

# LEARN HOW TO ASSESS AND IMPROVE CONTROL LOOP PERFORMANCE

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## BASICS

The metrics of control loops tell how well is the control loop performing. Diagnostics attempt to identify why a loop is performing poorly. Continuous performance monitoring requires benchmarking so you can see how you have changed with time. You need a benchmark specific to your plant to compare against. There are many possible performance indices: variability, IAE, SP crossing, average error, Harris index, valve travel, time in normal mode, dominant oscillation period. Choose the ones that are important for the plant.

## HOW TO DO IT

A performance monitor program identifies the areas in your plant where the greatest economic gains are possible. The software is designed to help you make the biggest impact on your plant. It pinpoints areas that will yield the greatest economic return. This determines which controllers in a plant are not performing well and which would benefit from re-tuning or require maintenance. The software digests data coming from the plant and generates Emails, reports and lists of loops outside predetermined performance limits. Remote access capability, loop tuning, process analysis tools, equipment analysis tools and simulation tools are essential.

## IMPACTS

- \* Increase process knowledge
- \* Find problems that are not obvious
- \* Analyze cross correlation
- \* Troubleshooting time reduced
- \* Monitor and benchmark performance over time for continual improvement
- \* Encourages communication between engineers, staff engineers, area managers, and maintenance forces
- \* Generates economic gains
- \* Focuses Engineering and Maintenance resources on key problems
- \* Development of a loop maintenance process

\* Determine the economic benefits for advanced control implementation

## **SPECIFIC TECHNIQUES**

One of the keys to making a performance monitor work is being able to quickly set up the system with metrics that are significant to the plant in question. There must be a template or cookie-cutter approach for setting up your system against a benchmark.

## **KEY METRICS**

Each assessment interval, every metric is calculated, but not all the metrics are important for every plant.

First the plant picks the metrics that are important. For example, paper mills may want to use variability as a key metric. Variability throughout plant loops effects variability in the final product. Whereas chemical plants may consider average error or integrated absolute error more significant. Most plants will feel oscillation detection an important metric. Some may want to look at the amount of time the loop is in automatic or a normal mode. Loops put in manual mode are probably not working properly.

Identifying some of the key metrics is a natural for most plants. The plant personnel often know the important factors effecting product quality, and downtime. Once the important key metrics are identified a template is built around these metrics.

## **PLANT BENCHMARK AND THRESHOLD**

The templates are applied to a period that you want to use for a benchmark of performance. The optimistic case for this period of time would be after every loop in the plant has been checked, optimized and tuned. However, the realistic case for the benchmark will represent a portion of time to compare future metrics against. Against this benchmark, there are thresholds for each important metric in the plant.

$\% \text{ Towards Threshold} = 100 \times (\text{Metric} - \text{Benchmark}) / (\text{Threshold} - \text{Benchmark})$

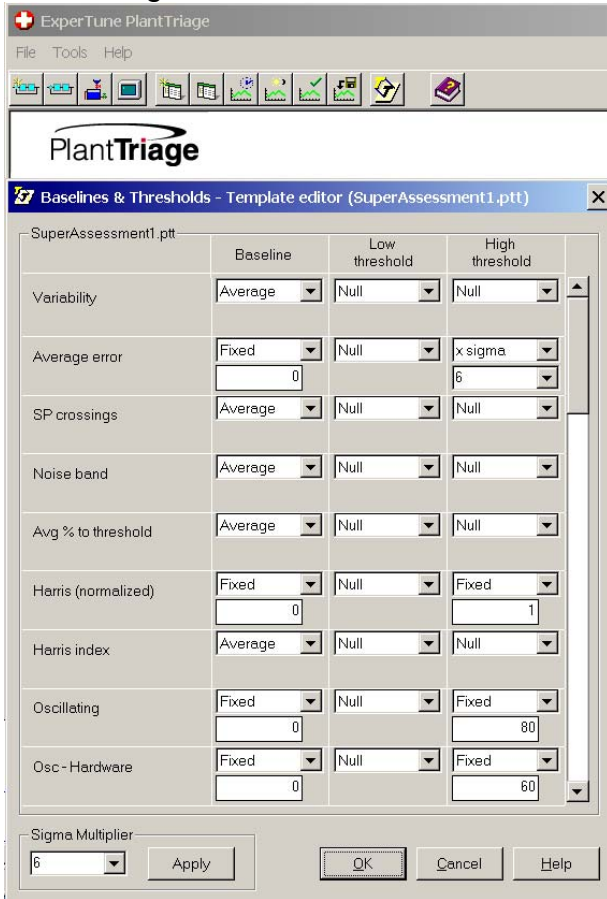
These thresholds combined with the benchmarks provide a comparison of this loop to other loops in the plant. They also provide a comparison of the loop, unit operation, or plant to previous time periods.

