ERCBH2S

A Model for Calculating Emergency Response and Planning Zones for Sour Gas Wells, Pipelines, and Production Facilities

Volume 3: User Guide, Version 1.20

Energy Resources Conservation Board

ERCBH2S was developed for the Energy Resources Conservation Board (ERCB) by:

Michael J. Zelensky, M.Sc., P.Eng.
Public Safety and Air Quality Management (PSAQM Inc.)

Brian W. Zelt, Ph.D., P.Eng.
Zelt Professional Services Inc.

The project was managed by Gary Neilson, B.Sc. (Hons), P.Phys. of the ERCB's Field Surveillance and Operations Branch. The Emergency Management Group's patience and creative suggestions are gratefully acknowledged.

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ENERGY RESOURCES CONSERVATION BOARD
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Centennial Place
Suite 1000, 250 – 5 Street SW
Calgary, Alberta T2P 0R4
Telephone: 403-297-2625
Fax: 403-297-3520
Web site: www.ercb.ca

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1. Introduction

ERCBH2S, a Model for Calculating Emergency Response and Planning Zones for Sour Gas Facilities

Emergency Response and Planning Zone Requirements

The Energy Resources Conservation Board (ERCB) has developed *ERCBH2S for Calculating Emergency Response and Planning Zones for Sour Gas Facilities* which are compliant with the requirements of *Directive 071 – Emergency Preparedness and Response Requirements for the Petroleum Industry*.

This User Guide is for the *ERCBH2S* Emergency Response and Planning (ERP) zones dispersion modelling spreadsheet.

The User Guide outlines how to calculate ERP zones using the model and provides much of the information about the User inputs required for the calculations. For a submission to the ERCB, complete requirements are provided in *Directive 071*.

Where to begin?

Several chapters in this manual take the user step-by-step through various applications of the *ERCBH2S* model, while others are designed for user reference. To use *ERCBH2S* it is not necessary to read the entire User Guide. A suggested format (in order) for a first time user is:

1. User Qualifications in Chapter 1 (this chapter)
2. Program Installation – Chapter 2
3. Quick-Start – Chapter 3
4. Inputs Page – Chapter 5. This chapter describes the *ERCBH2S* **INPUTS** page in detail, cell by cell. No user should be entering data to *ERCBH2S* without referencing this chapter.
5. *Gas Well Example Tutorial – Chapter 11
6. Batch Page – Chapter 8

If modelling pipelines, then continue through:

7. Gas Pipeline Example Tutorial – Chapter 10
8. Pipeline Gathering Systems – Chapter 9

*Even if a user is not modelling wells, the Gas Well Example Tutorial is recommended because it requires fewer inputs than pipeline modelling, and it acquaints the user with the *ERCBH2S* **BATCH** page.

ERCBH2S Components

The *ERCBH2S* model documentation is comprised of several components that are described in the following table.

Volume	Description
Directive 071: Emergency Preparedness and Response Requirements for the Petroleum Industry	This directive provides the requirements for the industrial operator. It covers not only sour operations but any activity where a hazard exists with the potential to cause a risk to the public.
Overview	Written for industrial operators and public with a particular interest in ERCBH2S. It provides an overview of the ERCB hazard management process and presents a higher level summary of the key components of the ERCBH2S software.
Volume 1: Technical Reference Document Version 1.20	Written for the technical specialist and to document the complex science within *ERCBH2S*. It provides the science required to calculate the hazard zone and the basis for selecting the components used to make the calculations within *ERCBH2S*.
Volume 2: Emergency Response Planning Endpoints	Written for the technical specialist with a particular interest in toxicology. It presents the data available to choose an EPZ endpoint, toxicological calculations and the EPZ endpoint values for H_2S.
Volume 3: **User Guide** **Version 1.20**	Written for the *ERCBH2S* user, it provides a description of the spreadsheet program usage, including installation instructions, descriptions of input and output from the program. Step-by-step tutorials to help familiarize the user with the program interface and interpret results are included.
ERCBH2S	Spreadsheet based program used to calculate planning zones. Includes *ERCBSLAB* and *ERCBFLASH* programs.

All of these documents are available on the ERCB website.

User Qualifications

ERCBH2S is freely distributed to update emergency response planning within Alberta. *ERCBH2S* is a complex tool that calculates site-specific ERP zones

using thermodynamics, fluid dynamics, atmospheric dispersion modelling, and toxicology. Hazard assessment is a multidisciplinary and iterative task with many assumptions and judgments. The approach, default ERCB inputs and constants have been carefully selected in order to balance hazard and safety to ensure that the ERP zones are representative yet err on the side of public safety.

ERCBH2S models were created so that a minimal amount of technical background is required to run the models. However, there remains some technical knowledge required to supply suitable inputs and the ability to understand whether the output is appropriate for the inputs and meets the needs of stakeholders. The user must recognise that the models are technical in nature and the correct interpretation of the result may require technical expertise that proceeds from consequences of the inputs. That is, garbage-in equates to garbage-out.

The models have been created with a professional commitment to environmental protection and safeguarding the well-being of the public. It is the responsibility of the software user to accept and continue this commitment in their application of the software. The software is supplied as a tool to assist the user to comply with applicable statutes, regulations and bylaws. Neither the software nor application of the software is intended to replace statutes, regulations or bylaws.

Suitable Technical Background

Environmental issues are interdisciplinary in nature. The practice of environmental science requires the integration of diverse disciplines and philosophies; many projects will require a team of appropriate specialists to address complex environmental issues. Persons doing the assessment should undertake only that aspect of environmental work that they are competent to perform by virtue of training and experience. Thus they should seek out and use appropriate Environmental Specialists to provide expert advice on certain environmental issues.

The basis of the models is technical with expertise required in chemistry, thermodynamics, atmospheric physics, meteorological processes, industrial processes and regulatory affairs. While the full technical background is not a requirement to execute the models, the user of the software is required to have a general engineering and environmental science background; a general knowledge of the emission sources: wells, pipelines, and pipeline networks; and a working knowledge of the most current version of:

- ERCB *Directive 071 – Emergency Preparedness and Response Requirements for the Petroleum Industry*
- ERCB *Directive 056 – Energy Development Applications and Schedules*
- ERCB *Directive 026 – Setback Requirements for Oil Effluent Pipelines*
- Alberta Environment Air Quality Modelling Guideline.

ERCBH2S Users

1. should develop and maintain a reasonable level of understanding, awareness and monitoring system (check that outputs are appropriate for model inputs) of the software, its inputs and its outputs;
2. shall use appropriate expertise of specialists in areas where the user's knowledge alone is not adequate to address the input or interpret the output;
3. shall apply professional and responsible judgment in their considerations of the model inputs and outputs;
4. shall comply with regulatory requirements and endeavour to exceed or better them;
5. shall disclose information necessary to protect public safety to appropriate authorities; and,
6. should actively work with others improve their understanding and practices.

There are many technical inputs required by *ERCBH2S* to perform the ERP zone calculations. Some have been prescribed by ERCB mandatory default entries. Others are input by the User for the specific sour gas facility. Source Mitigation entries must be based on actual capabilities.

Use of *ERCBH2S* and understanding whether the predictions are appropriate for the user inputs still, however, requires some specific technical understanding. If terminology such as "hazards, endpoints, fluctuations, choked flow, or stability class" is unfamiliar, you may require further expertise to operate the model and describe the results.

Further Information

For all of the information related to *ERCBH2S* and latest updates visit the ERCB website:

http://www.ercb.ca/portal/server.pt/gateway/PTARGS_0_0_303_263_0_43/http%3B/ercbContent/publishedcontent/publish/ercb_home/industry_zone/rules__regulations__requirements/directives/directive071_model.aspx

How this Document is Organized

This User Guide is organized as both an instructional guide and a tutorial. This guide does not describe the technical basis (see the companion document "**Volume 1: Technical Reference Document**" for a technical description of the equations and formulations), but describes the installation and use of the *ERCBH2S* program. This guide is divided into the following chapters:

Installation	How to install the *ERCBH2S* program
Quick-Start	A tutorial to familiarize the user with basic functions to navigate the program
Operation	How the *ERCBH2S* program works
INPUTS page	A description of the user inputs
Calculation Pages	A description of the calculation pages
Output Pages	A description of the output pages
Batch Processing	A description of how to set up the *ERCBH2S* program in batch mode processing
Pipeline Gathering Systems	A description of how to set up the *ERCBH2S* program for assessment of gas and liquid pipeline gathering system networks, including a tutorial example
Example 1: Gas Pipeline	A tutorial for a gas pipeline segment release
Example 2: Gas Well	A tutorial for a gas well release

2. Installation

This chapter describes how to install the *ERCBH2S* software. The install package includes the following modules:

- *ERCBH2S.xla* - a Microsoft®-*Excel* application software for Windows® containing macros and detailed calculations to determine emergency response and planning Zones for gas wells, gas pipelines and liquid pipelines.

- *ERCBH2S-Inputs(V120).xls*- a template spreadsheet that is the user-interface with intermediate calculations for sour gas emergency response planning for gas well, gas pipelines, and liquid pipelines/wells.

- Example files - spreadsheets using the *ERCBH2S-Inputs(V120).xls* with example values already filled in.

- *ERCBSLAB.dll* – a stand-alone program based upon the USEPA-*SLAB* heavier than air, air quality model. *ERCBSLAB* includes calculations for gas well blowouts, gas pipeline blowdowns, liquid pipeline vapours, indoor exposures and toxic load for sour gas releases containing hydrogen sulphide (H_2S) releases.

- *ERCBFLASH.dll* – a stand-alone program to calculate real gas properties of hydrocarbons required for the characterization of the releases.

The program extension *.dll* stands for dynamic link library. Programs are converted into *dlls* to allow accessible functionality with Microsoft Excel. The *ERCBH2S* installation contains all of the *ERCBH2S* programs, application and the template spreadsheets.

Minimum System Requirements

ERCBH2S is a Windows® based software application requiring Microsoft® Excel. The minimum system requirements* are:

- Windows® 7, Vista, XP, 2000, NT 4.0(SP3 or greater)
- Microsoft® Excel. (Program testing completed on Office 2000, Office 2002,Office 2003, Office 2007 and Office 2010. The program only runs on 32bit Office.)
- 16 MB free hard disk space
- 800x600 resolution
- 300 MHz processor
- 256 MB RAM
- Windows® - compatible mouse
- Optional: colour or b/w printer (300 dpi or better recommended)

* The installation of the software requires Administration level security privileges on the computer. If you do not have these privileges

About this Guide

The following symbols and conventions are used in this guide

Bold	Used for menu, command, and keyboard selections you make and screens you will see.
Italics	Used for emphasis and to identify new terms
`text`	User typed responses or entries
	Helpful information about a particular topic.
	Important information to prevent problems and ensure that you are successful in using the software.
link	A hyperlink to a section within the User Guide, an internet web site or email address

Where to Go for Help

For additional help with the *ERCBH2S* program, its installation and use, contact the following:

ERCB Support

Check the site below for detailed support for *ERCBH2S* including the latest revisions of the model, technical reference document, user guide and for important user messages:

http://www.ercb.ca/portal/server.pt/gateway/PTARGS_0_0_303_263_0_43/http%3B/ercbContent/publishedcontent/publish/ercb_home/industry_zone/rules__regulations__requirements/directives/directive071_model.aspx

Please send comments, program operation problems and problem spreadsheets to:

EPAssessment@ercb.ca

Overview of the Installation Process

If you have not already done so, download the installation software from the ERCB website (see above).

The single install program setup.exe file contains all of the software required for the *ERCBH2S* program (including *ERCBSLAB*, *ERCBFLASH* and template spreadsheet) to run within the users existing Microsoft Office (including Excel) environment.

STEP 1: The install program (provided in the software download) installs the *ERCBH2S* as a program in the system registry.

