

PETRONAS TECHNICAL STANDARDS

DESIGN AND ENGINEERING PRACTICE

MANUALS

ACTUATED VALVE MANAGEMENT STRATEGY

PTS 32.36.01.19

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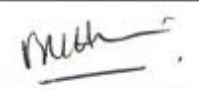
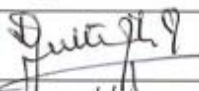
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This new PTS **32.36.01.19 – Actuated Valve Management Strategy (February 2010, Revision 0)** has been developed to provide guide in actuated valve management.

This PTS also includes PETRONAS Lessons Learnt and PETRONAS Best Practice for the subject matter **Actuated Valve Management Strategy**.

Document Approval

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PREFACE

PETRONAS Technical Standards (PTS) publications reflect the views, at the time of publication, of PETRONAS OPU/Divisions.

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/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 OBJECTIVE

This Strategy document, developed and approved by the SKG 14 (Instrumentation and Control) Technical Professionals and Technical Managers, provides the Best Practice framework for the execution of a Total Control Valve Management Strategy in PETRONAS. Control valves are the final element in an instrument loop and are a critical component in ensuring safe and reliable operation of the process. The intent of this strategy is to ensure that control valves in PETRONAS are designed, maintained and managed in the on-shore and off-shore process facilities in a fit-for-purpose manner, to safely deliver its best returns on investment to PETRONAS at optimum cost.

1.2 SCOPE OF COVERAGE

The scope of coverage for this strategy are as follows:

1. Engineering Design
2. Procurement
3. Installation
4. Commissioning
5. Maintenance
6. De-commissioning

For the context of this document, “actuated valves” are defined as all pneumatic (air and gas) and hydraulic actuated valves used in Emergency Shutdown (ESD), depressurizing valves, deluge valves, throttling control and on-off/sequence control.

The Instrument Engineer's scope of responsibility for the control valves covers all the process units, package units and rotating equipment packages. Hence, control valves, such as, anti-surge valves, tuning of control valves, where applicable, falls under the responsibility of the Instrument Engineer and not under any other discipline engineers' responsibility.

Specifically excluded from the coverage of this document are:-

1. Manual, hand-operated valves
2. Relief valves
3. Breather valves or vacuum Breakers
4. Motorized valves, except where 4-20 mA signals or Fieldbus signals are used. In such cases, the Instrument Engineers shall assist the Electrical and Mechanical Engineers.

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** 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 the project and ultimately pays for its design and construction. The Principal will generally specify the technical requirements. The Principal may also include an agent or consultant authorised to act for, and on behalf of, the Principal.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

1.3.2 Specific Definitions

ANSI	American National Standards Institute
API	American Petroleum Institute
BEC	Basic Equipment Care
BOM	Bill of Material
CBM	Condition Based Monitoring
CM	Corrective Maintenance
DCS	Distributed Control System
DEMM	Design Engineering Management Manual
ECA	Equipment Criticality Assessment
EPC / EPCC	Engineering Procurement Construction / Engineering Procurement Construction and Commissioning
ESD	Emergency Shutdown
GSCMD	Group Supply Chain Division
GTS	Group Technology Solution
H₂S	Hydrogen Sulfide
HIPPS	High Integrity Pressure Protection System
iAMS	Instrument Asset Management System
IPF	Instrument Protective Function
iPOCS	PETRONAS Plant Operating System
ITB	Invitation To Bid
MOC	Management of Change
MTBF	Mean Time Between Failure
NSR	Non-Standard Repair
OEM	Original Equipment Manufacturer
P&ID	Piping and Instrumentation Diagram
PEFS	Process Engineering Flow Scheme
PLC	Programmable Logic Controller
PMMS	PETRONAS Maintenance Management System
PPM	Planned Preventive Maintenance
PRM	Proactive Maintenance
PST	Partial Stroke Test
PTFE	Polytetrafluoroethylene
PTS	PETRONAS Technical Standard
QA/QC	Quality Assurance / Quality Control
RFQ	Request For Quotation
RFSU	Ready For Start-Up
PMMS	Computerized Maintenance Management System
SIL	Safety Integrity Level
SkG	Skill Group
SME	Subject Matter Experts
SPIR	Spares Parts Interchangeability Records
TA	Turn-Around
TP	Technical Professional
TSO	Tight Shut-off

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 [\(10\)](#).

