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GMS Station SOH Configuration Tool User's Guide

Version 1.23 (for GMS PI 23 Open Source Release)

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ABSTRACT

This document is a user's manual for the Geophysical Monitoring System (GMS) Station State of Health (SOH) Configuration Tool.

Prepared by Sandia National Laboratories Albuquerque, New Mexico 87185 and Livermore, California 94550

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CHANGES FOR VERSION 1.23

Removed section with example showing how to use the SOH Config Tool to set up a station capability rollup configuration.

Updated all figures.

Section 2 – Updated description of software installation and deployment. Split installation and deployment instructions into two sections.

Section 4.2 – Updated description of reloading.

Section 4.4 – Updated description to include how to add, delete, and move station groups in list.

Section 6 – Added description of lack of help menu options.

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1. GENERAL OVERVIEW

The Geophysical Monitoring System (GMS) State-of-Health Configuration Tool (SOH Config Tool) is a web-based application that allows a user to configure the information used to calculate station SOH status.

The SOH Config Tool will primarily be used by the System Maintainer, who configures processing components that are part of a pipeline processing sequence, in this case the SOH configurations of stations. The System Maintainer uses the SOH Config Tool to configure which stations, channels, and monitors are used to calculate the 1) station capability SOH statuses and 2) worst-of SOH statuses of available stations (Section 4).

There are 19 different monitors that can have threshold data configured for each Channel:

- Missing data – the percentage of missing data over a configurable time window
- Timeliness – the time difference (in seconds) between the current time and the most recent time a data sample that has been acquired
- Lag – worst transmission time (i.e., lag, in seconds) over a configurable time window
- Environmental issues – percentage of time a specific Environmental issue has a status of BAD over a configurable time window. In total, there are 16 possible types of environmental issue, including Vault Door Opened and Authentication Seal Broken. See Appendix B for a full list of available environmental issues.

The SOH Config Tool allows the user to configure how SOH statuses are calculated for stations and station groups. Parameters such as time intervals, channels, monitors, and monitor thresholds are all available for configuration.

2. THIS DOCUMENT IS AN IN-DEPTH USER'S GUIDE OF THE SOH CONFIG TOOL, INCLUDING BROWSER REQUIREMENTS AND AN OVERVIEW OF THE INTERACTIONS ALLOWED IN THE TOOL. DEPLOYMENT AND INSTALLATION

2.1. Creating a deployment

To use the SOH Config Tool application, the user must first generate a GMS config deployment. This deployment provides the URL needed as input for the SOH Config Tool (see Section 4.2). The following instructions assume the user has the 1.23 version of the gmskube tool installed. See the Command-Line Utilities file for details on gmskube.

1. Open a terminal on a machine with gmskube installed.

2. Set the cluster to deploy to by running kubeconfig {ClusterName}

    a. e.g., run **kubeconfig mycluster**

3. Install the deployment by running gmskube install --type config --tag {TAG NAME} {DEPLOYMENT NAME}, where TAG NAME identifies the GitLab branch to deploy from (e.g., develop) and DEPLOYMENT NAME is a user input defining the name of the URL to be generated.

    a. e.g., run **gmskube install --type config --tag 1.23 soh-config**

4. Run gmskube ingress {DEPLOYMENT NAME} and copy the output URL up to the port number. This URL will be input into the SOH Config Tool UI by the user.

    a. e.g., run **gmskube ingress soh-config**

    b. For example, for output URL https://soh-config.mycluster.provider.com:31209/user-manager-service, copy https://soh-config.mycluster.provider.com:31209

    c. The copied URL will be pasted into the Settings Page of the SOH Config Tool (see Section 4.2).

    d. Without the port number, the SOH Config Tool will freeze when trying to read in data, so make sure to include the port.

If the deployment remains installed, the generated URL can be used in the SOH Config Tool. If the deployment is uninstalled (see the 1.23 Command-Line Utilities file), a new URL will have to be generated by the user by repeating steps 1-4.

3. INSTALLATION INSTRUCTIONS:

1. From the top-level directory of the gms-common repository, navigate to the following directory:

    ```
    /test/gms-soh-config-tool
    ```

2. In the gms-soh-config-tool directory, execute the following commands:

    ```
    a. yarn

    b. yarn electron:build
    ```

3. This will create a new directory named *dist*. Navigate to the *dist* directory. There should be a file named *SOH-Config-UI-0.1.0.AppImage* . Run the SOH configuration Tool by double-clicking the application from a file explorer or with the following command:

```
./SOH-Config-UI-0.1.0.AppImage --no-sandbox
```

You are now ready to configure the tool's settings as described in Section 4.2

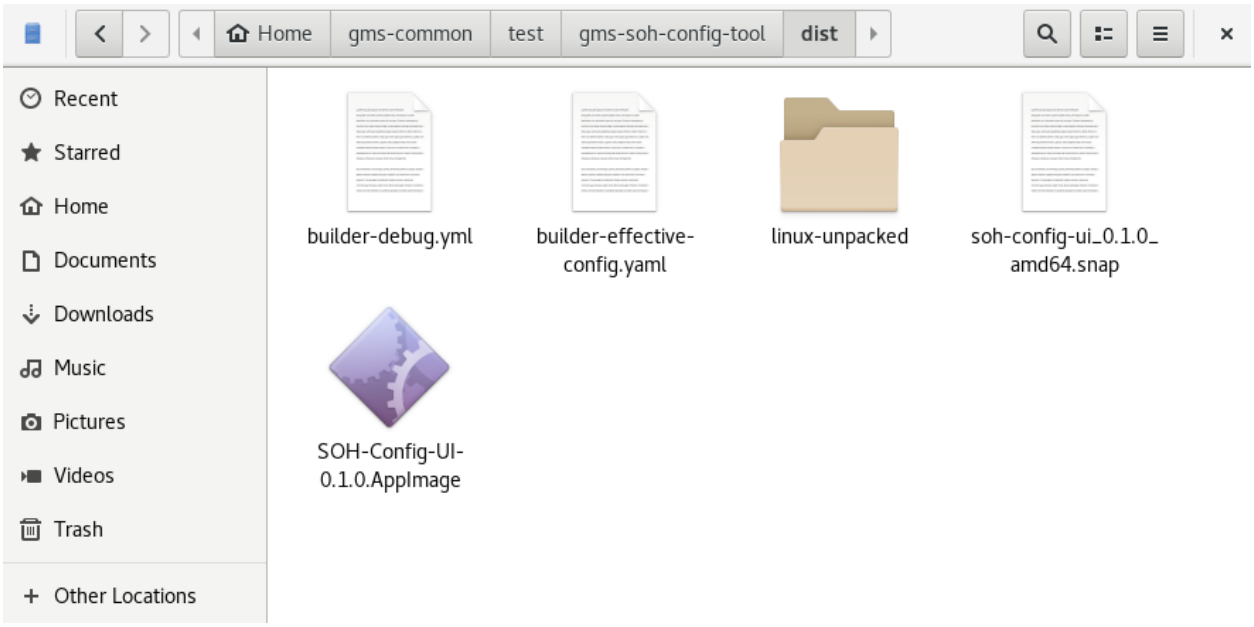

Figure 1. SOH Config Tool Executable in File Manager.

4. SOH CONFIG TOOL INTERACTIONS

The following sections will go over SOH Config Tool settings and available interactions.

4.1. General Toolbar

The user can quit the tool, modify the SOH Config Tool view, modify window size, and look up useful hotkeys (see Appendix C for full list) using the general toolbar located at the upper-left of the SOH Configuration Tool (Figure 2).

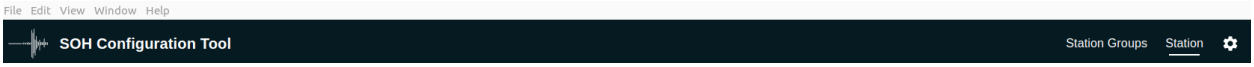

Figure 2. General SOH Configuration Tool Toolbar.

To use the toolbar, click on the menu of interest to pull up a list of available actions and their corresponding hot key combinations (see Appendix C). From this list of actions, the user can click on the desired action or enter its hot key combination.

Except for the View menu, the options under these toolbar menus are typical of most UIs, with options to quit the tool, edit input text, and modify window size. Note that the undo/redo options under the Edit menu are exclusively used to undo/redo text entries. They cannot be used to undo/redo user interactions. Additionally, the Help menu is empty (Section 6).

It is assumed that the user has familiarity with these menus and their options; this section will only go into detail about less familiar options in the View menu (Figure 3).

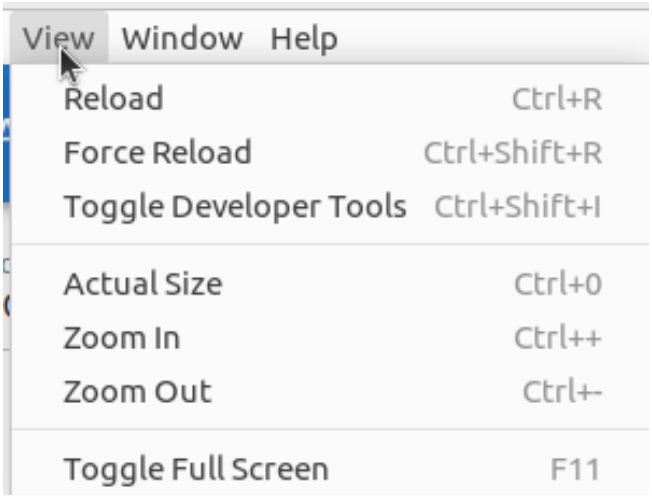

Figure 3. View Menu.

The Reload option can be used to refresh the SOH Config Tool by resetting any values input or modified by the user back to their initial state. Force Reload accomplishes the same task as

Reload but can be used if the SOH Config Tool is in a state that does not allow for a smooth Reload.

The option Toggle Developer Tools will open an additional window that allows the user to access tools intended for developer usage only (Figure 4). It is recommended that typical users NOT use the Developer Tools Window.

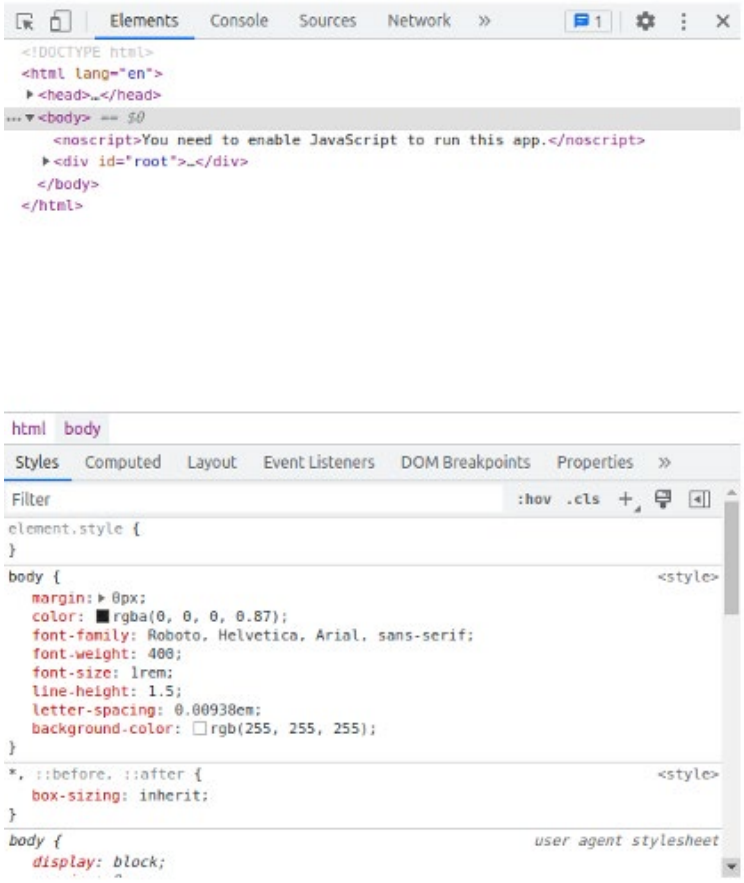

Figure 4. Developer Tools Window.

4.2. Settings Page

When a user opens the SOH Config Tool for the first time, they must input their settings in the Settings Page (Figure 5). To access the Settings Page, select the gear icon in the upper right corner of the SOH Config Tool.

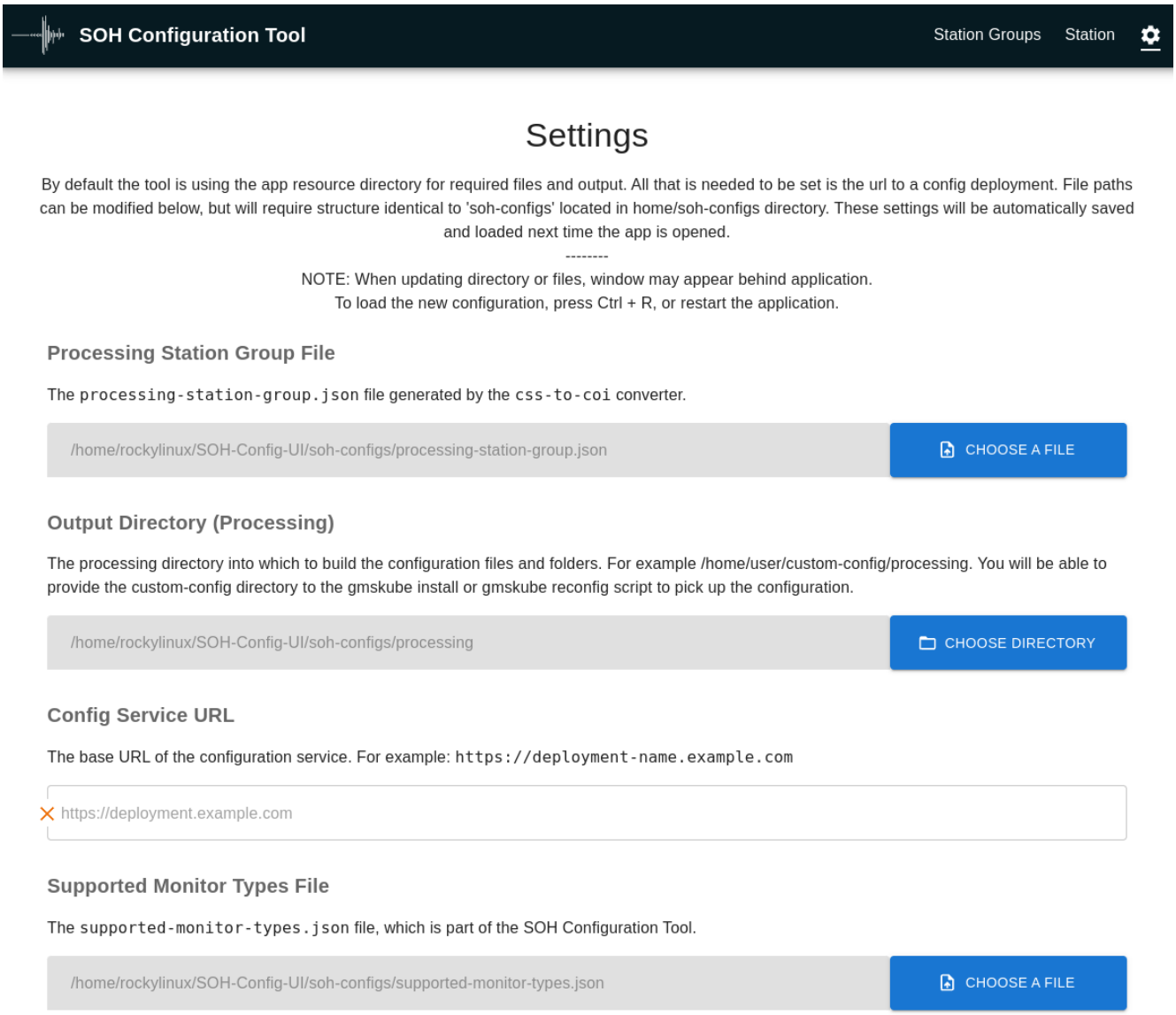

Figure 5. Settings Page.

Available settings on this page include:

1) Processing Station Group File – path to the *processing-station-group.json* file. By default, this field will point to *~/SOH-Config-UI/soh-configs/processing-station-group.json*.

    a. This json file contains the list of stations available for configuration as well the channels for each station. The file is automatically generated by the css-to-coi converter based on a corresponding set of metadata (saved as .dat files) and response files (in FAP format) for each station. Refer to the Command-Line Utilities file for details on how to run the css-to-coi converter.

i. Station metadata used to create the processing-station-group.json files can be found in */docker/PI23/1.23/config/station-reference/data/* where each station has a corresponding folder.

ii. The user needs the delivered code (version 1.23) copied onto their local machine from gms-repos to access this metadata. That code is located on gms-repos at the directory referenced above.

b. To add new stations:

i. Copy the *gms-common/config/station-reference/data* folder into the *{Output Directory}/station-reference* folder (see bullet 2 for definition of Output Directory).

ii. Add a folder containing the new station metadata to *gms-common/config/station-reference/data*.

iii. Change directories to {*Output Directory}/station-reference/stationdata*, if it exists, and delete all the files in this directory, as they will be regenerated. If the folder does not exist, create the folder prior to running the css-to-coi converter.

iv. Finally, run the css-to-coi converter to regenerate these files and to create a new *processing-station-group.json* file, which should now contain the new station information (see bullet 1). Refer to the 1.23 Command-Line Utilities file for details on how to run the css-to-coi converter.

2) Output Directory – path to the processing configuration directory where generated configuration files and folders are to be saved. By default, the output directory is *~/SOH-Config-UI/soh-configs*.