The installation software allows two options for the software installation:

- **Full Installation (Recommended)**
  Installs *ERCBH2S, ERCBSLAB*, *ERCBFLASH* and template spreadsheet. Creates a subdirectory for the spreadsheet template files.

- **Custom Installation**
  Installs only selected components.

STEP 2: After you have run the install software, you must complete the installation using either of two options:

- You may activate the *ERCBH2S* Excel add-in so that *ERCBH2S* is loaded every time you open Excel, or
- You can launch the *ERCBH2S* program for a single Excel session.

The install program will create folders and copy the following files to the folders, or you may select the destination:

File	Default folder
ERCBH2S.xla *ERCBH2S*-inputs(V120).xls Uninstall *ERCBH2S*	C:\program files\ERCBModels*ERCBH2S*
ERCBSLAB.for MODULES.for	C:\program files\ERCBModels*ERCBH2S*\SOURCE
ERCB_SLAB.dll ERCB_FLASH.dll ERCB_THERMOU.dll	C:\windows\system32

The dynamic link library (*.dll) files may be installed to alternate folder locations during the installation.

STEP 1:
Installing setup.exe:
Complete Program Installation

If you get an error message regarding Administrator privileges refer to the "Administration Privilege for Windows" in the "Troubleshooting and FAQs" section, later in this guide.

To ensure a successful installation, follow the steps outlined below.

1. Using Windows **Explorer** or the **My Computer** icon on your computer desktop, locate the installation file you downloaded from the ERCB website.

   Double click the installation file to open and run the install sequence.

   The InstallShield **Preparing to Install** window will be briefly displayed.

   The **Welcome to the InstallShield Wizard for ERCBH2S** welcome and loading screen will appear.

   Answer **Next** to continue installing the **ERCBH2S** software, or **Cancel** to end the installation.

2. The *ERCBH2S* **License Agreement** screen will appear.

   The License Agreement covers both the ERCBSLAB and ERCBFLASH programs.

3. After reading the License Agreement, select **I accept the terms of the license agreement**.

   Click **Next** to continue

4. The **Customer Information** screen will appear.

5. Enter you **User Name** and **Company Name**.

   If there are separate users that log in to use your computer, you can choose whether you would like all users to be able to use the software or just you. The **All Users** option is recommended.

   Make your choice and click **Next**.

   The **Destination Folder** screen will appear.

6. In the **Destination Folder** section of the screen, you can see the default location where the software will be installed. If you wish to change this, click **Browse** and choose a new location.

   When you are ready, click **Next**.

   The InstallShield **Ready to Install the Program** window should appear.

7. Click **Install**.

The InstallShield **Installing...** window will briefly appear and display the status of the installation of the program modules being installed.

The **InstallShield Wizard Complete** window will appear.

8. Click **Finish** to end the wizard InstallShield and complete the installation of the *ERCBH2S* program.

STEP 2:
Activating the *ERCBH2S* Add-In

In **STEP 1**, the software required for the *ERCBSLAB* and *ERCBFLASH* programs is installed. **STEP 2 - Activating the *ERCBH2S* ADD-In**, the *ERCBH2S.xla* is configured to run within Microsoft Excel. There are two options for this configuration:

1. Configure Excel so that *ERCBH2S.xla* application is loaded every time Excel is opened. **(Recommended)**
   The advantage with this configuration is that a template file (*ERCBH2S-inputs(V120).xls* or example files) can be opened and the *ERCBH2S* calculations can be performed without requiring the user to additionally load the *ERCBH2S.xla* application program.

2. Run the *ERCBH2S.xla* program for a single session of calculations. The advantage with this configuration is that users using Excel frequently for other than *ERCBH2S* calculations are not loading the *ERCBH2S.xla* application and unnecessarily occupying computer resources.

The user can change the configuration between the two options at a later date, by de-activating the *ERCBH2S* Add-in within Excel and using the alternative configuration.

Add-In Manager Activation (Recommended)

The Excel **Add-in Manager** is used to activate Excel Add-in applications. Note that by activating the add-in in this way, it will always be available in the menu bar when you start Excel (unless you turn it off manually). In this case, you do not need to change Excel's security setting.

By activating the *ERCBH2S.xla* Add-in using the Excel Add-in Manager, the *ERCBH2S* application will always be available in the menu bar when you start Excel (until such time as you turn it off, also using Excel Add-in Manager).

The *ERCBH2S* application menu bar is displayed but is active only with *ERCBH2S* template files (e.g., ERCB-inputs(V120).xls or renamed copies).

Follow these steps to activate the add-in.

1. Open Microsoft **Excel**

ERCBH2S is designed to be compatible with Microsoft Excel from Office® 2000 or higher version.

2. On the main menu bar, click on **Tools**

Select **Add-Ins…** from the list of operations.

If "Add-Ins…" is not displayed on the menu, select "»" to display the full list of menu options. Alternatively, right-click in the tool-bar area, select Options and un-check the "Menus show recently used commands first"

3. The Add-Ins manager window will appear

A list of Excel add-ins that are currently registered with the Add-In Manager are displayed. Several may appear activated, by displaying a check mark next to the title of the add-in.

Click **Browse…** to locate the *ERCBH2S.xla* add-in.

4. The **Browse** window will be displayed.

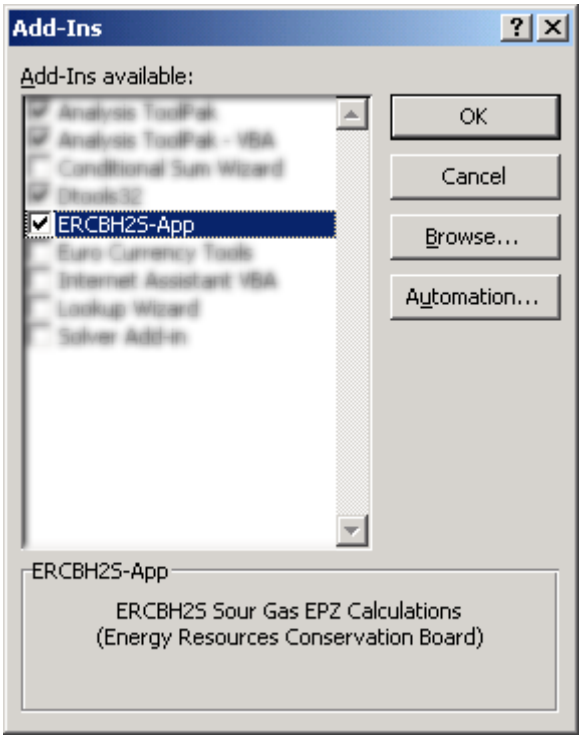
5. Locate the *ERCBSLAB.xla* add-in by navigating to the installation folder you selected during STEP 1 - Software Installation. If you installed to the default directory, the path is:
C:\Program Files\ERCBMODELS\ERCBH2S

6. Click on the **ERCBH2S.xla** file.

A version number may be displayed after the "*ERCBH2S*" to identify the program version number.

7. Click **OK.**

The *ERCBH2S* add-in will be displayed in the add-in Manager, as shown below. If the *ERCBH2S* add-in is not '**checked**', then click using the mouse in the box beside "*ERCBH2S*", to display a **check-mark**.



8. Click **OK** to complete the process.

ERCBH2S will now be displayed in the main menu bar.

The *ERCBH2S* button bar will appear when an *ERCBH2S* template spreadsheet is opened

9. Skip the "Single Session Activation" and follow the instructions in the "Quick-Start" section

Single Session Activation

To launch the *ERCBH2S.xla* add-in for a single session, follow these steps:

10. Click on the **Start** menu button on your computer desktop.

Select **Programs**

Select **ERCBMODELS**

Select **ERCBH2S**

Select **Launch ERCBH2S.xla**

11. The Microsoft **Excel** application window will open.

ERCBH2S will now be displayed in the main menu bar.

The *ERCBH2S* button bar will appear when an *ERCBH2S* template spreadsheet is opened

To change the security setting in Excel, go to the Tools menu then select Macro and then Security. In the Security window, you can change the setting to Medium, which will allow you to run the macro.

When Excel is closed the *ERCBH2S* application will close also. If Excel is restarted, the *ERCBH2S* application will not be opened unless you repeat the procedure described in this section.

12. Continue to follow the instructions in the "Quick-Start" section.

3. Quick-Start

Now that you have installed the software you will run a Quick-Start tutorial to become familiar with *ERCBH2S* and how to calculate Emergency Response and Planning (ERP) zones. Complete the following steps:

> If you have pre-set the install option for *ERCBH2S.xla* (**STEP 2: Activating the ERCBH2S Add-In** on page 12) go directly to step **2** in this Quick-Start tutorial. Otherwise, begin at step **1**.

1. Click on the **Start** menu button on your computer desktop.

Select **Programs**

Select **ERCBModels**

Select **ERCBH2S**

Select **Launch ERCBH2S.xla**

(The *ERCBH2S* menu in **Excel** is now launched)

Choose '**Enable Macros**'

2. Click on the **Start** menu button on your computer desktop.

Re-select **Programs**

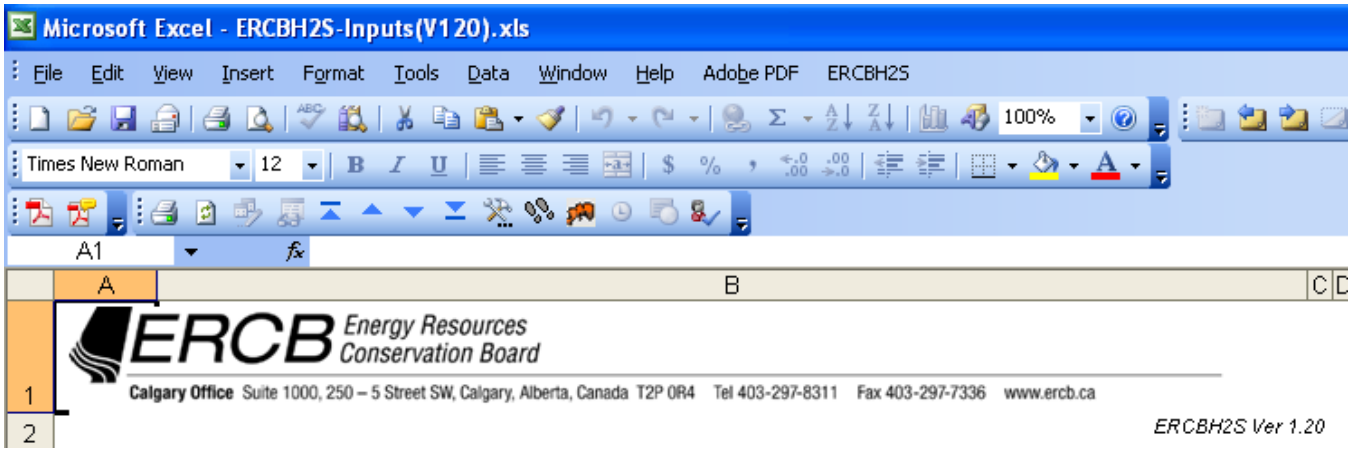
Re-select **ERCBModels**

Select **ERCBH2S-Inputs(V120).xls**

(An *ERCBH2S* example file in Microsoft **Excel** is now launched)

3. The example files already contain in the row 11-13 in the BATCH page. It opens on the **ABOUT** page, which provides a summary of the Introduction section of the User Guide and brief Instructions. Notice the Legend and colour scheme used for cells and sheet tabs. (Some earlier versions of Excel do not display the **page/sheet tabs** in colour.)

4. Are the *ERCBH2S* menu and menu-bar displayed and activated (non-grey)? If so, continue to the next step. If not, then *ERCBH2S.xla* was **NOT** launched, and you need to return to step **1** in this Quick-Start tutorial.



5. Select the **INPUTS** page.

Scroll up and down. The **INPUTS** page for example files are already completed, allowing the user to view example entries.

