ExHAC Reference Manual

Version 2.0

IEC Standard: IEC 60079-10-1 Ed. 3.0

EngWorks.ca

Table of Contents

# Welcome to the ExHAC Users Guide

Thank you for purchasing the ExHAC Application software for performing a classification design in accordance with IEC 60079-10-1 standard for the classification of areas where an explosive gas atmosphere may exist.

The following sections in this User Guide will help guide you through the configuration process for performing a classification design using the ExHAC software. There are multiple parameters that must be configured for a valid assessment. Many of these parameters require the application of engineering judgement to ensure an analysis is performed in a proper way. We highly recommend that you complete the ExHAC Hazardous Area Classification training course prior to using the software. The course provides you with the necessary insight into how an analysis is performed using the ExHAC software and the IEC standard.   The training course also provides several application examples that will further assist you in performing an analysis.

Home Page

The ExHAC Home page is where you start your analysis.
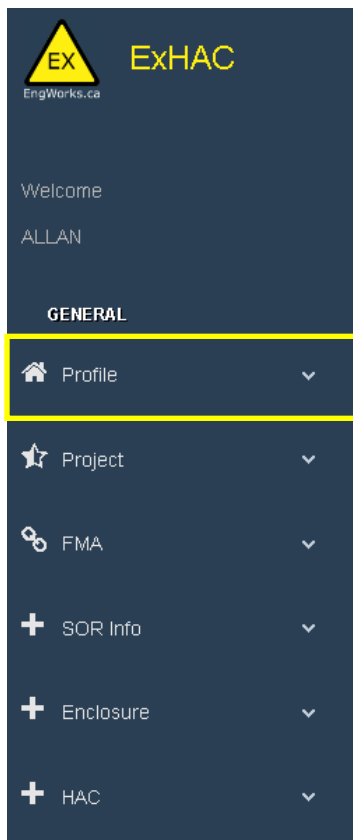
| Profile	Permits you to change passwords to the application
Project	Allows you to configure project information
FMA	Allows you to perform a Flammable Mixture Analysis
SOR Info	Allow you to configure a Source of Release
Enclosure	Allows you to configure an Enclosure surrounding a source of release
HAC	Allows you to select the Project, FMA, SOR and Enclosure for analysis

Profile Page
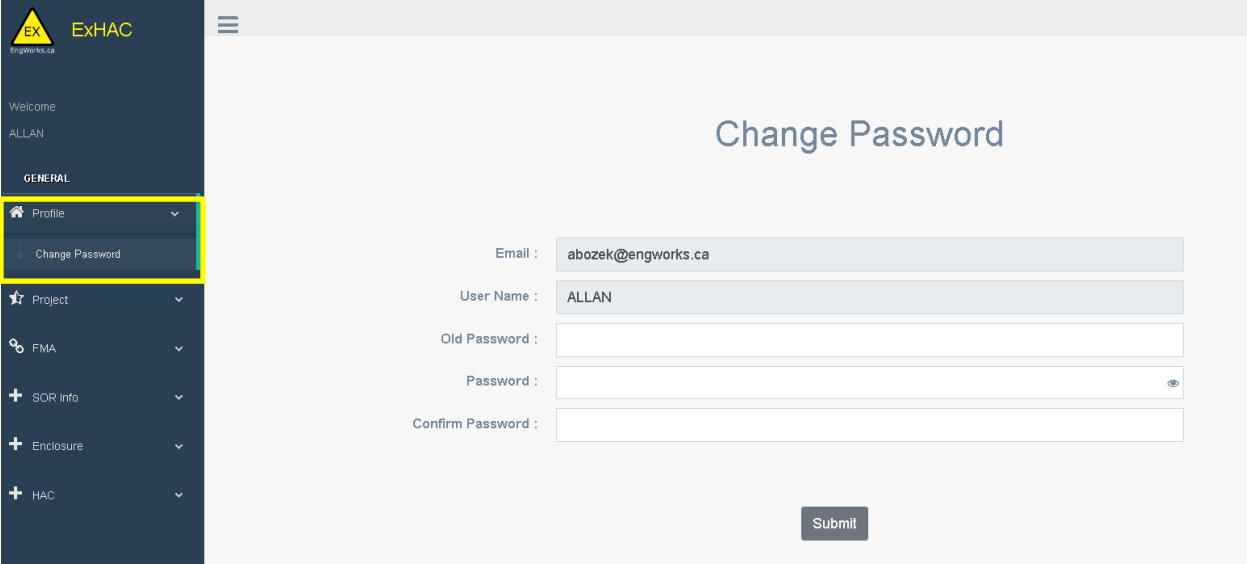
The profile page permits you to change the password assigned to the application based on the email address provided. It is recommended that you change the default password here when you use the application for the first time.

Project
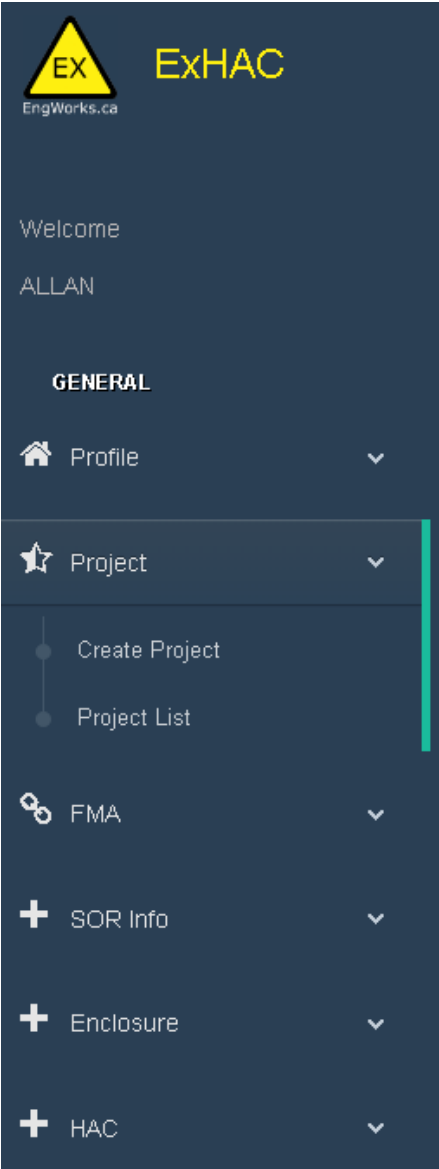
Every HAC analysis must be tied to a project which defines the high-level project parameters. You may store multiple projects in your project database.