Once a desired processing configuration is saved, that configuration can be reloaded by passing the output directory to either of the following commands:

a. **gmskube install --type soh --tag {TAG} --config ~/SOH-Config-UI/soh-configs {DEPLOYMENT NAME}**

b. **gmskube reconfig --config {USER SAVED LOCATION} {DEPLOYMENT NAME}**

The default {USER SAVED LOCATION} is: *~/SOH-Config-UI/soh-configs*

   c. Each simultaneous user of the SOH Config Tool should have their own copy of the Output Directory. This tool has not been designed for multiple users interacting with the same output directory at the same time.

3) Config Service URL – URL of the configuration service deployment generated in Section 2.1.

   a. The configuration service deployment is used by the SOH Tool to resolve configuration. Each simultaneous user of the SOH Config Tool should have their own configuration service deployment. This tool has not been designed to support multiple users interacting with the same configuration service deployment at the same time.

4) Supported Monitor Types File – path to the *supported-monitor-types.json* file. By default, this field will point to *~/SOH-Config-UI/soh-configs/supported-monitor-types.json*.

   a. This json file is used by the SOH Config Tool to configure which monitor types are supported by the tool. Only environmental issues, lag, timeliness, and missing are allowed.

   b. This file is provided with the SOH Config Tool.

   c. This file should not be modified unless there have been changes to the monitor types supported by SOH.

As stated at the top of the Settings Page (Figure 5), the user only needs to manually set the Config Service URL. Once the URL is set, the rest of the fields will automatically be populated based on the structure of the *soh-configs* directory. These other fields can be modified to a user-desired path; however, they must be placed in a directory structure identical to the automatically generated *soh-configs* directory.

If the Config Service URL input by the user is valid, a green checkmark will show to the left of the context box. Otherwise, a red x will be shown until the user inputs a valid URL.

Once all settings are in place, the user can begin to generate user-defined configurations via the actions described in Sections 4.3 and 4.4. As indicated on the page, the Config Service URL input by the user, along with its related settings, will automatically be saved and loaded by the tool the next time it is opened.

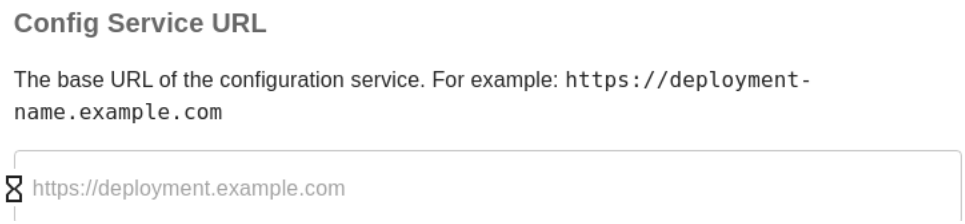

Figure 6. Loading Config Service URL.

The Config Service URL may take a moment to load. During loading, the user will see the hourglass icon in Figure 7.

Finally, if the user has set up a configuration via the actions described in Sections 4.3 and 4.4, but would like to load a new configuration, i.e., clear all entries, the user can 1) use the Ctrl + R hot key combination, 2) go to the View menu (Figure 3) and select Reload or Force Reload (Section 4.1), or 3) restart the application. If any of these actions are performed, the configuration entries described in Sections 4.3 and 4.4 are set back to their last saved state.

4.3. Station Configuration Page

Once the desired settings are in place, click the Station option in the upper-right corner of the SOH Config Tool to access the Station Configuration page (Figure 8).

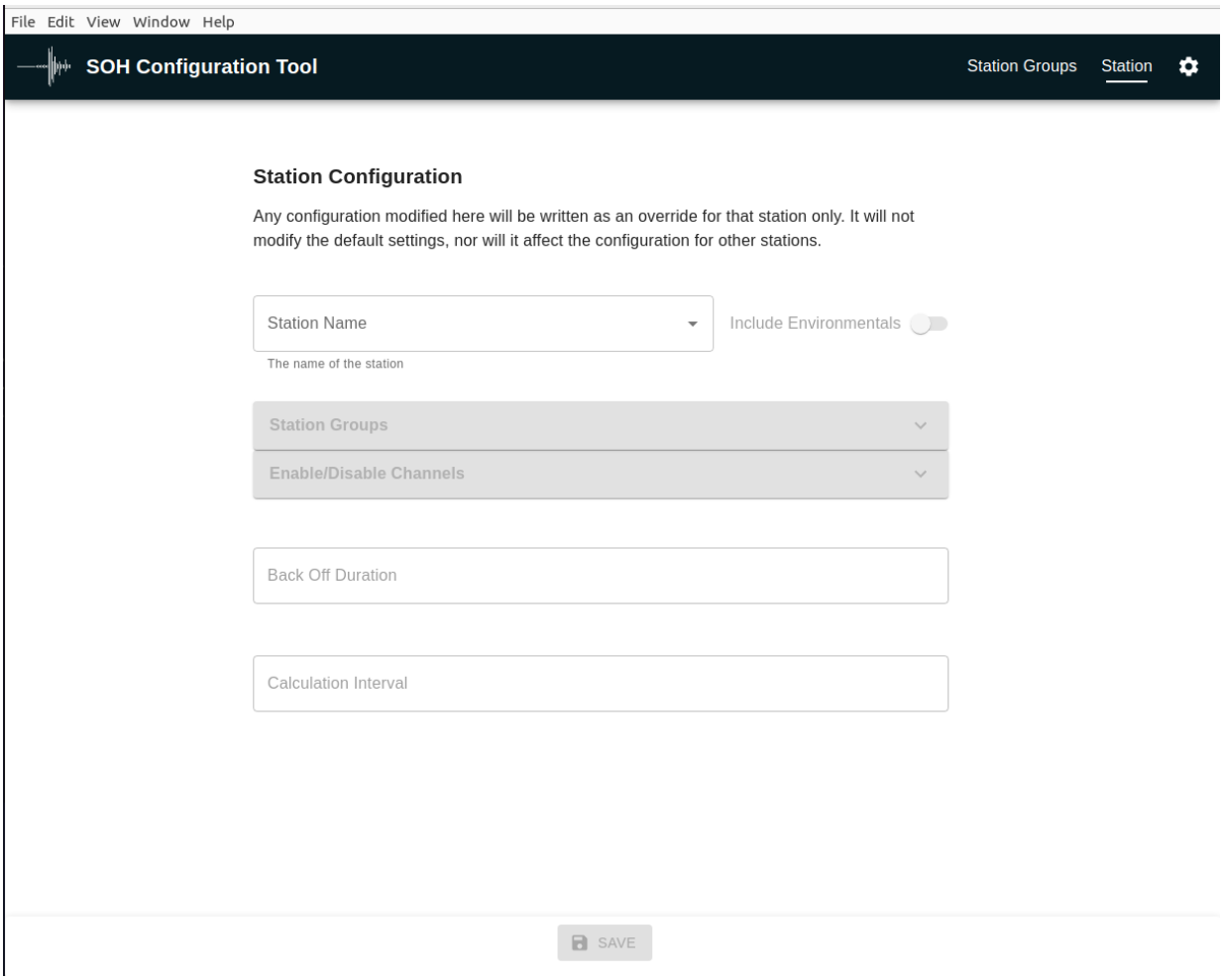

Figure 7. Station Configuration Page.

This page will be used to set and save the different configuration parameters used to calculate a station's 1) worst-of SOH status and 2) capability SOH status. A station's worst-of SOH status notifies the user of the severity of the worst issue on that station. A station's capability SOH status helps prioritize which issues to troubleshoot first, based on a station's importance to a configured capability. In-depth descriptions of worst-of SOH status and capability SOH status calculations are provided in Appendix A.1 and Appendix A.2, respectively.

When the Station Configuration page is initially opened, all fields will be unpopulated. To populate the page, the user must select a station by clicking on the Station Name context box. This action brings up the dropdown menu shown in Figure 9, which lists all available stations as defined by the *processing-station-group.json* file (see Section 4.2, bullet 1).

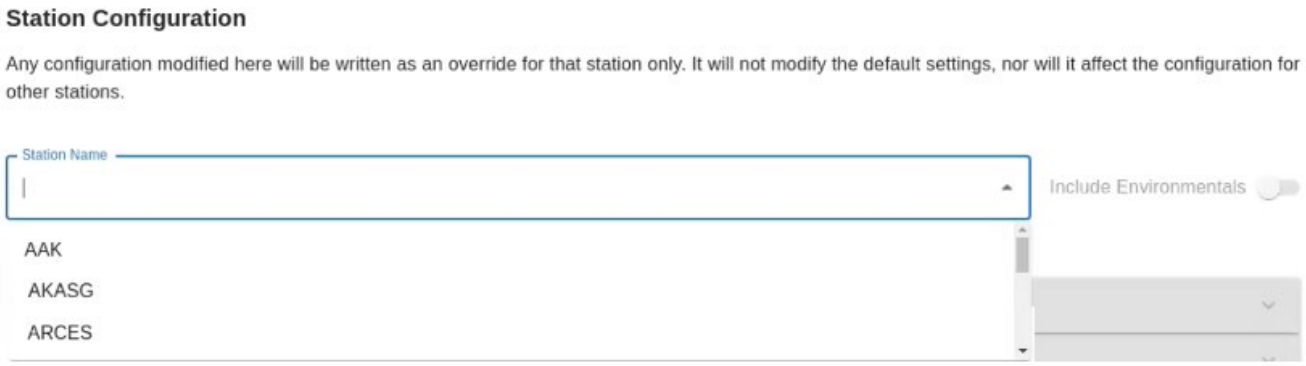

Figure 8. Station Name Dropdown Menu.

The user can scroll through the dropdown menu and select the desired station. Alternatively, the user can enter all or part of a station name in the context box to filter the station list, then select the desired station.

If an unavailable or invalid station name is entered, a warning indicating there are "No options", i.e., no stations, is printed to screen and the user will be unable to select. Clicking away from the dropdown menu will cause the entry to revert to the last valid station name. Finally, the user can clear the entered station name by hovering over the right of the Station Name dropdown menu and clicking the x that appears.

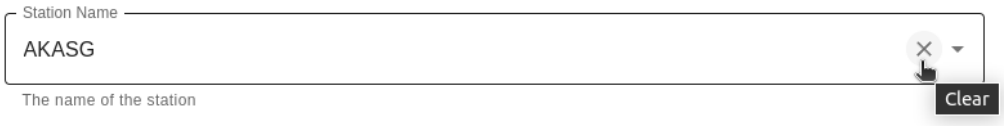

Figure 9. X Button to Clear Station Name.

When a station is selected, a blue circle loading icon will appear in the display until all metadata and default configurations associated with that station are loaded. When populated, the Station Configuration Page will appear as shown in Figure 11.

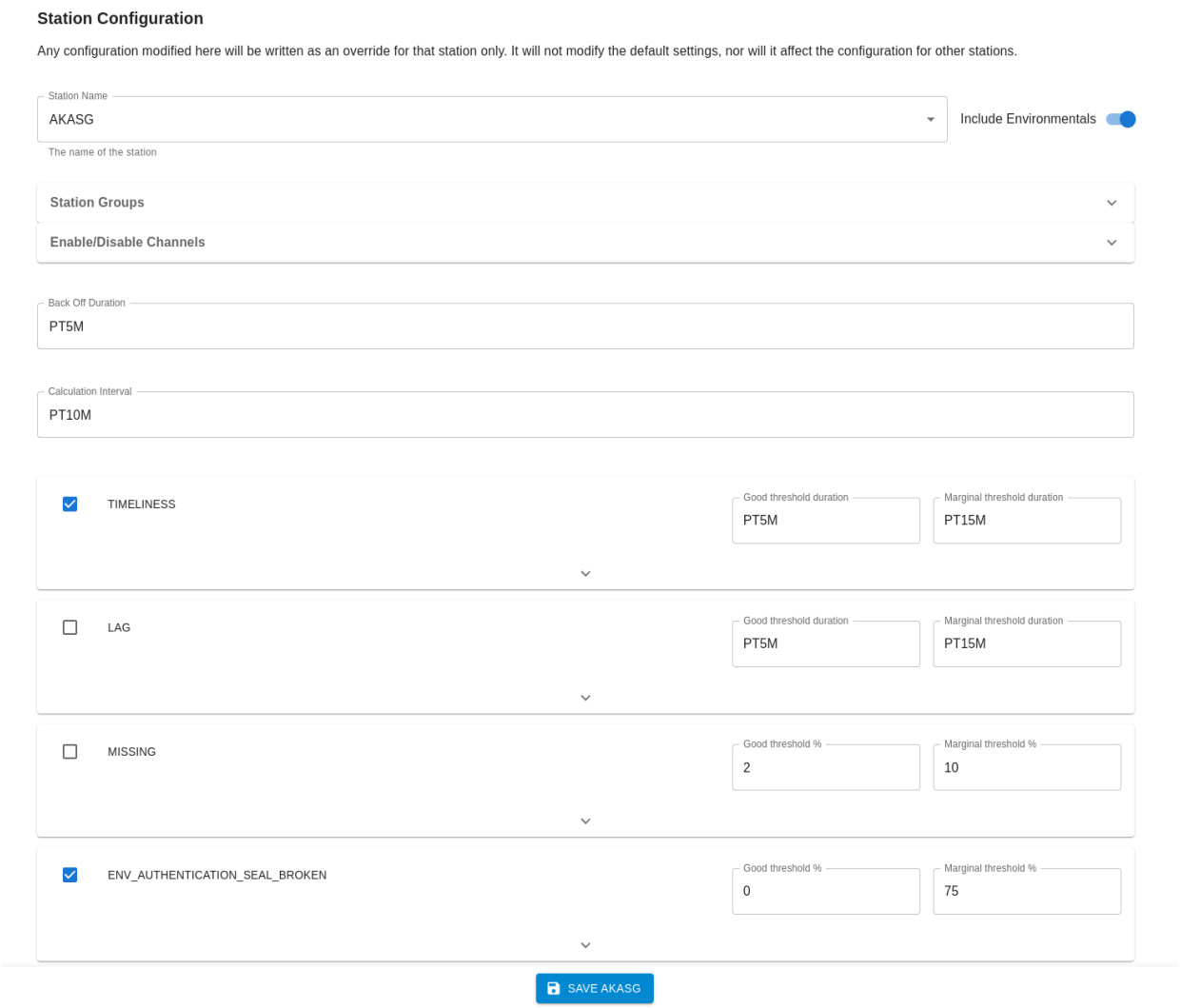

Figure 10. Station Configuration Page with Station AKASG Selected.

Once all defaults are loaded into the SOH Config Tool on initial startup, the user can scroll down in the Station Configuration Page to select/modify the desired parameters for that station via dropdown menus, check boxes, and context boxes. These menus will be described in the order they appear from top to bottom in later sections. The user can hover over the upper-left corner of any context box, except for the Station Name box, to bring up an information icon. Hovering over this icon will print to screen a tooltip briefly describing the usage of that context box, e.g., Figure 12.

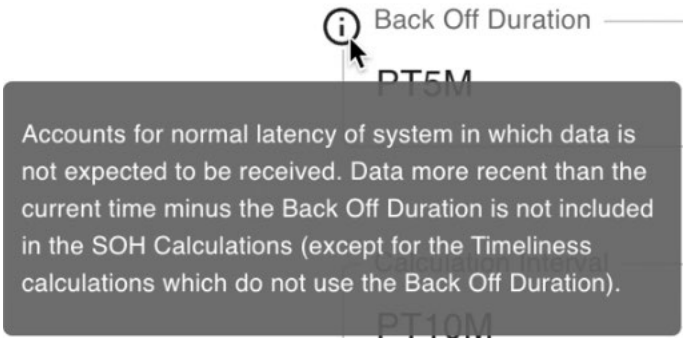

Figure 11. Example Info Icon and Tooltip for Back Off Duration Menu.

The default configurations loaded on initial startup are defined in several *default.json* files, each defining a separate component of the configuration. For instance, one *default.json* file defines the time windows used in SOH status calculations while another defines monitor thresholds used. Additionally, *{StationProfileName}.json* files may be used to define default configurations for a set of stations instead of just one station. For example, json files named *SEISMIC-CD11.json* are used to define default configurations for the set of seismic stations that send data in the native CD1.1 format.

These files are stored under *~/SOH-Config-UI/soh-configs/processing* in several folders structured as shown in Figure 13.

