

PETRONAS TECHNICAL STANDARDS

DESIGN AND ENGINEERING PRACTICE

MANUAL

HUMAN FACTORS ENGINEERING - VALVE ANALYSIS

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The objective is to set the recommended standard for good technical practice to be applied by PETRONAS' OPU/Divisions 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.

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1. INTRODUCTION

1.1 SCOPE

This PTS specifies requirements and gives recommendations regarding key HFE principles relating to valve design and layout, and describes a valve identification and classification procedure (Identification of valves Analysis, IVA). The PTS shall be applied as part of an overall HFE scope of work within a project.

This PTS can typically be applied in the following cases:

- New project plants/facilities (on and offshore), where process engineering is involved;
- Revamp/change of an 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). This includes cases where new valves are to be fitted on existing plants, or where functions of existing present valves are to be changed.

This PTS is intended for use during a project's front-end development, and is followed up in the implementation phase, in conjunction with the overall approach outlined within PTS 30.00.60.10, where it is best executed as part of the HFE Design Analysis. The valves analysis should be commenced as soon as PEFS become available for the project.

NOTE: The term "ergonomics" is used by many organisations and can be considered synonymous with Human Factors Engineering.

This PTS should be read in conjunction with the following other PTS in so far as they cover additional aspects of valves:

- Human Factors Engineering in Projects – PTS 30.00.60.10.
- Human Factors Engineering - Investment Justification Model PTS 30.00.60.12
- Piping – General Requirements PTS 31.38.01.11
- Plant Model Construction and Review PTS 30.10.05.11
- Steel Structures PTS 34.28.00.31

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by PETRONAS, the distribution of this document is restricted to companies forming part of or managed by 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 PTS are applied, a Management of Change (MOC) process should be implemented. This is of particular importance when existing facilities are to be modified.

This PTS is not sensitive to local legislation and is based on internationally recognised Human Factors Engineering standards and Shell best practices (i.e. other HFE PTS).

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

BDEP	Basic Design and Engineering Package
CAPEX	Capital Expenditure
HFE	Human Factors Engineering
FEEE	Front End Ergonomics Evaluation
MOV	Motor Operated Valve
PEFS	Process Engineering Flow Scheme
PT	Project Team
ROV	Remotely Operated Valve

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 (4).

2 GENERAL INFORMATION

2.1 APPLICATION OF HFE PRINCIPLES IN DESIGN AND ENGINEERING

HFE is the process of integrating human capabilities, limitations, requirements and expectations in the design of products, workplaces or work systems (plant/facility) resulting in the effective, efficient, safe and healthy functioning of human beings, thereby improving operational and maintenance task performance. The benefits identified relate both to business (economics) and to working conditions, resulting in a reduction of the life-cycle costs of a facility, see also PTS 30.00.60.12.

2.2 KEY HFE PRINCIPLES RELATING TO VALVE DESIGN AND LAYOUT

Key principles include:

- Fit the task to the person (shape design around people's needs):
 - i.e. design to optimise human performance of a task by clearly understanding the task, and the influence that design may have in supporting the task execution.
 - Valves shall be designed, arranged and labelled so that they can be accessed safely and efficiently; the required valve can be visually identified and distinguished without error; the information required for decision making is provided; and the physical and mental workload required remains within reasonable limits. Task demands should not exceed operator capabilities.
- Design influences behaviour; identify and apply design features that positively encourage and support desired behaviours. Do not inadvertently encourage unsafe or inefficient behaviours through poor design:
 - The designer should support operational tasks and reduce the likelihood of procedural violations by making the correct way the easy way.
- All valves, the accessing thereof and their associated workspaces shall be designed to foster:
 - Effective and efficient work procedures and work patterns;
 - High standards of personnel health and safety;
 - The minimisation of factors that contribute to human error;
 - High levels of human and system performance.
- Valves should be located so that the operator does not have to stand on, or access them by means of, adjacent pipe-work, pipe-racks, cable trays, handrails, or any other equipment or object not specifically meant to be used in that way in order to operate them.
- Hand wheels on all valves shall conform to the operational stereotype of requiring to be turned in an anticlockwise direction for opening and a clockwise direction for closing.
- Valve stems shall be checked in both their closed and open position when assessing clearance envelopes for operation and ensuring that stems do not constitute a potential obstruction hazard to operators (e.g. protruding into an escape route or walkway).
- Valves for emergency operations shall be operable from ground level, adequately protected from an emergency scenario, and provided with a means to establish rapid and clear feedback on their successful operation.

- Control valve assemblies should be located at ground level or on the first platform, except if otherwise required for process reasons, in which case their accessibility shall be duly considered.

Additional principles and design guidelines can be found in [Appendix 3](#).

2.3 AIMS AND BENEFITS OF APPLYING THE IVA

IVA stands for Identification of Valves Analysis, and is a valve identification and classification procedure. The overall aim of this procedure is to ensure that **all valve configurations are well designed from an operational task performance perspective**, and to avoid **design misfits in category 1 valves (critical)**. A key objective is to ensure that **valves are properly categorised and prioritised at an early stage in design**.

The expected results of and benefits from the proper application of the procedure include:

In the design phase:

- Reduced engineering hours (less re-work) through earlier and more explicit communications between Principal and Contractor on expectations regarding ergonomics and general operability;
- More efficient approval cycle through application of an early and “right first time” approach;
- More efficient and focused model reviews (2D and/or 3D CAD) with better traceability of design requirements and trade-offs;
- Potential reductions in CAPEX through reduction of (permanent) steel structures as a result of a tighter categorisation of Category 1 valves.

In the operational phase:

- Improved satisfaction on the part of the Principal's personnel (i.e. end users in operations)
- Reduced OPEX through reduced modification costs;
- Lower life-cycle operations costs through more efficient and effective performance of tasks by operators;
- Better plant operability and reliability; i.e. more efficient inspection and operation through:
 - o Easier visual perception of and physical access to valves;
 - o More efficient grouping of valves at convenient points for daily inspection rounds and operation (e.g. valves placed on same deck or access platform level and in a specific location that is aligned with the operator's preferred route, lines of sight and task requirements);
- Improved emergency response through quicker and more accurate identification, access, operation and status feedback of valves;
- Improved safety, and less likelihood of error in valve identification and operation (e.g. through effective and consistent labelling, and good visibility from operator positions); desired task behaviours are encouraged and undesirable behaviours discouraged through attention to targeted design features;
- Fewer health problems (e.g. from induced muscular-skeletal strain caused by poor design that causes operators to adopt awkward postures or requires forces to be exerted that exceed their capabilities).