Pacific Northwest
NATIONAL LABORATORY

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Watchmen 2.5.3 Users Guide

Revision 5

September 2020

DT Keller
TJ Suckow

U.S. DEPARTMENT OF ENERGY

Prepared for the U.S. Department of Energy
under Contract DE-AC05-76RL01830

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Richland, Washington 99352

Revision Log

Watchmen 2 User Guide

Rev. No.	Date	Describe Changes	Pages Changed
0	5/06/2016	Original Issued	NA
1	7/22/2016	General Improvements	Throughout
2	1/11/2017	Additions: Status Indicators and notifications, RRR/ARR, Trending, Graphing, Calculations	Throughout
3	3/24/2017	Watchmen software fixes and enhancements, XECON calculations	Throughout
4	8/18/2017	Interactive Particulate	Throughout
5	9/16/2020	User authentication and user interface revamped	Throughout

Acronyms and Abbreviations

2-D	Two-dimensional
ARR	Automatic Radionuclide Report
CSV	comma-separated value
FWHM	full width at half maximum
ID	identification
IMS	International Monitoring System
MDA	minimum detectable activity
MDC	minimum detectable concentration
PHD	pulse height data
PNNL	Pacific Northwest National Laboratory
QC	quality control
RN	radionuclide
ROI	region-of-interest
RRR	Reviewed Radionuclide Report
SAUNA	Swedish Automatic Unit for Noble gas Acquisition
SOH	state of health
sccm	standard cubic centimeters

Contents

Figures

Tables

1.0 Watchmen

Watchmen is a research software application developed by Pacific Northwest National Laboratory (PNNL) that incorporates the scientific and operational expertise for reviewing data from treaty monitoring radionuclide stations. These stations are part of a worldwide network to monitor for nuclear explosions, and the data they produce are critical to make the determination of whether a sample is from a nuclear explosion or some other source (i.e., nuclear reactor or medical isotope production facility). Stations deliver their measurements and system status to the International Monitoring System (IMS), which forwards it via email to all subscribers. Watchmen is capable of processing data from several radioxenon station types and development is in progress on a solution for particulate stations.

Screening of data in Watchmen may be done by a number of different users such as radionuclide analysts, evaluators, and data quality experts. This guide is provided to assist those users in navigating the application. The term Watchmen is used generically throughout this document to refer to any of the various components in the software application. The user interface that is viewed with a web browser is the primary focus of this user guide. Other components include a database to store measurements and state of health (SOH) data; and the data loader that monitors incoming emails, parses the data, populates the database, does the initial analysis, and routes data for review.

1.1 Product Functions

The Watchmen software is a toolset for monitoring station performance and diagnosing problems. It also provides basic screening of radioxenon measurements. In support of this goal, the software is equipped with tools for monitoring SOH data.

The primary functions of the software at the time of this report are:

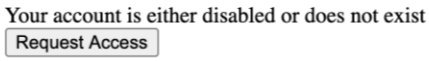
- Graphical display of radionuclide measurements
- Data analysis to calculate estimated concentrations and minimum-detectable-concentrations (MDCs) for radionuclides
- Automated radioxenon
- Ability to trend measurement analysis results
- Ability to facilitate a review process for radionuclide measurements, including the ability to escalate
- Ability to override the station-provided energy gain calibration as part of data quality review processes for cases when the energy calibration is suspect
- SOH functionality, including ability to monitor specific status indicators of any station’s health.

2.0 Viewer

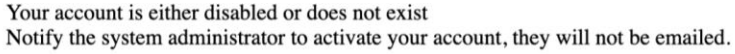
2.1 Logging In

Navigate in a web browser (Chrome or Firefox) to the Watchmen site. Ask an administrator for the URL. It will be in the form of https://servername/webviewer2, with *servername* as a placeholder for the name of the server or machine.

After authenticating as prompted (most likely by selecting a certificate from a smartcard) you will be prompted to request an account the first time you access the site.



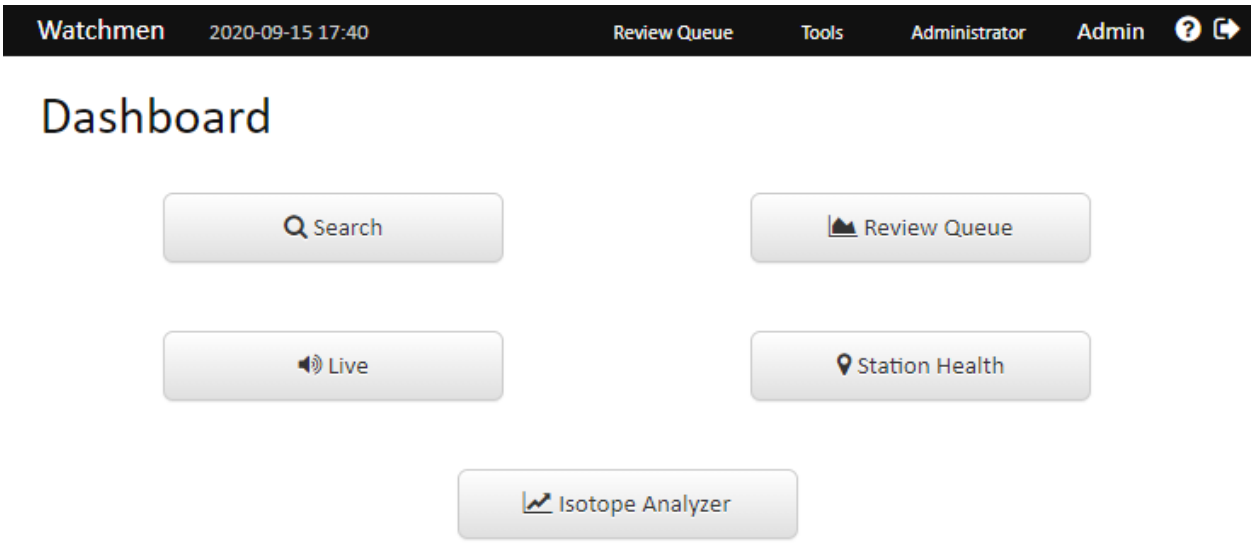
Click “Request Access” to create a disabled account in your name.



Then, contact an administrator (Director of Operations) of Watchmen to have your account enabled.

They will not know you have requested access unless you inform them. Likewise, they will not be able to activate your account unless you click “Request Access”.

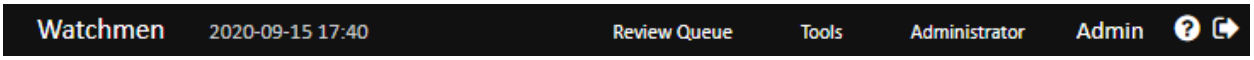
2.2 Dashboard



The first screen you will see is the dashboard which gives quick access to the most used tools in Watchmen.

2.3 Menu

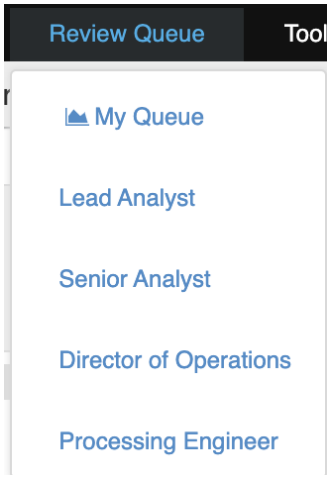
Along the top of the screen is a menu.



This menu gives quick access to review your queue and all the tools available in Watchmen. If you are Director of Operations, you also see an Administrator option allowing configuration of stations and users.

2.4 Review Queue

You can access your own review queue and the queues for any roles you possess from the “Review Queue” menu or by selecting the user on the search page. The dashboard also includes a quick link to your queue.



The review queue holds all the measurements assigned to the user or role. Releasing or reassigning a measurement to another role removes it from the original queue

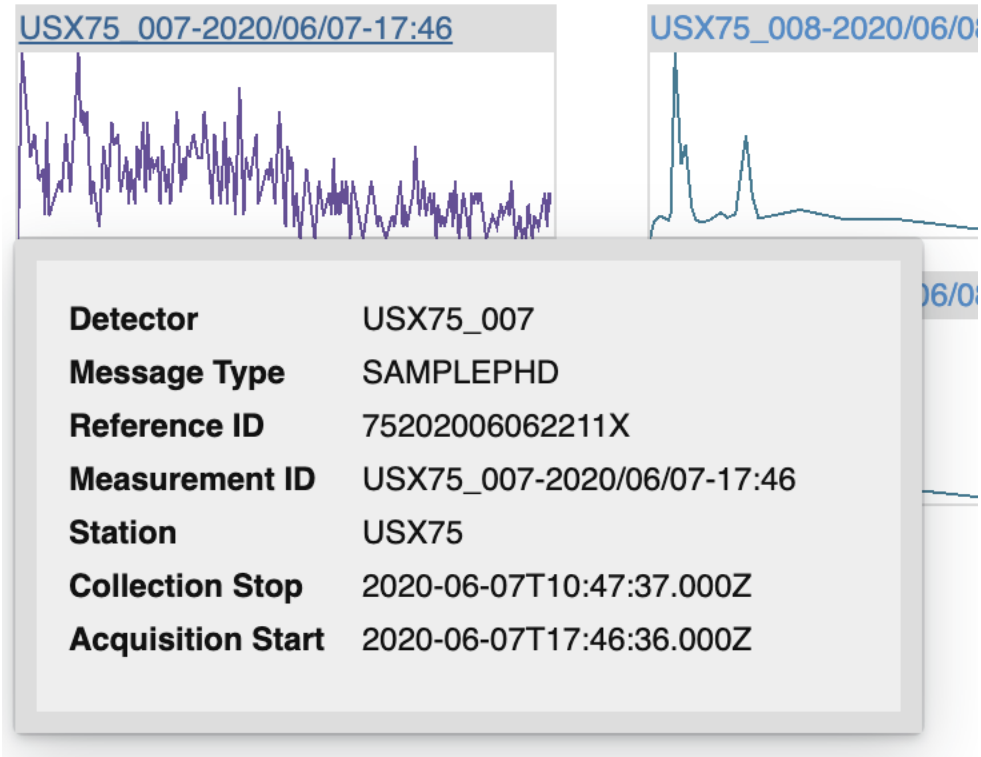
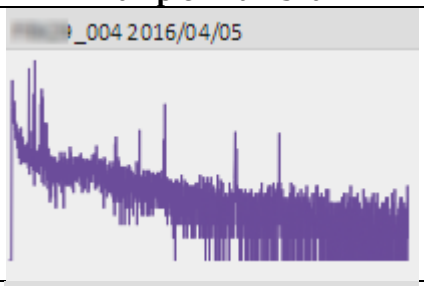
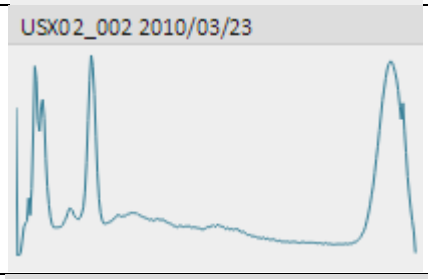
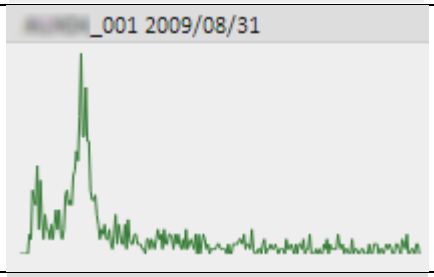
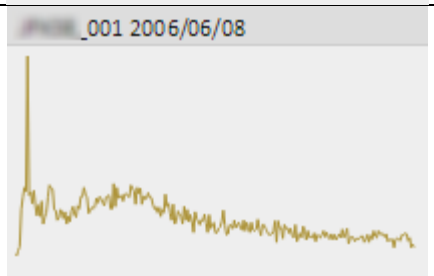
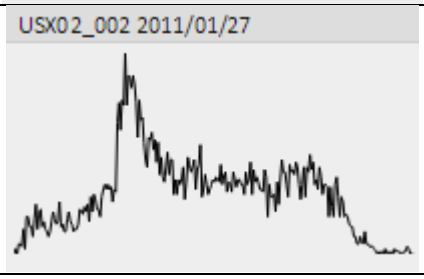


Figure 2.1. **Hover to view sample details**

2.5 Thumbnails

On the review and search pages where the thumbnails are displayed, different types of files are color coded for a visual representation (Table 2.1).

Table 2.1. Thumbnails

Measurement Type	Color	Example Thumbnail
Sample	Purple	
Quality Control (QC)	Blue	
Gas Background	Green	
Detector Background	Yellow	
Spike/Calibration	Black	

3.0 Searching

Watchmen retrieves measurements from its own database; it is not possible to search for IMS measurements that have not been processed by Watchmen. Measurements can be searched by using any combination of the following criteria:

- Station
- Detector
- Type (measurement type)
- Acquisition Start FROM and TO date range
- Assigned to (for review)
- Quality (review quality)
- ID (Sample Reference Identification or Measurement ID)
- Preliminaries (toggle to set to exclude, only "FULL" measurements are returned)

NOTE: Quality and Assigned To are mutually exclusive because once reviewed and given a quality, it is no longer assigned to anyone.

The primary set of criteria are "Station," "Detector," "Type," "Acquisition Start" and "Assigned To," which are immediately visible upon arriving at the search page. The second set of criteria are "Quality", "ID," and "Preliminaries," which can be displayed by clicking ellipses button ( ) at the upper right. When search by "ID", the operator may use the Sample Reference ID (e.g., 01888888882342G) or the Measurement ID (e.g., ABC01_001-2016/04/08-15:16). Searching on these IDs may have multiple results if the operator toggles "Preliminaries" to included (default is excluded) or if the IMS retransmitted an altered measurement.