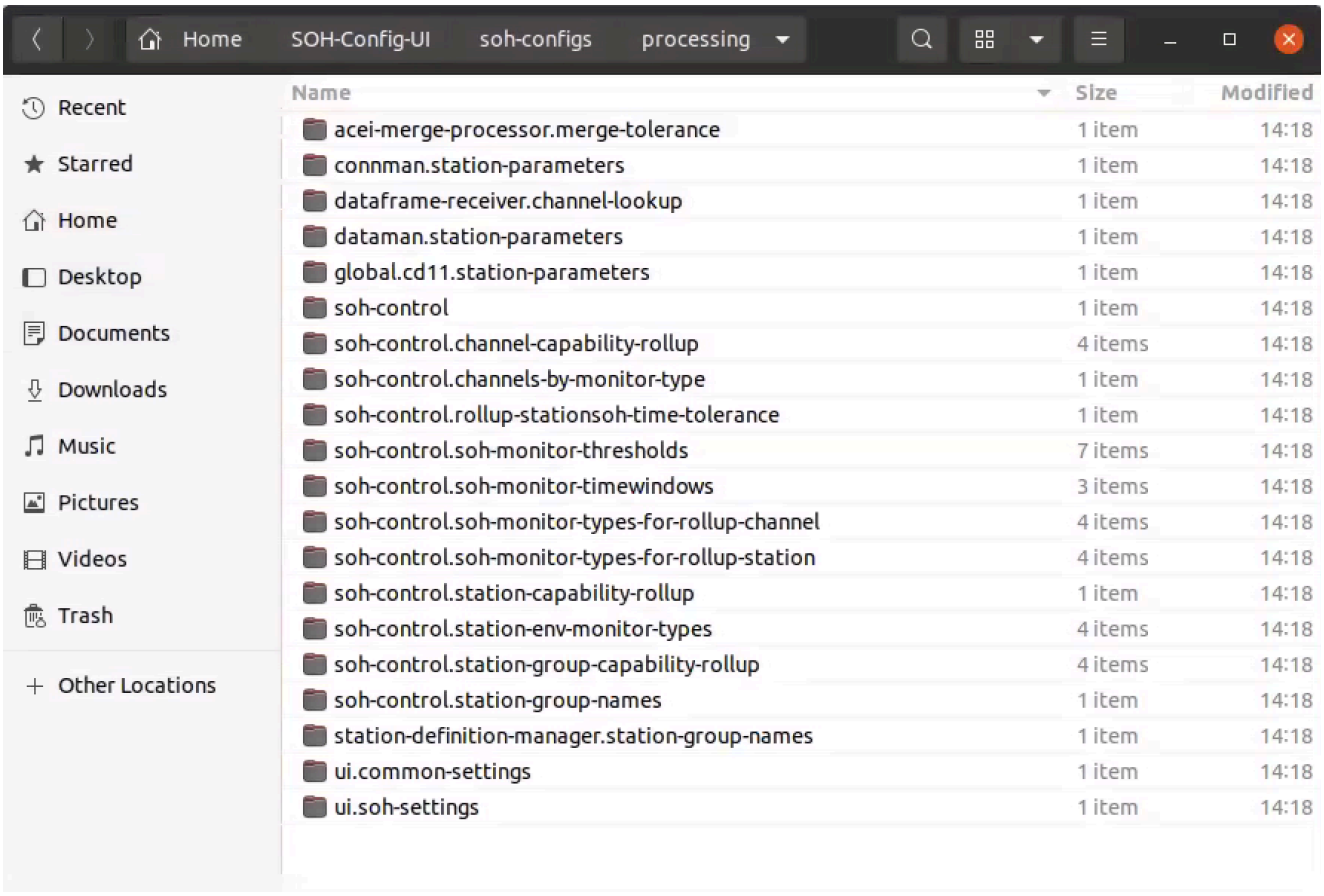

Figure 12. SOH Config Tool Processing Directory Structure.

Each folder, with the exception of *ui.common-settings* and *ui.soh-settings*, will contain a *default.json* and/or *{StationProfileName}.json* files pertaining to just one type of configuration, as indicated by the folder name.

For example, the *soh-control.soh-monitor-timewindows* folder contains a *default.json* file that configures time windows to be used in SOH status calculations (see Section 4.3.5). Additionally, *SEISMIC-AUX.json* and *SEISMIC-AUXDELAY.json* files are included; these configure time windows for the specific stations listed within each file. Stations belonging to neither *SEISMIC-AUX.json* nor *SEISMIC-AUXDELAY.json* are assigned time windows from *default.json*.

Note that *default.json* and *{StationProfileName}.json* files will never be generated, modified, or deleted by the SOH Config Tool. New configurations will be stored in separate json files as will be described below. Because these default files cannot be regenerated by the tool, it is imperative the user DOES NOT delete any *default.json* or *{StationProfileName}.json* files. If these are deleted, they will have to be manually regenerated or copied from a local save.

When generated, user-defined configurations will also be saved in the directory structure shown in Figure 13. These configurations are saved as *{StationName}.json* file(s) in the relevant folder(s). For instance, if the user configures the time window of station AKASG and saves the new configuration, a file named *AKASG.json* will be saved to the *soh-control.soh-monitor-timewindows* folder in Figure 13. When a json file is saved, the SOH Config Tool briefly prints out the save path at the top of the display. Note that the most recent user-defined configuration json file saved by the user will overwrite the previous save.

User-generated configuration files will always take precedence over default json files in the SOH Config Tool. Thus, the tool will automatically load user-defined configurations when available, unless the user-defined configuration file(s) (e.g., *AKASG.json*) is removed from the relevant folder(s). The user can manually remove unwanted user-generated json file(s) from the relevant folders (do NOT remove *default.json* files when performing this action) and reload or restart the SOH Config Tool (Section 4.2) to return to default; however, this is not recommended. Instead, the user can remove a user-defined configuration file(s) by restoring any changed value(s) back to the default and saving via the Station Configuration page. This action will cause the SOH Config Tool to automatically remove user-generated json file(s) corresponding to the value(s) restored to the default.

To save user-generated configurations, the user will click the Save button (Figure 14) located at the bottom of the Station Configuration page.

Figure 13. Save Button for Station AKASG.

If the user changes a station's configuration, then switches to a different station before saving those changes, a warning message will appear that prompts the user to either discard the unsaved changes or cancel the action (Figure 15).

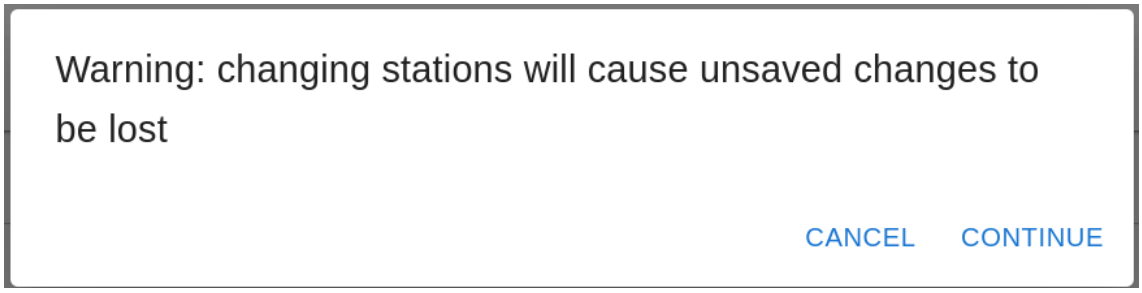

Figure 14. Warning Message Indicating Loss of Unsaved Changes.

If there are any invalid entries in the Station Configuration page, the user will be unable to save. This invalid state will be indicated by the Save button, which is now shown in red (Figure 16).

The cause(s) of the invalid state can be printed to screen by hovering over the exclamation point icon in the upper-left corner of the Save button (Figure 16).

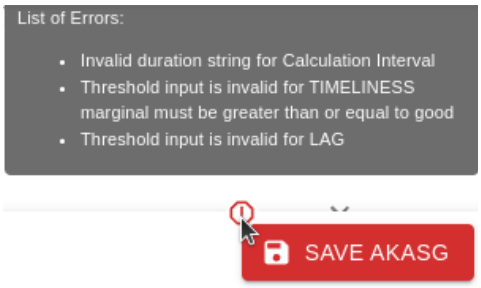

Figure 15. Save Button with Error List Printed to Screen.

This list points the user to each error made; these errors may occur in any of the configuration pages in the SOH Config Tool. The error list additionally provides guidance on how to address the error(s). Errors can include invalid string entries or invalid threshold settings. Until all errors are addressed, the Save Button will remain red and the ability to save files will be disabled. As errors are addressed, the list of errors will automatically update to remove messages pertaining to fixed errors. Once all errors are addressed, the Save button will become blue again, the error list icon will no longer be available, and the ability to save will be restored.

In addition to the error list shown in Figure 16, invalid entries are indicated to the user by highlighting the offending menu(s) in red as shown in Figure 17. In some cases, in addition to highlighting the error, a short error message is printed out to the screen (e.g., the 'Invalid duration string' message printed in Figure 17).

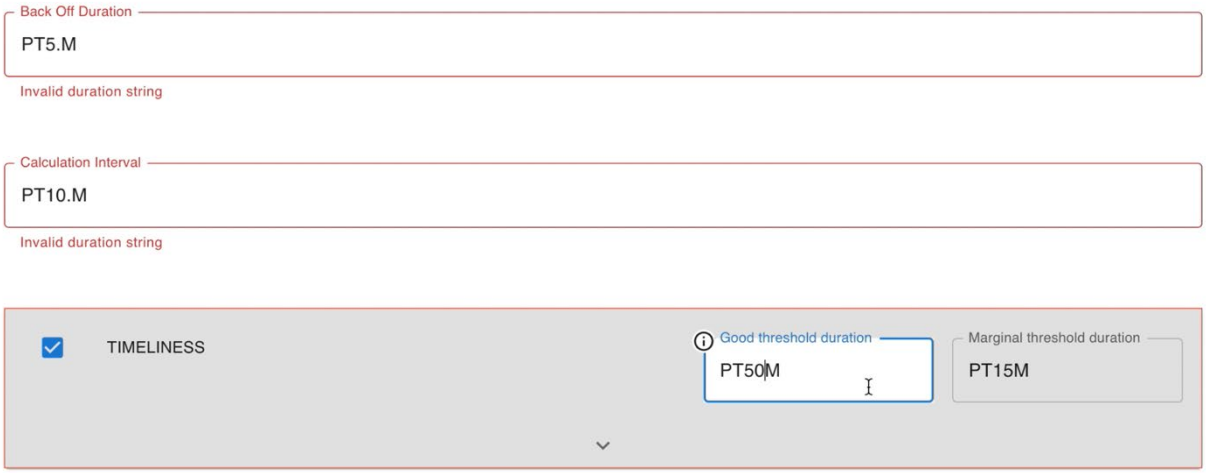

Figure 16. Example Invalid SOH Config Tool Entries.

Having described general features of the Station Configuration page, the following sections will describe each remaining menu and its interactions in detail.

4.3.1. Station Groups Dropdown Menu

A station belongs to at least one or more station groups by default. The Station Groups dropdown menu (Figure 18) allows the user to select which groups the station should be included in when doing SOH status calculations. To expand or contract this menu, click anywhere on the Station Groups bar.

Figure 17. Station Groups Dropdown Menu.

When expanded, the user will be provided a list of available station groups. Any group the selected station belongs to will be represented by a check mark. A single station can belong to multiple groups. For example, in Figure 18 station AKASG belongs to the station groups CD1.1, Secondary, and SEISMIC. The user can check or uncheck any station group to include or remove the selected station from that group; the only exception to this is station group ALL. ALL is defined to always include all stations as part of the station group definition. Thus, the check box by ALL is disabled such that a station can never be removed from this group. If the user hovers over the ALL group, a tooltip will appear that informs the user that they cannot make this deselection.

If a user checks/unchecks a station group, e.g., CD1.1, a warning will pop up (Figure 19).

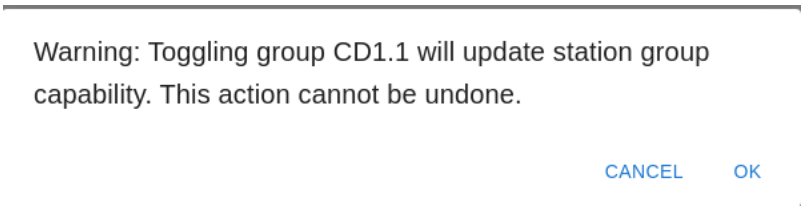

Figure 18. Station Group Modification Warning.

The user can choose to continue the action or press cancel so no change occurs. Note that checking/unchecking a station group in this menu will cause the station to be added/removed from that station group in the Station Groups Page; see Section 4.4 for details.

Under each of the selected station groups, worst-of and capability SOH statuses for the selected station are calculated. While the worst-of SOH status calculations for the selected station will not vary between groups, the capability SOH status for the selected station can be made unique under each station group. Thus, if station AKASG has a worst-of SOH status of BAD, its status will be BAD in all groups AKASG belongs to. At the same time, AKASG can be configured to have a capability SOH status of GOOD in station group ALL, MARGINAL in station groups CD1.1 and Secondary, and BAD in station group SEISMIC, for instance.

When a station group is selected, a pencil (edit) icon appears to the right of the station group name along with the station capability rollup configuration used to calculate the station's capability SOH status under that station group. For example, in Figure 18, AKASG inherits its capability SOH status from the BEST_OF_ALL_CHANNELS in station group CD1.1. By clicking the edit icon, the user opens the Station Capability Rollup page. This page is used to set up and save the capability rollup SOH configuration for the selected station (e.g., AKASG) under the selected station group (e.g., CD1.1).

Note that if the station capability rollup configuration for a station under a station group is changed using the Station Capability Rollup page, that station group's label will be updated in the Station Group Dropdown Menu. For instance, if the station capability rollup configuration for AKASG under group CD1.1 was modified by the user to be a worst-of rollup of all channels, CD1.1's label would change to WORST_OF_ALL_CHANNELS in Figure 18. The functionalities of the Station Capability Rollup page are described in detail in Section 4.3.2.

4.3.2. Station Capability Rollup Page

In the Station Capability Rollup page (Figure 20), menus are provided to allow the user to modify the Station Capability Rollup configuration for a selected station/station group pair (e.g., AKASG in CD1.1 in Figure 20).

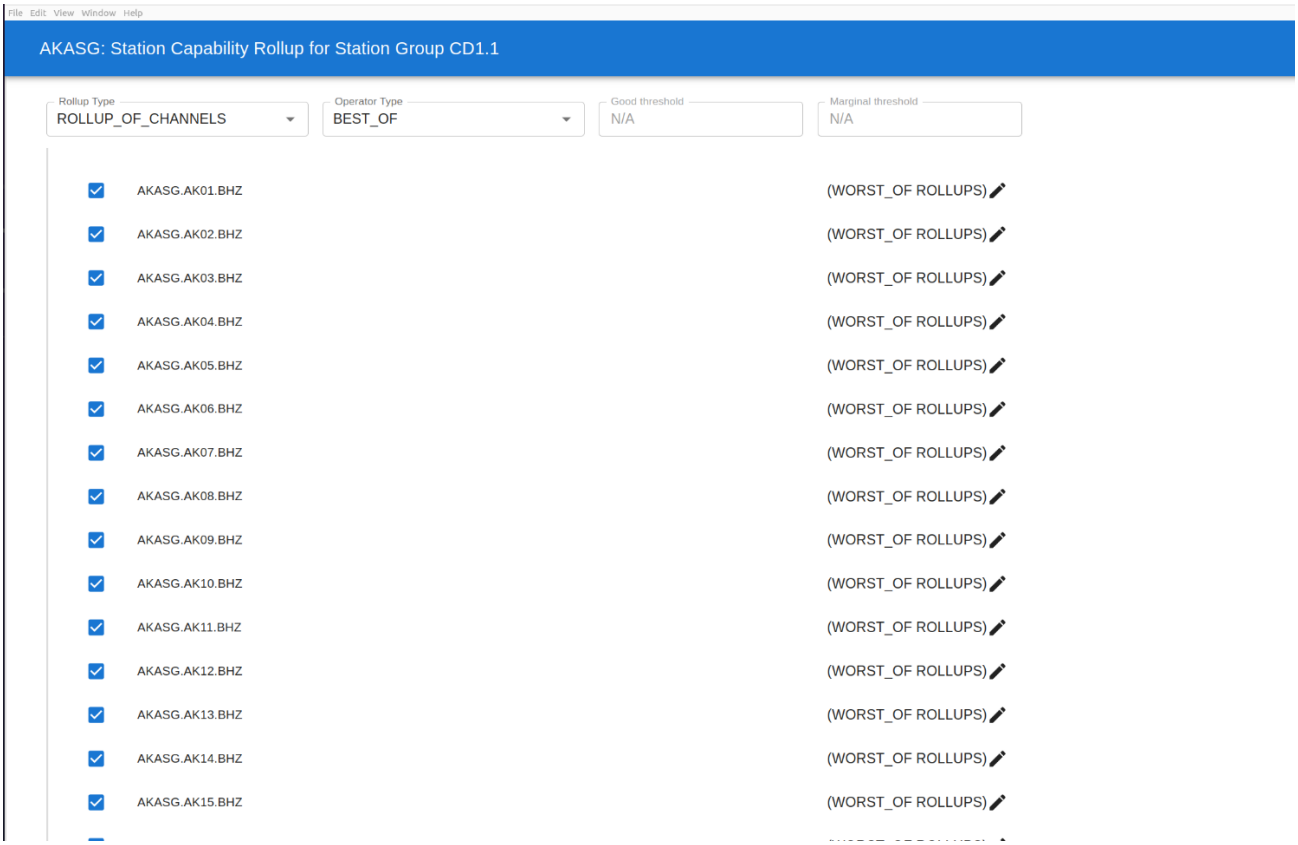

Figure 19. Default Station Capability Rollup Page for Station AKASG.

When this page is first opened, it is populated with values from the configuration files for the selected station/station group pair. As in the main Station Configuration Page, when a user saves a new configuration, the *{StationName}.json* files will take precedence over *{StationProfile}.json* files and/or *default.json* files and will be read by the SOH Config Tool until the user removes the *{StationName}.json* file (see Section 4.3).

