Software Requirements Specification

for

Statistical Process Control

Version 1.5.5 draft

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Software Quality Engineering Postgraduate Course

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Table of Contents

Revision History

Name	Date	Reason For Changes	Version
Kamil Marek	2017-10-01	Initial document	0.1
Kamil Marek	2017-11-03	Added basics functionalities	0.2
Krystian Jędrzejowski	2017-11-05	Reviewed and approved	0.3
Grzegorz Szczutkowski	2017-11-08	Reviewed and approved	0.3
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Krystian Jędrzejowski	2018-02-01	Reviewed and approved	1.1
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1. Introduction

1.1. Purpose

This document describes requirements for web application for managing Statistical Process Control for any production process. Application helps ensure the process operates efficiently, producing more specification-conforming product with less waste

1.2. Document Conventions

Document is written in form of all elements present in application with possible actions, transitions and relationships.

1.3. Intended Audience and Reading Suggestions

This specification is intended for especially for technical stuff such as developers and testers. It is organized as a feature list of application.

1.4. References

Mike Down and Others, Statistical Process Control Reference Manual, second edition

2. Overall Description

2.1. Product Perspective

Statistical process control (SPC) is a method of quality control which employs statistical methods to monitor and control a process. This helps ensure the process operates efficiently, producing more specification-conforming product with less waste (rework or scrap). SPC can be applied to any process where the "conforming product" (product meeting specifications) output can be measured. An example of a process where SPC is applied is manufacturing lines. The application of SPC involves three main phases of activity:

- *Understanding the process and the specification limits.*
- *Eliminating assignable (special) sources of variation, so that the process is stable.*
- *Monitoring the ongoing production process, assisted by the use of control charts, to detect significant changes of mean or variation.*

Main purpose of "Statistical Process Control" application is to automate and facilitate last phase of SPC – monitoring the ongoing production process by providing tool for providing, storing and analyzing production data and automatically calculating metrics and control charts.

2.2. Product Functions

Application provides possibility of adding processes which reflects real production processes, then specifying multiple characteristics per each process and enables adding samples for each characteristic and automatically calculating SPC metrics and control charts.

2.3. Development environment

SPC application requires .NET Core version 1.1 and MS SQL Server 2012 Express Edition or later

2.4. Installation environment

SPC Application is designed to install on the following operating systems: Microsoft Windows XP or higher, Windows Server 2012 R2 or higher, Mac OS, Linux
SPC Application requires access to local or remote MS SQL Server Express Edition 2012 or later
Access to database server needs to be configured in file appsettings.Production.json

2.5. Operating Environment

Application is designed to work on any operating system which provides a web browser supporting HTTP protocol, HTML, CSS and JavaScript.
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2.6. Assumptions and Dependencies

Project depends on amCharts open source JavaScript library (www.amcharts.com) for displaying control charts.

3. External Interface Requirements

3.1. User Interface

3.1.1. **GUI**

The user interface is provided by web browser. Access includes forms and reports for the users to manage, enter data and displaying reports.

3.1.2. **Command Line**

There is no command line interface.

3.1.3. **API**

There is no API interface.

4. System Features

Application provides features for managing and analyzing processes and data security by authentication and authorization.

4.1. Logging to application

4.1.1 Description

To use application, user has to log in. Logging in is possible through logging page which should be the default page after navigating to application main address or any other when user is not logged in.

4.1.3 Functional Requirements

REQ-1: Logging form contains the following elements:
- "Email" text field
- "Password" password field
- "Remember me?" Checkbox
- "Log in" button

REQ-2: There is a link under logging form "Not registered yet? Register now" which directs user to the registration page

REQ-3: When a user entered username which is not registered, Error: "Invalid login attempt." is displayed

REQ-4: When a user entered valid username but wrong password, Error: "Invalid login attempt." is displayed

REQ-5: When a user enters login, which does not meet email requirement, Error "The Email field is not a valid e-mail address." is displayed

REQ-6: When a user enters login and leaves empty password, Error "The Password field is required." is displayed

REQ-7: - When user does not fill email textbox, "The Email field is required." Error is displayed

4.2. Registering new user

4.2.1. Description

Not registered user has a possibility to register a new account using valid email address and password that meets functional requirements.