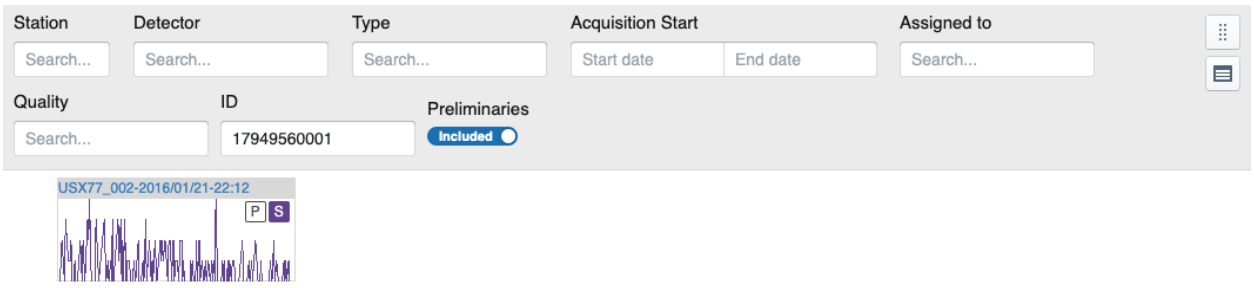


Figure 3.1. **Search Criteria Query**

As criteria is entered, the results are filter. Once you have selected a measurement, the address bar of the browser will also include the Watchmen-generated ID that uniquely identifies the measurement in the database. Sending someone the URL in the address bar of the measurement you are viewing will allow them to see the same measurement and search criteria, without searching.

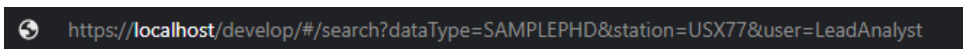


Figure 3.2. **URL with Search Criteria Query**

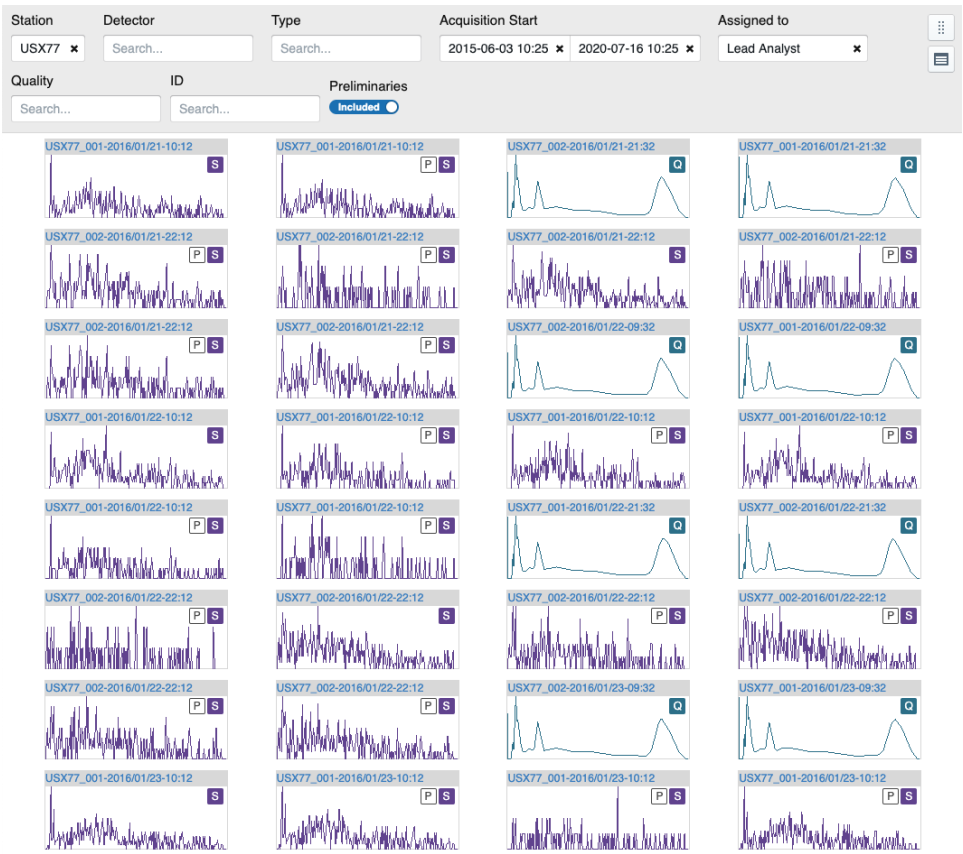
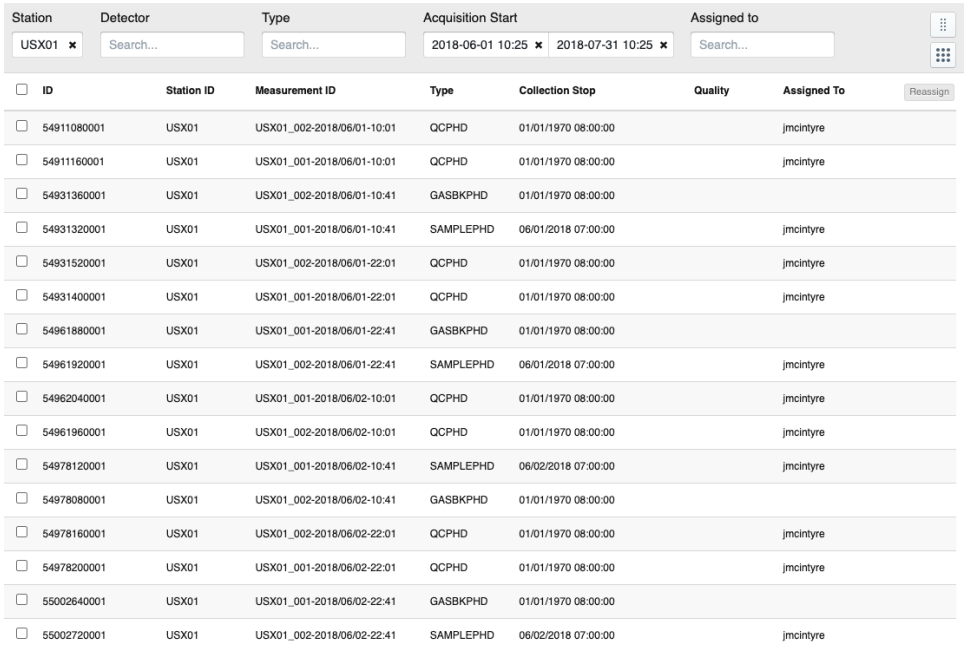


Figure 3.3. **Search Results, Grid View**

There is an optional list view (Figure 3.4) that is used for reassigning samples, that can be viewed by pressing the tab icon in the upper right corner, just below the ellipse button. A check box is located next to each sample for selection. To select multiple contiguous samples: 1) press and hold shift and then 2)

click the first and last sample in the range. If a sample has already been reviewed, the check box will not appear and cannot be selected, including when a range of samples is selected.



ID	Station ID	Measurement ID	Type	Collection Stop	Quality	Assigned To
54911080001	USX01	USX01_002-2018/06/01-10:01	QCPHD	01/01/1970 08:00:00		jmcintyre
54911160001	USX01	USX01_001-2018/06/01-10:01	QCPHD	01/01/1970 08:00:00		jmcintyre
54931360001	USX01	USX01_002-2018/06/01-10:41	GASBKPHD	01/01/1970 08:00:00		
54931320001	USX01	USX01_001-2018/06/01-10:41	SAMPLEPHD	06/01/2018 07:00:00		jmcintyre
54931520001	USX01	USX01_002-2018/06/01-22:01	QCPHD	01/01/1970 08:00:00		jmcintyre
54931400001	USX01	USX01_001-2018/06/01-22:01	QCPHD	01/01/1970 08:00:00		jmcintyre
54961880001	USX01	USX01_001-2018/06/01-22:41	GASBKPHD	01/01/1970 08:00:00		
54961920001	USX01	USX01_002-2018/06/01-22:41	SAMPLEPHD	06/01/2018 07:00:00		jmcintyre
54962040001	USX01	USX01_001-2018/06/02-10:01	QCPHD	01/01/1970 08:00:00		jmcintyre
54961960001	USX01	USX01_002-2018/06/02-10:01	QCPHD	01/01/1970 08:00:00		jmcintyre
54978120001	USX01	USX01_001-2018/06/02-10:41	SAMPLEPHD	06/02/2018 07:00:00		jmcintyre
54978080001	USX01	USX01_002-2018/06/02-10:41	GASBKPHD	01/01/1970 08:00:00		
54978160001	USX01	USX01_002-2018/06/02-22:01	QCPHD	01/01/1970 08:00:00		jmcintyre
54978200001	USX01	USX01_001-2018/06/02-22:01	QCPHD	01/01/1970 08:00:00		jmcintyre
55002640001	USX01	USX01_001-2018/06/02-22:41	GASBKPHD	01/01/1970 08:00:00		
55002720001	USX01	USX01_002-2018/06/02-22:41	SAMPLEPHD	06/02/2018 07:00:00		jmcintyre

Figure 3.4. **Search Results, List View**

Once the desired measurement has been found, click on the thumbnail to view the Sample Review Panels (see Section 3.1 for details).

Figure 3.5. **Search Results, Sample Review Panel**

3.1 Sample Review Panels

3.1.1 Sample Review at a Glance

Selecting a sample with a single left-click of the mouse in the search will bring up the Sample Review Panel (Figure 3.6). The interface will display the Sample Review Panel, for the selected measurement, below the graphical list of searched measurements. This panel provides detailed information (e.g., activity concentration, measurement times, etc.) on the currently selected sample along with the associated detector and gas background measurements, if the sample is from a beta-gamma type station. The measurement review layout displays the Detector name and Acquisition Start date at the top along with action buttons. The action buttons include Xecon Report (Section 3.1.2), Delete, Recalculate (Section 3.1.3); Related Measurements (Section 3.1.4); and Measurement Navigation Control (Section 3.1.6).

WARNING: The Delete button will delete the measurement and its analysis from the database.[1]

Next, the Overview panel contains the status indicators, Spectrum chart, two-dimensional (2-D) histogram (if a beta-gamma sample), a table with information about the measurement, and log entries. Following the Overview is the Trend panel (if a beta-gamma sample), the All Spectra panel (if a beta-gamma sample), Calibration panel, and finally the Review panel.

While the interface contains a similar layout for all measurements, the populated information will vary depending on the station and calculation type. Figure 3.6 and Figure 3.7 show a Swedish Automatic Unit for Noble Gas Acquisition (SAUNA) sample for the screen layout.

[1] Data can only be recovered by locating the original file in the archive and placing the file in the incoming directory for re-ingesting and re-analysis by Mothman.

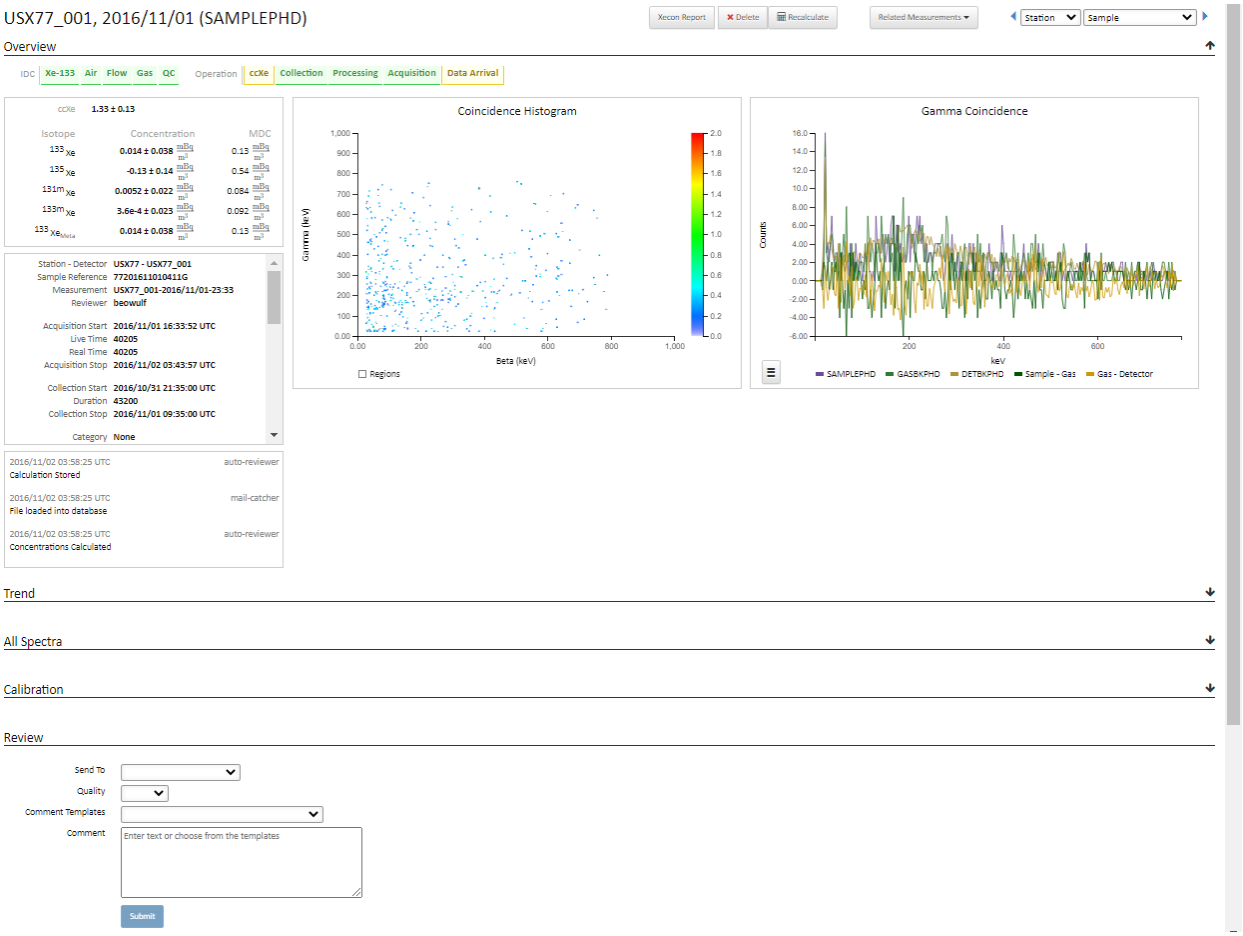


Figure 3.6. **SAUNA Review**

The overview contains the 2-D histogram with beta energy (in keV) on the x-axis and the gamma energy (in keV) on the y-axis (Figure 3.7). Regions of interest (ROIs) are outlined with the rectangular bars on the graph. The ROIs can be turned off or on by left clicking on the Regions options box. The box is bolded when regions are turned on.

