QEST Performance Monitor

Data Analysis

Document Control

Version	Author	Date	Comment
1.0	Krzysztof Kot	18/09/07	Original Document
1.1	Krzysztof Kot	06/11/07	Added note regarding the need for global lab access

Introduction

This document aims to outline some preliminary steps to follow when analysing the data generated by the QEST Performance Monitor application.

Note that these are only guidelines, not hard and fast rules, and may change over time. Users from different geographical regions may also find their requirements and data differ from those presented herein. These processes, therefore, are a good starting point but users are encouraged to experiment with the available reports and determine what works best for them.

QESTLab Reports

Once assessment data is available it can be viewed through the QESTLab reporting engine currently only available in the R&D system.

The reports are located under the 'QEST Performance Monitor' group of the 'Management Reports' node.

Notes:

- If you cannot see this report group it is likely that you have not been granted access to it. Please contact Spectra QEST and this will be remedied.
- If no results are being returned by the report filters please ensure that the laboratory (all) is selected for use as pictured above. If you do not have access to this laboratory please contact Spectra QEST and this will be remedied.

Step 1 – Recommendations

When an assessment is run on a family on a given day the following chain of events occurs.

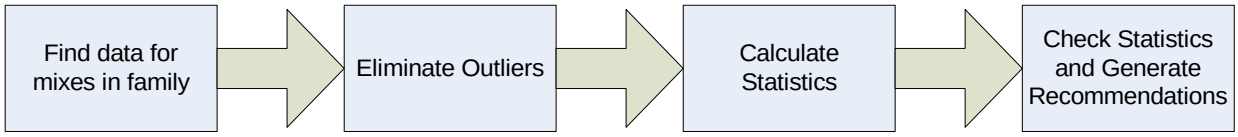

Figure 1 QEST Performance Monitor assessment execution overview

It is worth noting that once an assessment has been run any recommendations generated by the software will be stored in the database on a per-family basis. It is quite likely that the same recommendation will be generated for a particular family over many assessments.

For instance consider the following situation: A family exists, of strength grade N32, containing two mixes, Mix1 and Mix2, from one plant, Plant1. The family name is "Family1" and it is in the clan "Clan1". Assume the following test data is available in the database:

Table 1 Example strength data

				Strength		
Date Cast	Mix	Plant	Sample	7 Day	Predicted	28 Day
1/10/2007	Mix1	Plant1	Sample1	20.0	28.0	30.0
3/10/2007	Mix1	Plant1	Sample2	23.0	32.2	33.0

5/10/2007	Mix2	Plant1	Sample3	19.0	26.6	28.0
7/10/2007	Mix1	Plant1	Sample4	22.0	30.8	33.0
13/10/2007	Mix1	Plant1	Sample5	20.0	28.0	33.5
15/10/2007	Mix2	Plant1	Sample6	19.0	26.6	28.0
19/10/2007	Mix1	Plant1	Sample7	23.0	32.2	34.0
23/10/2007	Mix2	Plant1	Sample8	18.0	25.2	29.0

Note that the seven day strengths (and thus predicted strengths) will not be available until seven days after the cast date. So for Sample1 this will be 8/10/2007 and for Sample 8 it will be 30/10/2007. Similarly the 28 day strengths will not be available until 28 days after casting date.

If an assessment is run daily from the 8th of October through to the 30th the following statistics will be generated.

Table 2 Example predicted strength data averages as calculated on a given day

Predicted Strength Assessment

Date Run	Avg	Samples used
8/10/2007	28.0	1
9/10/2007	28.0	1
10/10/2007	30.1	2
11/10/2007	30.1	2
12/10/2007	28.9	3
13/10/2007	28.9	3
14/10/2007	29.4	4
15/10/2007	29.4	4
16/10/2007	29.4	4
17/10/2007	29.4	4
18/10/2007	29.4	4
19/10/2007	29.4	4
20/10/2007	29.1	5
21/10/2007	29.1	5
22/10/2007	28.7	6
23/10/2007	28.7	6
24/10/2007	28.7	6
25/10/2007	28.7	6
26/10/2007	29.2	7
27/10/2007	29.2	7
28/10/2007	29.2	7
29/10/2007	29.2	7
30/10/2007	28.7	8

Note that if the assessment is run on days where no new data is available from the previous assessment, the same statistics will be generated. For example, the same average value of 29.4 is generated for assessments running from 14/10 to 19/10. This is due to the fact all of these assessments located samples Sample1 through to Sample4 and used these for the calculation of the average.

If trigger parameters for the family are set correctly the system should generate a recommendation that the predicted strength of the family is low and needs to be analysed.

Since the Fc of this family is 32, the target strength would be even higher. It is likely that all of the values above would fall below warning limits for this target value.

Thus the user would get twenty three separate recommendations of the same nature for this particular family.

Summary

To make sorting through recommendation data easier, summary reports have been created. The first of these is titled 'Recommendations Summary'. This report is accessed through the 'QEST Performance Monitor' group under the 'Management Reports' node via QESTLab in the R&D system.

