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DACA II Review Task Force Conference Call Minutes (Meeting #5)
Wednesday October 27, 2021
9:00-10:30 AM Central

Minutes recorded by Patrick Lang
Direct any comments or corrections to: patrick.lang@swri.org

Membership:

The attendance list can be found as attachment # 1.

Agenda:

The proposed agenda can be found as attachment # 2.

Approval of Minutes:

Pat Lang advised that there were no requested changes or comments on the September 16, 2021 minutes. A motion was made by Pat Lang and seconded by Al Lopez to approve the minutes. The motion passed unanimously.

Review of the TMC document on System Time Response Guidelines:

The changes that were made to the document on the last call were incorporated and shown for a quick review. This document will be incorporated into the DACA III document and this new wording will no longer be a stand-alone document. It can be found as attachment #3.

Review of Quality Index Section:

The main topic of discussion for this meeting was review of the Quality Index section of the DACA II document.

George from Lubrizol provided a presentation that helped guide the review. The presentation with the suggested changes that were made during the call can be found as attachment #4.

The main areas of discussion were as follows:

Slide 3 (sampling period):

Although the term "sampling" is used in the context of the paragraphs reviewed on this slide relative to a QI, we are referring to logging rate. The group agreed that it was not necessary to calculate the logging rate as shown in the original wording. All of the information in that paragraph is dated and was more appropriate for the technology back when the DACA II document was written. Test procedures now state the minimum rate at which logging should be done so it was agreed that we should remove the current wording. It is the responsibility of the respective surveillance panels to ensure that the logging rates that are chosen are appropriate keeping in mind if there is any possibility of aliasing.

Slide 4 (Logging):

The group agreed that the wording on slide 4 that has a strike through can be completely removed.

Slide 5 (Limits):

Lots of discussion around the limits topic. In summary it is typical for the surveillance panel to review the matrix data and choose what the panel can live with relative to the operational parameters. Set the limits so the minimal accepted performance results in a zero QI. Since we will never know exactly what threshold of operational performance affect the test we have to make an engineering estimate on these limits.

Slide 6 (BQD):

The group agreed to revise the wording in the paragraph in the BQD heading in the original document since data acquisition and control systems have changed a lot since that was written. The revised wording is shown at the bottom of slide 6.

Slide 7 (Replacement of Data):

The group started to look at the flowchart that is in the original document which provides some logic on what to do if there is bad quality data. Slide 7 shows George's recommendation on some wording that can be used to replace the flow chart. There wasn't enough time remaining on the call to thoroughly review so this will be discussed on the next call.

Slides 8, 9 and 10:

Need further discussion on next call.

Next meeting Topic:

Pat Lang recommended that for the next meeting we continue reviewing the Quality Index (QI) section with a focus on the bad quality data (BQD) section.

Adjournment:

The meeting was adjourned at 10:30 AM CDT.

Next meeting at the call of the chairman.

Attachment #1

Attendance List

Attendance List for DACA II Document Review Task Force		
Name	**Company**	**Present 10-27-21** **X= present**
Amol Savant	Valvoline	X
Al Lopez	Intertek	X
Bill Buscher		X
Andrew Stevens	Lubrizol	X
George Szappanos		X
David Doerr		X
Jim Matasic		
Randy Harmon	Southwest Research	X
John White		X (part of meeting)
Ron Barthold		X
Khaled Rais		X
Bob Warden		X
Mike Lochte		
Ankit Chaudhry		
Tom Wirries		X
Chris Desruisseau		X
Bob Campbell	Afton	X
Tim Cushing	General Motors	X
Jim Gutzwiller	Infineum	
Andy Ritchie		
Michael Tucker	Exxon Mobil	X
Rohit Rao		
Jason Griffin		X
Mike Deegan	Ford	
Robert Stockwell	Oronite	
Jeff Clark	Test Monitoring Center	X
Rich Grundza		
Sean Moyer		X

Attachment #2

Agenda

AGENDA

Data Acquisition and Control Automation II (DACA II) Review Task Force
Virtual Meeting (WebEx) #5

Patrick Lang – Chairman

Wednesday October 27, 2021– 9:00 AM to 10:30 AM (CDT)

1. Attendance

2. Review of the minutes from the 9-16-21 conference call.

3. Review Items:

    1) Review Quality Index (QI) section of the DACA II document.