The user will use the following options to set up the desired Station Capability Rollup configuration for the selected station/station group pair:

1) Rollup Type – Defines the type of rollup to be performed. There are two types:

   a) ROLLUP_OF_CHANNELS – Perform an SOH capability status calculation based on the status of the selected channels and the chosen operator type (see bullet 2)

b) ROLLUP_OF_ROLLUPS – Perform an SOH capability status calculation based on statuses rolled up by prior SOH capability SOH status calculations and the chosen operator type (see bullet 2)

2) Operator Type – Sets the type of criteria to apply to an SOH status to determine whether it is rolled up to the next level. There are three available rollup operators that can be applied:

   a) BEST_OF – Rolls up the status of the best available monitor, channel, station, or rollup

   b) WORST_OF – Rolls up the status of the worst available monitor, channel, station, or rollup

   c) MIN_GOOD_OF – Rolls up the status of a monitor, channel, station, or rollup based on whether there are enough monitors, channels, stations, or rollups with a good status to meet or exceed the marginal or good thresholds set by the user

      i) See Appendix A.2 for examples of how BEST_OF, WORST_OF, and MIN_GOOD_OF operators are applied to determine capability rollup SOH status

3) Good Threshold – threshold used by the MIN_GOOD_OF operator to determine an SOH status. This context box will read N/A and be grayed out if the defined operator is not MIN_GOOD_OF

4) Marginal Threshold – threshold used by the MIN_GOOD_OF operator to determine an SOH status. This context box will read N/A and be grayed out if the defined operator is not MIN_GOOD_OF

In the example in Figure 20, the station capability SOH status will inherit the value of the channel with the best capability SOH status. For example, if the best status amongst AKASG's channels in station group CD1.1 is MARGINAL, station AKASG will inherit a capability SOH status of MARGINAL in CD1.1. The user can modify this default configuration via several actions described below.

To include or exclude specific channels from the station capability rollup calculation, the user can check or uncheck the checkbox next to the desired channel name(s). To check or uncheck all channels at once, hover over the upper left corner of the Rollup Type context box to bring up the check all and uncheck all buttons (Figure 21); then click on the desired button. If all channels are unchecked, the user will see warning indicators such as those in Figure 16, Figure

17, and Figure 23, as a ROLLUP_OF_CHANNELS needs at least one channel to be selected in order to perform its capability SOH status calculation.

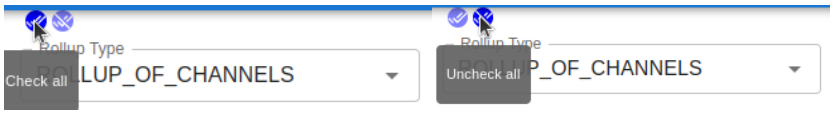

Figure 20. Buttons to Check (Left) and Uncheck (Right) All Channels.

The Rollup Type must be set to ROLLUP_OF_CHANNELS, for the check/uncheck buttons to be available. Further, if a channel is disabled in the main Station Configuration Page using the Enable/Disable Channels menu (Section 4.3.4), that monitor will be disabled in the Station Capability Rollup Page; if the user tries to enable the channel in this page, a tooltip indicating the user must enable the channel using the Enable/Disable Channels dropdown menu is printed to screen. See Section 4.3.4 for further details.

When a channel is selected, a pencil (edit) icon appears to the right of the channel name along with the channel capability rollup configuration used to calculate the channel's capability SOH status under that station/station group pair. For example, in Figure 20, AKASG.AK01.BHZ inherits its capability SOH status from the WORST_OF_ROLLUPS under station group CD1.1. By clicking the edit icon, the user opens the Channel Capability Rollup page. This page is used to set up and save the capability rollup SOH configuration for the selected channel (e.g., AKASG.AK01.BHZ) under the selected station group (e.g., CD1.1). The Channel Capability Rollup page will be described in the following section.

The Rollup Type and Operator Type can be changed by clicking the respective context box and selecting an option from the resulting dropdown menu (Figure 22).

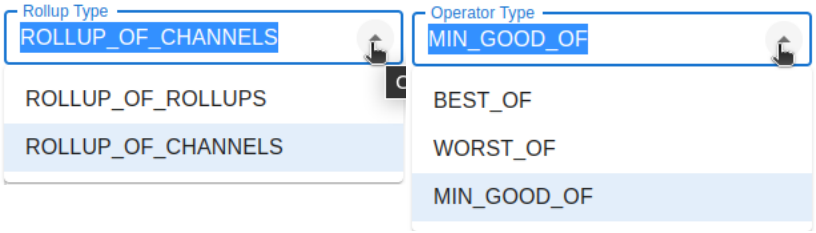

Figure 21. Rollup Type (Left) and Operator Type (Right) Dropdown Menus.

Alternatively, the user can directly type in the desired options into the Rollup Type and Operator Type context boxes. The user can only type in one of the options described above in bullets 1 and 2. If the user types in an invalid option, the dropdown menu will indicate there are

no options to select. Clicking anywhere in the UI will cause the invalid option to revert to the last valid option entered by the user.

Note that if the Operator Type is set to MIN_GOOD_OF, the user can also input a good threshold and marginal threshold by typing the desired values in the respective context boxes. To be valid, the good threshold must equal or exceed the marginal threshold and neither threshold can exceed the number of selected channels. Invalid entries will result in error messages such as those shown in Figure 16 and Figure 17, along with an error indicator in the Station Group dropdown menu (Figure 23).

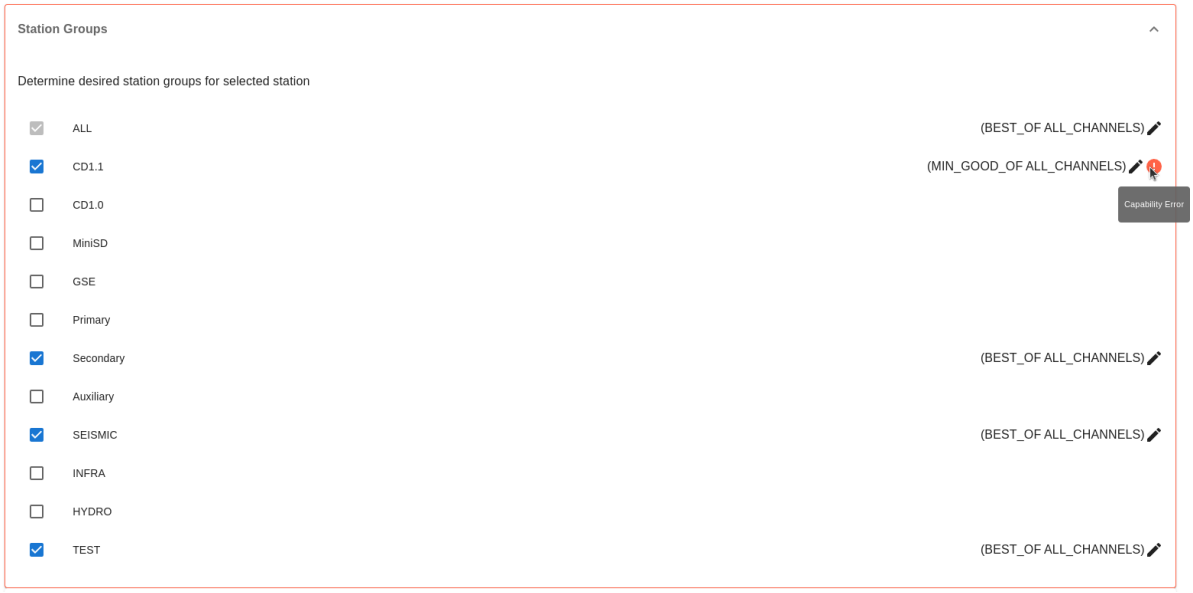

Figure 22. Station Group Dropdown Menu with Capability Error.

Values input into the threshold context boxes must be integer values; the UI will not allow non-integer values to be entered.

The example in Figure 20 shows a simple configuration, where the station capability SOH status is directly calculated from channel capability SOH statuses rolled up to a BEST_OF operator. To create more complex configurations, select the ROLLUP_OF_ROLLUPS option in the Rollup Type dropdown menu (Figure 22). This action will result in the creation of a new ROLLUP_OF_ROLLUPS row as shown in Figure 24. The new ROLLUP_OF_ROLLUPS row takes the

capability SOH status calculated by the ROLLUP_OF_CHANNELS row as input for its own SOH calculation, as indicated by the indentation.

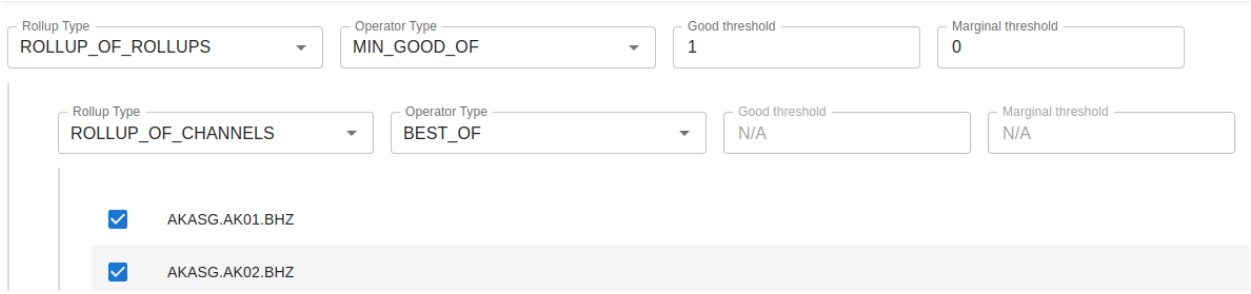

Figure 23. Example ROLLUP_OF_ROLLUPS Configuration.

Each time a ROLLUP_OF_CHANNELS Rollup Type is changed to a ROLLUP_OF_ROLLUPS, a new ROLLUP_OF_ROLLUPS row will be created. The user can add as many ROLLUP_OF_ROLLUPS rows as desired via this action.

For instance, if the ROLLUP_OF_CHANNELS in Figure 24 was changed to ROLLUP_OF_ROLLUPS, there would be three rows consisting of an inner ROLLUP_OF_CHANNELS, a middle ROLLUP_OF_ROLLUPS, and an outer ROLLUP_OF_ROLLUPS. The innermost ROLLUP_OF_CHANNELS rolls up its calculated capability SOH status to the middle ROLLUP_OF_ROLLUPS, which in turn rolls up its calculated capability SOH status to the outermost ROLLUP_OF_ROLLUPS; this outermost ROLLUP_OF_ROLLUPS determines the overall station capability SOH status.

Adding rows as described so far would result in a straightforward configuration where each capability SOH status is passed directly up to the next level. As there are no other statuses to compare to in this scenario, the ROLLUP_OF_CHANNELS capability SOH status would automatically roll up to the station capability SOH status.

To make more complex configurations that compare SOH capability statuses calculated in different ways, the user can add (or delete) rows by hovering over the upper-left corner of a

Rollup Type context box to bring up the add and delete buttons (Figure 25), shown as a green + and a red x, respectively.

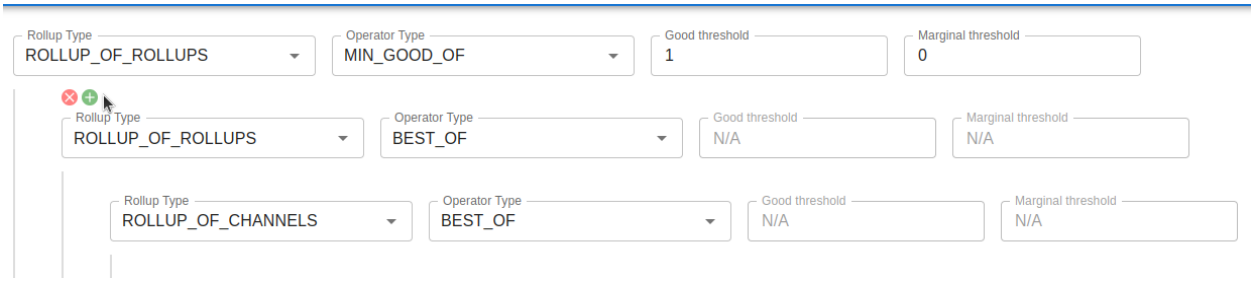

Figure 24. Add and Delete Buttons.

By clicking the add button, a new ROLLUP_OF_CHANNELS row is created beneath the parent row. This new child row is indented, indicating that it rolls up its calculated capability SOH status to the parent row that created it. Because a child row must always roll up its calculated SOH status to the parent row, only ROLLUP_OF_ROLLUPS rows provide the add button. A ROLLUP_OF_CHANNELS row, which takes in channel capability SOH statuses as input, can never take in SOH statuses rolled up from previous calculations.

If a parent ROLLUP_OF_ROLLUPS row had an existing ROLLUP_OF_CHANNELS row or the add button was used to create more child rows, these rows would all be indented to the same level. This indentation indicates the child rows all roll up their uniquely calculated capability SOH statuses to the parent ROLLUP_OF_ROLLUPS row, which then calculates a capability SOH status based on these inputs and the chosen Operator Type.

Note that while the created child rows are ROLLUP_OF_CHANNELS rows by default, they can be changed to ROLLUP_OF_ROLLUPS rows using the Rollup Type dropdown menu (Figure 22). Changing rollup type to ROLLUP_OF_ROLLUPS would result in new ROLLUP_OF_ROLLUPS rows, as described earlier in this section. Also, if a parent ROLLUP_OF_ROLLUPS row is changed to a ROLLUP_OF_CHANNELS, the child rows of the ROLLUP_OF_ROLLUPS will be replaced by the list of channels ROLLUP_OF_CHANNELS takes as input. This action cannot be undone; thus, the child rows would have to be recreated.

Finally, any row can be deleted with the red x button (Figure 25) except for the topmost row, which does not provide a delete button. If the user deletes a row, the SOH Config Tool prompts

the user to confirm deletion (Figure 26); click yes to complete the action. Clicking no will result in no change.

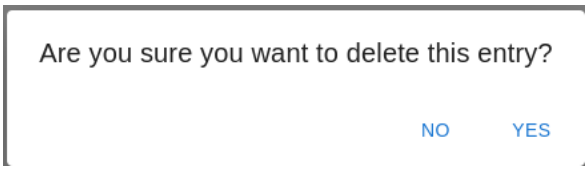

Figure 25. Delete Entry Prompt.

The topmost row lacks a delete button because at least one capability SOH status calculation must be performed to get the station capability SOH status. Further, at least one ROLLUP_OF_CHANNELS row must be present in the configuration as the capability SOH statuses required for calculation are inherited from the station's channels. If all ROLLUP_OF_CHANNELS rows are deleted, the user will see warning indicators such as those in Figure 16, Figure 17, and Figure 23.

Once the user has set all options for the station capability rollup to the desired configuration, the user can click the x in the upper-left corner of the Station Capability Rollup page to save the changes automatically and temporarily in the SOH Config Tool. To permanently save all changes to file, the user must click the save button (Figure 14) in the main Station Configuration Page (Figure 8).

4.3.3. Channel Capability Rollup Page

As previously stated in Section 4.3.2, the capability SOH status configuration of a selected channel in the Station Capability Rollup page can be modified by clicking the pencil icon next to the channel name (Figure 20).

When this edit button is selected, the user is taken to the Channel Capability Rollup page, which is used to set up configuration for the Channel Capability SOH status calculation. This is the most basic level in the capability SOH status calculation, i.e., the SOH statuses determined here

are rolled up to be used in the station capability SOH status calculation described in Section 4.3.2; see the flowchart in Appendix A.2 for details.

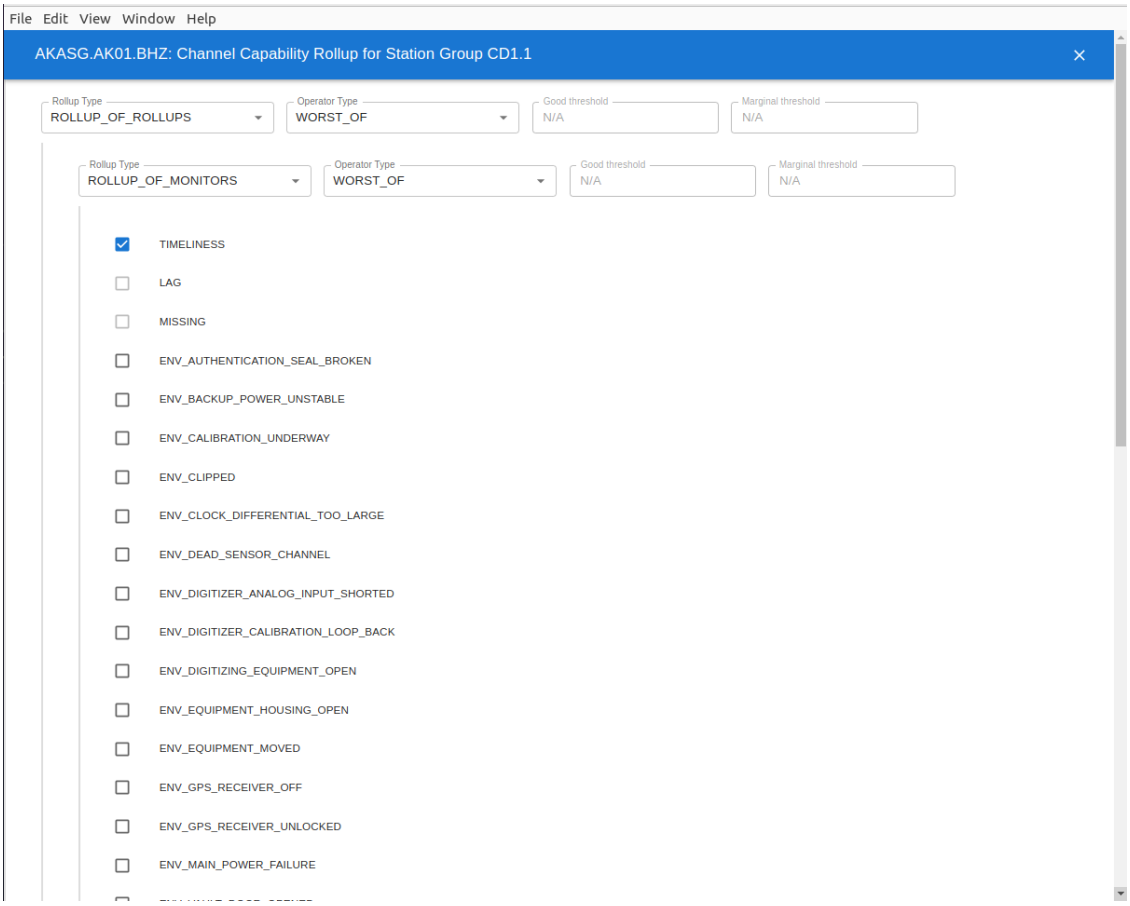

Figure 26. Channel Capability Rollup Page.

