NOT NORMALLY MANNED PLATFORMS

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ASSESSING THE PROGRESS TOWARDS
A STANDARDIZED DESIGN
FOR
NOT NORMALY MANNED PLATFORMS.

by

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ABSTRACT

This paper reviews the evolution and present status of Not Normally Manned Platforms with the main emphasis on the development in the North Sea within the last two decades.

The paper also reviews the design premises for Not Normally Manned Platforms and shows that very high production up time is easily achievable, if simplicity is the governing code.

Further the design and safety aspects for a Not Normally Manned Platform and problems related hereto are discussed and it is shown that the relative personal safety is actually increased on platforms with less equipment than has been the usual standard.

Finally the future trends for Not Normally Manned Platforms and possible areas of applications are discussed.
1. INTRODUCTION

The productivity of oil and gas wells has over the years increased due to development of new production techniques and drilling methods, such as multiple completions and horizontal wells. Oil and gas fields which some years ago were not considered interesting may now be financially viable, if the enhanced production and drilling techniques are combined with the cost effective concept of Not-Normally-Manned Platforms (NNMPs) and there exists an adequate infra-structure to receive and process the un-treated well fluids from a satellite platform.

The NNMP concept also allows for small or complex but not thoroughly appraised oil and gas fields to be developed stepwise and in a modularised form, thereby reducing the risk and initial capital investment, until the productivity and reserves has been better ascertained.

In Denmark Mærsk Olie og Gas AS the operator for DUC (Danish Underground Consortium) adopted this stepwise and modularised approach in 1989/90, due to the uncertain production potentials, in their development strategy for two oil fields Kraka and Dagmar and is continuing this concept strategy for the oil/gas field Valdemar [1] and [2].

Further in the Oil Companies development strategy, a NNMP should also be looked upon and treated in the same manner as sub-sea completion, only that everything is in the dry and not as a small platform with facilities. Only if this concept is adopted and accepted the full benefit of NNMPs can be realized.

Another important factor when judging and comparing the various concepts available for the development i.e. platform versus sub-sea, apart from initial investment, is the operation and maintenance costs and the possibilities for future expansions and personnel safety.

This paper only deals with the aspects related to the design and operations of new topsides facilities for satellite field development. Standardization of the structural design for the supporting jacket is considered outside the scope of this paper and further it has also been extensively dealt with by others. J. Marino of Texaco has in [3] given a very comprehensive review of structures available for marginal field development options. Further the aspects associated with de-manning of existing manned platforms is a very interesting subject, but is also considered outside the scope of this paper.

2. EVOLUTION OF NNMPs.

The development of NNMPs is definitely not new, it is something that has been on-going for a long time. The first NNMPs put into service were not really un-manned in to-days terminology. They either required daily visits or had a very limited crew (2 to 3). This trend is very well exemplified by the conversion of existing manned facilities and the recent new builds by DUC [1].

The development of NNMPs in Denmark as shown in Fig. 1 and 2 is unique for the North Sea area.
Figure 1: Skjold satellite platform, installed in 1982
(courtesy Mærsk Olie og Gas AS)

Figure 2: Dagmar satellite platform, installed in 1990.
(courtesy of Mærsk Olie og Gas A/S)
The first unmanned platform in the North Sea was the Skjold platform [4] installed and put into operation in 1982. The facilities were designed using codes and standards applicable for manned platform, modified with respect to the capacity of fire water pumps, installation of a dry fire water system and emergency accommodation (not shelter), otherwise the platforms included all the facilities one would expect on a manned platform. The Skjold deck is shown in Fig. 3.

Figure 3: Skjold deck from the early eighties.

Another example of a small jacket and unmanned deck is the platform installed in 1986 by Unocal in Holland [5].

To date two oil/gas fields with NNMPs installed are in operations in Denmark with more planned. The operability expressed in terms of up-time is reported to be better than 99.0%. [2], when events causing shut downs originating at the central processing centre are excluded as shown in Fig 4. In Fig. 5 and 6 is shown the actual number of visits and number of shutdowns, one should especially note that the number of visits slightly exceeds the originally planned, but is still significantly less than what is "allowed" by UKON8 [8].