Because this **INPUTS** page was created for a tutorial, each of the three 'details' sections (Gas Pipeline, Gas Well and Liquid Pipeline/Well) have been completed with sample user entries. Normally a user completes only one of the three the details sections – the one related to the sour operation type being modelled.

Input fields are shown with **white** background, input prompts and comments in **green**, and default or calculation (protected) fields in **grey**. All user entries are in column C.

6. The first section of the **INPUTS** page, titled **ADMINISTRATIVE**, is always available for user inputs (column C).

ADMINISTRATIVE	Units	User Input	Comments	Warnings (if applicable)

7. Delete the user entry for '**BA CODE**' in row 4.

Notice the **red flag** warning at the top of the page.

(1) Missing entry(s) for ERCB Submission,				
ADMINISTRATIVE	Units	User Input	Comments	Warnings (if applicable)
	BA CODE			Required for ERCB submission

The **red flag** indicates 1 missing entry for the ERCB Submission and the Required for ERCB submission warning appears in column E.

Now delete the user entry for **Surface Elevation** in row 21.

Notice that the **red flag** remains but the message inside it has changed. Also, there is now a warning in column E for row 21 Required for calculation.

This warning appears for missing user inputs that are required for the *ERCBH2S* calculations to proceed. Either select the 'Undo' button twice (to replace the last two deleted entries) or replace the "A" entry in row 4 and the "1000" entry in row 21. The **red flag** disappears along with the orange warnings in column E.

For the remainder of this tutorial, you can ignore any **red flags** that appear at the top and bottom of the page.

8. Below **ADMINISTRATIVE** are three sections titled – **GAS PIPELINE, GAS WELL,** and **LIQUID PIPELINE OR LIQUID WELL**.

GAS PIPELINE (includes oil effluent pipeline with Gas to Liquid Ratio> 1000)	Units	User Input	Comments	Warnings

GAS WELL (includes oil well and other well with Gas to Liquid Ratio> 1000)	Units	User Input	Comments	Warnings

LIQUID PIPELINE or LIQUID WELL (includes oil effluent pipeline, oil well, other pipeline and other well) with Gas to Liquid Ratio≤1000	Units	User Input	Comments	Warnings

Access to each of these three sections is controlled by the user selection in **SOUR OPERATIONS TYPE** (located within **ADMINISTRATIVE**).

9. Locate **SOUR OPERATIONS TYPE** within the **ADMINISTRATIVE** section.

SCENARIO NAME			UNIQUE description - Label 3 (i.e., Mitigation Option 1, Upstream to Downstream Node)	Required for ERCB submission
SOUR OPERATIONS TYPE		Gas Well	Select the Type of Sour Gas or Sour Liquid operation	
ANALYSIS TYPE		Gas Well Sour Gas Pipeline with H2S >10 mol/kmol Natural Gas Pipeline with H2S ≤10 mol/kr Oil/Liquid/Other Well (GLR>1000) Oil/Liquid/Other Well with GLR≤1000 Oil Effluent Pipeline with GLR>1000 Oil Effluent Pipeline with GLR≤1000 Acid Gas Pipeline Crude Oil Pipeline with GLR≤1000 LVP Products Pipeline with GLR≤1000 Salt Water Pipeline with GLR≤1000	Select "NO MITIGATION" or "WITH MITIGATION"	**Uncontrolled H2S Release**
Name of Well / Pipeline Licence Number			Label 1	
Well Licence Number or Well Application Number			enter na if pipeline or new well	
Legal Surface Location of Well or Pipeline Line Number			LSD-SEC-TWP-RGE W?M - Label 2	
Pipeline From Location (enter na if well)			LSD-SEC-TWP-RGE W?M	
Pipeline To Location (enter na if well)			LSD-SEC-TWP-RGE W?M	
Surface Elevation	m (ASL)		at facility or average in ERP area	
Existing EPZ Distance	km	na	enter na if not applicable	
Datum for Surface Locations		OTHER	mapping datum for locations	
Selected Inputs Flavour		2	**GAS WELL (steady jet)**	

The type of sour gas or sour liquid operation selected determines which part of the **INPUTS** page is 'active'.

Toggle between the eleven sour operations types and observe how the **SELECTED INPUTS FLAVOUR: GAS PIPELINE**, **GAS WELL** and **LIQUID PIPELINE/WELL** display changes on the rest of the **INPUTS** page. Depending on the user selection, one of the sour operations sections is available for user input (non-grey) and the other two are greyed-out.

Remember; for this tutorial you can ignore **red flags** that appear at the top and bottom of the page. Some selections will generate a **red flag**.

Also notice that, depending on the selection made, there are some rows within the 'Gas Pipeline' and 'Liquid Well or Liquid Pipeline' sections that are greyed out. Depending on the user selection in **SOUR OPERATIONS TYPE**, *ERCBH2S* does not require all of the inputs within a given section.

10. Within each of the three sour operations sections (**GAS PIPELINE**, **GAS WELL** and **LIQUID PIPELINE/WELL**), there is a sub-section titled **SOURCE MITIGATION**.

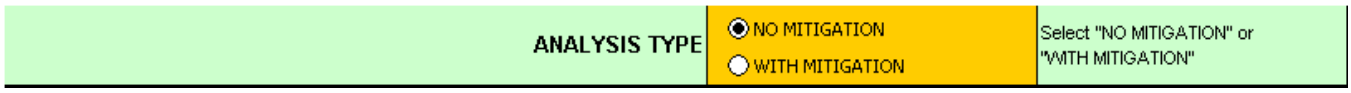
SOURCE MITIGATION		USER OVER-RIDE OF DEFAULT	DEFAULT	MODEL INPUT

SOURCE MITIGATION choices reflect very specific valves and/or operational settings, along with licensee 'action' commitments for reducing source duration for improved hazard management. Short, smaller amounts

of hydrogen sulphide released to the atmosphere equates to a smaller hazard which equates to smaller ERP zones.

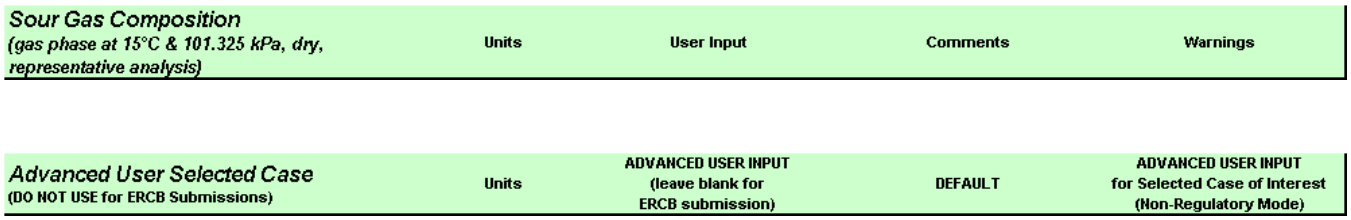
Access to this sub-section is controlled by the user selection for **ANALYSIS TYPE**.

11. Locate **ANALYSIS TYPE** within **ADMINISTRATIVE**.



Toggle between, **NO MITIGATION** and **WITH MITIGATION** and observe how the display changes within the sour operations group selected.

12. You may have observed that the final two sections of the **INPUTS** page are always available for user input.



These two sections are discussed in more detail in other tutorials, and in Chapter 5 of the *ERCBH2S* User Guide under Sour Gas Composition and Advanced User Selected Case.

13. Using the page tabs at the bottom of the screen, select the **ERP SUMMARY** page.

The first part of this page to observe is the upper portion – the part **above** the title '**RESULTS**' (in row 36).

The first part of the **ERP SUMMARY** page is a summary of all of the inputs related to whatever sour operations type is selected on the **INPUTS** page.

If you toggle back to the **INPUTS** page and change the sour operations type, the 'inputs display' portion of the **ERP SUMMARY** changes too - it always displays whatever is currently 'active' on the **INPUTS** page.

14. The **ERP SUMMARY** page also provides a graphic and tabular summary of the ERP zones calculated, along with a table describing applicable land-use setback information and certain other details. This information is

displayed on the lower part of the page **below** the title '**RESULTS**' (in row 36).

At any given time, there is **only one set of calculation results (outputs)** shown on the lower part of the **ERP SUMMARY** page. If these results don't 'match' the inputs on the upper part of the page, a **red flag** appears at the top and bottom of almost **every** *ERCBH2S* page, including the **ERP SUMMARY** page.

For the tutorial example, a **red flag** can be removed by returning to the **INPUTS** page and selecting the **SOUR OPERATIONS TYPE** '**LIQUID PIPELINE/WELL**' and the **ANALYSIS TYPE** '**WITH MITIGATION**'. This example input file already received the program 'run' command '**Calculate EPZ**' - therefore these are the calculation results shown at the bottom of the **ERP SUMMARY** page.

15. Return to the **INPUTS** page. To complete the calculations required for submission to the ERCB you will run a new example file:

Select **GAS PIPELINE** for the Sour Operations Type.

Select **NO MITIGATION** for the Analysis Type.

Go to row 13 and change **SCENARIO NAME** to 'Scenario 4'.

Observe that these changes caused a **red flag** to appear at the top of the page (because the inputs no longer match the calculation results or 'outputs').

Select **Calculate EPZ** from the **ERCBH2S** menu item, or select  on the button bar.

As part of the ERP zones' calculation sequence, the *ERCBSLAB* program (among other things) runs a total of 594 times for a pipeline. The program searches for the worst gas pipeline release 'failure size' (the hole size fraction exit area ratio – there are 11 of them) that produces the largest hazard zone for each of 54 different meteorological conditions (combinations of wind speed, atmospheric stability class) to get 54 different worst-release hazard distances. The weighted-averaged value of these 54 distances is calculated by multiplying the hazard distance in each of the 54 categories by the fraction of time that each meteorological condition occurs.

It may take several moments to complete the calculations - depending on the speed of your computer. Pipeline calculations take longer than wells because where pipeline a pipeline calculation runs 11 x 54 times (594 times), a well runs only 54 times.

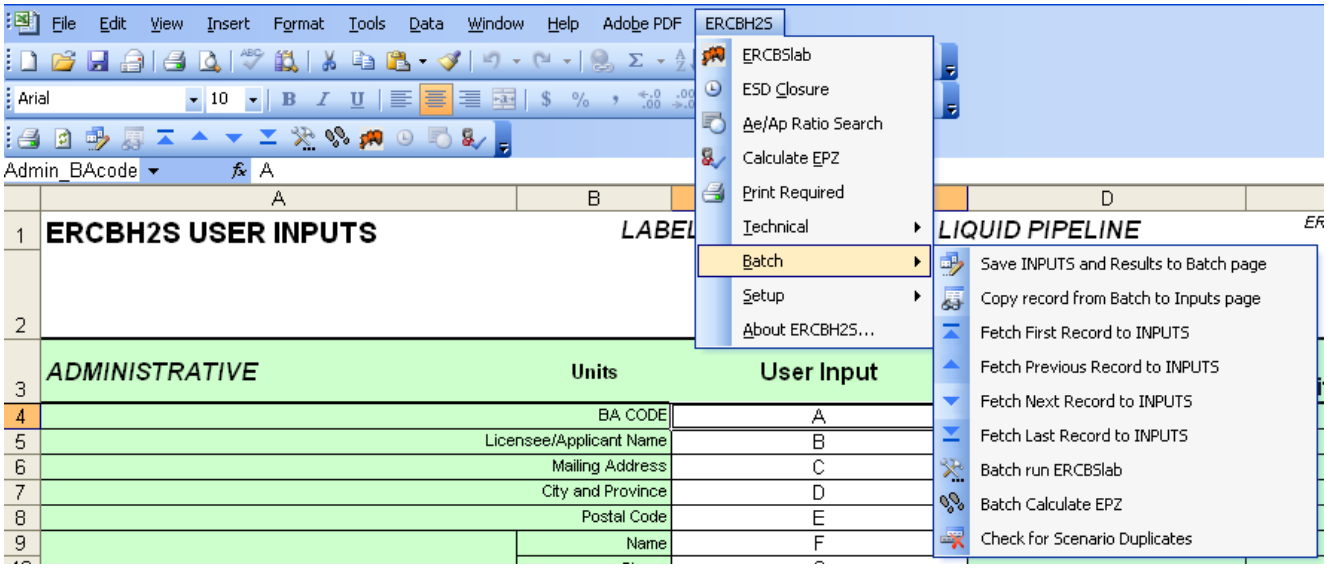
16. When the calculations are completed, the *ERCBH2S* program displays the **ERP SUMMARY** page. Review the results. If there is a **red flag** at the top and bottom of the page, the calculation results are invalid for ERCB submission.