Here the user can modify the channel capability rollup configuration for a selected channel in the chosen station/station group pair. In Figure 27, the channel capability rollup configuration of channel AKASG.AK01.BHZ is shown, with channel AKASG.AK01.BHZ being a channel of AKASG in station group CD1.1.

Channel capability SOH status is based on input monitor type capability SOH statuses (see Appendix A.2). The interactions and calculations of capability SOH statuses for a channel are nearly identical to those shown in the Station Capability Rollup page (Section 4.3.2), except that the rollup type ROLLUP_OF_CHANNELS (Section 4.3.2, bullet 1a) is replaced by a rollup type of ROLLUP_OF_MONITORS. The ROLLUP_OF_MONITORS performs an SOH capability SOH status calculation based on the SOH status of the selected monitors and the chosen operator type.

The other available rollup type ROLLUP_OF_ROLLUPS, as well as the operator types, are identical to those defined in Section 4.3.2.

The available monitor types are defined in the file *~/SOH-Config-UI/soh-configs/supported-monitor-types.json*. In total there are 19 individual monitor types in four categories: missing data, timeliness, lag, and environmental issues. These are defined as:

- Missing data – the percentage of missing data over a configurable time window
- Timeliness – the time difference (in seconds) between the current time and the most recent time a data sample that has been acquired
- Lag – worst transmission time (i.e., lag, in seconds) over a configurable time window
- Environmental issues – percentage of time a specific environmental issue has a status of BAD over a configurable time window. In total, there are 16 possible types of environmental issue, including Vault Door Opened and Authentication Seal Broken. See Appendix B for a full list of available environmental issues.

Monitor types to be included in the capability SOH status calculation are indicated by a checkmark. Note that if a monitor is disabled for all station groups in the main Station Configuration Page using the monitor type menus (Section **Error! Reference source not found.**), that monitor will be disabled in the Channel Capability Rollup Page. If the user tries to enable the monitor in this page, a tooltip will be printed to screen indicating the user must enable the monitor using the monitor type menus. However, if a monitor is disabled for only specific station groups using the monitor type menus, the user will be able to enable/disable that monitor in the Channel Capability Rollup Page. See Section **Error! Reference source not found.** for further details.

4.3.4. Enable/Disable Channels Dropdown Menu

In Section 4.3.2, the capability to enable/disable a channel in the Station Capability Rollup page was described. Alternatively, if the user desires to add or remove a channel from all possible SOH status calculations, they can click the Enable/Disable Channels dropdown menu (Figure 28) provided directly beneath the Station Groups menu in the main Station Configuration page.

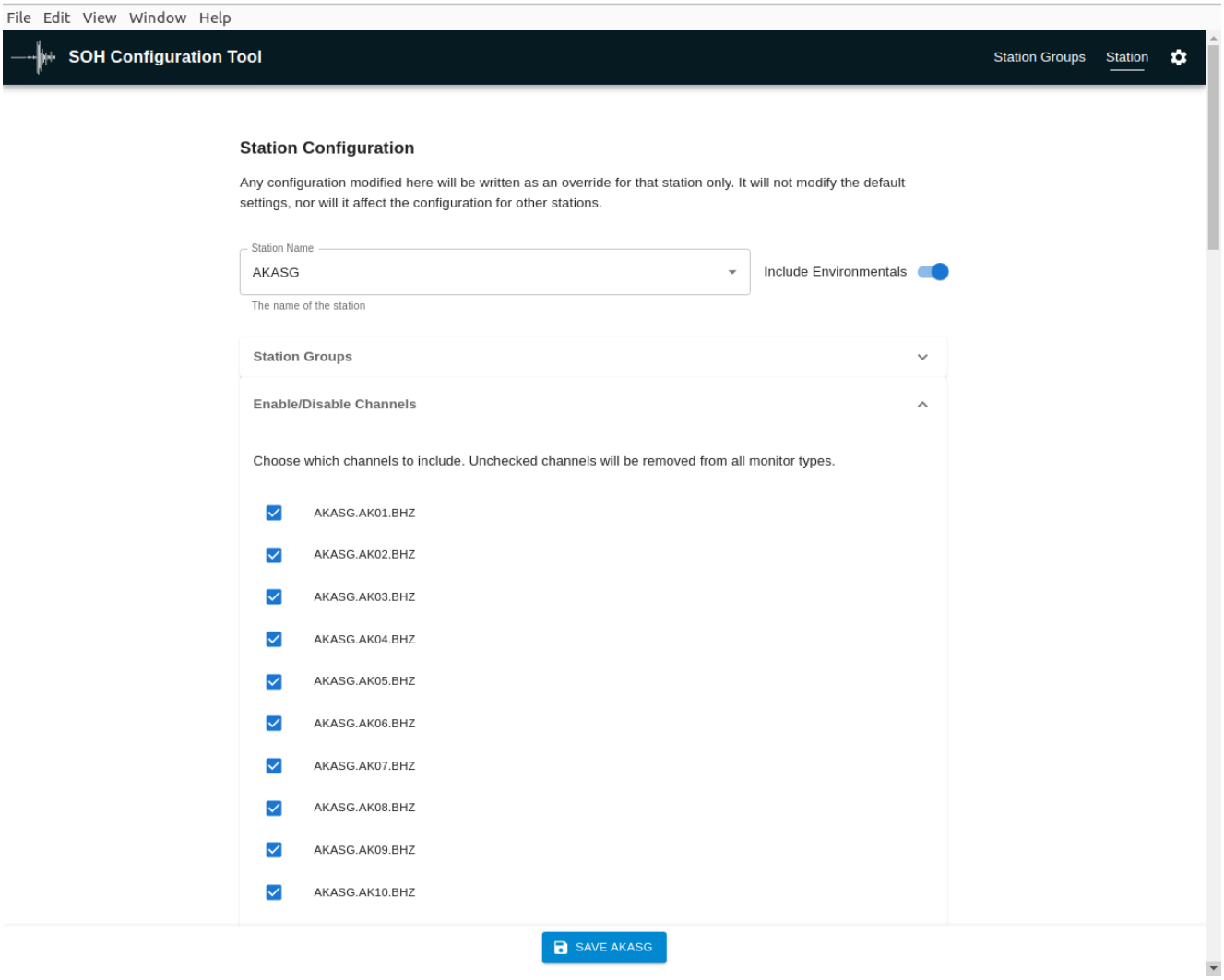

Figure 27. Enable/Disable Channels Dropdown Menu.

The available channels for the selected station (here AKASG) that can be included/excluded in SOH status calculations are listed in the menu. From this list, the user can select or deselect which channels to include via the checkbox at left of the channel name. By default, all channels will be selected.

When a channel is enabled/disabled in the Enable/Disable Channels dropdown menu, the Station Capability Rollup page (Section 4.3.2) and the monitor type options used to set station worst-of SOH status (Section 4.3.6) are synced such that any options related to that channel are also enabled/disabled. When a user performs the action to enable/disable channels, a warning is printed to screen to indicate the effect these actions have on the rest of the configuration for that station (Figure 29). The user can either continue with the action or cancel.

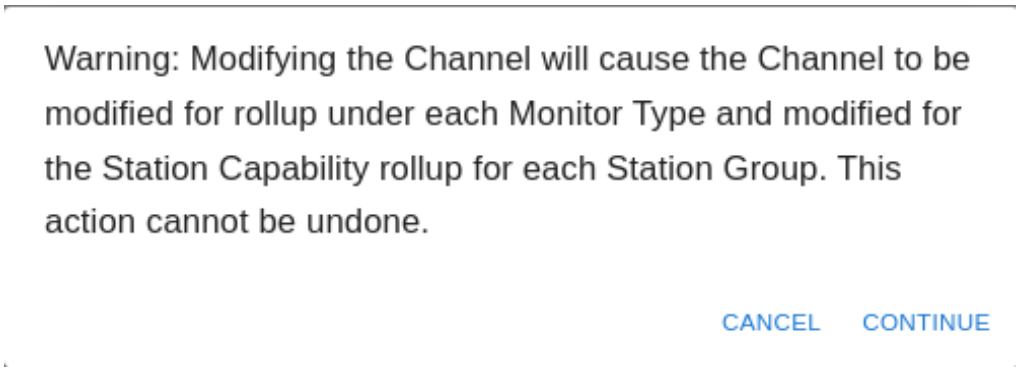

Figure 28. Modification of Channel Warning.

The user can hover over the enabled/disabled channel in the Enable/Disable Channels Dropdown menu to print out a tooltip describing the effects of the selection/deselection on the worst-of and capability rollup SOH status configurations (e.g., Figure 30).

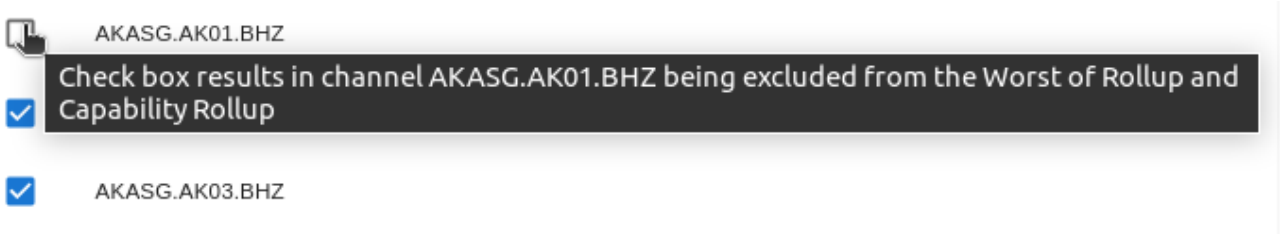

Figure 29. Tooltip Describing Effect of Deselecting Channel AKASG.AK01.BHZ in Enable/Disable Channels Dropdown Menu.

Further, the user can hover over enable/disabled channels in any page or menu (e.g., in the Station Capability Rollup page in Figure 20) to see why the channel is enabled/disabled. This allows the user to know if a channel was manually enabled/disabled in the current menu or if it was universally enabled/disabled using the Enable/Disable Channels dropdown menu (Figure 31).

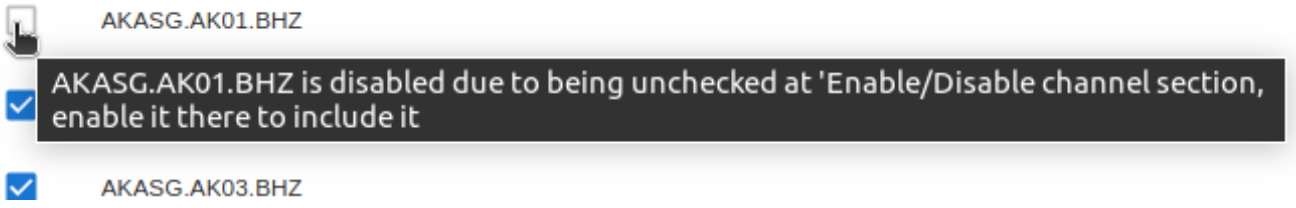

Figure 30. Tooltip in Station Capability Rollup Window Indicating Channel AKASG.AK01.BHZ was Disabled Via the Enable/Disable Channel Dropdown Menu.

4.3.5. Back Off Duration and Calculation Interval

Next, the user can define the Back Off Duration and Calculation Interval to use in both the worst-of and capability SOH status calculations via the context boxes shown in Figure 32. These two values together define the time window to use in the SOH status calculations, with the window beginning defined as Current Time minus Back Off Duration and the window duration set by the Calculation Interval. Thus, in Figure 32, the window would begin 5 minutes prior to the current time and would have a total duration of 10 minutes.

Figure 31. Back Off Duration and Calculation Interval Context Boxes.

In both cases, the user can either directly enter in a time, or select from a list of default suggested times from a dropdown menu that appears when either context box is clicked (Figure 33).

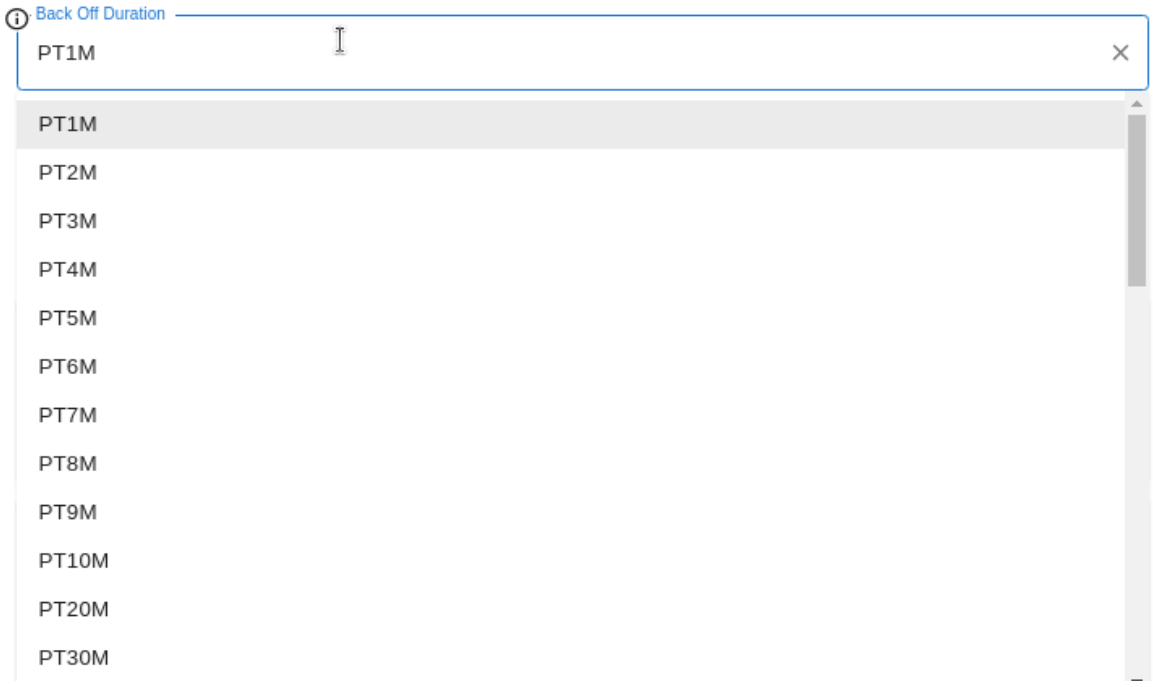

Figure 32. Back Off Duration Dropdown Menu.

Times entered will be defined in the ISO 8601 standard, with a P (period) symbol placed prior to the year (Y), month (M), week (W), or day (D) values and a T (time) symbol placed prior to the time components of hour (H), minute (M), and second (S). Thus, times can appear as 1) PValueUnitTValueUnit, 2) PTValueUnit if the time defined is less than a day, or 3) PValueUnit if the time entered has no time components.

For example, in Figure 33 the Calculation Interval is listed as PT10M, indicating that the interval duration is 10 minutes. If this duration was instead set to be 1 day and 100 minutes, it would be written as P1DT100M. If the duration was set to 1 day, the time would be P1D. Finally, in the most complex example, if the duration was set to 1 year + 1 month + 1 week + 1 day + 1 hour + 1 min + 1 sec, the time would be P1Y1M1W1DT1H1M1S.

All time values provided must be in integers. If an incorrect value such as a floating point is entered, the context box will be highlighted in red and an error message of "Invalid duration string" will be shown below the box (see Figure 17). Note that adding invalid strings to the beginning or end of the string does not result in errors (Section 6). Thus, configuration and saving can technically proceed as normal in this case, although it isn't recommended.

When the changes are input, the user can save using the save button at the bottom of the screen (see Figure 14). The json file containing Back Off Duration and Calculation Interval will be stored in the *soh-control.soh-monitor-timewindows* folder in the directory structure (see Figure 13).

4.3.6. Monitor Type Menus

The user can enable/disable the use of a monitor type in the calculation of the worst-of SOH status of the selected station (e.g., AKASG) and modify the thresholds of that monitor type via the options described below. The monitor types that can be enabled/disabled are timeliness, lag, missing, and environmental issues, in that order. See Section 4.3.3 for definitions of these monitor types.

The first two monitor type menus are timeliness and lag (Figure 34).

