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|  | TECHNICAL SPECIFICATION | Nº I-ET-3000.00-5400-947-P4X-007 | REV. A           |
|   | AREA:                   | -                                | SHEET: 2 of 24   |
|   | TITLE:                  | HUMAN FACTORS ENGINEERING (HFE)  | ESUP<br>INTERNAL |

## SUMMARY

|  |    |
|--|----|
| 1. INTRODUCTION .....  | 3  |
| 2. OBJECTIVES.....   | 3  |
| 3. DEFINITIONS.....  | 4  |
| 4. REQUIREMENTS FOR HFE ACTIVITIES .....                                     | 8  |
| 4.1 CONCEPTUAL DESIGN.....   | 9  |
| 4.2 BASIC DESIGN .....   | 10 |
| 4.3 DETAILING DESIGN.....  | 12 |
| 4.4 CONSTRUCTION AND COMMISSIONING (C&C) .....                               | 15 |
| 5. REQUIREMENTS FOR HFE PROFESSIONALS .....                                  | 16 |
| 5.1 PROJECT DISCIPLINE REPRESENTATIVES (RD's).....                           | 16 |
| 5.2 SPECIALIZED COMPANY FOR QHRA APPLICATION .....                           | 16 |
| 6. REQUIREMENTS FOR HFE ANALYSES .....                                       | 19 |
| 7. REQUIREMENTS FOR IDENTIFICATION OF SAFETY CRITICAL PROCEDURES (SCP) ..... | 20 |
| 8. REQUIREMENTS FOR HFIP CLOSEOUT REPORT CONTENT.....                        | 21 |
| 9. RULES, REGULATIONS, STANDARDS AND CONVENTIONS.....                        | 22 |
| 10. REFERENCE DOCUMENTS .....  | 23 |
| 11. APPENDIX .....   | 24 |

|   |   |   |               |
|---|---|---|---------------|
|  | <b>TECHNICAL SPECIFICATION</b>                | Nº <b>I-ET-3000.00-5400-947-P4X-007</b> | REV. <b>A</b> |
|   | AREA: -                                       | SHEET: 3 of 24                          |               |
|   | TITLE: <b>HUMAN FACTORS ENGINEERING (HFE)</b> | ESUP                                    |               |
|   |   | INTERNAL                                |               |

## 1. INTRODUCTION

The Human Factors Engineering (HFE) consists of the incorporation of human factors in the engineering design process with the main purpose of reducing any risks associated with human factors/ergonomics, as well as the potential for human errors to a level that is as low as reasonably practicable (ALARP).

The principles and technical requirements, hereinafter defined, aim to define how to include due consideration of HF within the engineering design process of the Maritime Production Units, hereinafter designated as Unit, to outline the overall approach to be followed, and therefore to ensure early and appropriate application of HFE at design phase.


Following this Technical Specification (TS) should allow project to demonstrate that sufficient consideration has been given for designing systems and equipment in a way that minimizes potential for design-induced risks to health, personal or process safety or environmental performance.

This TS is applicable only to Petrobras Owned Units that have not started their BID process as of the date of its publication. Units already in the basic design phase are exempt from the conceptual design requirements stated in this publication.

## 2. OBJECTIVES

This Technical Specification is intended to define minimum technical requirements and risk management principles focused on HFE for the following engineering design phases: conceptual design, basic design, detailing design, construction, and commissioning. This TS has as main objectives, the following:


- a) Define scope and criteria for performing the HFE activities for the Unit's engineering design process,
- b) Define responsibilities between the involved parts for HFE of the Unit,
- c) Define the standardization, content, and minimum requirements for the final technical documentation of the analysis, hereinafter designated as Human Factors Incorporation Plan (HFIP) Closeout Report.


|   |                         |                                  |                |
|---|-------------------------|----------------------------------|----------------|
|  | TECHNICAL SPECIFICATION | Nº I-ET-3000.00-5400-947-P4X-007 | REV. A         |
|   | AREA:                   | -                                | SHEET: 4 of 24 |
|   | TITLE:                  | HUMAN FACTORS ENGINEERING (HFE)  | ESUP           |
|   |                         |                                  | INTERNAL       |


### 3. DEFINITIONS


For general technical terms, refer to I-ET-3010.00-1200-940-P4X-002 - GENERAL TECHNICAL TERMS. Some terms used in this TS are explained below.

- 3.1** ALARP (As Low As Reasonably Practicable) - a concept which seeks to ensure that the magnitude of the risk is reduced, through the application of appropriate prevention and control measures, to a level as low as reasonably practicable, and that additional measures to reduce it would be disproportionately costly compared to the potential benefits of these measures.
- 3.2** Buyer - the company that is buying the FPSO, that is PETROBRAS.
- 3.3** Consequence - expressed qualitatively by the degree of severity of damage to human health, environment, economic losses and the company's image, resultant from accidental scenarios.
- 3.4** Cognitive Reliability and Error Analysis Method (CREAM) - qualitative and quantitative method of human reliability analysis to estimate the likelihood of human errors and identify the performance influencing factors during the execution of safety critical tasks. The application of CREAM shall follow the respective standard method (Reference: HOLLNAGEL, 1998).
- 3.5** Closeout Report - final report on the management of safety studies recommendations for each project phase. This report shall reflect the management of the recommendations of the safety studies, evidencing the implementation of the recommendations and technical justifications of those not implemented. For detailing design, this report shall also include the recommendations from HFE activities.
- 3.6** Hazard - condition or property inherent to a substance, activity, system, or process with the potential to cause damage to people, environment, asset, or company's image.
- 3.7** Human Errors - non-intentional human failures, consisting in a sequence of actions or omissions, which did not achieve the intended result, and may cause or contribute to critical accidental scenario, if the acceptability limits defined by the system are exceeded, or may affect its recovery if during a response to the event.
- 3.8** Human Factors (HF) - individual, technological, and organizational factors which influence the human behavior during the execution of activities and may affect the Unit's operational safety.
- 3.9** Human Factors Engineering (HFE) - process of integrating human factors in the Unit's engineering design process (Reference: IOGP Report 454:2020).
- 3.10** HFE activities - encompass the HFE screening, HFE analyses, the consideration of human factors/ergonomics on the risk studies, the Safety Critical Task Analysis