4. Determine topic for next meeting

5. New Business

6. Next Meeting will be at the call of the chairman.

7. Adjournment

Attachment # 3

TMC System Time Response Guidelines Document with Changes Incorporated

TMC

System Time Response Measurement Guidelines

5/27/1998

Revised 9-16-21

The following information is to assist laboratories in measuring system time response.

System time response refers to the time that a complete data acquisition system takes to log a step change for a given parameter. **The complete data acquisition system takes into account sensor, any associated wiring leads or piping along with signal conversion, computer processing and any other manipulation of data to the point of logging that would be in place during normal test operation.** During TMC lab visits engineers may note sensor information (manufacturer, model number, principal employed for measurement, thermocouple type (J, K, E) or RTD, grounded or ungrounded. Also, make note of unusual wiring, piping layout and the use of snubbers, condensate traps or electrical capacitance caps in control panels.

A system time response can be determined by measuring the amount of time to reach a certain percentage of an imposed step change. For this document, the value of 63.2 % of the amount of the imposed step change will be used.

In order to provide an accurate measurement of system time response, a channel may be optionally used to display a triggering switch that indicates when the stimulus was imposed. Response time starts when the stimulus is imposed and ends when the process reaches 63.2% of the final value. In addition, because some system time responses are in the millisecond range, an adequate sampling rate should be used to record values. **Typically, a system that can record and display values at 10 hertz or more frequently is necessary to measure an accurate system time response.** Recommended step changes are shown below. If these step change deltas are inadequate, step changes should be at least 100 times the resolution of the measurement system and representative of typical operating conditions when possible. Permanent digital record of the response values and triggering are to be made.

The techniques used to measure response time for typical parameter are as follows:

Parameter	Step Change
Temperature	Quickly insert probe at ambient conditions into ice/distilled water mixture to cover the length of the probe. Care must be exercised to insure that handling of the thermocouple does not change the initial temperature reading, i.e. the temperature plot should be flat prior to inserting into ice bath.
Pressure	Pressurize system to an appropriate value then instantly release pressure. Response time pertains to the response to the release in pressure
Torque	Apply the appropriate load to dynamometer arm. Then remove applied weights quickly from the load cell. Response time will start when the torque signal begins changing.

Speed	Impose a step change to an appropriate r/min at the sensor connection through a frequency generator.
Flow	For flow meters, in general, the system is filled with the appropriate fluid and operated. At the desired time, a shutoff valve is closed and the system response is measured. Other systems will require some other procedure that will have to be determined. Step inputs are typically test area dependent.

Attachment # 4

DACA II Review-Quality Index LZ Presentation

DACA review

Quality Index

The following slides contain all the detail in DACA II related to Qi.

Prepared by George Szappanos, Lubrizol, 10/26/2021

DACA II text:

Statistical Calculations:

The quality of the control of the parameter being measured shall be calculated through the use of the Quality Index (QI):

$$QI_i = 1 - \frac{1}{n}\sum_{1}^{n}\left(\frac{U + L - 2X_i}{U - L}\right)^2$$

where:

U = Upper QI limit

L = Lower QI limit

Xi = Data reading at instance i

n = Number of readings thus far in the test

No issues and good to go!

Perfect control of a parameter results in a QI of 1.00. Any deviation from the target lowers the QI. The amount and duration of the deviation affects the final QI for the parameter. How often the QI is updated, and conversely, how many readings are taken also affect the effectiveness of the QI to capture the quality of the control of the parameter.

For multi-stage tests, the test developer/surveillance panel should determine whether or not a separate QI will be calculated for each stage. If separate Qls are calculated, and a single final QI is desired, the final QI should be an appropriately weighted average of the individual Qls.

