

PETRONAS TECHNICAL STANDARDS

DESIGN AND ENGINEERING PRACTICE

MANUAL

HUMAN FACTORS ENGINEERING IN PROJECTS

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They are based on the experience acquired during the involvement with the design, construction, operation and maintenance of processing units and facilities. Where appropriate they are based on, or reference is made to, national and international standards and codes of practice.

The objective is to set the recommended standard for good technical practice to be applied by PETRONAS' OPU in oil and gas production facilities, refineries, gas processing plants, chemical plants, marketing facilities or any other such facility, and thereby to achieve maximum technical and economic benefit from standardisation.

The information set forth in these publications is provided to users for their consideration and decision to implement. This is of particular importance where PTS may not cover every requirement or diversity of condition at each locality. The system of PTS is expected to be sufficiently flexible to allow individual operating units to adapt the information set forth in PTS to their own environment and requirements.

When Contractors or Manufacturers/Suppliers use PTS they shall be solely responsible for the quality of work and the attainment of the required design and engineering standards. In particular, for those requirements not specifically covered, the Principal will expect them to follow those design and engineering practices which will achieve the same level of integrity as reflected in the PTS. If in doubt, the Contractor or Manufacturer/Supplier shall, without detracting from his own responsibility, consult the Principal or its technical advisor.

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1. INTRODUCTION

1.1 SCOPE

This new PTS specifies requirements and gives recommendations for the application of Human Factors Engineering (HFE) principles in project design. It identifies best practice HFE procedures to enable project teams to identify what level of HFE input is required and where in a project it would be most beneficial.

This PTS adopts many of the principles and recommendations of human-centred design established in ISO/DIS 6385 and ISO 13407.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by PETRONAS, the distribution of this PTS is restricted to companies forming part of PETRONAS, and to Contractors nominated by them.

This PTS is intended for use in oil refineries, chemical plants, gas plants and, where applicable, exploration and production facilities and supply/marketing installations. When PTSs are applied, a Management of Change (MOC) process should be implemented. This is of particular importance when existing facilities are to be modified.

If national and/or local regulations exist in which some of the requirements may be more stringent than in this PTS the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable as regards safety, economic and legal aspects. In all cases the Contractor shall inform the Principal of any deviation from the requirements of this PTS which is considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned with the object of obtaining agreement to follow this PTS as closely as possible.

1.3 DEFINITIONS

1.3.1 General definitions

The **Contractor** is the party that carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project or operation of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier/Vendor** is the party that manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party that initiates, and ultimately pays for, the project. The Principal will generally specify the technical requirements. The Principal may also include an agent or consultant, authorised to act for the Principal.

The **Purchaser** is the party that buys the equipment and services for its own use or as agent for the owner. The Purchaser may be either the Principal or the Contractor.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

The word **may** indicates a possible course of action.

1.3.2 Specific definitions and abbreviations

BDP	Basic Design Package
BDEP	Basis Design and Engineering Package
CAD	Computer Aided Design
CAPEX	Capital Expenditure
CCR	Central Control Room
CM	Construction Manager
Effectiveness	Accuracy and completeness with which users achieve specified goals.
Efficiency	Resources expended in relation to the accuracy and completeness with which users achieve goals.
EFP	Ergonomics Focal Point
GFT	General Failure Types
HCI	Human Computer Interaction
HRA	Health Risk Assessment (though HRA also means Human Reliability Assessment – an approach used in HFE)
HF	Human Factors
HFE	Human Factors Engineering
HIP	Human Factors Engineering Implementation Plan
HMI	Human Machine Interface
Hotspot	Problem in the past with a specific area of a project
HSE	Health, Safety, Environment
HSE-MS	Health, Safety and Environment Management System
MHMS	Minimum Health Management Standards
OU	Operating Unit
PE	Process Engineer
Performance issue	Opportunity to improve the performance of the system via design
PFS	Process Flow Scheme
PEFS	Process Engineering Flow Scheme
PEP	Project Execution Plan
PET	Project Ergonomics Team
PIP	Project Implementation Plan
PIR	Post Implementation Review
PM	Project Manager
PS	Project Specification
PT	Project Team
RAM	Risk Assessment Matrix
SI-HE	Shell Health Services
Usability	Extent to which a product can be used by specific users to achieve specified goals with effectiveness, efficiency and satisfaction in a specific context of use.

