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Engineering solutions optimization aimed at mitigating risks

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Abstract

Current Facilities for unloading, storage, preparation, transportation and offloading as a rule have design life to last of over 30 years, often 50 years. In reality very often facilities require life cycle extension as being still in demand after expiry of design life. Such an approach has become more in demand during recent decades as modern engineering more and more aims at optimizing the overall costs while engineering values, to achieve higher efficiencies.

During latest periods the occurring disastrous events are being observed with the aging facilities, like fires, explosions etc., which sometimes are ascribed to conspiracies, which however often are due to inadvertent attitudes to facilities and hazards those facilities may conceal. Risks are not properly identified and addressed, thus leading to artificial higher cost efficiency missing critical assessment criteria for brownfield engineering solutions.

This Article aims at structuring the approaches to safer engineering by dividing the process into stages each having its weight in consideration of extension of facility's longevity. Such approach will significantly minimize risks of hazardous events during exploitation of facility beyond their design life. This will be through staged approach, evaluation of threats at each stage and developing solutions at various levels of approach.

Keywords: oil and gas, optimization, design life, hazards identification, risk assessment, critical parameters, efficiency engineering

1. Introduction

The contemporary situation with the industrial facilities and their engineering systems being under operation, requires a significant change in the attitude to their upgrades and maintenance. This is the result of the quick progresses in engineering fields and very often the crucial and sometimes step

changes in various fields occur within the design life of the facility. Accordingly, service life of some equipment may expire and even replacement by the same model may not be possible as equipment has already been replaced by newer versions.

Such a situation requires that an active interaction of the operating and engineering team with the systems under operation takes place within all service life of the system and periodic reassessments and revalidations of various parts of the system take place.

This new tendency requires developing and using new approaches and tools of analyses to be applied to the system that enable the team to effectively identify the potential gaps, threats and risks to operation and launch corresponding processes to prepare and realize the necessary changes, updates, upgrades and integration to bring the system back into the safe mode of operation.

It is necessary to note that despite a diversity existing in the systems, equipment, operation etc., there are some similarities that allow to generalize approaches and theorize in order to have more developed concept of the contemporary requirements to operations of the systems.

This Chapter summarizes the extensive experience of the authors in the area of the upgrades, modifications and modernizations of the engineering systems in the facilities under operation, which required multidiscipline approach, multidiscipline thinking and uniting of efforts of various engineering disciplines in order to achieve the best or optimal result.

The general approaches in this field embrace variety of engineering disciplines as well as such tools and processes like those to identify the potential threats, evaluation of risks to operation, identifying the range of solutions and evaluation of their comparative efficiencies, value engineering, development selection criteria and others.

2. Methodologies involved in such approach

Generally speaking, engineering is oriented towards problem solving. Modern engineering is focused on optimization and polishing of the conventional and nonconventional approaches for problem solving.

Development and application of the optimization methodologies starting from conceptual stage of upgrade in modern large scale engineering systems is not just necessary but an absolute must. Technology, engineering/tools and advanced methodologies are widely developed and applied for solving of the largescale problems and projects. Modern engineering is accelerated, very flexible and combine optimized qualitative and quantitative solutions' mechanism.

New applications and software interconnects knowledge and statistical data with mathematic models at the level of the artificial intelligence and eliminates the time and scale limitations in problem solving. Margins of cost and time applied for achieving quality can be easily controlled and optimized shortly and accurately.

Motto of the modern engineering is – “quality and safety can easily be achieved at optimized cost and maximum efficiency”.

For this reason, engineering process is split into various stages starting from high levels of design up to detailed approaches.

Each level gradually has become quite independent of others and develops its own tools for solving engineering problems. Significant differences nowadays require different skills of engineers to develop in order to effectively and efficiently solve problems that occur within existing operations.

Accordingly, companies develop their own structures in order be able to fit into one or more sectors down the stream of levels where engineering is needed.

The differences between various stages are quite uncertain generally. To define those in a more precise way. Encotec company developed the comparison table (Table1) where these differences are cleared out and assist to select the right approach to problem solving.

