UV Secondary Lamp Calibration SOP

The Canadian Brewer Spectrometer Network
Réseau Canadian de spectrophotometric – Brewer

2017

UV Reference Lamp Calibration – Secondary Irradiance File Creation

The purpose of this SOP is to document the process used by Environment Canada's Brewer Spectrometer Network to calibrate Secondary UV Lamps. The resulting irradiance files are used to establish the absolute spectral sensitivity of a Brewer which is used to convert outdoor UV measurements to calibrated mW/m^2 values.

The UV lamps (primary and secondary) are inter-compared annually to ensure stability and to create updated IRR files for the secondary UV lamps.

Refer to the Ultraviolet Calibration SOP for details in how to acquire UV lamp scans (QL scans), including setup, Brewer preparation, lamp optimization and data processing.

Note: A MKIII Brewer should always be used to perform UV lamp calibrations.

Equipment

1. An operational, level and calibrated MKIII Brewer Spectrometer, tracker and stand.
2. UV calibration equipment, lamp enclosure, holder, fixed ruler, collimator and guide.
3. Remote 1 UV Calibration system (BSN calibration lab system).
4. Primary and Secondary DXW lamps.
5. UV Calibration processing software, LampsPro 17/10/2012 or newer.

Intercomparison Procedure

Install and operate the UV lamp calibration system as described in the Ultraviolet Calibration SOP document.

A DXW test lamp is used to warm up the Brewer instrument to 30 ± 1 °C and to stabilize the calibration room temperature. The diagnostic string pdporew1frhphgsldtrsappf is initiated on the Brewer instrument concurrently with the test lamp to insure Brewer functionality.

Following the Brewer conditioning and pre-calibration routine a reference lamp is installed and warmed up for a period of ten minutes. Upon completion of the reference lamp warm up a calibration test string pdzehphgb1qlhgzeb1qlhgslpd is run. When the calibration string is completed the lamp is cooled for 5 minutes before handling. Next another reference lamp is installed and the process is repeated for all of the remaining primary and secondary lamps.

Note: It is very important to orient UV lamps correctly in the UV calibration system housing. Incorrect lamp orientation may result in a different level of irradiance reaching the instrument and/or permanent damage to the lamp if the polarity of the lamp is reversed.

Lamp Scan Acceptance Criteria

Daily diagnostic strings are examined to confirm that the Brewer being used in the inter-comparison is operationally stable.

The mercury lamp test following each lamp scan must report a difference between the target step and the step where the micrometer started the test of less than ± 1.5 steps

Absolute value of mean percentage difference between the “calibration shunt voltage” and the measured “shunt voltage” after the ten minute lamp warm up is less than or equal to 0.0020%. The standard deviation of percentage difference between the “calibration shunt voltage” and the measured “shunt voltage” after the ten minute lamp warm up is less than or equal to 0.0040%.

Percent standard deviation of each individual scan is equal to or within ± 1.0%.

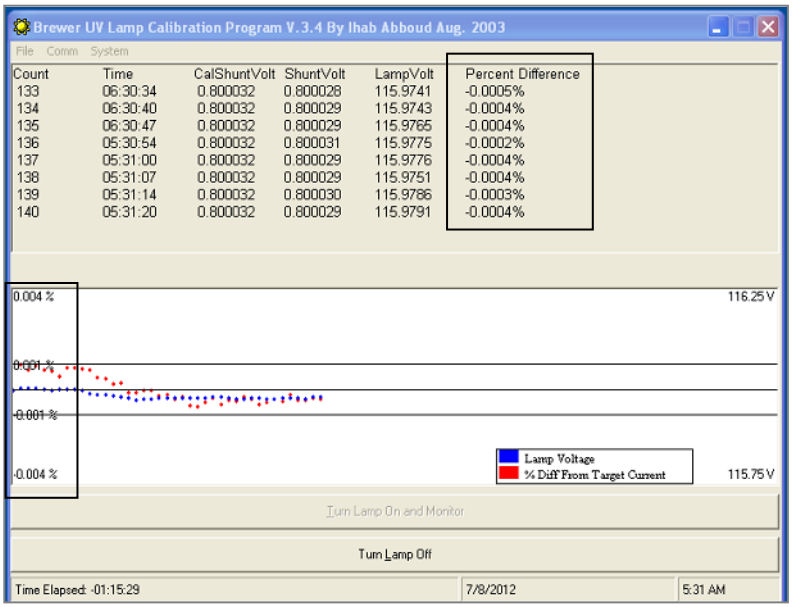
Percent standard deviation of less than 1.0% for at least three of the lamp scans together.