|   |                         |                                  |                |
|---|-------------------------|----------------------------------|----------------|
|    | TECHNICAL SPECIFICATION | Nº I-ET-3000.00-5400-947-P4X-007 | REV. A         |
|   | AREA:                   | -                                | SHEET: 5 of 24 |
|   | TITLE:                  | HUMAN FACTORS ENGINEERING (HFE)  | ESUP           |
|   |                         |                                  | INTERNAL       |
| <p>(SCTA) and the Human Reliability Analysis (HRA), applicable for the Unit's engineering design phases.</p> <p><b>3.11</b> HFE analyses - encompass the 7 (seven) analyses mentioned on Annex D of IOGP Report 454:2020, herein are named TRA, VCA, VPSR, CRAR, HMIAR, AAR and DR, which are more detailed in the next items.</p> <p><b>3.12</b> HFE screening - HFE activity undertaken in the conceptual design, which aims to define the HFE requirements to be accomplished along the engineering design process, through the identification of the relevant HFE issues (such as task complexity, unit criticality, novelty, design scope over HFE aspects, and HFE known problems) and the HFE applicable standards (prescriptive requirements which may include regulatory, international, national, industry and company standards) (Reference: IOGP Report 454:2020).</p> <p><b>3.13</b> Human Factors Integration Plan (HFIP) - plan of application of HFE on the engineering project process (Reference: IOGP Report 454:2020).</p> <p><b>3.14</b> HFIP Closeout Report - HFE final documentation compiling all deliverables of the HFE activities performed during the Unit's engineering design phases.</p> <p><b>3.15</b> Human Error Probability (HEP) - measure of the likelihood that personnel will fail to initiate the correct, required, or specified action or response in a given situation, or by commission performs the wrong action. The HEP is the probability of the human failure event (Reference: The Petro-HRA Guideline, Revision 1, Vol. 1).</p> <p><b>3.16</b> Human Machine Interface (HMI) - interface between the operating staff and the instrumentation and computer systems connected to the Unit (Reference: IEC 60050-394:2007).</p> <p><b>3.17</b> Human Reliability Analysis (HRA) - structured approach which uses qualitative and quantitative method to identify potential human failure events and to systematically estimate the probability (HEP) of those events, taking into consideration the applicable relevant data, models, and expert judgment (Reference: The Petro-HRA Guideline, Revision 1, Vol. 1).</p> <p><b>3.18</b> Critical accidental scenario - scenario with a "Non-tolerable" initial risk level, or "Moderate" initial risk level with severity categories "IV" or "V" for people or environment or "V" for asset, based on the risk's tolerability matrix indicated on Safety Guideline DR-ENGP-M-I-1.3.</p> <p><b>3.19</b> Accidental scenario associated with human factors - critical accidental scenario which can be initiated or caused by human failures or can have its consequences increased by human failures during a response to the event.</p> <p><b>3.20</b> Minimum Effective Staff Analysis - timeline analysis with the aim of defining the minimum quantity of personnel which are essential to safely operate the Unit. It shall be calculated for all tasks which compose the safety critical procedures of the Unit (Reference: Technical Note Nº 10/2023/SSO-CSO/SSO/ANP-RJ).</p> |                         |                                  |                |

|   |                         |                                  |                |
|---|-------------------------|----------------------------------|----------------|
|    | TECHNICAL SPECIFICATION | Nº I-ET-3000.00-5400-947-P4X-007 | REV. A         |
|   | AREA:                   | -                                | SHEET: 6 of 24 |
|   | TITLE:                  | HUMAN FACTORS ENGINEERING (HFE)  | ESUP           |
|   |                         |                                  | INTERNAL       |
| <p><b>3.21</b> Minimum Effective Staff Report - report which documents the relevant information about the Minimum Effective Staff Analysis, including the method used, the premises adopted, the multidisciplinary team of the analysis, and the results achieved.</p> <p><b>3.22</b> Petro-HRA - qualitative and quantitative method of human reliability analysis used to estimate the likelihood of human failures events in the onshore and offshore petroleum industry. The application of Petro-HRA shall follow the respective standard method (Reference: The Petro-HRA Guideline, Revision 1, Vol. 1).</p> <p><b>3.23</b> Recommendations - proposed measures to prevent the occurrence of accidental scenario or mitigate its consequences whenever safeguards are absent, or the existing safeguards are considered insufficient.</p> <p><b>3.24</b> Risk - Combination of the expected frequency of occurrence of an accidental scenario with the severity of its consequence.</p> <p><b>3.25</b> Safeguards - any device, system, or action, already planned in the project or existing in the Unit, capable of interrupting the chain of events that occurs from an initiating event, reducing the probability of occurrence of the undesirable scenario or reducing the severity of its consequences.</p> <p><b>3.26</b> Safety Barriers - all physical and non-physical means designed to prevent, control, or mitigate accidental events. Barriers shall be auditable, effective, and independent of the initiating cause and of another safety barrier related to the same accidental scenario. They include project safeguards, and safety and operational procedures.</p> <p><b>3.27</b> Safety Critical Task (SCT) - task contained in a safety critical procedure and whose execution failure or omission may cause or contribute to an accidental scenario associated with human factors or may not reduce its consequences (Reference: Guidance on human factors safety critical task analysis - EI, 2020).</p> <p><b>3.28</b> Safety Critical Task Analysis (SCTA) - study of what a person is required to do, in terms of actions and mental processes, to achieve a goal during the execution of safety critical tasks, which allow to prioritize, understand, and represent those tasks as input to the Human Reliability Analysis (HRA) (Reference: Guidance on human factors safety critical task analysis - EI, 2020).</p> <p><b>3.29</b> Safety Critical Procedures (SCPs) - procedures composed by a set of tasks which are essential to prevent or mitigate a critical accidental scenario, or whose failure or omission may cause or contribute to its occurrence or affect its recovery. SCPs include those procedures which (i) are considered as premises or safeguards for critical accidental scenario in safety studies, or (ii) encompasses operational maneuvers of safety critical equipment or systems which are performed during emergencies response, or (iii) encompasses functional tests or integrity assurance activities which describes requirements for maintenance, inspection and tests to ensure availability and functionality of safety critical equipment or systems, or (iv) describes a proper contingency for failure or unavailability of a</p> |                         |                                  |                |

