

APROMON™

Data File Version 6.1

ADVANCED PROCESS CONTROL MONITORING SOFTWARE

USER'S MANUAL

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INTRODUCTION TO PICONTRON SOLUTIONS LLC

PiControl Solutions LLC (www.picontrolsolutions.com) is an industrial process control software technology development company.

PiControl Solutions LLC specializes in innovative development of process control technology, algorithms, software products, and also in turnkey process control consulting, advanced control implementation and plant startup/commissioning (a complete array of process control services for the industry).

PiControl Solutions LLC has been providing products and services to the industry since 1992 and runs its operation in several countries worldwide.

Following is a list of PiControl Software products:

1. **Pitops™** (Transfer function identifier and PID tuning optimizer)
2. **Simcet™** (Real-time PID tuning simulator for training, grading and certification)
3. **Apromon™** (Online PID and advanced control quality performance monitor)
4. **Process Control CBT** (Computer-based Training module)
5. **Tadpole™** (Online oscillation detection with adaptive control)
6. **PiLims™** (Laboratory information management system)
7. **PiBridge™** (OPC server-to-server real-time data communication)
8. **Chromatiqx™** (Online analyzer data validation and OPC server-to-server bridge)

9. **PiConX™** (Batch, sequence and continuous rule-based closed-loop controller)
10. **ReciCon™** (Product grade transition and non-linear process controller)
11. **TurboMax™** (Constrained non-linear online optimizer)
12. **PiLogger™** (Fast data logger for equipment fault diagnostics)
13. **PiConect™** (Excel-to-DCS/PLC two-way bridge)

All PiControl products use OPC, connect easily to any DCS or PLC and can be easily learnt and installed by any plant operator, control engineer, DCS/PLC technician or researcher.

Use of PiControl products does not require deep academic knowledge of process control theory or advanced college degrees. You can configure and use our products in just a few minutes.

For more information on all these products, visit the website www.PiControlSolutions.com or send an email to info@PiControlSolutions.com.

Apromon™ User Manual

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Apromon™ User Manual

1. Introduction

Dear fellow process control professional, congratulations on your purchase of your Apromon™ process control monitoring software. We at PiControl Solutions Company are proud of creating and making available to you the simplest and the most powerful process control-monitoring tool available today.

Apromon™ is equipped with PiControl Solutions' proprietary *True Amplitude Detection* (TAD) algorithm that uniquely isolates the true process signal frequency by identifying and isolating the white noise and other non-process signal contributions.

Apromon™ also decomposes the PID controller's action into its independent components to provide unique and useful PID control diagnostics.

Apromon™ provides all the tools you will ever need to quickly and easily monitor all your control loops, both quantitatively and qualitatively with the least effort on configuration and installation.

We pride ourselves for providing the best technical support to all our users.

As you learn about Apromon™; you will realize that PiControl Solutions has created a breakthrough in the area of modern process control monitoring.

1.1. Process Control Monitoring

Apromon™ is a software product for process control performance monitoring. It analyzes and reports the performance of PID control loops in the DCS or PLC. Apromon™ can also analyze and report the quality of any process signal including signals that are raw, analog PV signals, not necessarily part of any control loop or a PID controller.

Apromon™ will help to improve process control quality, plant stability and help push the plant closer to economic constraints resulting in increased production rates and plant profits.

1.2. Apromon™ Functions and Capability

Every plant has tens or hundreds of controllers. Each controller has at least three tuning parameters. No one can watch all controllers carefully every day. A few badly functioning controllers can cause a large section of the plant to cycle (oscillate). Oscillations can propagate or even magnify based on recycle streams and heat integration. Eroded or old valves may be sticking or malfunctioning because of needed maintenance but could go unnoticed for indefinite periods of time.

Apromon™ identifies the worst performing loops in the plant. It generates a report showing the worst controllers and signals so that the process control engineer or DCS technician can focus on this list of bad controllers and fix them far sooner than before.

Apromon™ provides over twenty control criteria on all controllers. As the end user, you can pick and choose your favorite criteria. We encourage you to see all the criteria in the beginning. With time and experience, you will get skilled in using the right criteria for the right situation in the best, most powerful way.

Apromon™ comes with a simple user interface, far easier than any other products out in the marketplace. In just an hour or two, you can install and start using Apromon™ and start improving your plant performance.

2. Software/Hardware Requirements and Installation

This manual specifies the hardware required to run Apromon™ software. It also explains the software installation procedure and how to start and use Apromon™.

Apromon™ runs on Windows 7, Vista, XP, NT and other Windows operating systems.

To install Apromon™, first send an email request to PiControl Solutions Company at info@PiControlSolutions.Com. A web-link to download the program installation setup executable file from the PiControl Solutions website will be sent.

To start installation, double-click the Apromon_Setup.exe file.

To complete installation, follow all the step-by-step installation instructions on the screen.

All Apromon™ files will be installed to the specified program folder. A program Group "Apromon" will be created with program icons "Apromon", "Apromon Help", "Readme First" and "License Agreement".

For technical help on Apromon, please contact us via email at info@PiControlSolutions.com.

3. **Apromon™ Installation and Configuration**

This section provides a step-by-step procedure on how to configure and run Apromon™. You can install Apromon™ on any computer with an Microsoft Excel to read Excel Data files generated by DCS.

3.1. **Create Apromon configuration (Apromon.INI) File and Read into Apromon**

We can have separate folders for each Data file set we wish to analyze. For each data set, we need to configure a file named **Apromon.INI**. A sample starting file is provided with the Apromon™ software in "**Test Case1**" folder. The procedure on how to configure this file is described below:

- a) Copy and save **Apromon.INI** from "**Test Case1**" folder to the folder containing data file we wish to analyze. Open the file **Apromon.INI** using any text editor to study its contents. The INI file contents are shown below:

```
[Header]
ID=Apromon Config File
[ParameterNamesOfDCSTags]
ProcessVariableParameterName=PV
SetpointParameterName=SP
ControllerOutputParameterName=OP
ControllerModeParameterName=CTS
ProcessVariableLowLimitParameterName=PVEULO
ProcessVariableHiLimitParameterName=PVEUHI
ControllerProportionalGainParameterName=K
ControllerIntegralParameterName=T1
ControllerDerivativeParameterName=T2
[MODEValues]
MANValues=MAN
AUTValues=AUT,AUTO
CASValues=CAS,BCAS,COMP
[Files]
TAG=Apromon_Tag_Case1.xls
CONFIG=Apromon_Config_Case1.xls
[Data Samples]
TotalSamples=120
[Dir]
OutputDir=D:\Apromon Data Sets\Plant Data Files Set 1
[OPCTags]
1=FC000
2=FC001
3=FC002
4=FC003
5=FC004
6=FC005
```

7=FC006
8=FC007
9=FC008
10=FC009
11=FC010
[TagNames]
NoTags=0
[Criteria]
NoCriteria=0

b) Structure of **Apromon.INI** file

Various sections in the INI file are as below:

Do not modify **Header** section. It is used by Apromon to validate the file.

Section **ParameterNamesOfDCSTags** specifies various parameter names used in the DCS or PLC for the Process Variable, Setpoint, Controller Output, Controller Mode, Process Variable Low Limit, Process Variable High Limit, Controller Proportional Gain, Controller Integral and Controller Derivative. Our values entered are PV, SP, OP, CTS, PVEULO, PVEUHI, K, T1 and T2 respectively.

Section **MODEValues** specifies the different possible values for controller modes. The three different modes may have different valid values. E.g., in our example, we specified MAN for manual mode, AUT and AUTO for auto mode and CAS, BCAS and COMP for cascade mode. Specify the correct valid values for your DCS or PLC.

Section **Files** contains TAG and CONFIG file names.