2. STRATEGY FRAMEWORK

This overall control valve management strategy provides greater emphasis on accountability and responsibility of the control valve performance on the Instrument TP. The strategy requires the proactive “hands-on” execution by the Instrument TP. The strategy covers the entire scope of the control valve management, from design up to decommissioning. This strategy shall apply to both Upstream and Downstream process facilities.

This strategy encompasses the existing PTS and GTS guidelines already in place. This strategy intends to specify the exact requirements to be in place in all stages of the control valve management. Failure at one stage of the management will result in failures at the subsequent stages. Hence, the responsible Instrument TPs shall institute all the requirements specified in this document at the earliest opportunity.

This strategy constitutes a joint effort by the Group Instrument TPs and shall be subjected to updates from time to time.

3. SCOPE OF RESPONSIBILITY

The following shall be the general Roles and Responsibilities of the various categories of engineers and managers

1) Technicians

Execution of specific activities as directed.

2) Technical Trade Specialists (TTS)

- a. Overall health and maintenance of the control valves;
- b. Leading front line performance and health monitoring;
- c. Control valves tuning;
- d. Leading control valve repair and overhauls;
- e. Inspection and verifications of spares and assemblies;
- f. Control valves specific procedures and Job Safety Analysis (JSA);
- g. Logistic requirements for control valve maintenance;
- h. Monitoring and verifying contractor performance;
- i. Update Engineers, TPs and TMs on issues and findings;
- j. Seek guidance from Engineers and TPs as required.

3) Instrument Engineer (E1 / E2)

- a. Generate and maintain control valve database, such as,
 - i. Equipment master list;
 - ii. BOM.
- b. Generate and maintain control valve engineering documents, such as,
 - i. Specification data sheet;
 - ii. Design drawing such as dimensional drawings, assembly drawings, etc.;
 - iii. Sizing calculations;
 - iv. Installation drawing;
 - v. Procurement requirements.
- c. Generate and maintain control valve maintenance strategy, such as,
 - i. Identify MTBF of control valves;
 - ii. ECA;
 - iii. Service history;
 - iv. Spares requirements, including Spares Parts Interchangeability Records (SPIR);
 - v. Budgeting requirements.
- d. Perform PMMS transactions such as,
 - i. Work order transactions, including close out of technical reports;
 - ii. Material reservations;
 - iii. Generate and verify material coding;
- e. Seek TP guidance as and when required.

4) Instrument TP

The responsible person (s) for the total safe design, operation and maintenance of the control valves shall be the Instrument Technical Professional (TP). The instrument TP shall regularly update the Technical Manager on control valves performance and issues. Generally, the responsible Instrument TP shall be the individual (s) responsible for the correct sizing, selection and specification of the control valve to be installed in the process.

The Instrument TP shall be responsible for the technical review and approval of all documents. The Instrument TP shall also be responsible to review and approve non-standard sizing and non-standard repairs and shall be in line with company MOC procedures. The Instrument TP shall execute functions such as :-

- a. Developing strategies to ensure long term availability and reliability of the control valves;
- b. Analyze control valve performance;
- c. Provide proactive and reactive solutions to control valve issues;
- d. Be the Benchmarking focal person.

The level of TP approval, responsibility and accountability shall be based on the degree of complexity of the control valve and the severity of the process. Generally, the following should be the guidelines:-

- i. Blow-down valves;
- ii. Anti-surge valves;
- iii. Flashing services;
- iv. Steam conditioning valves;
- v. Cryogenic services where the process temperature is less than -101 °C;
- vi. Oxygen services where content of oxygen is more than 35%;
- vii. Toxic services;
- viii. High capacity control valves where the globe valve is greater than 12", ball valve greater than 24" and/or butterfly valve greater than 48";
- ix. Low capacity control valves where the Cv is less than 0.05;
- x. High temperature applications where the temperature is greater than 200 °C.

5) Custodian TP

Incumbent shall be consulted on need basis to provide the necessary technical guidance and shall take the accountability and responsibility on the advice provided. The Custodian TP shall set the overall strategic technical directions on control valves, within the incumbent's sphere of responsibility and influence. The Custodian TP shall be the only authority to approve deviations from the PTS and company technical guidelines. When such authority is exercised, the endorsement shall be documented, complete with technical reasoning.

6) Instrument Technical Manager

The Technical Manager (TM) has overall responsibility on the total plant instrumentation asset. The TM shall provide the overall strategic business directions and allocate the resources necessary to ensure the safety, reliability and availability of the plant.

The TM shall consult the Instrument TPs on control valve technical issues and execute the business evaluation of recommendations by the Instrument TP, before the final management endorsement. The TM shall approve all control valve documents, as per the company LOA.