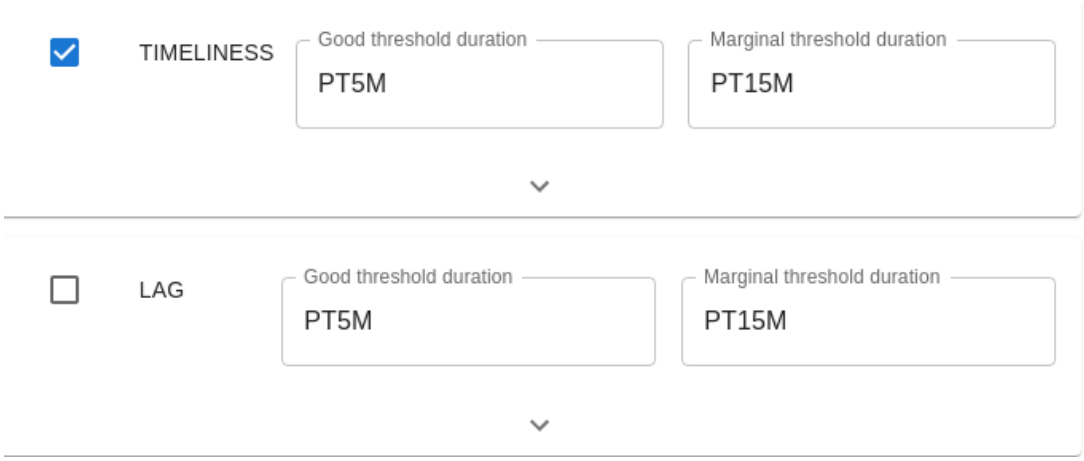

Figure 33. Menus to Enable/Disable Timeliness and Lag Monitor Types.

To enable or disable timeliness and/or lag, the user selects or deselects the checkbox to the left of the monitor type label.

When a user enables/disables a monitor type, that monitor type is included/excluded from the calculation of the station's worst-of SOH status. Further, an enabled/disabled monitor type is included/excluded from the station's capability SOH status calculation in all station groups (see Sections 4.3.2, 4.3.3). Thus, in Figure 34, the timeliness monitor is used in worst-of and capability SOH status calculations for station AKASG, but the lag monitor is not.

When a monitor type is enabled/disabled, a warning is printed to screen to indicate the effects on the station's worst-of and capability SOH status configurations (Figure 35).

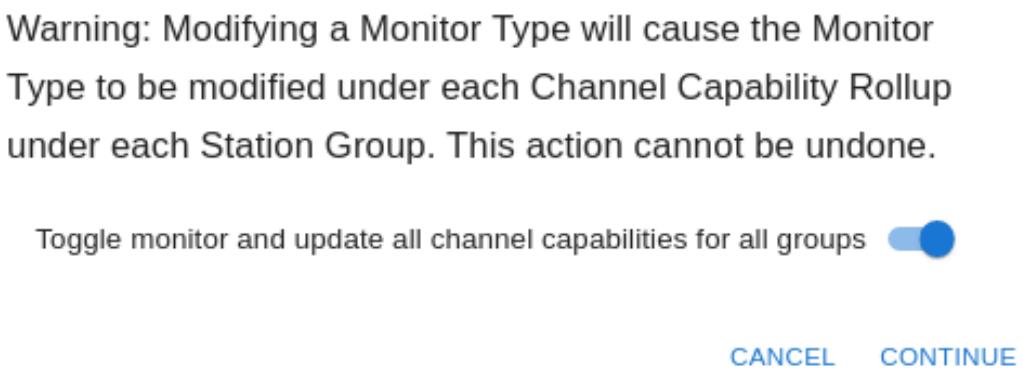

Figure 34. Modification of Monitor Type Warning.

This warning provides the user an option to enable/disable a station's monitor type under some or all station groups. By default, a monitor type will be enabled/disabled for all station groups.

To enable/disable the monitor type under specific station groups, click on the toggle button in Figure 35 to bring up the list of station groups in Figure 36.

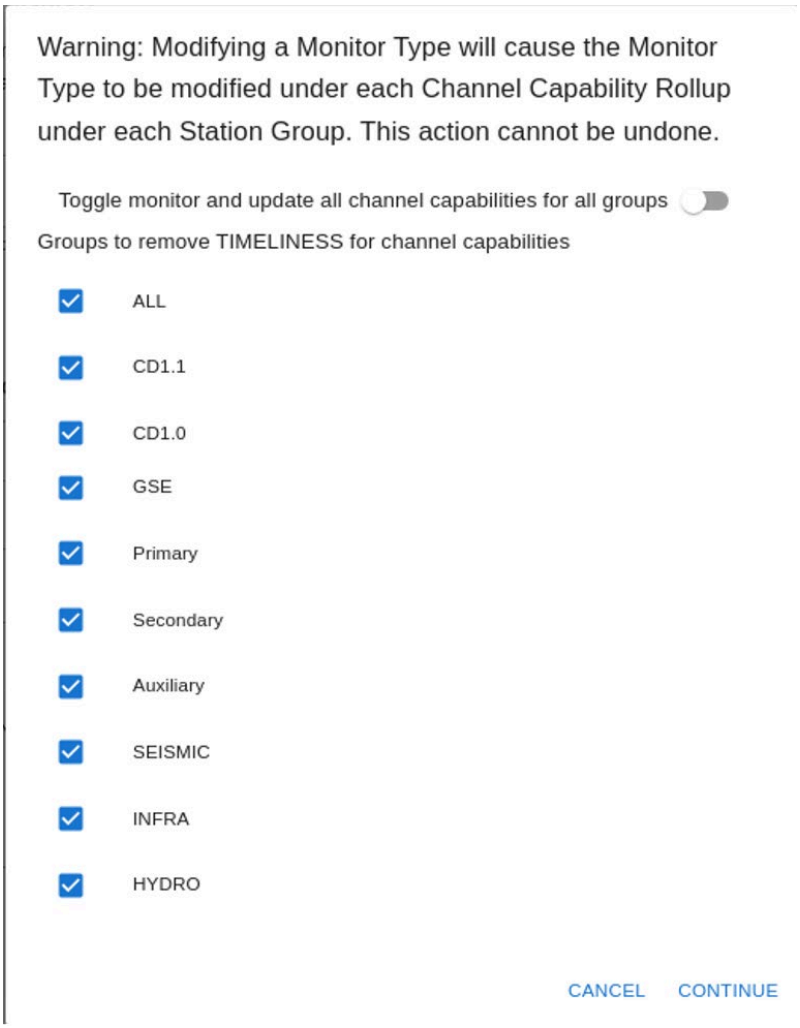

Figure 35. Dropdown Menu to Enable/Disable a Monitor Type in Specific Station Groups.

In this list, the user can click the checkbox to select/deselect station groups. Station groups that are selected (checked) will have the user action applied to them. Thus, if the user enabled/disabled the monitor type, the selected station groups will have that monitor type enabled/disabled. For instance, in Figure 36, AKASG's timeliness monitor is disabled under all station groups. Once all desired station groups are selected/deselected, the user can choose to continue with the action to enable/disable a monitor type or to cancel.

Note that enabling/disabling a monitor type only for certain station groups will not prevent the user from enabling/disabling that monitor type using the Channel Capability Rollup page (see Section 4.3.3). Further, if disabling a monitor type results in channel capability rollups with no monitors (Section 4.3.3), error messages similar to those in Figure 16, Figure 17, and Figure 23

will appear in the Station Configuration Page (Section 4.3), Station Capability Rollup page (4.3.2), and Channel Capability Rollup page (4.3.3).

If the timeliness and/or lag monitor types are enabled for one or more station groups, the context boxes to the right of the monitor type label (Figure 34) can be used to set the thresholds at which the station monitor worst-of SOH status is declared marginal or good. For timeliness and lag, thresholds are based on time. As with the back off duration and calculation interval, times are input in ISO 8601 standard format. In Figure 34, station AKASG's worst-of SOH status for Timeliness will be GOOD if the timeliness is ≤ 5 minutes and MARGINAL if the timeliness is ≤ 15 minutes.

The timeliness and lag monitor type menus also provide options to 1) enable/disable a monitor type and 2) set thresholds for individual channel(s). To access these options, click on the arrow directly below a monitor type menu, e.g., beneath TIMELINESS in Figure 34. This action will bring up the additional menu options in Figure 37.

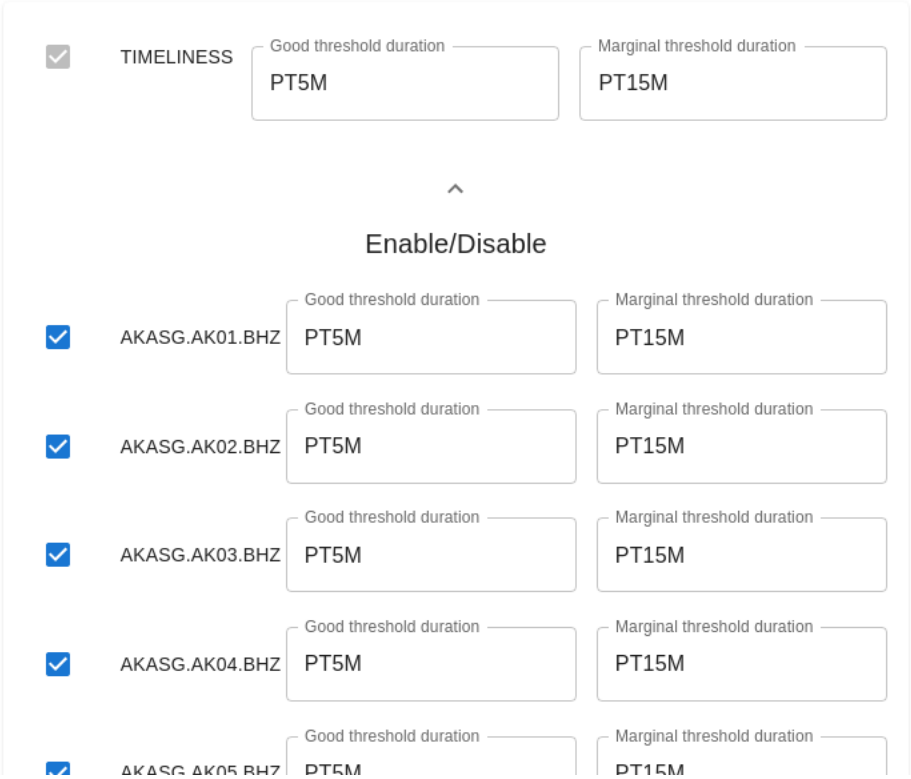

Figure 36. Expanded Menu to Enable/Disable Timeliness Monitor Type.

The actions to enable/disable monitor types for individual channels and set thresholds for these channels are the same as described above, with the exception that the enable/disable warning for individual channels does not include the toggle in Figure 35. Note that if the overall monitor

status thresholds are modified (e.g., the thresholds for TIMELINESS in Figure 37), all channel thresholds will change to match.

The Missing (Figure 38) and Environmental Issues (Figure 39) monitor type menus behave in the same way as the Timeliness and Lag menus (Figure 34), except that thresholds are now based on percentages. For instance, in Figure 38, AKASG's worst-of SOH status for the Missing monitor type is good if ≤ 2% of data are missing and marginal if ≤ 10% of data are missing.

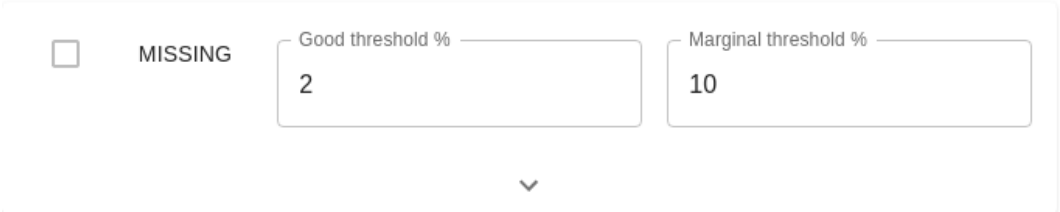

Figure 37. Menu to Enable/Disable Missing Monitor Type with the Missing Monitor Type.

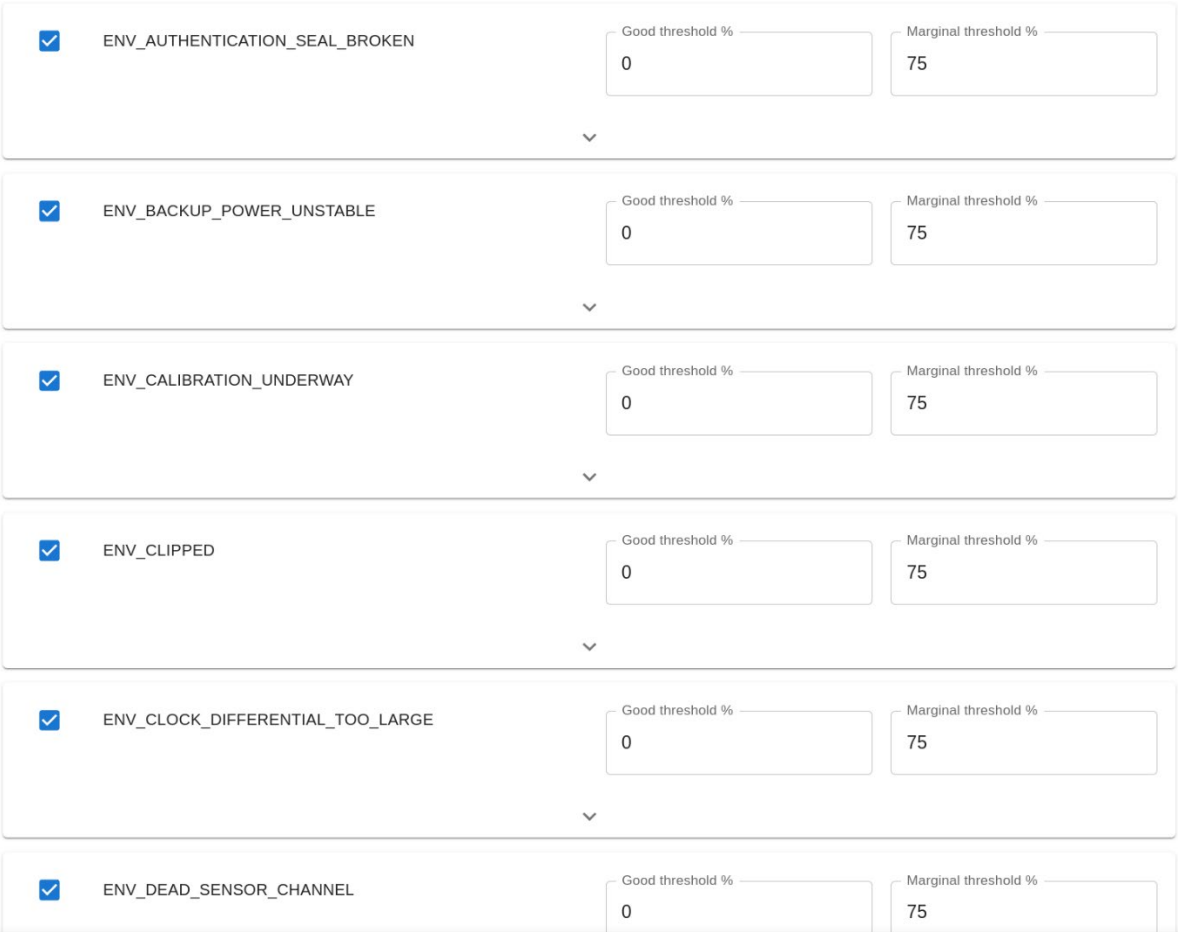

Figure 38. Menu to Enable/Disable Environmental Issue Monitor Types.

Note that worst-of SOH status configurations for Environmental Issues must be set individually for each type of environmental issue (e.g., ENV_AUTHENTICATION_SEAL_BROKEN in Figure 39); there are 16 environmental issues in total. A list of all available environmental issue monitor types is provided in Appendix B.

Also note that to use the Environmental Issues monitor type menus, the *Include Environmentals* toggle, located to the right of the Station Name menu on the Station Configuration page (Figure 40), must be turned on (button to the right, colored blue).

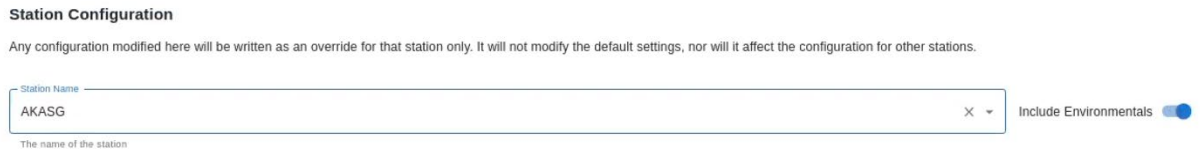

Figure 39. *Include Environmentals* Toggle Button.

When the *Include Environmentals* toggle button is off (button to the left, colored gray), all environmental issues are automatically disabled and cannot be enabled using the environmental issue monitor type menus (Figure 39). By default, *Include Environmentals* is toggled off for all stations, as they typically do not report environmental issue data. The exceptions are stations belonging to station group CD1.1, which typically do report environmental issue data and thus have *Include Environmentals* turned on by default.

Once the user has set all monitor type configuration parameters to the desired configurations using the menus described in this section, click the save button (Figure 14) at the bottom of the screen to save the configuration.

If a monitor type was added or removed from the worst-of SOH status calculation as compared to default, a json file will be saved in *soh-control.soh-monitor-types-for-rollup-station*. If a threshold in the worst-of SOH status calculation was modified, a json file will be saved in *soh-control.soh-monitor-thresholds.* Finally, if a specific channel was added or removed from the worst-of SOH status calculation, a json file is saved in *soh-control.channels-by-monitor-type*.

4.4. Station Groups Page

In previous sections, the station capability rollup (Section 4.3.2) and channel capability rollup (Section 4.3.3) pages were discussed. In this section, the final rollup available for configuration, the station groups capability rollup, is detailed. To modify the station groups capability rollup, the user must select the Station Groups page from the upper-right menu, bringing up the page in Figure 41.