Work system	System in which one or more workers and equipment act together to perform a task that is relevant to the functioning of the system (examples: process units as shown in PEFS, facilities within an office environment, alternative customer service areas etc.)
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1.4 CROSS REFERENCES

Where cross-references to other parts of this PTS are made, the referenced section number is shown in brackets. Other documents referenced in this PTS are listed in (7). Bibliographical information is listed in (8).

2. MANAGEMENT SUMMARY

2.1 GENERAL

The PETRONAS Group's diverse activities require projects to be designed to allow a wide range of end users to reliably use the end product in an effective, efficient, safe, healthy and productive manner. In some cases, the end users may also be members of the public who must interface with certain facilities and products, which requires additional design measures to ensure their health, safety and satisfaction.

Industry today is even more conscious about how people work and recognises that the design of the working environment plays a critical role in the effective functioning of a work system and the productivity a working population can achieve. Any limiting factors that hinder an efficient and effective design, and hence overall system performance, should therefore be properly identified early in the design stages and minimised by a user-centred, participative design approach as outlined in this procedure.

The PETRONAS Group's Committee of Managing Directors (CMD) has endorsed a set of Minimum Health Management Standards (MHMS). These are the *minimum* requirements for the implementation of Health standards where PETRONAS has operational control. At the same time, compliance with the national statutory requirements of each country where the Group operates is mandatory for all aspects of health management.

This PTS is one of several HFE-related PTSs which support the MHMS *Human Factors Engineering (HFE) in New Facilities Projects*, and are designed to support a wide range of projects.

Human Factors Engineering principles shall be considered and applied during the early design stage of new facilities projects where design can have a critical impact on equipment usability and user safety or health.

2.2 GOALS AND OBJECTIVES

The primary goal of this PTS is to help Project Teams with the implementation of HFE principles and to assist PETRONAS OPUs to become compliant with the MHMS *Human Factors Engineering (HFE) in new facilities projects*.

This PTS will ensure that HFE principles are properly considered and applied in the early design stages of new projects where design can have a critical impact on project success.

This PTS also provides a best practice methodology for OUs to meet the mandatory achievement criteria. The process presented and the accompanying appendices provide further guidance to assist in meeting these mandatory criteria; see (3.4).

2.3 TARGET READERSHIP

The target readership for this PTS is primarily the Project Team of new projects. However, Process Engineers, Discipline Engineers, IT designers, Retail station designers and Operations and Maintenance personnel should also refer to this PTS throughout the design of new facilities. This PTS is aimed at the promotion of health, safety, efficiency and usability.

When work systems are changed or new projects are developed there may also be changes in the organisational structure/procedures/practices. As described in (3), HFE considers the organisational elements of projects as well, recognising that the system as a whole must be properly designed. Therefore, Human Resources, Organisational Design and Resource Planners should also make use of this PTS.

2.4 RELATIONSHIP WITH OTHER DOCUMENTS

The PETRONAS Group has a hierarchy of documents dealing with Health, Safety and Environmental issues starting with the *Statement of General Business Principles*. These were issued in March 1997, along with *Group Procedures for an HSE Management System*.

The *Group HSE Management System* (February, 2002) describes how mandatory Group requirements are managed at Group level. Each Group Business Organisation has an HSE-MS.

This PTS should be read independently of all other MHMS governing documents. Following the procedures and achieving the criteria set out in [\(3.3\)](#) constitutes compliance with the Minimum Health Management Standard, *Human Factors Engineering in New Projects*.

3. HUMAN FACTORS ENGINEERING (HFE)

3.1 BENEFITS

NOTE: The term "ergonomics" is used by many organisations and can be considered synonymous with HFE. PETRONAS has adopted the term "Human Factors Engineering" and this term will be used throughout this PTS.

A driving philosophy behind the application of HFE is that strong operational performance starts with good design and that an understanding of what constitutes good design requires a detailed knowledge of how humans interact within the work system.

As a formal definition, HFE is a multidisciplinary field that considers the integrated knowledge of human capabilities, limitations and needs in the interaction between humans, technology and the working environment. HFE is applied to the design of work systems, workplaces and products, with the following objectives:

1. To increase the operational performance, safety, health and comfort of the work system (through attention to safety, operability, maintainability and constructability in design).
2. To reduce the likelihood of or prevent human errors and/or limit the consequences (through attention to human and systems reliability in design).
3. To enhance the productivity of human efforts (through attention to efficiency in design)
4. To enhance overall system performance by improving the ease and efficiency of use (through attention to usability issues in design).
5. To incorporate user knowledge in the design of the system/product (through attention to user acceptability and marketability).