Every project, revamp and maintenance teams shall identify the responsible and accountable parties for control valves. For OPU's that have control valve issues and where TPs are not available in-house, the OPU's shall consult neighboring OPU TPs or GTS TPs to provide the necessary recommendations.

4. ENGINEERING DESIGN

The engineering design takes place at the start of a project or plant change. The work process of the engineering design shall generally follow the DEMM procedures. The control valve selection process shall generally follow the relevant PTS. In event of conflict between the DEMM and any PTS, the responsible TP shall exercise the necessary engineering judgment to resolve the conflict in a technically sound manner.

It is the responsibility of the Process engineers to provide relevant process data to the Instrument Engineers to execute the control valve engineering design.

4.1 SELF ACTING REGULATING VALVES

Self-acting regulating valves shall only be used in non-critical applications, such as, utility services, chemical injection applications, where control to within 10% is acceptable. Actuators for self-acting regulating valves shall be capable of withstanding the maximum upstream design pressure.

4.2 ESD VALVES

All ESD valves shall have its SIL classification and required test frequency documented. All efforts shall be taken to ensure that the required test frequencies are met. The IPF Studies conducted during the design stage shall account for all operational constraints in conducting the ESD valve testing. In the event that the required ESD valve test frequencies cannot be met during the operational phase, the responsible TP shall ensure that the necessary risk assessments are conducted and documented. The documentation shall also cover the operationally acceptable test frequencies and the responsible TP shall ensure that these test frequencies are operationally executed.

For ESD valves that are also used as sequence shut-off valves, the operation/stroking of the valves shall be logged by the control system to provide record of the valve stroking, including stroking time where applicable, in-lieu of specific test.

4.3 PARTIAL STROKE TEST (PST)

The use of PST may be considered for ESD valves that are unable to meet the required test frequencies determined from the IPF Studies. The use of external independent PLCs and use of pneumatic switches shall not be used for PST.

PST shall not be used for SIL 4 or HIPPS applications.

The design of PST on ESD valve shall not hinder the activation of the ESD valve by the ESD system, in event the PST is in progress i.e. the activation of the ESD signal shall override the PST requirements to ensure that the ESD function takes place. In the event that mechanical PST are used, documented procedure shall be put in place to enable activation of the ESD valve, in event of activation of the ESD signal from the ESD system while the PST is in progress.

The usage of any PST on a ESD valve shall require a documented procedure to be put in place when the PST shall be activated, managed during normal operation, the analysis required to be undertaken and mitigation actions to be taken in event of failure of the PST.

4.4 HANDWHEELS

The need for a handwheel on a control valve shall be clearly documented. The documentation shall clearly indicate :-

- a. conditions on when the handwheel shall be used during normal operation of the process;
- b. how the Operations personnel shall control the process, using the control valve wheel, during normal process operation.

The documentation may be prepared by Process Engineers or Operations Engineers or the Process Designers. However, the documentation shall be approved by the responsible Instrument TP. If the purpose for usage of a handwheel during normal operation cannot be justified, a handwheel shall not be installed on the control valve.

For existing process facilities where the documented need for handwheels are not available, such documentation shall be prepared and approved by the responsible Instrument TP within six (6) months of issuance of this document. Where the need for handwheels cannot be justified, preparations shall be made to remove the handwheels at the next available opportunity.

4.5 POSITIONER

To enable on-line diagnostics, use of intelligent valve positioner is strongly encouraged. However, the use of these intelligent positioner shall be accompanied by a documented method of how the functional features of the intelligent positioner shall be utilized on-line, during normal operation, to maximize availability and reliability of the control valve i.e. a document on how on-line control valve Asset Management shall be executed utilizing the intelligent positioner.

If there is no intention to set-up a control valve on-line Asset Management System, then the cheaper and standard electro-pneumatic positioner should be considered.

In normal installations, the valve characteristic is base on trim design and the characteristic set in positioner is always linear. In the case where the valve characteristic needs to be set at the positioner, approval from the responsible TP is required. The valve position scale shall also be change to the respective positioner characteristic to ensure correct position is shown by the pointer.

4.6 ACCESSING MOUNTING INSTALLATION

Generally, not more than 3 accessories, including the positioner, should be mounted directly on the actuator. If more than 3 accessories are required, the mounting of these accessories, except the positioner, should be on a separate panel close to the control valve.