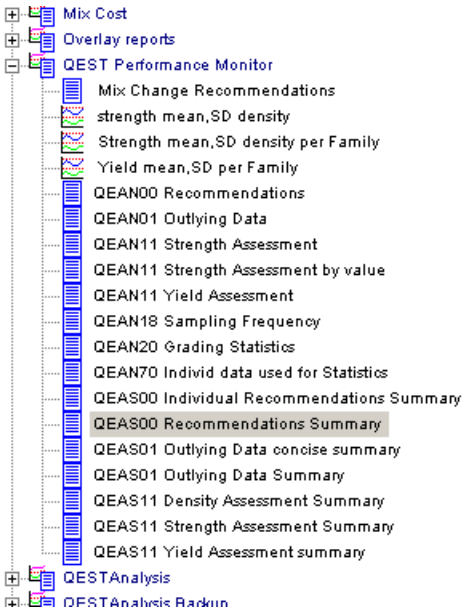

Figure 2 Recommendations Summary report

This report gives the user, at a glance, the information they may wish to investigate further. All recommendations are grouped by their respective families. Additionally all recommendations of the same type are grouped onto one row. So, for example, all of the recommendations generated for the family above would be shown on one row.

The report contains the following columns:

- Family – The family the recommendation relates to
- FamilyClan – The clan the family belongs to
- Grade – Grade of the family
- First Triggered on – The "To" date of the assessment on which this recommendation was first made. In the example above this would be 8/10/2007 for the predicted strength average.
- Last Triggered On – The "To" date of the assessment on which this recommendation was last made. In the example above this would be 30/10/2007 for the predicted strength average.
- # - The number of times this recommendation has been made for this family. For the example above this would be 23.
- Reason – The recommendation type. For the example above this would be "Low predicted strength".

So a row of this report relating to the example assessment above would look something like the following.

Table 3 Recommendations summary report for example data

Group: Family = Family1

Family	FamilyClan	Grade	First Triggered On	Last Triggered On	#	Reason
Family1	Clan1	N32	8/10/2007	30/10/2007	23	Low predicted strength

A snapshot of actual output generated by this report is shown below.

Group: Family = S10_N20 20mm 20%FA.

Family	FamilyClan	Grade	First Triggered On:	Last Triggered On:	#	Reason
S10_N20 20mm 20%FA	SADL	N20	5/07/2006	5/08/2007	217	High Actual Density
S10_N20 20mm 20%FA	SADL	N20	16/09/2006	5/08/2007	108	High predicted strength
S10_N20 20mm 20%FA	SADL	N20	2/06/2007	5/08/2007	10	No Data
S10_N20 20mm 20%FA	SADL	N20	5/07/2006	5/08/2007	160	High Slump Failure
S10_N20 20mm 20%FA	SADL	N20	20/10/2006	5/08/2007	75	High pred strength var
S10_N20 20mm 20%FA	SADL	N20	2/11/2006	1/08/2007	24	Low Sampling
S10_N20 20mm 20%FA	SADL	N20	3/09/2006	31/07/2007	60	Insufficient Data
S10_N20 20mm 20%FA	SADL	N20	2/11/2006	31/07/2007	178	High yield
S10_N20 20mm 20%FA	SADL	N20	2/11/2006	31/07/2007	199	High yield variation
S10_N20 20mm 20%FA	SADL	N20	27/08/2006	31/07/2007	851	Mix Changed
S10_N20 20mm 20%FA	SADL	N20	14/01/2007	17/04/2007	34	Low yield
S10_N20 20mm 20%FA	SADL	N20	2/11/2006	1/02/2007	20	No Target Grading

Figure 3 Snapshot of actual recommendations summary report

It is possible to trim the information shown on this report even further by specifying the assessment date of interest. The latest assessment run is generally the one of interest and entering this date into the "To max between" field of the filter associated with the report will only bring up recommendations that were last triggered for assessments run on this date.

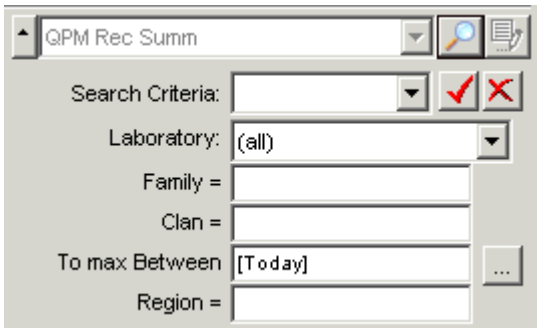

Figure 4 Recommendation Summary report search criteria

The search criteria above would bring up recommendations made for assessments run today. A region or family clan of interest should be entered into the search criteria to return only the recommendations made for the families of interest.

After viewing the summary of recommendations for the latest assessment the user may wish to see the values which caused these to be generated. This can be done with the individual summary report.

Individual Summary

This report also groups recommendations by family. Recommendations of the same type are no longer grouped together by type but rather, by the type and the value that caused the recommendation to be generated.