**Figure 4: Up-time for two NNMPs**

**Figure 5: Number of visits to NNMPs over a period of 1 year**
Figure 6: Number of shutdowns

3. CODES AND REGULATIVE REQUIREMENTS for NNMPs

During the operation of unmanned platforms designed and built to the regulations for a manned platform it was realized that "new" thinking to an old problem was required with respect to the codes and standards which should be used for a "truly" un-manned operation. The development of the regulation in Denmark took place after some years of operational experience with NNMPs designed to the rules for manned platforms and in the aftermath of the drastic drop in oil prices in the spring of 1986. It was realized by all parties that some major simplifications to the existing set of rules and regulations were needed to make the small Danish oil and gas fields economically viable [1].

In response hereto the Danish Authorities issued in 1989 their new "Guidelines for the Design of Unmanned Production Platforms (UP)" [7].

A very important concept underlying the new Guidelines is that the design shall be simple with no (or as little as possible) continuously rotating equipment, not relying on planned maintenance (design against maintenance) and protection and safety of personnel is achieved by a combination of preventive and active safety systems, with the main emphasis on efficient and safe evacuation procedures. The protection of invested capital and environment relies solely on passive protection, i.e. the use of proven and robust equipment, but no active protection like firewater or deluge system.

The Danish Guidelines for NNMPs are based on the following main principles:

- simple remotely operated un-manned installations
- safety level for the personnel servicing the platform should not be less than for personnel on manned facilities.
Only equipment absolutely necessary for the production or which gives a significant positive contribution to the overall safety is allowed on the platform.

Safety level shall be achieved by preventive measures, i.e., the platform shall only be manned in weather conditions where a safe evacuation is possible.

The Guidelines in terms of personal safety operates with two types of platforms:

**Type A:**

Manning is only allowed in daylight and in weather conditions that allow safe transfer and evacuation by boat only.

**Type B:**

Manning is only allowed in weather conditions that allow safe transfer by helicopter and safe evacuation by lifeboat.

In Fig. 7 and 8 is shown an example of what a type A and a type B deck could look like [6].

![Diagram of Type A deck]

**Figure 7: Type A deck**

ref [6]
Figure 8: Type B deck

ref [6]

Similar development has taken place in the UK where the Health & Safety Executive issued in 1991 the Operations Notice #8, "Manning of Offshore Installation" [8], which gives almost identical or very similar directives in terms of safety and operability, except that Notice #8 does not operate with the case of transfer by boat as the only means of personnel transfer.

3.1 Equipment and safety appliances needed for a NNMP

To guide but also to ensure that a NNMP is not being filled up with "unnecessary" equipment the Danish Guideline has established a (tentative) list of acceptable types of equipment for a NNMP.

The most simple both in terms of equipment and operation is the so-called type A deck, which will typically include the following equipment and procedures for remote operation.

- X-mas trees, hydraulic wellhead control panel, production manifold and ESDs on all wells
- Battery power pack with recharging and a diesel generator (small) or external power supply
- Portable fire extinguishers permanently mounted and portable gas detections and if the well stream is sour portable breathing apparatus
- Riser system incl. ESD valve
• emergency shelter (open wind breaker) incl. dry closet
• radio link to mother platform (line of sight) or dedicated communication umbilical
• one primary and one secondary escape route
• boat landing for transfer/evacuation of personnel
• life rafts (2*100%)
• all transfer is by boat, standby vessel in continuous attendance, when manned.

and for the somewhat more "complex" type B there might be the following additional equipment to that listed under type A facilities,

• helideck
• test separator and test manifold
• pig launcher
• permanent fire- and gas detection systems
• resting facilities for over night stay in case of an emergency
• main and emergency generators
• two separate escape routes
• life boat (free fall)

The difference between type A and B facilities is therefore not so much by the kind and amount of equipment, but much more by the means of personnel access and emergency evacuation.

For both types of topside facilities the underlying principle is simplicity, robustness and change out of equipment instead of planned maintenance requiring prolonged stay at or regular visits to the platform.

4. DESIGN PREMISES FOR NNMPs

The standardization of NNMPs can be understood either in terms of selection of equipment or function of the platform as discussed by [9].

Standardization of equipment is indeed an important subject, but is not an end in itself. The benefit from standardization is first fully achieved, if both the functional requirements and the selection of equipment can be brought together in a true NNMP.

For many of the satellite and smaller fields where there exist the necessary infra-structure to support a NNMP within a distance of 30 to 45 km, the production profiles could typically vary as shown below

No. of wells: 1 to 10
Pressure range: up to 4000 psi
Temperature range: 40 to 110 dgr. C
Flow range: 1000 to 40,000 bpd

The design problems associated with the design of a NNMP for the above stated ranges, are briefly.