4.7 CONTROL VALVE SPARES

The responsible Instrument Engineer for the procurement of new control valves, either for new projects, revamp or replacement, shall be responsible to ensure that all the required commissioning spares and maintenance for 2 years of operation are coded into the PMMS system or the equivalent computerized Materials Spare Parts Requisition System. As a minimum, the commissioning spares shall comprise of one set of body internal gaskets for each type of control valve.

The responsible Instrument Engineer for the procurement of the control valves shall also ensure that all the required spares Bill Of Materials (BOMs) are coded into the PMMS PETRONAS Maintenance Management System or its equivalent

4.8 TECHNICAL REQUISITION DOCUMENT

The technical requisition document for the purchase of complete new control valve either for a new project or for a revamp project or for a replacement shall require the approval of the responsible Instrument Engineer.

5. PROCUREMENT

5.1 MANUFACTURER SELECTION

The manufacturer selected for procurement of new control valves shall be only from the manufacturers endorsed by SKG 14. This requirement shall also apply to third parties engaged by PETRONAS to execute the project procurement works, such as EPC or EPCC contractors and consultants.

5.2 REQUEST FOR QUOTATION (RFQ) OR INVITATION TO BID (ITB)

The RFQ or ITB technical document shall be approved by the responsible Instrument Engineer, as laid out in Section 6.

The technical evaluation of the RFQ or ITB shall be executed by the responsible Instrument Engineer.

5.3 SPARES PROCUREMENT

All spares purchased for the control valves shall only be procured from the PETRONAS authorized agents of the valve manufacturer or the component Original Equipment Manufacturer (OEM). Control valve spares shall not be procured from the third party "trading houses". Similarly, the use of "equivalent parts" is not allowed i.e. only original OEM parts shall be procured. The responsible Instrument Engineer shall be held accountable, responsible and liable for the spares purchased and installed into the control valves.

5.4 PRESERVATION

5.4.1 Complete Valves

Complete valves shall be shipped with all open connections, from valve body connections to cable entries and tubing connections, sealed from ingress of moisture and foreign materials during shipment and storage. The seals shall not be removed unless for inspection or when ready for installation. Upon completion of inspection, all seals shall be replaced to as good as factory shipment. The delivery inspection process shall be documented.

Complete valves shall be stored in weather proof covered area until ready for installation. Open yard storage shall not be allowed, even if the valve is crated and vacuum packed.

5.4.2 Spare parts

Spare parts shall be shipped in sealed packages, complete with spare part identification and documentation. Parts such as seats and plugs shall be protected against inadvertent damage to its seating surfaces. Spare parts shall not be delivered loose. Unidentified parts shall not be accepted for use. Spare parts inspection shall be documented.

All spare parts shall be stored in weather proof covered areas. Sensitive rubber based or Teflon based parts, such as o-rings, seals, diaphragm, etc. and electronic parts shall be stored in an air conditioned environment.

6. INSTALLATION

Prior to installation, the new control valve shall be function tested to ensure no damage occurred during transportation. After the test, the control valve shall be preserved by putting it back inside the case as per original condition from manufacturer. The open connections shall be covered all the time with the caps provide by the manufacturer to ensure no moisture and foreign material ingress into the valve during storage, transportation to site and during installation.

Before the control valves are installed into a new piping system, the piping system shall be fully flushed of all debris, the piping inspected and documented.

In cases where the control valve is used for piping alignment works, the valve shall be removed from the line before the pipe blowing and flushing activities. A spool shall be used to replace the valve. The valve shall be properly preserved by putting it at proper covered area at site with all open connections properly sealed to prevent moisture and foreign material ingress.

The installation personnel shall be competent in the correct installation of the control valves. The competency of the installation personnel shall be verified and endorsed by the responsible Instrument Engineer or TTS. This includes installation works for projects, revamps and maintenance works.

All control valve installation inspection shall be done by the responsible Instrument Engineer, either from projects, revamps and maintenance works, and shall be signed off.

7. COMMISSIONING

7.1 PRE-COMMISSIONING

Pre-commissioning shall be executed prior to the process start-up and shall be part of the plant Ready For Start-Up (RFSU) activities. The pre-commissioning shall be carried out on all control valves installed arising from projects, revamps and maintenance works.

The personnel executing the commissioning activities shall be competent. The competency of the pre-commissioning personnel shall be verified and endorsed by the responsible Instrument Engineer or TTS.