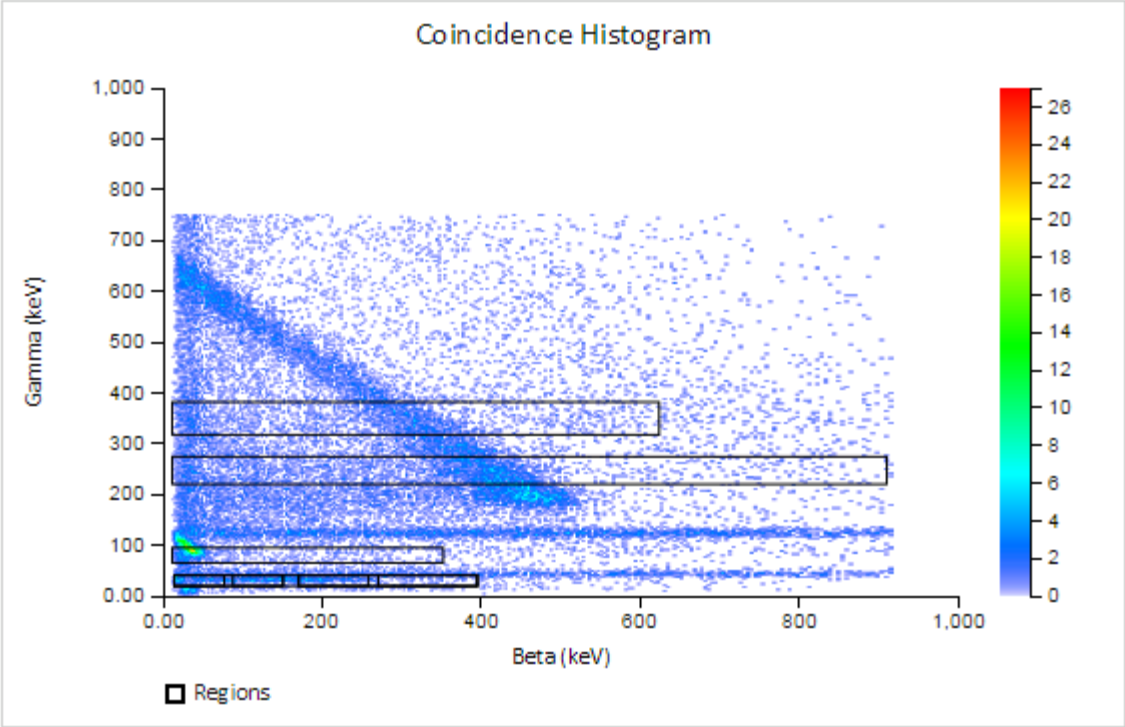


Figure 3.7. **2-D Histogram**

The ROIs are used to compute the four reported radioxenon isotopes (^{131m}Xe, ^{133m}Xe, ^{133}Xe, and ^{135}Xe).

3.1.2 XECON Report

You can perform XECON calculations and generate a textual report on your selected sample. Click on the "Xecon Report" button (Figure 3.8) and a new browser tab will appear. This new tab will produce the XECON Report (Figure 3.9).

NOTE: XECON version 1.2.1 is used by the software.

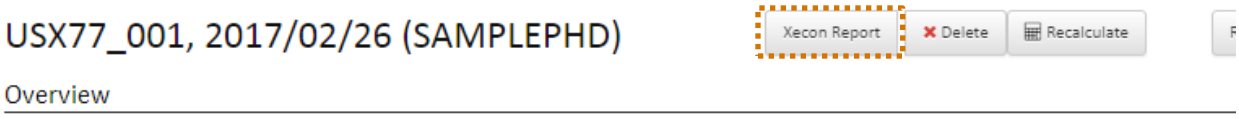
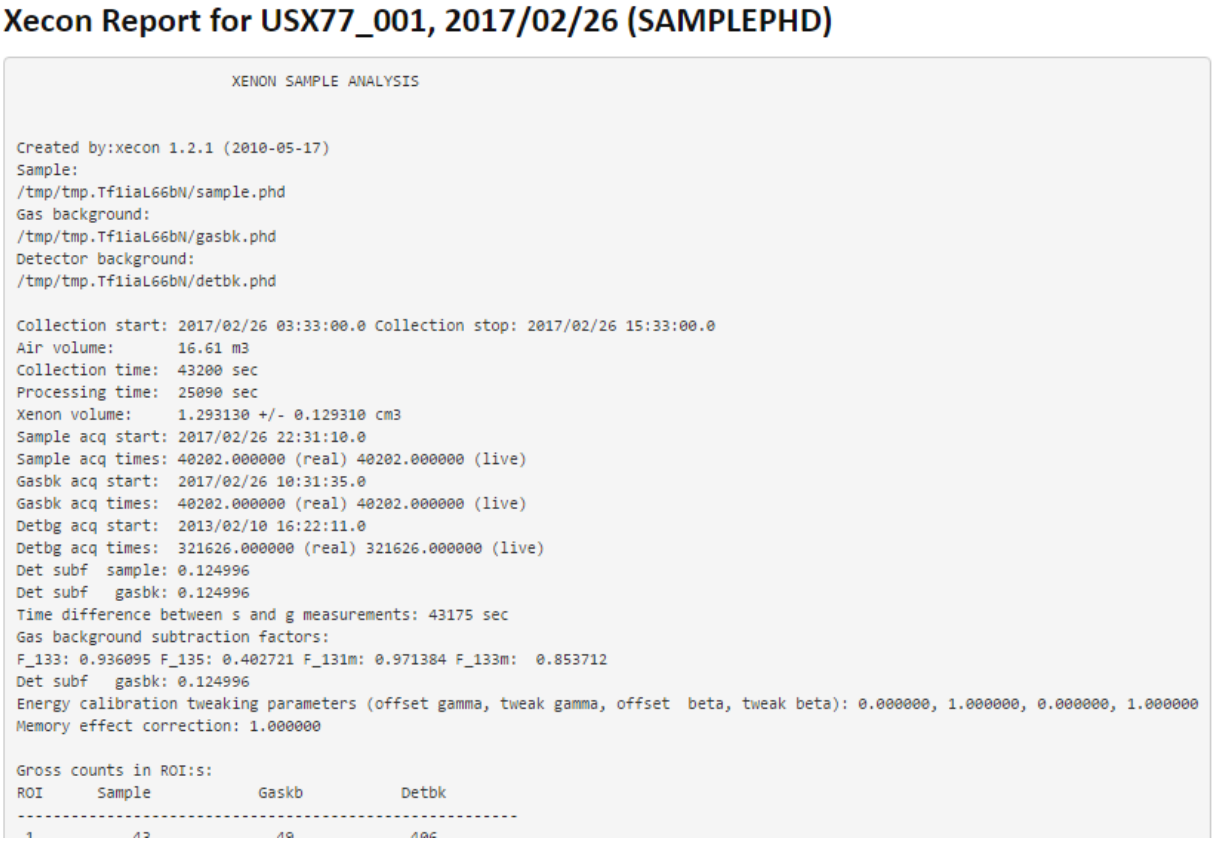


Figure 3.8. **XECON Report Button**



Xecon Report for USX77_001, 2017/02/26 (SAMPLEPHD)

```
                    XENON SAMPLE ANALYSIS


Created by:xecon 1.2.1 (2010-05-17)
Sample:
/tmp/tmp.Tf1iaL66bN/sample.phd
Gas background:
/tmp/tmp.Tf1iaL66bN/gasbk.phd
Detector background:
/tmp/tmp.Tf1iaL66bN/detbk.phd

Collection start: 2017/02/26 03:33:00.0 Collection stop: 2017/02/26 15:33:00.0
Air volume:       16.61 m3
Collection time:  43200 sec
Processing time:  25090 sec
Xenon volume:     1.293130 +/- 0.129310 cm3
Sample acq start: 2017/02/26 22:31:10.0
Sample acq times: 40202.000000 (real) 40202.000000 (live)
Gasbk acq start:  2017/02/26 10:31:35.0
Gasbk acq times:  40202.000000 (real) 40202.000000 (live)
Detbg acq start:  2013/02/10 16:22:11.0
Detbg acq times:  321626.000000 (real) 321626.000000 (live)
Det subf  sample: 0.124996
Det subf   gasbk: 0.124996
Time difference between s and g measurements: 43175 sec
Gas background subtraction factors:
F_133: 0.936095 F_135: 0.402721 F_131m: 0.971384 F_133m:  0.853712
Det subf   gasbk: 0.124996
Energy calibration tweaking parameters (offset gamma, tweak gamma, offset  beta, tweak beta): 0.000000, 1.000000, 0.000000, 1.000000
Memory effect correction: 1.000000

Gross counts in ROI:s:
ROI      Sample           Gaskb          Detbk
-----------------------------------------------------
 1          43              49            406
```

Figure 3.9. **XECON Report**

3.1.3 Recalculate

If a detector's energy coefficients have been changed (see Stations Section 9.2), the new calculations are not automatically applied to measurements that were already in your review queue, as new coefficients are only applied to samples that are inserted to the database after the coefficients were applied, or if you click Recalculate. If the coefficients have been changed recently, select the Recalculate button located on the right, in line with the Overview panel to apply the new calculations. Refresh the screen when the calculations have finished to view the modified data.

NOTE: This change is permanent, and the measurement will be stored in the database with the revised calculations. In addition, when the calculations are rerun, the sample will be assigned back to the default reviewer for the station, which may be a different review queue if the measurement had been assigned to a lead analyst for review.

3.1.4 Related Measurements

Once you have selected a measurement, you can navigate to any of its related measurements (Backgrounds, Quality Checks, or Preliminaries) by using the Related Measurements drop-down menu located on the right side of the screen (see Figure 3.10). If there are no related measurements in the database, the drop-down menu will be disabled. Selecting a measurement in the Related Samples list will take you to the selected measurement.

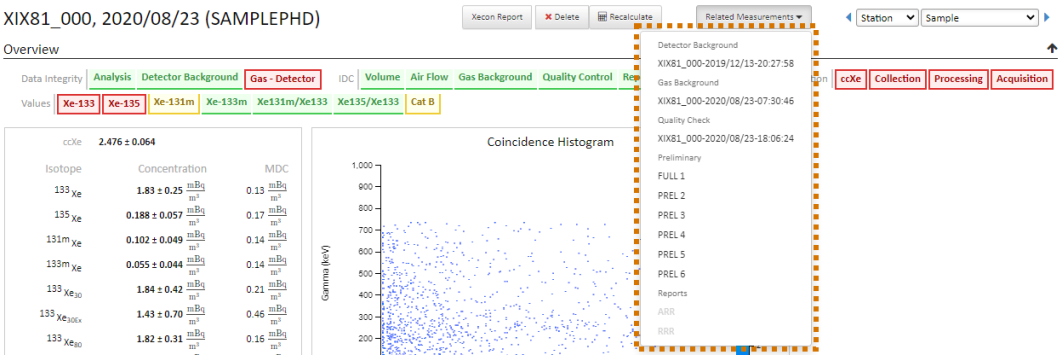


Figure 3.10. **Related Measurements**

3.1.5 Automatic Radionuclide Report and Reviewed Radionuclide Report Views

Automatic Radionuclide Report (ARR) and Reviewed Radionuclide Report (RRR) views are available from the Related Measurements menu. If an ARR or RRR is available, it will be clickable. Otherwise they will be grayed out if they do not exist. Once you click on the ARR or RRR (see Figure 3.10), the web browser window will navigate to the detailed ARR or RRR data.

The detailed ARR or RRR displays the report information along with a percent difference comparison to the Watchmen MDC calculations. If the calculation difference is greater than 5%, the difference is highlighted in red. You can also export the MDC calculations to comma-separated value (CSV) format—indicated by the "Download Summary" link. See Figure 3.11—the MDC comparison section is outlined in blue.

Radionuclide Report Comparison - ARR

Creation Date: 2016/12/26 17:51:09 UTC
Sample Arrival Time: 2016/12/26 17:40:03 UTC
Time difference from receipt of raw data to report creation: 0d 0h 11m 6s

Sample Information

Station ID:	USX74	Detector Code:	USX74_006
Authenticated:	NO		
Station Location:	Ashland, KS, USA		
Detector Description:	Detector #6 for USX74 Noble Gas Test Station.		
System Technology:	SAUNA		
Sample Reference ID:	74201612251111G		
Sample ID:	3907557		
Stable Xe Volume:	1.07 mL	Sample Type:	Gas
Collection Start:	2016/12/25 11:19:41 UTC	Sampling Time:	0d 12h 0m 2s
Collection Stop:	2016/12/25 23:19:43 UTC	Processing Time:	0d 7h 13m 42s
Acquisition Start:	2016/12/26 06:33:25 UTC	Acquisition Time:	0d 10h 58m 17s
Acquisition Stop:	2016/12/26 17:31:42 UTC		

Measurement Categorization

Categorization Legend

Level A	=	Clean spectrum - No Xenon is present in the sample.
Level B	=	Xenon detection within the typical range for the station.
Level C	=	Anomalous Xenon detection.