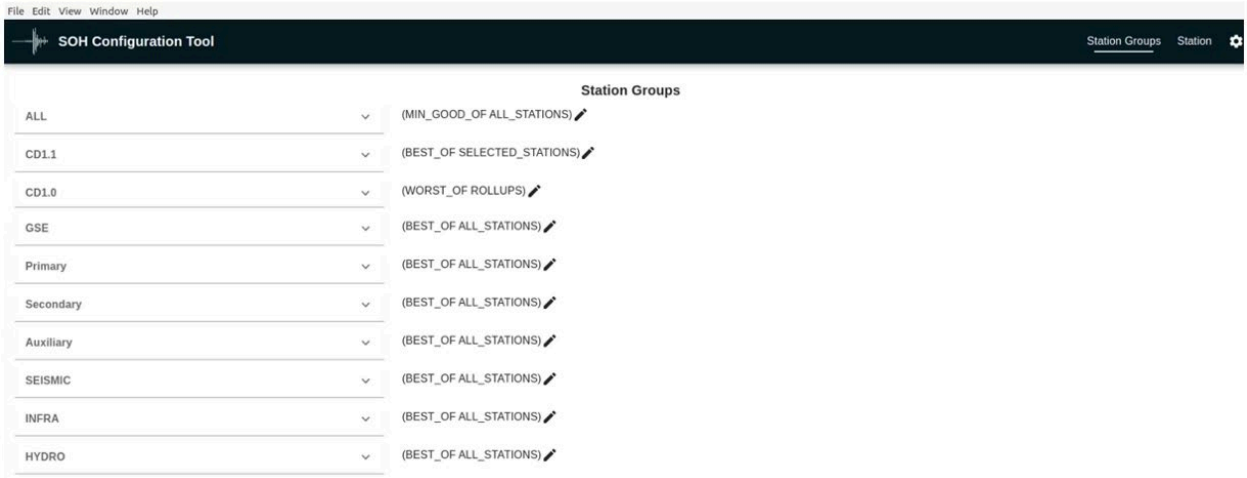

Figure 40. Station Groups Page.

On this page, all available station groups are listed. Alongside each station group, a pencil icon representing an edit button can be seen, along with the current capability rollup used to calculate that station group's capability SOH status (e.g., BEST_OF_SELECTED_STATIONS for station group CD1.1 in Figure 41). When the edit button is clicked, the user is taken to the Station Group Capability Rollup page (Figure 45), which is used to set up configuration for the Station Group SOH status calculation. This page is described in Section 4.4.1.

In addition to providing access to the Station Group Capability Rollup page, the Station Groups page also provides dropdown menus to allow the user to view which stations have SOH statuses that contribute to the Station Group capability status calculation. To expand a station group's dropdown menu, select the arrow to the right of the desired station group name. This

action will provide the list of stations contributing to the capability SOH status calculation, as shown in Figure 42 for station group CD1.1.

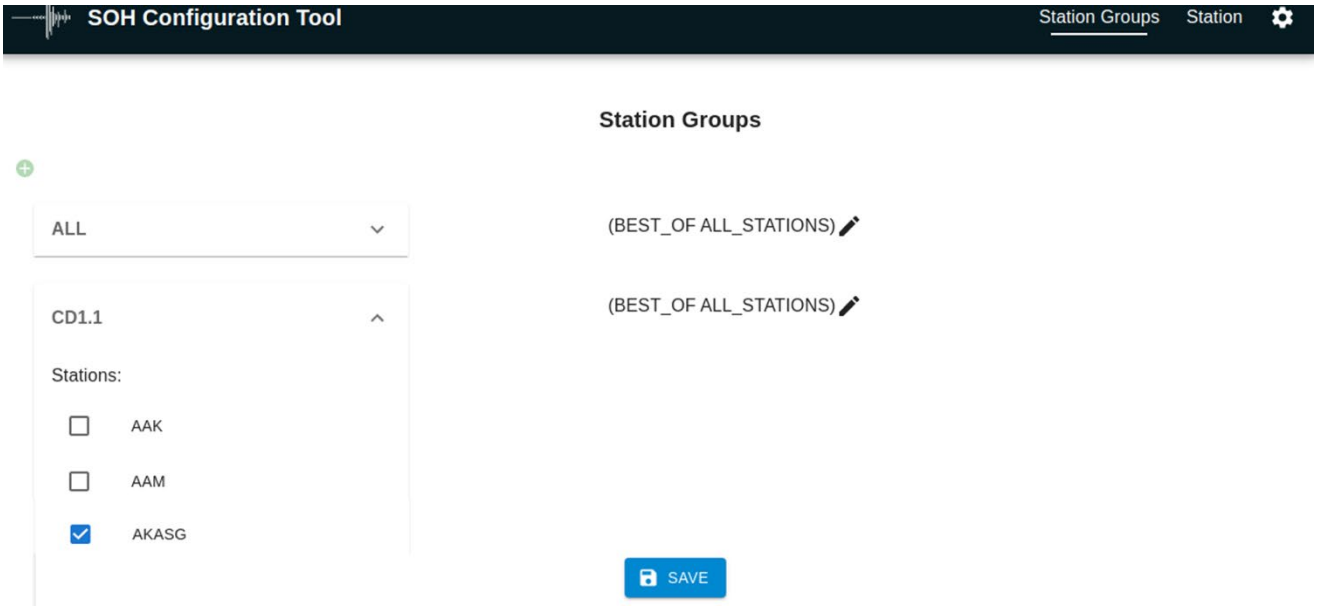

Figure 41. Station Groups Page with Station Group CD1.1 Expanded.

Stations included in the Station Group are indicated by a checkmark; they are initially defined based on the provided *processing-station-group-definition.json* file, except for the ALL group, which is defined in the *processing-station-group.json* file. To add/remove a station, simply check/uncheck that station and press the Save button (e.g., Figure 14) at the bottom of the page.

This dropdown menu is synced with the Station Group Capability Rollup page (Figure 45) and the Station Groups Dropdown menu (Figure 18) in the Station Configuration page (Section 4.3.1). In the case of the Station Group Capability Rollup page, adding or removing stations in the Station Group dropdown menu results in the station being added/removed from the Station Group Capability Rollup page. For instance, if station AKASG in Figure 42 was unchecked, it would not be listed in Figure 45.

In the case of the Station Groups Dropdown menu, if a station group is checked/unchecked in a station's Station Groups Dropdown menu, the user will see that station included/excluded from the checked/unchecked station group in the Station Group page. For instance, if CD1.1 was unchecked in the Station Groups Dropdown menu of station AKASG (Figure 18), AKASG would be unchecked in the CD1.1 dropdown menu (Figure 42) on the Station Groups Page.

Finally, station groups can be added or removed from the Station Groups Page by hovering over the upper-right corner of an existing station group and clicking the plus or minus buttons that appear (Figure 43).

Figure 42. Add and Delete Station Group Buttons.

When a station group is added, the menu in Figure 44 pops up.

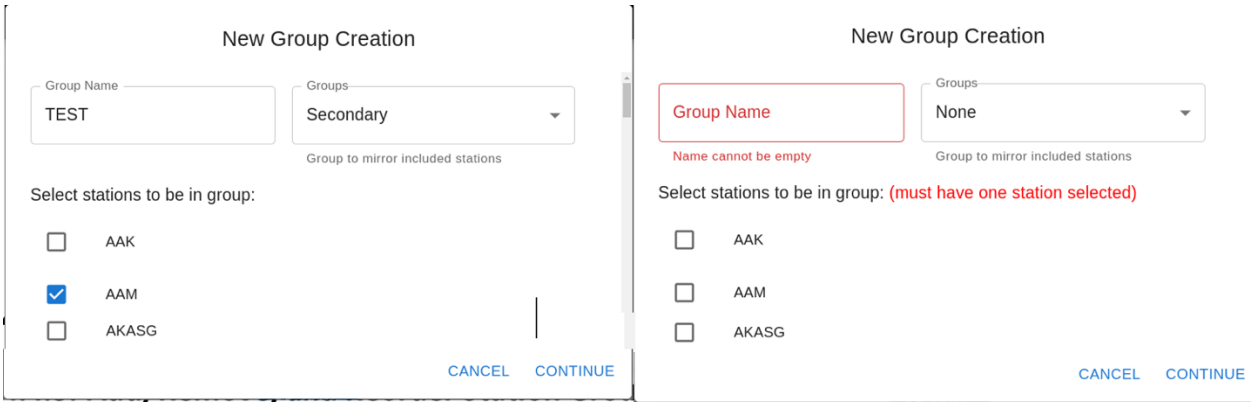

Figure 43. New Group Creation Menu Without (Left) and With (Right) Error.

In the New Group Creation menu, the user inputs a Group Name and defines which stations will be included in the new group. Note that a Group Name must be entered and at least one station must be included in the group, otherwise an error occurs (Figure 44, right).

Stations can be added or removed to the station group by checking or unchecking available stations in the provided list. Alternatively, a list of stations to include can be mirrored, i.e., copied, from an existing group by clicking on the Groups dropdown menu and selecting a station group from the list. For example, the stations included in group TEST in Figure 44 (left) are mirrored, i.e., copied, from station group Secondary. By default, Groups is set to *None* and no mirroring is done. Once the group is defined, the user can either click continue to create the group or click cancel so no action occurs.

When a new group is created, it will initially only be available on the Station Groups page. To make the new group available for configuration throughout the SOH Config Tool, in particular in the Station Groups dropdown menu (Section 4.3.1, Figure 18), the user must click the Save button at the bottom of the page (e.g., Figure 14). Clicking save after adding or removing a Station Group will cause the SOH Config Tool to reload. The new station group configuration will be saved in *~/SOH-Config-UI/soh-configs/station-reference/definitions/processing-station-group-definition.json* and *~/SOH-Config-UI/soh-configs/processing/soh-control.station-group-*

names/default.json. In this case, there is no default *processing-station-group-definition.json* file; thus, when the user saves a modified station groups list, this file gets overwritten.

Finally, station groups listed on the Station Groups page (Figure 41) can be reordered by clicking and dragging the station group context box to a desired position; once there, release the touchpad/mouse to drop the station group context box into its new position. The order of Station Groups will be the order they appear in the SOH UI (e.g., the order Station Groups are shown on the SOH Overview Display).

4.4.1. Station Group Capability Rollup

In the Station Group Capability rollup page (Figure 45), the user can configure a station group's capability SOH status calculation.

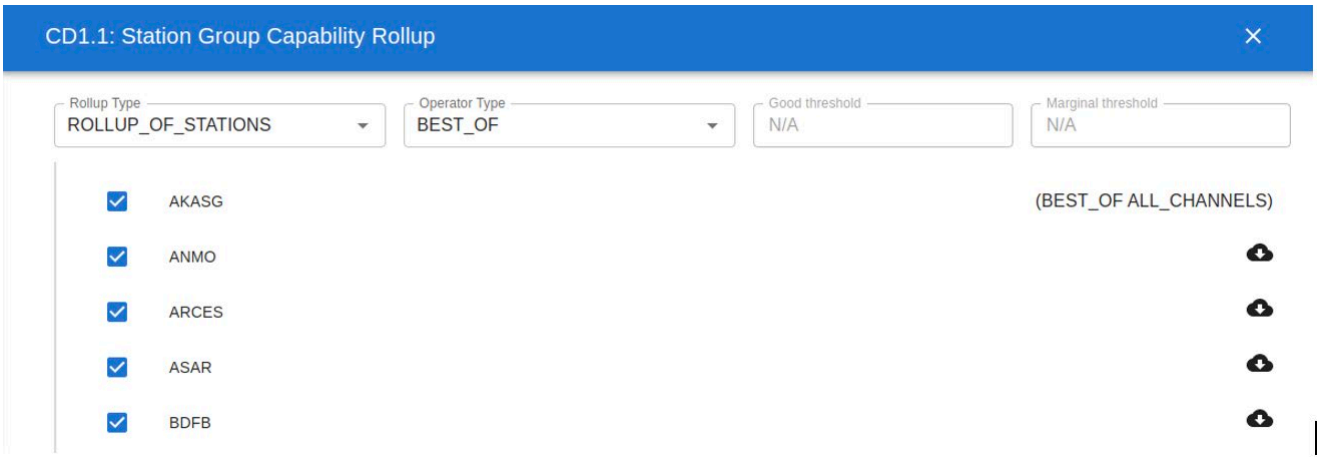

Figure 44. Station Group Capability Rollup Page for Station Group CD1.1.

Station group capability rollup is based on station capability SOH statuses. To see a specific station's current station capability rollup configuration, the user must click on the cloud icon next to the selected station. This action downloads the configuration and prints it to screen as shown in Figure 45, where the station capability SOH status of AKASG is the BEST_OF_ALL_CHANNELS.

The user cannot modify station capability rollup configurations directly from this page. Instead, the user must go to the Station Configuration page (Figure 8), select the station to be modified, e.g., AKASG, and use the Station Groups Dropdown menu (Figure 18) as described in Section 4.3.1.

Otherwise, the interactions and calculations of capability SOH status for station groups are effectively identical to those shown in Sections 4.3.2 (Station Capability Rollup) and 4.3.3 (Channel Capability Rollup). Now the rollup type is ROLLUP_OF_STATIONS rather than ROLLUP_OF_CHANNELS (Section 4.3.2, bullet 1a) or ROLLUP_OF_MONITORS (Section 4.3.3).

The ROLLUP_OF_STATIONS performs an SOH capability status calculation based on the status of the selected stations and the chosen operator type. The other available rollup type ROLLUP_OF_ROLLUPS, as well as the operator types, are identical to those defined in Section 4.3.2.

5. MANUALLY EDITING DEFAULT VALUES

There are two types of default values: profile defaults and universal defaults. Profile defaults define defaults for a set of stations. Universal defaults define default values used for all stations not defined as part of a profile. Universal defaults are also used as the default for a profile when the profile does not specify a value.

5.1. Universal Defaults

Each folder contained within the Output Directory (Processing) folder as defined on the settings page has a default.json file, which defines the universal defaults.

5.1.1. Manually Edit Universal Defaults

To modify universal defaults, open the default.json file under the folder for which you want to modify the profile, and change the parameter value.

5.2. Profile Defaults

Each station can only be part of one profile; however, it is not required that a station be part of any profile. An example of a profile would be HYDRO-CD1.1. This profile is used for the set of HYRDO-CD1.1 stations. It is important to note that a newly added station will not automatically inherit values from a profile, even when that station has characteristics that match the profile. For instance, if a HYDRO CD1.1 station is added, it will not automatically inherit its values from the HYDRO CD1.1 -profile. For a station to inherit values from a profile, it is necessary to manually add the station to the profile as outlined in the section below.

Profile defaults are contained in files named {ProfileName}.json.

5.2.1. Adding/Deleting a Station to An Existing Profile

To manually add a station to an existing profile, the user must first ensure that the station is not part of any other profile contained in the Output Directory (Processing) folder. To delete a station from undesired profiles, the user must:

1) Search for the station in each existing {ProfileName}.json file in any of the subfolders within the Output Directory (Processing) folder, as defined on the Settings page.

2) Delete the station name from any undesired {ProfileName}.json file that contains the station.

    a) This deletion should include the comma following the station name or, in the case when the station is the last in the list, the comma prior to the station name.

Once the station has been removed from all undesired profiles, the user can manually add in said station to the desired profile. To add a station to the desired profile, the user must:

1) Search for the desired profile json file(s) in any of the subfolders within the Output Directory (Processing) folder, as defined on the Settings page.

2) For each desired {ProfileName}.json file found, add the station name to the list of stations.

    a) This addition should include a comma after the station name or, in the case when the station is the last in the list, a comma prior to the station name should be added.

5.2.2. Manually Modify a Profile

To modify a profile, open the {ProfileName}.json file in the subfolder to be modified and change the parameter value.

5.2.3. Manually Delete an Existing Profile

To manually delete an existing profile:

1. Delete all existing {ProfileName}.json files contained in any of the subfolders within the Output Directory (Processing) folder, as defined on the settings page.

5.2.4. Manually Add a New Profile

To manually add a new profile:

1. Choose a station that is not part of any existing profile
2. Using the SOH Configuration tool, configure the station in the following manner:
    a. Do not set thresholds for any specific channel
    b. Do not deselect a channel for monitor specific rollup
    c. Ensure all channels are selected when configuring the station capability rollup
    d. Configure the channel capability rollup of the first channel

3. Save using the SOH Config Tool (see Figure 14)

4. Search for the chosen station's json files (i.e., {StationName}.json) in any of the subfolders within the Output Directory (Processing) folder as defined on the settings page. For each station json file found:

    a. Rename the {StationName}.json file to {ProfileName}.json

    b. Open the new {ProfileName}.json file

    c. For the soh-control.channel-capability-rollup file:

        i. Delete the constraints for all channels excluding the first channel. The first channel is used to set the channel capability rollup configuration for the new profile, as detailed in bullet 2d above

        ii. For each remaining constraint:

            1. Rename all remaining constraints (up to 1 per station group) to change the station name and channel name to the profile name

            2. Add the default constraint string to all remaining constraints:

                {

                "constraintType": "DEFAULT"

                },

            3. Delete the entire channel name constraint each time it appears in the file

    d. For all other {StationName}.json files besides the soh-control.channel-capability-rollup file:

        i. Add the default constraint string to the file under the constraint section (same as bullet 4cii2)

        ii. Update the name to include the profile name instead of the station name

        iii. Add all other stations that are to be part of the profile to the file

5.3. Manually Deleting Stations

To delete a station:

1. Open the SOH Configuration Tool
2. On the Station tab, select the station
3. Expand the Station Group dropdown menu
4. Remove the station from all station groups
5. Click Save (see Figure 14)
6. Close the SOH Config Tool
7. Manually delete the station from any profile it is a part of (see Section 5.2.1).
    a. If there are no stations remaining in the profile after station deletion, manually delete the empty profile (see Section 5.2.1).
8. Search through all existing {StationName}.json files contained in any of the folders within the Output Directory (Processing) folder as defined on the settings page and delete any {StationName}.json files for the station to be deleted.
9. Remove the file from the station-reference/data folder.
10. Run the css-to-coi converter (see the Command-Line Utilities file, version 1.23, for details).