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|---|--------------------------------|---|-----------------|
|    | <b>TECHNICAL SPECIFICATION</b> | Nº <b>I-ET-3000.00-5400-947-P4X-007</b> | REV. <b>A</b>   |
|   | AREA:                          | -                                       | SHEET: 7 of 24  |
|   | TITLE:                         | <b>HUMAN FACTORS ENGINEERING (HFE)</b>  | <b>ESUP</b>     |
|   |                                |   | <b>INTERNAL</b> |
| <p>safety critical equipment or system, or (v) are prescribed as critical by BUYER's management system, based on previous events or learned lessons, to prevent "Non-tolerable" occupational accidental scenarios (Reference: PE-2E&amp;P-00261_F - Identification and Management of Safety Critical Elements).</p> <p><b>3.30</b> Seller - the responsible for the detailing design, purchase all instrument, equipment, system, unit, material, assembly and construction, commissioning, lift, hook up, installation and integration of all Modules on the Unit Hull.</p> <p><b>3.31</b> Task Requirement Analysis (TRA) - process of undertaking a review of the tasks to be performed to identify any key HFE requirements to be taken forward for the design. The aim is to early identify any design requirements that should be met to optimize task performance and minimize any operational risk. It is typically carried out for tasks involving novelty, safety critical or known HFE issues, and shall be based on Annex D.1 of IOGP Report 454:2020.</p> <p><b>3.32</b> Valve Criticality Analysis (VCA) - process of valves categorization and prioritization according to their criticality and frequency of operation. The aim is to ensure proper access and visibility to the critical valves for regular or emergency operation and maintenance. It shall be based on Annex D.2 of IOGP Report 454:2020.</p> <p><b>3.33</b> Vendor Package Screening and Review (VPSR) - process of identifying the critical vendor packages, based on criticality and frequency of manual interaction, and the HFENG aspects of the design and layout of the unit which require special attention. It shall be based on Annex D.3 of IOGP Report 454:2020.</p> <p><b>3.34</b> Control Room Analysis and Review (CRAR) - process of reviewing the control room operation, the equipment requirements, the staffing level and roles, and tasks of key operators, aiming to define the specific requirements that need to be addressed. It shall be based on Annex D.4 of IOGP Report 454:2020.</p> <p><b>3.35</b> HMI Analysis and Review (HMIAR) - process of identifying the HF and ergonomics good practice principles and requirements for HMI design, focusing on new HMIs or modifications of existing HMIs if in case, to ensure system "usability" and reduce the potential for human error. It shall be based on Annex D.5 of IOGP Report 454:2020.</p> <p><b>3.36</b> Alarm System Analysis and Review (AAR) - process of identifying the HF and ergonomics good practice principles and requirements for alarm systems design. The output of this process typically forms part of the wider input into HMI analysis and review. It shall be based on Annex D.6 of IOGP Report 454:2020.</p> <p><b>3.37</b> Facility/plant Layout Design Review (DR) - review of the compliance of the HF and ergonomics requirements for workplaces design, ensuring safe and efficient operations, accessibility to equipment, as well as enable operators to move around safely, easily, and efficiently. It shall be based on Annex D.7 of IOGP Report 454:2020.</p> |                                |   |                 |

|   |                         |                                  |                  |
|---|-------------------------|----------------------------------|------------------|
|  | TECHNICAL SPECIFICATION | Nº I-ET-3000.00-5400-947-P4X-007 | REV. A           |
|   | AREA:                   | -                                | SHEET: 8 of 24   |
|   | TITLE:                  | HUMAN FACTORS ENGINEERING (HFE)  | ESUP<br>INTERNAL |

#### 4. REQUIREMENTS FOR HFE ACTIVITIES


The focus of this section is on the application and incorporation of HF considerations to the engineering design process. Ensuring that HFE is properly addressed means that plant, systems, and equipment will be designed to effectively support operator tasks, taking account of human capabilities and limitations. This in turn reduces the likelihood of human errors or their contribution to a MAH, leading to improved Unit's safety and operational efficiency.

Considering Units involve complexity (in terms of technology, tasks, equipment, systems, and layout), high risks for safety, environment, asset, and Company's image, and the historical of issues involving HF, based on the Annex A of IOGP Report 454:2020, this TS pre-sets that HFE strategy to be considered for Units is a "High Estimated level of HF specialist input". Therefore, the HFE strategy requires:

- 1) designated HFE Specialist with suitable level of competence (as per the criteria of IOGP 454:2020 described on item 5) to manage the HFE activities along the design phases,
- 2) integration of HF on the engineering design process, herein designated as Human Factors Engineering (HFE). For Units, the HFE consists of:
  - a) determining the scope of and planning the application of HFE for the Unit's engineering design process (conceptual design, basic design, detailing design, construction, and commissioning),
  - b) carrying out HFE activities to support the engineering design process, including HFE analyses and consideration of HF as input for risk management through the application of HRA method,
  - c) issuing HFE recommendations to be incorporated on the Unit's engineering design process,
  - d) developing HFE plan for construction,
  - e) managing and monitor the closeout of the HFE recommendations,
  - f) documenting the HFE activities and their results, compiling on a final documentation, the HFIP Closeout Report.