These objectives will form the philosophy of this procedure and be the key drivers in the process outlined in the following sections.

HFE includes the design of user centred products, workstations and work systems. This science also addresses organisational issues and looks at how the job and tasks are structured and designed within a wider context so that all human efforts are optimised.

Some potential benefits of HFE in projects include:

- CAPEX reduction.
- Engineering hours reduction.
- Operational and maintenance life cycle costs reduction.
- Reduced re-work during construction.
- Overall improvement of HSE performance.
- Improved usability of designed products, information technology and buildings
- Enhanced client commitment ('buy in') often resulting in a reduction of approval cycles in the design phase.
- Improvement of knowledge of operations and maintenance tasks during design and engineering leading to improved life cycle cost awareness and cost reduction measures in design.

3.2 HFE IN PROJECTS

Human Factor Engineering shall be applied in the following projects:

- New plants/facilities (onshore and offshore),
- Revamp of existing plant/facility (unless there is no change to the work system, e.g. like-for-like change out, and no benefits from design improvements can be justified).
- Buildings and workstations design (e.g. retail stations, central control rooms, offices, workshops, laboratories);

- IT software/hardware, instrumentation.

An important principle in the approach to meeting the HFE MHMS is that the process of identifying, understanding and specifying the detailed HFE design requirements should be started at an appropriately early stage in the design process, so that these 'requirements' (technical design specifications and/or HFE scopes of work to be executed to derive/check design specifications) are incorporated in the Basic Design and Engineering Package (BDEP) / Project Specification (PS) documents. While further refinement activities may be required at later stages (e.g., in detailed design), this avoids the need to change design at a late stage, when to do so may not be cost effective.

Application of the principle is based on the premise that strong operational performance begins with good design. The operational performance requirements/expectations need to be actively considered in order to specify design requirements that will serve as a platform for desired performance levels.

3.3 HFE IN DESIGN

At a high level, the key design principles that should be considered include the need for a user-centred, integrated, proactive and participative approach to design. HFE principles have been developed for a range of work contexts and are all aimed at guiding the designer in the achievement of fit for purpose work systems.

The user-centred design approach should be initiated at the development phase. While HFE efforts are initiated at the development stage, the overall HFE input may well span the entire development and implementation phases.

Design activities shall be addressed from an HFE standpoint and shall not only cover hardware and software, but also consider other critical issues and design interfaces that arise from a project such as organisational design, work cycles, locations, job/task design, and operational and manning philosophy.

The following aspects shall be addressed:

1. Critical impact - This is where poor design can have a negative impact on task and system performance.
2. Equipment usability - This describes the ease with which people interface with machines or technology.
3. User safety and health - Human performance during work is optimised by a user centred design approach, leading to a safe, comfortable and healthy working environment that minimises the likelihood of human error and work related injuries or ill health. Safety refers to occupational health and safety and also major hazard safety.

The HFE design analysis process is detailed in [Appendix 4](#).

3.4 ACHIEVEMENT CRITERIA

The Minimum Health Management Standard is achieved when:

1. All new facilities projects are reviewed for minimum HFE requirements.
2. Where the screening indicates that HFE input is necessary, the location or business applies the correct processes, tools and competencies at the correct stages of the project.
3. The HFE recommendations have been discussed with management and action parties and target dates agreed.