Never use predicted ERP zones or include the **ERP SUMMARY** page printout in your ERP if a **red flag** appears at the top and bottom of the **ERP SUMMARY** page.

If a printout is required, use the printer icon  , in the **ERCBH2S** button-bar. The **ERP SUMMARY** page will be sent to your default printer.

Now you will create the export file required for ERCB submission, by first saving the completed scenario to the **BATCH** page.

17. Return to the **INPUTS** page. Go to '**ERCBH2S**' on the menu-bar, select '**Batch**', then select '**Save INPUTS and Results to Batch Page**'. Alternatively, select the **Save INPUTS and Results to Batch Page** command  from the button-bar.

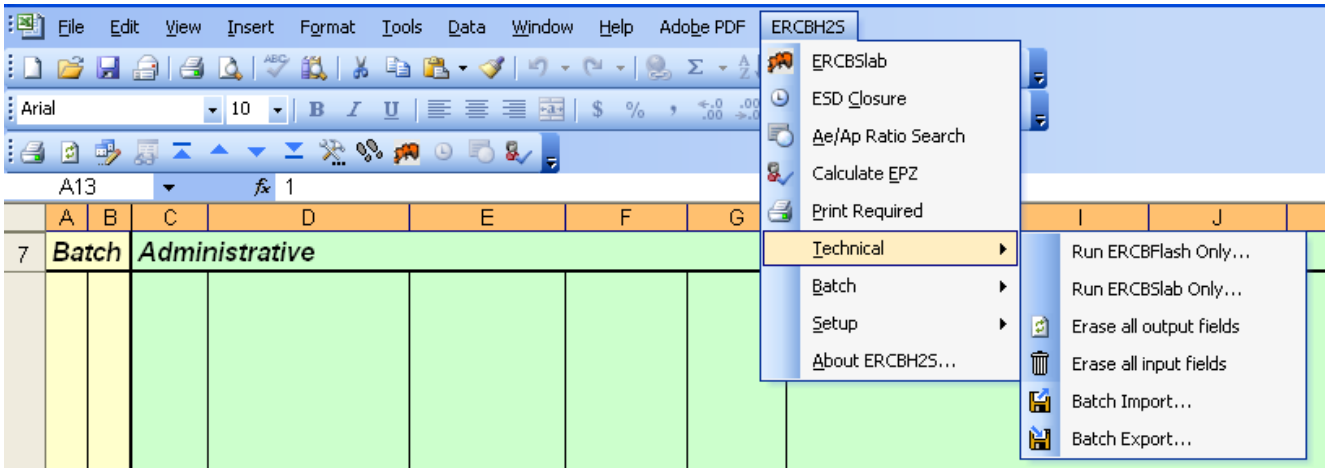


Select the **BATCH** page tab at the bottom of the screen. Notice that the **BATCH** page has four records (rows) on it. There were already three completed records in it when you opened the Quick-Start tutorial file, and you just added another one.

Each row on the **BATCH** page represents a column of user inputs (from column C on the **INPUTS** page), and calculation results that correspond to those inputs. The **BATCH** page is very large and can hold hundreds of scenarios of all different sour operations types.

It is the electronic copy of the **BATCH** page a licensee/applicant is required to submit to the ERCB. Make a habit of scrolling over to column DO to verify that there is no error messages (**red flags**) listed before you create the export file for submission.

18. Go to '**ERCBH2S**' on the menu-bar, select '**Technical**', then select '**Batch Export**'.



A prompt will appear for you to name the export file. The ERCB requires licensees/applicants to use the following file naming protocol:

BA code - ERP Plan Ref# - Date (DD/MMM/YY)

For example, if a company with the BA code of WXYZ submits a file on July 5th, 2008, the file would be named:

WXYZ-1234-05Jul08.csv

The **.csv** file extension - '**c**omma **s**eparated **v**ariable - is automatically attached to the file name. **This is the file required for ERCB submission.**

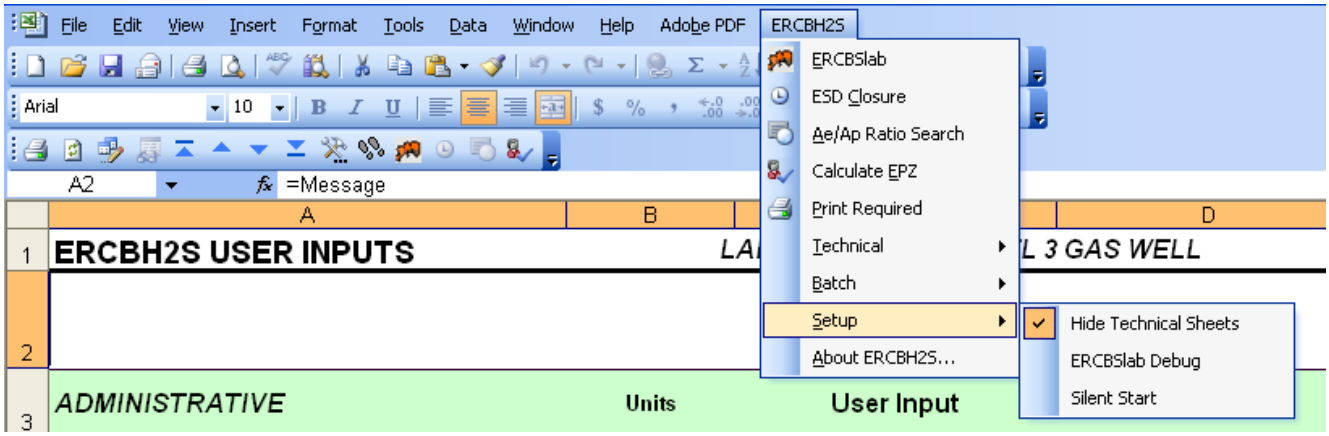
The .csv file does not contain user information added to the **NOTES** page.

19. **OPTIONAL** Return to the **INPUTS** page. Select other combinations of sour operations type and with/without mitigation, or try changing required numerical inputs. After making some changes, selecting **Calculate EPZ** will activate the required calculation sequence, and a revised **ERP SUMMARY** page will be displayed.

20. **OPTIONAL** How does **ERCBH2S** perform all of these predictions? To see the more detailed intermediate calculation pages and results, the user can select a different 'view' – the technical view.

Return to the **INPUTS** page, and go to the menu item **ERCBH2S→Setup→Hide Technical Sheets**. With 'hide technical sheets' checked, the detailed calculation pages are hidden, and only certain

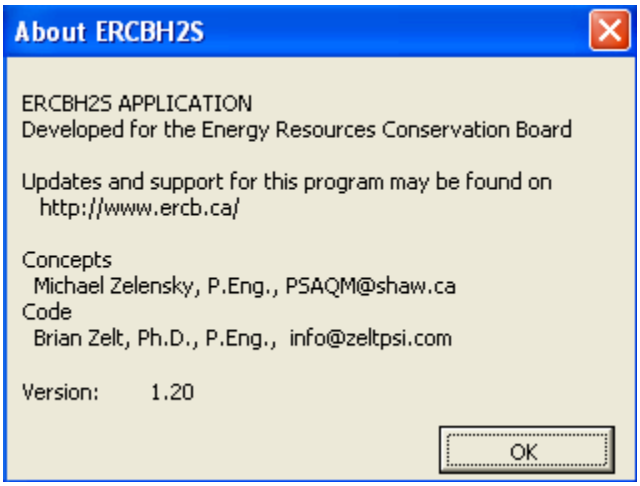
pre-selected input and output pages are displayed and menu-bar buttons are active. This is considered a 'typical view'.



Click to remove the check-mark and observe that many more page tabs are displayed at the bottom of the screen. Visit the pages and view the displayed information. This is considered a 'technical view'.

Most users prefer the 'typical view', because it provides the necessary information to determine the ERP zones. However, some ERP Planners may choose the 'technical view' to better understand the hazards and how they can be mitigated at the source.

21. **OPTIONAL** Return to the **INPUTS** page, and go to the menu item **ERCBH2S→About ERCBH2S**. The following window box will appear:



This provides the information about the program and the version numbers. By clicking on the OK button, the macros are reset and the display disappears.

22. Exit **without saving** (to prevent over-writing the Quick-Start tutorial file).

Now that you have run the Quick-Start tutorial you can learn more about the inputs, calculations, outputs, batch processing, and try a few more examples.

To continue working with the *ERCBH2S* program, the next chapter to review is Chapter 5 – Inputs. This chapter provides detailed instruction for what to enter (and what not to enter) into the ERCBH2S **INPUTS** page. Until a user is well acquainted with *ERCBH2S*, Chapter 5 should always be referenced when completing the **INPUTS** page.

Until a user is well acquainted with *ERCBH2S*, Chapter 5 should always be referenced when completing the **INPUTS** page.

4. Program Operation

This chapter provides the following information about the general operation of the *ERCBH2S* program:

- what the principal files are and how they work together
- what the buttons/menu items do
- overview of the calculation processes
- importing and exporting model inputs
- printing the results

Introduction

The *ERCBH2S* program uses the familiar Microsoft Excel as host for the calculations. The *ERCBH2S* application consists of two parts

- *ERCBH2S*.xla program (the macros and detailed calculations with links to the **dynamic link library** - .dll), and
- *ERCBH2S*-INPUTS.xls.

To run the *ERCBH2S* program, both the *ERCBH2S*.xla program and an *ERCBH2S* – INPUTS.xls file must be open.

If the *ERCBH2S* application is configured as an Add-in for automatic loading when Excel is started, it is not necessary to open both the .xla and .xls files each time. *ERCBH2S*.xla will open automatically every time an .xls file is opened. See Activating the ERCBH2S Add-In in Chapter 2.

ERCBH2S.xla is a set of macros and programming that runs as a Microsoft Excel add-in (an application that runs within Excel, adding extra functions and capabilities). One of its many functions is linking to the .dll program files.

> Dynamic link library files (.dll) are program files loaded into your computer when *ERCBH2S* is installed. These programs; ERCBSLAB, and ERCBFLASH are accessed (linked) via *ERCBH2S*.xla.

ERCBH2S-INPUTS.xls contains the user-interface for the calculations, allowing the user to input information and view calculation results.

ERCBH2S-INPUTS.xls is an Excel spreadsheet file (.xls) that acts as a template file for the *ERCBH2S* application.

All inputs and outputs are stored within the *ERCBH2S*-INPUTS. xls template file. Although technical debugging files are stored in separate text files in the same directory as the *ERCBH2S* template file, most users do not require using these extra text files.

User-Interface

Overview – The ERCBH2S Template file in Excel

All user input and output are controlled using an *ERCBH2S* template file for Microsoft Excel. The template file (.xls) contains several Excel worksheets (**pages**). While user inputs for the *ERCBH2S* calculations are on a single page, calculations and outputs are displayed on several pages - all within the same template file.

You may use either a **template** (blank) or **example** file to build your release scenario. It is **recommended** that you **create a new folder** for your scenario files. It is also **recommended** that you create a file naming convention for your scenario files to **avoid over-writing** the 'pre-packaged' blank template or example files. Following this advice allows the user to create new projects from the same known starting point.

