REDUCED MANNING ON OFFSHORE FACILITIES

BACKGROUND

Increasing focus is being placed on minimizing or removing the human presence on board floating offshore facilities by utilizing remote operations and assistive technologies for monitoring and decision support. By utilizing new technologies, the number of personnel can be reduced, minimizing personnel exposure and potentially reducing overall capital and operating costs. Since a significant reduction in manning is a fundamental shift for the industry, it needs to be completed carefully so that safety is not compromised.

Floating facilities with reduced or no personnel on board can be remotely operated from a nearby facility or a control center located onshore. To enable such changes, real-time monitoring, control automation and maintenance procedures incorporating remote diagnostics and simulations with minimal human intervention will be required. This concept requires detailed consideration of the remote-control center, the communication infrastructure, smart functionalities and potentially leveraging digital twin and simulation technologies.

This paper introduces some of the design considerations, enabling technologies and the existing regulatory framework.

DESIGN CONSIDERATIONS

Compared to a conventional facility, a facility with reduced or no personnel on board will have roles transferred from a crew on board the facility to a remote-control center on a nearby facility or to an onshore support team. The ability to perform operations remotely relies on the design features, technologies, sensors, data flow and the software collecting and analyzing the data. New risks may arise from the reduction or absence of crew, and this must be addressed in the overall design effort.

Factors to consider when reducing the number of personnel on an offshore facility include:

1. **Functional Focus:** The functional requirements should be considered as the primary driver. Key functions should be identified based on type of facility, level of automation and autonomy and facility main function. They may include remote control and monitoring, accessibility and maintenance, remote testing, fire safety/fire detection and firefighting, main and emergency power supply and import/export systems.
2. **Operational Principles:** Remote control systems and technology should be analyzed in detail to identify all relevant potential hazards and their impact.
3. **Structures, Arrangements and Systems:** While most design principles, such as structural integrity, will be the same as for a fully manned facility, consideration should be given to any unique elements introduced by the reduction in manning.
4. **Software Quality and Security Engineering:** Given that software will become even more integral to the operation of a facility with reduced manning, rigorous software engineering practices should be followed. This includes detailed testing of functional and extra functional requirements and employing highly developed software FMECA (Failure Modes Effects and Criticality Analysis) techniques to identify and control potential risks to asset safety and mission completion.
5. **System Engineering and Integration:** Close attention is to be paid to system engineering and integration. Verification and validation of an integrated system will require focus on functionality, operability and safety.
6. **Degree of Automation and Human Involvement:** The desired degree of autonomy and level of control need to be decided and documented.
7. **Human Factor Engineering:** Human in the Loop (HILT) analysis for the remote-control room and facility are needed, addressing the implementation of basic principles of human factors engineering (HFE) and ergonomics.

ABS SUPPORT

As the industry continues to explore and implement approaches for reduced manning on offshore facilities, ABS is available to assist with:

- Regulatory compliance implications
- Review of enabling technologies, via Technical Readiness Levels (TRL) for new technology qualification
- Input to concept design and assessment of alternatives, including Approval in Principle (AIP) for Novel Concepts

The overall objective of the design of unmanned facilities is typically to provide an equivalent level of safety to traditionally manned facilities. This challenge is typically addressed through a risk-based approach. This can include identifying and managing the risk of novel features to an acceptable level using as low as reasonably practical (ALARP) principle or other criteria.

ENABLING TECHNOLOGIES

Significant technology developments in recent years enable the number of personnel on offshore facilities to be reduced. These technologies include:

- Remote monitoring of structure and machinery health
- Remote control and operation of process and support facilities
- Remote inspection and maintenance including the use of
  - Robots
  - Drones
  - Closed Circuit TV (CCTV)

REGULATORY FRAMEWORK

For marine applications, the International Maritime Organization (IMO) has defined several levels of autonomy. These levels are driven by the varying levels of controls representing human and machine involvement with monitoring, analysis, decision-making and action. The below table is an example of autonomy levels and control methods applicable to offshore installations.