The report contains the following columns:

- Family – The family the recommendation relates to
- FamilyClan – The clan the family belongs to
- Grade – Grade of the family
- To Max – The date of the latest assessment for which this recommendation was made
- Type – The type of assessment the recommendation relates to
- Number – Number of times this recommendation type, with these values was observed
- Reason – The reason for the recommendation being made
- Field0 – The first value to which this recommendation applies to
- Value0 – The value associated with field0
- Field1 - The second value to which this recommendation applies to
- Value1 - The value associated with Field1
- Field2 - The third value to which this recommendation applies to
- Value2 - The value associated with Field2

Each group in this report is also sorted in descending order with respect to the "To Max" date. A snapshot of output generated by this report is shown below:

S10_N20 20mm 20%FA	SADL	N20	5/08/2007	STRENGTH	58	High Actual Density	Actual Density	2263.63
S10_N20 20mm 20%FA	SADL	N20	31/07/2007	STRENGTH	1	High Actual Density	Actual Density	2279.06
S10_N20 20mm 20%FA	SADL	N20	30/07/2007	STRENGTH	9	High Actual Density	Actual Density	2271.88
S10_N20 20mm 20%FA	SADL	N20	29/05/2007	STRENGTH	12	High Actual Density	Actual Density	2267.21
S10_N20 20mm 20%FA	SADL	N20	17/05/2007	STRENGTH	1	High Actual Density	Actual Density	2263
S10_N20 20mm 20%FA	SADL	N20	16/05/2007	STRENGTH	29	High Actual Density	Actual Density	2264.54
S10_N20 20mm 20%FA	SADL	N20	17/04/2007	STRENGTH	7	High Actual Density	Actual Density	2274.51
S10_N20 20mm 20%FA	SADL	N20	10/04/2007	STRENGTH	20	High Actual Density	Actual Density	2283.85
S10_N20 20mm 20%FA	SADL	N20	21/03/2007	STRENGTH	14	High Actual Density	Actual Density	2286.68
S10_N20 20mm 20%FA	SADL	N20	7/03/2007	STRENGTH	13	High Actual Density	Actual Density	2277.11

Figure 5 Screenshot of actual recommendations individual summary report

In the screenshot above it can be seen that the "High Actual Density" recommendation has been triggered for the "S10_N20 20mm 20% FA" family a large number of times. Field0 is "Actual Density" and Value0 is the average actual density values found for this family.

The bottom row indicates that for thirteen assessments, up to 07/03/2007, the average value for actual density was found to be around 2277 kg/m^3. This suggests that the same data set was used for all thirteen of these assessments. From the second to last row it can be observed that new data was available when the assessment was run on the 8th of March, giving an average value of 2286. This data set was used until the 21/03/2007, for fourteen assessments, until the 22nd.

To get a clearer understanding of what this report is attempting to convey, consider the chart below.

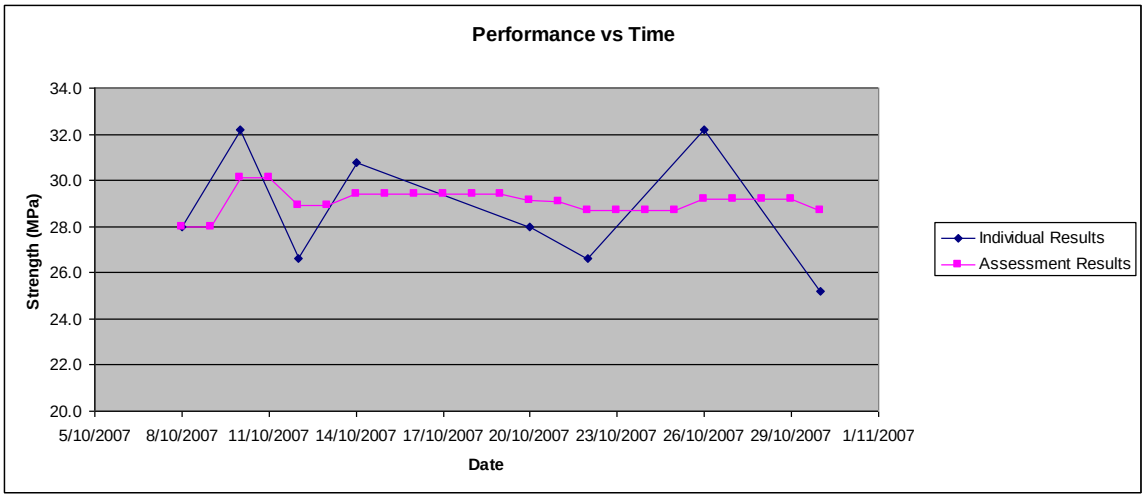

Figure 6 Chart of example data

This chart represents the performance of the example family discussed in the first section of this document. The blue line represents individual points present in the data set. That is, the predicted strength values for Sample1 through to Sample8. The pink line represents the average predicted strength value up to a given day where the data set consists of available predicted strength values of the eight samples.