Project	Allows you to configure project information
Create Project	Create a project for inclusion in the Project database
Project List	Select a project from the Project Database

Create Project

To create a project entry for inclusion in your project database, enter the project information as indicated. Press **SUBMIT** to store the project in your project database.

Create Project

User Project Number*:	ExHAC Example 7
Project Name*:	Forced Ventilated Enclosure Application
Altitude(m)*:	100.0
Min Ambient Temperature(°C)*:	0.00
Max Ambient Temperature(°C)*:	40.00
Location*:	Process Building
User Project Description:	Example of a forced ventilated enclosure application

Submit   Cancel

User Project Number	The project number or code is a unique identifier that you can use to manage your projects.
Project Name	The project name as you describe it.
Altitude	Enter the project altitude if known. Enter 0 if unknown. ExHAC compensates for effects of atmospheric pressure in release calculations using this parameter.
Min. Ambient Temperature	Enter the expected minimum ambient temperature of the application.
Max. Ambient Temperature	Enter the expected maximum ambient temperature of the application.
Location	Enter the project location.
User Project Description	Enter any additional information that helps with documenting the assessment.

Project List

Your projects will appear in the Project List database once you create a project. You may edit the project parameters using the **EDIT** Function or delete a project using the **DELETE** function.

Note that if a HAC analysis is connected to a project, you cannot delete the project until the HAC analysis is deleted.

Project List search function will search all cells in the project database to allow you to find a specific project if you know the specific parameters you are looking for.

Project List

[Search]

#	User Project Number	Project Name	Altitude(m)	Min Ambient Temperature(°C)	Max Ambient Temperature(°C)	Location	Create DateTime		
1	ExHAC Example 1	Fuel Gas Manifold	1000	-40	40	Refinery	2023-07-17 10:59:59	Edit	Delete
2	ExHAC Example 2	Propane Tank	500	-40	40	Propane Filling Station	2023-08-01 14:56:18	Edit	Delete
3	ExHAC Example 3	Gasoline Pump	500	-20	40	Gasoline storage facility	2023-08-01 15:00:00	Edit	Delete
4	ExHAC Example 4	Benzene Pump	200	-10	32	Petrochemical Plant	2023-08-01 15:13:44	Edit	Delete
5	ExHAC Example 5	Hydrogen Compressor	450	-15	40	Refinery	2023-08-01 15:16:03	Edit	Delete
6	ExHAC Example 6	Crude Dehydration Vessel	10	-15	40	Oil Battery	2023-08-01 15:19:04	Edit	Delete
7	ExHAC Example 7	Forced Ventilated Enclosure Application	100	0	40	Process Building	2023-08-02 12:32:27	Edit	Delete
8	ExHAC Example 8	Naturally Ventilated Process Building	300	-32	40	Process Building in Oil Battery	2023-08-02 12:38:17	Edit	Delete

FMA – Flammable Mixture Analysis

The flammable mixture analysis tab is a powerful tool to help you assess the properties of flammable compounds. It will handle both pure flammable compounds and compound mixtures consisting of more than one flammable compound. To perform a HAC analysis, you will have to configure your flammable compound mixture within the FMA module.
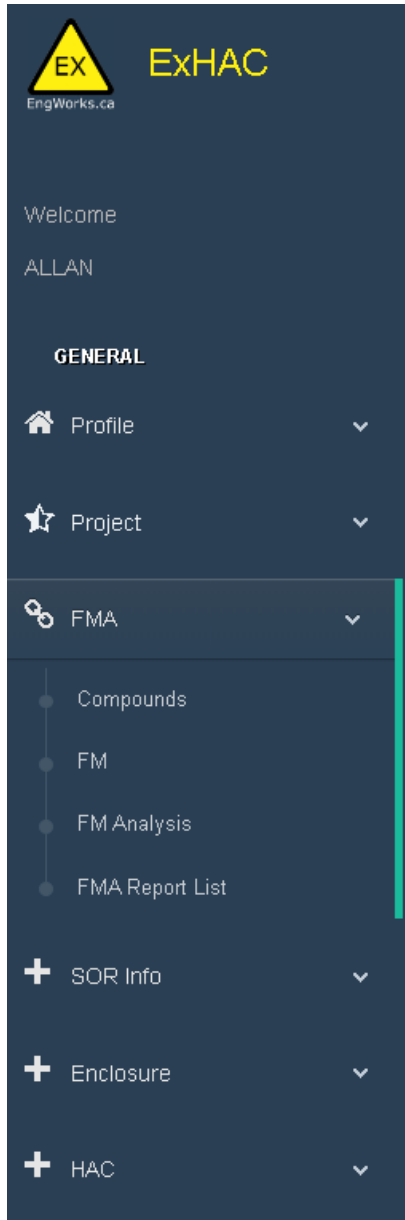
Compounds	Allows you to create a compound in the FM compound database or search for a preconfigured compound in the ExHAC compound database.
FM	Allow the creation of a flammable mixture for analysis.
FM Analysis	Permits you to select a configured flammable mixture for analysis and create a report summarizing the analysis.
FMA Report List	Allows you to retrieve a Flammable Mixture Analysis report.

Compounds Management

Generic Compounds

ExHAC incorporates a compound database to help you configure your flammable mixture. The database incorporates both flammable materials based on IEC 80079-20-1 and some commonly found non-flammable compounds that may influence the properties of a flammable mixture.

Compounds Management

Custom Compounds

No.	Compound Name	MW[kg/kmol]	MESG[mm]	MIC Ratio	LFL[%]	UFL[%]	Flashpoint[°C]	Boiling Point[°C]	AIT[°C]	Cp [kJ / kg K]	Pvap @20 °C [kPa]	Custom Compound Type		
1	Turpentine	136	1		0.8	6	35	154	253	1.72	0.67	Flammable	Edit	Delete

Generic Compounds

No.	Compound Name	MW[kg/kmol]	MESG[mm]	MIC Ratio	LFL[%]	UFL[%]	Flashpoint[°C]	Boiling Point[°C]	AIT[°C]	Cp [kJ / kg K]	Pvap @20 °C [kPa]	Compound Type
1	N2	28.014						-195.8		1.04	3395	Inert
2	H2O	18.015						99.98		4.18	2.34	Inert
3	CO2	44.01						-78.5		0.85	5729	Inert

To search for a preconfigured compound, enter the compound name in the Generic Compound search bar and the relevant matches will appear along with their relevant area classification material parameters.