Isotope Category

Isotope	Nuclide detected	Abnormal_limit *(mBq/m3)*	Category
^{131m}Xe	NO	1.61e-1	A
^{133m}Xe	NO	1.24e-1	A
^{133}Xe	NO	3.70e-1	A
^{135}Xe	NO	9.62e-1	A

Spectrum Category: A

Activity Summary and Minimum Detectable Concentration for Xenon Isotopes

Radon Level in Xenon sample

Nuclide	Half-Life	Area	%RelErr

Radon counts in Xenon sample: 93

Xenon Isotopes

Net Count Calculation Analysis Method
Beowulf Tolerance Threshold: 5%

Download summary:

			Conc (mBq/m3)			MDC			
Nuclide	Half-Life	LC	IDC	Beowulf	% Diff	IDC	Beowulf	% Diff	%RelErr
^{131m}Xe	1.03e+6	4.00e-2	< LC	5.13e-2	N/A	1.00e-1	1.54e-1	5.36e+1	N/A
^{133m}Xe	1.89e+5	4.00e-2	< LC	5.30e-2	N/A	1.10e-1	1.30e-1	1.85e+1	N/A
^{133}Xe	4.53e+5	9.00e-2	< LC	8.77e-3	N/A	1.90e-1	2.07e-1	9.07	N/A
^{135}Xe	3.29e+4	3.90e-1	< LC	9.52e-1	N/A	8.20e-1	7.33e-1	1.06e+1	N/A

Processing Specific Parameters and Results

Method 1 (Net Count Calculation)

ROI Net Count Results

ROI	Nuclide	Net Counts	Abs Net Error	LC	Efficiency	Abs Eff Error
1	^{214}Pb	2.17e+1	1.04e+2	1.49e+1	N/A	N/A

Figure 3.11. **ARR/RRR details with MDC comparison outlined in blue**

3.1.6 Measurement Navigation Control

Once you have selected a measurement, it is possible to navigate to measurements on the same station or detector using the Measurement Navigation Control located on the right side of the screen (see Figure 3.12). You can specify if you would like to navigate based on the Station or Detector (the leftmost drop-down menu) as well as the type of measurement (rightmost drop-down menu). Arrows on either side of the navigation control will navigate to the previous (leftmost arrow) or next (rightmost arrow) measurement chronologically when clicked. If there is no measurement available, the arrows are disabled.

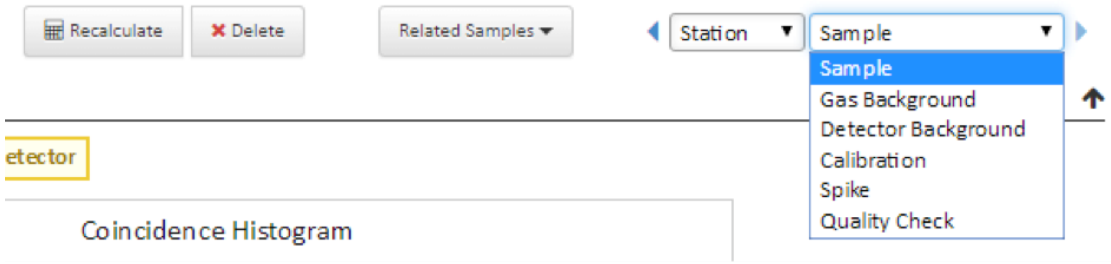


Figure 3.12. **Measurement Navigation Control**

3.1.7 Status Indicators

Multiple status indicators, such as xenon volume (ccXe), acquisition time and data arrival time, xenon activity and isotope ratios, and the presence of related measurements, are displayed on the top of the Overview section in the Sample Review Panel. The indicators are categorized by Operation, Values, and Data Integrity. These status indicators display as red, yellow, or green. If they are green, they are collapsed by default. To expand collapsed indicators, click on the category. Hover over the indicator with your mouse to display a pop-up with additional details such as bounds for the parameter. The concentrations listed in the overview panel also contain color-coded information that corresponds to the status indicators.

- Data Integrity
    - Analysis
        - Red – Calculations are missing.
        - Green – Calculations are completed.
    - Detector Background
        - Red – A detector background file is not present.
        - Yellow – A detector background file is outdated.
        - Green – A detector background file is present.
- IDC
    - Gas Background (on compatible station types)
        - Red – A gas background file is not present.
        - Yellow – A gas background is outdated.

        - Green – A gas background file is present.
    - Quality Control – The quality control (QC) status lights for the Sample files are controlled by reviewing the corresponding QC file (Figure 3.13).
        - Green – The corresponding QC files were present and reviewed as good.
        - Yellow – The corresponding QC files were present and have not been reviewed yet or were not marked as a good file.
        - Red – All other conditions, including the corresponding QC files are not present.
    - Report Time
    - Data Arrival - Within the time specified by the indicator
- Operation
    - ccXe – Cubic centimeters of xenon (setpoint is based on SAUNA ideal of 1 sccm/24hr)
        - Red – Volume of xenon is greater than 0.5 sccm from the set point
        - Yellow – Volume of xenon is between 0.25-05 sccm from the setpoint
        - Green – Volume of xenon is within 0.25 sccm of setpoint
    - Collection
        - Red – Difference from expected collection time is greater than 2%
        - Yellow – Difference from expected collection time is between 1-2%
        - Green – Difference from expected collection time is less than 1%
    - Processing
        - Red – Difference from expected processing time is greater than 2%
        - Yellow – Difference from expected processing time is between 1-2%
        - Green – Difference from expected processing time is less than 1%
    - Acquisition Real Time - Within the tolerance for the station and sample type
- Values
    - Xe133 – Red, yellow, green to show Above, Above Half, or Below MDC (respectively)
    - Xe135 – Red, yellow, green to show Above, Above Half, or Below MDC (respectively)
    - Xe131m – Red, yellow, green to show Above, Above Half, or Below MDC (respectively)
    - Xe133m – Red, yellow, green to show Above, Above Half, or Below MDC (respectively)
    - 131m/133 Ratio – Red, yellow, green to show if the ratio of the isotopes is below the minimum detectable concentration. Additional information about concentration displayed.
    - 135/133 Ratio – Red, green to show if the ratio of the isotopes is below the minimum detectable concentration. Additional information about concentration is displayed.
- Gas – Detector – Detects levels of counts and coincidence.

- Measurement information (Figure 3.14) – The metadata associated with the file collection such as acquisition time and station. The IDs for the corresponding gas and detector background files are also displayed. This information is displayed in the scrollable pane.

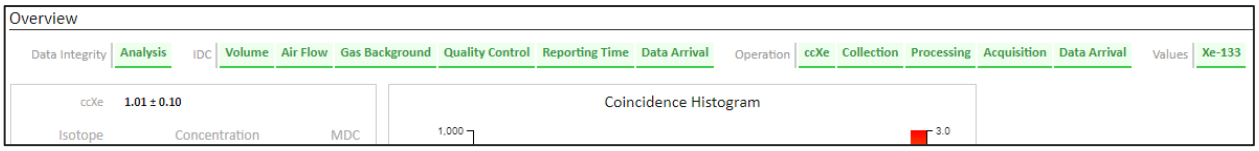


Figure 3.13. **Status Indicators**

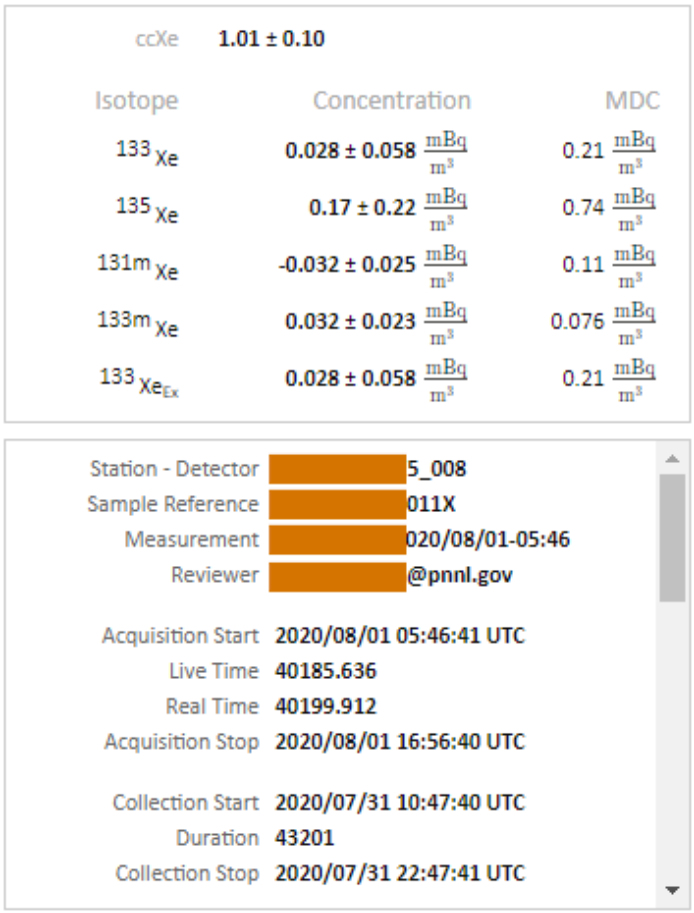


Figure 3.14. **Measurement Information**

3.1.8 Chart Features

The charts throughout the interface have a built-in zoom feature. With the mouse cursor over an area of interest in a chart, hold the ALT key and mouse-scroll to zoom in. You can hold ALT+SHIFT and mouse-scroll to zoom only the x-axis, or ALT+CTRL and mouse-scroll to zoom only in the y-axis. You also can click-and-drag to zoom into an area of interest. Once zoomed in, you can right-click to zoom back out. Points in trend graphs (Figure 3.15) are clickable and linked to the measurement. Clicking the point will navigate to the sample measured.

The small download icon ( ) may be used to download the data to a CSV format. Select the download icon, then use the drop-down menu for Export to CSV.

Click on the y-axis to toggle between log and linear.

Each chart legend controls which data are displayed on the chart. Click on an item in the chart legend to turn the display of that specific data on and off.

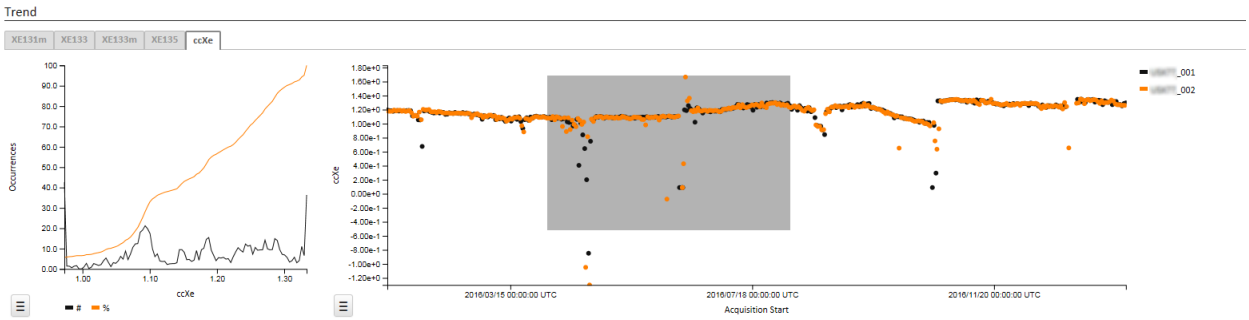


Figure 3.15. **Chart Features**

3.1.8.1 Chart Panels

There are two detailed charting panels, Trend, and All Spectra. After selecting a measurement, the data from the different charts may be viewed by selecting the different tabs within these panels.

3.1.9 Station Frequencies and Trends

Two different displays for station frequencies and trends are supported in the Watchmen viewer - the frequency histogram and the trend over time plot as seen in Figure 3.16. The frequency histogram shows the frequency of the activity concentrations for each of the four radioxenon isotopes as well as the volumes of xenon for the samples. The trend data provide a different presentation of the same data to illustrate trends in the data over time. Both the frequency and trend data are shown together.

Two methods exist to display the frequency and trend data from a station. Firstly, the trends data is displayed along with the measurement information automatically (if available) on the search and review screens. The second is in the Station application and is described in Section 9.2.