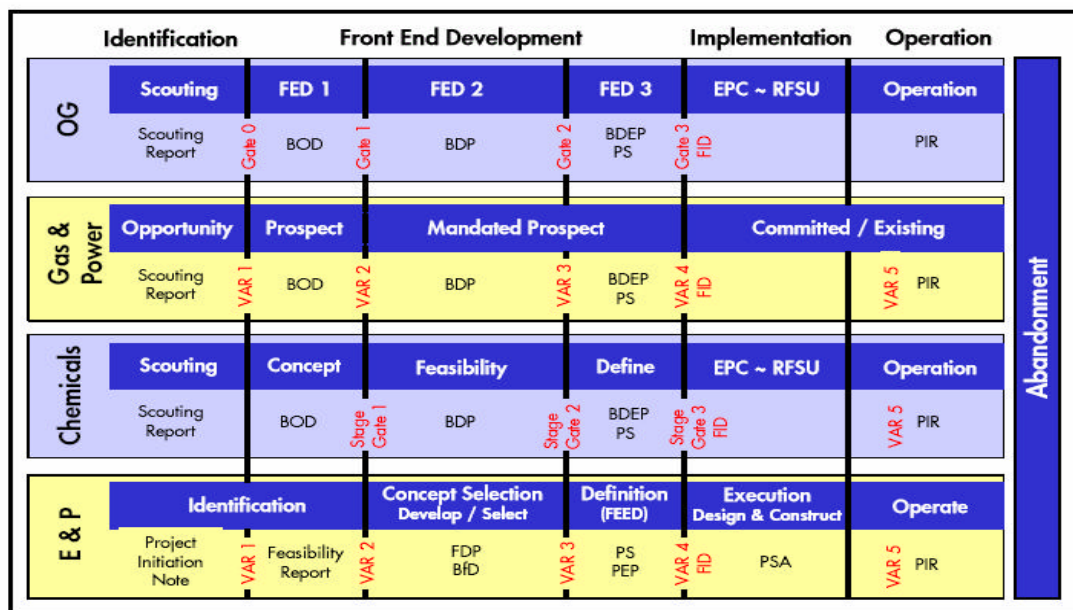
4. APPLICATION OF HFE IN PROJECTS

4.1 GENERAL

This section describes how Human Factors Engineering is applied in projects and which person(s) is/are responsible for HFE implementation at which stages of design, and recommends appropriate tools to carry out these activities.

To enable the HFE base case model to be used by other business sectors, Figure 1 below illustrates the relationship between OG nomenclature and that used in other sectors.

Figure 1 Overview of project phases and decision points for different PETRONAS businesses



The next Section (4.2) provides a detailed description of the activities in the HFE road map with reference to the appropriate appendices.

4.2 DESCRIPTION OF ACTIVITIES

4.2.1 General

Figures 2 and 3 below illustrate the flow of required HFE activities during the life cycle of new projects. In the left hand column of the flow scheme are the necessary inputs into the process. The middle column lists the activities that take place during the design stage. The right-hand column lists the required documents (in green) that must be produced in order to document HFE results and meet audit requirements.

The process shall be auditable according to the Auditing Guidelines in PTS 30.00.60.14 Sections [\(4.2.2\)](#) through [\(4.2.3\)](#) provide a description of the HFE activities and follow [Figures 2](#) and [3](#).

Tools to help identify whether and where HFE is required are provided as good practice guides e.g. in [Appendices 1](#) and [2](#) of this PTS and in PTS 30.00.60.12

PTs having similar tools that allow the above goals to be achieved can use their existing good practices/tools to carry out the activities presented in this PTS. An audit trail is however required.

To assist Project Teams in completing the content of the Focusing and Work Systems Tools, an example of this work process is provided in [Appendix 6](#).