All acceptable lamp scans have a Brewer temperature of ± 1 °C from the mean temperature of all acceptable lamp scans.

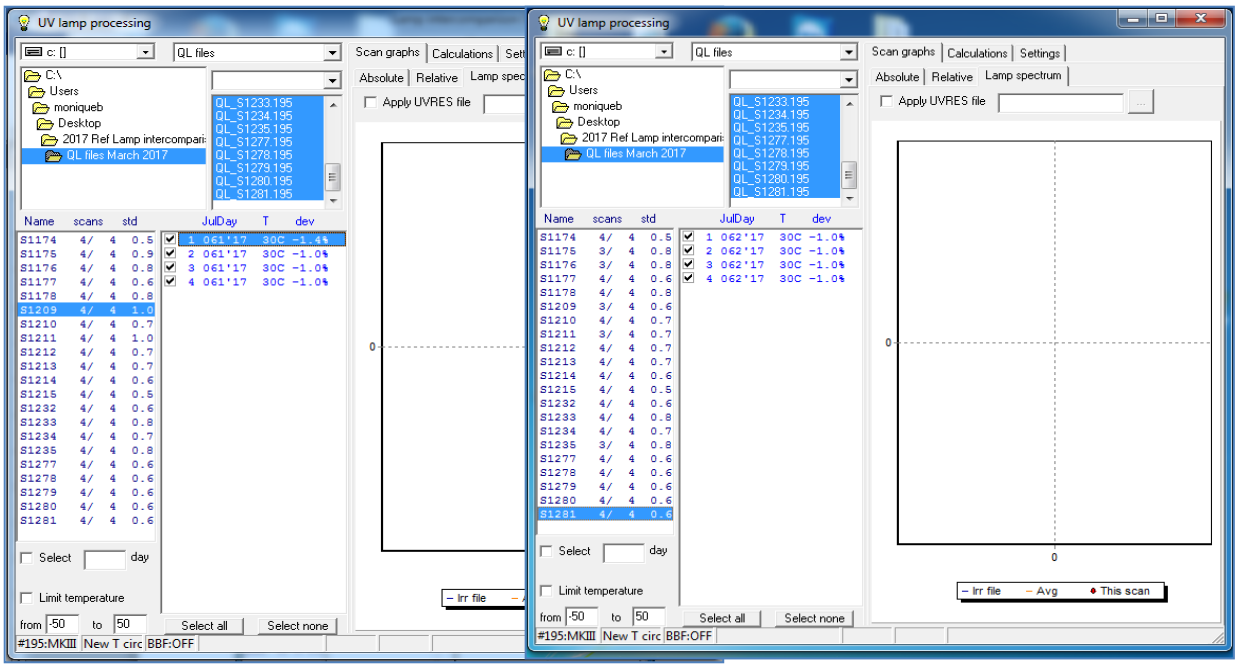
Evaluation of Lamp Scans

1. During the acquisition of the QL scans monitor the following and ensure that the results are within the acceptance criteria outlined above.

    a. Hg tests before and after the QL scans. If the Hg step has moved more than ± 1.5 steps following a QL scan, the QL scan will have to be re-run with Hg’s before and after. Use the D-file to confirm the Hg test results.
    b. Ensure that the UV systems’ voltage supplied to the DXW lamp is within the range outlined above. These parameters are outlined below.



2. Using LampsPro, point to the QL scans obtained for the reference and secondary lamps. Using the lamp scan acceptance criteria remove all disqualified scans by unchecking the box beside the scan number. In the example below, the left picture indicates that scan 1 for lamp S1209 will be removed because the percent standard deviation of the individual scan is not equal to or within ± 1.0%. The example on the right shows the remaining lamp scans that will be used in the determination of the new secondary IRR file.