4.2.2. Functional Requirements

REQ-1: Registration form contains following elements:
- "Create account" title
- "Email" text fil
- "Password" password field
- "Confirm password" password field

- "Register" button

REQ-2: There is the link under logging form
"Already a member? Log in" which directs user to the logging page

REQ-3: Requirements for password
- Length between 6 and 100 characters
- Minimum 1 Uppercase letter
- Minimum 1 lower case letter
- Minimum 1 number
- Minimum 1 non-alphanumeric character

REQ-4: Error messages displayed when the relevant requirement is not met
- "Password must be at least 6 and at max 100 characters long."
- "Passwords must have at least one uppercase ('A'-'Z'). "
- "Passwords must have at least one lowercase ('a'-'z'). "
- "Passwords must have at least one digit ('0'-'9')."
- "Passwords must have at least one non alphanumeric character."

REQ-5: Error message displayed when provided email does not meet email format
- "Entered email is not a valid e-mail address."

REQ-6: Error message displayed when provided a confirmation password does not meet password
- "The password and confirmation password do not match."

REQ-7: Requirements for email
- Email must consist of local-part, @ and domain-part
- Local-part length is minimum 1 character, maximum 20 characters
- Local-part can contain
  - uppercase and lowercase Latin letters `A` to `Z` and `a` to `z`
  - digits `0` to `9`
  - dot `.` hypen `-` underscore `_`
- domain-part consists of two parts separated by dot
- requirements for both parts
  - uppercase and lowercase Latin letters `A` to `Z` and `a` to `z`;
  - digits `0` to `9`, provided that top-level domain names are not all-numeric;
  - hyphen `-`, provided that it is not the first or last character.
- Requirements for part before dot
  - Length minimum 2 characters maximum 30 characters
- Requirements for part after dot
  - Length minimum 2 characters maximum 3 characters

REQ-8: When user clicks Register button but Email textbox is empty, error "The Email field is required." Error is displayed

REQ-9 When user clicks Register button but Password textbox is empty, error "The Password field is required." is displayed

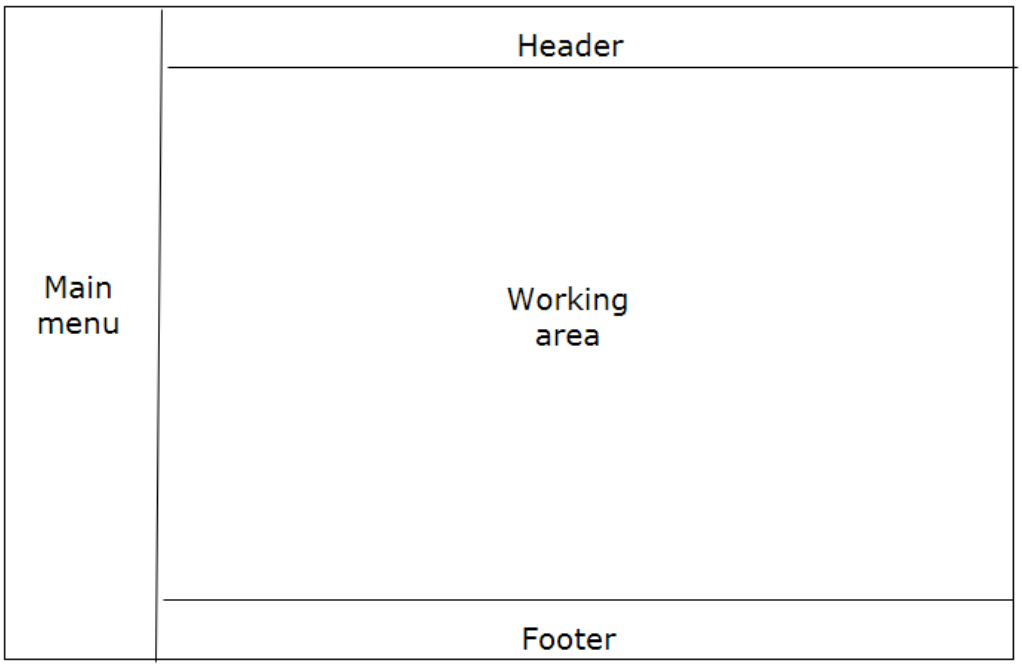
REQ-10. When user tries to Register account for email which is already registered, Error "Username '<email>' is already taken." Is displayed where <email> is replaced by actual email.