9
4.1 No. of wells

The basic idea of producing from satellite fields is to establish a simplified production system with as many wells as possible. It has been shown that up to at least 10 wells (producers, injectors, gas lift) can be drilled and safely and efficiently operated [1].

If the reservoir characteristics are such that more wells are required or the fluid composition is such that continuous separation and attendance is required, the basic concept of a simple NNMP is probably not viable any more, due to the number of visits required for overnight stays.

4.2 Pressure range

From a safety point of view the simplest way is usually to design the entire piping/valve and riser/pipeline system for the full wellhead shut-in pressure.

Piping and valves specified for the shut-in pressure of the wells up to say 4000 psig can easily be procured and delivered and is also covered by the standard ANSI ratings. Wellhead shut-in pressure significantly greater than 4000 psig will usually require special equipment to be manufactured.

4.3 Temperature

Installation and operation of a NNMP in the temperature range from 40 to 110 dgr C. does not require any special precaution to be taken and a standard design covering this range is easily achieved.

4.4 Test separator

The concept for installation of a remotely controlled and operated test separator is not new and several have been put into operation [9]. Due to the variety of flow regimes and fluid compositions the size of a test separator is difficult to standardize.

For safety reasons the test separator shall either be designed for the full well-head shut-in pressure or have quite an elaborate safety system for over pressure protection installed, which could start to violate the basic concept for a NNMP, i.e keep as much as possible simple.

Development of electronic three phase measuring systems for well testing seems to represent a very attractive alternative to the test separator, but there is still some way to go.

4.5 Process equipment

Process facilities should be minimised and if large scale separation is required, great attention to the reliability and control integrity must be exercised. If later addition is needed, it should be done in a modular form as has been shown and discussed by [4], [6] and [9]. The simplest and most efficient way to exploit a oil/gas reservoir is to produce in a two/three phase mode to the mother platform. Several projects have recently been proposed with two/three phase pipelines longer than 40 km, and with improved inspection technology becoming available it should also be possible to operate pipelines in a two phase mode up to 80 to 90 km long.
4.6 Helideck

The requirement for a helideck depends on an evaluation of the need (security of supply) to access the platform in (nearly) all weather conditions and is not a safety consideration.

4.7 Gas lift and chemical injections

Gas lift and chemical injection, if required, should be designed such that the supply and pressurization takes place at the process platform in order to minimize the power consumptions on and visits to the NNMP.

4.8 Metering

The requirement for fiscal metering at a NNMP should be discouraged and avoided with all fiscal metering to take place at the receiving platform.

4.9 Remote control

Line of sight for remote control and monitoring can be used up to a distance of 30 to 35 km with an antenna of acceptable height and provides a very reliable and cost efficient control system. Remote control using dedicated umbilical is also a very reliable but prohibitively expensive, when compared to line of sight system.

4.10 Power supply

Electrical power for process control and monitoring is, most conveniently and cost efficiently, supplied from a battery pack and a diesel generator (20 to 150 kW) placed on the platform. The maintenance associated with a diesel generator can be kept low by selecting equipment suitable for offshore and continuous operation. Only for the cases where the NNMP is close to the process platform (up to 3 to 5 km) or there is an excessive high power demand, does a subsea power cable become a viable alternative.

5. STANDARDIZATION

The term standardization versus tailor made/design is often used as a modern catch word by engineers and managers convinced that this in itself will solve many of the evils encountered in the offshore industry.

The concept of high flexibility and low cost may seem incompatible, but if the message that low cost does not necessarily mean low initial cost and that flexibility does not mean that every conceivable eventuality shall be catered for, they can indeed become compatible.

The efficient combination of the low costs and flexibility is achievable, if time and effort is spent by management up front at the definition and conceptual design stage to sell and educate the concept to the designers, suppliers and production/maintenance personnel.

On the other hand if the problems associated with standardization is tackled incorrectly and with a preconceived mind there are probably more problems than benefits to be found in implementing standardization of NNMPs.
Standardization of the design and installation of a NNMP can very easily bring the following benefits:

- Uniform (standard) approach to the development of remotely controlled satellite fields, i.e. the standard design can be re-used at several but different fields and the design effort could be directed to implement operational experience into the facilities (do not try to re-invent the wheel for every new development).