## **METRIC TEMPLATES**

The templates provide a framework for setting up the assessment of key metrics in the plant. For the benchmark the template allows the user to specify:

- \* Use the average value of this benchmark
- \* Use a fixed value for this benchmark

- \* Unused benchmark
- \* Unchanged the benchmark



**FIGURE 1: TEMPLATE EDITOR EXAMPLE**

The most common benchmarks are either fixed or average values depending on the plant. For example, an optimistic benchmark for average error or integrated absolute error would be the fixed value of zero. Zero representing the best attainable. However, one could also use the average value of the integrated absolute error or average error over the time window of metrics included. For an oscillation detection metric, zero would make a good benchmark.

If you were re-applying a template to many loops and only wanted to change one or two metrics, you could specify to not change any of the others.

Thresholds can be set either high or low or both high and low. Thresholds can be specified as either:

- \* Use a statistically significant value of the metric over the benchmark time
- \* Use the minimum or maximum value of this metric over the benchmark time
- \* Use a fixed value for this threshold
- \* Unused threshold
- \* Unchanged threshold

\* Use this threshold for overall performance measure

To use a statistically significant value of the metric, you would need to specify a sigma value. Some plants will want to use 6 sigma while others may pick a different value. Statisticians recommend that for the standard deviation of the metric to be significant there must be roughly 30 assessments of that metric in the benchmark time.

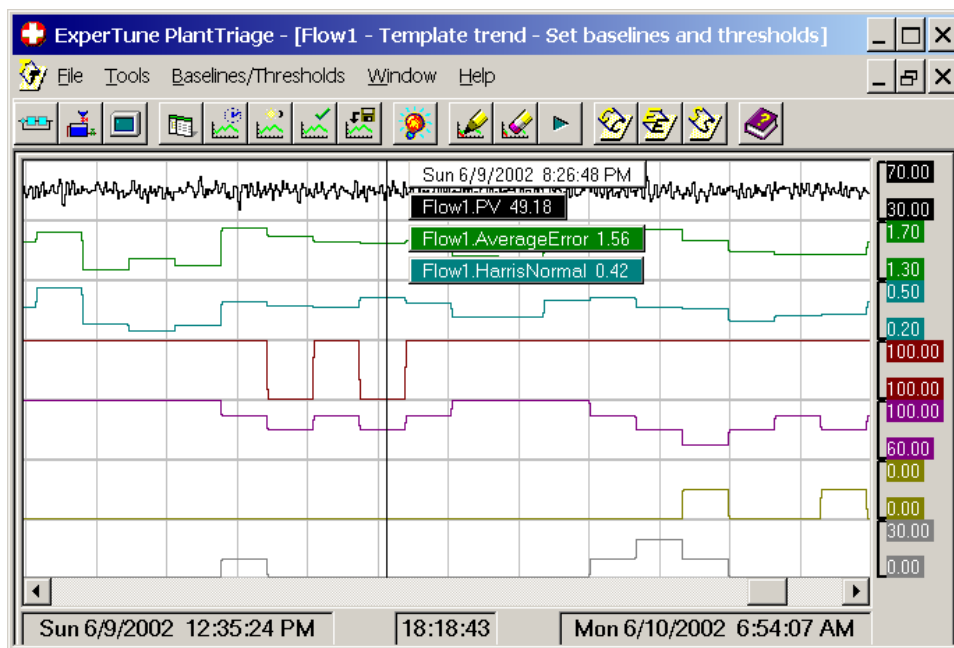
For example, for average error or integrated absolute error a good threshold may be to use the 6 sigma value during the benchmark time. For an oscillation metric, a fixed value of 80% would make a good threshold.