4.3. Home page

4.3.1. Description

Home page is opened after user logs in to application. It contains Main menu, header working area and footer. Content of the working area depends of actually selected operation

4.3.2. Layout



4.4. Main menu

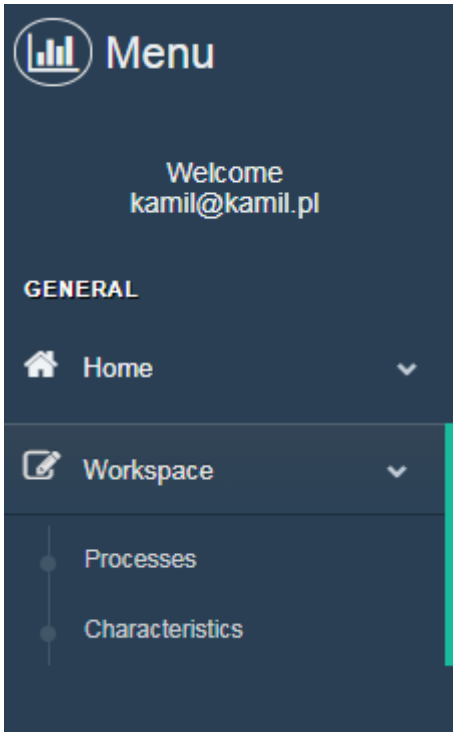
4.4.1. Description

Main menu is located on the left side of main page. Menu can be expanded or collapsed using expand/collapse button located on Header. By default, menu is displayed expanded.

4.4.2. Functional Requirements

REQ-1: Expanded menu contains following items

- Graph Icon with “Menu” text next to it
  Clicking icon or text should redirect the user to home page.
- Welcome text which contains an email of logged in user
- “General” text
- Home menu item with “Home” text next to it
  Clicking expands home submenu and collapse other submenus
- Dashboard submenu item
- Workspace menu item with “Workspace” text next to it
  Clicking expands the workspace submenu and collapse other submenus

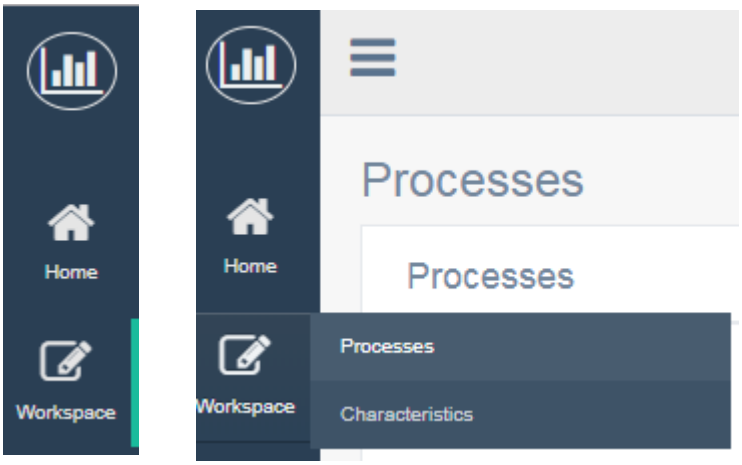


- Processes submenu item

Characteristics submenu item

REQ-2: Collapsed menu contains following items

- Graph Icon
- Home icon with “Home” text below
  Clicking expands home submenu on the right
- Workspace icon with “Workspace” text below
  Clicking expands home submenu on the right



REQ-3: Bottom-left corner of menu has Logout button which logs out user and redirects to Login page.

REQ-4: After logout, popup “User successfully logged out” is displayed

4.5. Header

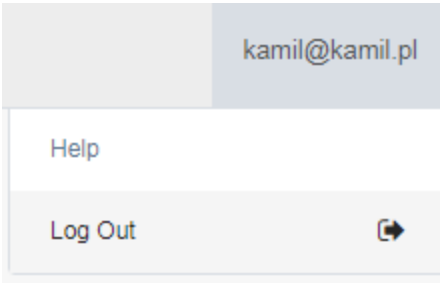
4.5.1. Description

Header is visible always and offers the possibility to expand/collapse main menu, get access to help pages and logout from application.

4.5.2. Functional Requirements

REQ-1: Expand/collapse button is located on the left side of header. The is no text, only icon

REQ-2: Email of actual logged in user is located on the right side of header. Clicking it expands a settings menu which contains “Help” and “Log Out link with Logout icon.