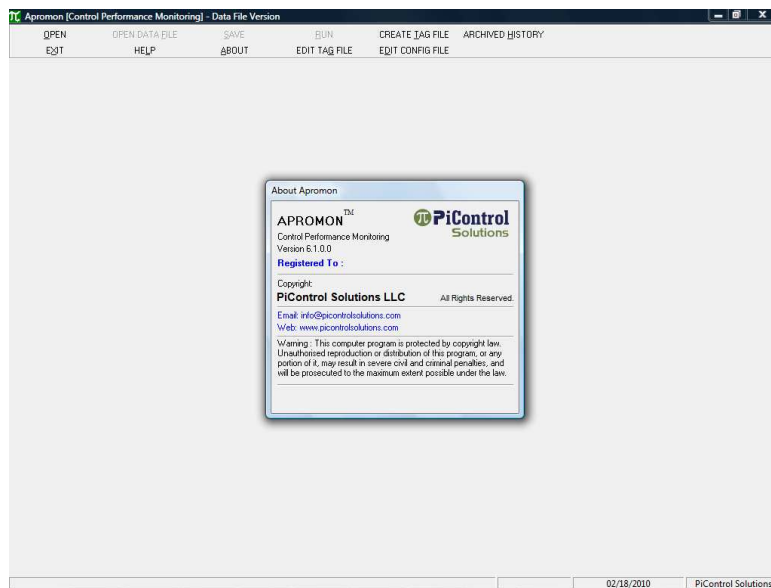
In the **Data Samples** section, specify the number of total data samples contained in the data file.

Section **Dir** contains path for output files generated by Apromon.

Section **OPCTags** contains list of OPC tags for which data file is generated by DCS. The order should be exactly the same as in data file.

Sections **TagNames** and **Criteria** are maintained by Apromon. No need to modify this section.

- c) Start Apromon™ program. You will see the initial Apromon™ screen as shown below:



3.2. Create TAG file

The next step is to create a file called the TAG file. This file is created automatically by Apromon based on the list of PID tags specified in the **Apromon.INI** file. The TAG file is an Excel file that contains one column for each PID tag we want to monitor. Various parameters related to the control quality criteria calculations are stored inside the TAG file.

To create the TAG file, click on the **CREATE TAG FILE** button near the top of the screen.

Set Scan Rate here equal to or greater (larger value) than the OPC Scan Rate set as explained in a previous section above.

Click inside the box under **PID Equation**, from "**Select PID Equation**" window, select the appropriate PID equation, and then click OK.

At this stage leave all other parameters at their default values.

Click on the **Create Tag File** button.

Now select the **Apromon.INI** file from the appropriate file sub-directory. Click on **Open**.

Now you can chose the filename and directory location for the TAG file. First, at the bottom of the dialogue box click on the down-arrow next to **Save as Type** and select **Apromon Excel Tag File**. Next, chose the appropriate file sub-directory where you want to save all files related to this instance and specify a filename. In our example, we had created a subdirectory "Plant Data Files Set 1" to save all files related to this instance. Type in the filename and click **Save**. You will see a message indicating that the file was successfully created.

3.3. Create CONFIG file

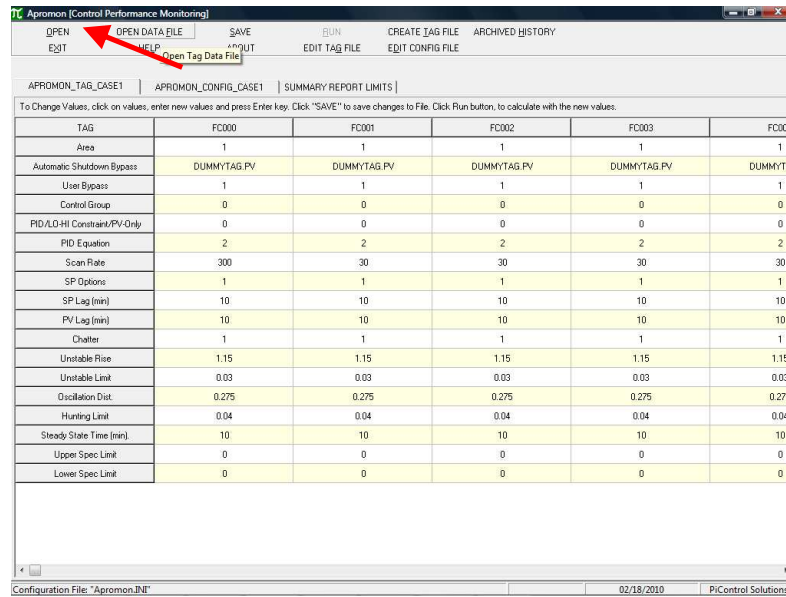
A file called **Apromon_Config_Case1.XLS** is supplied with the ApromonTM software. Copy and locate this file in the same file directory as the TAG file.

3.4. Read configuration File

Now that we have the three files (TAG, CONFIG and INI) in their appropriate directories, the next step is to read the INI file into Apromon.

Click on the **OPEN** button near the top left corner of the screen. Select the appropriate data file directory path and then select **Apromon.INI** file and click on the **Open** button the read the configuration file. Now Apromon reads the configuration file and based on the file paths specified for the TAG and CONFIG files, reads the TAG and CONFIG

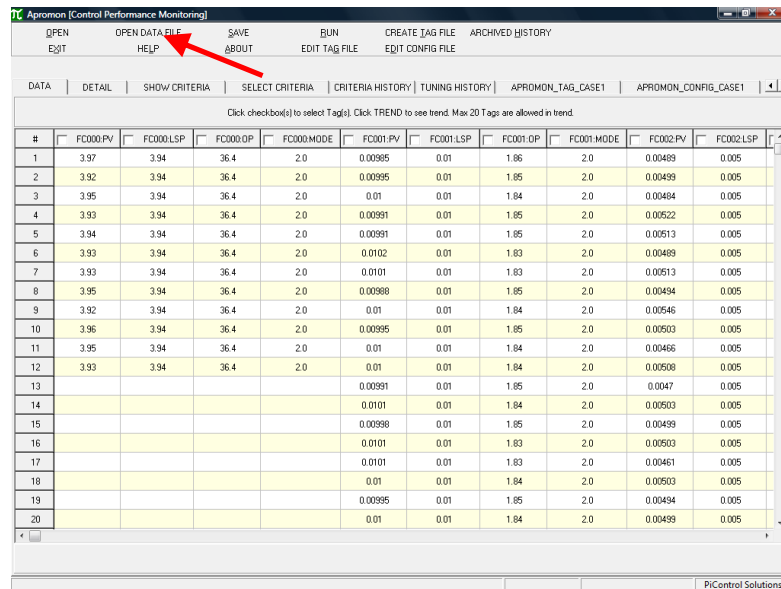
files also. Notice that new buttons with the names of the TAG and CONFIG files now show up on the Apromon screen as shown below.



If you click on the TAG or the CONFIG buttons, now you can see the file contents of the TAG and CONFIG files directly from the Apromon screen.

3.5. The OPEN DATA FILE button

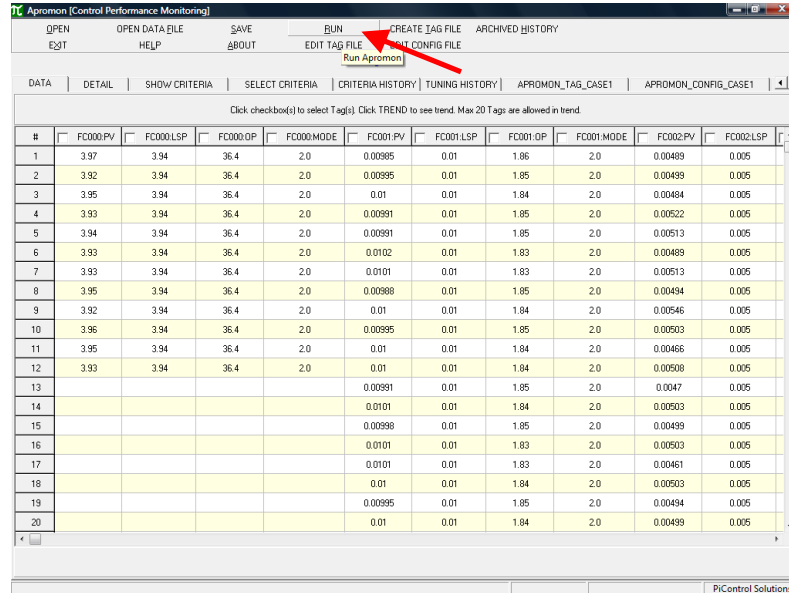
Click on the **OPEN DATA FILE** button from the top toolbar, select Excel data file generated by DCS and click on the **Open** button to read the data from the data file. Notice the Apromon screen showing the data read from the file.