Sampling period

~~The test developer/surveillance panel should determine, for each parameter, whether variations in the signal are random or cyclical. If random, a minimum of 103 samples must be used for the QI calculation. If cyclical, the period at which the data for the QI calculation is sampled for a parameter can be dependent upon the "period of the phenomenon of interest" (ti). Phenomenon of Interest is defined as that quality of the measured parameter that is primary interest to the surveillance. For example, oil pressure may fluctuate with each oil pump gear mesh, but that is limited interest compared to larger fluctuations in pressure due to more macro processes. The QI sampling period can be derived from the t period by the following equation:~~

~~QI SamplingMax(sec) = t/2~~

~~where:~~

~~t = period of phenomenon of interest in sec~~

~~note: the Nyquist theorem is 2 readings/period to reproduce the waveform~~

~~Any new test development shall include a determination of the cyclic period for each of the parameters of interest to be measured, if applicable. For parameters such as speed, intake vacuum, etc, that have an extremely fast response rate, with a corresponding cyclic period shorter than 2 sec, the minimum required QI sampling period should be determined from data from the Golden stand.~~

The "period of interest" is usually a result of controller tuning. Most tests calculate Qi on recorded data at a rate of about 30-60 sec per sample, rarely any more frequent. This is probably good enough for slow loops, but not for others (rpm, load…)

Sampling (logging) period is determined by the SP and should be based on the requirements of the test. Remove this section.

logging

The final, reported QI is to be based on the final recorded data set captured at the minimum data logging rate as defined by the SP. The QI could optionally be calculated and updated each time a reading is logged to allow monitoring of the controlled parameter during the test. ~~, or the samples logged and the QI calculated from logged data. Laboratory systems employed should be able to calculate QI from in-progress test data, either in real time or on command.~~

~~For purposes of TMC verification, the laboratory data acquisition system should be capable of "dumping" sufficient data onto permanent media in electronic format. The data should include a time stamp for each reading, the data reading, and a final QI for that set of data. The data should be from an actual test stand and acquired, at a minimum, at the required QI calculation rate.~~

This seems confusing, test stands can acquire "real time" data at up to 1000 hz, but save data only ever minute. The QI is normally based on the saved data.

This section is revised as indicated in yellow.

Limits determination

The upper and lower limits for the QI calculations are derived from the operating conditions of the test development or from a matrix of stands, or based on the engineering judgment of the SP. The limits should be set such that minimum acceptable system performance results in a QI value of 0. ~~These limits should be calculated from the operational data. This will result in a uniform criteria for assessing the quality of a test.~~

~~For test validity, the QI threshold should be below the QI of the test development Golden stand. This threshold should be determined after sufficient operational data from multiple labs have been generated.~~

In many cases the “golden” standard is the collection of stands involved in the precision matrix. The Qi limits are based on what level of control performance is reasonably achievable for all labs.

These limits should be tempered with knowledge of what effect a parameter’s variability has on the test, if that insight is available. Reworded.

BQD (bad quality data)

~~Some automated test cells may employ separate systems for the control of operating parameters, and for the acquisition and logging of data. In these systems, it is possible for the data acquisition system to suffer a temporary malfunction while the control system continues to maintain the proper conditions, or one control system "channel" may malfunction while the rest are unaffected. These malfunctions may result in missing or erroneous (such as 9999 deg C on a temperature) data points. These data points are referred to as Bad Quality Data (BQD). In cases of malfunctions in the test control system, in which the actual test conditions are affected, the deviations must be recorded, estimated, or otherwise incorporated into the final test QI for the parameter.~~

Occasionally, data acquisition systems can malfunction and record erroneous data. These data are usually a result of faulty instrumentation where the reported value is missing or saturated (such as 9999°C). If averaging or filtering is employed, then data points immediately following the malfunction can also be affected. These data points are referred to as Bad Quality Data (BQD). These occurrences must be counted and the actual values estimated and incorporated into the statistical calculations for the parameter. The SP may provide a table of maximum and minimum values (over-range and under-range) for parameters which should be used in cases where missing or erroneous values need to be estimated.