REQ-3: Clicking Help menu item shows help subpage.

REQ-4: Clicking logout menu item logs out the user and redirects to logging page.

REQ-5: After logout, popup “User successfully logged out” is displayed

4.6. Footer

Footer contains a name of the application and actual installed version.

4.7. Application Dashboard

4.7.1. Description

Purpose of Application Dashboard is to display most important information about available processes

4.7.2. Functional Requirements

REQ-1: When there is no process defined, text “There are no processes defined” is displayed on the working area
REQ-2: When there is no process defined, “Create your first process” button which redirects user to “Create new process” form
REQ-3: When at least one process exists, table with the process list is displayed. Each row represents one process and contains buttons for editing and deleting process

4.8. Processes

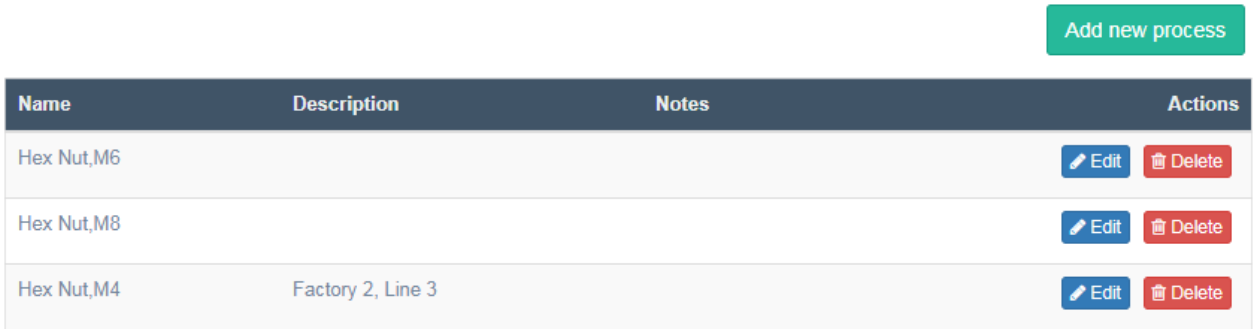
4.8.1. Description

Process

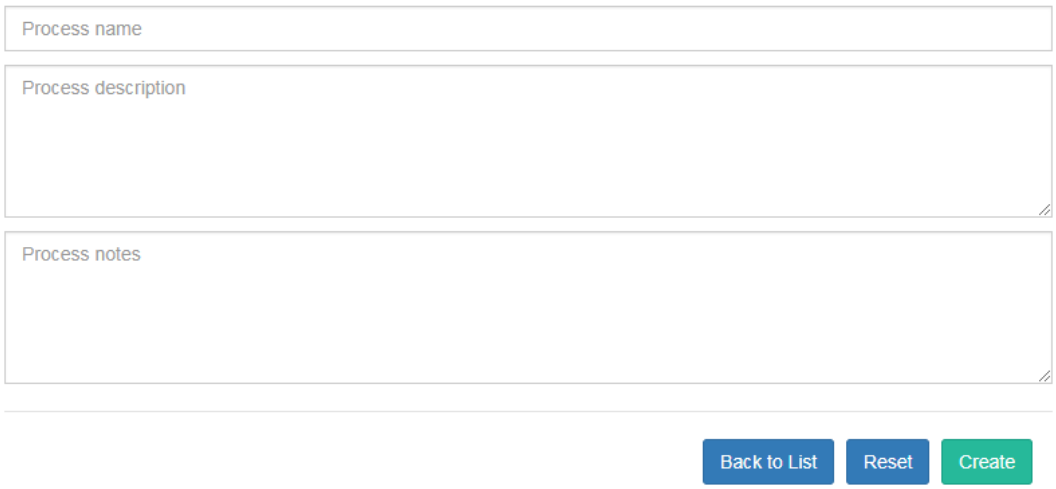
Processes page contains table with the list of all defined process and "Add new process" button. Table has four columns: Name, Description, Notes and Actions.

Page can be collapsed/expanded using arrow on top of the page.

4.8.2. Process list



4.8.3. Form for adding new process



4.8.4. Form for process editing

Form is similar to the form for adding new process but button has Save label instead of Create.