Table 1

| No | Criteria | Appraise / Select Projects Typical format | | Define / Execute stage projects Typical format | |
|----|--------------------------|--|--|---|--|
| | | Level/Rates | Main Features | Level/Rates | Main Features |
| 1 | Uncertainty/Risk level | High Uncertainty / Risk | Risk identification, analyses based on policies and techniques (risk matrix, levelling, ranking etc). Engagement with other work groups and third parties to reduce uncertainties. Identification of Risk level as per Annex 3 Risk Matrix of GDP 3.1-0001 and propose risk reduction solutions. Develop and implement risk mitigation plans. | Low Uncertainty / risk | Follow Requirements Implementation of risk reduction recommendations and solutions. Follow risk mitigation plans |
| 2 | Project Definition level | 0% - 25% | Decision making, engineering solutions, benchmarking, development analyses and optimisation of alternatives, market screening for innovative/alternative solutions. Undertake risk / costs / Hazard assessment and select an optimal solution. | 15% - 100% | Systems, procedures, specifications, flow charts, project controls |

| | | | | | |
|---|---|-----------------------------|---|----------------------|---|
| 3 | Project Estimating accuracies and method | +/- 60% to +/- 20% | Requires high level estimating techniques, capacity, benchmarking, judgement or analogy and analysis. Focus on reliability and value engineering, economic assessment (CAPEX / OPEX, NPV, IRR etc.) | +/- 20% to +/- 10% | Focus on details Unit cost based on detailed Take-off |
| 4 | Manhours | X | Requires capacity to define the uncertainty and propose solutions | 5X - 50X | Require Strong Management of multiple / multidiscipline works |
| 5 | Project Execution | Development of requirements | Communication / Coordination | Follow Requirements | Project management led |
| 6 | Project planning level | level 1 - level 2 | Capacity to skip over details and prioritise | Level 3 - level 5 | Delving into many details |
| 7 | Average experience of involved engineering staff. Qualification requirements. | 10 years plus | Approach based on experience, expertise and risk analyses. Versatile, with diverse experiences, capability of broad, 'out-of-box' thinking, qualities of leaders, strong analytical capabilities | below 10 years | Skill based approach. Specialisation, skills development, focus on instructions |
| 8 | Project Quality | Expression of goals | Define requirements, roles and responsibilities, | Achievement of goals | Measurement of KPIs, criticalities, quality assurance / control |
| 9 | Operations Experience input | Major | Engagement with Operations work groups to identify operation requirements, based on experience. | Minor to Medium | Compliance and/or verification of Operation experience requirements |

| | | | | | |
|----|------------------------------|---------------|--|-------------|--|
| 10 | HSE impact | Establishment | Identification and evaluation of HSE risks as per Risk Framework – HSE Impact Levels. Identification of Risk level as per Annex 3 Risk Matrix of GDP 3.1-0001 and propose risk reduction solutions. Input into ESIA and health impact assessment process | Application | Implementation of risk reduction recommendations and solutions. Incorporate into design and execution (third parties and subcontractors) |
| 11 | SOW/engineering completion % | 1-10% | Conceptual Engineering / Scoping Study / Opportunity Phase | 10-100% | Detailed engineering/Final design/Installation deliverables |

3. Outcomes and discussion

Efficiency has been major problem standing in front of the engineering during decades. To achieve efficiency, to measure it and combine the outputs of the successes and failures to develop tools to be applied to the problem solving required certain knowledge, experience and efforts and were not always providing required results.

Decades before, concepts/solutions were engineered to last for long as tendency in change and innovation was so slow that it could take decades of developments to integrate new ideas into the industry. Rapid growth and development of technology nowadays enable new features and solutions for the green field and brown field engineering. Modern engineer has to consider multiple aspects and growth tendencies while developing a solution as it has to be enough flexible to be partially/fully replaceable and upgradable.

The appropriate tools usually need to be developed to enable uncovering such ‘mystic’ areas as uncertainties, risks, multiple opportunities, expected expenditures and their assessments, etc. etc.

Tools and measures applied by modern engineering does not cover only engineering but also extend to financial and management aspects of the projects. Such an extend in recent decades has brought solutions as:

- Modular blocks
- Large operation range equipment packages;
- Plug and play equipment requiring minimum or no integration efforts;
- Low cost high durability materials;
- High efficiency and comparatively low cost modern solutions/packages due to standardized manufacturing process;
- Solutions optimized from weight, dimensions and transportability point of views;
- Optimized from project management point of view.

Based on the practice and experience of the world wide engineering, most of the conventional approaches scarify 1-2 out of 3 fundamental design elements. These elements are cost, time and quality.

Widely applied even today conventional engineering methodologies enable double or in some cases triple of the capacities actually required. Multiple life extension projects of the facilities built in 80th and 90th has been carried out and within these project via application of modern tools it has been revealed that original design offers way too longer design life from what original cope required.

Such margins of course brought benefit at later stages of the facility life time by providing solid bases for life extensions. But, these pre-installed margins should be controlled and accurate. Such can be achieved via clear identification of scope and expectation considering the rapid growth of technology and change of demands.

Dealing with the existing operations and working to improve/optimize those is associated with certain risks of achieving adverse results. This is due to the interference with the operating area and current operations going on. Eliminating or mitigating risks at stage of engineering brings benefit to aforementioned key criteria - cost, time and quality.