If you accidentally overwrite the blank template or example files, you can re-install them by

1. re-naming the existing template and example files; and
2. re-running the install program to re-install selected components.

Within the single blank template or example file (both '.xls' files), initial user selections on the **INPUTS** page lead to one of three sour operation 'types' (or 'flavours'):

1. **GAS PIPELINE**. Used to model gas pipeline releases. A gas pipeline release has a transient flow rate (transient jet).

2. **GAS WELL**. Used to model gas well releases. A gas well release has a steady in flow rate (steady jet).

3. **LIQUID PIPELINE OR LIQUID WELL**. Used to model liquid releases from pipelines or wells. A liquid release creates a pool of liquid on the ground, with the sour gas rapidly coming out of solution. The release has a steady flow rate (steady jet).

ERCBH2S calculation process differs for each of the sour operation types. Processes details are described later in this chapter under Calculation Process.

The ERCBH2S Excel Pages

ERCBH2S has the following four types of pages in the Excel user interface – each category identified by name and page tab colour (for Office 2002 and newer versions of Excel only):

USER INFORMATION

ERCB contacts, brief instructions and error code descriptions, and a blank page for user 'notes'. (Blue page tabs)

INPUTS

Prompts and data entry boxes for user specified values for the *ERCBH2S* models. (Green page tabs)

TECHNICAL/CALCULATION (INTERMEDIATE)

Intermediate steps in the modelling process: for the input into *ERCBSLAB* or *ERCBFLASH;* and for post-processing of the data into a user-friendly format. Calculations are divided between Excel (the user can view these calculations within Excel) and compiled code programs, *ERCBSLAB,* and *ERCBFLASH* (the equations used in these programs are described in the Technical Reference Document and in the USEPA SLAB User Guide). (Yellow page tabs)

SUMMARY GRAPHICS (OUTPUT)

Output information summarized in both tabular and graphical form. (Pink page tabs)

Tabs for the page types are colour coded **for Office 2002 and newer** versions of Excel (earlier versions do not display the page colours).

User information pages are *blue*, input pages are *green*, calculation pages are *yellow*, and output pages are *pink*.

Recall that the *ERCBH2S* model uses an industry standard model (US EPA SLAB model), modified to perform additional calculations. The input / output format used by the *ERCBH2S* model is adapted from the USEPA SLAB model. *ERCBH2S* reconfigures the user-specific inputs into the proper format for the *ERCBH2S* model.

A complete list of user-interface pages are described in the following table:

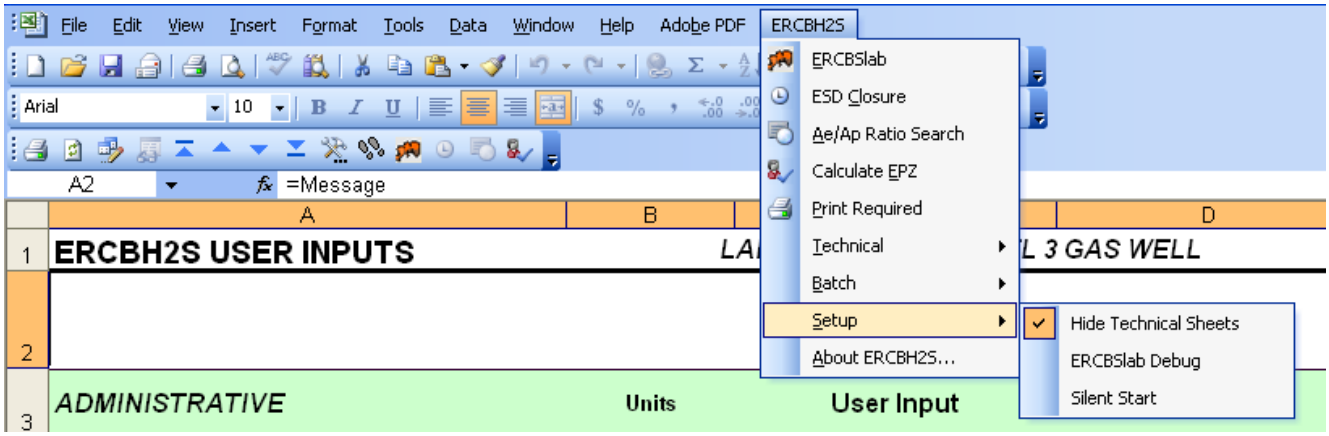
Page Name	Purpose	View		Description
		Typical	Technical	
ABOUT	User Information	☐	☐	General information and instructions for use of the spreadsheet and submission of the results to the ERCB. Use this sheet to link to the latest information regarding ERCBH2S.
ERROR CODES	User Information		☐	Error code listing. Consult this sheet to interpret error codes.
NOTES	User Information	☐	☐	A formatted sheet for the User to record details about the inputs.
BATCH	Input and Results	☐	☐	User input for batch processing (multiple scenarios in a single file) and pipeline gathering system plus summary of results.
INPUTS	Input	☐	☐	User input for administrative, facility, mitigation and sour gas composition data.
CONSTANTS	Input		☐	ERCB default inputs, not editable.
SHARED	Calculation		☐	Includes calculations of chemical/physical properties and gas composition that are common to all ERCBH2S analysis flavours, not editable
ERCBFLASH	Calculation		☐	*ERCBFLASH* input variables are created from the calculations on other pages.
ERCBFLASH OUTPUT	Read Only Data		☐	Output variables from *ERCBFLASH*.
ERCBSLAB	Calculation		☐	*ERCBSLAB* input variables are created from the calculations on other pages.
ERCBSLAB OUTPUT	Read Only Data		☐	Variables from *ERCBSLAB*. Selected values from this page are graphed on the GRAPH-ERCBSLAB(x).
TOX OUTPUT	Read Only Data		☐	Predictions from *ERCBSLAB* for user selected case. Provides concentrations and toxic load-equivalent concentrations as a function of down wind distance. Data from this page are graphed on the GRAPH-TRANSIENT EVENT (X) or GRAPH-STEADY EVENT (X).
MAX OUTPUT	Read Only Data		☐	Maximum of predictions from *ERCBSLAB* for all screening cases. Provides concentrations and toxic load-equivalent concentrations as a function of down wind distance. Data from this page are graphed on the GRAPH-TRANSIENT EVENT (X) or GRAPH-STEADY EVENT (X).
ERP SUMMARY	Output	☐	☐	Summary of Inputs and Emergency Response and Planning Zones. This page to be included for each well and pipeline segment in the Emergency Response Plan.
HAZARDS	Tabular Summary		☐	Summary of Release Description, User Selected Case Hazard Distances, Maximum of Screening Hazard Cases ERP Zones.
GRAPH-MET	Graphic Summary		☐	Tabular and graphical representation of the METMATRIX data. Hazard distances for the range of meteorological conditions and wind speeds. Presented in tabular and graphical format. The maximum computed distance is highlighted.
GRAPH-ERCBSLAB(x)	Graphic Summary		☐	Graph showing how variables change as the release moves away from the source.
METMATRIX	Tabular Summary		☐	Hazard distances for the Screening Matrix of 54 different stability class / wind speed combinations.
HAZARD DISTANCES	Tabular Summary		☐	Calculates worst-release with worst-dispersion distance and worst-release with averaged-dispersion distance.
SOUR GAS PIPELINE flavour				
SOUR GAS PIPELINE	Calculation		☐	Calculates inputs to *ERCBFLASH* and uses output from *ERCBFLASH* to calculate inputs to ESD CLOSURE and *ERCBSLAB*.
ESD CLOSURE	Tabular Summary		☐	Intermediate calculation page to determine ESD valve closure time for the input settings for the user selected AeAp.
AeAp-ITERATION	Tabular and Graphic Summary		☐	Intermediate calculation page to determine the pipeline source exit area to pipeline area that leads to the largest ERP Zones
GRAPH-TRANSIENT EVENT(x)	Graphic Summary		☐	Graphical representation of the TOX OUTPUT and MAX OUTPUT concentrations. The Planning and Alert Criteria are highlighted on the graph

Page Name	Purpose	View		Description
		Typical	Technical	
SOUR GAS WELL flavour				
SOUR GAS WELL	Calculation		☐	Calculates inputs to *ERCBFLASH* and uses output from *ERCBFLASH* to calculate inputs to *ERCBSLAB*.
GRAPH-STEADY EVENT(x)	Graphic Summary		☐	Graphical representation of the TOX OUTPUT and MAX OUTPUT concentrations. The Planning and Alert Criteria are highlighted on the graph
SOUR LIQUID PIPELINE/WELL flavour				
SOUR LIQUID	Calculation		☐	Calculates inputs to *ERCBFLASH* and uses output from *ERCBFLASH* to calculate inputs to *ERCBSLAB*.
GRAPH-STEADY EVENT(x)	Graphic Summary		☐	Graphical representation of the TOX OUTPUT and MAX OUTPUT concentrations. The Planning and Alert Criteria are highlighted on the graph

Hidden Technical Pages

All *ERCBH2S* Excel pages (sheets) are available in the blank template or example files. Because most users require only a few of the pages, the blank template and example files open with most of the technical pages 'hidden'. This is referred to as the '**typical view**'. The typical view displays five page tabs – **ABOUT**, **NOTES**, **BATCH**, **INPUTS** and **ERP SUMMARY**. Most users prefer the typical view because it provides the necessary information to determine the ERP zones.

Some ERP Planners prefer access to all *ERCBH2S* Excel pages to better understand the hazards and how they can be mitigated at the source. This view is referred to as the '**technical view**'. To access this view, from the **INPUTS** page the user must go to the menu item **ERCBH2S→Setup→Hide Technical Sheets**. With 'hide technical sheets' checked, the detailed calculation pages are hidden, and only five pre-selected input and output pages are displayed (the typical view).



With the check-mark 'clicked' for removal, all the *ERCBH2S* Excel page tabs are displayed at the bottom of the screen. This is the technical view.

For users choosing the technical view, a copy of the *ERCBH2S User-Interface Page Guide* will provide handy reference (previous section).

Excel Functionality

The *ERCBH2S* user-interface was developed within Excel to provide a relatively common platform for most technical users. The Excel spreadsheet also provides a transparent implementation of the model as opposed to compiled code. Because Excel is used as the interface, much of the Excel functionality is retained within the *ERCBH2S* program. That is, user input boxes can accept numeric or text information, as well as calculations including Excel function calls.

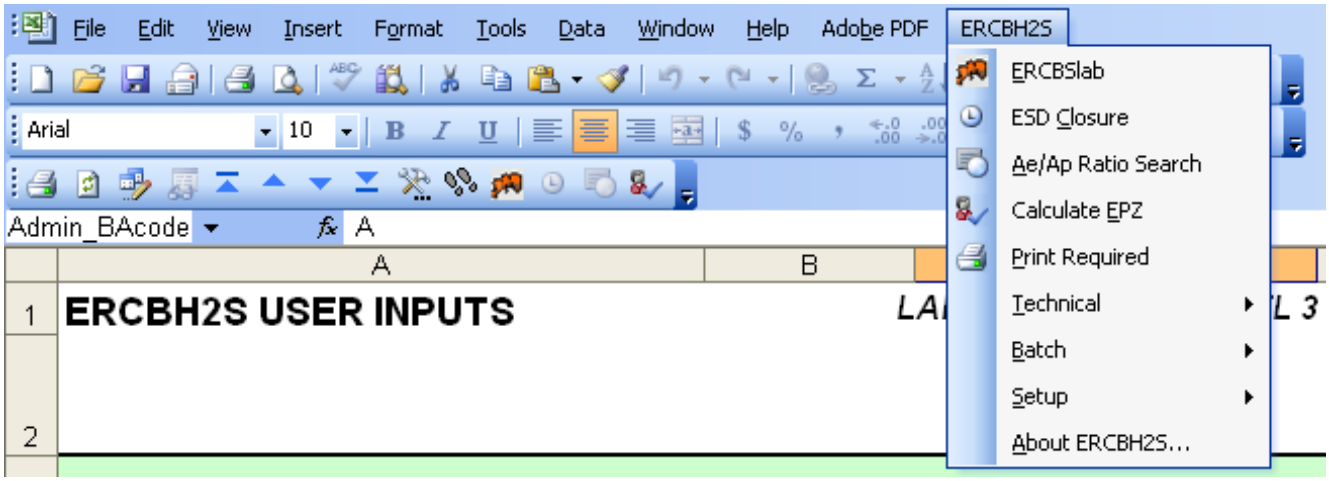
Using function calls, a technical user can link input cells (such as on the **BATCH** page, see page 117) to other spreadsheets.