4.8.5. Functional requirements

REQ-1: Process Name requirements

- Required field

- Length between 3 and 30 characters
- Name can contain upper case letters, lower case letter [a-z], numbers, spaces and special characters

REQ-2: Process Description requirements
- Optional field
- Maximum length is 256 characters

REQ-3: Process Notes requirements
- Optional field
- Maximum length is 256 characters

REQ-4: Given all fields requirements are met, when user clicks Create button then new process is created and user is redirected to process list. Pop up window "New process has been created" is displayed for 3 seconds.

REQ-5: Given at least one field requirement is not met, when user clicks Create button then proper error is displayed and new process is not created. User stays at form view with all entered values preserved.

REQ-6: Error messages for Create Process
- "The field Name must be a string with a minimum length of 3 and a maximum length of 30." – when Process Name does not meet length requirements
- "The Name field is required." When Process Name was not filled
- "The field Description must be a string with a maximum length of 256." – when Process Description does not meet length requirements
- "The field Notes must be a string with a maximum length of 256." – when Process Notes does not meet length requirements

REQ-7: "Reset" button clears all field on form

REQ-8: "Back to List" button redirects user to list of processes. Any entered values are lost.

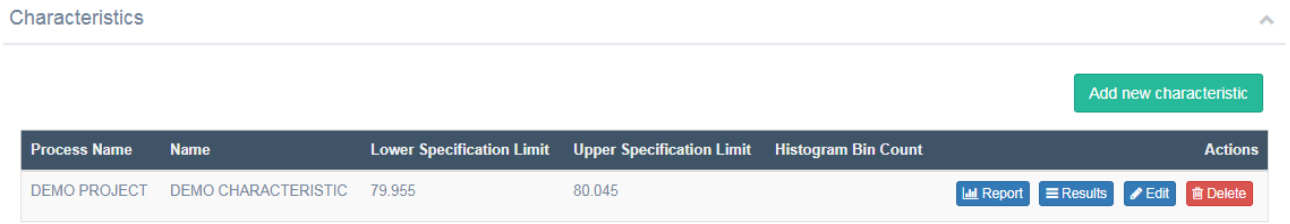
REQ-9: When user is od Edit form and all fields requirements are met, when user clicks Save button then edit form is closed and user is redirected to process list. Pop up window "Process has been saved" is displayed for 3 seconds.

4.9. Characteristics

4.9.1. Description

Characteristics are used to store results for particular metric which are basics for calculating reports and quantitative measures of the stability of the processes. One process can have multiple characteristics but characteristic can belong only to one process.

4.9.2. Characteristic list

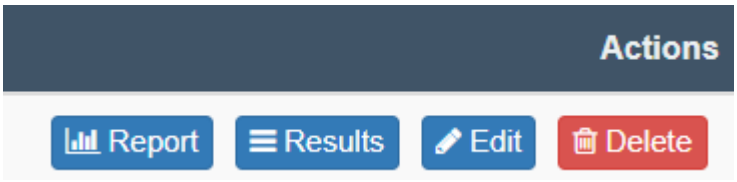


Every characteristic occupies exactly one row in the table. Table contains following columns:

- Process Name
- Name
- Lower Specification Limit
- Upper Specification Limit
- Histogram Bin Count
- Actions

Actions column contains 4 action buttons

- Report
- Results
- Edit
- Delete



Actions related to Action buttons

Action button	Action	More information
Report	Report page is opened	See 4.11
Results	Results page is opened	See 4.10
Edit	Edit form is opened	See 4.9.4
Delete	Delete confirmation dialog is opened	See 4.9.5

4.9.3. Adding new characteristic

When user clicks ‘Add new characteristic’ button, new form is opened.

Form contains following fields

Field name	Field type	Is required	Other requirements	Error message
Select process	Dropdown list	Yes	List contains all processes	The value 'Select process' is not valid for ProjectId.
Characteristic name	Textbox	Yes	Length min 3 characters, max 30 characters	The field Name must be a string with a minimum length of 3 and a maximum length of 30.
Lower Specification Limit	Textbox	Yes	Number with dot (.) as decimal separator Number 0,00 to 99999,99	The value 'a' is not valid for Lower Specification Limit.
Upper Specification Limit	Textbox	Yes	Number with dot (.) as decimal separator Number 0,00 to 99999,99	The value 'd' is not valid for Upper Specification Limit.
Histogram bin count	Textbox	No	Integer	-

4.9.4. Editing characteristic

Characteristic can be edited using Edit button from characteristic list.
Edit characteristic form is displayed, which contains the same fields as form for Create new characteristic and 3 buttons: Back to List, Reset and Save.