- Standardization will reduce warehouse and storage requirement at supply centres or at the operators own centre.

- Avoiding suboptimization of design (design varies from platform to platform) by quantifying the cost benefits of using existing and proven equipment.

- Interchangeability of equipment

6. MULTIPLE USE.

Multiple use of offshore facilities has always been at the forefront of the operators mind, provided that the installation can fulfil the various production profiles and that the platform is not technically obsolete when time comes for using it second or third time around.

Unocal’s small un-manned platform for the Helder development [5] was designed for possible re-use. The design of the jacket for two different locations was feasible at little extra cost, because the soil conditions and water depth at the two locations were equal. Re-use of the supporting structure is very location dependent and is therefore in general not very attractive, as it seldom makes economical sense to design a jacket for a variety of soil conditions, water depth and environmental criteria.

For the deck the economical advantages are much more obvious and attractive. A deck is only to a very small degree location dependent but is production/reservoir dependent and as discussed above.

7. SAFETY

Safety of personnel and safe guarding the invested capital is two very important and compatible aspects, which need to be considered both separately and jointly.

In Denmark the development of the Guidelines for Unmanned Platform [7] were all written against a set of general risk assessments covering a wide range of production profiles. The risk assessment performed in connection with the development of the guidelines [1] showed that all equipment that could not be shown to improve safety and were not absolutely essential for the operability of the platform should be eliminated/removed.

The main finding in [1] was that, the level of risk exposure for type A and B topsides is far lower than the risk exposure associated with the earlier satellite developments [4], due to the reduced number of visits and is of the same order of magnitude as for manned installation.
For the as-designed and built NNMPs the risk assessment for the particular platform has shown that the platforms are very safe from a risk assessment point of view and some more equipment could be added, if so desired.

The most important safety aspect as identified during the risk analysis was to ensure unrestricted escape routes at all times during emergency evacuation.

8. COSTS

If the oil company can predict with some kind of certainty in their development strategy that there will basis for several satellite developments, the extra cost required to develop an in-house standard topside design covering several eventualities, is quite insignificant when considering the future benefits in terms of development, operability and maintenance.

The extra design cost for a standard deck for a NNMP would only come to some £35 to £75,000 or some 10 to 15% of the overall design cost. The extra design expenses are however easily recovered with more than one platform.

The extra construction cost for a standard deck versus a tailor made will not exceed £150,000 or less than 10% of the overall fabrication cost.

The design, fabrication and installation cost will for a NNMP (jacket and deck) under the following conditions,

- location, the North Sea, water depth, 40 to 48 meters,
- 6 to 7 wells,
- pressure rating up to 4000 psig,
- flow rate up to 25,000 bpd,

and using the very simple facilities as indicated for a type A facility be approximately 8.0 to 9.0 mill £ excl. pipeline and modifications to processing facilities.

9. FUTURE TRENDS

A trend is at present emerging with respect to have agreed and issued unified and universal guidelines for the design, fabrication and operation of NNMPs within the auspices of ISO and with a heavy input from API. This should help and assist the operators to achieve their goal of safe and cost efficient remotely operated oil and gas facilities based on international agreed principles.

Another trend that is also emerging, is that oil fields, outside Denmark, can also be remotely operated and controlled, [9] and [10].

Irrespective of the emergence of International Guidelines, the major trust for standardization of NNMPs has to come from within the oil companies, because they are those who stand to gain. The trend is already seen in many places where the management is actively promoting the concept of standardization at the expense of "opinionated/innovative" and "nice to have" engineering, to both it’s own personnel and suppliers, which is very well argued in [11].

13
Another trend which will further promote the concept of standardization is that to operate a multitude of NNMPs, special but dedicated maintenance teams will be deployed, thereby also forcing the production personnel to think standard.

10. CONCLUSION

The design of NNMPs requires a high level of discipline and commitment by all parties involved (designers/operations/authorities) that only absolute essential equipment and monitoring is permitted/required.

With this in mind, the NNMPs can then compete with sub-sea developments for (small) hydrocarbon accumulations requiring cost effective solutions.

A step wise development for under appraised fields will often be the only cost effective solution i.e drill (appraise), develop, produce, drill (more appraisal) and so forth and here a proper standardized NNMP designed for modular expansions, becomes a valuable assets in good reservoir management. An excellent example hereof is found in the STAR deck concept as described in [6].

11. ACKNOWLEDGEMENT

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