The following content provides information about the HFE activities and deliverables required at each stage of the Unit's engineering design process, which is summarized on the workflow attached on **Appendix I** of this TS.



|   |                         |                                  |                  |
|---|-------------------------|----------------------------------|------------------|
|  | TECHNICAL SPECIFICATION | Nº I-ET-3000.00-5400-947-P4X-007 | REV. A           |
|   | AREA:                   | -                                | SHEET: 9 of 24   |
|   | TITLE:                  | HUMAN FACTORS ENGINEERING (HFE)  | ESUP<br>INTERNAL |


## 4.1 CONCEPTUAL DESIGN

In this phase, BUYER shall:

- designate the HFE professionals for the application of HFE on the project, including at least HFE Specialist to manage the HFE activities along the Unit's engineering design process, and HFE Representative to participate of HFE activities as applicable, who shall comply with training and experience requirements described on item 5 of this TS,
- carry out the Unit's HFE screening, proposing the HFE activities to be carried out along the Unit's engineering design process, indicating the operations, systems, equipment, or areas of the Unit applied to them, and the HFE standards to be followed, following the Annex D of IOGP 454:2020 (as per described on item 6),
- issue the Ergonomics Descriptive Memorandum for Basic Design documenting the results of the HFE Screening, and the essential information for the next phase of design, including HFE requirements and activities.
- carry out Preliminary Hazardous Analysis (PHA) considering human factors and identifying preliminarily the Unit's safety critical procedures and the accidental scenarios associated with human factors, following the technical specification [Ref. 1], and with participation of operational team, who shall indicate the safety critical procedures to be considered as reference for Unit,
- issue the PHA Report documenting the preliminary list of accidental scenarios associated with human factors and the preliminary list of Unit's Safety Critical Procedures, presenting a table which correlates both, and following the requirements established on technical specification [Ref. 1],
- manage the Unit's HFE Recommendations List, resulted from PHA, on information management system, and issue the Closeout Report, following the technical specification [Ref. 4],

Table 1: Inputs and outputs for HFE at Conceptual Design.

| Inputs               | Outputs  |
|----------------------|--|
| -Basis of the Design | -PHA Report (Conceptual Design)<br>-Closeout Report<br>-Ergonomics Descriptive Memorandum for Basic Design |

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| <br><b>PETROBRAS</b> | <b>TECHNICAL SPECIFICATION</b> | Nº                                     | <b>I-ET-3000.00-5400-947-P4X-007</b> | REV.     | <b>A</b> |          |
|   | AREA:                          | -                                      |                                      |          | SHEET:   | 10 of 24 |
|   | TITLE:                         | <b>HUMAN FACTORS ENGINEERING (HFE)</b> |                                      |          | ESUP     |          |
|   |                                |  |                                      | INTERNAL |          |          |

### 4.2 BASIC DESIGN

In this phase, BUYER shall:

- a) carry out HFE analyses based on the Ergonomics Descriptive Memorandum for Basic Design, following the Annex D of IOGP 454:2020 (as per described on item 6),
- b) issue Ergonomics Technical Specifications for Unit's hull and topside based on the results of HFE analyses of basic design, indicating the HFE requirements, recommendations, and activities applicable to the next phase of design,
- c) carry out risk analyses (PHA & HAZOP) considering human factors and identifying the accidental scenarios associated with human factors and the Unit's safety critical procedures, following the technical specifications [Ref. 1 and 2], and with participation of operational team, who shall indicate the safety critical procedures to be considered as reference for Unit,
- d) issue the PHA and HAZOP Reports documenting, for each risk analysis, the list of accidental scenarios associated with human factors and the list of Unit's safety critical procedures, presenting a table which correlates both, and following the requirements established on technical specifications [Ref. 1 and 2],
- e) carry out SCTA for Unit's safety critical procedures for identifying, understanding, and representing the Unit' safety critical tasks, which are contained in each safety critical procedure, following the technical specification [Ref. 3], with participation of operational team, who shall provide the safety critical procedures to be analyzed and shall designate the operators to participate on SCTA workshops as applicable,
- f) issue the SCTA Report documenting the list of Unit's safety critical tasks and the list of HFE recommendations, as applicable, and following the requirements established on technical specification [Ref. 3],
- g) manage the Unit's HFE recommendations list, resulted from PHA, HAZOP and SCTA, on information management system, implementing those ones applicable for basic design, and issue the Closeout Report, following the technical specification [Ref. 4],
- h) issue the Ergonomics Descriptive Memorandum for Detailing Design documenting the results of the HFE analyses carried out on basic design, including the HFE recommendations generated, and the essential information for the next phase of design, including HFE requirements and activities.



|   |                                |   |                  |
|---|--------------------------------|---|------------------|
|  | <b>TECHNICAL SPECIFICATION</b> | Nº <b>I-ET-3000.00-5400-947-P4X-007</b> | REV. <b>A</b>    |
|   | AREA:                          | -                                       | SHEET: 11 of 24  |
|   | TITLE:                         | <b>HUMAN FACTORS ENGINEERING (HFE)</b>  | ESUP<br>INTERNAL |

Table 2: Inputs and outputs for HFE at Basic Design.

| Inputs   | Outputs  |
|--|--|
| -PHA Report (Conceptual Design)<br>-Ergonomics Descriptive Memorial for Basic Design | -PHA Report (Basic Design)<br>-HAZOP Report (Basic Design)<br>-SCTA Report<br>-Closeout Report<br>-Ergonomics Technical Specifications for Hull and Topside<br>-Ergonomics Descriptive Memorial for Detailing Design |

|   |  |                                  |                 |
|---|--|----------------------------------|-----------------|
|  | TECHNICAL SPECIFICATION                          | Nº I-ET-3000.00-5400-947-P4X-007 | REV. A          |
|   | AREA:  | -                                | SHEET: 12 of 24 |
|   | TITLE:<br><b>HUMAN FACTORS ENGINEERING (HFE)</b> | ESUP                             |                 |
|   |  | INTERNAL                         |                 |