3.6. The SAVE button

Click on the **SAVE** button from the top toolbar to save all the changes made from Apromon to the TAG and CONFIG files. **Apromon.INI** file is also updated and saved.

3.7. Click RUN button to analyze data and perform calculations.



3.8. Using Apromon™ to Improve Control Performance

Now that Apromon is installed and running, the next step is to examine its calculations and use the information to improve the PID tuning in the plant. The sections below guide you through all the functions and calculations of Apromon™.

4. Sub-Folders Containing Calculation Output and Results

After each run, Apromon™ saves all the calculation results on control quality in Excel files in various sub-folders. The names of the sub-folders are as follows: Backup Files, Detailed Reports, Error Log Files, History Apromon, Summary Reports and Tuning History. Apromon™ automatically creates all these sub-folders. The contents of these sub-folders are described below:

4.1. Backup Files Subfolder

The subfolder **Backup Files** is where Apromon™ saves a copy of TAG and CONFIG files in CSV (comma separated variable) format every time when data is processed (when Apromon™ runs).

4.2. Detailed Reports Subfolder

The subfolder **Detailed Reports** is where all detailed calculation report files are saved. Apromon™ generates these files automatically after all criteria calculations are complete. The detailed reports list all the control criteria calculations.

A typical detailed report file name is named as follows: **ApromonReport (11.15.06 10.16 AM).xls**. It contains the date and time stamp corresponding to the time of run.

4.3. Error Log Files Subfolder

The subfolder **Error Log Files** is where error log files are saved. These files are generated automatically by Apromon™ if bad data (or out-of-range data) are encountered. It contains information about tagnames, the number of data points found out of range or to have Bad data status (Not-a-Number etc.) and the percentage of tags that are bad.

A typical error log file name is as shown below:
ApromonErrorLog (2006-10-24_13-54-58).xls. It contains the date and time stamp corresponding to the time of run.

4.4. History Subfolder

The subfolder **History Apromon** is where all history files are saved. These files are generated automatically by Apromon™ and contain the detailed control criteria calculations for each individual tag.

Each Tag will have separate history file and the calculation results are appended to this files.

Typical History file names are as shown below:

FC111.csv

FC222.csv

FC333.csv

(where FC111, FC222, FC333 are tagnames).

4.5. Summary Reports Subfolder

The subfolder **Summary Reports** is where all summary calculation report files are located. These files are generated automatically by Apromon™ and contain summary reports, summarizing performance criteria for every tag.

A typical summary report file name is as shown below:

ApromonSummaryReport_2006-10-24_13-55-42.csv.

It contains the date and time stamp corresponding to the time of run.

4.6. Tuning History Subfolder

The subfolder **Tuning History** is where the P, I, D tuning parameters are saved for each tag in individual history files.

5. Processing of Bad Input Data

The Apromon™ screen displays various tabs below the instance name. Use the left and right arrow buttons at the extreme right side of tabs to navigate through the tabs. One of the tabs is labeled **ERRORS**. If you do not see this tab, then click on the arrow for scrolling near the right side of the screen arrow until the **ERRORS** tab is visible. Click this tab. You will now see a window with four columns showing information on tags that contained some bad values during the data collection. There is one column each for PV, SP, OP and Mode (four columns in all).

5.1. Bad PV (Process Variable) Data

At every scan period, Apromon™ reads live data from the DCS or PLC through the OPC server. If the PV value is outside the high and low instrument range for that tag, or if the PV value has Bad status (NaN or not-a-number), then this value is counted as Bad. The total number of such bad PV values divided by the total number of values scanned during that time period is reported as percent bad.

5.2. Bad SP (Setpoint) Data

Since the low and high ranges of SPs are the same as those of PVs, the logic for bad value handling for SPs is the same as that for PVs. The total number of bad SP values divided by the total number of values scanned during that time period is reported as percent bad.

5.3. Bad OP (Controller Output) Data

The PID controller output range can be 0 to 100%. In some DCSs, an extended range of -7% to 107% is allowed. If OP is less than -7% or more than 107% then Apromon™ counts the OP value as bad. If the OP value is less than 0%, then it is clamped to 0%. If the OP value is more than 100%, then it is clamped to 100%.

Apromon™ also works with analog input signals and other signals that are not controllers (non PID tags). For such tags that are PV only, the OP signal is completely disregarded and all criteria calculations using the OP signals are bypassed.

5.4. Bad Mode Data

The PID controller modes are typically Manual, Auto and Cascade. Apromon™ converts these mode names (strings) into integer values: Manual mode or Local mode = 1, Auto mode = 2, Cascade mode, Computer mode or Remote mode = 3. If the mode string read from the OPC server does not match any of the strings defined under the section **MODEValues** in the **Apromon.INI** file, then the Mode value is counted as bad. The various valid mode string names are defined under the section **MODEValues** in **Apromon.INI** file.

5.5. Bad Data Tolerance Specification

A few bad data samples are to be expected in any industrial process. When technicians are working on an instrument, the PV signal could go bad. If a tag is inactivated in the DCS for configuration changes, its signals also may go bad for a few seconds or minutes. But if data are bad for too long, then Apromon™ can be configured to skip (bypass) all calculations for that tag.

The bad data tolerance is defined in the **CONFIG** file. Open the **CONFIG** file with Excel to view its contents or click the tab for the **CONFIG** file from the Apromon™ screen. Notice that the default **PERCENT BAD DATA TOLERANCE** is 5%. This means that if more than 5% of the data (PV, SP, OP or Mode) are bad, then all calculations are skipped for that tag completely and the **User Bypass** parameter inside the **TAG** file is set to 0 (meaning that the tag is set to **Inactive**). Note that if you want to deliberately skip certain tags (bypass their criteria calculations), in TAG file set **User Bypass** value to 0 (Inactive).

6. Review Plant Data

Apromon™ allows you to inspect the data collected from the DCS or PLC for all tags. You can click on the following three tabs to inspect the data: **OPC DATA**, **DATA** and **TREND**.

6.1. DATA

Click the left scroll arrow button located near top right until the **DATA** tab is visible at the left.



Click on the **DATA** tab to see all collected data for all the parameters (PV, SP, etc.) for all tags. The Data Sample Number is shown in the leftmost column.

The next column (first data column) shows the PV data.

The second column shows the SP data and so on. Scrolling further right, you will see all the data- PV, SP, OP, Mode, etc. for all other tags.

6.2. TREND

The **TREND** tab allows you to trend the data for any tag. Click on the **TREND** tab. Then check one or more of the check-boxes in the rightmost column. You will see the data trends for the checked variables.

6.2.1. Zoom and Drag Function

Zoom and Drag Feature: Apromon™ has powerful zooming and drag feature. To zoom the data trends, follow the procedure below:

1. Check one or more checkboxes to generate trends
2. Inside the trend plots, click and hold with the left mouse button.

3. While holding the left mouse button down, move the mouse diagonally downward and rightward to draw a rectangle.
4. Release the left button to see the zoomed window.
5. Double click anywhere inside the trend box to restore the original window.
6. To drag trends, inside the trend plots, press and hold the right mouse button. While holding down the right button, move the mouse up/down/left/right. Notice how conveniently you can zoom and move anywhere along the X or Y axis.
7. Double click anywhere inside the trend area to restore the original trends.

6.2.2. Tag Search Function

This function helps to short list the tags shown in the upper box to trend. Say you type FC1 inside the text box (at the bottom right side of the screen, below the Tags list). Then only the tags containing the string FC1 will be displayed in the tag-list box above. Similarly, if you type FC2 then you will see only those tags that contain the string FC2 in their tagname.