Information can be copied to and from the template files using standard Excel methods, such as the **Cut**, **Copy** and **Paste** edit commands.

The *ERCBH2S* program template spreadsheets include security protection on non-user-input cells and pages. You will not be able to **Cut** or **Paste** to these cells.

ERCBH2S Excel Menus

The *ERCBH2S* application menu is added to the main menu-bar for Excel when the *ERCBH2S* application is loaded using the Add-in Manager or when the XLA file is opened using **File→Open→ERCBH2S.xla.** The *ERCBH2S* application menu is shown below. These options link to the principal *ERCBH2S* program operations.

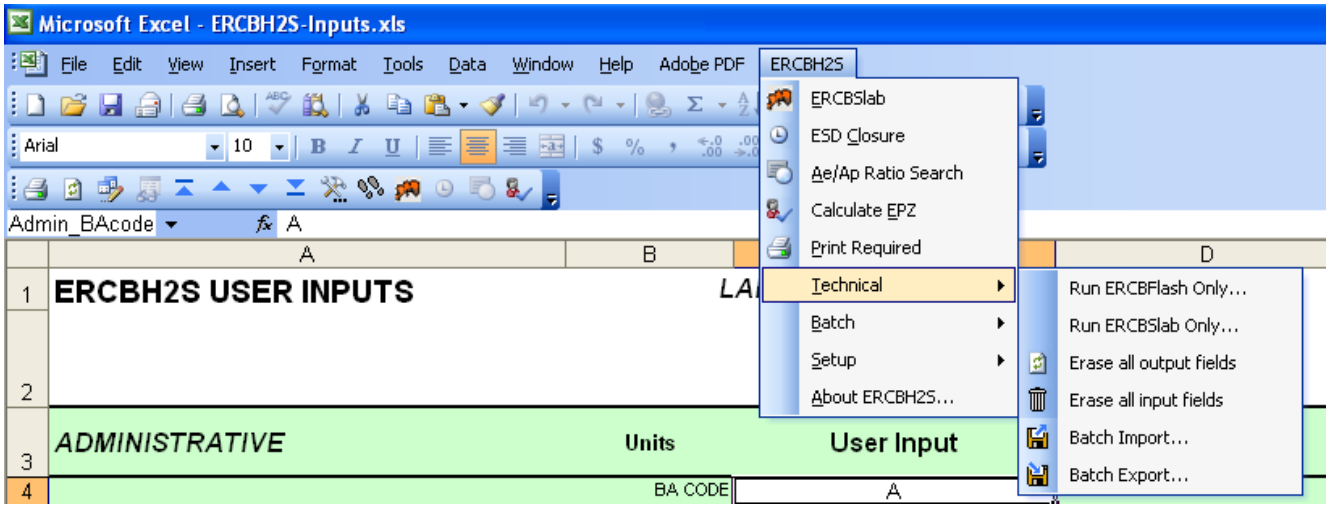


BUTTON	DESCRIPTION
	Run the **ERCBSLAB** calculation for the inputs on the INPUTS page for the user selected wind speed, meteorological stability and exit area ratio.
	Run the **ESD Closure** calculation for the gas pipeline entries on the INPUTS page
	Run the **Ae/Ap Ratio Search** (exit area ratio) for the gas pipeline entries on the INPUTS page for the user selected wind speed and meteorological stability.
	**Calculate EPZ** for the inputs on the INPUTS page to determine the ERP zones for all wind speeds, meteorological stabilities and (for sour gas pipelines) exit area ratio and ESD timing.
	Print the **ERP SUMMARY** page.

Many selections shown under menu item *ERCBH2S* (and some of the sub-menu items) also appear as 'Buttons' on the *ERCBH2S* Button-bar.

Technical Submenu

The **Technical** submenu is shown below with a description of the menu items. These operations are provided for the technical user or for operations debugging. These operations allow the user to complete individual program steps (ERCBFLASH and ERCBSLAB) as described below.

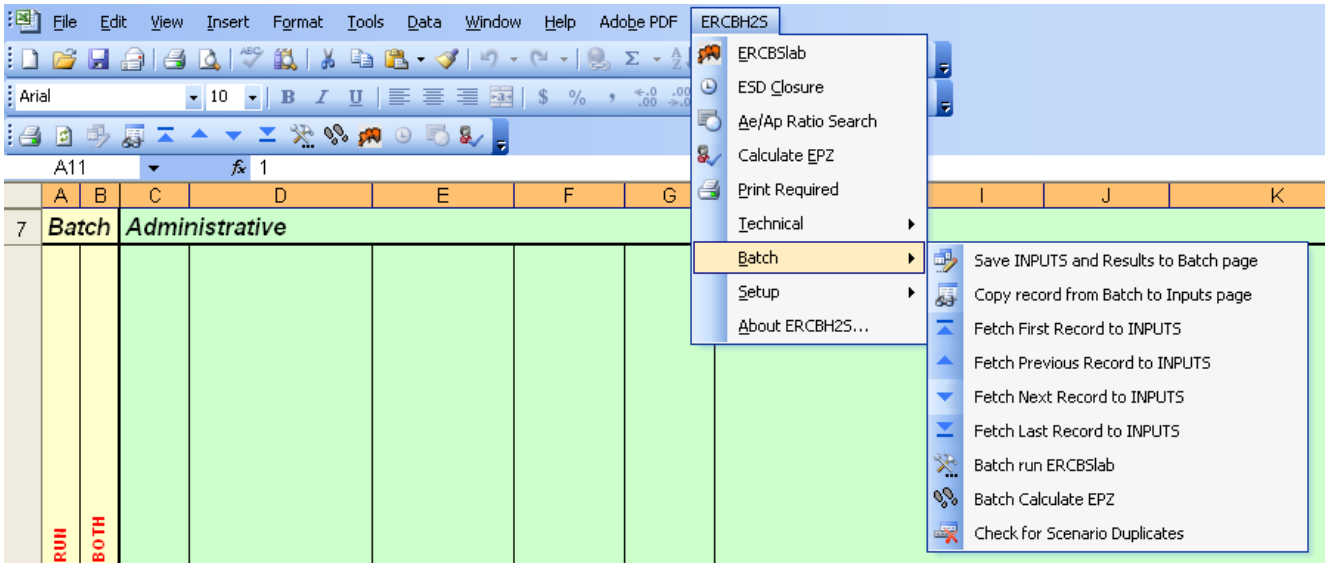


BUTTON	DESCRIPTION
Run ERCBFLASH Only…	Runs the *ERCBFLASH* calculations for the current model configuration
Run ERCBSLAB Only…	Runs *ERCBFLASH* and then runs the *ERCBSLAB* calculations for the current model configuration and the current *ERCBFLASH* output information
	Erase all output fields in the template spreadsheet file (does NOT erase output data stored on the BATCH page).
	Erase all input fields on the INPUTS page (does NOT erase input data stored on the BATCH page)
	Imports a BATCH export file to the BATCH page.
	Exports a BATCH import file (input and **ERP SUMMARY Results**) with data stored on BATCH page.

Batch Submenu

The **BATCH** submenu is shown below with a description of the menu items. The **BATCH** page is very large and can hold hundreds of scenarios of all different sour operations types. **BATCH** operations assist in loading and saving information from the **INPUTS** page. While ERP zone calculations can be done directly from the **BATCH** page, information can be moved back and forth between the **BATCH** page and **INPUTS** page. Other menu items are for selecting run-time functions for testing or full processing.

ERCB Submission Requirements – Licensees/applicants are required to submit an electronic copy (export file) of the **BATCH** page for the subject submission. Details about the **BATCH** page (including the ERCB file naming protocol) are in Chapter 8 - Batch Page.

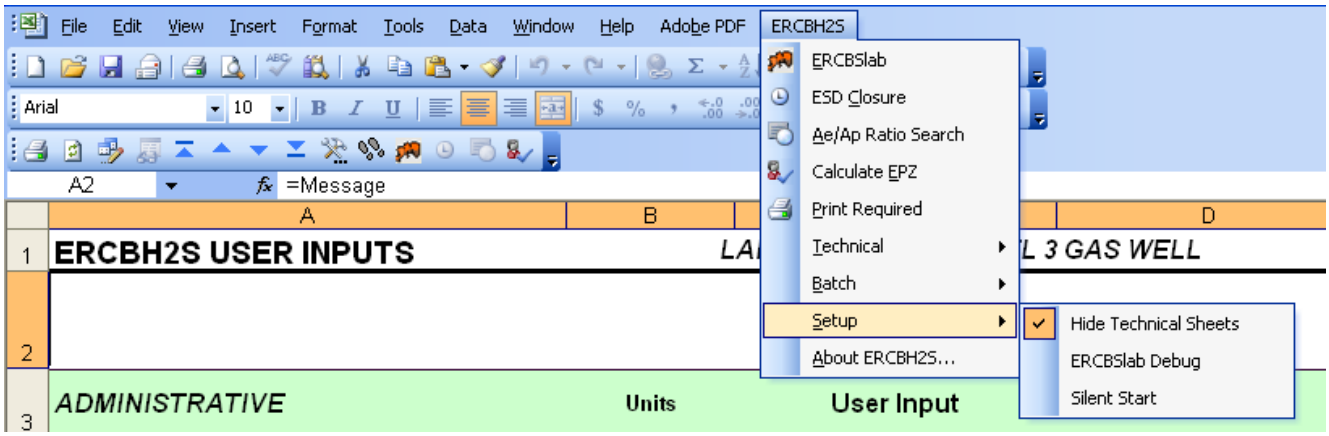


BUTTON	DESCRIPTION
	**INPUTS page is active: Saves** parameters from the INPUTS page and results to a new line (row) on the Batch page, or overwrite an existing record with the same Scenario Name.
	**BATCH page is active: Copy** the selected INPUT record from the BATCH page to the INPUTS page (calculation results are NOT brought over to the ERP SUMMARY page).
	**INPUTS page is active: Fetch** the first record on the BATCH page to the INPUTS page (calculation results are NOT brought over to the ERP SUMMARY page).
	**INPUTS page is active: Fetch** the previous record on the BATCH page to the INPUTS page. The previous record is 'above' the record with the "Scenario Name" that matches what is currently displayed on the INPUTS page (calculation results are NOT brought over to the ERP SUMMARY page).

	**INPUTS page is active: Fetch** the next record on the BATCH page and read (copy) the records to the INPUTS page. The next record is 'below' the record with the "Scenario Name" that matches what is currently displayed on the INPUTS page (calculation results are NOT brought over to the ERP SUMMARY page).
	**INPUTS page is active: Fetch** the last record on the BATCH page to the INPUTS page (calculation results are NOT brought over to the ERP SUMMARY page).
	**Batch Run ERCBSLAB** for each record marked RUN on the BATCH page. This is a 'test run' and is not sufficient for ERCB submission – user must run the **Batch Calculate EPZ** calculation for ERCB submission.
	**Batch Calculate EPZ** calculates ERP Zones for each record marked RUN on the BATCH page.
	**Check for Scenario Duplicates** Check the scenario name of each record on the BATCH page for duplicate names.