An example of the risk analyses and its report are provided in the Table 2. Example of Sensitivity Analyses and decision based on sensitivity to risk / assumptions is provided in the Table 3.

Table 2

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RISK REDUCTION STUDY AND CONCEPT REPORT

Prepared by: Saiti Kizilci
Checked by: Murat Yamaner

ENRF_13-05-07-459-003
407 140276646 / AD REPORTS AD-0034 SOP-RV-AS-PR-0037
RISK REDUCTION
01.03.2014

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| Option A (Optimized Base Case) | Base Case | This case considers optimizing the same situation as it is. |
|--|-----------|---|
| Option B (Process Reconfiguration) | Variant 1 | 2 Hot Tags + Stripper + valve repair/ replacement |
| Option C (Process Reconfiguration + New Block Value during planned shutdown) | Variant 2 | Stripper + valve repair/ replacement |
| | Variant 3 | Stripper operation of the reactor between AD-0034 and AD-0035 |
| Option D (Process Reconfiguration + New Block value on the line #B02) | Variant 1 | valves + valve repair/ replacement (not required as more than 10 jobs will be done for the control) |
| | Variant 2 | 4 Hot Tags + Stripper + 10 jobs + valve repair/ replacement |

B. COMPLETENESS COMPARISON & ALTERNATION

| RISK REDUCTION ANALYSIS OF B02-AS | | |
|--|-----------|---|
| Actualized valve release frequency | 2.838 /Oa | From DDP 434-02. Includes main valves on main piping. |
| Number of actualized valves on line section | 2 | SWT-0203, SWT-04, A2-04 |
| Overall actualized valve release frequency | 1.632 /Oa | |
| Manual vent valves | 0.833 /Oa | |
| Number of Manual vent valves on line section | 4 | |
| Overall Manual vent valves release frequency | 1.632 /Oa | |
| Total release frequency | 3.265 /Oa | |
| Offshore of the facility | 05 | |
| Frequency over 1000m | 0.00002 | |
| ADP 3.1.0001 Risk Ranking | 04 | |
| Shielding of pipeline valve section between AD-AS (B02) | 74 | 10 valves on Block value neighboring with B0-AS is damaged. |
| Amount of valve gas stored in pipeline to be vented (Cubic meters) | 000000 | |
| Loss of product due to degradation | 1000.000 | 10 cubic meters per 1.000 |
| SW | | |

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| Loss of production - value | 100000000 | 10 days 0 for venting and 0 for repair |
|---|-----------|--|
| Repair cost | N/A | Is not considered for this case |
| Loss of product to distribution and degradation (average over 1000) | 100000000 | Assumption |
| Total financial impact | 100000000 | |
| Indicative speed | 1000000 | |
| FC | 4000000 | |
| Ind. speed (COST BONUS) | 3.2 | |

NOTE: It is considered the 'extra ordinary' case. This is when one of the valves (or piping) that neighboring the industrial area releases. The calculated extra gas vented into the atmosphere, the social impact analysis of production (extra gas).

If ultimately defect, the case (disasters) is why release is a statistical process and does not count as extra. This is why the ordinary case does not contribute to the indicative spent with the resources.

| OPTION | PROFIT | Indicative Speed (COST) |
|----------------------|--------|-------------------------|
| Option A | 0 | 0 |
| Option B - Variant 1 | 4000 | 3.2 |
| Option B - Variant 2 | 4000 | 3.8 |
| Option B - Variant 3 | 9000 | 3.2 |
| Option C - Variant 1 | 4000 | 3.8 |
| Option C - Variant 2 | 4000 | 2.8 |

Cost includes:
Option B - Variant 1: (4000 TON + 3000 TON) + 10000 Contractor cost (control action, design and maintenance) + 20% Contingency

10

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| | | |
|---|---|---|
| <p>Option B (Repair/Replacement the Block Valve during planned shutdown)</p> <p>Variant 3 Depressurization of the section between A2-A4 block valves + valve repair/replacement</p> | <ul style="list-style-type: none"> No hot tap works to be undertaken on pipeline. No TDW involvement, less cost. | <ul style="list-style-type: none"> Inevitable gas venting from section between A2-A4 block valves. Approx. 11 m³ of gas. Loss of product Potential risk of explosion and formation of concentrated gas cloud. Approximately 5 days of depressurization time after shutdown shall be required prior to starting replacement works. Stabilizing of pressure in pipeline after valve replacement. |
| <p>Option C (Repair/Replacement the Block Valve in the live pipe)</p> <p>Variant 1 Hot taps + stopples + by pass + valve repair/replacement</p> | <ul style="list-style-type: none"> Installation of stopples to prevent gas venting from the blocked section. By pass installation shall provide continued transportation of product through pipeline Reliable and common practice method Less cost compared to smart plug option | <ul style="list-style-type: none"> High risk level due to undertaking of hot tapping and replacement works on live pipe Multiple hot tapping (4 openings are required) which increase potential future pipe fatigue due to hot tapping works |
| <p>Option C (Repair/Replacement the Block Valve in the live pipe)</p> <p>Variant 2</p> | <ul style="list-style-type: none"> This option provides timely replacement of the block valve and elimination of potential valve | <ul style="list-style-type: none"> High risk level due to undertaking of hot tapping and replacement works on live pipe Involvement of TDW for smart plugs installation and operating |

