

PETRONAS TECHNICAL STANDARDS

DESIGN AND ENGINEERING PRACTICE

ADVANCE PROCESS CONTROL READINESS (BASE LAYER CONTROLLER ASSESSMENT)

PTS 20.00.20.45

MARCH 2010



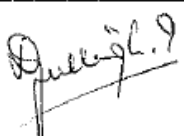
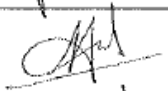
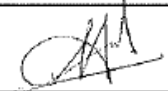
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This new PTS 20.00.20.45 – **Advance Process Control Readiness (Base Layer Controller Assessment)** has been developed to provide standards, guidelines and methodology to carry out Base Layer Controller Assessment as a preparation for APC implementation. This document also includes the requirement and the deliverables for an effective Base Layer Controller Assessment as part of APC readiness.

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APPENDICES

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1 INTRODUCTION

The main purpose of this document is to provide standards, guidelines and methodology for Base Layer Controller Assessment (BLCA) as part of APC readiness assessment. The work flow of APC implementation can be summarised as follows:

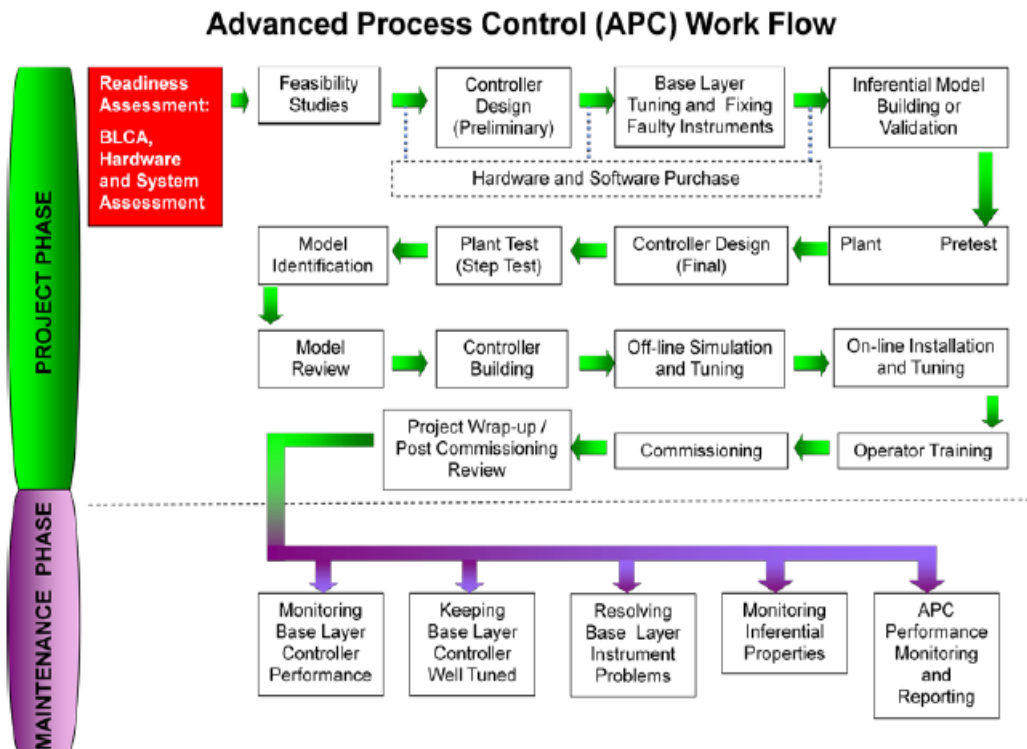


Figure 1

The performance of base layer controller need to achieve a certain standard before it is considered ready for APC implementation. It is intended for use by PETRONAS Engineers before embarking on APC applications or any other optimisation initiatives.

The methodology proposed in this document can be used to assess the performance of the base layer controllers in preparation for optimisation initiatives and ensure benefits sustenance. This assessment is to ensure quality delivery of a successful APC application.

This document provides a systematic approach in identifying potential problematic control loops using process engineering experience and base layer controller assessment evaluation tools.

Base Layer Controller Assessment can be carried out for plantwide or per unit operation basis depending on the scope of application. Base Layer Controller Assessment is a systematic method of checking the status & evaluates the performance of controllers to determine the overall health of the control system, enabling the search for non-compliance resulting from improper operation of controllers, faulty instrumentation, incorrect control strategies, limitations on unit operation and tuning settings.