OFFSHORE FACILITY CATEGORY	DEGREE OF AUTONOMY*	LEVEL OF CONTROL			
		MONITORING	ANALYSIS	DECISION	ACTION
Manned - Conventional	1 (Manned)	Human On Board and/or Remote	Human On Board and/or Remote	Human On Board	Human On Board
Reduced Manning	2 (Remotely Controlled with Human On Board)	Remote and/or Human On Board	Remote and/or Human On Board	Remote and/or Human On Board	Remote and/or Human On Board
Unmanned - Remote Controlled	3 (Remotely Controlled with No Human On Board)	Remote and/or Machine	Remote and/or Machine	Remote	Remote

**This category is similar to IMO autonomous vessel categorization*

For offshore applications, which are often not subject to the full IMO framework, the proposed arrangements and operations will need to comply with the local requirements in effect where the facility will be installed. In many cases, requirements have been developed based on traditional manning requirements and require careful consideration with regulatory authorities to achieve compliance.

INSTITUTIONAL AND REGULATORY BARRIERS TO REDUCED/ZERO MANNING

Considerable work has already been undertaken to understanding the existing regulations and standards, and their inherent 'barriers' to deploying and operating facilities with minimal or no personnel on board.

The barriers can be risk ranked (critical, high, medium, low and negligible) and re-evaluated with potential 'technology' credit whereby the risk ranking is changed due to application of new technologies to remove or minimize human presence and involvement.

Mitigating barriers will require a structural/organizational change possible with the widely recognized model focusing on three areas of People, Process and Technology. The barriers and their mitigation will need to be a subject of discussion and open communication with stakeholders including regulatory bodies.

FOCUS AREA — PEOPLE

The people element will need to consider the HITL and the implementation of basic principles of HFE and ergonomics, critical for safety and health purposes whether on board the facility or at the remote-control station. This will include considerations such as crew habitability and the integration of HFE and ergonomics, so that the facility is designed and arranged to support consistent task performance in both normal operations and crisis management.