Generic Compounds

No.	Compound Name	MW[kg/kmol]	MESG[mm]	MIC Ratio	LFL[%]	UFL[%]	Flashpoint[°C]	Boiling Point[°C]	AIT[°C]	Cp [kJ / kg K]	Pvap @20 °C [kPa]	Compound Type
1	N2	28.014						-195.8		1.04	3395	Inert
2	H2O	18.015						99.98		4.18	2.34	Inert
3	CO2	44.01						-78.5		0.85	5729	Inert
4	Methanol	32.042	0.92	0.82	6	36	9	64.7	440	2.5	13	Flammable
5	CO	28.01	0.84		10.9	74	-191	-191.5	607	1.04	3494	Flammable
6	H2S	34.081	0.83		4	45.5	-82.4	-60.3	260	1.01	1781	Flammable
7	Diesel No 2	170.335	0.94		0.6	6.5	52	175	254	2.21	0.055	Flammable

Custom Compounds

If a predefined compound does not exist in the generic compound database, or, if the preconfigured compound does not match the compound in your application, you can create a custom compound by pressing the CREATE NEW CUSTOM COMPOUND button.

Compounds Management

| Custom Compounds | [   ] Search | Create New Custom Compound |
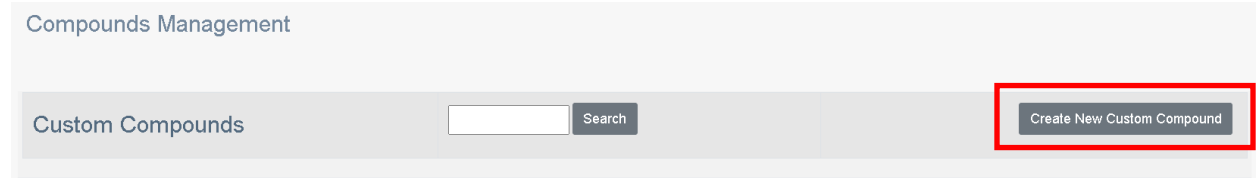
Enter the new custom compound information into the form and press **Submit**.

Create New Custom Compound

Compound Name*	Turpentine
Custom Compound Type*	Flammable
Molar Mass [kg/kmol]*	136.000
Boiling Point[°C]*	154.00
MESG[mm]*	1.00
MIC Ratio	
LFL[%]*	0.80
UFL[%]*	6.00
Pvap @20 °C [kPa]*	0.670
Flashpoint[°C]*	35.00
Cp [kJ / kg K]*	1.72
AIT[°C]*	253.00

Submit   Cancel

Note that to save the new custom compound you must enter all the information listed except for the MIC ratio. The new custom compound will appear in the custom compound section of the Compounds Management database.

Compounds Management

| Custom Compounds | [   ] Search | Create New Custom Compound |

No.	Compound Name	MW[kg/kmol]	MESG[mm]	MIC Ratio	LFL[%]	UFL[%]	Flashpoint[°C]	Boiling Point[°C]	AIT[°C]	Cp [kJ / kg K]	Pvap @20 °C [kPa]	Custom Compound Type		
1	Turpentine	136	1		0.8	6	35	154	253	1.72	0.67	Flammable	Edit	Delete

Flammable Mixtures

Once you have determined that all the compounds needed to configure your flammable mixture, you are required to add your flammable mixture to the flammable mixture database in the ExHAC FM tab. There are two sections to the FM database. **Custom Flammable Mixtures** are mixtures that you create. **Generic Flammable Mixtures** are preconfigured flammable mixtures included with the ExHAC application.

To create a custom flammable mixture, press the **ADD NEW FLAMMABLE MIXTURES** button. Enter the name of the flammable mixture you wish to analyze.

Next step is configuring the flammable mixture using the compounds listed in the compounds database. Enter the mole% values in the table provided. ExHAC handles all heavy end hydrocarbons as C11+ and it will estimate the vapour pressure of the mixture using C11 as basis. This will provide a conservative value for vapour pressure. If a more accurate estimate of the crude heavy ends is required, you may enter the boiling fractions as a custom compound tab. Be sure that the mole% adds up to 100% before pressing SAVE.

Flammable Mixture

| Mixture Number: | FM20240006 |
| Mixture Name: | Heavy Crude Oil |

Generic Compounds

No.	Mole %	Compound Name	Compound Type	MW[kg/kmol]	MESG[mm]	MIC Ratio	LFL[%]	UFL[%]	Flashpoint[°C]	Boiling Point[°C]	AIT[°C]	Cp [kJ / kg K]	Pvap @20 °C [kPa]
1	38.00	C11+	Flammable	156.308	1.05		0.6	6.5	62	195.9	206	2.18	0.037
2	15.00	n-Decane	Flammable	142.282	1.05		0.7	5.6	46	174.1	210	2.17	0.128
3	14.00	n-Nonane	Flammable	128.255	0.94		0.7	5.6	30	150.8	205	2.19	0.421
4	12.00	n-Octane	Flammable	114.229	0.94		0.8	6.5	13	125.6	206	2.21	1.39
5	10.00	n-Heptane	Flammable	100.202	0.91	0.88	0.85	6.7	-7	98.4	204	2.22	4.72
6	5.00	n-Hexane	Flammable	86.175	0.93	0.88	1	8.9	-22	68.7	225	2.23	16.2
7	4.00	n-Pentane	Flammable	72.149	0.93	0.97	1.1	8.7	-40	36.1	243	2.29	56.6
8	2.00	n-Butane	Flammable	58.122	0.98	0.94	1.4	9.3	-60	-0.5	372	1.71	208

Upon success, the "FM successfully Created" message will appear, and the flammable mixture will appear in the Custom Flammable Mixtures Database.

Flammable Mixtures

Add New Flammable Mixtures

Custom Flammable Mixtures

No.	Mixture Name		
1	Heavy Crude Oil	Edit	Delete
2	Pentane	Edit	Delete
3	Crude Oil	Edit	Delete
4	Hydrogen	Edit	Delete
5	Benzene	Edit	Delete
6	Propane	Edit	Delete

To edit the composition of a custom flammable mixture, press the **Edit** tab for mixture of concern and you can edit the composition of the mixture. You may also delete a custom flammable mixture from the database provided it has not been used in an FM Analysis.

FM Analysis Management

Next step is to perform an analysis of the custom flammable mixture that you have created. To do so, Press the ADD NEW FMA button in the FM analysis tab.

The CREATE New FM Analysis will appear. Select the new flammable mixture by clicking on the select function corresponding to the mixture you want to analyze. A search function is also available to help locate the mixture to be analyzed.

Once you have selected the flammable mixture, the composition will appear as well as the START ANALYSIS button.