### 4.3 DETAILING DESIGN

In this phase, the SELLER shall:

- designate a qualified HFE Lead, according to IOGP 454:2020, for managing and carrying out the HFE activities for the detailing design, who shall comply with training and experience requirements described on item 5 of this TS,
- carry out HFE analyses indicated on the Ergonomics Descriptive Memorandum for Detailing Design, following BUYER's requirements and the best practices contained in the Annex D of IOGP 454:2020, which shall be considered as mandatory,
- issue and submit to BUYER's comments the Ergonomic Analyses Reports, documenting the HFE requirements applied and the HFE recommendations generated from HFE analyses carried out at detailing design,
- carry out risk analyses (PHA & HAZOP) reviewing and validating the final lists of Unit's accidental scenarios associated with human factors and Unit' safety critical procedures, based on the technical specifications [Ref. 1 and 2], and with participation of operational team, who shall indicate the safety critical procedures to be considered as reference for Unit,
- issue and submit to BUYER's comments the PHA and HAZOP Reports documenting, for each risk analysis, the final list of accidental scenarios associated with human factors and the final list of Unit's safety critical procedures, presenting a table which correlates both, and following the requirements established on technical specifications [Ref. 1 and 2],
- apply a quantitative human reliability analysis (QHRA) method (limited to Petro-HRA preferably, or CREAM), following BUYER's specific requirements, criteria, standards and documentation and the industry's best practices (see Note 1), to the Unit' safety critical procedures with the purpose of (i) identifying the safety critical tasks contained in each safety critical procedure (see Note 2), and for each safety critical task (ii) identifying the potential human errors (HE's) and the performance influencing factors (PIF's), (iii) estimating the human error probability (HEP), and (iv) proposing additional safety measures (HFE recommendations - see Note 3) for human error reduction, as applicable,

Note 1: In cases which there are no BUYER's specific requirements, criteria, standards, or documentation to be followed, SELLER shall follow the best practice available for the oil and gas industry for the specific subject.

Note 2: for safety critical procedures identified during detailing design, identify the safety critical tasks, contained in each safety critical procedure, applying preferably the SCTA method, following the criteria of the "Guidance on human factors safety critical task analysis - EI, 2020". For safety critical procedures identified during the basic design, consider the Unit' safety critical tasks list contained on SCTA Report from basic design.

|   |                         |                                 |                               |      |                 |
|---|-------------------------|---------------------------------|-------------------------------|------|-----------------|
|  | TECHNICAL SPECIFICATION | Nº                              | I-ET-3000.00-5400-947-P4X-007 | REV. | A               |
|   | AREA:                   | -                               |                               |      | SHEET: 13 of 24 |
|   | TITLE:                  | HUMAN FACTORS ENGINEERING (HFE) |                               |      | ESUP            |
|   |                         |                                 |                               |      | INTERNAL        |

Note 3: the HFE recommendations shall be set with participation of multidisciplinary team, including BUYER's professionals (HFE Representative, operational team, and project engineers).

g) Cancelled,

h) issue and submit to BUYER's comments the QHRA Report, documenting the application of the QHRA method (refer to the item 4.3.f of this TS), including information about the QHRA method applied, the multidisciplinary team involved, the results achieved for each step of the method, the criteria considered for human error reduction, and the compiled list of HFE recommendations generated, following BUYER's specific requirements, criteria, standards, and documentation,

i) carry out a Minimum Effective Staff Analysis, considering regular, degraded and emergency operational modes, applying a timeline analysis method in line with BUYER's specific requirements, criteria, standards, and documentation and the industry's best practices (see Note 4), validate the results with BUYER's team (HFE Representative, operational team, and project engineers, as applicable), and issue the Minimum Effective Staff Report,

Note 4: The recommended references to be followed are (i) "Human factors briefing note no. 11 - Task analysis", Energy Institute, (ii) "Guidance on ensuring safe staffing levels", Energy Institute, and (iii) "A Guide to Task Analysis", B. Kirwan and L.K. Ainsworth, CRC Press.


j) manage the Unit's HFE Recommendations List, resulted from HFE activities (HFE analyses, PHA, HAZOP, SCTA and QHRA), implementing those ones applicable for detailing design, and issue the Closeout Report, following the technical specification [Ref. 4],

k) issue and submit to BUYER's comments the Ergonomic Evaluation Report, documenting the evidence of implementation of the HFE recommendations for detailing design which are resulted from HFE analyses,

l) issue and submit to BUYER's comments the HFIP Closeout Report, documenting the HFE activities performed at detailing design, the HFE requirements applied, and the Unit's HFE Recommendations List, following the item 8 of this TS.

In this phase, BUYER shall:


m) issue the Unit' safety critical procedures considering the HFE recommendations resulted from HFE analyses, PHA, HAZOP, SCTA, QHRA, as applicable, as well as the Minimum Effective Staff Report results, ensuring the participation of a multidisciplinary team (operational team, HFE Representative, and project engineers),

|   |                         |                                 |                               |      |          |
|---|-------------------------|---------------------------------|-------------------------------|------|----------|
|  | TECHNICAL SPECIFICATION | Nº                              | I-ET-3000.00-5400-947-P4X-007 | REV. | A        |
|   | AREA:                   | -                               | SHEET: 14 of 24               |      |          |
|   | TITLE:                  | HUMAN FACTORS ENGINEERING (HFE) |                               |      | ESUP     |
|   |                         |                                 |                               |      | INTERNAL |

- n) apply specific training, involving manufactures and project team, for operators and maintainers involved on the execution of the Unit' safety critical procedures, demonstrating how the human errors and performance influencing factors may contribute to a critical accidental scenario or impact on its recovery, keeping the evidence of training,
- o) apply specific training, involving manufactures and project team, for operators and maintainers involved on the actuation of safety systems, which are actuated manually, or which are automatic, but their failure demands human intervention for recuperation, keeping the evidence of training.