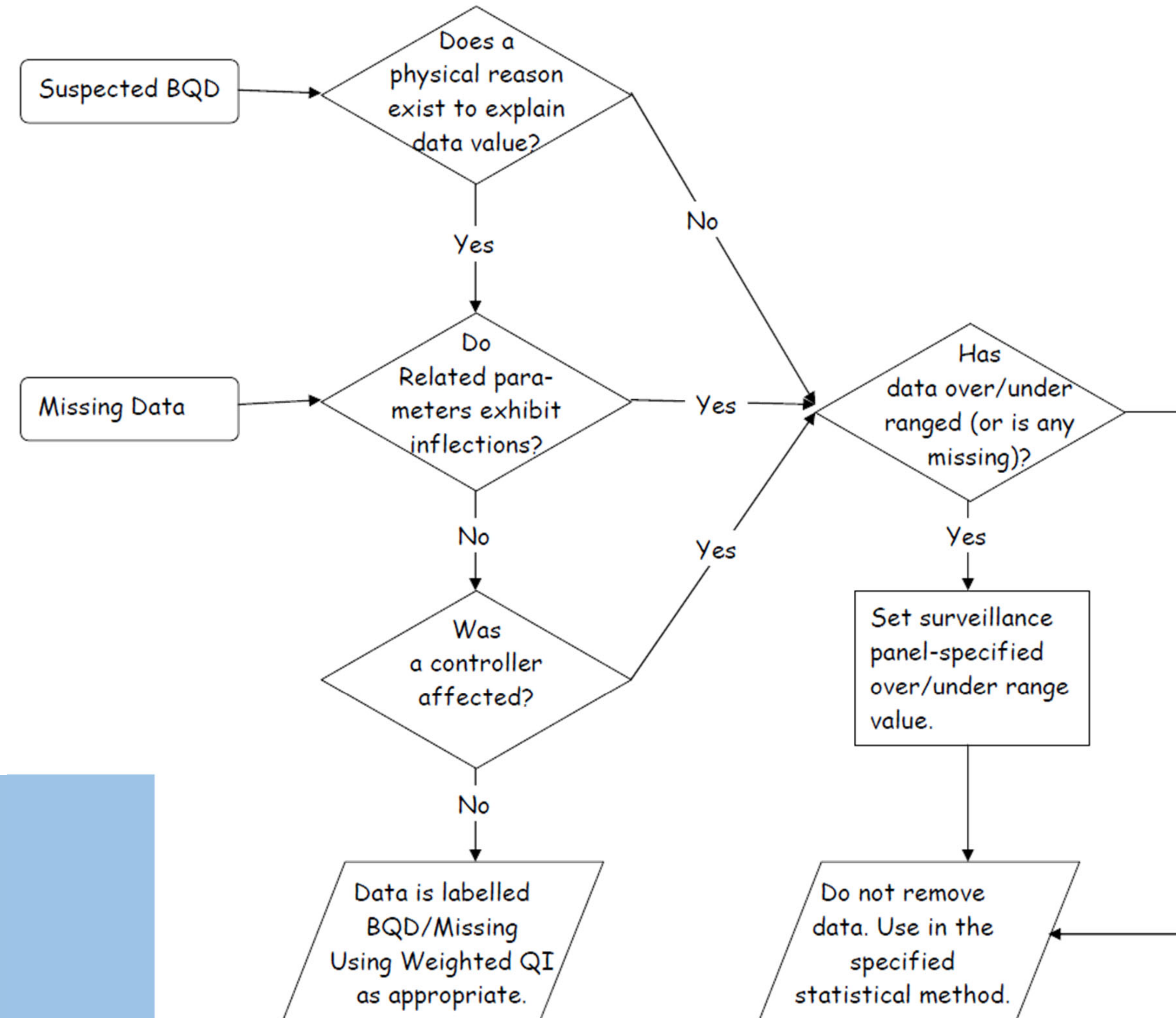
Obsolete wording. In the vast majority of cases, BQD is caused by faulty instrumentation (open TC, saturated transducer, etc) and the reading is very obviously erroneous or “bad”. In such cases, that data should be replaced (not deleted). Values reported for QI as well as maximum, minimum, average, and percent over/under should also be based on corrected BQD values. Reworded.