Pre-commissioning activities shall comprise of the following activities :-

- a. availability of pre-commissioning check sheets prepared by the responsible Instrument Engineer. The check sheets shall include verification of air failure operation, lock-up, stroking speed, VAS capacity checks, switching requirements, verification of limit switch settings in DCS or PLC, etc;
- b. verify clearances of all punch list items. A risk assessment shall be carried out and documented on all remaining punch list items to verify the safety, integrity and reliability of the control valves to be commissioned with the un-cleared punch list items;
- c. the control valve shall be stroked a number of times to ensure repeatability of results;
- d. for control valves fitted with diagnostic type positioner, the valve signatures shall be obtained for use as future operational and maintenance reference as "base design valve signature";
- e. the control valve shall be completely stroke checked from the DCS or ESD;
- f. pre-commissioning of new anti-surge valves shall require pre-set loop tuning to be implemented by the surge control specialist, either from the vendor or the Instrument TP.

The pre-commissioning activities shall be documented and signed off by the responsible Instrument TP.

7.2 COMMISSIONING

Commissioning period shall be from the time of process start-up until 100% process load is achieved. Commissioning activities also covers the process start-up after a Turn-Around (TA), where the control valve has been removed for maintenance during the TA.

As part of the commissioning activities, the responsible Instrument Engineer shall execute site verifications on all control valves installed to verify site operational conditions such as vibration, stickiness, leaks, excessive heat / coldness, etc.

For new and revamp projects, where the responsible project Instrument Engineer is different from the maintenance Instrument Engineer, the project Instrument Engineer shall be responsible for the control valve performance during commissioning until project hand-over to the Operations and Maintenance. The maintenance Instrument Engineer shall provide the project Instrument Engineer a hand-over deliverables, agreed well before the start of the commissioning activities.

Commissioning activities includes the final tuning of the valve performance. The valve performance shall be documented at the various stages of the process start-up until 100% process load is achieved or until project hand-over, and shall be signed off by the responsible Instrument TP.

8. MAINTENANCE

Effective control valve maintenance is critical to safeguard and assure the control valve integrity throughout its operating life. To effectively execute a maintenance plan on control valves, the 7 phases must be executed as follows :-

8.1 PHASE 1 – EQUIPMENT MASTER LIST (CONTROL VALVE DATABASE)

In order to plan for the maintenance of control valves, the complete inventory of control valves in the facilities must be known. Hence, the complete control valve inventory (Equipment Master List) shall be loaded into the PETRONAS Maintenance Management System (PMMS) or its equivalent. The data loaded into the system shall minimally comprise of the following information :-

- a. Equipment number (automatically generated by the PMMS)
- b. Valve tag number
- c. Service / Process description
- d. Process unit
- e. Manufacturer
- f. Model
- g. Bill of Materials (BOM)
- h. Criticality Class (as per Section 9.2)

The sources of information for the Equipment Master List are project, revamp documents, P&IDs, PEFs, etc.

For process facilities that have already incorporated the control valves inventory into the Equipment Master List, a review shall be carried out, led by the responsible Instrument Engineer, once every 2 years.

For process facilities that do not have control valves inventory incorporated into the Equipment Master List, this exercise shall be completed within 1 year of issuance of this document, led by the responsible Instrument Engineer.

A hardcopy of the control valve Equipment Master List shall be printed out from the PMMS system, signed by the responsible Instrument TP and filed for third-party verification purposes.

8.2 PHASE 2 - EQUIPMENT CRITICALITY ASSESSMENT (ECA)

The ECA determines the relative importance of the control valves with respect to the process. ECA shall be conducted for every control valve installed in the process. The process of determining the ECA shall be in accordance to the IPOCS guidelines on determining the ECA.

Based on the ECA, the specific Criticality Class of 1(most critical), 2 or 3 (least critical) shall be assigned to each control valve and documented in the Equipment Master List.

As a general rule, SIL 3 and 4 classified valves shall be assigned Criticality Class 1. For valves classified for SIL 2 and below, the Criticality Class shall be the more stringent requirements of either the IPF Classification or the ECA.

The responsible Instrument Engineer shall lead the ECA classification studies, with inputs from Process and Operations.

8.3 PHASE 3 - MAINTENANCE PLANNING AND EXECUTION

Once the control valve inventory is known, through the Equipment Master List, and its criticality is known, the maintenance planning can be executed. All the maintenance plans shall be loaded into the PMMS for automatic generation of "Notifications".

The maintenance planning shall be in following forms :-

a. Condition Based Monitoring (CBM)

In the PMMS, CBM is known as Predictive Maintenance (PDM). For purposes of this document, the term CBM shall be used.