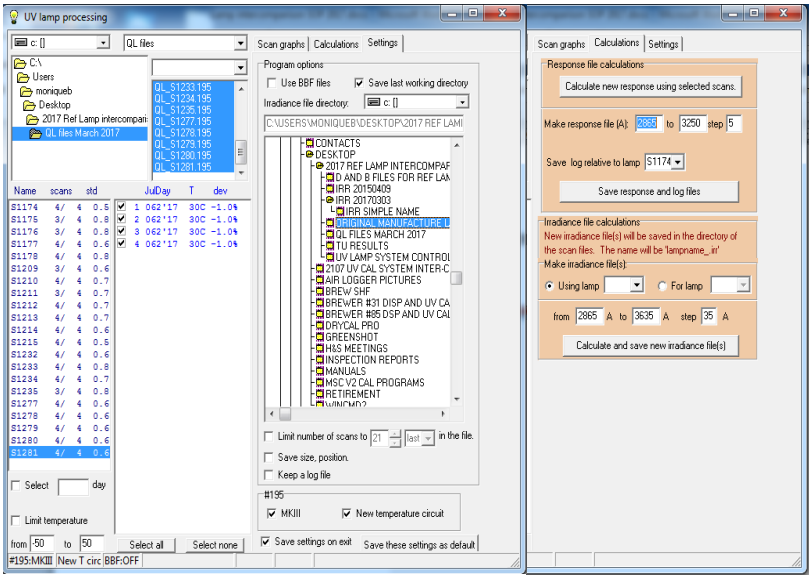
A summary of the acceptable lamp scans being used are tabled for simplicity below.

#	Lamp S/N	Accepted QL Scans	Std. Dev of Accepted Scans	Temp. °C	Lamp Use
1	S1174	1-4	0.5	31	Secondary, Field Kit 1
2	S1175	1-3	0.8	30	Primary Reference
3	S1176	1,2,4	0.8	31	Primary Reference
4	S1177	1-4	0.6	30	Primary Reference
5	S1178	1-4	0.8	30	Secondary, Field Kit 1
6	S1209	2-4	0.6	30	Secondary, Field Kit 1
7	S1210	1-4	0.7	30	Primary Reference
8	S1211	1-3	0.7	30	Primary Reference
9	S1212	1-4	0.7	30	Secondary, Field Kit 1
10	S1213	1-4	0.7	30	Primary Reference
11	S1214	1-4	0.6	30	Primary Reference
12	S1215	1-4	0.5	30.5	Primary Reference
13	S1232	1-4	0.6	31	Secondary, Field Kit 2
14	S1233	2-3	0.8	31	Secondary, Field Kit 2
15	S1234	1-4	0.7	31	Secondary, Field Kit 2
16	S1235	1,2,4	0.8	31	Secondary, Field Kit 2
17	S1277	1-4	0.6	29.5	Primary Reference
18	S1278	1-4	0.6	30	Primary Reference
19	S1279	1-4	0.6	30	Primary Reference
20	S1280	1-4	0.6	30	Primary Reference
21	S1281	1-4	0.6	30	Primary Reference

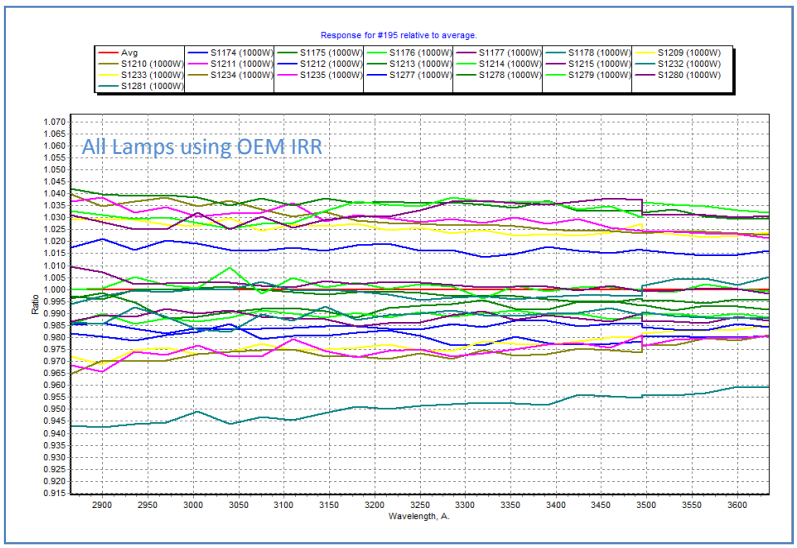
Determination of a New Secondary Lamp IRR File

Using the accepted lamp scans determined in the previous section, create a plot using the OEM IRR files for each lamp.

1. Click on the Setup tab and point to the directory containing the OEM IRR files.
2. Next click on the Calibrations tab and click on *Calculate new response using selected scans* button.