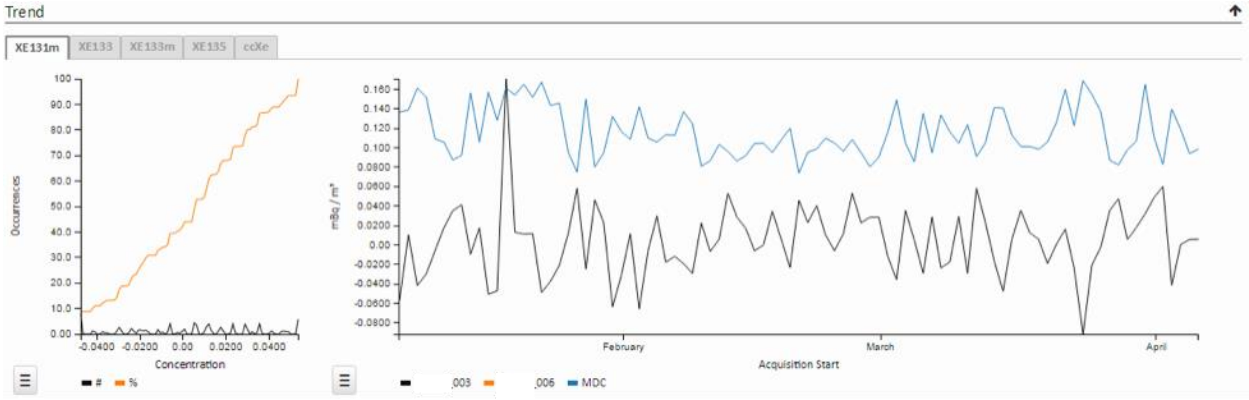


Figure 3.16. **Trend Panel**

3.1.10 All Spectra

The All Spectra panel (Figure 3.17) shows different views of the selected measurement, indicated by the tabs. You can toggle the Normal and History tabs. Normal shows current measurement data from all relevant measurements. History shows aggregated data from the detector over one day, one week, and one month. See Section 3.1.10 for additional information on the chart features. The All Spectra panel contains the following tabs of graphs:

- Gamma Coincidence Spectrum: only gamma energy values where the gamma and beta spectra are in coincidence are displayed on the coincidence beta spectrum.
- Beta Coincidence Spectrum: only beta energy values where the beta and gamma spectra are in coincidence are displayed on the coincidence beta spectrum.
- Region 4 – Beta Coincidence: 30-keV Gamma, Coincidence Beta Spectrum: the plot is similar to the coincidence beta spectrum chart previously described; however, only coincidence data in the 30keV gamma region of interest are displayed.
- Gamma Singles Spectrum: The entire detector response for the gamma detector is displayed on the singles gamma spectrum. All values, including background are displayed without a coincidence being required.
- Beta Singles Spectrum: The entire detector response for the beta detector is displayed on the singles beta spectrum. All values, including background are displayed without a coincidence being required.

Figure 3.17. **All Spectra Panel Beta-gamma Measurements (Normal/History View)**

3.1.11 Calibration Panel

The values from the header for each file are displayed on the calibration panel (Figure 3.18). Select the type of values from the tabs.

- ROI Limits – The region of interest (ROI) limits for beta and gamma
- Ratios – The interference ratios for each region of interest
- Gamma
    - Efficiency - The gamma energy, efficiency and efficiency uncertainty
    - Energies – The gamma energy, channel, and channel uncertainty
    - Resolutions – The gamma energy, full width at half maximum (FWHM), and FWHM uncertainty
- Beta
    - Energies - The beta energy, channel, channel uncertainty, and decay mode
    - Resolution - Beta energy, FWHM, and FWHM Uncertainty
- Beta Gamma Efficiency – ROI, nuclide name, and efficiency with uncertainty.

Calibration

ROI Limits | Ratios | Gamma | Beta | Beta Gamma Efficiency

ROI	Beta Start	Beta Stop	Gamma Start	Gamma Stop
1	34.994	632.713	312.624	382.136
2	34.994	780.61	207.964	278.357
3	34.994	367.897	65.593	100.697
4	34.994	408.973	17.5002	41.4733
5	87.3721	168.987	17.5002	41.4733
6	198.175	291.725	17.5002	41.4733
7	34.994	78.6376	17.5002	41.4733
8	300.506	408.973	17.5002	41.4733
9	198.175	408.973	17.5002	41.4733
10	34.994	168.987	17.5002	41.4733

Figure 3.18. **Calibration Panel**

3.1.12 Review Panel

Review and promote functions enable analysts to read and submit reviews and promote measurements for review by others. To complete the review on a sample, find the review panel at the bottom of the selected measurement user interface. You can also press <AccessKey>+R to jump to the review panel, <AccessKey> is typically Alt, Alt+Shift, or Ctrl+Alt, depending on the browser used. The review panel is the last panel in all measurement user interfaces. This panel contains the interface shown in Figure 3.19.

Use the “Send To” drop-down menu to assign the measurement to another user, or the “Quality” drop-down menu to complete a review.

The process of sample review is intended to be completed in chronological order. If it is completed in this order, then the QC file corresponding to the Sample file will always be reviewed first, thus changing the status lights to the expected status when reviewing the Sample file. The QC review should include a check of the energy calibration and acquisition time to verify that the results were as expected. See Section 3.1.14 of this guide for additional information on modifying the energy calibration if the QC review reveals results that need to be modified.

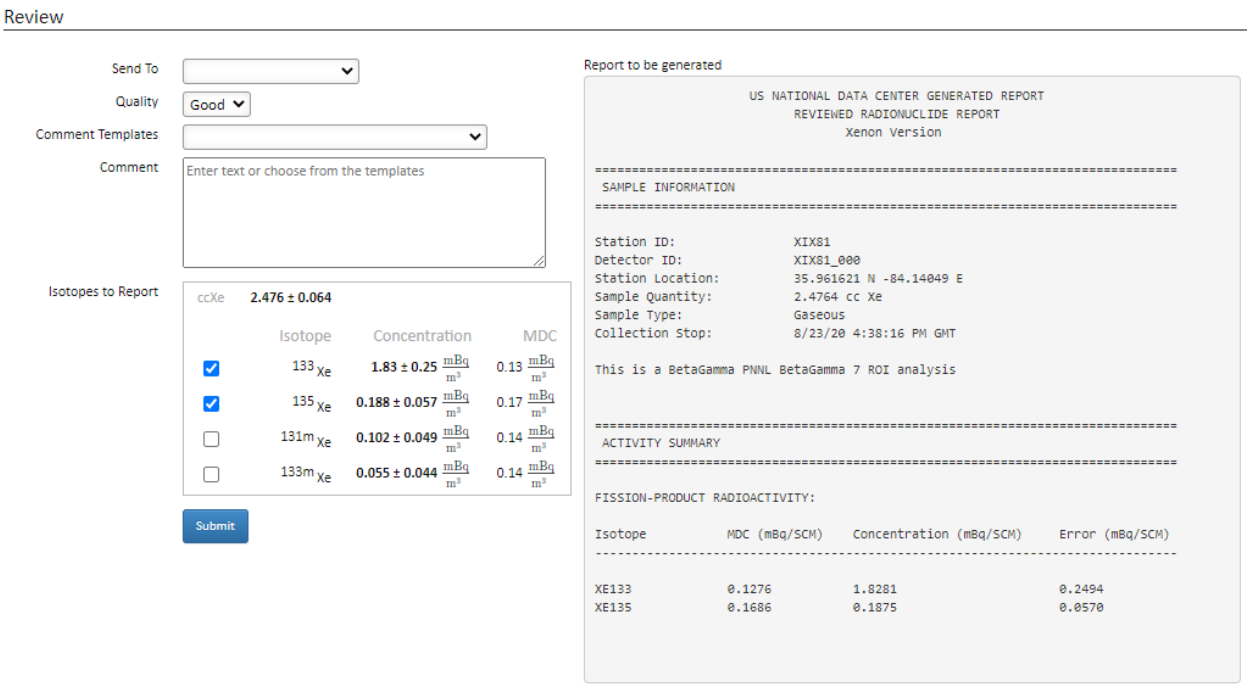


Figure 3.19. **Review Panel**

3.2 Completing a Review – Alternative One

One alternative is to pass the measurement to another user for review using the choices in the Send To drop-down menu. This drop-down menu contains the roles of "Lead Analyst," "Senior Analyst," "Process Engineer," and "Director of Operations." Users are mapped to the roles of "Lead Analyst," "Senior Analyst," etc., through the "Manage Users" application (see Section 9.3). After selecting the role from the drop-down menu, click the "Submit" button to transfer the spectra from your queue to the selected role.

3.3 Completing a Review – Alternative Two

The second alternative for a review is to complete the review by selecting a choice from the "Quality" drop-down menu of "Good," "Warn," or "Bad."

A comment may be entered for either passing spectra or completing the quality review. The comments and results of the review are logged and subsequently displayed in the log. Some frequently used comments have been included in the "Comment Templates" drop-down menu. Select one of these if desired and then additional text may be entered.

3.4 Selecting Isotope Checkboxes

The Isotope checkboxes at the bottom of the Review page may be pre-selected depending on the calculations. These selections may be changed by checking or unchecking the box. If a checkbox is selected, the Reviewed Radionuclide Report will be generated for preview, and saved to the file system

upon submission. If no checkboxes are selected, the comment and action status will still be logged, but no Reviewed Radionuclide Report will be saved.

Checkboxes appear in the Isotopes to Report section once a Quality selection is picked. These checkboxes may or may not appear, depending on the measurement type.

3.5 Submitting the Review

After completing the review options, click the Submit button to complete the review.

3.6 QC Review

The analysts reviewing the files can determine if they need to modify the energy calibration to change the gain in cases where the energy of peaks do not line up with known energy values (Figure 3.20).

Figure 3.20. **QC Review**

Normally when the QC file is in the review queue and has been opened from the review queue, the analyst will verify that the Log Entries shows the automatic peak fitting was successful (log displays QC Peaks & Coefficients Calculated as shown in Figure 3.20), and that the peaks are as expected in the plot. The analyst will then click the Review Sample link to review the QC files in a process similar to the sample files.

The trend chart located at the bottom of the QC Review Normal page displays the peak centroids, area and resolution over time for the QC files.

4.0 Isotope Analyzer

The Isotope Analyzer module provides a charting tool for RN Evaluators to compare sample data with data from known sources or models, to determine or rule out possible sources of the radionuclide release. The Isotope Analyzer module allows the evaluators to select models and specify model parameters, select sample data of interest, and to configure one or more charts displaying model and sample data. A number of graphing options are available, including plotting isotopes and isotope ratios with respect to time, plotting ratios of isotopes (triple isotope plots), selecting the isotopes produced at a number of hold up times and irradiation times for different types of nuclear reactors and medical isotope production facilities, and allowing the user to add relevant samples collected on particulate and radioxenon systems. This provides a graphical comparison of real data sets to data sets from models.

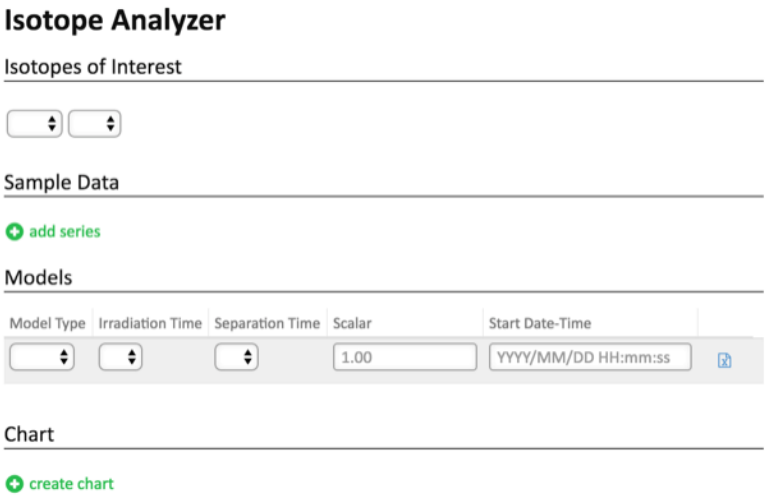


Figure 4.1. **Isotope Analyzer**

The first step to using Isotope Analyzer is choosing the isotope(s) of interest. The chosen isotope(s) will be available for plotting on the charts and will have a column when entering data. Isotopes can be added or removed at any time. Removing an isotope will delete all hand entered activities for that isotope.

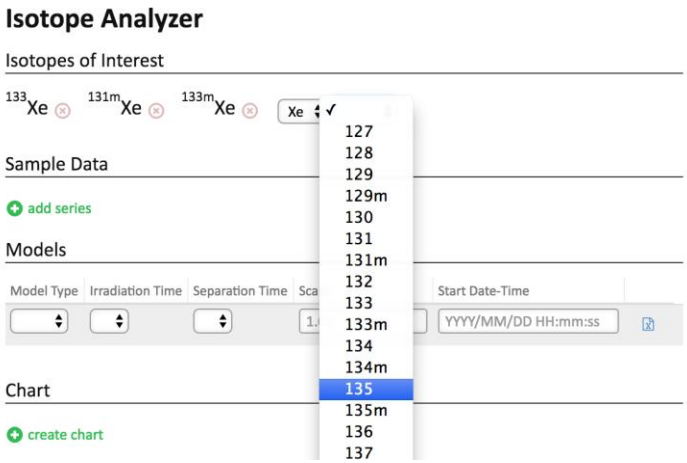


Figure 4.2. **Isotope selector**

After choosing the isotopes you are interested in, data from sample measurements can be entered as a series into the Sample Data panel. Data from separate locations or equipment can be entered as different series. If you have multiple measurements from the same piece of equipment you can enter each and record the time of the measurement.

Values for measurements may be entered as activities or concentrations. The same unit must be used throughout all measurements or an incorrect conclusion will result. The "Dilution" of the entered values can be adjusted to normalize the entered values. The dilution value is a multiplicative term which will scale up or down the values. An example of the use of dilution would be to normalize activities measurements to concentration values by accounting for sample size.