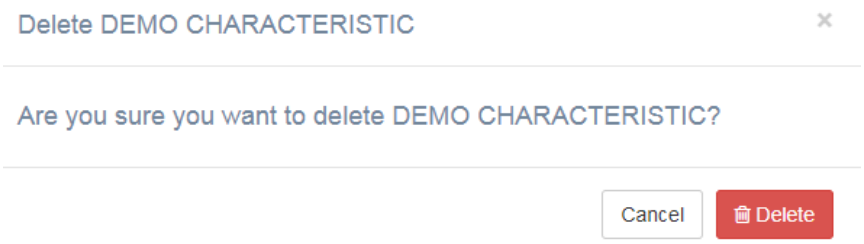
There is no confirmation dialog displayed when saving characteristics.

'Edit characteristic' form have the same requirements as 'Add new characteristic' form, also the same error messages should be displayed if particular value does not meet requirement.

4.9.5. Deleting characteristic

Characteristic can be deleted using Delete button from characteristic list. Confirmation dialog is displayed where the user can cancel request or confirm. Only confirmation results in deleting Characteristics with all results.

Confirmation dialog example:



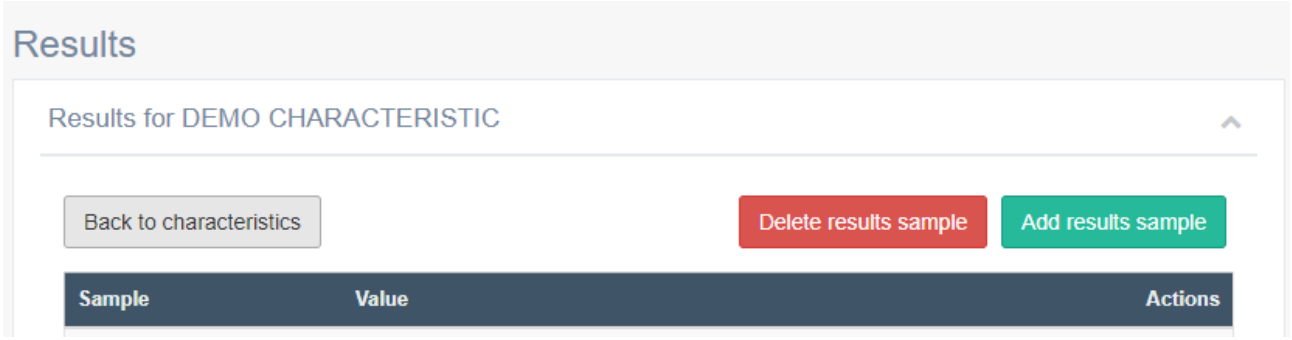
4.10. Results

Results are used for storing measurements for certain characteristics. Results are the basis for reports and process quality characteristics.

Result page contains three main buttons

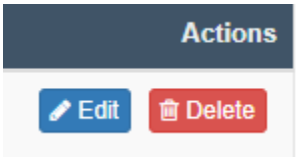
Back to characteristics – which should redirect user back to Characteristic page
Delete results sample – which should open 'Delete results sample' dialog

Add results sample – which should open ‘Add results sample’ dialog.



Below there is a table for displaying already added results with columns Sample, Value and Actions.

‘Actions’ column contains buttons Edit and Delete



Edit button opens Dialog Edit results

4.10.1. Adding results

Adding results is possible via samples (set of results) using the “Add Sample” button available on the results page. Sample contains name and set of semicolon-separated results. Single result should use comma (,) as a decimal separator. While loading, results are split by semicolon and every result becomes one row in a table.