This document does not cover comprehensive instrumentation performance evaluation and assessment. It focuses on the controller performance with respect to process requirement.

1.1 OBJECTIVE

The objective of this document is to provide standards, guidelines and methodology for Base Layer Controller Assessment (BLCA) via:

1. Rating, measuring and evaluating the performance of compliance controllers.(Refer to Section 2.2, Figure 2)
2. Consolidate reasons for non-compliance controllers and poor performing controllers. (Refer to Section 2.2, Figure 2)
3. Identifying the gap for improvement and prioritisation for rectification to meet standard requirements.

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1.3 DEFINITIONS

1.3.1 General Definitions

The **Contractor** is the party which 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 which manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party which 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

Advanced Process Control (APC)

An APC manipulates several set points and/or valve positions simultaneously to achieve its control objectives. It employs a model predictor containing dynamic models of the process and predicts the process behaviour and responds accordingly.

Controller Mode

Controller mode refers to the mode of controller's operation on DCS, i.e. Manual Mode, Automatic Mode, Cascade Mode.

Automatic Mode

In automatic mode, the controller set point is entered by the operator. All control function & PID algorithm will determine the output of the controller.

Manual Mode

In manual mode, PID algorithm is suspended and operator is allowed to adjust the output of the controller.

Cascade Mode

In cascade mode, master controller sends a remote set point to slave controller. The remote set point is essentially the output of the master controller.

Controller Status

Controller status referring to whether controller is operating in compliance mode or in non-compliance mode.

Compliance

Controller is operating in the correct mode as per design intent. This includes:

- Controllers operating in automatic as per design intent (intermediate and advance regulatory control i.e. cascade, split range)
- Controllers operating in manual with valid operational reasons, i.e. standby controllers, on/off controllers (in automatic when in service), sequence controllers.

Non-Compliance

Controller is operating in the **incorrect** mode and not as per design intent. This includes:

- Master and slave controllers when a cascade is broken
- Split range controller operating in automatic with one or two of its handle (MV) is detached or not used
- Controllers operating in manual due to
 - incorrect control strategy
 - incorrect tuning settings (erratic control)
 - instrumentation and DCS system related issues
 - operator preference (norms)
 - process unit capacity and design limitation (e.g. undersized pump or control valve, heat exchanger)

Plantwide Base Layer In-Control Index

A measurement of plantwide base layer controller uptime. This index excludes manual controllers in compliance mode. Also known as plant controller service factor, plant controller uptime or plant controllability factor.

1.3.3 Abbreviations

APC	Advanced Process Control
ARC	Advanced Regulatory Control
BLCA	Base Layer Controller Assessment
DCS	Distributed Control System
HSE	Health Safety & Environment
MV	Manipulated Variable (Controller Output)
P&ID	Piping and Instrumentation Diagram
PFD	Process Flow Diagram
PIMS	Plant Information Management System
PV	Process Value
SP	Set Point

1.4 SOFTWARE & TECHNOLOGY UTILISATION IN PETRONAS

There are many software available in the market which can be used to perform time consuming data processing and computation for analysis. The analysis is meant for use as part of the assessment only. Good engineering experience and knowledge are still required for the analysis.

Example of software available are as follows:

<u>Vendor</u>	<u>Software</u>
i. Matrikon	CPM
ii. Yokogawa	Shell MDPro
iii. Honeywell	Loop Scout
iv. Control Station	Loop Pro
v. Aspen	Aspen Watch
vi. OSI PI	PI Control Monitor

Analysis can also be performed using spreadsheet if software is not available. Software used in PETRONAS is listed in Appendix C.

1.5 PERSONNEL INVOLVEMENT

BLCA should involve, but not limited to, process control engineer, Instrumentation & DCS engineer, technologist and operators.