Figure 2 Flow schemes of HFE activities during Project Development Phase

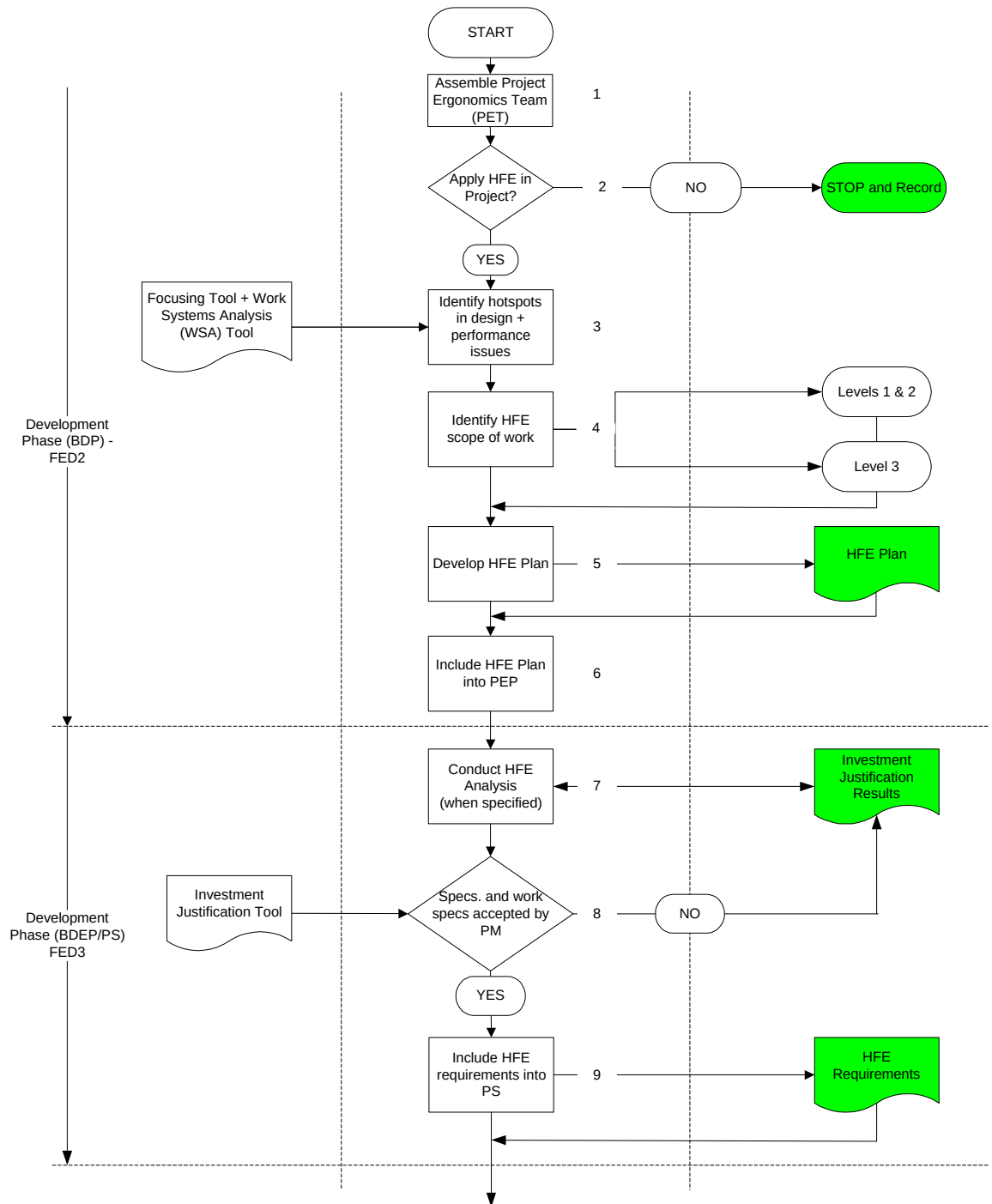
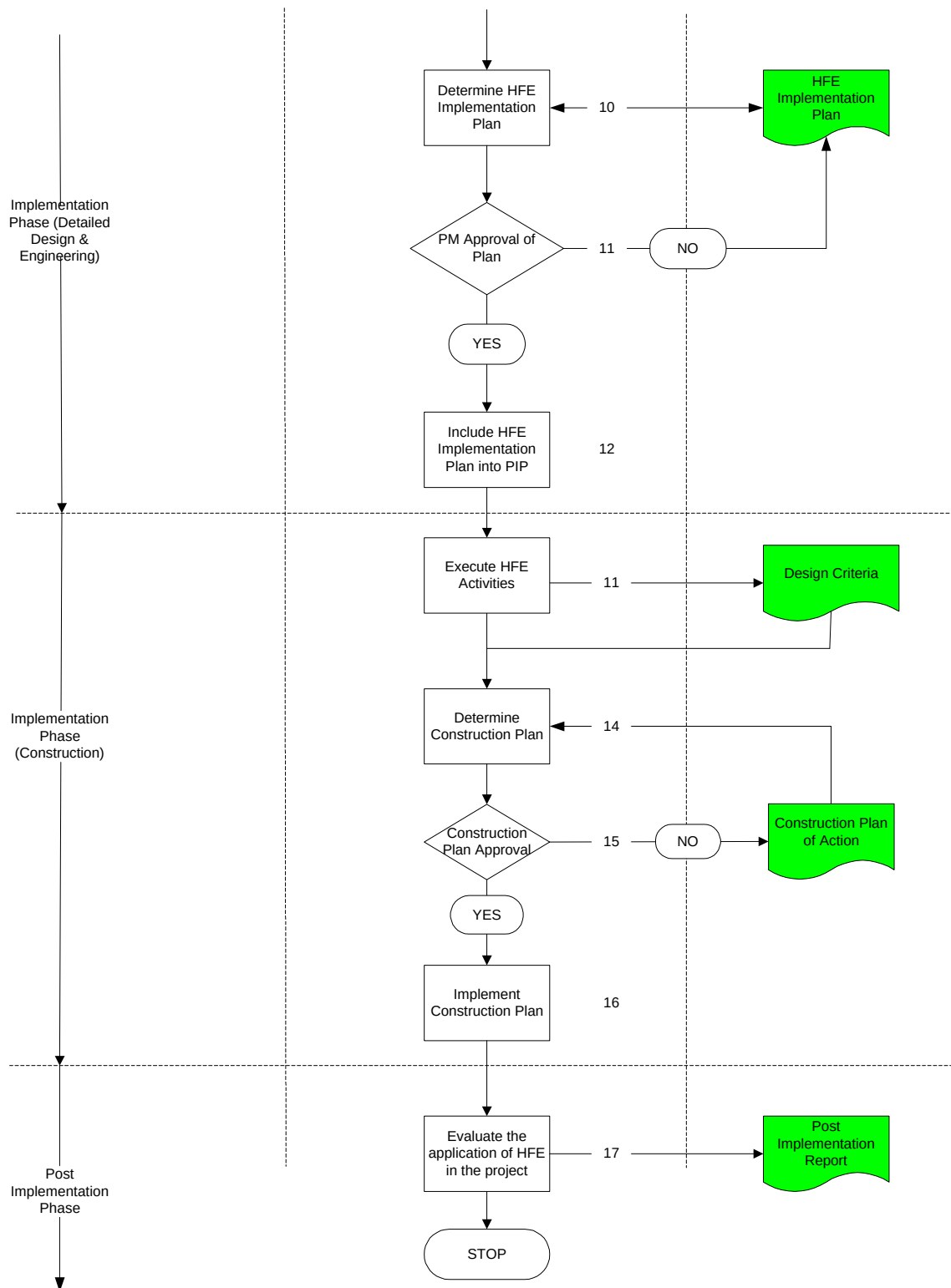