For this example, the first predicted strength values will be available on the 8th, 10th, 12th and 14th of October respectively. If an assessment is run daily then the same data set will be used for the assessment running on the 8th as well as on the 9th of October. Similarly the assessments running on the 10th and 11th will use the same set of data, which will have one more sample available than the assessments running on the 8th and 9th.

Periods where the same data set is used can be seen on the chart above and are horizontal sections of the line representing average values. The largest such section in the chart above is between the 14th and 19th with six assessments using the same data set. The "Individual Summary" report for the example above would look like the following.

Table 4 Individual recommendations summary report for example data

Family	FamilyClan	Grade	To Max	Type	Number	Reason	Field0	Value0	Field1	Value1	Field2	Value2
Family1	Clan1	N32	30/10/2007	STRENGTH	1	Low Predicted Strength	strength	28.7	target	36.6	trigger	36
Family1	Clan1	N32	29/10/2007	STRENGTH	4	Low Predicted Strength	strength	29.2	target	36.6	trigger	36
Family1	Clan1	N32	30/10/2007	STRENGTH	1	Low Predicted Strength	strength	28.7	target	36.6	trigger	35.9
Family1	Clan1	N32	21/10/2007	STRENGTH	2	Low Predicted Strength	strength	29.1	target	36.6	trigger	35.7
Family1	Clan1	N32	19/10/2007	STRENGTH	6	Low Predicted Strength	strength	29.4	target	36.6	trigger	35.5
Family1	Clan1	N32	13/10/2007	STRENGTH	2	Low Predicted Strength	strength	28.9	target	36.6	trigger	35.1
Family1	Clan1	N32	11/10/2007	STRENGTH	2	Low Predicted Strength	strength	30.1	target	36.6	trigger	34.3
Family1	Clan1	N32	9/10/2007	STRENGTH	2	Low Predicted Strength	strength	28	target	36.6	trigger	32

Note that the trigger and target values are based on a nominal standard deviation of 2.8 and a limit k factor of 1.65.

This report can be used to quickly check the values which generated the recommendations and help get a feel for how recent the data used for the assessment may be.

Note that this report does not show the actual cast dates of the samples used to determine the values but a count of how often the same values have been obtained for an assessment. This can be viewed as a guide to how often the same data set has been used.

Outliers

As shown in figure 1 the QEST Performance Monitor will gather data and remove any outliers prior to calculating the actual statistics which are to be checked.

An outlier in a QEST Performance Monitor data set is defined as any point, y_i, lying outside of the range $y_{AVG} \pm k * s_Y$. Where y_{AVG} is the arithmetic mean of the data set and s_Y is the standard deviation of the data set. If there are N points in the data set, these values are defined as:

$Y_{AVG} = \Sigma y_i / N$
$S_Y = \sqrt{(1/(N-1) * \Sigma(y_i - y_{AVG})^2)}$

The value of k is set up as a trigger parameter per family in the QEST Performance Monitor client. Generally a value of 3 or so should be used. Using a value of 3 should ensure that 99.73% of normally distributed data in the set falls within this range. Any data outside of this range, therefore, can be removed as an aberration with some confidence.

Any time an outlier is removed from a data set, a recommendation is generated to this effect by the Performance Monitor. This special type of recommendation can be viewed in their own set of reports.

Outlying Data Concise Summary

The first outlying data summary report is the concise summary. The data in this report is grouped by family and sample id.

The following columns are available in this report:

- Family – The family this outlier relates to
- Grade – The grade of this family
- To Max – The date of the last assessment that this outlier was removed from
- Number – The number of times this outlier has been removed from a data set
- Statistic – The statistic this point was to be used for
- Sample ID – The sample id of the sample in which this outlying value was found
- - Limit – The *average* lower limit that was placed on this outlier
- + Limit – The *average* upper limit that was placed on this outlier

A snapshot of this report is shown below.

Group: Clan = QALL, Family = QBB_40_Q1N402SA.

Family	Grade	To Max	Number	Statistic	SampleID	- Limit	+ Limit	Value
QBB_40_Q1N402SA	40	13/09/07	1	ActualDensity	CWH-07/04341	2293.99	2537.95	2270.88

Figure 7 Screenshot of concise outlier summary report

Of interest to the user here would be the sample id of the outlying data. With this information, the user can view the actual sample within QESTLab and attempt to discern the reason for such a large deviation from the average value. The idea behind this report is that each affected sample should only show up once per family, per statistic.

Outlying Data Summary

The outlying data summary report is again grouped by family and contains the same columns as that shown in figure 7. This time, however, the actual limits used are shown in the "– Limit" and "+ Limit" columns rather than the averages thereof. This means that samples may show up multiple times but is also an indication of how many different data sets the point was removed from.

A screenshot of the report is shown below in figure 8. It can be seen that sample CSF-07/00726 was removed on 32 occasions from a data set where actual density was being

considered but because these are all contained on one row the same data set was likely used in each case.