Setup Submenu

The **Setup** submenu is shown below with a description of the menu items.



BUTTON	DESCRIPTION
Hide Technical Sheets	This toggle switch hides/shows the technical calculation pages (typical or technical view). Most users will not require viewing of the technical sheets.
ERCBSLAB debug	This toggle switch is used to turn on/off the creation of text output file generation of the output from the *ERCBSLAB* model to the current working folder.
Silent Start	This toggle switch is used to turn off/on the confirmation prompts for when BATCH calculations are about to be performed, and suppresses error message dialog pop-ups. This switch is useful when automating BATCH processes.

ERCBH2S Excel Button-Bar

The *ERCBH2S* application button bar is added to the Excel window when the *ERCBH2S* application is loaded using the Add-in Manager or when the XLA file is opened using **File→Open→ERCBH2S.xla.** The *ERCBH2S* application button bar (shown below) displays principal commands for *ERCBH2S* program operation. All of the buttons are also listed as choices under *ERCBH2S* in the menu-bar.

BUTTON	DESCRIPTION
	Print the ERP SUMMARY page.
	Erase all output fields in the template spreadsheet file (does NOT erase output data stored on the BATCH page).
	**INPUTS page is active: Save** INPUTS and Results to a new line (row) on the Batch page, or overwrite an existing record with the same Scenario Name.
	**BATCH page is active: Copy** the selected record from the BATCH page to the INPUTS page (calculation results are NOT brought over to the ERP SUMMARY page).
	**INPUTS page is active: Fetch** the first record on the BATCH page to the INPUTS page (calculation results are NOT brought over to the ERP SUMMARY page).

	**INPUTS page is active: Fetch** the previous record on the BATCH page to the INPUTS page. The previous record is 'above' the record with the "Scenario Name" that matches what is currently displayed on the INPUTS page (calculation results are NOT brought over to the ERP SUMMARY page).
	**INPUTS page is active: Fetch** the next record on the BATCH page and read (copy) the records to the INPUTS page. The next record is 'below' the record with the "Scenario Name" that matches what is currently displayed on the INPUTS page (calculation results are NOT brought over to the ERP SUMMARY page).
	**INPUTS page is active: Fetch** the last record on the BATCH page to the INPUTS page (calculation results are NOT brought over to the ERP SUMMARY page).
	'Test run' the BATCH page inputs. This command runs the **ERCBSLAB** calculation for each record marked RUN on the BATCH page. This is not sufficient for ERCB submission – user must run the **Batch Calculate EPZ** calculation for ERCB submission.
	Run the **Batch Calculate EPZ** calculation for each record marked RUN on the BATCH page.
	Run the **ERCBSLAB** calculation for the inputs on the INPUTS page for the user selected wind speed, meteorological stability and exit area ratio.
	Run the **ESD Closure** calculation for the gas pipeline entries on the INPUTS page
	Run the **Ae/Ap Ratio Search** (exit area ratio) for the entries on the INPUTS page for the user selected wind speed and meteorological stability.
	Run the **Calculate EPZ** for the inputs on the INPUTS page to determine the ERP zones for all wind speeds, meteorological stabilities and (for sour gas pipelines) exit area ratio and ESD timing.

Note that as you move your cursor across the button-bar that active buttons are framed and in colour. If the button is inactive, it will appear gray in colour. The activity depends on the Sour Operations Type, if the technical sheets are hidden or what sheet is active.

Saving Scenarios as Excel Files

ERCBH2S scenarios are saved as Excel files. It is recommended that you save scenarios with a logical description, such as the pipeline segment name or scenario name. Remember not to overwrite the original blank template file. This ensures new scenarios have consistent 'starting data' to help minimize calculation problems.

If using the *ERCBH2S* 'Gathering System Analysis' feature on the **BATCH** page (Chapter 9 - Pipeline Gathering Systems), refer to the suggested scenario naming format in Chapter 9 under Pipeline Segment Label (Scenario Name).

Unless saving a **BATCH** file for ERCB submission needs, it is recommended that you choose another file naming convention. The required file naming protocol for ERCB submissions is described in this chapter under Importing and Exporting *ERCBH2S* Batch Files.

To save a scenario file:

1. Click **File** in the menu-bar and select **Save As**.

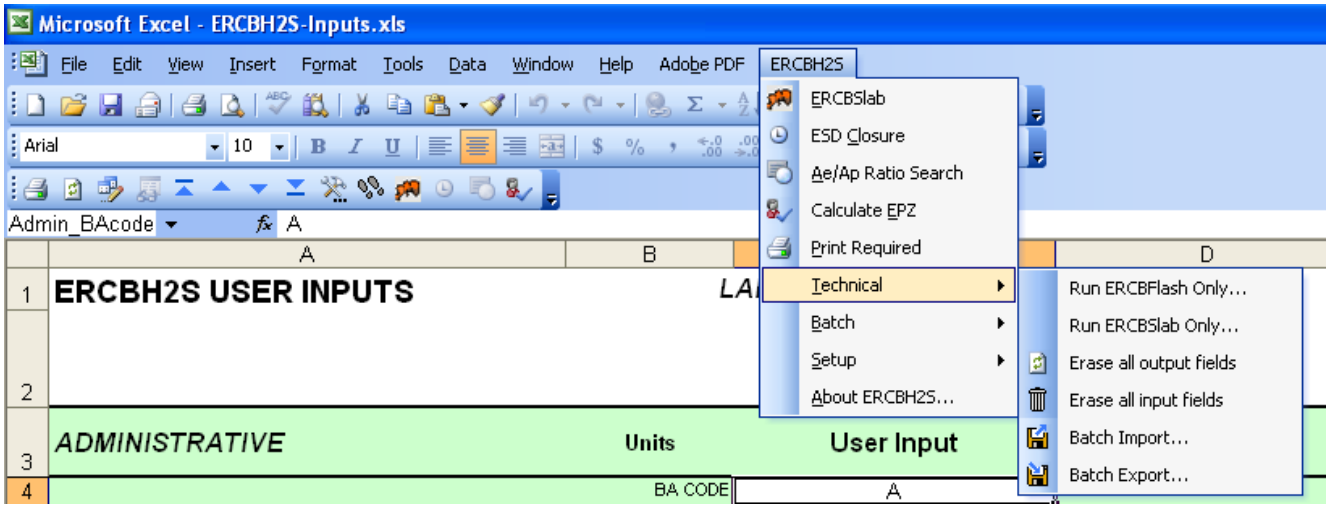
2. Create a file name for your scenario and click the **Save** button. This method of file saving also stores any information added to the **NOTES** page.

You are not restricted in your selection of folder in which to save your scenario files. It is recommended that you create a new folder and naming convention to store related scenarios.

You may also use the **BATCH** Page (see page 117) to store multiple scenarios or sensitivity tests within a single file.

Importing and Exporting ERCBH2S BATCH Page

The input and certain key ERP output data stored on the **BATCH** page can be exported to an *ERCBH2S* export file for convenient email transfer or backup. From the menu-bar, **ERCBH2S→Technical→ Batch Export...** prompts the user using common windows file dialog window for a folder and a file name.



For ERCB submissions, licensees/applicants are required to use the following file naming protocol:

BA code - ERP Plan Ref# - Date (DD/MMM/YY)

For example, if a company with the BA code of WXYZ submits a file on July 5th, 2008, the file would be named:

WXYZ-1234-05Jul08.csv

The **.csv** file extension (**c**omma **s**eparated **v**ariable) is automatically attached to the file name. The variable names are those expected by *ERCBH2S* to match the **INPUTS** page - the order of the variables in the file is not important.

The batch export file can be viewed using **Excel** or **Notepad** or other text editor. Note that the .csv file does not contain user information added to the **NOTES** page.

An *ERCBH2S* batch export file can be reloaded to a **BATCH** page using the batch-import function **ERCBH2S→Technical→Batch Import...** from the menu bar.

BATCH page submissions to the ERCB must not have any error codes in column DO!

An example **.csv** export file is provided in the listing below.

```
ERCBH2S File Version,1
ERCBH2S Version, 1.2
ERCBH2S Spreadsheet Version,1.21.0002
ERCBH2S Macro Version,1.21.0002
ERCBSLAB Version, 001.002.0001
ERCBFLASH Version, 001.000.0001
[START ---------------------------------------- ]
Admin_BAcode,A
Admin_Licensee,B
Admin_Address,C
Admin_City,D
Admin_PostalCode,E
Admin_ContactName,F
Admin_Phone,G
Admin_Fax,H
Admin_eMail,I
Calc_ScenarioName,Label 3 Gas Well
Calc_SubstanceType,1
Calc_AnalysisType,1
Admin_FacilityName,Label 1
Admin_FacilityLicense,K
Admin_SurfaceLocation,Label 2
Admin_SurfaceLocation_Start,M
Admin_SurfaceLocation_End,N
Admin_Elevation,1000
Admin_EPZExisting,na
Admin_Datum,7
Pipeline_StartX,O
Pipeline_StartY,P
Pipeline_EndX,Q
Pipeline_EndY,R
Pipeline_MOP,9930
Pipeline_Pressure,5000
Pipeline_OutsideDiameter,273.1
Pipeline_WallThickness,9.3
Pipeline_SegmentLengthActual,1000
Pipeline_EquivalentLength,5420
Pipeline_EquivalentVolume,
Pipeline_GOR,
Pipeline_H2SMax,14
Pipeline_H2SConcentration,7
Pipeline_Ti,
Pipeline_ESDTclose,
Pipeline_ESDPressureTrigger,
Pipeline_ESDPROCTrigger,
Pipeline_ESDTpoll,
Pipeline_TESDManual,
Pipeline_TimeBeforeMitigation,
Well_Phase,2
Well_IsCritical,1
Well_UniqueWellIdentifier,O
```

Figure 1: Export/Import CSV file sample

ERCBH2S Excel Print Settings

Each page has been paginated for proper display of the data on Letter size paper (North American, 8.5in ×11in or 216mm×279mm). Any page may be printed by clicking the standard *Excel* print icon.

The **ERCBH2S→PRINT REQUIRED** command,  , automatically sends the **ERP SUMMARY** page to the default printer.

ERCBH2S Excel Pages – RED FLAG WARNINGS

A **red flag** warning appears as a banner at the top of many *ERCBH2S* Excel pages when user inputs are missing, outside of allowable ranges, or have changed **since the last calculation** sequence was performed. It is important to remember that at any one time, there is only **one** current set of calculation results displayed on the *ERCBH2S* Excel pages (other than the **BATCH** page, which can store many different sets of calculation result records). **Red flag** warnings are described in detail under Red Flag Warnings in Chapter 5.

The *ERCBH2S* Calculation Process

Calculations are controlled by the *ERCBH2S.xla* application file. All user input, intermediate calculations and output displays are done in the *ERCBH2S* template file for Microsoft Excel, **ERCBH2S-INPUTS.xls**. Major calculations are done in the dynamic link library programs (dll) as directed by *ERCBH2S.xla*.

Run ERCBSLAB

There are eight steps in the basic calculation process known as **Run ERCBSLAB** with the button  , as described below and shown in the flow diagram that follows:

1. Basic information about the scenario **Flavour** and release description are entered on the **INPUTS** page. The user then presses the **ERCBH2S→ERCBSLAB** command to start the sequence of calculations.

2. Intermediate calculations are immediately performed by Excel when data changes on the **INPUTS** page. Depending on the scenario Flavour, calculations are performed on one of the **SOUR GAS PIPELINE, SOUR**

GAS WELL or **SOUR LIQUID** pages. The intermediate calculations prepare a model input file for the *ERCBFLASH* program.