Example of the role and function of each personnel is tabulated in the table below:

No	Personnel	Roles and Function
1	Process Control Engineer	- Lead and conduct BLCA - Assist process technologist to gather data - Perform data analysis - Review Control Strategy - Ask questions and draw information from all parties. Note: In some plants, process control engineer assume the role of process technologist during BLCA. (See role of process technologist)
2	Process Technologist	- Compile and provide documentation for reference, i.e. PFD, P&ID. - Provide information and troubleshoot problems from process perspectives. - Advise on the best time to collect data and provide data from PIMS. - Participate in base layer controller prioritisation since process technologist is well-versed with the plant economics.
3	Instrument /DCS Engineer	- Instrument engineer with in-depth process knowledge can lead and conduct BLCA with the support of process technologist or process control engineer. - Provide information and troubleshoot problems related to instrumentation and DCS. - Perform instrumentation health check and fixing instrumentation problems after BLCA. - Provide information related to DCS & PIMS.
4	Operators / Panel Man	- Provide information and explanation on the operability of controllers. - Provide information on the limitation faced while operating the unit operation or controller. - Advise on the best time to collect data. - Determine the requirements for a control scheme. - Participate in base layer controller prioritisation.

2 REQUIREMENTS AND DELIVERABLES

2.1 REQUIREMENTS

The following shall be the requirements for BLCA:

1. A comprehensive BLCA shall be carried out at least once in the plant's life time and monitored continuously.

Note: The duration of the first BLCA is expected to take between 1 to 2 months from the point that good data is made available for approximately 100 to 300 controllers.

2. The following documents shall be made available:

- Process Description
- Process Flow Diagrams (PFD)
- Process & Instrument Diagram (P&ID)
- DCS Graphic
- List of Intermediate and ARC controllers *with their design mode*
- Process Control Narratives / Process Control Functional Logic Diagram
- List of PID Tuning Parameters (Optional)

3. The following process data format shall be made available:

A minimum of 1 to 2 weeks uncompressed data at maximum of 1 minute interval at all normal plant operating condition. A minimum of 3 to 4 days of uncompressed data is still acceptable depending on plant operating condition.

- Data compression in PIMS shall be removed. (There is a need to verify whether there are limitations on the capacity and loading of PIMS server and DCS network.)
- Tags required for the assessment shall be configured, historised and retrievable from PIMS.
 - FOXBORO : MEAS, SPT, OUT, MODE
 - YOKOGAWA : PV, SV, MV, MODE
 - HONEYWELL: PV, SP, OP, MODE
- Data shall be taken at the same time span for each tag.

- Data shall be taken at normal plant operating load as determined by the plant operators.
 - Data format shall be made consistent with the requirement of tool /software utilised for the assessment.
4. A suitable tool to perform assessment analysis. Refer to Section 1.4.
 5. Support and assistance from process technologist, operators, panel operators, and DCS & instrument engineers to provide inputs on process information such as process upsets, process behaviour, abnormal incidences, maintenance activities, etc for a specified assessment period.
 6. The assessor should have good process & operation understanding, statistical and process trends interpretation skills. The assessor should consult relevant personnel to verify the interpretation if he or she is not familiar with the process.

2.2 DELIVERABLES

At the end of the assessment, there shall be:

- Presentation
- Report
- Monitoring spreadsheet or database

containing the following information to verify the overall health of the controllers:

1. **Current mode of the controllers (i.e Auto/Manual/Cascade) versus design operating mode.**

The actual number of controllers operating in automatic & manual shall be quantified as follows:

Controller Mode:

- Total number of controllers
- % of Manual Controllers
- % of Automatic Controllers (Including Cascade Controllers)

Note: Please refer to Section 1.3.2 for the definition on mode. Please refer to Section 3.4.1 for method of computation.

2. **Current status of the controllers (Compliance/Non-compliance) against the standard requirements.**

The actual number of controllers in compliance and non-compliance mode shall be quantified as follows:

Controller Status:

- Total number of controllers
- % Compliance controllers
- % of Non compliance controllers

Note: Please refer to Section 1.3.2 for the definition on status. Please refer to Section 3.4.1 for method of computation.

3. Controller ratings for compliance automatic controllers.

Controllers shall be rated to Good and Poor performing controller based on engineering experience and controller performance assessment criteria. Please refer to Section 3.5 for the criteria of assessment. Please refer to Figure 2 for reference.

4. Reasons for non-compliance controllers & poor performing controllers.

Information on reasons for controller operating in non compliance mode (including manual mode) and poor performing automatic controllers shall be consolidated for further action. Please refer to Figure 2 for reference.