The actual yield value of this sample was also removed when being calculated but since this spans many rows, it was likely that differing data sets were used for each row.

Group: FamilyName = S12_N32 all.

Family	Grade	To Max	Number	Outlayer Type	SampleID	Docket	Date Cast	- Limit	+ Limit	Value
S12_N32 all	N32	05/06/07	32	ActualDensity	CSF-07/00726	5259554	n/a	2325.82	2421.53	2314.80
S12_N32 all	N32	21/05/07	1	ActualYield	CSF-07/00726	5259554	n/a	94.67	99.30	99.33
S12_N32 all	N32	20/05/07	5	ActualYield	CSF-07/00726	5259554	n/a	94.72	99.23	99.33
S12_N32 all	N32	15/05/07	2	ActualYield	CSF-07/00726	5259554	n/a	94.79	99.11	99.33
S12_N32 all	N32	13/05/07	2	ActualYield	CSF-07/00726	5259554	n/a	94.84	99.06	99.33
S12_N32 all	N32	11/05/07	4	ActualYield	CSF-07/00726	5259554	n/a	94.80	99.11	99.33
S12_N32 all	N32	07/05/07	2	ActualYield	CSF-07/00726	5259554	n/a	94.86	99.08	99.33
S12_N32 all	N32	05/05/07	5	ActualYield	CSF-07/00726	5259554	n/a	94.95	98.98	99.33

Figure 8 Screenshot of outlying data summary report

Individual Recommendations

Once the overall recommendation summary reports have been dealt with the user may look at each recommendation made individually. These give some high-level suggestions as to the actions that may be taken to remedy the situation. A screenshot of this report is shown in figure 9.

It is recommended that the filter search criteria used for this report are rather stringent such that a manageable amount of data is returned. These criteria would be determined from analysis of the preceding reports. A screenshot of the individual recommendations report is shown below in figure 9.

Group: Family Name = S10_N32 10mm 20%FA.

Family	FamilyClan	Grade	To	Type	Reason	Recommendation	Field0 Value0	Field1 Value1	Field2 Value2
S10_N32 10mm 20%FA	SADL	N32	05/08/07	STRENGTH	High Actual Density	Recheck design	Actual Density 2359.21	limit 2285.95	target 2285.95
S10_N32 10mm 20%FA	SADL	N32	05/08/07	STRENGTH	Insufficient Data	Include additional mixes or increase strength	count 0	required 10	
S10_N32 10mm 20%FA	SADL	N32	05/08/07	YIELD	Low yield	Actual yield too low, recheck design	yield 97.7425	target 99.0082	limit 0.01
S10_N32 10mm 20%FA	SADL	N32	04/08/07	STRENGTH	High Actual Density	Recheck design	Actual Density 2359.21	limit 2285.95	target 2285.95
S10_N32 10mm 20%FA	SADL	N32	04/08/07	STRENGTH	Insufficient Data	Include additional mixes or increase strength	count 0	required 10	
S10_N32 10mm 20%FA	SADL	N32	04/08/07	YIELD	Low yield	Actual yield too low, recheck design	yield 97.7425	target 99.0082	limit 0.01
S10_N32 10mm 20%FA	SADL	N32	03/08/07	STRENGTH	High Actual Density	Recheck design	Actual Density 2359.21	limit 2285.95	target 2285.95

Figure 9 Screenshot of individual recommendation report

The "Recommendation" field stores a preliminary recommendation as to what may be done to rectify the problem encountered.

Step 2 – Statistics

Statistics reports can be used to view all the individual statistics which were calculated for a particular assessment.

These reports are broken down by their respective assessment types and some views are offered to make viewing and using these reports easier.

These reports can be used to further check statistics for a particular assessment of a particular family if need be.

These reports are a good way of checking for consistency between assessments or families and for spotting numerical trends.

There are a number of reports which can be used to view this data. They are highlighted in the screenshot below.

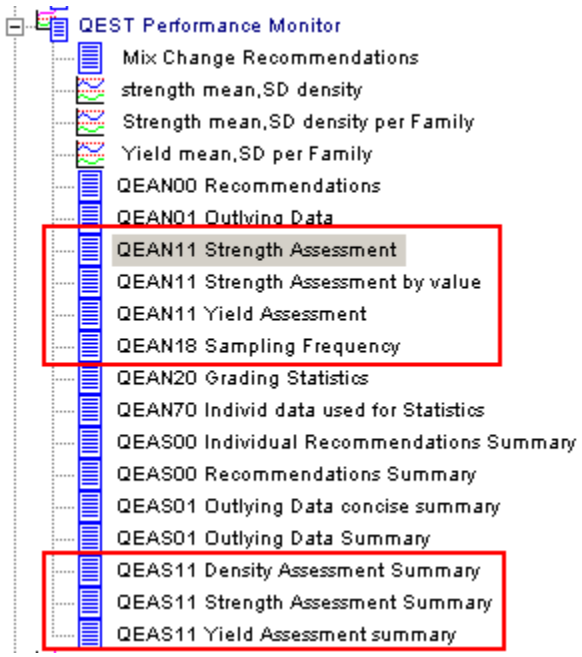

Figure 10 Assessment statistics reports

As with recommendation reports, summary reports are provided in order to try and cut down on the amount of data which is shown in these reports. They are grouped by family and a row should only appear where one or more of the calculated values have changed.