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| | | |
|---|--|--|
| <p>Smart plugs + hot taps + by pass + valve repair/replacement</p> | <ul style="list-style-type: none"> Continued transportation of product via by pass Minimal hot tap works are required compared to Option C1 (only 2 openings) Ease of launching smart plugs via pig launching and receiving units | <ul style="list-style-type: none"> failure to do blocking Any stuck of smart plug in inappropriate section of pipeline because of improper smart plug operation effected by failure of smart track system shall require to repeat the smart plug operation again or to consider option C1. |
|---|--|--|

8. RECOMMENDATION

Quantitative risk analysis indicates that the repair/replacement of the valve should be the recommended option. However, this is subdivided into Options B and C, each of which subdivides further into variants.

Risk analysis and considerations should be focused on the most reliable and the least risky variant as the potential outcomes of failure will be huge losses. Of all considered variants, Variant B1 is considered of minimal risk (Medium, see the attached risk assessment matrix). So, it is recommended to follow the **Option B Variant 1**. This Option considers to undertake the repair/replacement of the Block Valve during shutdown (August 2015) with hot tapping and installed stopples. As there are long lead items, manufacturing of which may take quite a lengthy period, it is recommended to start project preparation the soonest.

The following shall also be taken into account: the pipeline shutdown may not be sanctioned or may be recalled. In this case, same preparations can be applicable to the **Option C Variant 1** as recommended one.

9. ATTACHMENTS



PIR.doc



Engineering Evaluation report.wrt



2009 11/Nov She Report.pdf



Risk Assessment Matrix.xlsx

All aforementioned are aimed at full or partial elimination of the obstacles preventing engineering to achieve high efficiency.

One has to understand that efficiency is relative understanding and what is efficient today will become in-efficient shortly.

4. Conclusion

The area of providing solutions to the emerging problem during existing operations is not studied to the degree adequate to its occurrence nowadays. Only a few publications are dedicated to this and the demand is quickly growing. The multiple and multidiscipline character of the emerging problems complicates development of unified tools and approaches.

At the same time, at the current stage some important tools have been developed that enable effective solutions to the problem being identified, developed and managed.

The most important issues are defining the problem and identifying all uncertainties associated with it, further to which start dealing with uncertainties and their management. The general tools are Identification of the type of uncertainty, considering approaches to uncertainty and developing alternative options as solutions, analysis of alternative options and their ranking, risk analysis for each alternative option, analysis of various scenarios related to alternative options, cost analysis, constructability analyses etc., summarizing analyses of considered options and selecting the most applicable against certain criteria developed specifically for the project.

Along with this, the risk management approach is a very important tool of the process as ignoring risks may create serious deficiencies in the proposed solution up to an overall project failure.

The stated approaches to conceptual level of the engineering approaches to the solution are supported by examples from the practical work of Encotec LLC enabling successful project development and a significant tool to making right decision on all stages of the project.

Conflict of interest

The authors declare that they have no conflict of interest in relation to this research.

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Possibility to eliminate accidents in oil and gas wells occurring with glass fibre rods with the help of a rod head designed for them.

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Abstract

The operation of oil and gas wells with sucker rod deep well pumping units takes place in aggressive conditions of the oil and gas production field. This leads to accidents arising with deep well pump rods of these units. The report talks about the possibility of eliminating accidents arising with glass fibre rods, which differ from metal, steel rods by their physical and mechanical properties. These rods are the most important part of a deep-water pumping unit. It is noted that in order to eliminate accidents with deep-well pumping units it is necessary to develop a catching tool rod-header. The diameters of these rods used in production are specified. It is noted in the report that fibreglass rods are made in order to save metal, as well as these rods are anticorrosive in comparison with metal rods. The disadvantage of fibreglass rods is their relatively low strength (σ) compared to metal, steel rods and their smoother surface, which is less able to be effectively gripped by the rod head. The report explains the process of eliminating a fibreglass rod accident with this catching tool. Continuing the lowering of the rod-header there is a gripping inside the tool body by the surface of the coupling or body of the fibreglass rod by gripping elements, spiral parts and collet. The efficiency of the process of gripping of the glass fibre rod depends on what, as a