5. Controller's Prioritisation.

All controllers shall be prioritised according to its criticality and importance for systematic improvement implementation.

6. Recommendations for improvement for the following items:

- Controllers which may require tuning
- Controllers with instrumentation and system related issues
- Controllers which require review in process design
- Controllers with incorrect control strategy
- Controllers not operating in the correct mode due to operator preference.

The recommendations should also include readiness for implementation APC. This is to cater for specific requirements.

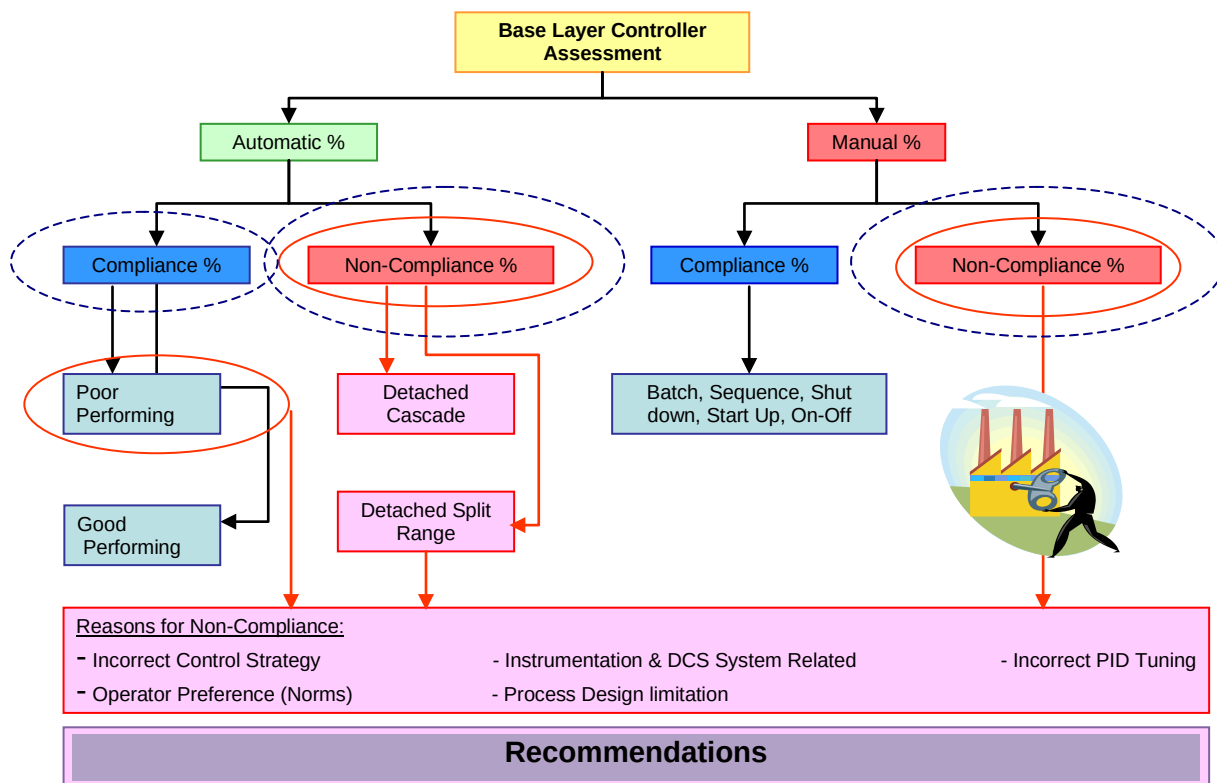
7. Plantwide Base Layer In-control Index.

At the end of BLCA, Plantwide Base Layer In-control Index to monitor the uptime of controller in compliance/design mode shall be established for continuous monitoring.

Please refer to the table below for classification of the index. Please refer to Section 3.4.2 for method of computation.

Index/uptime	Rating	Description
< 70%	Poor	Requires rectification on base layer controls
70% - 80%	Moderate	Requires rectification on base layer controls prior to APC implementation
80% - 95%	Good	Ready for APC Implementation with minor rectification on base layer controls
> 95%	Excellent	World class standard, ready for APC implementation immediately

Typical findings from BLCA shall be summarized as follows:



Legend:

○ Requires Improvement

○ Monitoring Controller Uptime (Plantwide Base Layer In-control Index)

Figure 2