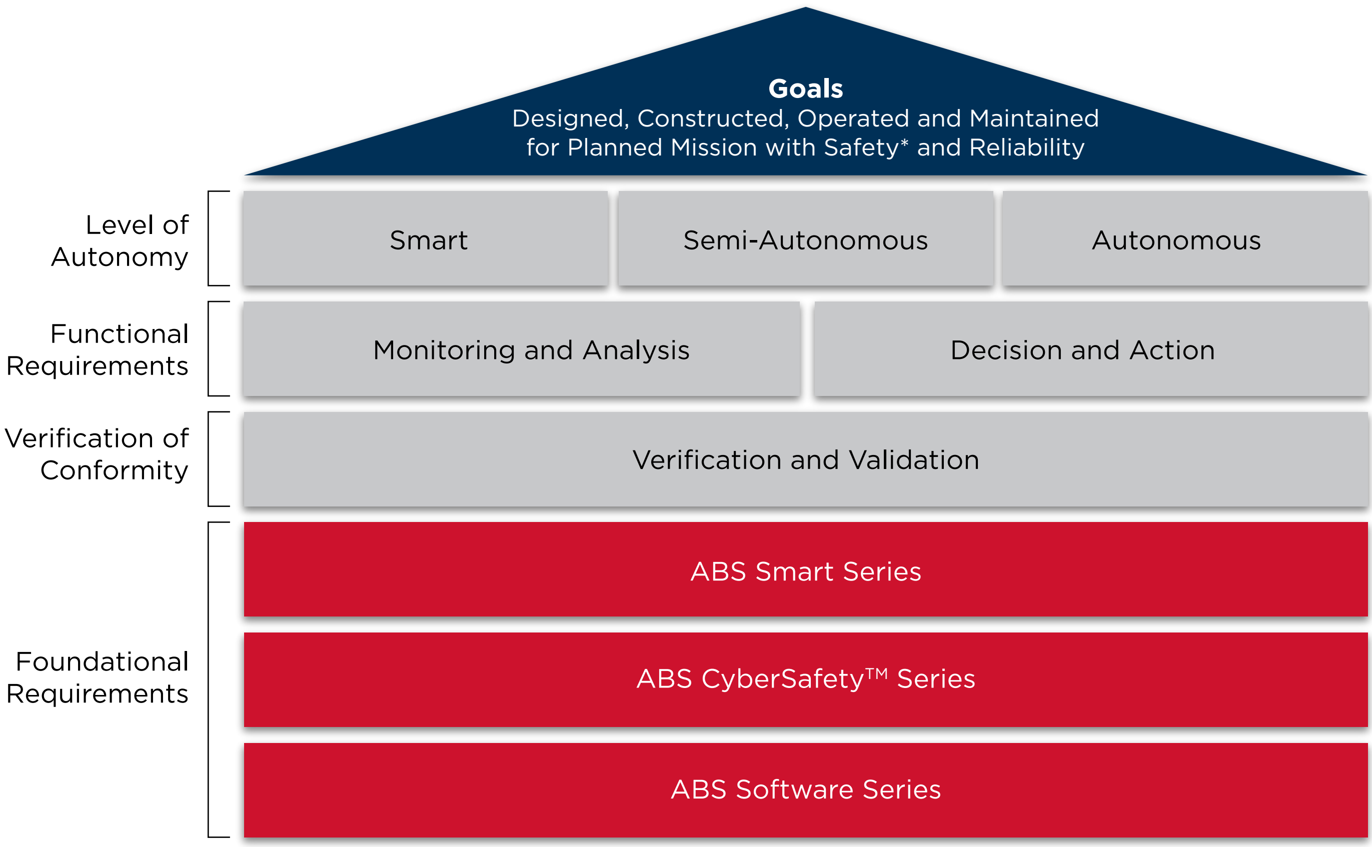
FOCUS AREA — PROCESS

The shifting of processes to adopt more automation with minimal or no human involvement will require adoption of new technologies as well as a rethink of the life-cycle strategy, reliability strategy and maintenance management. If human involvement is required, then the process should be capable of being run from a remote location. Process improvement should be carried out in a structured manner starting with an Enterprise Asset Management assessment to evaluate the elements of the life-cycle strategy, reliability strategy, smart functionality and an overall organization readiness.

FOCUS AREA — TECHNOLOGY

The adoption of new technology and replacing action by humans will need to show that risk has been reduced to ALARP level. The new technologies will have to have a reasonable technology readiness level (TRL) and qualified to be considered. New technologies for the facility may include such areas as connectivity, data collection and storage, management and analytics of sensor information, condition- based and predictive maintenance information, digital twins, etc.

Since vessels incorporating autonomous functions on a vessel or facility is often an incremental process, ABS applies a 'smart to autonomous' framework. This works toward the goals of the facility on a firm basis of the established Rules and Guides in the Smart, CyberSafety™ and Software Series. These are applied so that the technical requirements for software, cyber security and data are met along the path from manned to reduced manning to unmanned facilities in a systematic and planned way.



**Safe execution of mission has to consider the consequences to people, environment and the vessel.*

ABS ACTIVITIES

ABS has been engaged in activities which support the reduction of personnel on board offshore facilities. These activities include:

- Engagement in remote controlled vessel projects with owners and shipyards in Europe, Americas and Asia
- Engagement in various normally unattended facility studies, including a study for a major industry organization, focusing on regulation, codes and standards to identify potential barriers to an unmanned deepwater facility
- Development of technical papers, including OTC 2020 paper: SPE-30486-MS – "Unmanned/Minimally Manned Floating Deepwater Installations: Design and Safety Considerations"
- Participation in various industry working groups on unmanned cargo ships and automated and autonomous vessels
- Representation on IMO working groups on behalf of various flag Administrations
- Development of classification requirements for equipment reliability, smart functionality, autonomous and remote-control operations

REFERENCES

1. OTC 2020: SPE-30486-MS – "Unmanned/Minimally Manned Floating Deepwater Installations: Design and Safety Considerations"
2. ABS *Guide for Smart Functions for Marine Vessels and Offshore Units*
3. ABS *Guidance Notes on Smart Function Implementation*
4. ABS CyberSafety™ series
5. ABS *Guidance Notes on Assessment Applications for the Marine and Offshore Industries*
6. ABS *Guidance Notes on Review and Approval of Novel Concepts*
7. ABS *Guidance Notes on Qualifying New Technologies*
8. ABS *Guidance Notes on The Implementation of Human Factors Engineering into Design of Offshore Installations*
9. ABS *Guide for Surveys Based on Machinery Reliability and Maintenance Techniques*
10. ABS *Guidance Notes on Reliability Centered Maintenance*
11. ABS *Guide for Autonomous and Remote-Control Functions*

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