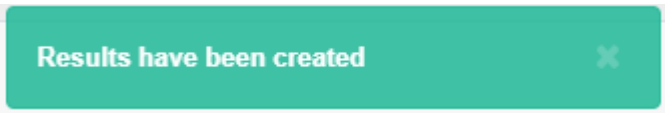
Add sample dialog have title “Add results sample for *characteristic_name*” and contains following fields:

Field name	**Field type**	**Is required**	**Other requirements**	**Error message**
Sample name	Textbox	Yes	Length min 3 characters, max 30 characters	Cannot add results. Check values and try again
Results	Textbox	Yes	Semicolon-separated numbers	Cannot add results. Check values and try again

	Number max 12 chars with dot (.) as decimal separator

Form has two buttons:
Create – which closes dialog and adding results to database
Cancel – which closes dialog but not adding results to database

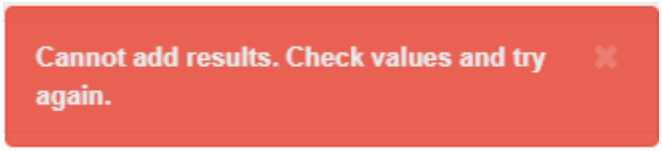
When all fields have correct values, information Results have been created is displayed after clicking **Create** button



Popup can be closed using **x** button or is automatically closed after 5 seconds.

When any field has incorrect values, error Cannot add results. Check values and try again is displayed after clicking **Create** button.

Error popup:



Error popup can be closed using **x** button or is automatically closed after 5 seconds.

4.10.2. Editing results

Results can be edited one-by-one using edit button or by sample using Edit Sample button.

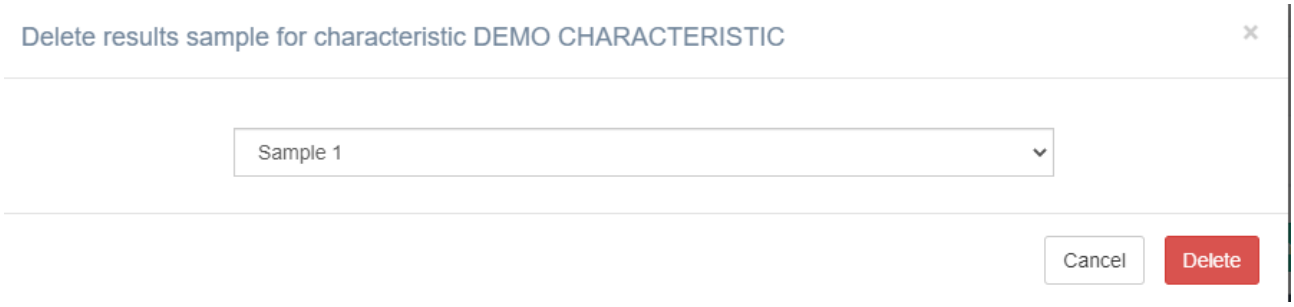
Clicking Edit button for selected result opens dialog Edit result

Same requirements for text fields apply as for Adding results. Clicking Cancel button closes form without saving changes.
Clicking Save button closes form and then proper popup should be displayed (the same as for Adding results sample)

4.10.3. Deleting results

Results can be deleted one-by-one using Delete button or by sample using Delete Sample button.

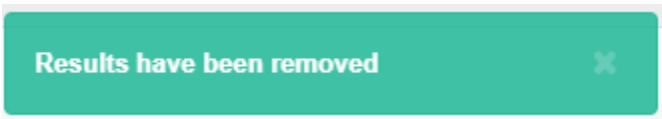
Delete sample dialog:



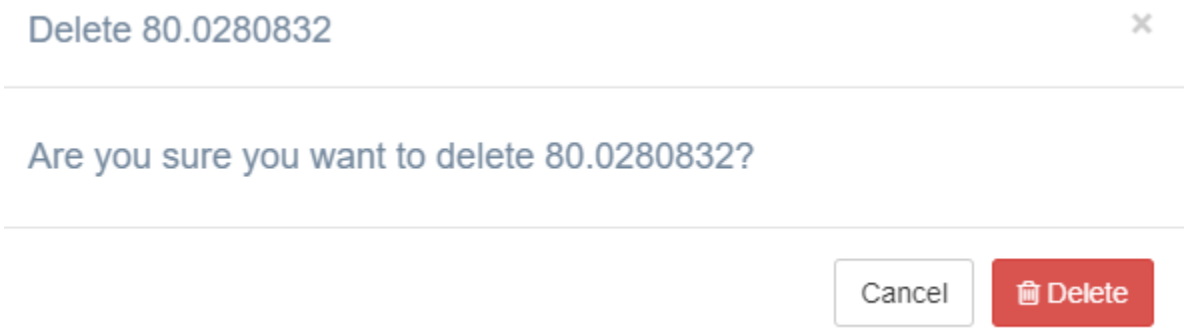
Dropdown list (Default value: **Select sample**) should allow to select any existing sample for characteristic.