Create New FM Analysis

Available Flammable Mixtures

	Mixture Name	Mixture Type
Select	Propane	Custom
Select	Benzene	Custom
Select	Hydrogen	Custom
Select	Crude Oil	Custom
Select	Pentane	Custom
Select	Heavy Crude Oil	Custom
Select	Natural gas	Generic
Select	Gasoline	Generic

Selected Flammable Mixture Composition : Heavy Crude Oil

Generic Compounds

Compound Name	Mole %	MW[kg/kmol]	MESG[mm]	MIC Ratio	LFL[%]	UFL[%]	Flashpoint[°C]	Boiling Point[°C]	AIT[°C]	Cp [kJ / kg K]	Pvap @20 °C [kPa]
C11+	38.00	156.308	1.05		0.6	6.5	62	195.9	206	2.18	0.037
n-Decane	15.00	142.282	1.05		0.7	5.6	46	174.1	210	2.17	0.128
n-Nonane	14.00	128.255	0.94		0.7	5.6	30	150.8	205	2.19	0.421
n-Octane	12.00	114.229	0.94		0.8	6.5	13	125.6	206	2.21	1.39
n-Heptane	10.00	100.202	0.91	0.88	0.85	6.7	-7	98.4	204	2.22	4.72
n-Hexane	5.00	86.175	0.93	0.88	1	8.9	-22	68.7	225	2.23	16.2
n-Pentane	4.00	72.149	0.93	0.97	1.1	8.7	-40	36.1	243	2.29	56.6
n-Butane	2.00	58.122	0.98	0.94	1.4	9.3	-60	-0.5	372	1.71	208

Press START ANALYSIS and the results will be displayed.

Within the results, you have the option to select the AIT calculation method and/or override the Auto Ignition temperature and the group classification based on your own engineering judgement. To change the AIT Calculation method, choose a selection from the drop-down menu. To manually override the Auto Ignition Temperature, select "User Defined" from the drop-down menu and enter the value you desire.

Be sure to enter "Start Analysis" to update your analysis and enter "Save Analysis" to save any changes to your analysis. This will store your results for later use in an HAC analysis.

FMA Report List

To view the results of your FM Analysis in an IEC format, you must create a report in the FM Analysis menu. Click on **CREATE REPORT** to view your analysis.

If the report is satisfactory, Click on **SAVE REPORT** and the results will be saved in your Saved Report database for later retrieval if needed. To download a report in in an Excel or PDF format, Click on the desired option as shown.

Hazardous area classification data sheet- Part I: Flammable substance list and characteristics

| Doc # | FD20230004-240201 |
| FM Name | Crude Oil |

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Flammable substance						Volatility a		LFL/ UFL		Ex Chracteristics		
	Name	Composition	Molar mass (kg/kmol)	Relative density gas/ air	Polytropic index of Adiabatic Expansion (γ)	Flash point (°C)	Ignition temp.b (°C)	Boiling point (°C)	Vapour pressure at 20 °C (kPa)	vol (%)	(kg/m3)	Equipment group.b	Temp. class	Any other relevant information or remark
1	Crude Oil	0.03%Ethane,0.43%Propane,3.78%n-Butane,17.03%n-Pentane,11.84%n-Hexane,13.29%n-Heptane,13.75%n-Octane,8.05%n-Nonane,6.13%n-Decane,25.67%C11+	113.39	3.91	1.035	4.60	204.00	118.20	20.745	0.79 / 6.98	0.037 / 0.329	IIA	T3	

a   Normally the value of vapour pressure is given, but in the absence of that, boiling point can be used;

b   Value in second line is user defined.

FMA Report List

The FMA Report List provides an overview of your saved FM Analysis. To view a stored report, click on **VIEW REPORT** and your saved report will be displayed. You can then download a report in an Excel or PDF format as before.

FM Analysis Report List

No.	Mixture Name	Report Created By	Create DateTime		
1	Pentane	ALLAN	2023-09-04 12:22:17	View Report	Delete
2	Methanol	ALLAN	2023-09-04 12:22:57	View Report	Delete
3	Crude Oil	ALLAN	2023-09-04 12:23:15	View Report	Delete
4	Propane	ALLAN	2023-09-04 12:24:43	View Report	Delete
5	Benzene	ALLAN	2023-09-04 12:26:17	View Report	Delete
6	Hydrogen	ALLAN	2023-09-04 12:28:01	View Report	Delete
7	Crude Condensate	ALLAN	2023-09-04 12:29:17	View Report	Delete
8	Heavy Crude Oil	ALLAN	2024-02-19 10:43:06	View Report	Delete

Should you desire to delete an FM Analysis from your database, click on DELETE and the FM Analysis will be removed.

SOR Info

The SOR Info tab in the ExHAC main menu is where you configure a Source of Release.
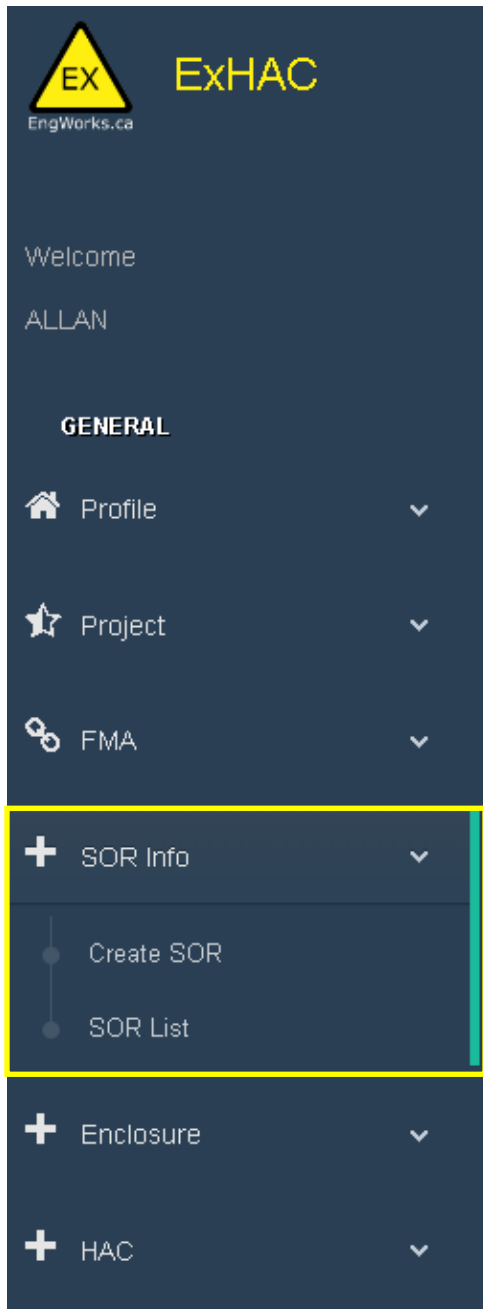
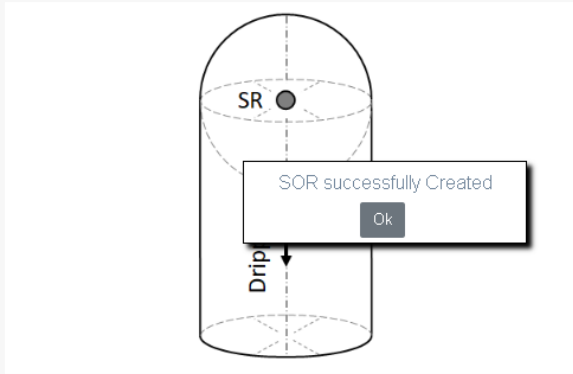| Create SOR	Allows you to create a Source of Release in the SOR List Database
SOR List	Displays a list of all SOR's you have created