CBM is possible for the following categories of valves:

i) ESD valves fitted with intelligent Partial Stroke Test (PST) devices

For these ESD valves, a hardcopy schedule of PST activation shall be defined and signed off by the responsible Instrument TP and approved by the Technical Manager who is overall in-charge of the total plant asset. When intending to use PST, Probability of Failure (PFD) of the control valve shall be re-calculated to determine if the intended SIL rating has been achieved to the required SIL. The overall test schedule shall include both the PST schedule and the full stroke test schedule.

The use of automatic activation of the PST is not permitted. Manual activation, supported by the required Work Permit, is required. This ensures that the appropriate focus is given to the PST activity during normal operation. Every activation of the PST shall be documented by the responsible Instrument Engineer.

The schedule shall be loaded into the PMMS system with automatic generation of Notifications to execute the PST and the full stroke test on the required schedule. The responsible Instrument Engineer shall verify the Technical Report produced by the PETRONAS Instrument personnel supervising the test. The responsible Instrument TP shall review and analyze all PST results on a regular basis.

In event of PST failure, the responsible Instrument Engineer shall generate a new Proactive Maintenance (PRM) work order against the ESD Valve Tag to execute defect rectification at the next available opportunity. The responsible Instrument TP shall record all defects arising from the PST for further analysis and calculation of MTBF for the PST ESD valves.

ii) Throttling valves fitted with intelligent valve positioner

The intelligent valve positioner enables on-line diagnostics to be undertaken. However, to execute these on-line diagnostics, an on-line Instrument Asset Management System (iAMS) must be in place. All the intelligent valve positioner must be connected to this iAMS. The iAMS shall be monitored on a daily basis by the responsible instrument engineer. The iAMS diagnostic criteria and alert settings shall be determined by the Instrument TP.

As a minimum, the following parameters and alerts shall be incorporated:

- I. Travel deviation alerts
- II. Supply pressure alerts
- III. Drive signal error alerts

For off-shore facilities, the iAMS shall be located on-shore engineering office and monitored daily on-shore by the responsible instrument engineer.

All defects identified shall be recorded for further analysis, defect rectification and MTBF calculations. All defects shall be recorded in the PMMS and PRM work order generated against that control valve tag.

iii) Sequence valves fitted with both on-off limit switches

Critical sequence and switching valves are sometimes fitted with both on-off limit switches to monitor their switching performance in the DCS. In such instances, the monitoring of these sequence valves shall be undertaken on a daily basis by the Instrument Engineer and not the DCS Panel Operator.

In event of any observed defects, the Instrument Engineer shall perform the analysis and defect rectification. All defects shall be recorded and PMMS PRM Order generated against the valve tag.

b. Planned Preventive Maintenance (PPM) / Basic Equipment Care (BEC)

PPM is maintenance activities carried out during normal plant operation. All control valves, regardless of criticality class, shall have a documented PPM plan schedule in place that is signed off by the responsible Instrument TP. The schedule shall be loaded into the PMMS system with automatic generation of Work Orders to execute the PPM.

The PPM plan comprises of on-line visual inspections during normal plant operations and complete stroke check during shutdowns for Criticality 1 and 2 valves. On-line visual inspections shall be conducted on all control valves with the inspection findings documented and signed off by the responsible Instrument TP.

All defects identified during the PPM shall be notified to the responsible Instrument Engineer and PRM work order raised.

Personnel executing the PPM shall be competent in the works. The personnel competencies shall be verified and endorsed by the responsible Instrument Engineer.

c. Corrective Maintenance (CM)

CM works, in the PMMS context, are works executed arising from defect notification from Operations and/or Process personnel and is called Reactive Maintenance (REM). For the purpose of this document:

- i) the term CM shall be used
- ii) CM works shall also include corrective maintenance works arising from defects identified from CBM and PPM works.

All CM works shall be documented and endorsed by the responsible Instrument Engineer.

In general, all planned maintenance works shall be scheduled and documented. All maintenance works executed shall be executed through work orders from the PMMS system. All defects and its rectification shall be documented. All documentation shall be endorsed by the responsible Instrument Engineer. At least 5 records shall be maintained for each valve, starting with the latest record. If all 5 records occur in a span of less than one year, then all records in the period of one year shall be maintained. All documentation shall be made available for any third-party verifications.

8.4 PHASE 4 – SHUTDOWN / TURN-AROUND (TA) PLANNING AND EXECUTION

Shutdown and/or TA planning and execution are critical activities due to the limited time and resources available. Hence, the maintenance activities must be carefully planned and control valves required to be maintained during the TA activities must be carefully selected.

