Close Valve!	Fatigue	Over pressure in the Gate of Valve	Overload pressures	System shutdown	3,0exp-04	critical	Proper design basis, demands, over dimensioning and test analysis

12.REFERENCE LIST

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