Create SOR

To create an SOR for analysis, enter the data as presented on the screen. Drop down menus are provided when selecting the SOR Type and the Grade of Release. The SOR type will change the diagram displayed to indicate the release behavior. Note that all fields must be entered to Submit an SOR.

For a Gas or Vapour Release, the stream temperature and pressure will factor into the release scenario. The Grade of Release will influence the Zone classification. The ambient temperature will influence the gas density in a gas or vapour release and the evaporation rate of a liquified gas or pool release.

Enter **Submit** when you have entered the required information. A "SOR Successfully Created" message will appear.

The SOR will then appear in the SOR List.

SOR List

The SOR list displays all SORs successfully configured.   A search function can be used to locate an SOR in the list.

You may edit an SOR by clicking on the edit button. You may also delete an SOR provided it has not been used in an HAC Analysis.

SOR List

| Search |

#	SOR Name	Type	Grade Of Release	Ambient Temperature(°C)	Create DateTime		
1	Condensate Release	Liquid Pool Release	Secondary	20	2023-05-29 15:11:19	Edit	Delete
2	Natural Gas Manifold Release	Gas or Vapor Release	Secondary	20	2023-07-17 12:32:27	Edit	Delete
3	Pentane Pool Release	Liquid Pool Release	Secondary	20	2023-07-17 15:36:12	Edit	Delete
4	Propane Release	Liquefied Gas Release	Secondary	20	2023-08-03 11:37:30	Edit	Delete

Enclosure

The Enclosure tab in the ExHAC main menu is where you configure an Enclosure surrounding a Source of Release. It is not necessary to configure an enclosure for an HAC analysis. If no enclosure is configured, ExHAC assumes that it is an open-air, "Non-Enclosed" application.
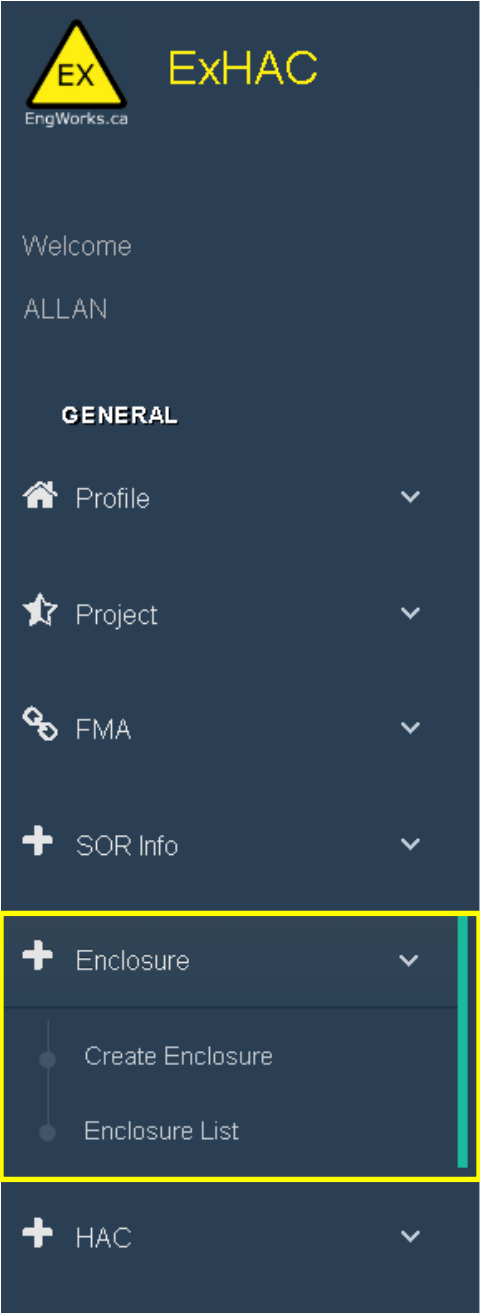
Create Enclosure	Allows you to create an enclosure surrounding a Source of Release.
Enclosure List	Displays a list of all Enclosures you have created

Create Enclosure

To configure an enclosure, enter the information required to complete the form. When configuring the length and width dimensions for the enclosure, pay attention to the direction of the airflow anticipated through the enclosure. The location of the forced ventilated fans or natural ventilation louvers define the "length" side of the building.

For example, a forced ventilation enclosure with an extraction fan will define the "Length-Upwind" dimension.
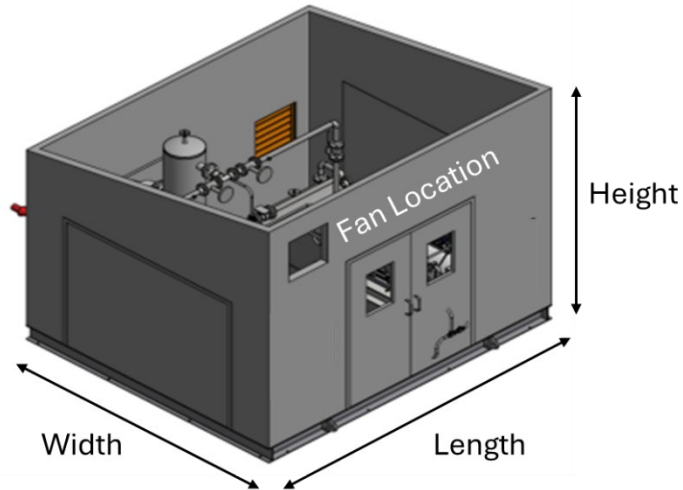
In a naturally ventilated enclosure application, the "Length-Upwind" dimension will be defined by the location of the ventilation louvers.
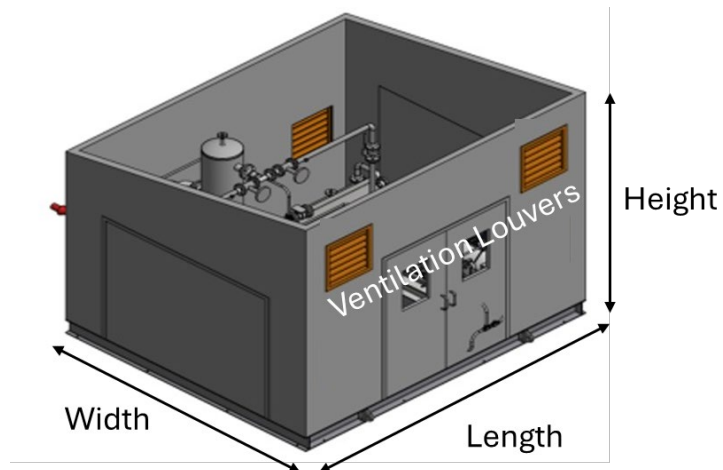
If an enclosure is defined as "Naturally Ventilated", you will be prompted to enter an interior and exterior temperature. This will be used to define the "Stack Effect" ventilation velocity in the HACK analysis. The values selected should be a worst-case ambient temperature scenario expected where the inside