The control valve work list for the TA activities shall be frozen for a minimum of 6 months before the planned TA. All maintenance contracts shall be in place minimum of 1 month before the planned TA. All required spares shall be available at site a minimum of 1 month before the planned TA.

There are two main maintenance activities during a TA, as follows :-

a. PPM Activities

PPM activities are the scheduled maintenance activities that can only be performed when the process is shutdown. Following are expected maintenance activities to be carried out:

- i) For Criticality 1 and 2 valves, total calibration and total loop stroke checking
- ii) For ESD valves, full loop stroke test to be executed to comply with IPF testing frequencies identified from the IPF Studies.

All PPM activities, including defects found and rectified, shall be documented and endorsed by the responsible Instrument Engineer

Personnel executing the PPM activities shall be competent. The responsible Instrument TP shall verify the competency of the personnel executing the PPM activities.

b. CM Activities

CM activities are control valve maintenance activities identified from the CBM, PPM, CM as raised by Operations or Process and PRM requiring a process shutdown to execute the defect rectifications. The CM activities may be executed in two ways, as follows:

i) In-situ maintenance

In-situ maintenance takes place on-site, without removal of the control valve. In-situ maintenance activities include replacement of defective accessories, replacement of corroded parts, actuator maintenance, etc.

All in-situ maintenance carried out shall be documented and endorsed by the responsible Instrument Engineer.

Personnel executing the in-situ maintenance activities shall be competent. The responsible Instrument TP shall verify the competency of the personnel executing these activities.

ii) Off-site maintenance

Off-site maintenance takes place when the control valve is removed from the pipeline and taken to the workshop for defect rectification or inspection purposes. The need to remove a control valve from a pipeline to execute workshop maintenance should be based on the analysis of the iAMS or PPM data. Alternatively, the control valve may be removed due to poor performance identified by the Operations and/or Process Engineers. Nevertheless, even in such cases, the need for removal of the control valve should be supported by the iAMS data.

Control valves may also be taken out for replacement of Non-Standard Repair (NSR) parts with OEM parts.

With the iAMS effectively in place, it is expected that no control valve shall be unnecessarily taken out of the pipeline for maintenance.

It is also acknowledged that control valves may have to be taken out of the pipeline for maintenance in event that they are unable to fully stroke.

When removed from the pipeline, the control valve flanges and the pipe line flanges shall be fully covered to prevent ingress of any foreign materials. Site isolation requirements and procedures shall be followed with regards to pipe and blind specifications.

If the control valve has an accessories panel, the accessories panel shall also be removed to the workshop to enable subsequent full functional test of the control valve in the workshop, prior to re-installation.

Personnel executing the removal of the control valve shall be competent in instrumentation installation requirements. The use of mechanical contractors with no instrumentation knowledge shall not be permitted. The responsible Instrument Engineer and TTS shall verify the competency of the personnel executing the removal and re-installation of the control valve.

The disassembly, overhaul and re-assembly of the control valve in the workshop shall strictly follow the manufacturer's manual. All parts used shall be OEM parts. In the event that hard parts are not available, temporary repairs, such as machining or fabricating new parts are allowed. However, such temporary repairs shall be documented as Non-Standard Repair (NSR) and the method of NSR shall be approved by the Instrument TP. It is the responsibility of the Instrument TP to verify against other Subject Matter Experts (SME) or other discipline TPs on the appropriate NSR method to be executed.

It is the responsibility of the Instrument TP to monitor control valves with NSR through-out its operations until the NSR parts are replaced with the OEM parts at the next available opportunity.

It is the responsibility of the Instrument Engineer to ensure that appropriate and documented QA/QC procedures are in place and executed throughout the overhaul of the control valves. All QA/QC hold points shall be documented and signed off by the Instrument Engineer.

During the control valve overhaul, all soft parts, such as gaskets and o-rings shall be replaced with new OEM parts. Re-use of soft parts is strictly prohibited. Hence, before control valves are overhauled, it is the responsibility of the Instrument TP to ensure that all OEM soft parts are available at the workshop.

In executing the replacing of control valve parts, due economic and engineering considerations shall be made between the replacements of parts, especially "hard" parts, against the purchase of a complete new valve engineered to the latest process conditions and technology available.