7. The **DETAIL** Tab

The **DETAIL** screen shows diagnostics on oscillation detection. The vertical blue lines in the bottom window are called *True Amplitudes*. The location and height of the true amplitudes match with the (PV-SP) deviations on the **TREND** plot.

Even if the PV data are noisy, Apromon™ identifies only the meaningful amplitudes (true amplitudes), which indicate true oscillations. The small squiggles consisting of fast (high frequencies) noise and all other disturbances (slower frequencies) are automatically isolated and rejected, regardless of how much is the noise or disturbance level.

7.1. The **SPECTRUM** Criterion

The **DETAIL** screen displays the **SPECTRUM** criteria value. The spectrum indicates the level of oscillation in the signal. High values of **SPECTRUM** (values typically over 5) mean higher the extent of oscillations, hunting and/or instability. For an oscillating signal, you will see just a few (typically only one to three) tall red bars in the upper window, which means the frequency distribution is narrow. A perfect sine wave will have one single red bar in the top window indicating one single dominant frequency.

Low values of **SPECTRUM** (values typically below 5) mean the signal is not oscillating. For a non-oscillatory signal, you will see several red bars in the top window indicating that the signal has multiple frequencies and no single dominant frequency.

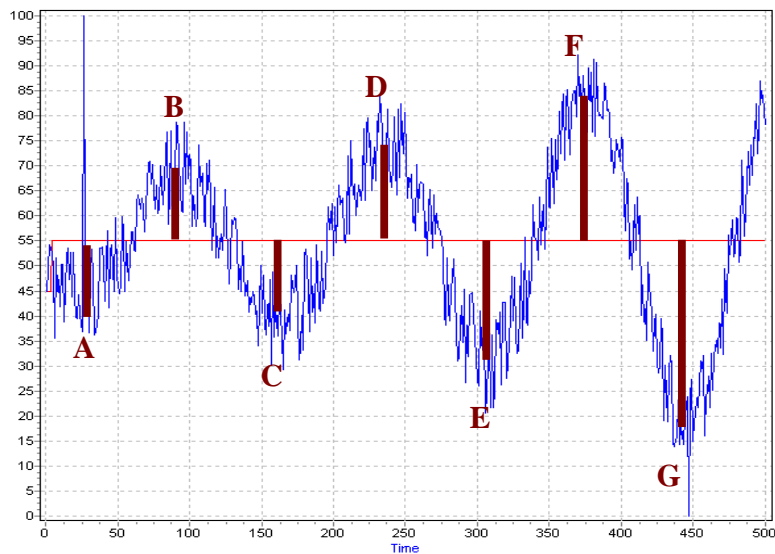
Oscillations, hunting or instability are undesirable in any chemical process. Using the **SPECTRUM** and *True Amplitude Detection (TAD)* technology, Apromon reliably identifies the oscillations.

7.2. The Chatter Parameter Tuning

The *True Amplitude Detection* (TAD) algorithm has a few tuning parameters for every tag. These parameters are located in the TAG file. The default tuning works well for most cases. For certain abnormal situations, some tuning adjustment may be necessary.

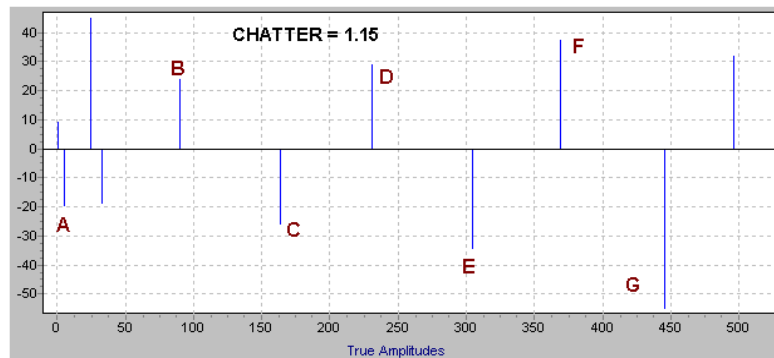
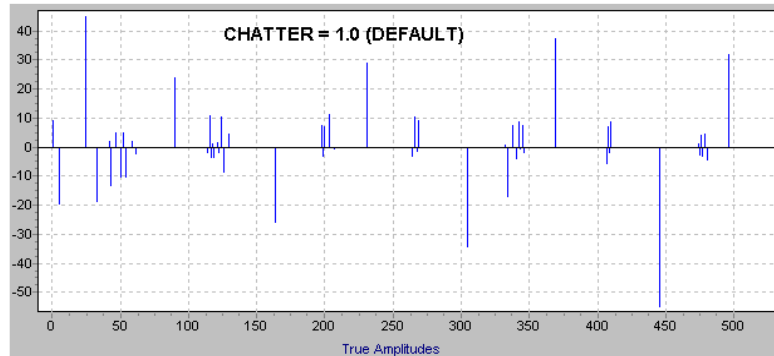
One of the tuning parameters related to the TAD algorithm for oscillation detection is called **CHATTER**. The default value for chatter is 1.0. For extremely noisy signals (characterized by high noise to signal ratio), the chatter may need to be increased in the range of 1.001 to 1.5.

To understand the chatter tuning parameter, see the plot below. The red line is the setpoint (SP), the blue trend is the process variable (PV). The signal is oscillatory – the true amplitudes are the vertical brown bars labeled by letters B, D, F (positive peaks) and A, C, E, G (negative peaks).



Notice that the PV signal has both a fast frequency (random noise) and a slow frequency showing the real oscillations. We are not interested in the fast noisy squiggles but are only interested in the slow oscillations. The top window below shows the TAD display with a default chatter value of 1.0.

The bottom window below shows the TAD display with a chatter of 1.15. Notice that the short amplitudes (small vertical blue lines) are eliminated with the chatter value of 1.15.



8. Individual PID Contributions

Based on the PV, SP and OP signals, Apromon™ calculates the individual breakdown of the proportional, integral and derivative contributions and reports them as a percent of the total PID control action. The sum of all three contributions equals the total change in the PID's output.

To see the individual breakdown of the P, I, and D contributions, click on the **DETAIL** tab and then click on any tagname on the right side of the screen. You will see the blue, red and purple horizontal bars near the bottom right corner of the screen showing the three PID contributions - *Proportional*, *Integral* and *Derivative*. The three values will always add to 100%.

Note that you have to specify the correct type of PID equation in the TAG file (as explained in Section 3.5). This equation selected in the TAG file has to match with the PID equation in the DCS or PLC; otherwise the PID contributions reported by Apromon™ will not be correct.

If your PID equation is not listed in the PID equation menu shown earlier in this manual, then please contact PiControl Solutions for a free software update (send an email to info@PiControlSolutions.Com).

9. SP (setpoint) Options

The SP signal is used in several control quality criteria calculations. Apromon™ offers four options for conditioning setpoints for use in the calculations. The conditioning can help to make the criteria calculations more accurate. The SP options are specified in the TAG file. To see or modify the option for any tag, open the TAG file in Excel or click the tab for the TAG file on the Apromon screen and notice the **SP Options** row. The four options are:

- 1=LSP (lagged SP)
- 2=ASP (average SP)
- 3=LPV (lagged PV)
- 4=APV (average PV)

You have to also specify the values of **SP Lag** and **PV Lag** parameters specified under the **SP Options** field. The default values for SP Option, SP Lag and PV Lag can be set during the TAG file creation step described in an earlier section in this manual.

9.1. LSP Option (Lagged SP)

Since the process dynamics in many chemical processes are slow, when a SP is changed, it can take several minutes or hours for the PV to reach the new SP. Lagging the SP allows time for the PV to reach the SP and reduces needless error on the control action because of slow dynamics. The **LSP** option is the most common option. The **SP Lag** is just a simple first order time constant. Typical values of **SP Lag** are from 0 to 500. The time unit for **SP Lag** is the same as the **Scan Rate** (milliseconds). If you do not know the process dynamics, default the SP Lag to 4 for all tags (an error on this value will not significantly deteriorate the criteria calculations and results).