ambient temperature is a few degrees higher than the exterior ambient temperature. Refer to clause 7.2.2 of IEC 60079-10-1 standard for a discussion on this.

Press SUBMIT when you have entered all the required data.

Enclosure List

Once you have configured your enclosure, it will appear on the Enclosure list. You can edit or delete an enclosure from the list. Note that you cannot delete an enclosure if it has been used in a HAC analysis.

Enclosure List

No.	Enclosure #	Enclosure Name	Length-Upwind(m)	Width(m)	Height(m)	Volume(m3)	Exterior Temp.(°C)	Interior Temp.(°C)	Naturally Ventilated		
1	E20230001	Pentane Pump Building	5	8	4	160	0	0	No	Edit	Delete
2	E20230002	Heat Exchanger Building	11.5	5	4	230	28	31	Yes	Edit	Delete
3	E20240003	Naturally Ventilated Enclosure	11.5	5	4	230	28	31	Yes	Edit	Delete

HAC

The HAC tab in the ExHAC main menu is where you configure a HAC analysis using the Project, FMA, SOR and Enclosure information you have entered.
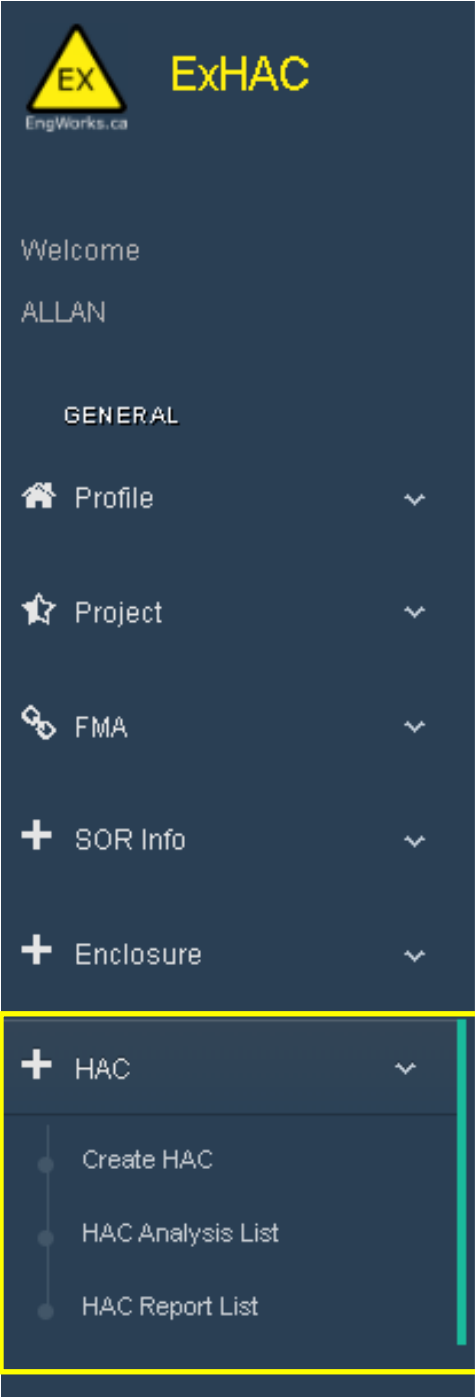
Create HAC	Allows you to create an HAC analysis using the data created in the FMA, SOR and Enclosure tabs
HAC Analysis List	Displays a list of all HAC analysis you have configured and saved. Allows you to edit and create a report output for a configured HAC analysis
HAC Report LIst	Allows you to display and print out the results of a HAC report

Create HAC

To create a HAC, you must first configure your analysis by selecting the Project, FMA, SOR and enclosure to use in your analysis. You can do this my clinking on the blue tabs adjacent the Site number, FMA number, SR number and the Enclosure number. Select the items you want to use in your analysis.

If your application does not incorporate an enclosure, there is no need to configure an enclosure. ExHAC will assume the release source is non-enclosed.

Once you have configured your HAC, enter "Configure analysis".

Once the configure analysis is complete, a series of parameters will appear on the right-hand side of the screen. ExHAC will provide a set of default parameters as a starting point for your analysis. You can enter your own parameters by entering new values in the override cells provided. Note that cells with a N/A value indicate the parameters are not required for the configured analysis.

For a HAC analysis involving an enclosure, you will be prompted to enter a ventilation rate for a forced ventilated design or define the size of louvers and other relevant parameters for a naturally ventilated design. Your analysis cannot proceed until the relevant parameters are defined.

To display the results of an analysis, click on the HAC Output tab.