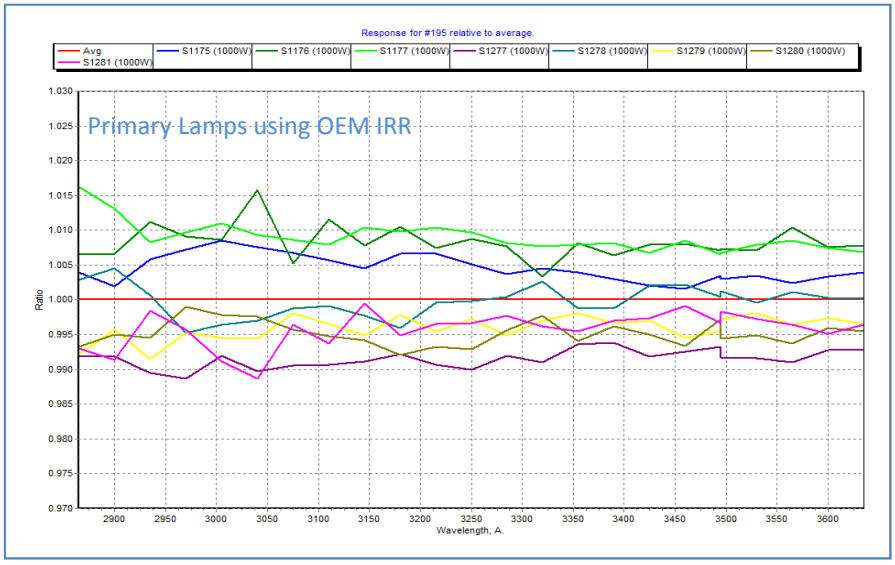


3. The UV response for the Brewer being used will be displayed however the individual lamp response relative to the average of all the lamps is desired. To display this, click on the average field. The resulting graph is displayed below.



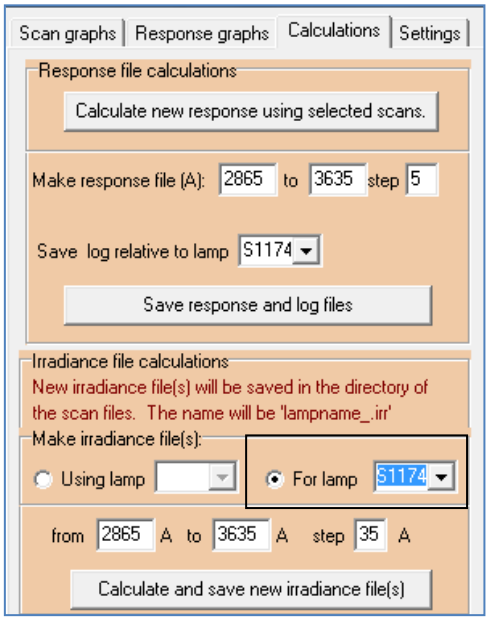
This graph indicates the relationship between the lamps. Based on this graph, Reference lamps S1210, S1211, S1213-S1215 are very different from the cluster of Reference lamps S1175-S1177 and S1277-S1281. Therefore lamps S1210, S1211, S1213-S1215 will not be included in further analysis.

4. After removing Reference lamps S1210, S1211, S1213-S1215 and re-calculating the response of the remaining Reference lamps the following graph is obtained.



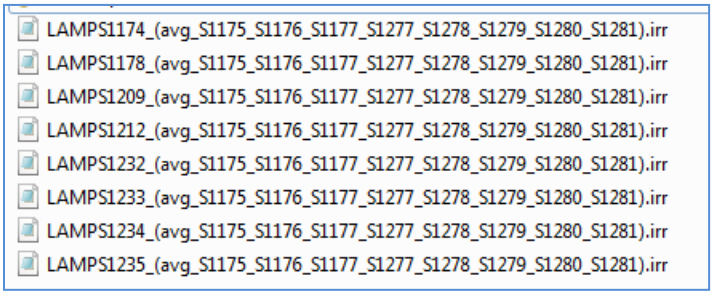
The resulting graph indicates good agreement between the Reference lamps (all scans within ± 1.5% of the average. This average is used to calculate a new IRR file for each secondary lamp.

5. To calculate a new IRR file for each secondary lamp click on the *For lamp* field and select the Secondary lamp that a new IRR file will be created for. Then click on the *Calculate and save new irradiance file(s)* button. This new IRR file will be saved in the same directory as the QL files used in this process.