Table 3: Inputs and outputs for HFE at Detailing Design.

| Inputs   | Outputs   |
|--|---|
| <ul style="list-style-type: none"> <li>-PHA Report (Basic Design)</li> <li>-HAZOP Report (Basic Design)</li> <li>-SCTA Report</li> <li>-Ergonomics Technical Specifications for Hull and Topside</li> <li>-Ergonomics Descriptive Memorial for Detailing Design</li> </ul> | <ul style="list-style-type: none"> <li>-PHA Report (Detailing Design)</li> <li>-HAZOP Report (Detailing Design)</li> <li>-QHRA Report</li> <li>-Minimum Effective Staff Report</li> <li>-Ergonomic Analyses Reports</li> <li>-Ergonomic Evaluation Reports (Detailing Design)</li> <li>-Closeout Report (Detailing Design)</li> <li>-HFIP Closeout Report (Detailing Design)</li> <li>-Package of Unit' safety critical procedures and Training Evidence</li> </ul> |

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|---|--------------------------------|---|-----------------|
|  | <b>TECHNICAL SPECIFICATION</b> | Nº <b>I-ET-3000.00-5400-947-P4X-007</b> | REV. <b>A</b>   |
|   | AREA:                          | -                                       | SHEET: 15 of 24 |
|   | TITLE:                         | <b>HUMAN FACTORS ENGINEERING (HFE)</b>  | <b>ESUP</b>     |
|   |                                |   | <b>INTERNAL</b> |


#### 4.4 CONSTRUCTION AND COMMISSIONING (C&C)

In this phase, SELLER shall:

- designate a qualified HFE Lead, according to IOGP 454:2020, for managing and carrying out the HFE activities for the construction and commissioning, who shall comply with training and experience requirements described on item 5 of this TS,
- manage the Unit's HFE recommendations List, implementing those ones applicable for construction and commissioning phase, and issue an update of the Closeout Report following the technical specification [Ref. 4],
- issue and submit to BUYER's comments an update of the Ergonomic Evaluation Report, documenting the evidence of implementation of the HFE recommendations for construction and commissioning phase, which are resulted from HFE analyses,
- issue and submit to BUYER's comments an update of the HFIP Closeout Report, documenting the HFE activities performed at construction and commissioning phase, following the item 8 of this TS,
- perform Design Change Management in case of the need for alterations on project due to infeasibility of the design and/or need for on-site adjustments, documenting all alterations in "as built" models and documents.

Table 4: Inputs and outputs for HFE at Construction and Commissioning.

| Inputs  | Outputs   |
|---|---|
| -PHA Report (Detailing Design)<br>-HAZOP Report (Detailing Design)<br>-QHRA Report<br>-Minimum Effective Staff Report<br>-Ergonomic Analyses Reports<br>-Ergonomic Evaluation Report (Detailing Design)<br>-HFIP Closeout Report (Detailing Design) | -Closeout Report<br>-Ergonomic Evaluation Report<br>-HFIP Closeout Report |

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|---|-------------------------|----------------------------------|------------------|
|  | TECHNICAL SPECIFICATION | Nº I-ET-3000.00-5400-947-P4X-007 | REV. A           |
|   | AREA:                   | -                                | SHEET: 16 of 24  |
|   | TITLE:                  | HUMAN FACTORS ENGINEERING (HFE)  | ESUP<br>INTERNAL |

## 5. REQUIREMENTS FOR HFE PROFESSIONALS

Based on IOGP Report 454:2020, Annex B, the HFE professionals (BUYER or SELLER) shall have the minimum competence, training, and experience requirements, based on the HFE event they will attend, which is defined on **Appendix II**, and the type of role they will perform on a HFE event, as per described on Table 5.

### 5.1 PROJECT DISCIPLINE REPRESENTATIVES (RD's)

Based on the IOGP Report 454:2020, the project RD's (BUYER or SELLER) shall receive a HFE awareness training to encourage appropriate consideration of HFE throughout the design process, to raise awareness of the key HF/ergonomics principles and requirements to be followed, and to ensure that project design personnel know when to seek input from an HFE professional. The project RD's and their substitutes shall comply with the minimum competence, training and experience requirements required for "Level 1 - HFE Support", as per described on Table 5.

### 5.2 SPECIALIZED COMPANY FOR QHRA APPLICATION

For Quantitative Human Reliability Analysis (HRA) application, SELLER shall hire a specialized and qualified company on human reliability analysis which shall comply with the following minimum requirements:

- Have proven experience on QHRA application in the oil and gas industry for at least 2 (two) years,
- Have professionals qualified to lead the QHRA application on the method of analysis (Petro-HRA or CREAM), following the requirements described on Table 5,
- Have qualified and well-dimensioned professional staff to ensure diligence and quality on the QHRA application, following the requirements described on Table 5.

SELLER shall submit the selection of the specialized and qualified company on human reliability analysis for BUYER's approval, evidencing the full attendance of the above-mentioned requirements.






|   |                         |                                  |                  |
|---|-------------------------|----------------------------------|------------------|
|  | TECHNICAL SPECIFICATION | Nº I-ET-3000.00-5400-947-P4X-007 | REV. A           |
|   | AREA:                   | -                                | SHEET: 17 of 24  |
|   | TITLE:                  | HUMAN FACTORS ENGINEERING (HFE)  | ESUP<br>INTERNAL |

Table 5: Qualification requirements for HFE professionals.