Figure C.1 - Chart for assessing the degree of dilution

Figure D.1 - Chart for estimating hazardous area distances
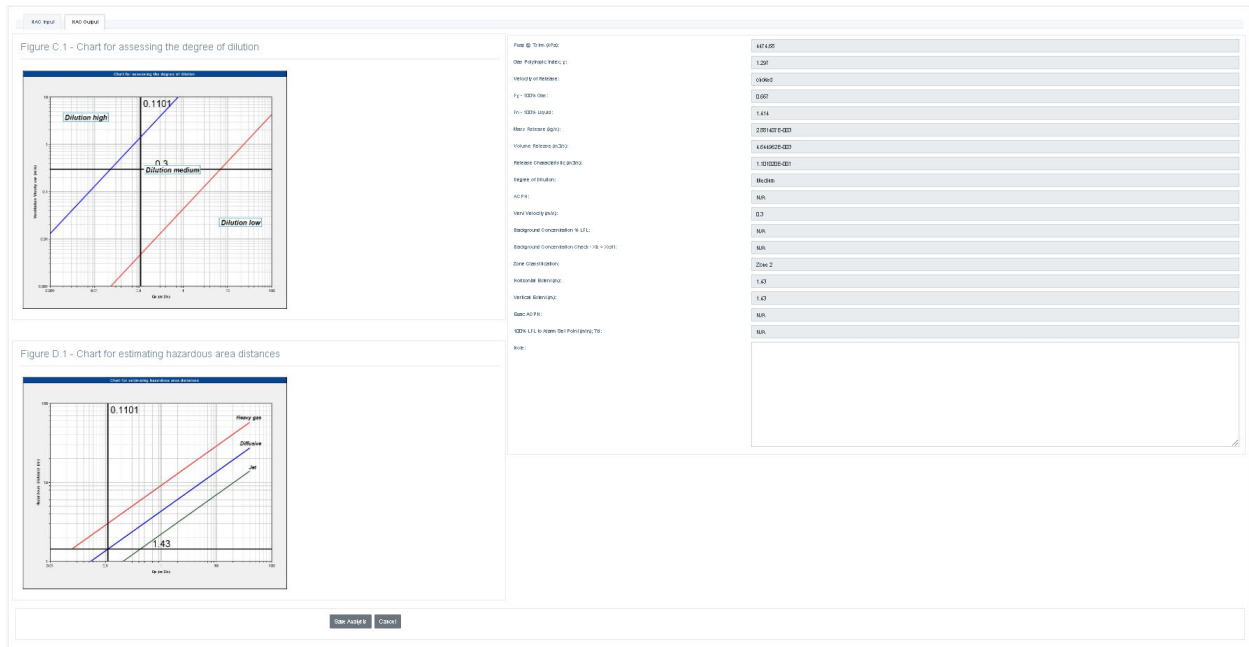
The HAC output tab will display your results in a tabular and graphical format. Figure C.1 will display the degree of dilution and Figure D.1 will display the classification extents based on the release characteristic calculated for the assessment.

To modify the input parameters for your analysis, click on the HAC Input tab to go back to the original input parameter configuration. You can then modify parameters as you see fit optimize your results.

You have the option to enter additional information related to your analysis in the "Notes" section of the output tab.

 Once you are satisfied with your analysis, enter "Save Analysis" to save the results.
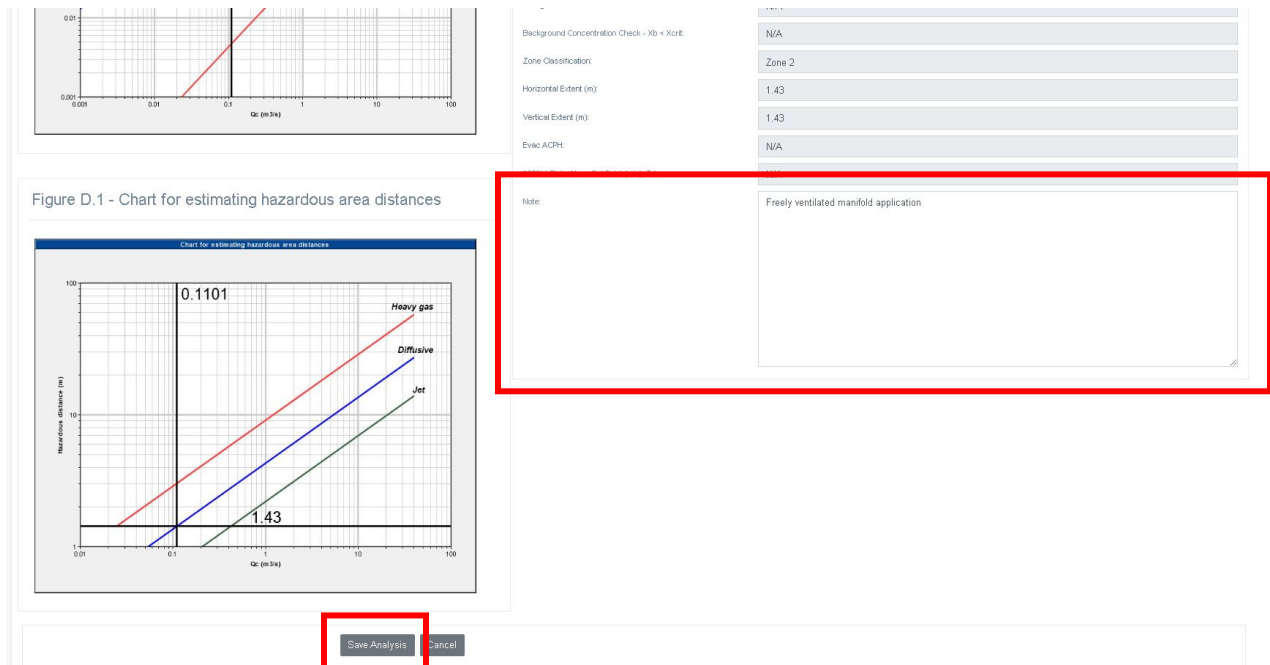
HAC Analysis List