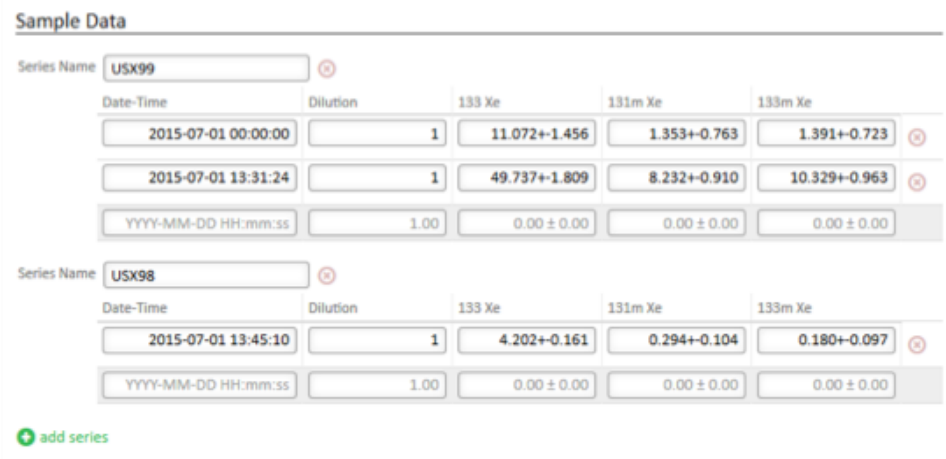


Figure 4.3. **Series parameters**

After entering sample data, there are a number of models that can be selected to compare against the entered data. The dropdowns allow the user to select a model. The magnitude of the model can be adjusted by use of a Scalar value for comparison with the entered data. This will be apparent on charts with an axis in the Activity Domain. The start time of the model can be adjusted to match with charts that are measured with Time.

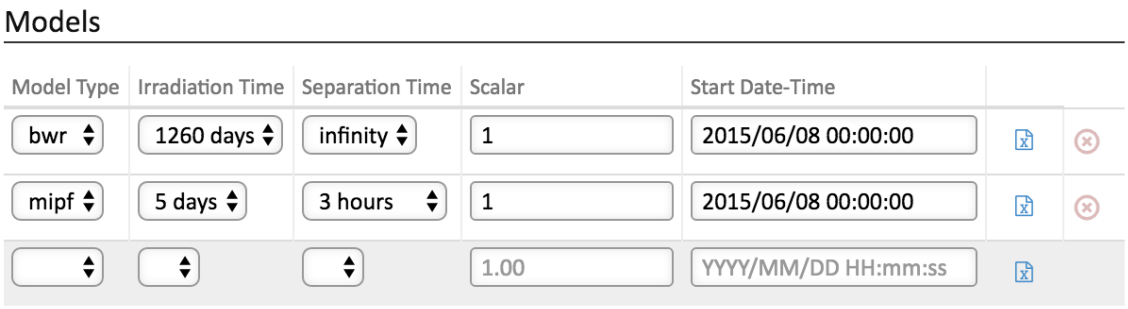


Figure 4.4. **Model selection and parameters**

After the data has been entered and models chosen, charts can be created to confirm the models represent the dataset. It is important to note that while Ratio vs Ratio plots may match a model, it is possible that Activity vs Time or Activity vs Activity may not match a model. When that occurs, it implies the model does not represent the entered data. Uncertainties will be displayed on the chart as black bars when inputted in the sample data.

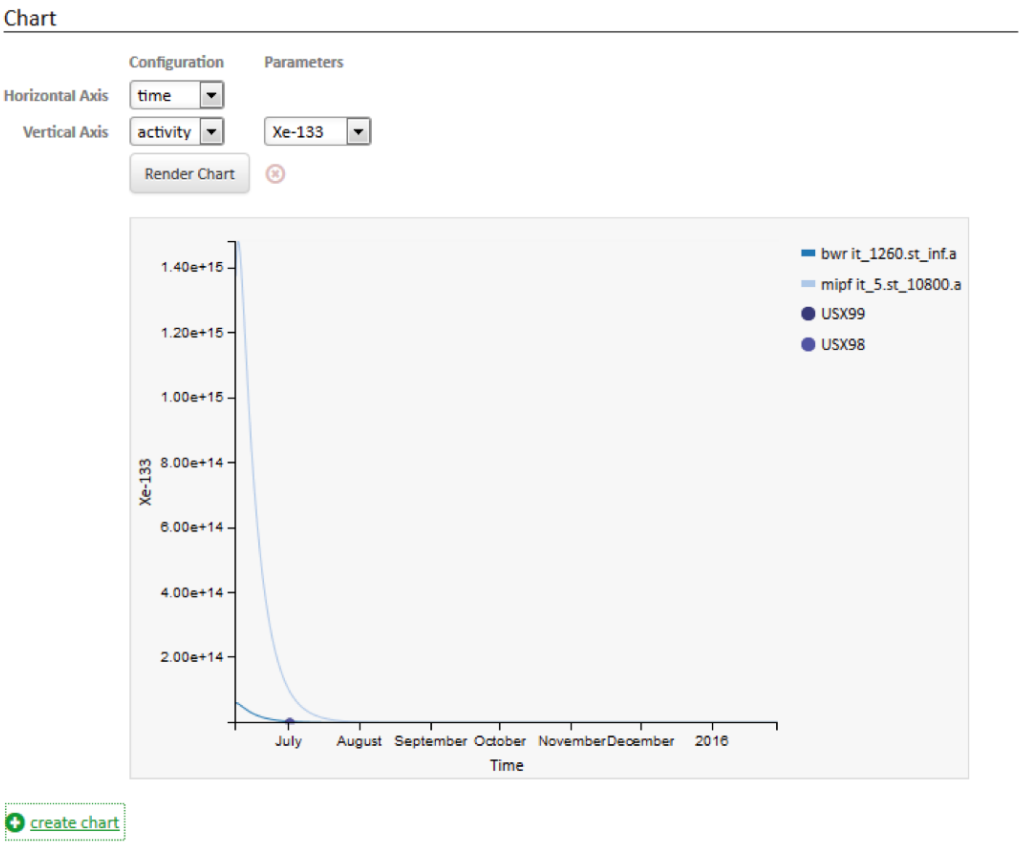


Figure 4.5. **Isotope Analyzer plotting**

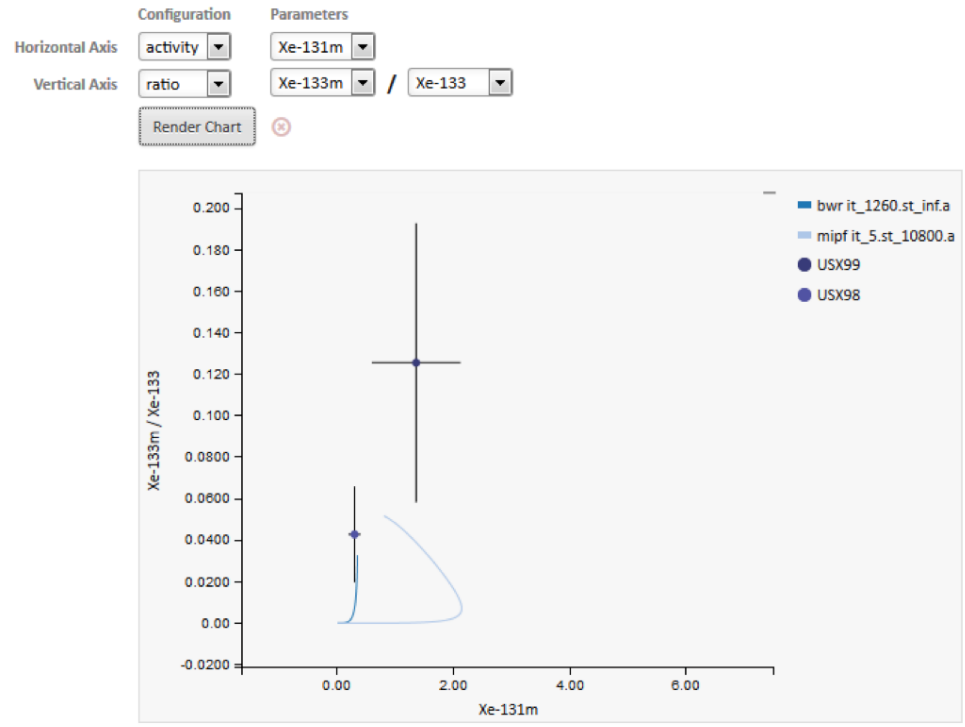


Figure 4.6. **Multi-isotope plot**

5.0 Station Health

5.1 Station Health Application

The Station Health application is an overview of station health categorized by the measurement type (Sample PHD, Gas Background PHD, and Quality Check PHD). This application displays tabular information of each station's health based on their measurements. These health metrics per measurements are cc of xenon, quality indicator (Good, Fair, or Bad status), Last Full Sample PHD received date, number of measurements received in the last seven days, measurement reception interval (time span based), indication of past due measurement (red is past due, green is on time), and the time span of the past due measurement. For details, see Figure 5.1.

Station Health

Station	PHD Type	Measurement	Last Full Sample PHD Received	Number received in last 7 days	Interval	Past Due	Overdue
[illegible]	SAMPLEPHD		2017/01/12 21:47:47 UTC	0			
	GASBKPHD		2017/01/12 21:47:47 UTC	0			
	QCPHD		2017/01/12 21:47:47 UTC	0			
[illegible]	SAMPLEPHD		2017/01/12 21:47:47 UTC	0			
	GASBKPHD		2017/01/12 21:47:47 UTC	0			
	QCPHD		2017/01/12 21:47:47 UTC	0			
[illegible]	SAMPLEPHD		2017/01/12 21:47:47 UTC	0			
	GASBKPHD		2017/01/12 21:47:47 UTC	0			
	QCPHD		2017/01/12 21:47:47 UTC	0			
[illegible]	SAMPLEPHD		2014/03/03 13:53:28 UTC	0	a day		3 years
	GASBKPHD		2014/03/02 19:46:06 UTC	0	a day		3 years
	QCPHD		2014/03/03 14:30:58 UTC	0	a day		3 years
[illegible]	SAMPLEPHD		2017/01/12 21:47:47 UTC	0			
	GASBKPHD		2017/01/12 21:47:47 UTC	0			
	QCPHD		2017/01/12 21:47:47 UTC	0			
[illegible]	SAMPLEPHD		2017/01/12 21:47:47 UTC	0			
	GASBKPHD		2017/01/12 21:47:47 UTC	0			
	QCPHD		2017/01/12 21:47:47 UTC	0			
[illegible]	SAMPLEPHD		2017/01/12 21:47:47 UTC	0			
	GASBKPHD		2017/01/12 21:47:47 UTC	0			
	QCPHD		2017/01/12 21:47:47 UTC	0			
[illegible]	SAMPLEPHD		2017/01/12 21:47:47 UTC	0			
	GASBKPHD		2017/01/12 21:47:47 UTC	0			
	QCPHD		2017/01/12 21:47:47 UTC	0			
[illegible]	SAMPLEPHD		2017/01/12 21:47:47 UTC	0			
	GASBKPHD		2017/01/12 21:47:47 UTC	0			
	QCPHD		2017/01/12 21:47:47 UTC	0			
[illegible]	SAMPLEPHD		2017/01/12 21:47:47 UTC	0			
	GASBKPHD		2017/01/12 21:47:47 UTC	0			
	QCPHD		2017/01/12 21:47:47 UTC	0			
[illegible]	SAMPLEPHD		2017/01/12 21:47:47 UTC	0			
	GASBKPHD		2017/01/12 21:47:47 UTC	0			
	QCPHD		2017/01/12 21:47:47 UTC	0			
[illegible]	SAMPLEPHD	ccXe	2017/01/12 18:49:59 UTC	14	a day		
	GASBKPHD		2017/01/12 18:48:56 UTC	14	a day		
	QCPHD		2017/01/12 19:34:50 UTC	28	12 hours		
[illegible]	SAMPLEPHD	ccXe	2017/01/12 18:44:28 UTC	14	a day		
	GASBKPHD		2017/01/12 18:44:07 UTC	14	a day		
	[illegible]		[illegible]	[illegible]	[illegible]		

Figure 5.1. **Station Health Application**

6.0 Live View

The Live View application (Figure 6.1) is located in the menu next to the Stations link within the RN Analyst role. Live View provides a current display of the latest 10 measurements sent to Watchmen. This screen refreshes every 10 seconds.

Each measurement has some metadata along with a spectra thumbnail. You can hover over the spectra just as in the Search applications to get extra details (Figure 2.1). The Live View also displays the status indicators (Section 3.1.7). You can click on the spectra to navigate to the measurement in the Search application (Section 3.0).

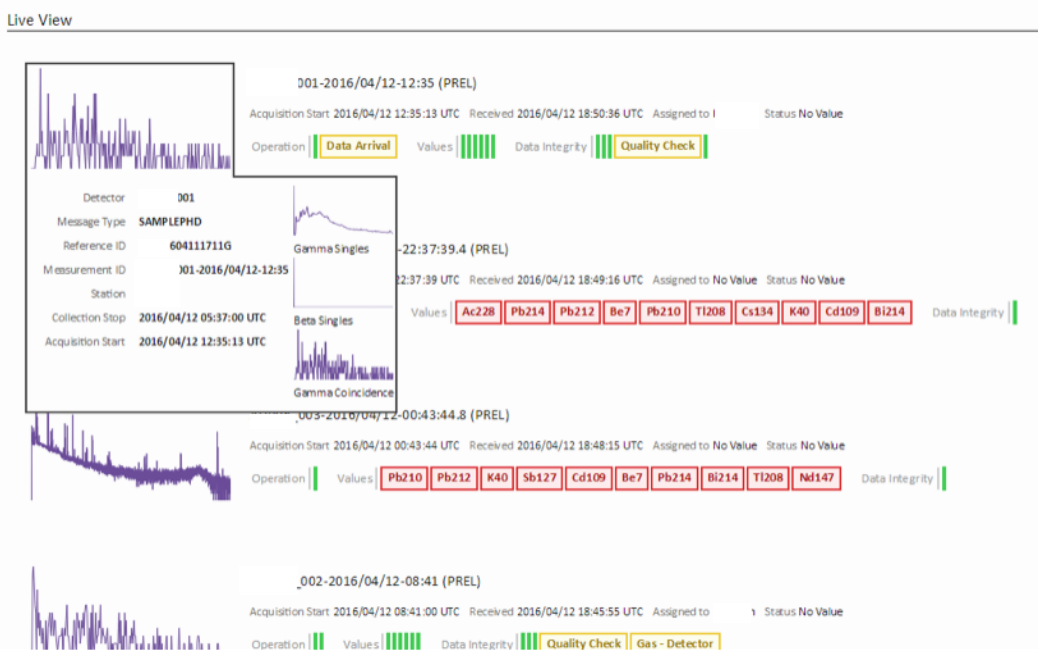


Figure 6.1. **Live View Application**

7.0 SOH Overview

7.1 Station Performance Overview

The Station Performance overview screen gives an overall view of Watchmen's stations and their performance. The overview is based on a historical view of quality indicators. The three statuses for any indicator are Bad, Fair, and Good. The status of the indicators displays as the worst-performing indicator in any given time frame—that is an indicator that is in Bad state will override a Good or Fair indicator. By default, the overview screen displays all stations' performance over the past seven days with the stations in Bad performance ordered at the top of the screen. Each station displays a time-based horizontal band per detector. A station's current performance is based on the most recent quality indicator's status. A user can optionally change the time frame of a station to get historical performance. A user can also re-sort the stations based on status by clicking on the status legend at the top of the screen. The status legend also shows the count in each status marker (see Figure 7.1)

Upon clicking on a station graph, the application navigates to the station detail screen.