replacement

~~For each occurrence of suspected BQD or missing data, the following flowchart should be used:~~

For each occurrence of BQD, data shall be replaced with a surrogate value that can be derived from other operational data, or from over-range and under-range values provided by the respective test procedure. Comments are to be provided in the test report explaining the data replacement rationale and methodology.

- Should be limited to known bad or missing data
- If data is “real” then Qi should use all the data
- No data is removed
- Section revised and flowchart removed.



Over / under values

~~This procedure includes a requirement for each test Surveillance Panel to set over/under-range limits. These limits will be used as substitutions for data that is acquired, but is physically impossible, such as a negative fuel flows, or temperatures of 9999°C. In cases where the flowchart does not adequately fit the situation, the final determination of test validity and the disposition of the BQD will depend more upon engineering judgment.~~

This procedure includes a requirement for each test Surveillance Panel to set over/under-range limits. These limits will be used as substitutions for data that is acquired, but is physically impossible, such as a negative fuel flows, or temperatures of 9999°C.

- Each surveillance panel should carefully determine reasonable limits for over and under values. In cases of BQD where no surrogates are available, then the over / under values are to be used. This section was reworded.

TABLE A10.2 L and U Constants and Over- and Under-Range Values

Quantity, unit	Stages	L	U	Over-Range	Under-Range
Coolant flowrate, L/min	1	38	42	267	0
	2	68	72	267	0
Coolant-out temperature, °C	1	44.5	45.5	134	0
	2	84.5	85.5	134	0
Exhaust back pressure, kPa	1	102	106	304	0
	2	105	109	304	0
Humidity, g/kg	1, 2	10.4	12.4	109.9	0
Inlet-air pressure, kPa	1, 2	0.03	0.07	2	–1.9
Inlet-air temperature, °C	1, 2	31.5	32.5	81.2	0
Oil gallery temperature, °C	1	49.5	50.5	149.2	0.8
	2	99.5	100.5	149.2	0.8
Engine speed, r/min	1	1545	1555	2992	1058
	3	2495	2505	2992	1058
Torque, N·m	1	48	52	325	0
	2	126	130	325	0
Coolant pressure, kPa	1, 2	68	72	267	0
Air-charge temperature	1, 2	29.5	30.5	79.2	0
Lambda	1	0.73	0.83	5.9	0
	2	0.95	1.05	5.9	0

calculation

In cases where data is labeled as BQD/missing, per the flowchart, the Adjusted QI is calculated

as follows:

1) Remove BQD/missing data from data set per the flowchart

2) Calculate QI with remaining data points

3) Adjust QI by multiplying number of data points and dividing by the number of data points per the procedure, to obtain the QIBQD:

$$QIBQD = QI\left(\frac{n}{n_{total}}\right)$$

where: QI = QI calculated without missing/BQD points

n = number of data points used to calculate QI

ntotal = total number of data points for a complete data set

4) Obtain the EOT QI as follows:

$$EOTQI = QI\left(\frac{n}{n_{total}}\right) + QIBQD\left(\frac{n_{BQD}}{n_{total}}\right)$$

where: QI = QI calculated without missing/BQD points

n = number of data points used to calculate QI

ntotal = total number of data points for a complete data set

nBQD = number of missing/BQD data points (nBQD = ntotal – n)

This is much more complex way of just saying: replace the bad data with the over/under data.
This section can be deleted.

Maximum BQD limit

~~Suitable backups should be employed by the labs to use as supporting evidence. The maximum logging interval for these backups should be 1 hour.~~ Missing data should not be more than 1% of the test length.

1% of 100 hr test x 1 sample per minute = 60 samples (1 hour's worth of data)
What IF missing data > 1%? Invalid test?