Figure 3 Flow scheme of HFE activities during Project Implementation Phase



4.2.2 Project Development (Figure 2)

4.2.2.1 Basic Design

1 Assemble Project Ergonomics Team (PET)

The PET meets at the beginning of the Basis of Design Phase, and shall include the:

- Project Manager, Project Engineer;
- Process Engineer;
- Operations/Maintenance representative.

2. Apply HFE in Project

The Project Manager shall address this question in order to assure that the project complies with MHMS (3.3).

3. Identify Design Hotspots and Performance issues

This is achieved by means of the HFE Focusing Tool (Appendix 1), and the Work Systems Analysis Tool (Appendix 2). These tools are used to help identify relevant Performance Factors in the project that may require more detailed thought and HFE attention.

The PET shall consider the 10 Performance Factors in the HFE Focusing Tool through discussion of past experiences from similar projects and knowledge of the current project. Such discussions shall be open with participation from all relevant team members. Where specific past experience is not known or clearly understood, it should be captured and evaluated for the purposes of the current project, e.g. by identifying end users with the required experience and competence, and by analysing the data and root causes of any accidents and incidents (e.g. from Tripod Beta databases, HFE relevant general failure types, and the associated organisation and procedures).

Once it has been established which specific design aspects would benefit from attention, those hotspots and associated performance issues shall be recorded within the project Work Systems Analysis Tool.

The Work Systems Analysis Tool is used by the PET to identify the work systems of the project that will benefit from HFE efforts with respect to the performance factors identified by means of the HFE Focusing Tool.

4. Identify HFE Scope of Work

Figure 4 (Appendix 2) assists in determining the appropriate level of HFE activity in order to achieve the desired design and performance outcome. Table 5 (Appendix 2) outlines the criteria for the three levels of HFE effort that may be applied.

Any Level 1 HFE input required (application of HFE specs alone) must adhere to the criteria laid out in Table 5. Activities for this level will not require the involvement of additional HFE competence (other than the awareness training that the team has already undertaken).

Identified Level 2 activities are carried out by a competent individual (6) and are incorporated as part of the regular review procedures of the project (e.g. at 30 %, 60 % and 90 % completion). This individual shall perform required reviews from the necessary HFE perspective.

For Level 3 activities, it will have been decided by the PET that either additional scrutiny of a particular project aspect is required (using a more formal front end HFE requirements identification tool) in order to identify key issues and requirements, or/and particular actions have been identified that will require specific targeted scopes of work to achieve the end result. For either of these, Human Factors Engineer (i.e. a skilled or mastery level HFE professional (6)) will be required to assist.