6. GENERAL LIMITATIONS

The Help menu provided in the SOH Config Tool has no help options.

The SOH Config Tool is not designed for multiple users to support using the same Configuration Service Deployment or same files at the same time.

The SOH Config Tool cannot edit default values.

The SOH Config Tool cannot edit multiple stations with similar characteristics at once.

The SOH Config Tool does not allow the user to copy a capability rollup from one station group and apply it to other station groups.

The SOH Config Tool does not automatically handle deleting stations.

Appendix A. SOH Status Rollups

This section details how the worst-of station SOH and capability SOH statuses are calculated.

Appendix A.1. Worst-of SOH Status Rollup

A station's worst-of SOH status notifies the user of the severity of the worst issue on that station. The worst-of SOH status of a station is inherited from the channel/monitor pair with the worst SOH status through a process called rollup. Rollup begins by determining the SOH status of each channel's monitors, see the right side of Figure 46. In the following examples, the available monitors are missing data, timeliness, lag, and environmental issues. Note that all environmental issues monitor types (e.g., Authentication Seal Broken, Clipped) are shown as a single box (labeled ENV_*) in Figure 46.

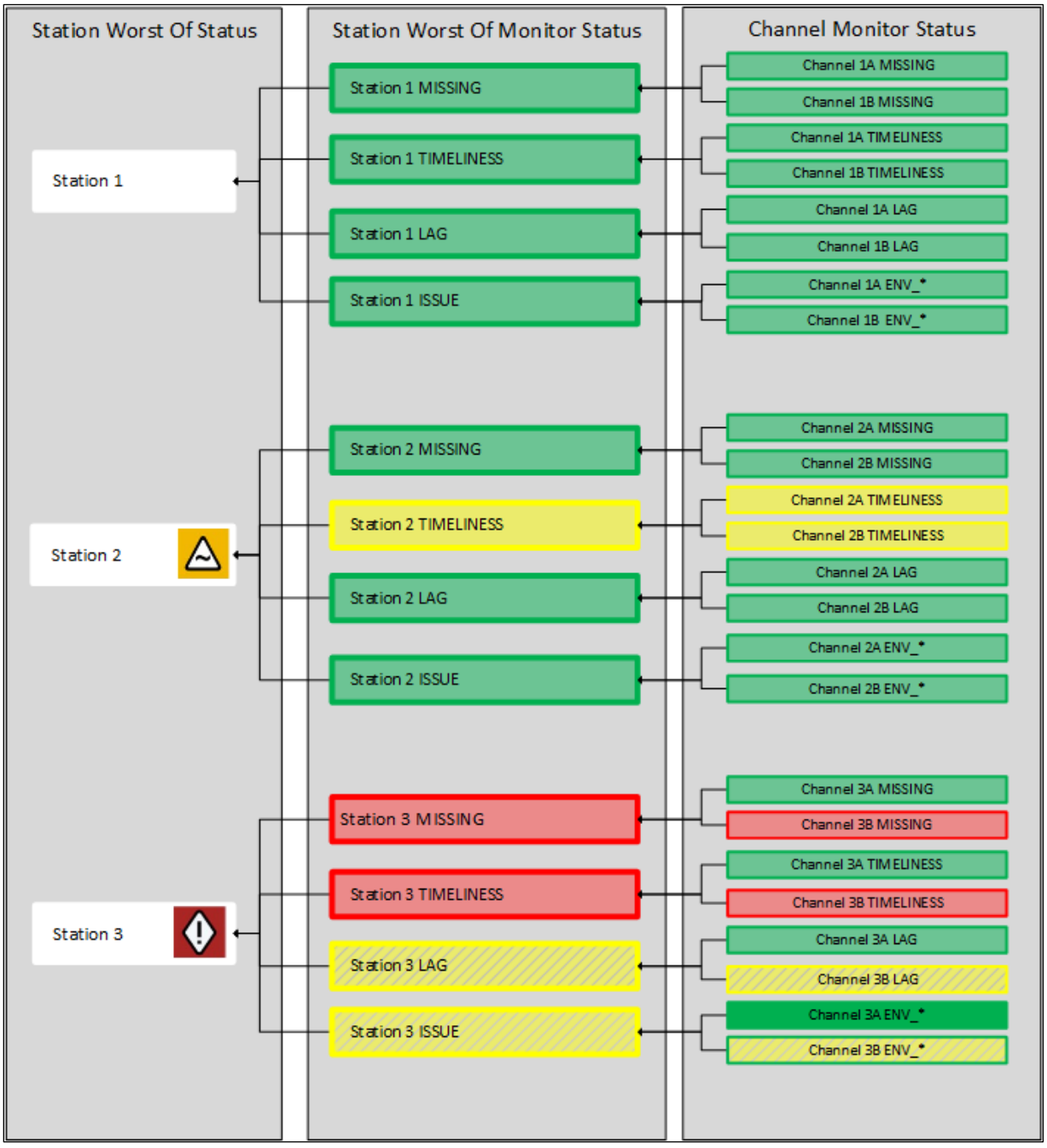

Figure 45. Flowchart Example of Worst-Of SOH Status Rollup.

After the SOH status of all a channel's monitors has been determined, these statuses are rolled up to the Station Worst-of Monitor Status level (middle column in Figure 46). At this level, the SOH status of a specific channel monitor type is compared across all channels and the worst status is inherited by the station monitor type, resulting in the Station Worst-of Monitor Status.

The worst SOH status among the station monitor type statuses is inherited by the station as its Worst-of SOH status.

For example, in Figure 46, Station 2 has two channels, 2A and 2B, each with the monitor types: missing data, timeliness, lag, and environment (right column of Figure 46). The missing data, lag, and environment monitors of Channels 2A and 2B have a good SOH status, while the timeliness monitors have a marginal SOH status. When these monitors are rolled up to the Station Worst-of Monitor status level (center column of Figure 46), the worst available status for the missing data, lag, and environmental issues monitors is good while the worst available status for timeliness is marginal. Thus, the resulting station monitor types, Station 2 Missing, Station 2 Lag, Station 2 Issue have an SOH status of good while Station 2 Timeliness has an SOH status of marginal. Finally, the four station monitor types are compared and the station inherits the worst station monitor SOH status as its worst-of SOH status. For Station 2, its overall worst-of SOH status is marginal because the worst station monitor SOH status is the Station 2 timeliness monitor with a status of marginal.

Monitors that are Unknown, i.e., had no data received and were configured to receive data, are classified as marginal worst-of SOH statuses and will contribute to the worst-of SOH Status rollup. An example of this type of status is shown for Station 3 at the bottom of Figure 46, with Channel 3B Lag and ENV_* having an Unknown status. This type of status typically arises if a channel or station are down and no longer transmitting data. If a station only has monitors with worst-of SOH statuses of good and marginal/Unknown, the station inherits a worst-of SOH status of marginal/Unknown; however, if a station's worst available monitors are a mix of marginal/Unknown and marginal with a numeric value, the station will inherit the worst-of SOH status of the monitor with the worst numeric value.

When calculating worst-of SOH status rollup, selected monitors and channels can be ignored by configuration (see Configuration documentation).

Appendix A.2. Capability SOH Status Rollup

While the worst-of SOH status rollup notifies users of issues with a station, the capability rollup helps prioritize which issues to troubleshoot first based on a station's importance to a configured capability. Capability rollups exist for stations and station groups. Station group capability rollup represents SOH statuses for a subset of stations in the group, while station capability rollup represents SOH statuses for a subset of channels in a station. In both cases, the subset of channels and monitors contribute as long as they meet a set of configured criteria.

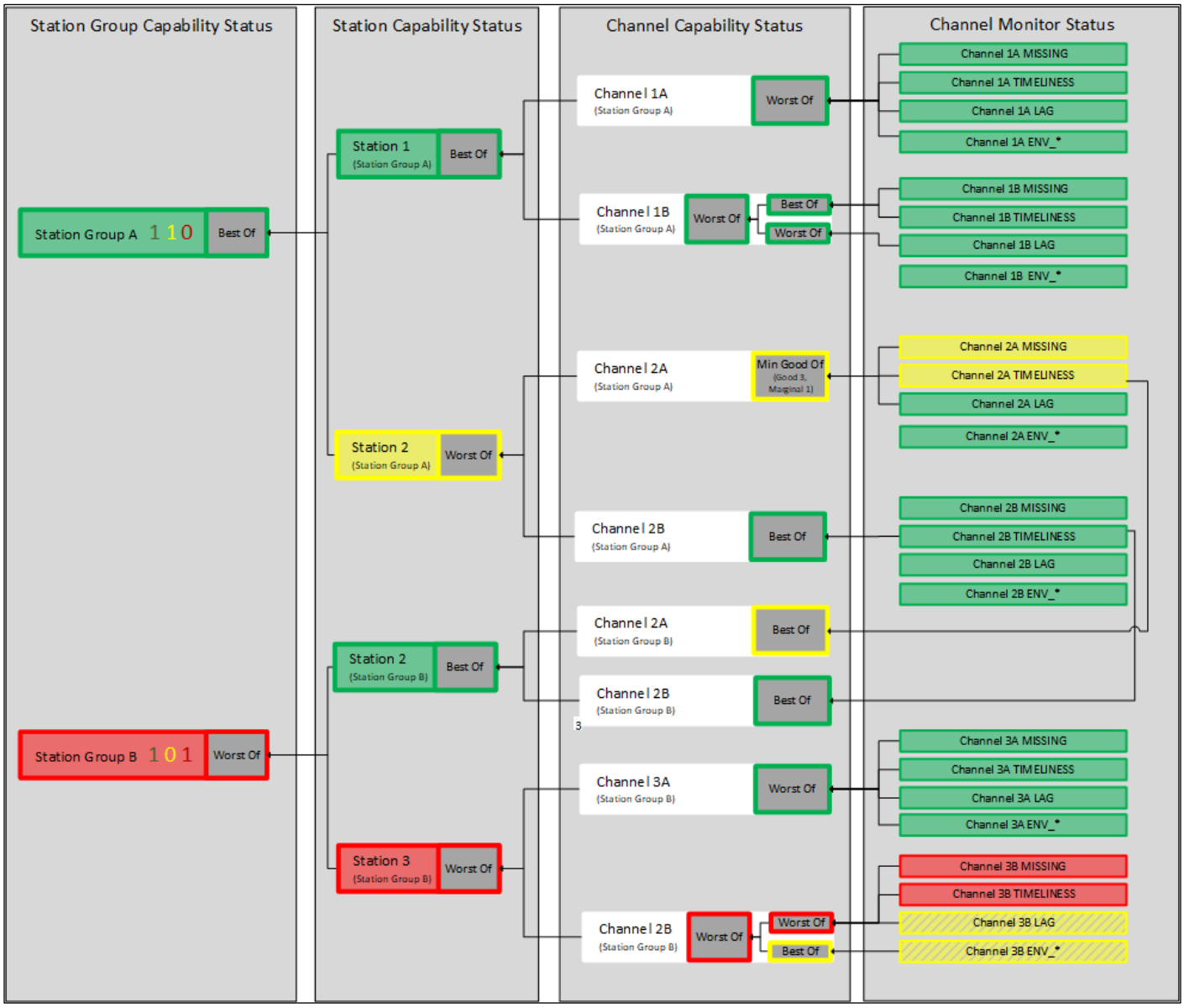

Figure 46. Flowchart Example of Capability SOH Status Rollup.

Capability SOH status rollup calculation begins by calculating the SOH status of each channel's monitors, see the Channel Monitor Status column in Figure 47. The monitors include missing data, timeliness, lag, and environmental issues. In Figure 47, all environment SOH monitor types are denoted as a single box and labeled as ENV_*.

Figure 47 depicts an arbitrary capability SOH status rollup, starting with monitors on the right and ending with station groups on the left. Arrows indicate which monitors, channels, or stations are input into a rollup operator (Worst-of, Best-of, or Min-Good-of).

A capability SOH status is only rolled-up if it meets criteria set by an applied rollup operator. There are three available rollup operators that can be applied to monitors, channels, or stations.

1) Best-of – Rolls up the best available monitor, channel, or station.

2) Worst-of – Rolls up the worst available monitor, channel, or station.

3) Min-Good-of – Rolls up the status of a monitor, channel, or station based on whether that SOH status meets or exceeds the marginal or good thresholds set by the user (see Configuration documentation).

A single operator can only have inputs of a single type, e.g., an input from a rollup operator and a monitor is not allowed. Additionally, rollup operators must obtain their capability SOH statuses using the hierarchy of stations, channels, and monitors. For instance, a station cannot get its capability SOH status directly from the monitors; it must get its status from the channels, which in turn got their SOH statuses from the monitors. The worst-of SOH status rollup described in Section Appendix A.1 is a special case of the capability SOH status rollup described here, where only the Worst-Of operator is applied throughout the flowchart (Figure 46).

Figure 47 demonstrates how the capability SOH status rollup and the rollup operators work. In this figure, Channel 2A in Station Group A has three monitors, missing data, timeliness, and lag while Channel 2B in Station Group A only has timeliness, as indicated by the single arrow.

A Min-Good-Of operator was applied to all three monitors in Channel 2A. The Min-Good-Of operator is defined with two thresholds, Good: 3 and Marginal: 1. This can be seen in the Channel 2A box under the Channel Capability Status column. These thresholds indicate that the Min-Good-Of operator will return:

- A good SOH status when 3 or more monitors have a good SOH status,
- A marginal SOH status if just one monitor has a good SOH status, or
- A bad SOH status if zero monitors have a good SOH status.

In Figure 47, the lag monitor has a good SOH status, but the missing and timeliness monitors have a marginal SOH status; therefore, Min-Good-Of returns an SOH status of marginal for Channel 2A. The Best-Of operator is only applied to the timeliness monitor in Channel 2B; it returns a good SOH status for Channel 2B.

Sometimes a channel's capability SOH status can be further rolled up by another operator. This is the case for Channel 3B in Station Group B, which applies another Worst-of operator to the returned SOH statuses from Best-Of (marginal SOH status) and Worst-of (bad SOH status) operators, thus returning a bad Channel Capability status for Channel 3B. The operations described above are repeated until each channel has its own SOH status.

These channel SOH statuses are then input into rollup operators to determine the station's capability SOH status. A Worst-of operator is applied to Channels 2A (marginal) and 2B (good) in Station Group A, resulting in a marginal capability SOH status for Station 2 in Station Group A.

The capability SOH status rollup is repeated for each station until every station has a capability SOH status. Note that the same station, e.g., Station 2 in Figure 47, can have a different capability SOH status in different groups. In this example, Station 2 has a marginal status in Station Group A and a good status in Station Group B. The rollup operators are applied to all stations until a station group capability SOH status is obtained. In Figure 47, a Best-Of operator is applied to Station 1 (good SOH status) and Station 2 (marginal SOH status) to return a good capability SOH status for Station Group A.

Like channel SOH statuses, a capability SOH status of a station or station group can be further rolled up by another operator. Also, multiple operators can be applied to different channels within a station or to different stations within a station group.

As shown in Figure 47, capability SOH status rollups can be defined by changing the monitors, channels, or stations used, and also the number of inputs to a rollup operator, the rollup operators applied, and the Min-Good-Of thresholds used; however, further details on these capability SOH status rollup configurations are beyond the scope of this document. For more information, see the Configuration documentation.

Appendix B. List of Environmental Issues

This is a list of available environmental issues in the SOH Config Tool, specifically representative of CD1.1 Station Issues. This list can be configured to include other environmental issues (see Configuration documentation).

1) Authentication Seal Broken

2) Backup Power Unstable

3) Calibration Underway

4) Clipped

5) Clock Differential Too Large

6) Dead Sensor Channel

7) Digitizer Analog Input Shorted

8) Digitizer Calibration Loop Back

9) Digitizing Equipment Open

10) Equipment Housing Open

11) Equipment Moved

12) GPS Receiver Off

13) GPS Receiver Unlocked

14) Main Power Failure

15) Station Power Voltage

16) Vault Door Opened

17) Zeroed Data

Appendix C. Hot Keys

The following table lists hot keys available for each display.

Operation	Hot Key
Load new configuration in Settings page	Ctrl + R
Force Reload	Ctrl + Shift + R
Toggle Developer Tools	Ctrl + Shift + I
Actual Size	Ctrl + O
Zoom In	Ctrl + +
Zoom Out	Ctrl + -
Toggle Full Screen	F11
Minimize	Ctrl + M
Close	Ctrl + W
Quit SOH Configuration Tool	Ctrl + Q
Undo	Ctrl + Z
Redo	Ctrl + Shift + Z
Cut	Ctrl + X
Copy	Ctrl + C
Paste	Ctrl + V
Select All	Ctrl + A

Appendix D. Release Notes

Appendix D.1. Fixes

- Fixed issue on Capability Rollups in which changing Rollup Type does not clear error that gets hidden by change

Appendix D.2 New Features

- An easy toggle switch was added to include/remove environmental issues for a station
- Added ability to View/Edit/Save/Validate Stations in a Station Group
- Added ability to View/Edit/Save/Validate Stations in a Station Group
- Users are now able to Add/Remove/Reorder Station Groups

Appendix D.3 Known Issues