| Required Role   | Required Competency Level                                       | HFE Events                  | Competence, Training & Experience Requirements   |
|---|---|-----------------------------|--|
| Support, Participate as non-HF/ Ergonomics professional                           | Level 1 - HFE Support   | HFE Analyses, SCTA and QHRA | <p>Competence - knowledge of the scope and relevance of HFE, awareness and ability to apply HF/ergonomics standards.</p> <p>Training - HFE awareness training as per <b>Appendix III</b>.</p>  |
| Represent HF/Ergonomics Discipline on HFE Events, Participate as HF/Ergonomics RD | Level 2 - HFE Practitioner (herein named as HFE Representative) | HFE Analyses, SCTA and QHRA | <p>Competence - ability to carry out HFE activities and reviews, to produce HFE technical deliverables and to support identification, tracking and resolution of HFE issues.</p> <p>Training - <b>graduation</b> degree level in HF, ergonomics, applied psychology or other relevant degree, and specific training as per <b>Appendix III</b>.</p> <p>Experience - 1 year experience in application of HF within high-hazards industries.</p>   |
| Lead, Manage HFE Application  | Level 3 - HFE Lead (herein named as HFE Specialist)             | HFE Management              | <p>Competence - ability to produce HFE plans, to manage HFE activities throughout the project in accordance with the HFE plan, to lead the HFE professionals, to manage the identification, tracking and resolution of HF issues and to produce, review and approve HF technical deliverables.</p> <p>Training - graduation degree level in HF, ergonomics, applied psychology or other relevant degree.</p> <p>Experience - five or more years' experience in application of HFE within high-hazards industries, including at least two years' experience in the energy sector.</p> |

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|---|--|------|--|-----------------|
|  | TECHNICAL SPECIFICATION                |      | Nº I-ET-3000.00-5400-947-P4X-007   | REV. A          |
|   | AREA: -                                |      |  | SHEET: 18 of 24 |
|   | TITLE: HUMAN FACTORS ENGINEERING (HFE) |      |  | ESUP            |
|   |  |      |  | INTERNAL        |
| Lead QHRA   | -                                      | QHRA | <p>Competence - ability to lead and conduct the participation of a multidisciplinary team on analysis application.</p> <p>Training - graduation degree level in engineering, HF, ergonomics, applied psychology or other relevant degree, and certificate of formal training on the method of the analysis (e.g. for Petro-HRA, Petro-HRA Training, for CREAM, CREAM Training).</p> <p>Experience - evidence of actuation as leader of QHRA application, in the method of analysis chosen to be used (Petro-HRA or CREAM), for at least 3 (three) times in oil and gas industry.</p> |                 |

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|---|-------------------------|----------------------------------|------------------|
|  | TECHNICAL SPECIFICATION | Nº I-ET-3000.00-5400-947-P4X-007 | REV. A           |
|   | AREA:                   | -                                | SHEET: 19 of 24  |
|   | TITLE:                  | HUMAN FACTORS ENGINEERING (HFE)  | ESUP<br>INTERNAL |

## 6. REQUIREMENTS FOR HFE ANALYSES

The HFE analyses to be carried out on a particular Unit's engineering design process may vary, based on the scope of the project and the findings from HFE screening. Based on the IOGP Report 454:2020, Annex D, the HFE analyses required to be carried out for Units are:


1. Task Requirements Analysis (TRA),
2. Valve Criticality Analysis (VCA)\*,
3. Vendor Package Screening and Review (VPSR)\*,
4. Control Room Analysis and Review (CRAR),
5. HMI Analysis and Review (HMIAR),
6. Alarm System Analysis and Review (AAR),
7. Facility/Plant Layout Design Review (DR).

*\*All Vendor Package valves shall be included in Valve Criticality Analysis.*

The HFE analyses shall comply with the BUYER's requirements, described on the "Ergonomics Descriptive Memorial", and with the international standards contained on the IOGP Report 454:2020, Annexes D.1 to D.7.

If any requirement or international standard is not applied for a specific Unit's engineering design, a technical justification shall be registered within the "Ergonomics Descriptive Memorial", which shall be approved by BUYER's HFE Specialist.

Also, the HFE analyses shall be performed by a multidisciplinary team, including Ergonomics/HF, Operation, Process Safety, Process, Electrical, Piping, Instrumentation/Automation and Control, Marine Systems, Architecture, and Arrangement RD's, as applicable.

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|---|-------------------------|----------------------------------|------------------|
|  | TECHNICAL SPECIFICATION | Nº I-ET-3000.00-5400-947-P4X-007 | REV. A           |
|   | AREA:                   | -                                | SHEET: 20 of 24  |
|   | TITLE:                  | HUMAN FACTORS ENGINEERING (HFE)  | ESUP<br>INTERNAL |


## 7. REQUIREMENTS FOR IDENTIFICATION OF SAFETY CRITICAL PROCEDURES (SCP)

The Unit' Safety Critical Procedures shall be identified by SELLER from the Unit's risk analyses (e.g. PHA, HAZOP), following the technical specifications [Ref. 1 and 2], in addition to the prescriptive SCPs defined by BUYER in line with specific standard [Ref. 7].

If the Unit does not have specific procedures issued in the moment of definition of Unit' SCPs list, considering they are issued in a specific timeframe of the detailing design, BUYER shall indicate existed operational procedures to be considered as reference, considering at least the similarity with the Unit (in terms of technology, systems, equipment etc.) and the existence of experienced operators in the reference procedure chosen.

The Unit' SCPs list shall be defined by SELLER and submitted for BUYER's approval.

After BUYER's approval, the Unit' SCPs list shall be used by SELLER for QHRA application. For the reference procedures, a previous adjustment on the operational procedure shall be done with the purpose of adequate them to the Unit's reality in terms of technology, systems, equipment etc., as applicable, before the QHRA application. This adjustment, if applicable, shall be done with participation of BUYER's representatives (operational team, and project engineers), and it shall be evidenced and registered as a step of the QHRA method applied.