Most thresholds will not be used for the overall performance measure. Only those key metrics that are important to the plants performance should be used for the overall performance measure since these are what the plant will use to compare loops to other loops and loops, units and the plant to itself over time.

## TEMPLATE SERIES

Once a template is specified and created, it can be applied to a loop, a unit operation, group of loops, or the entire plant. There is no limit on the number of templates used.

## BENCHMARKING AND THRESHOLD SETTING

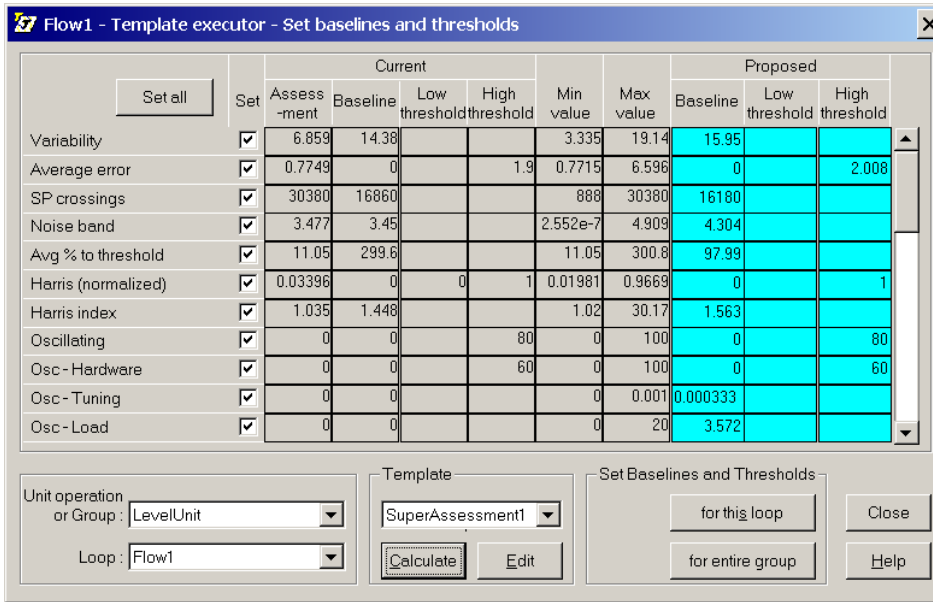


**FIGURE 2: TREND GRAPH OF BENCHMARK ASSESSMENT METRICS**

Setting the baselines and thresholds brings up 2 windows. One is a trend graph of the PV, and assessments of metrics you would like to view. The other is a dialog for executing or applying the templates. First, you pan, zoom or otherwise locate the position in time that

represents the time you want to use for the benchmark. Whatever time is shown in the trend window is used for the calculations by the template executor.

Next, from the executor you select the Unit operation, group of loops or specific loop you would like to apply benchmarking and thresholds to. From here you can also select (or even edit) the appropriate template. Directing the executor to calculate proposed values will populate the right side of the window. From here you can manually change values if you wish to have total control of the settings.



**FIGURE 3: TEMPLATE EXECUTOR**

From here in the executor you can also direct it to calculate and apply the template for this loop or the entire group, or unit operation. Note that the group could be the entire plant.

## CONCLUDING NOTES

Very quickly it is possible to establish a benchmark of metrics or assessments for an entire plant or group of loops. Once established, these this benchmark and threshold settings are used as a comparison against other loops in the plant. This will direct the efforts of plant personnel to those loops effecting the operation the most. Being set also allows comparison in time that shows how the work and moneys spent by personnel benefits the operation of the plant from an economic point of view.

## ACKNOWLEDGEMENTS

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