Upon completion of the total overhaul works, the control valve shall be fully tested. The test shall minimally comprise of:

- i) Testing & verification of valve bench set
- ii) Seat leakage test
- iii) Bonnet pressure test
- iv) Actuator pressure test
- v) Calibration
- vi) Stroke checks
- vii) Execution of pre-commissioning checks as identified in Section 10.1

The results of the entire test shall be documented for each valve and endorsed by the Instrument Engineer. In event failure of any of the tests, the Instrument TP shall exercise sound engineering judgment on the mitigation measures to be undertaken.

Personnel executing the overhaul, QA/QC and testing shall be competent personnel. The Instrument TP shall verify the competency of the personnel prior to start of work. Where there are a high numbers of control valves to be overhauled, the use of the control valve OEM supervisors are strongly encouraged, to relieve the Instrument TP workload.

8.5 PHASE 5 - BAD ACTOR MANAGEMENT

Control valve "Bad Actors" are all control valves that have regular defects or are unable to sustain performance between TA periods. The responsible Instrument TP shall compile and document a Bad Actor listing and shall work towards elimination of these Bad Actors through consultation with the Group TPs and/or consultation with the OEMs.

As part of the process to eliminate control valve Bad Actors, a thorough engineering review of the control valve design shall be carried out.

For every process facility, there shall be at least 10 numbers of Bad Actors compiled. For a high performing process facility, these Bad Actors are expected to be minor nuisances but nevertheless, the Bad Actor listing shall be compiled and the Instrument TP shall work towards eliminating these minor nuisances.

8.6 PHASE 6 – OBSOLESCENCE MANAGEMENT

All facilities that are more than 10 years in operation shall have a obsolescence management plan in place for control valves, endorsed by the Instrument TP and Instrument TM. The obsolescence management plan covers the prudent risk assessment of the current control valves in service and their ability to continue to perform satisfactory services throughout the intended asset lifetime.

The verification source for obsolescence shall generally be the control valves' vendor and the responsible Instrument Engineer's technical judgment.

8.7 PHASE 7 – PERFORMANCE METRICS AND REPORTING

The responsible Instrument Engineer shall review all the CBM (PMMS - PDM), PPM, CM (PMMS – REM) and PRM findings and analyze the data. The Instrument Engineer shall take proactive steps, based on analysis conducted, to improve the overall control valve performance in the process facility.

The overall control valve performance shall be reported, minimally on a quarterly basis, to the facility management. The reporting metrics to the facility management shall at least cover the following:-

- a. Number of unscheduled downtime due to control valve failures
- b. Number of Criticality 1 and Criticality 2 control valves potentially liable for failures in the future, based on analysis carried out
- c. Number of valves proactively rectified due to iAMS analysis and/or PPM execution
- d. Number of control valve NSR in place
- e. Number of control valve Bad Actors and number of Bad Actors resolved.
- f. Calculation of MTBF of various categories and makes of valves

The above performance metrics shall be compared against Group Benchmarking data.

9. DE-COMMISSIONING

De-commissioning of control valves or its components can take place due to obsolescence or abandonment of the facility. In the event of decommissioning parts or complete control valve, the decommissioned parts shall be removed from site. This is especially so for off-shore facilities, where space is of utmost importance.

The Instrument Engineer responsible for installing a new part or for the abandonment project shall be responsible for the removal of the affected part or complete control valve from the process facility.

The responsible Instrument Engineer shall also ensure the PMMS (PMMS) Equipment Master is updated i.e. all removed equipment from site are also removed from the Equipment Master listing.

In the event that the abandoned facilities are intended to be use for training purposes, the control valves in these facilities shall be subjected to PPM activity to ensure its continued safe usage for training purposes.

Abandoned facilities located offshore or within high risk areas such as slug catchers, shall not be used for training purposes. In such facilities, the abandoned control valves shall be removed from the facility.

10. REFERENCES

In this PTS reference is made to the following publications:

NOTE Unless specifically designated by date, the latest edition of each publication shall be used, together with any amendments/supplements/revisions thereto.

PETRONAS STANDARDS

Control Valves – Selection, Sizing and Specifications	PTS 32.36.01.17
Classification and implementation of instrumented protective functions	PTS 32.80.10.10
Management of instrumented protective functions	PTS 32.80.10.12
Instrumentation of depressurizing systems	PTS 32.45.10.10
Hydraulic Systems For Remote Operation Of Shut-Off Valves	PTS 31.36.10.30
Quarter-Turn On/Off Actuators	PTS 31.40.70.30
Actuated Ball Valves	PTS 20.08

OTHER PETRONAS DOCUMENTS

Group Reliability and Integrity Management System (RIMS)	August 2004
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