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|---|-------------------------|---------------------------------|-------------------------------|--------|----------|
|  | TECHNICAL SPECIFICATION | Nº                              | I-ET-3000.00-5400-947-P4X-007 | REV.   | A        |
|   | AREA:                   | -                               |                               | SHEET: | 21 of 24 |
|   | TITLE:                  | HUMAN FACTORS ENGINEERING (HFE) |                               |        | ESUP     |
|   |                         |                                 |                               |        | INTERNAL |

## 8. REQUIREMENTS FOR HFIP CLOSEOUT REPORT CONTENT

The HFIP consists of the compilation of the minimum following relevant documentation and information related to the HFE activities along the Unit's engineering design process.

1. List of HFE applicable standards (prescriptive requirements),
2. Reference Document, including:
  - a. Ergonomics Descriptive Memorial for Basic Design,
  - b. Ergonomics Descriptive Memorial for Detailing Design,
  - c. Ergonomics Technical Specifications for Hull and Topside (containing the results and recommendations of the HFE Analyses from basic design),
  - d. Ergonomic Analyses Reports (containing the results and recommendations of the HFE Analyses from detailing design),
  - e. Ergonomic Evaluation Reports (containing the evidence of the implementation of the HFE recommendations on detailing design, construction, and commissioning phases),
  - f. Valve Criticality Analysis Closeout Report,
  - g. Alarm Systems Analysis and Review Report,
  - h. Layout Review Closeout Report,
  - i. Unit's risk analyses reports (PHA & HAZOP) from conceptual, basic, and detailing design phases,
  - j. Human Reliability Analyses Reports (SCTA and Petro-HRA/CREAM) from basic and detailing design phases,
  - k. Minimum Effective Staff Report.
3. Table correlating the final lists of Unit' safety critical procedures, safety critical tasks, and the accidental scenarios associated with human factors,
4. Final list of HFE Recommendations (consolidating all HFE recommendations generated from HFE activities along the Unit's engineering design process),
5. Package of the Unit' safety critical procedures issued,
6. Evidence of trainings applied during HFE process.


It is required that the HFIP content includes an executive summary and conclusions, as well as BUYER's comments.

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|---|--------------------------------|---|-----------------|
|  | <b>TECHNICAL SPECIFICATION</b> | Nº <b>I-ET-3000.00-5400-947-P4X-007</b> | REV. <b>A</b>   |
|   | AREA:                          | -                                       | SHEET: 22 of 24 |
|   | TITLE:                         | <b>HUMAN FACTORS ENGINEERING (HFE)</b>  | <b>ESUP</b>     |
|   |                                |   | <b>INTERNAL</b> |

## 9. RULES, REGULATIONS, STANDARDS AND CONVENTIONS


HFE analyses, studies and reports shall comply, but not limited to, with the version valid on the date of signing the contract of the following applicable rules and regulations:

- SGSO - Operational Safety Management System issued by Resolution of the National Agency of Petroleum, Natural Gas and Biofuels - ANP No. 43/2007 (or the one valid for the project timeframe),
- TECHNICAL NOTE Nº 10/2023/SSO-CSO/SSO/ANP-RJ,
- Regulatory Norms (NR's) of the Brazilian ministries whenever applicable,
- IOGP - International Association of Oil & Gas Producers - Report 454 - Human factors engineering in projects - Section 2 (2020),
- ISO 17776 - Petroleum and natural gas industries - Offshore production installations - Major accident hazard management during the design of new installations - Section 2 (2016),
- ABS Guidance Notes for the Application of Ergonomics to Marine Systems,
- ISO 11064, Ergonomic design of control centres (all parts),
- ISA-TR101.01-2022, HMI Philosophy,
- ISA-TR101.02-2019, HMI Usability and Performance,
- EI - Energy Institute - Guidance on human factors safety critical task analysis - Second Edition (2020),
- IFE, The Petro-HRA Guideline, Revision 1, Vol. 1 (IFE/E-2022/001) and Vol. 2 (IFE/E-2022/002),
- HOLLNAGEL, Erik. Cognitive reliability and error analysis method (CREAM), Elsevier, 1998.

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|---|-------------------------|---------------------------------|-------------------------------|------|----------|
|  | TECHNICAL SPECIFICATION | Nº                              | I-ET-3000.00-5400-947-P4X-007 | REV. | A        |
|   | AREA:                   | -                               | SHEET: 23 of 24               |      |          |
|   | TITLE:                  | HUMAN FACTORS ENGINEERING (HFE) |                               |      | ESUP     |
|   |                         |                                 |                               |      | INTERNAL |


## 10. REFERENCE DOCUMENTS

1. I-ET-3000.00-5400-98V-P4X-001 - Preliminary Hazard Analysis (PHA),
2. I-ET-3000.00-5400-98X-P4X-001 - Hazard and Operability Study - HAZOP,
3. ET-3000.00-5400-947-P4X-006 - *Análise de Tarefas Críticas para Segurança* (SCTA),
4. I-ET-3000.00-5400-947-P4X-002 - Management of Recommendations from Safety Studies
5. I-ET-3000.00-5400-947-P4X-001 - Management of Change of Safety Studies,
6. I-ET-3010.00-5520-800-P4X-001 - Supervision and Operation System (SOS) Screens
7. PE-2E&P-00261\_F - Identification and Management of Safety Critical Elements.

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|---|-------------------------|--|---------------------------------|-------------------------------|-----------------|---|
|  | TECHNICAL SPECIFICATION |  | Nº                              | I-ET-3000.00-5400-947-P4X-007 | REV.            | A |
|   | AREA:                   |  | -                               |                               | SHEET: 24 of 24 |   |
|   | TITLE:                  |  | HUMAN FACTORS ENGINEERING (HFE) |                               | ESUP            |   |
|   |                         |  |                                 |                               | INTERNAL        |   |


# 11. APPENDIX

## I - HFE WORKFLOW




I - HFE Workflow.pdf

## II - HFE EVENTS X PARTICIPANTS MATRIX



II - HFE Events X  
Participants.pdf

## III - HFE INTERNAL TRAINING X PARTICIPANTS MATRIX



III - HFE Training  
Requirements X Partic