9.2. ASP Option (Average SP)

When the **SP Option** is set to 2, then the average of all the raw SP values in the entire time period is calculated as the

ASP value. This single ASP value is then used in the criteria calculations. On the **TREND** display, the ASP trend for any tag will be just a straight horizontal line, the value equal to the average value of the SP values. The value of **SP Lag** is not used in this option.

9.3. LPV Option (Lagged PV)

If the **SP Option** is set to 3, then the LPV option is used. The entire raw SP data collected are completely disregarded. Here, the **PV Lag** value is used. PV Lag is just a simple first order time constant. The raw PV signal is passed through the **PV Lag** time constant to generate the LPV (lagged PV) signal. This signal is used now as the SP for all criteria calculations.

9.4. APV Option (Average PV)

When the **SP Option** is set to 4, then the average of all the raw PV values in the entire time period is calculated as the APV value. This single APV value is then used in the criteria calculations. On the **TREND** display, the APV trend for any tag will be just a straight horizontal line, the value equal to the average value of the PV values. The value of **PV Lag** is not used in this option.

9.5. Guidelines for Choosing the right SP Option

In most cases, use the default option as the **LSP** option with **SP Lag** of 0 to 5. In some cases other options may give better results by identifying the true amplitudes and detecting oscillations more accurately. Cases where other options (ASP, LPV or APV) may benefit for detecting oscillations are on:

- Pure analog signals not used in PID controllers where there is no setpoint to work with. Here use LPV.
- Slave loops may also work better with the LPV option and an appropriate PV Lag parameter.

You may examine the raw data on the **TRENDS** display to estimate decent values of SP Lag and PV Lag. While it is desirable to estimate good values for these lags, values with some error will not significantly deteriorate the calculation results from Apromon.

Note that with the LSP option, only the SP Lag is used and the PV Lag is not used. With the LPV option, only the PV Lag is used and the SP Lag is not used. For the ASP and APV options, neither SP Lag nor PV Lag values are used.

10. Control Performance Quality Criteria

This section describes all the control performance quality criteria calculated by Apromon™. Apromon™ calculates about 30 criteria.

Click on the **SELECT CRITERIA** tab to see names of all criteria. Click on **SELECT ALL** to select all criteria to display. Click on **SELECT NONE** to unselect all criteria. Click on each of the criteria buttons to toggle from select to unselect.

If any of the parameters in the TAG file or CONFIG file are changed, then you must first click on the **RUN** button in order to update the criteria calculations.

Click on the **SHOW CRITERIA** tab and click on **Change Criteria for Sort Order**. You can select any of the criteria for sorting. You also have the option of **Sort Ascending** or **Sort Descending**.

Now we will explain each of the 30 criteria calculated by Apromon™:

10.1. Criteria #1- Error

This is the Integrated Absolute Error, called IAE. Error is calculated as PV minus SP. IAE is the absolute value of the error, integrated over the full time period. The SP data used in the calculation are not the raw SP values but the conditioned SP values depending on the selected **SP Option** (LSP, ASP, LPV or APV).

Click on the tab for the **CONFIG** file. See the variable called **EU/PCT**. The default value is 1; this means that the error is calculated as the percent of scale. If **EU/PCT** is set to 0, then the error is calculated in engineering units.

The default value for **EU/PCT** (1 = percent of scale) is recommended since this shows all values in percent-of-scale, and therefore the **ERROR** criteria values from all tags are

directly comparable and hence more meaningful. The percent of scale is based on the **PV Hi Range** and **PV Lo Range** values specified in the TAG file.

10.2. Criteria #2- Error Squared

This is the **I**ntegrated **S**quare of the **E**rror (ISE). Error is calculated as PV minus SP. ISE is the square of the error, integrated over the full time period. The SP data used in the calculation are not the raw SP values but the conditioned SP values depending on the selected **SP Option** (LSP, ASP, LPV or APV).

Click on the tab for the **CONFIG** file. See the variable called **EU/PCT**. The default value is 1; this means that the error is calculated as the percent of scale. If **EU/PCT** is set to 0, then the error is calculated in engineering units.

The default value for **EU/PCT** (1 = percent of scale) is recommended since this shows all values in percent-of-scale, and therefore the **ERROR SQUARED** criteria values from all tags are directly comparable and hence more meaningful. The percent of scale is based on the **PV Hi Range** and **PV Lo Range** values specified in the TAG file.

The results from this criterion are similar to the **ERROR** criterion. You can closely examine both the **ERROR** and **ERROR SQUARED** criteria, but using only one of them will be found to be sufficient.

10.3. Criteria #3- Error Deviation

This is the average error between the PV and SP calculated over the full time period.

Click on the tab for the **CONFIG** file. See the variable called **EU/PCT**. The default value is 1; this means that the error is calculated as the percent of scale. If **EU/PCT** is set to 0, then the error is calculated in engineering units.

The default value for **EU/PCT** (1 = percent of scale) is recommended since this shows all values in percent-of-scale, and therefore the **ERROR DEVIATION** criteria values from all tags are directly comparable and hence more meaningful. The percent of scale is based on the **PV Hi Range** and **PV Lo Range** values specified in the TAG file.

This criterion is similar to the **ERROR** and **ERROR SQUARED** criteria, but is less commonly used. If you have decided to use either the **ERROR** or **ERROR SQUARED** criterion or both, this criterion could be ignored.

10.4. Criteria #4- Variance

The variance is the commonly used statistical calculation. The mean value is μ , the standard deviation is σ and the number of samples is N:

$$\text{Variance} = \sigma^2 = \frac{\sum (X - \mu)^2}{N}$$

10.5. Criteria #5- Standard Deviation

The standard deviation is the commonly used statistical calculation. The mean value is μ , the standard deviation is σ and the number of samples is N:

$$\sigma = \sqrt{\frac{1}{N} \sum_{i=1}^N (x_i - \mu)^2},$$

10.6. Criteria #6- Control Tightness

This criterion is a function of how often the PV crosses the SP. High numbers for this criterion means that the control is tight and crisp. Low numbers indicate potentially sluggish control. Sluggish control may be caused by weak integral

action. Excessively high derivative action also can potentially cause this criterion to show high values.

Click on the tab for the TAG file and set the **Steady State Time (minutes)** correctly for each tag. The steady state time is the time required for the PV to reach the new steady state after a bump in the OP (valve position). Typical values of steady state time are as follows:

- Flow PID 2 minutes
- Pressure PID 5 minutes
- Temperature PID 20 minutes
- Level PID 30 minutes
- Online Analyzer PID 120 minutes
- Motor KW or Amps control 3 minutes

10.7. Criteria #7- Imbalance

The imbalance criterion looks at the ratio of the time spent by the PV on any one side of the SP. A value of 1.0 is the highest (best) rating for this criterion. Higher values indicate that the PV spends more time on one side of the SP (higher or lower than the SP) and this is not desirable. Higher values can be indicative of weak control action, possibly large external disturbances or control valve problems.

This criterion is in some ways analogous to the skew criterion (explained later below). The difference is that the imbalance criterion looks at the ratio of the time spent on one side of the SP whereas the skew criterion looks at the ratio of the integrated positive and negative errors.

10.8. Criteria #8- Skew

The skew criterion shows the ratio of the positive and negative integrated errors. Higher values are undesirable and indicate that the integrated error on one side of the SP is more than the other side.

Higher error on one side of the SP can be indicative of weak control action, possibly large external disturbances or control valve problems.

This criterion is in some ways analogous to the imbalance criteria. The difference is that the skew criterion looks at error ratio whereas the imbalance criterion looks at the ratio of the time spent on one side of the SP.

10.9. Criteria #9- Crimp

This is the ratio of accumulated changes in SP to the accumulated changes in PV. Lower values up to the value of 1.0 are good. Values over 1.0 warn one of two possibilities:

- Controller tuning is so sluggish that the new SPs are not reached in a timely manner. In this case it may be desirable to make the controller tuning more aggressive.
- If the controller is of slave type in a cascade loop, then the master's controller tuning is so aggressive that the slave is unable to keep up with the SP changes caused by the master. In this case, it may be desirable to make the master controller less aggressive and/or the slave more aggressive.