Step 3 – Charts

Charts are a good way of visualizing the data present in the QEST Performance Monitor database. Three charts are currently available for this purpose.

Note that, as mentioned above, an assessment will run as normal even if there is no new data available since the last time it ran. This results in the following phenomenon being observed in the charts.

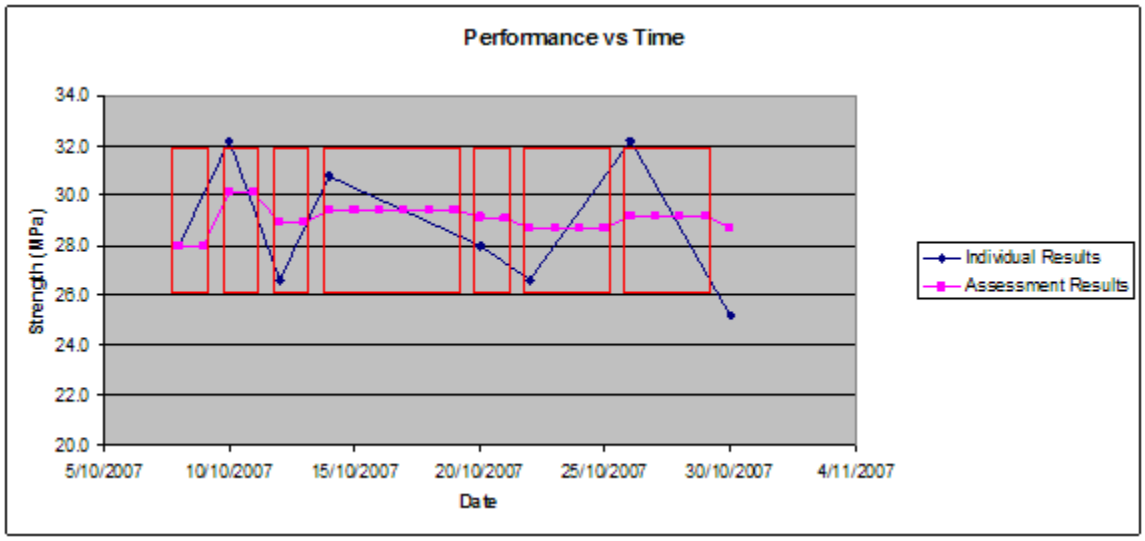

Figure 11 Example chart

Only the pink line will be visible on these charts, note that the areas where the line is perfectly horizontal generally represent assessments where no new data is available. The periods of time where the same data set was used have been highlighted with red boxes on the chart above.

Note that all chart filters have a "Grade" search criteria which should be used such that the returned results are comparable. Also note that, since the independent axis of the charts is the assessment date, a number of assessments will need to be run prior to any use being derived from these charts.

Charts are a good way of determining whether a particular value is over performing or under performing consistently or spotting trends.

Strength mean, SD, density

This chart does not group by family, it will simply show all results combined into one chart. This is useful as an overview of the current situation but should not be used, in and of itself, as a basis for any action.

As the name suggests, this chart displays three graphs. One of strength averages, one of strength standard deviations and one of density values. If this chart shows some interesting features they should be investigated further by considering individual families. This can be done by using the search criteria of the filter on this chart or simply using the chart described in the following section which creates separate charts for each family automatically.

A screenshot of this chart is shown below in figure 12. Since the search criteria used to generate the chart in figure 12 were a strength grade of "N32" and one particular region it can be said with some confidence that strength values in this region are rather high for this particular grade. Checks should still be made on a per family basis however to ensure this is the case.