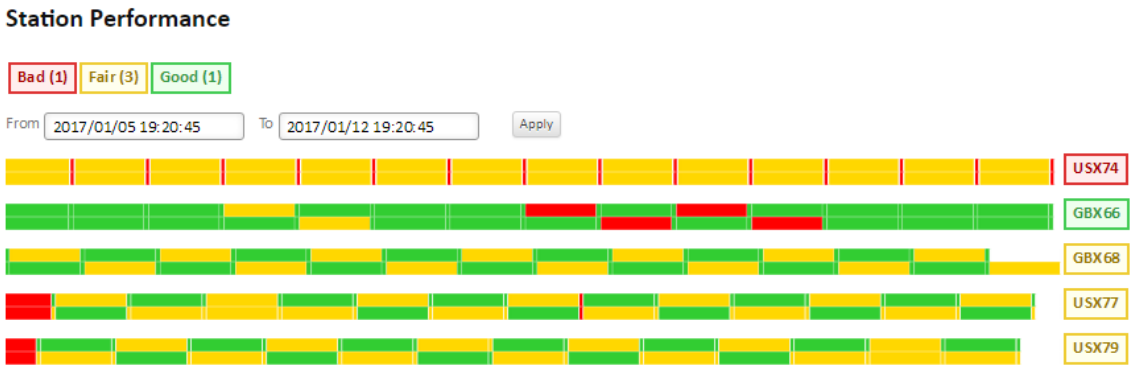


Figure 7.1. **Station Performance**

7.2 Station Health

On the station detail screen (see Section 9.1 for full station detail documentation), the heading "Station Health" contains indicator information that defines this station's health. Similar to the Station Performance Overview graphs (see Figure 7.1), the Station Health section displays a set of timebased horizontal band of quality indicators. These quality indicators are rolled up to the topmost indicator, which is the Station Overview. The Station Overview is equivalent to the Station Performance Overview station graph. Hovering over any point in an individual indicator gives a detail of the indicator value and the details of the status—Bad, Fair, Good (see Figure 7.3). Clicking on any point in an individual indicator will navigate to the containing measurement (Figure 3.6). White space indicates no data are available at a specific time because of expected or unexpected missing data. Each individual indicator's data for the given time range can be exported to CSV via the icon to the right of the indicator name (). See Figure 7.2.

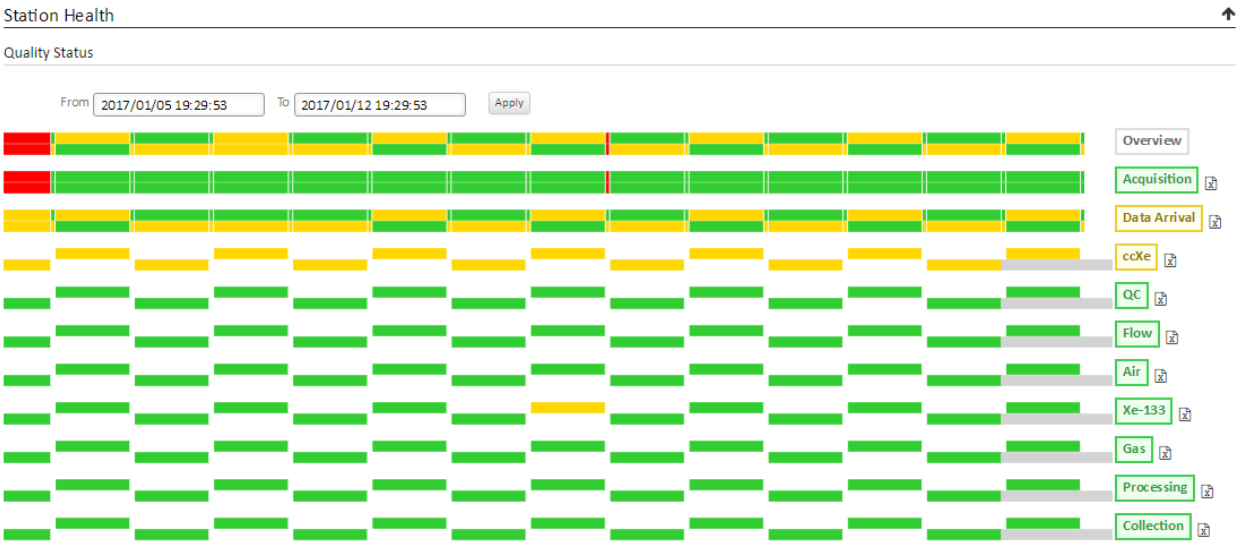


Figure 7.2. **Station Health**

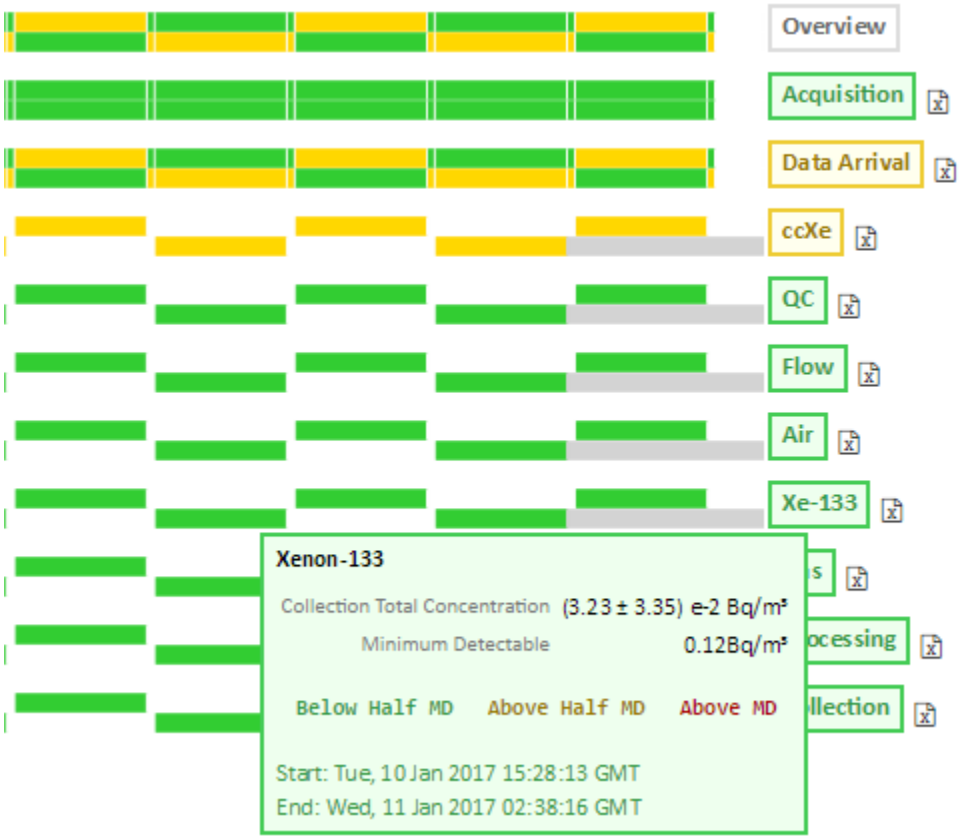


Figure 7.3. **Station Health Hover**

8.0 Radionuclide Data Quality

The Radionuclide (RN) Data Quality screen displays station trending across a selected time frame. Users choose from a variety of trending variables. Users can optionally select a particular detector of the station. See Figure 8.1.

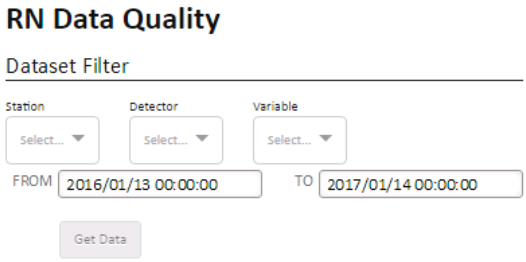


Figure 8.1. **RN Data Quality**

Once the user selects desired station, detector, and variable, the user clicks on "Get Data" button to display a trend chart across the selected time frame (the default time frame is a year from today). See Figure 8.2 for a trend chart example.

NOTE: Users can use the mouse wheel to zoom in and out of the charts. The reset button in the upper right of the chart will reset to the original zoom.

The resulting graphs show two charts, Individual Chart and Moving Range Chart. Each chart shows all data points in the trend along with upper and lower bounds (in blue dashed horizontal lines). Below the graphs, the dataset section shows a tabular format of each point. Users can optionally ignore data points by clicking the checkbox in the ignore column. The tabular data also displays blue and orange tags indicating violations of the respective limits. See Figure 8.3 for details on the tabular "Dataset" section.

Figure 8.2. **Trend Charts**

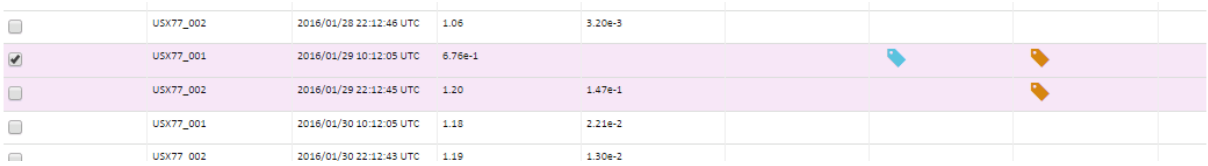


Figure 8.3. **Trend Tabular**

9.0 Administration

The administrative functions previously contained in a separate interface are now included in the Navigation. To open, select the administrative option of interest from the menu. The options are:

- Pending Reviews
- Stations
- Indicator Configuration.
- Users

9.1 Pending Reviews

A station may only be assigned to one reviewer. The stations should be assigned to users with a role of Analyst. If a change in station assignments is made, any samples loaded for stations assigned to users after a change has been made will start appearing in the Pending Reviews application for the changed user. However, already assigned reviews will not be affected.

To change a station's measurement review to a different user, select the desired Station and `Unreviewed` Quality. Click on the row corresponding to the measurement that you are reassigning and select the Reassign button. In the pop-up menu, select the new user from the drop-down menu. To highlight multiple samples, hold down the Shift or Ctrl key and click to select multiple rows (Figure 9.1).

NOTE: You will see the same filters as the Search application in the Get Measurements panel (see Section 3.1). You can use these to filter the measurements to assign.

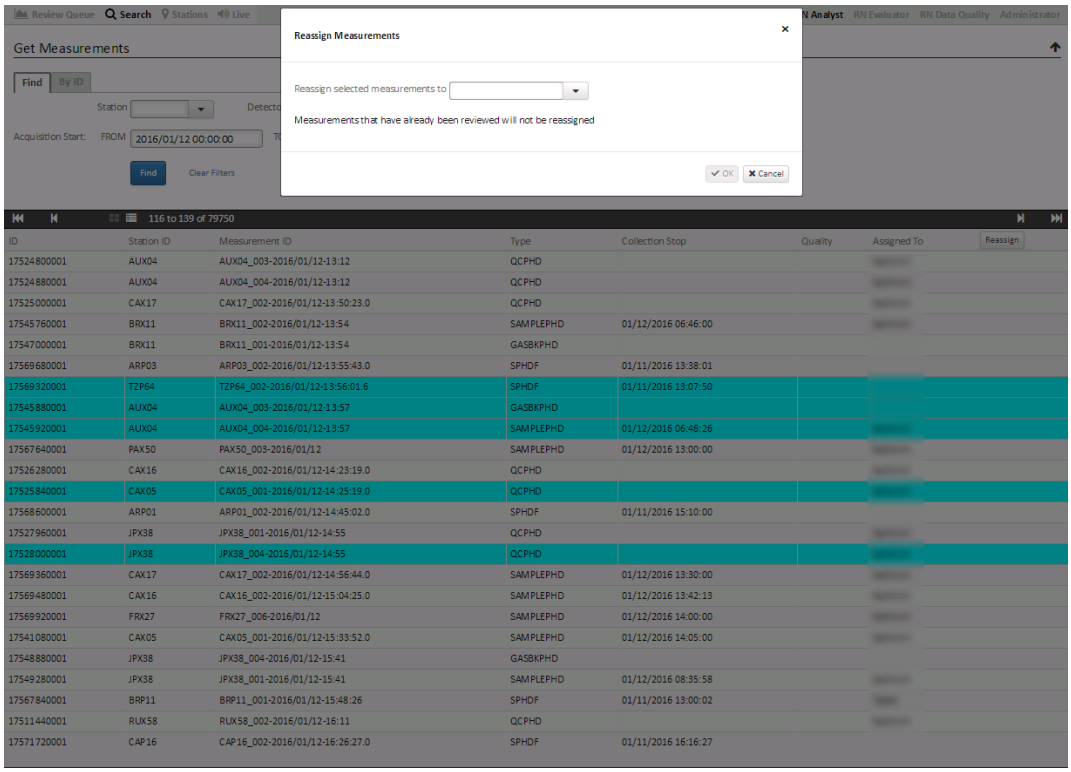


Figure 9.1**. Pending Sample Reviews Application**

9.2 Stations

The Stations application contains a list of all the stations currently available in the database for viewing in the Watchmen interface. The Information panel contains the following information:

- Station Code – A code given to each station that is the list of stations displayed throughout the interface
- Country Code – The two-letter code of the country operating the station
- Type – A feature not currently implemented in this software
- Description – A test field for the users to add a description of the station
- Assigned To – The analyst assigned, all samples from the station will appear in this user's review queue
- Lat - Latitude
- Lon – Longitude
- Elevation – A feature not currently implemented
- Status – A feature not currently implemented
- POCID – A feature not currently implemented

- Indicator Configuration – Set to the preferred station configuration for the station's status indicators. See SOH Configuration section for more information on managing indicator configurations.
- Calculation Type – Specific to the calculations needed for the data type. Available calculation types are listed in a drop-down menu.
  - Not Set (no calculations will be performed)
  - PNNL BetaGamma 7 ROI
  - FOI BetaGamma 10 ROI
  - CEA Basic SPALAX
  - Melusine

To manage the station information, click the Edit Station button at the bottom of the Information panel. This will enable in-line editing. Make the desired changes, and then select the Done checkmark button to save the changes or the X Cancel button to cancel.