10.10. Criteria #10- Unstable

The Unstable criterion shows how many times the PV signal became unstable during the time window. "*Becoming-Unstable*" is defined as when the PV signal starts oscillating with increasing amplitudes.

Zero is the desired value (no unstable oscillations). Any positive number indicates the number of times this signal became unstable. Non-zero value is indicative of aggressive tuning, most likely excessively high proportional and/or integral action.

10.11. Criteria #11- Hunting

The Hunting criterion shows how many times the PV signal was hunting during the time window. "*Hunting*" is defined as when the PV signal is oscillating with large amplitudes with fairly constant heights. Hunting can also be defined as when the signal oscillates at larger than desirable amplitudes.

Hunting is what happens first before the signal goes to "Unstable".

Zero is the desired value (no hunting). Any positive number indicates the number of times the signal was hunting. Non-zero value is indicative of aggressive tuning, most likely excessively high proportional and/or integral action.

10.12. Criteria #12- Spectrum

The spectrum criterion indicates whether the signal comprises many signal frequencies or comprises a few dominant frequencies.

Lower values (values under 4 or 5) indicate that the signal has many frequencies and no single dominant frequency. Lower values are desirable.

Higher values (more than 10) mean there are some noticeably dominant frequencies and this can indicate cycling. Higher values could be a result of aggressive PID tuning (aggressive control action) or also of oscillatory external disturbances causing the signal to oscillate.

The range of spectrum can extend from around 2 (no cycling or oscillations) to over 200 (strong symptoms of cycling and oscillations).

10.13. Criteria #13- Match

This criterion shows tags that have the same dominant frequency. Tags with the same match value have similar

signal frequencies. Apromon categorizes all tags into 14 categories based on their frequency distribution.

Tags with fast dominant frequencies are likely to have similar or identical match values (lower values). Tags with slower dominant frequencies are likely to have higher values.

10.14. Criteria #14- Noise Level

This criterion is a complex function related to the amount of random noise component in the PV signal.

10.15. Criteria #15- Saturation OP

This criterion shows the percent of time when the controller output was over 90% or less than 10% and when the controller was not in manual mode.

Low values are desirable. Zero means the output was never saturated.

10.16. Criteria #16- Spike OP

This criterion shows the largest change in the output (OP) value during three consecutive scans over the entire data set. This value can capture proportional kick on a SP change and flag excessive proportional action. Also, this value can capture excessive derivative action if the PV signal is noisy and derivative action is excessive. Larger values of this criterion are not necessarily bad and do not necessarily show poor performance. The purpose of the criterion is to flag excessive movement in the OP, which can possibly help to alert control that is too aggressive or to show the need for more PV filtering.

10.17. Criteria #17- Saturation PV

This criterion shows the percent of time when the PV (process value) was within 3% of either the high or low PV range (instrument range) and when the controller was not in

manual mode. Low values are desirable. Zero means the PV was never close to the instrument range units.

10.18. Criteria #18- Spike PV

This shows the largest change in the PV value over the entire data set. Larger values of this criterion are not necessarily bad nor are they indicative of poor performance. But they warn that the PV is changing suddenly by a large value. If this PV is used for closed-loop control action, then large PV changes could possibly cause excessive, potentially undesirable control action. It may be desirable to validate this spiky signal with a spike rejection functionality that freezes the signal or changes it based on the maximum rate of change limit.

10.19. Criteria #19- Frozen PV

This criterion counts the number of times the PV signal was frozen (did not change- compared to the last value) and then reports the criterion calculation as a percentage of the total number of scanned samples.

10.20. Criteria #20- Rope Length

This criterion displays the total control valve movement during the entire data set. High value indicates excessive control valve movement and can cause control valve damage and premature replacement.

In certain control schemes, large control valve movement is unavoidable, so high values are not necessarily bad. But this could possibly reflect aggressive tuning.

10.21. Criteria #21- Vacillation

This criterion indicates the number of times the control valve changes the direction of travel. If the control valve was opening from 10% to 11% and then goes to 5%; this is considered as one change in travel direction (valve position changes direction from increase to decrease).

Excessive number of valve direction change can wear out the valve prematurely. In certain control schemes, frequent valve travel directional changes are unavoidable; so high values are not necessarily bad. But this could possibly reflect tuning that is too aggressive..

10.22. Criteria #22- Proportional Contribution

Apromon™ is equipped with the PDA algorithm (**P**roportional **C**omponent **D**ecomposition **A**lgorithm) that looks at the full PID control action and then decomposes it into the individual Proportional, Integral and Derivative components. This value shows the percent of the total PID action that is because of the Proportional action only.

10.23. Criteria #23- Integral Contribution

Apromon™ is equipped with the PDA algorithm (**P**roportional **C**omponent **D**ecomposition **A**lgorithm) that looks at the full PID control action and then decomposes it into the individual Proportional, Integral and Derivative components. This value shows the percent of the total PID action that is because of the Integral action only.

10.24. Criteria #24- Derivative Contribution

Apromon™ is equipped with the PDA algorithm (**P**roportional **C**omponent **D**ecomposition **A**lgorithm) that looks at the full PID control action and then decomposes it into the individual Proportional, Integral and Derivative components. This value shows the percent of the total PID action that is because of the Derivative action only.

10.25. Criteria #25- PP (Process Performance)

The PP (process performance) is a standard statistical performance calculation. It is calculated as follows:

$$PP = \frac{(USL - LSL)}{6 \sigma_i}$$

PP = Process Performance
 USL = Upper Specification Limit
 LSL = Lower Specification Limit
 σ_i = Standard Deviation

Note that both the Upper Specification Limit (USL) and the Lower Specification Limit (USL) are defined in the TAG file. If the USL and LSL values are zero, then this criterion is not calculated.

10.26. Criteria #26- PPK (Process Performance Index)

The PPK (process performance index) is calculated as follows:

$$Z_{upper} = \frac{(USL - \bar{X})}{\sigma_i} \quad Z_{lower} = \frac{(\bar{X} - LSL)}{\sigma_i}$$

$$Ppk = \frac{Z_{min}}{3}$$

Z_{min} = Smaller of (Z_{upper} and Z_{lower})
 PPK = Process Performance Index
 USL = Upper Specification Limit
 LSL = Lower Specification Limit
 σ_i = Standard Deviation
 \bar{X} = Mean

Note that both the Upper Specification Limit (USL) and the Lower Specification Limit (USL) are defined in the TAG file. If the USL and LSL values are zero, then this criterion is not calculated.

10.27. Criteria #27- Cheat

When an advanced control scheme is not working well, experienced operators often help it by flipping one or more PIDs either from Auto to Manual or from Cascade to Auto/Manual and then bumping the SP or OP and then flipping it back to their normal mode. This action is caused "cheating" because the operator is helping the control scheme. The time during which the mode change is made is typically under a minute. The cheat value is incremented by one each time the mode changes from normal mode to a temporary abnormal mode (lasting less than a minute) and then back to the normal mode.

10.28. Criteria #28- Intervene

This shows the number of times the PID underwent a mode change. There are three common modes - Manual, Auto and Cascade. Each time the mode is changed the value of this criterion is incremented by one.

10.29. Criteria #29- Onstream Factor

This criterion shows the fraction of the time the controller is in automatic or cascade modes (not in manual mode). 100% indicates the controller is never in manual mode. 0% indicates that the controller is always in manual mode.

The criterion not only looks at the Mode value (showing controller mode - manual, auto, cascade, etc.), but also examines the OP, PV and SP values from the entire data set.

If OP values are frozen (fixed at some constant value), then the criterion knows that the controller is initializing and reports it as though in manual even though the Mode values may show non-manual. Also, if the PV and SP are exactly equal, then the criterion also knows that the controller was PV-tracking and hence reports it as though in manual mode, even though the Mode values may show a non-manual state.