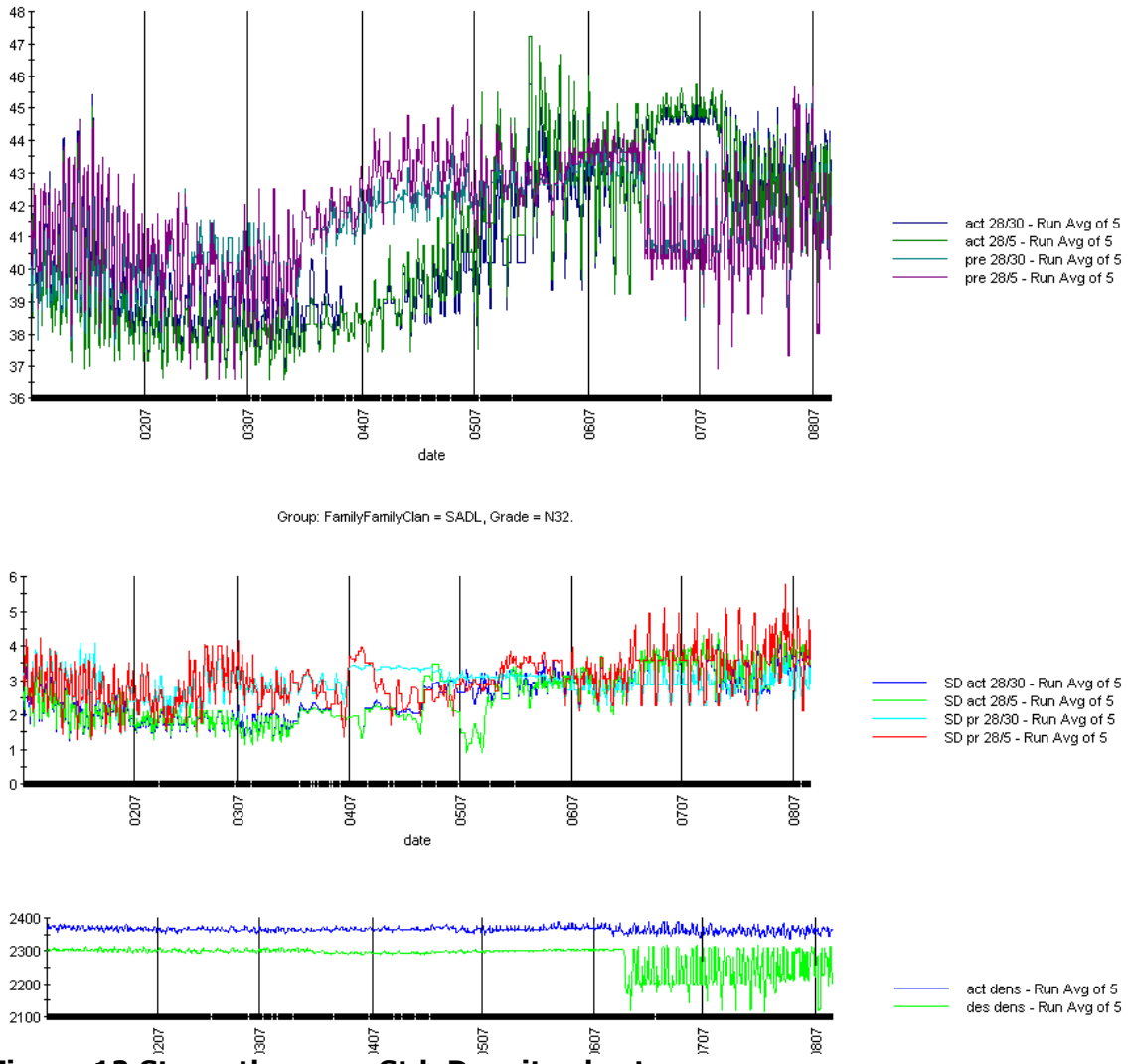

Figure 12 Strength mean, Std, Density chart

Strength mean, SD, Density per Family

As the name suggests this chart splits the results returned by the search into separate charts based on the various families.

With these charts the user can check the performance of individual families of mixes over time. These charts again show information regarding the predicted strength averages, standard deviations and densities.

The charts themselves have the same structure as that shown above in figure 12.

Yield mean, SD per Family

This chart enables the user to view yield assessment results graphically. The charts show average values obtained for actual yield results, design yield results as well as standard deviations thereof. A screenshot of these charts is shown in figure 13 below.