Click the New button at the top left of the screen to add new stations.

The Detectors information provides energy calibration information. The information are coefficients of a polynomial fit function of the form Ax^2+Bx+C where A, B, and C are numbers provided in the chart on the page. There are two type of calibration information provided for each the beta detector and the gamma detector; Channel to energy (C2E) coefficients and energy to channel (E2C). These coefficients are used when performing analysis. They can be updated manually by clicking the edit icon to the right of the coefficients. Measurements will not be reanalyzed automatically when these coefficients are updated.

For station trend plotting, select the Station name from the drop-down menu. You may then set the start and end date of interest in the "Trend Range" panel (Figure 9.2). The default display is one year. Frequency and Trend charts are displayed, if there are data to display. If no charts appear, adjust the dates and try again.

Clicking the Samples Report link in the Trend Range will open a new window with tabular information. You can also click the Download Samples Report to get an Excel export of the trend data.

NOTE: The "Station Health" section is detailed in Section 7.2.

Figure 9.2. **Manage Stations Application**

9.3 Indicator Configuration

Users can administer and change the configuration of limits for a station's quality indicators (see Section 7.2 for a definition of indicators). Start by going to the "Indicator Config" menu item (found in the Administrator and RN Data Quality roles). You can then modify a configuration by selecting the configuration from the "Select a Config" drop-down menu. Or you can start a new configuration from a pre-defined system template by clicking "Start from Template" (see Figure 9.3). Selecting an existing config navigates to the config detail screen with the selected configuration populated. Selecting "Start from Template" navigates to the same config detail screen with a default set of values populated.

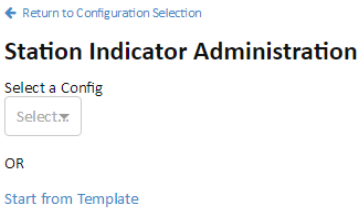


Figure 9.3**. Indicator Administration Start**

On the Station Indicator Administration detail page users can create or modify station configurations. Station configurations can be assigned to stations on the Station Detail screen (see Section 9.1).

The Station Indicator Administration detail page can set the configuration name, along with details for each quality indicator. For each quality indicator, users can adjust the limit label, and adjust the limit value. If the quality indicator value crosses a limit value, the indicator's status is assigned within that limit. See Figure 9.4 for an overview of the screen.

Users can also toggle email notifications for an indicator's limits. If a quality indicator value crosses a limit and the email notification is enabled for that limit, a notification is sent to the configured email address at the time of calculation. See Figure 9.5.

NOTE: A weekly summary of all indicators is sent regardless of notification settings in the configurations.

Once satisfied with the configuration, users can save the new configuration—or overwrite an existing configuration—by clicking the appropriate button (located under the "Config Name" field). For a description of an indicator configuration, see Figure 9.6.

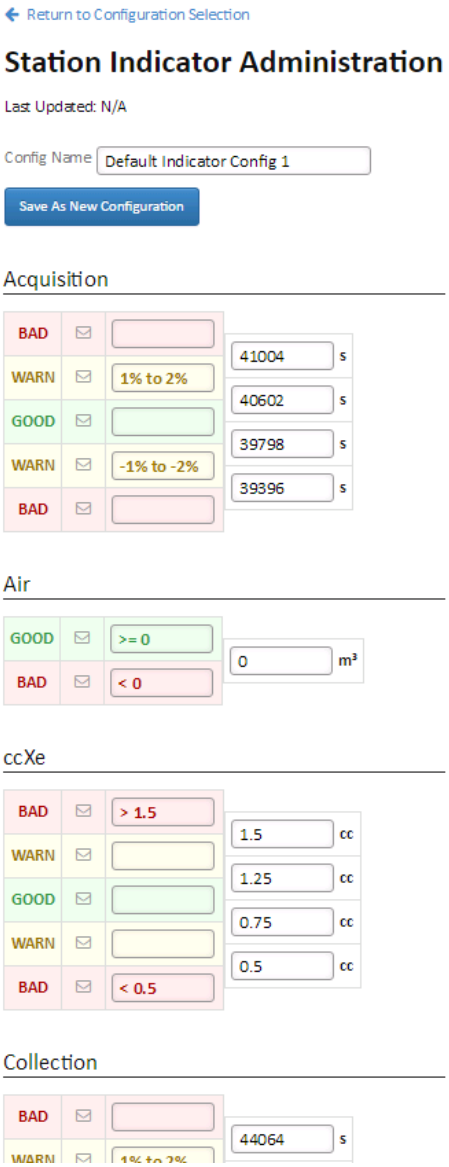


Figure 9.4. **Station Indicator Administration Configuration**

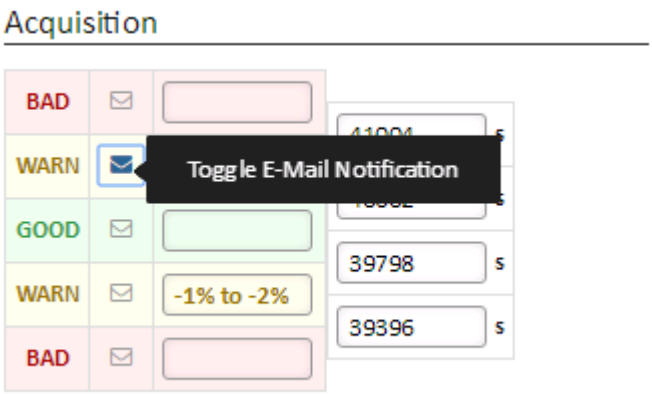


Figure 9.5. **Toggle E-mail Notifications**

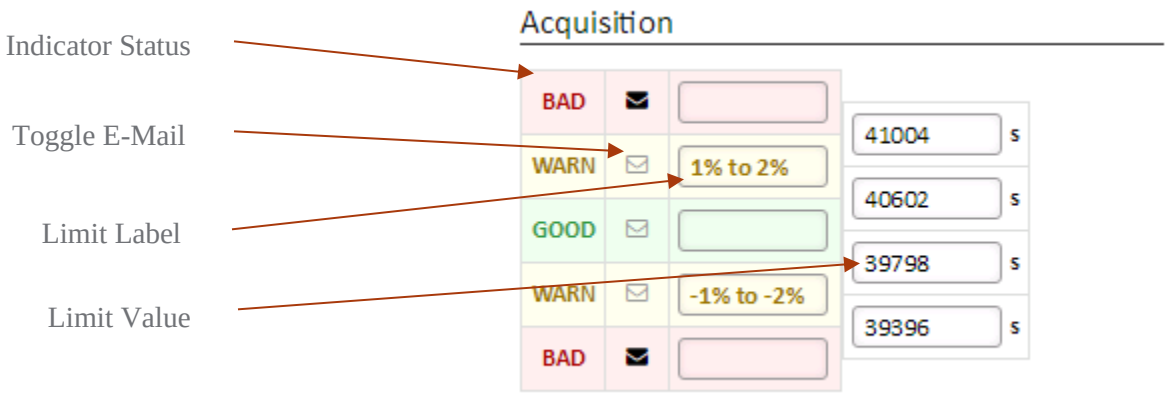
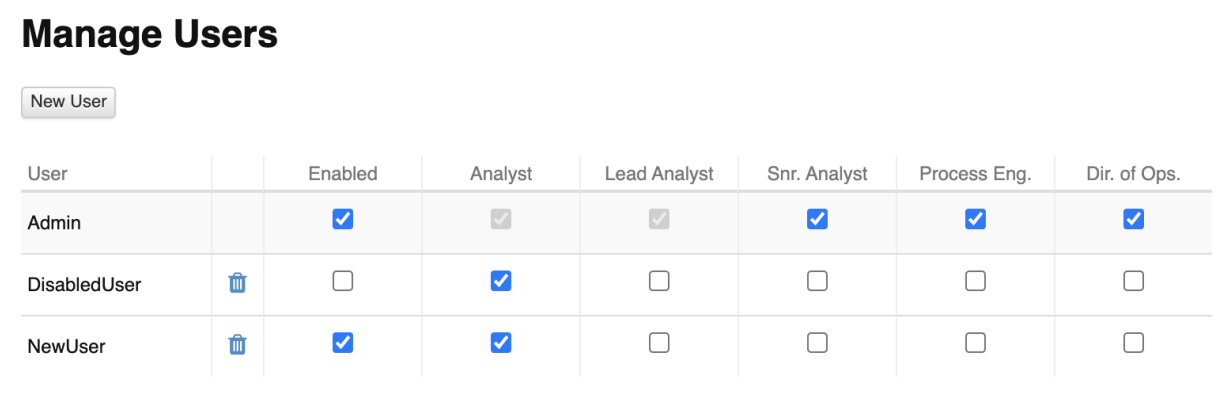


Figure 9.6. **Indicator Configuration Detail**

9.4 Users

The Manage Users screen is used to assign roles to users which controls which review queues they have access to.



NOTE: The new user button will be removed in a future version.

The first column shows common name of the user, hovering the mouse over the name shows the full name of the user if it is different.

The checkboxes can be used to select the roles (Analyst, Lead Analyst, Senior Analyst, Processing Engineer, or Director of Operations) a user is assigned. The Analyst role will be automatically added to a user granted the role(s) Lead Analyst, Senior Analyst, Processing Engineer, or Director of Operations. The Lead Analyst role will be automatically added to a user granted the Director of Operations role. Changes are saved automatically. Inherited roles will not be unchecked along with the heir role (e.g. unchecking Lead Analyst role will not uncheck the Analyst role). The “Enabled” role controls access to Watchmen; any user not enabled will be shown an error when trying to access Watchmen. A user is not assigned a role, besides “Enabled,” will be able to view measurements, but will not be capable of reviewing them. To remove an existing user, click the trash can to the right of the username. Only users without references (no assigned or reviewed measurements) in the Watchmen application can be deleted.

10.0 Information

By clicking on the question mark in the menu bar (), users can access the Information screen. This screen displays information about the Watchmen application. The information sections are defined in the following areas. See Figure 10.1 for an illustration of the information screen.

Server Information

Components

War

Version 2.3

Built 2017/01/24 20:36:40

Environment

Server Apache Tomcat/7.0.35

Java VM Name IBM J9 VM

Java VM Vendor IBM Corporation

Java VM Version 1.7.0

OS Name Linux

OS Version 2.6.32-131.0.15.el6.x86_64

Max Memory 1024 MiB

Total Memory 1024 MiB

Free Memory 317.4 MiB

Processors 8

Calculation Information

10 Region Calculation Definition Report

Legal

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operated by
BATTELLE
for the
UNITED STATES DEPARTMENT OF ENERGY
under Contract DE-AC05-76RL01830

Notice

```
This software bundles the following NPM packages:
backbone                          https://spdx.org/licenses/MIT
backbone-react-component          MIT (https://github.com/magalhas/backbone-react-component/blob/master/LICENSE-MIT
bootstrap                         MIT (https://github.com/twbs/bootstrap/blob/master/LICENSE)
d3                                BSD (https://github.com/mbostock/d3/blob/master/LICENSE)
filesaver.js                      https://spdx.org/licenses/MIT
flux                              https://spdx.org/licenses/BSD-2-Clause
font-awesome                      OFL-1.1 (http://scripts.sil.org/OFL), MIT (http://opensource.org/licenses/mit-lic
jquery                            MIT (https://github.com/jquery/jquery/blob/2.1.4/MIT-LICENSE.txt)
keymirror                         Apache-2.0 (http://www.apache.org/licenses/LICENSE-2.0)
leaflet                           https://spdx.org/licenses/BSD-2-Clause
```

Figure 10.1. **Information Detail**

10.1 Server Information

This identifies information about the web server hardware and versioning, as well as the software build date.

10.2 Calculation Information

This is a link to a PDF document that illustrates the 10-region calculation process for Watchmen.

10.3 Legal

This section is a legal software notice from PNNL operated by Battelle, sponsored by the U.S. Department of Energy.

10.4 Notice

This section reveals all third-party software licenses used in the Watchmen application.

10.5 Developer Information

This section contains a link to the development REST API for documentation.

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