10.30. Criteria #30- InUse

This value will normally be 100% for all slave or cascade PIDs. This criterion is relevant only for master PIDs that are part of a low or high selector (override constraint control) scheme. In a constraint control scheme, you have multiple master PIDs who's OP goes to a low or high selector. The signal from the selector provides a SP to a slave PID. At any given time, the OP of only one of the master PIDs will be selected by the selector. The other PID OPs will be unselected. The InUse criterion reports the percent of total time that PID was selected. If a PID was always selected, then the InUse will be 100%. If a PID was selected 25% of the time, then InUse will be 25%.

10.31. Criteria #31- Grade

Apromon™ calculates an overall "grade" value based on some of the above criteria. The grade is calculated based on various criteria explained above:

- Error criteria
- Onstream factor
- Extent of cycling (oscillations) as determined by the spectrum, hunting and unstable criteria
- Combination of other criteria

The grade calculation algorithm is "smart". It does not double-penalize the score because of overlapping criteria.

10.32. Criteria #32- Diagnostics

The diagnostics criterion displays a text message describing the overall performance of each tag. If the control performance is good, the diagnostic displays "Control Performance is Satisfactory". Various other messages are generated based on the values of the various criteria.

11. History Files – Archival and Trending

Apromon™ saves the results of all calculated criteria in historical files for future retrieval and analysis.

11.1. History File Archival Setting Options

Click the tab for the CONFIG file. You will see the two fields called **SAVE HISTORY FILES - INTERACTIVE** and **SAVE HISTORY FILES - SCHEDULED**.

Both have default values of 1 (which means save files on exit). This means that every time the program exits, all calculated criteria are saved into historical files. You are running the interactive version of Apromon™ and the “Save History Files – Interactive” setting should be 1 for this interactive version. “Save History Files – Scheduled” is not applicable for this OPC version. It is provided for backward compatibility. You can keep both settings at 1. Inside the CONFIG file, if the value for “Save History Files – Interactive” is set to 0, then the criteria values will not be saved to the history files.

The historical files are in CSV (comma separated variable) format and are located in the subfolder **History Apromon** in the **Case Files** folder.

11.2. ARCHIVED HISTORY - Criteria History

Apromon™ trends history data from the historical data files described earlier. Click the **ARCHIVED HISTORY** button and select **Criteria History** which will open a Criteria History Analysis window. Now under **Select History Folder**, select the subfolder **History Apromon**. Now under **SELECT TAG** you will see the various tags. In the rightmost column (all criteria are provided including the Select-none and Select-all options) select the desired criteria to display. After selecting the desired criteria, double click any tag to see the historical performance.

11.3. ARCHIVED HISTORY - Tuning History

Apromon™ also trends tuning parameters history data from the historical data file. Click the **ARCHIVED HISTORY** button and select ***Tuning History***, which will open a Tuning Parameters History Analysis window. Now under **Select History Folder**, select the subfolder ***Tuning History***. Now under **SELECT TAG** you will see the various tags. In the rightmost column (all parameters are provided) select the desired parameters to display. After selecting the desired parameters, double click any tag to see the historical performance.

11.4. CRITERIA HISTORY and TUNING HISTORY tabs

The **CRITERIA HISTORY** and **TUNING HISTORY** tabs allow you to see the history trends for the tags from the history files of the **current (latest) run**.

Note that the **ARCHIVED HISTORY (Criteria History and Tuning History)** described in previous sections allows you to see historical trends from the **past (archived) runs**.

12. Summary Report

After every run, Apromon™ generates a summary report. This is in addition to the detailed report described earlier.

To see the summary report, click on the tab **SUMMARY REPORT**. (If you cannot see this tab, then use the left and right scroll arrow buttons located near the top right corner of the screen to get to this tab). Notice that the information inside the summary report is similar to the information under the **SHOW CRITERIA** table. The difference is that the summary report has less data to make it more concise and show limited information.

Now click tab **SUMMARY REPORT LIMITS**. Notice that each criterion has a **LOW LIMIT, HIGH LIMIT** and a **SELECT (Yes/No)** option. If "No" is selected, then the criterion is not displayed under the summary report. Tagnames shown for a given criterion show up in the summary report only if the criterion value happens to lie within the low limit and high limit.

The summary report is a nice feature to short list only those tags whose criteria-values fall within the user specified range. Tags that are performing well with small error values, tags that are not oscillating etc., can be kept out of the summary report so that the focus is only on the poorly performing tags with poor criteria values.

13. Tuning Procedure for the Unstable and Hunting Criteria

Apromon™ is equipped with a novel algorithm called TAD (True Amplitude Detection) to detect unstable and hunting characteristics in a signal. This section shows how to tune parameters related to the hunting and unstable criteria.

Open the TAG file using Excel or click on the tab for the TAG file (the tab with the TAG file name just to the right of the SELECT CRITERIA tab) on the Apromon screen. Notice that for each tag, there are fields for **Unstable Limit** and **Hunting Limit**. The default values for these fields are 0.03 and 0.04 respectively.

The 0.04 value for the **Hunting Limit** means that if the signal amplitude ($ABS(PV-SP)$) is more than 4% of the PV High minus PV Low Range, then the signal is considered to be *hunting*.

The 0.03 value for the **Unstable Limit** means that if the signal amplitude ($ABS(PV-SP)$) is more than 3% of the PV High minus PV Low Range, then the signal is considered to be *unstable*.

Also in the TAG file, notice a field called **Unstable Rise**. The default value for this is 1.15. This means that if the ratio of the heights of three or more consecutive positive or negative amplitudes is 1.15 or more, then the signal is flagged as *unstable*. This means that newer amplitudes are taller than the most recent one by 15%. In most cases, this default 1.15 value will be suitable and there will be no need for a change.

In the TAG file you will see another parameter called **Oscillation Distance**. Its default value is 0.275. The oscillation distance checks to make sure that consecutive hunting or unstable amplitudes are equidistant. If three consecutive amplitudes pass the amplitude (height) criteria but are spaced too far differently, then the signal is not oscillating and both the unstable and hunting criteria will report a zero.

For some rather unique cases, it may be necessary to adjust the above limits for a few tags to improve the accuracy of the estimation of the **Hunting** and **Unstable** criteria. However, experience has shown that the need for these adjustments is very rare.

14. Steady State Time

Open the TAG file with Excel or click on the TAG file tab on the Apromon screen. There is a parameter called **Steady State Time (min)**. This is the time required for the PV to reach a new steady state after a change in the PID OP (or valve position). Normally, the steady state time is set to about 2 to 4 times the first order time-constant of the process. Typical values for Steady State Time are as follows:

<u>Signal Type</u>	<u>Steady State Time</u> <u>(minutes)</u>
Flow signals	3
Pressure signals	7
Temperature signals	20
Level signals	30
Online analyzer signals	60-150

Set your best guess for this parameter. Apromon™ is equipped with auto self detection of this parameter and hence approximate or even somewhat inaccurate setting of this parameter will not seriously impact any of the performance criteria calculations.

15. CONFIG File Parameters

This section describes all parameters inside the CONFIG file not yet explained in any of the previous sections.

The CONFIG file will typically have a name such as **Apromon_Config_Case1.XLS**.

Open the CONFIG file using Excel or click on the CONFIG tab on the Apromon screen to view its contents.

15.1. Grade Limit

Based on various criteria, Apromon calculates an overall grade, which is reported under the **GRADE** column, which is on the far right under **SHOW CRITERIA**. The default value for grade limit is 85. If the grade is more than this limit, then you will see a message “Control performance is Satisfactory” under the **DIAGNOSTICS** column, which is also on the far right under **SHOW CRITERIA**. Otherwise, you will see a diagnostic message indicative of any performance deficiencies for the tag.

15.2. Criterion for Sort

This is the criterion used to sort all tags. E.g., if **ERROR** is selected, then all tags are sorted based on the **ERROR**.

15.3. Sort Order

The sort order can be set to either ascending or descending.

15.4. Save Error Log

If value of this field is set to 1, then ApromonTM saves the error log file if bad data (or out-of-range data) are encountered.

15.5. Error Scale

The **ERROR SCALE** is a pure multiplier for the **ERROR**, **ERROR SQUARED** and **ERROR DEVIATION** criteria. The default value is 1. In most cases, this is always set to 1, but may be used to scale if necessary to compare errors from different plants with different PV High and Low Ranges.