Your HAC analysis will then appear in the HAC Analysis list. You can edit or create a report summarizing your results by pressing on the "HAC Analysis List" tab entering the "Edit" or "Create Report" function for your analysis.
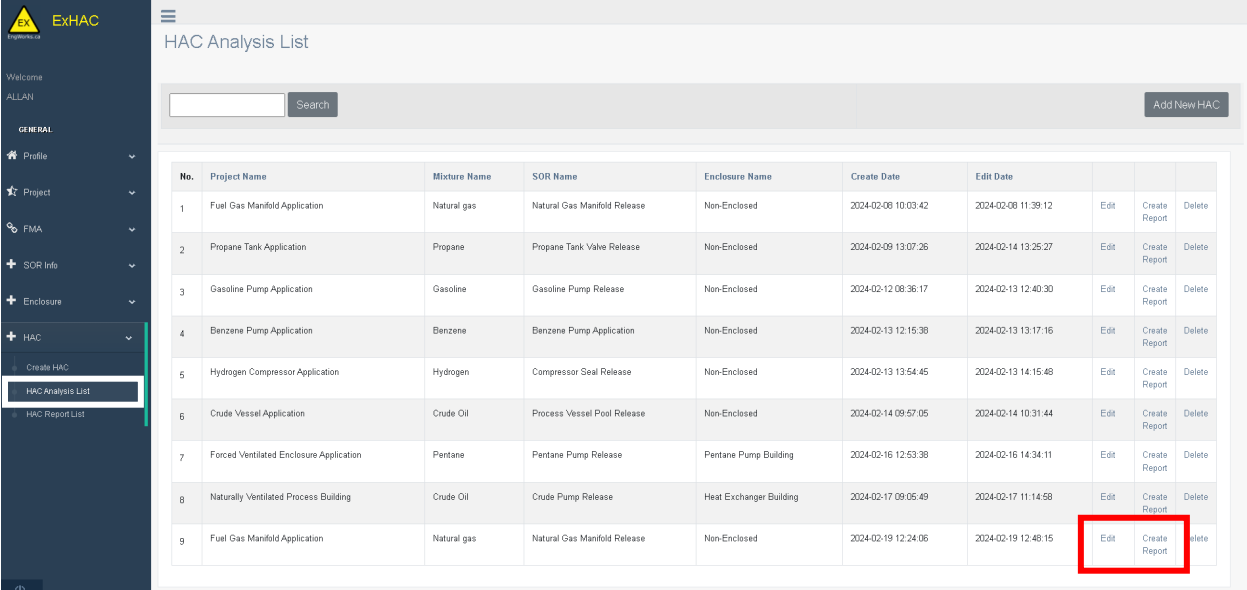
Clicking on the "Create Report" function will display a complete report of your analysis on the screen. All input parameters and output results will be summarized in a tabular and IEC format.
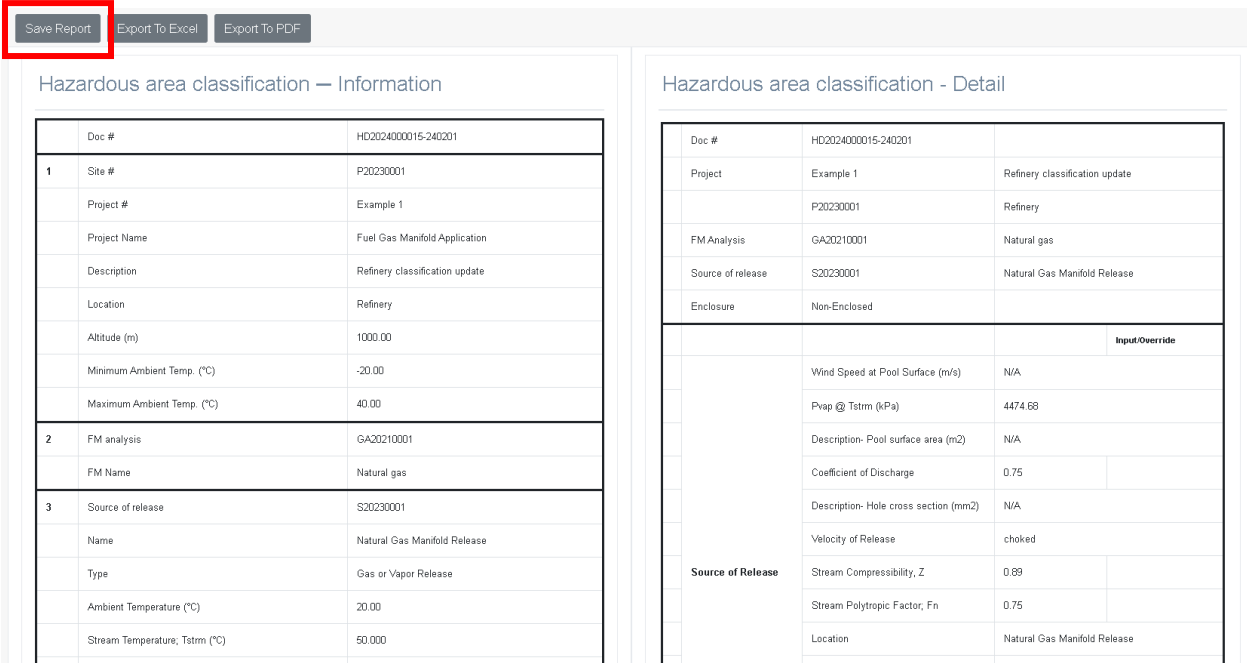
HAC Report List

You have the option to export the report as an Excel or pdf file. To save the report as a permanent record, enter "Save Report".

The saved report will appear in the HAC report list accessed from the "HAC Report List" tab. You can view and export a report in an Excel or PDF format.

Your analysis is now complete and fully documented! You can use the results to create a plot plan or cross-sectional diagram of your application indicating the degree and extent of your classification design.
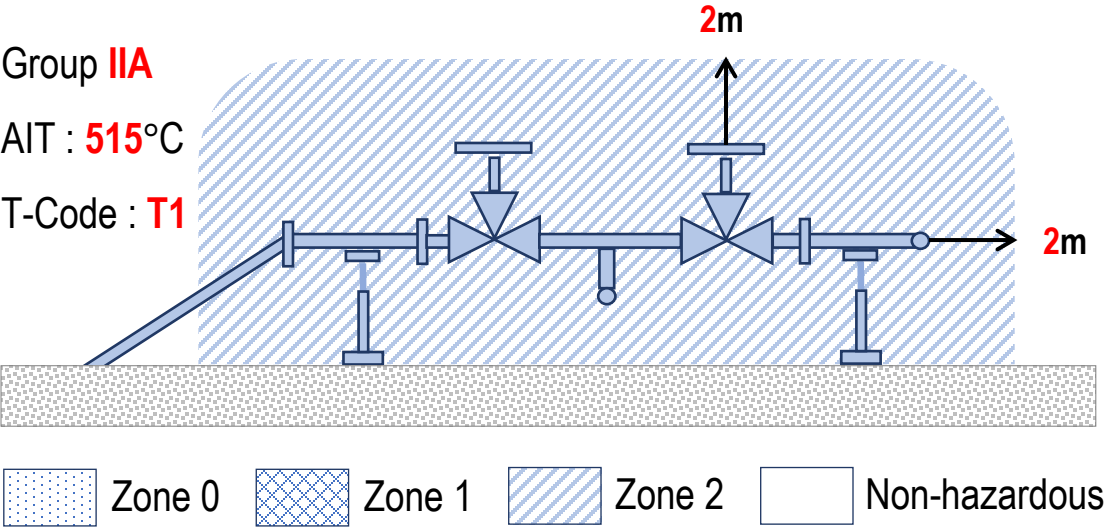
Piping Manifold Hazardous Area Classification

For additional guidance on how to perform an hazardous area classification design assessment for a variety of applications, please see our application examples we have included in the ExHAC training course.