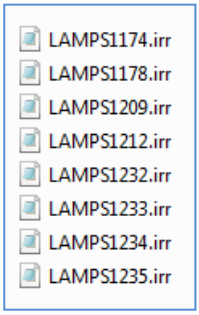


6. Continue this process until all Secondary lamps have been processed.

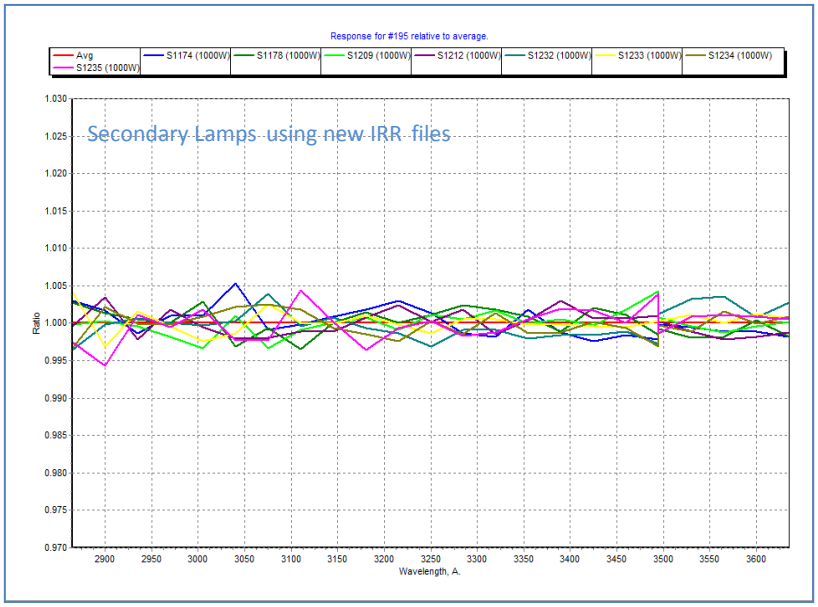
7. The following files are the result of the processing completed in the previous step. As the naming implies the average of Reference lamps S1175-S1177 and S1277-S1281 were used to create the new Secondary lamp IRR files.



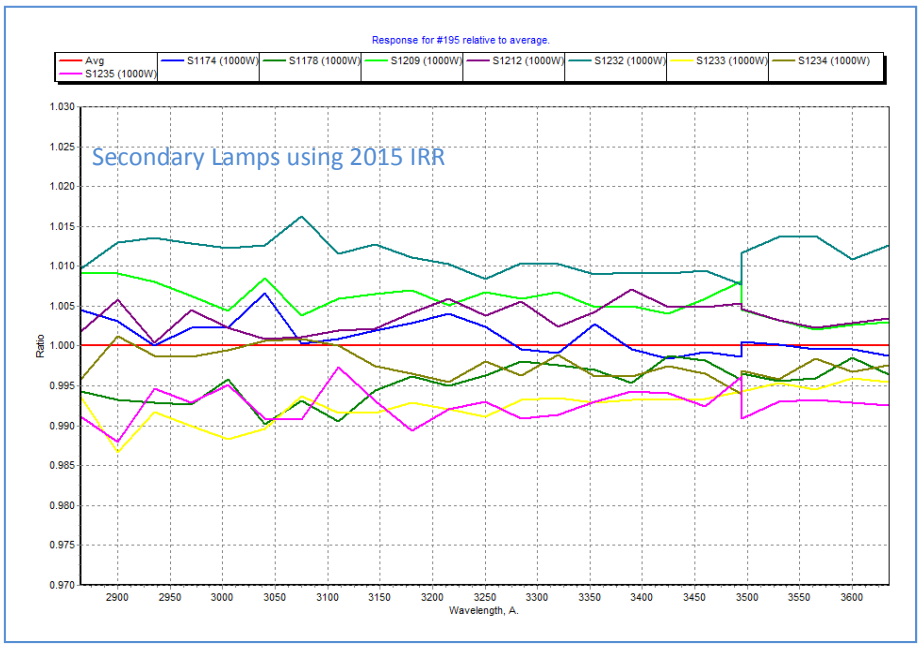
8. The above IRR files are then renamed in order for the UV processing software to use them in its processing.



9. Applying these new IRR files to the acceptable secondary lamp scans the following plot was determined. The secondary lamp scans are within ± 0.5 % of the average.



10. For comparison, the secondary lamps are also plotted using the past Secondary lamps' IRR files.



As the previous two graphs indicate the secondary lamps drift over time and use. Thus, it's important to recalibrate the secondary lamps on a yearly basis in order to maintain traceable UV Brewer Calibrations.