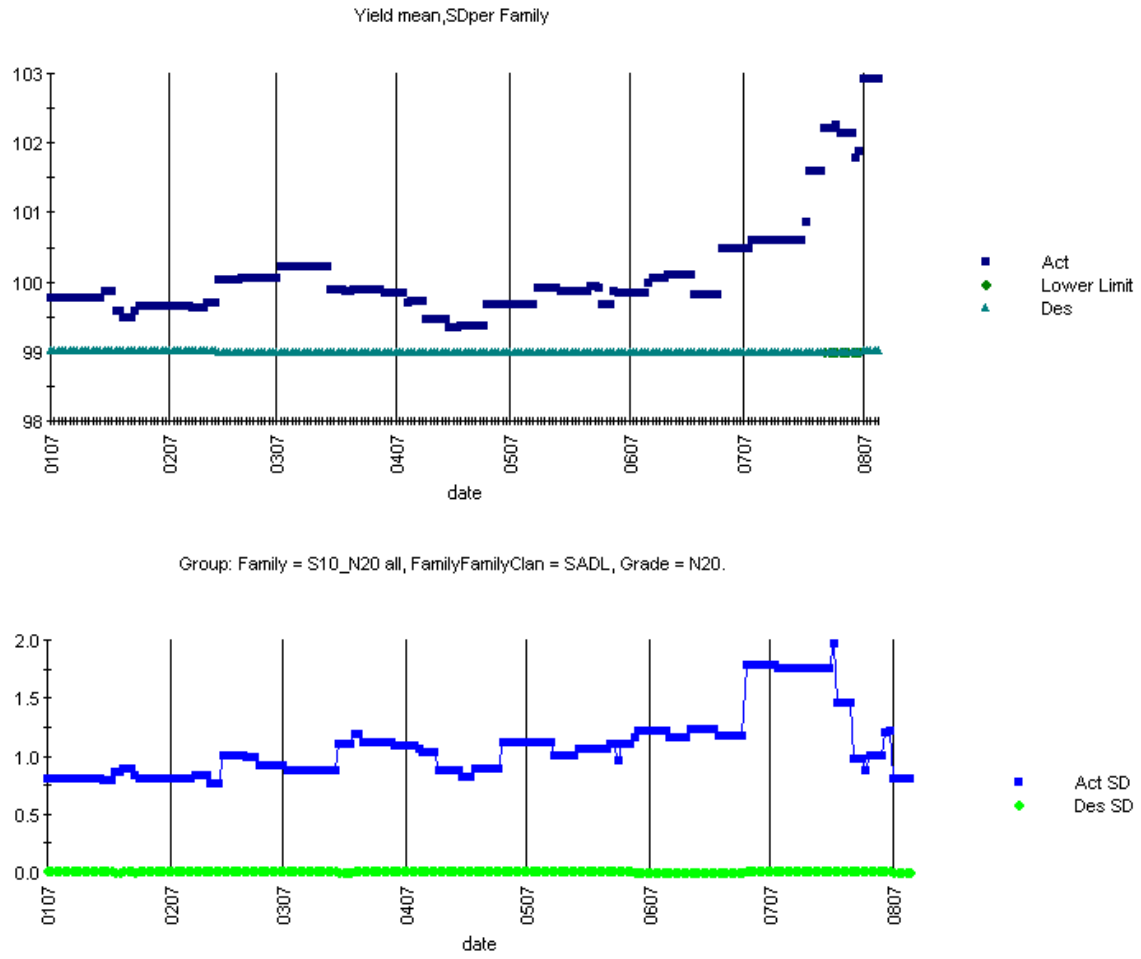

Figure 13 Yield mean, SD per family chart

Step 4 – Raw Data

The last report allows the user to view the raw data that was actually used for assessments. It is strongly recommended that very tight search criteria are used for this report. The user should know, at least, the date of assessment they are interested in, the grade and region.

It is also useful to enter the family name such that results are further constrained. This report is available under the "QEST Performance Monitor" report group with the title "Individ data used for Statistics".

Note that this report has to look up the actual QESTLab data used and may therefore run slower than the others present in this section as a result.

The report results are grouped by family as well as the statistic of interest. A screenshot of this report is shown below in figure 14. This screenshot shows that for an assessment run on 01/07/07, for the family "S10_N32 20mm Win 20% FA", the actual slump calculation used three samples. The family "S10_N32 all" used seven.

This report is a good last check of results such that any consistently low or high values can be seen. It could also serve as a double check of the results reported by the QEST Performance monitor.

Group: StatisticName = Actual Slump (30 results), Family = S10_N32 20mm Win 20%FA, Assessment To = 1/07/2007.

Statistic	Grade	SampleID	Docket	Date Cast	28 Day St	7 Day Pred St	28 Day Dif St	Actual Sl	Design Sl	SG	Des Yld
Actual Slump	N32	CSF-07/00661	5003712	17/04/2007	45	43.5	0	85	80	2329.392	0.9900264
Actual Slump	N32	CSF-07/00682	5003764	19/04/2007	43	40.6	1	95	80	2330.177	0.9900263
Actual Slump	N32	CSF-07/00710	5003801	23/04/2007	41	38.5	1	130	80	2330.18	0.9900264

Group: StatisticName = Actual Slump (30 results), Family = S10_N32 all, Assessment To = 1/07/2007.

Statistic	Grade	SampleID	Docket	Date Cast	28 Day St	7 Day Pred St	28 Day Dif St	Actual Sl	Design Sl	SG	Des Yld
Actual Slump	N32	CSF-07/00661	5003712	17/04/2007	45	43.5	0	85	80	2329.392	0.9900264
Actual Slump	N32	CSF-07/00682	5003764	19/04/2007	43	40.6	1	95	80	2330.177	0.9900263
Actual Slump	N32	CSF-07/00710	5003801	23/04/2007	41	38.5	1	130	80	2330.18	0.9900264
Actual Slump	N32	CSF-07/00870	5004086	18/05/2007	42	45	1	100	80	2321.479	0.9901798
Actual Slump	N32	CSF-07/00888	5004130	22/05/2007	49.5	46.6	2	85	80	2322.714	0.9901798
Actual Slump	N32	CSF-07/01116	5004597	27/06/2007	41.5		0	85	80	2325.952	0.9901822
Actual Slump	N32	CSF-07/01119	5004602	27/06/2007	39.75		0.5	80	80	2348.196	0.9898854