Clicking Cancel button closes popup without deleting any results.

Clicking Delete button deletes all results for selected sample. Confirmation popup ‘Results have been removed’ should be displayed:

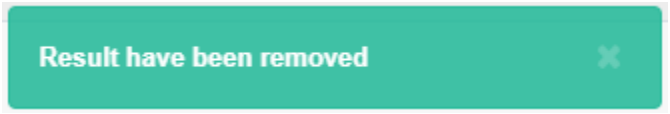


Delete single result dialog:



Clicking Cancel button closes popup without deleting any results.

Clicking Delete button deletes selected result. Confirmation popup ‘Result have been removed’ should be displayed:



4.11. Reports

4.11.1. Table

Results table contain process quality attributes calculated based on all characteristic results

- Lower Specification Limit (LSL) – specified during creation of characteristic
- Upper Specification Limit (USL) – specified during creation of characteristic
- Mean(x) – arithmetic mean value (Average)

$$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$$

Where
n – total number of results
x_i – value of each individual result

– Standard deviation (s)

$$s = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}}$$

x – mean value
n – total number of results
x_i – value of each individual result

– Performance Index (Pp)

Performance compares the process performance to the maximum allowable variation as indicated by the tolerance. This index provides a measure of how well the process will satisfy the variability requirements. Pp is calculated by

$$P_p = \frac{USL - LSL}{6 \cdot s}$$

– Lower process performance index (Ppl)

$$P_{pl} = \frac{\bar{x} - LSL}{3 \cdot s}$$

– Upper process performance index (Ppu)

$$P_{pu} = \frac{USL - \bar{x}}{3 \cdot s}$$

– Process performance index (Ppk)

Process performance index takes the process location as well as the performance into account. For bilateral tolerances Ppk will always be less than or equal to Pp. Ppk will be equal to Pp only if the process is centered.
Ppk is calculated as the minimum of Ppu and Ppl

$$P_{pk} = min\{P_{pl}; P_{pu}\}$$

4.11.2. Histogram

Histogram is visual interpretation of results and and specified limits (lower and upper). Value Ranges is divided into equivalence classes. Number of equivalence classes is integer value taken from Histogram Bin Count specified for characteristic, or if not specified – calculated from following formula:

$$k \approx 1 + 1{,}3 \cdot \log(n)$$

Range of results that are taken into one equivalence class is calculated from formula:

$$c \approx \frac{result_{max} - result_{min}}{k}$$

Frequency axis shows numbers of results for particular equivalence classes.

4.11.3. Functional Requirements

REQ-1: Histogram provides additional possibilities by menu, which can be expanded from top-right corner of graph area
REQ-2:Menu provides possibility to save histogram as image in following formats
- PNG
- JPG
- SVG
- PDF

REQ-3: Menu provides possibility to export data to following formats:
- CSV
- XLSX
- JSON

REQ-4: Menu provides possibility to annotate chart area and then clear changes or download modified chart as any of formats specified in REQ:2
REQ-5: Menu provides functionality to print Histogram via any of installed printers

5. Nonfunctional Requirements

5.1. Performance Requirements

PERF-REQ-1: All actions performed after clicking any button must be completed within 2 seconds.
PERF-REQ-2: Loading home page after successfully logging must be completed within 5 seconds.

5.2. Safety Requirements

Backups of the databases should be done hourly and be kept for one week.

5.3. Security Requirements

All data can be accessed only by authenticated and authorized users. User cannot access data which belong to another user.
Databases should be behind a firewall.

5.4. Software Quality Attributes

Availability should be at least 99,7% time.
Maintenance window cannot be longer than 30 minutes.

Appendix A: Glossary

SPC – Statistical Process Control

Ppk – Process Performance Index

Ppl - Lower Process Performance Index

Ppu – Upper Process Performance Index

s – Standard deviation

Pp - Performance Index

x – mean (average)

LSL – lower specification limit

USL – upper specification limit

n – number of results

Appendix B: Analysis Models

Diagram 1: Relationships between Process, Characteristic, Result sample and results