15.6. Spectrum 1-14 Limits

If you click on the **DETAIL** tab and then click any tag on the right, you see the frequency distribution in the top window. There are up to 15 vertical red bars. The spectrum limit values are used to adjust spacing if your plant data dynamics are uncommonly fast or slow.

Click **Default Spectrum Limits** button for some good starting default settings. On the **DETAIL** tab, if you see most tags with a single tall bar on the right (bar #15), then increase the **Spectrum Limits** by 3-5 and click **RUN** from the top toolbar. Try a few times with increased limits (raise all limits by 3-5).

Conversely, if you see most tags with a single tall bar on the left (bar #1); then reduce the **Spectrum Limits** by 3-5 and click button **RUN**. Try a few times with reduced limits (lower all limits by 3-5).

PiControl Solutions will provide you free email assistance to optimize your Spectrum Limits if you feel you need some expert assistance.

15.7. Save OPC Data to Files

If this value is set to 1, then the entire sets of all OPC data values (PV, SP, OP etc.) are saved to files in the Apromon root directory.

The filenames have the following structure:
OPCdataArray_11-22-09_14-19-16.csv
and OPCDataGrid_11-22-09_14-19-16.csv

15.8. Other Parameters in CONFIG File

Leave all other parameters not explained thus far unchanged at their default values. These are for use by PiControl Solutions personnel only.

16. TAG File Parameters

The TAG file stores tag specific tuning values needed to calculate the control performance criteria. Typical names for the TAG file are: Apromon_Tag_Case1.XLS. You can view or modify the TAG file contents by either opening the file with Excel or by clicking on the TAG file tab from the Apromon screen.

Note that if you modify the TAG file from the Apromon screen, then you must also click on the **SAVE** button in order to save the changes to the file in the sub-folder.

Also you need to click the **RUN** button to see the effect of changed parameters on the calculated criteria.

In this section we will describe all TAG file parameters not explained in the previous sections:

16.1. Area

This is a string that identifies the plant or process area or equipment unit with which the tag is associated. You have to manually specify the **Area** for each tag.

Typical examples for **Area** are: FCC, Utilities, Aromatics Plant, etc. It helps to categorize tags. Using the **Area** field, you can selectively see tags for just the selected areas only while hiding all other tags belonging to other areas while viewing the **SHOW CRITERIA** tables.

You can just leave this field to some default name “Area” or “Unit” if you do not wish to use this function.

16.2. Automatic Shutdown Bypass

You have to create a tag in the DCS or PLC with some name such as FCC.PV or AROMATICS.MEAS or anything to tell Apromon whether that unit is running and whether you want to run calculations for that tag. When a unit or plant is

shutdown you may want all calculations for a group of tags to be completely bypassed.

The default tagname.parameter specified in the TAG file is dummytag.pv and must be set to the appropriate name that exists in your DCS or PLC. A value of 1 for this tagname.parameter tells Apromon to run all calculations. If the value is 0, then Apromon bypasses all calculations for that tag.

For each group of tags belonging to a specific plant area or equipment, you should create a unique tag in the DCS or PLC (tagname.parameter). In addition to the tag creation, you need to also write logic to toggle the value from 0 to 1 depending on whether you want calculations to be processed or bypassed.

16.3. User Bypass

If you want to deliberately bypass calculations for a tag for whatever reason then set this value to 0. Apromon will then skip this tag. The default value is 1, which means run calculations for the tag.

16.4. Control Group

For single, slave and cascade PID, the value of **Control Group** should be 0.

Non-zero values for the control group are for a group of tags that are part of an override constraint control strategy. These strategies have a layer of master PIDs whose outputs go to a high or a low selector. Each constraint control strategy uses a unique **Control Group** identifier and all master PIDs in a given strategy use the same **Control Group** identifier.

Let's say your plant has three such independent constraint control strategies. The first strategy has three masters going to a low selector. The second strategy has five master PIDs going to a high selector. The third strategy has two master

PIDs going to a low selector. Then all the three masters in the first strategy will have control group = 1; the five masters in the second strategy will have control group = 2; and finally the two masters in the third strategy will have control group = 3.

Note that all slaves receiving a SP from the low or high selectors should have control group = 0 as they are not considered to be part of the constraint override strategies; they are simply the slaves of a cascade control strategy.

16.5. PID/LO-HI Constraint/PV-Only

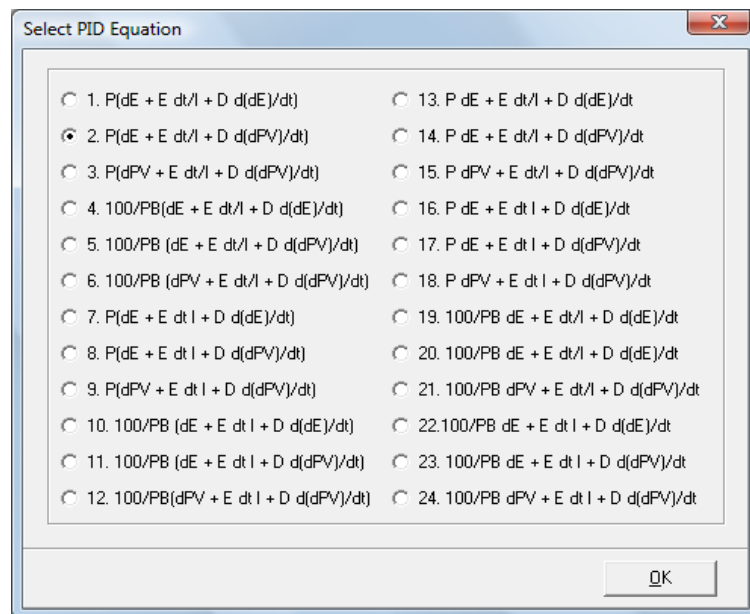
Set this to 0 for all single, slave and cascade PIDs.

If the PID is a master and also part of a constraint override control strategy as described in the previous section, then set it to 1 if its output (OP) goes to a low selector and set it to 2 if its output (OP) goes to a high selector.

If the tag is not a PID but is a simple PV-only signal (analog input signal) then set it to 3. In this case, Apromon understands that it is a PV-only signal and will not look for its SP, OP and Mode data.

16.6. PID Equation

Specify the PID equation running in the DCS or PLC. The various equations are shown below.



The default value in the TAG file is set to 2.

Contact PiControl Solutions at info@picontrolsolutions.com if you need to add new equations.

16.7. Scan Rate

This belongs to ApromonOPC™ version. So not applicable to this Apromon Data File Version.

16.8. Upper Spec Limit and Lower Spec Limit

These are the USL and LSL parameters required by the PP and PPK criteria calculations explained in a previous section.

16.9. Other Parameters in the TAG File

All other parameters in the TAG file not explained in this section have been explained in previous sections.

17. Editing the TAG and CONFIG Files

This section describes how to modify the TAG and CONFIG files.

17.1. TAG File

Click **EDIT TAG FILE** button from the top toolbar and then click the button next to the “**Select Tag File**” Textbox. In the “**Open**” Dialog, select the folder containing TAG file and select TAG file to be modified.

Note: TAG file can be in Excel (xls) or Comma Separated Values (csv) format. Select appropriate option from “Files of type” list shown at the bottom of the dialog.

Now you can conveniently modify any TAG file.

17.2. CONFIG File

Click button **EDIT CONFIG FILE** from the top toolbar and then click the button next to the “**Select CONFIG File**” Textbox. In the “**Open**” Dialog, select the folder containing CONFIG file and select CONFIG file to be modified.

Note: CONFIG file can be in Excel (xls) or Comma Separated Values (csv) format. Select appropriate option from “Files of type” list shown at the bottom of the dialog.

Now you can conveniently modify a CONFIG file.

18. Technical Assistance

PiControl Solutions Company values you, the customer and wants to make sure you are provided with the highest quality help and the friendliest support possible. For any technical or other questions, please send us an email at Info@PiControlSolutions.com and also visit our website www.PiControlSolutions.com. Thank you for reading this Apromon™ User Manual.