The model input file is listed on the **ERCBFLASH** page. The input file is compared to the previous input file for *ERCBFLASH*. If the input is the same as the previous file, the *ERCBFLASH* is not required to be executed again, and the results from the previous run are still valid. In this case, the *ERCBH2S* program calculations will continue at step 4. If the input file is new, then the calculations continue at Step 3.

3. After the *ERCBFLASH* program has completed its calculations of real gas properties for the gas composition and physical parameters input, output data is displayed on the **ERCBFLASH OUTPUT** page. The *ERCBH2S* program resumes the calculation process.

4. Intermediate calculations then proceed on either the **SOUR GAS PIPELINE**, **SOUR GAS WELL or SOUR LIQUID** pages depending on the scenario flavour, using the real gas properties calculated by the *ERCBFLASH* program for the physical conditions entered in the **INPUTS** page.

5. Intermediate calculations are performed by Excel on either the **SOUR GAS PIPELINE**, **SOUR GAS WELL or SOUR LIQUID** pages to calculate source parameters for dispersion modelling using the *ERCBSLAB* program. The intermediate calculations prepare a model input file for the *ERCBSLAB* program.

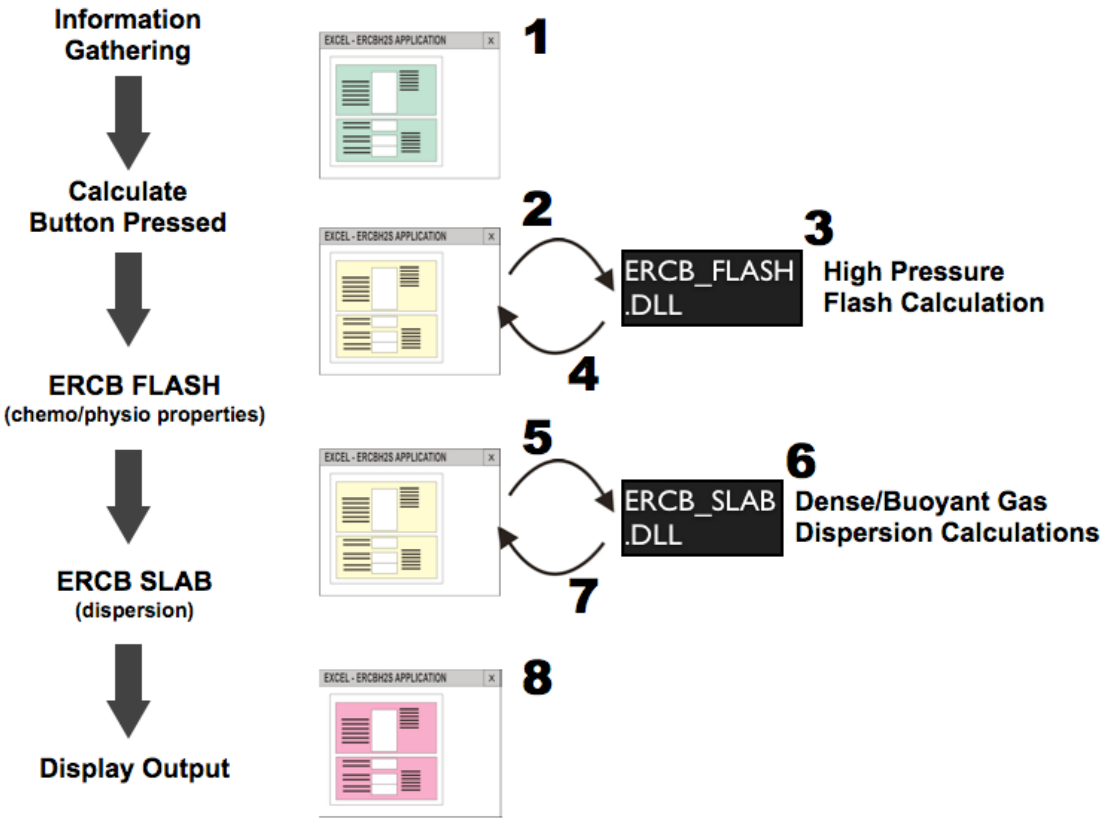
The model input file is listed on the **ERCBSLAB** page. The input file is compared to the previous input file for *ERCBSLAB*. If the input is not the same as the previous file, the **red flag** may appear, indicating that the previous results are invalid. Different than the *ERCBFLASH* process, the *ERCBH2S* program will always re-run the *ERCBSLAB* program when the **Run ERCBSLAB** command is used.

6. After the *ERCBSLAB* program has completed its dispersion calculations for the real gas properties and physical parameters input, output data is displayed on the intermediate calculation technical **ERCBSLAB OUTPUT** and **TOXOUT** pages.

7. The Intermediate calculations then proceed on the **GRAPH-ERCBSLAB (x)**, **GRAPH-TRANSIENT(x)**, or **GRAPH-STEADY(x)** pages, depending on the scenario flavour. These pages display the technical intermediate calculation results in a graphical format. Each of these graphs display information as a function of downwind distance or x-distance.

8. After the *ERCBSLAB* program has completed its dispersion calculations for the parameters input, output data is displayed on the intermediate calculation technical **MET MATRIX** page.

The final results of the calculations are displayed on the **HAZARD DISTANCES** page, in the form of a table. The table lists the calculated *Worst-Release Hazard Distance* for the meteorological stability class, wind speed and exit area ratio on the **INPUT** page.

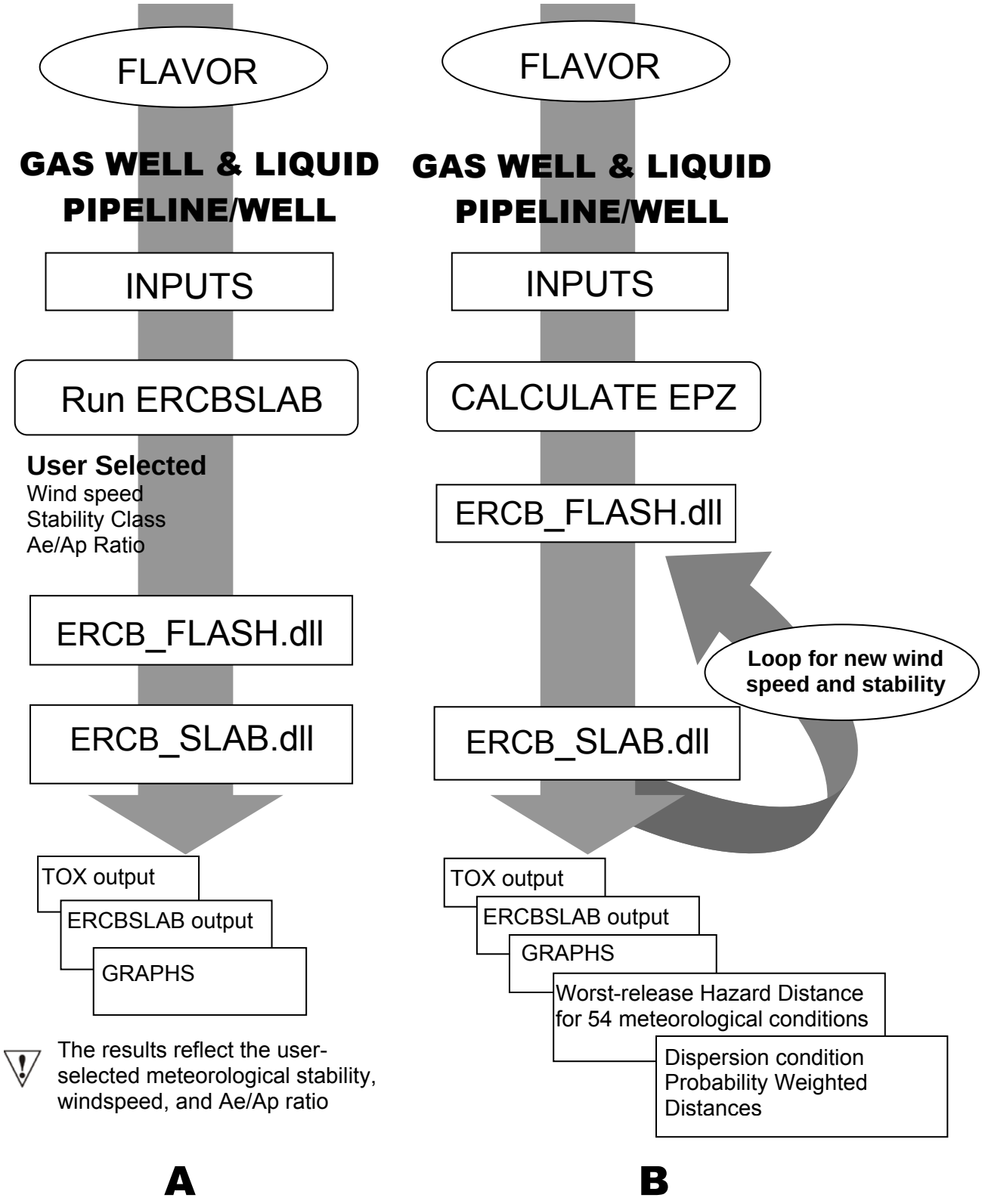


Gas Well Calculation Process

There are two basic flow sequences for the **WELL flavour** as shown in the following calculation flow graphic. The basic 'once through' **Run ERCBSlab**  sequence (**A**) is a single iteration of the overall calculation process as shown in the preceding graphic. The calculation is performed using the single meteorological stability class and wind speed entered on the **INPUTS** page.

A series of calculation processes is performed for the **Calculate EPZ**  command to iterate automatically to calculate the *Dispersion Condition Probability Weighted Hazard Distances*. The calculation process is shown as flow pattern (**B**) in the following graphic. The overall process is similar to the process (**A**), except that the *ERCBSLAB* calculations are repeated many times to calculate the *Worst-Release Hazard Distances* for different meteorological stability class and wind speed. The iteration process in (**B**) is repeated 54-times for the various combinations of meteorological conditions and results 54 *Hazard Distances*. The dispersion condition probability weighted value of these 54 distances is calculated by multiplying the hazard distance in each of the 54 categories by the fraction of time that each meteorological condition occurs, and results the *Worst-Release with Averaged-Dispersion Hazard Distances.* The final results of the calculations are displayed on the **HAZARD DISTANCE** page, in the form of a table.

For the detailed technical description of the calculations and methods used in the programs see **Volume 1 - Technical Reference Document Version 1.20.**


FLAVOR
GAS WELL & LIQUID PIPELINE/WELL
INPUTS
Run ERCBSLAB
User Selected
Wind speed
Stability Class
Ae/Ap Ratio
ERCB_FLASH.dll
ERCB_SLAB.dll
TOX output
ERCBSLAB output
GRAPHS
The results reflect the user-selected meteorological stability, windspeed, and Ae/Ap ratio
A
FLAVOR
GAS WELL & LIQUID PIPELINE/WELL
INPUTS
CALCULATE EPZ
ERCB_FLASH.dll
Loop for new wind speed and stability
ERCB_SLAB.dll
TOX output
ERCBSLAB output
GRAPHS
Worst-release Hazard Distance for 54 meteorological conditions
Dispersion condition Probability Weighted Distances
B

Liquid Pipeline and Liquid Well Calculation Process

There are also two basic flow sequences for the **LIQUID flavour**. The parameters are entered for the **LIQUID flavour** on the **INPUTS** page and intermediate calculations are provided on the technical **LIQUID** page. The **LIQUID** calculation process is the same as the **WELL** calculation process illustrated as process (**A**), and (**B**) in the above graphic.

Gas Pipeline Calculation Process

There are three basic flow sequences for the **PIPELINE flavour** as shown in the following calculation flow graphic. The basic 'once through' sequence (**C**) is a single iteration of the overall calculation process, already described in **Run ERCBSLAB**. The calculation is performed using the selected meteorological stability class, wind speed and pipeline exit area ratio entered on the **INPUTS** page.

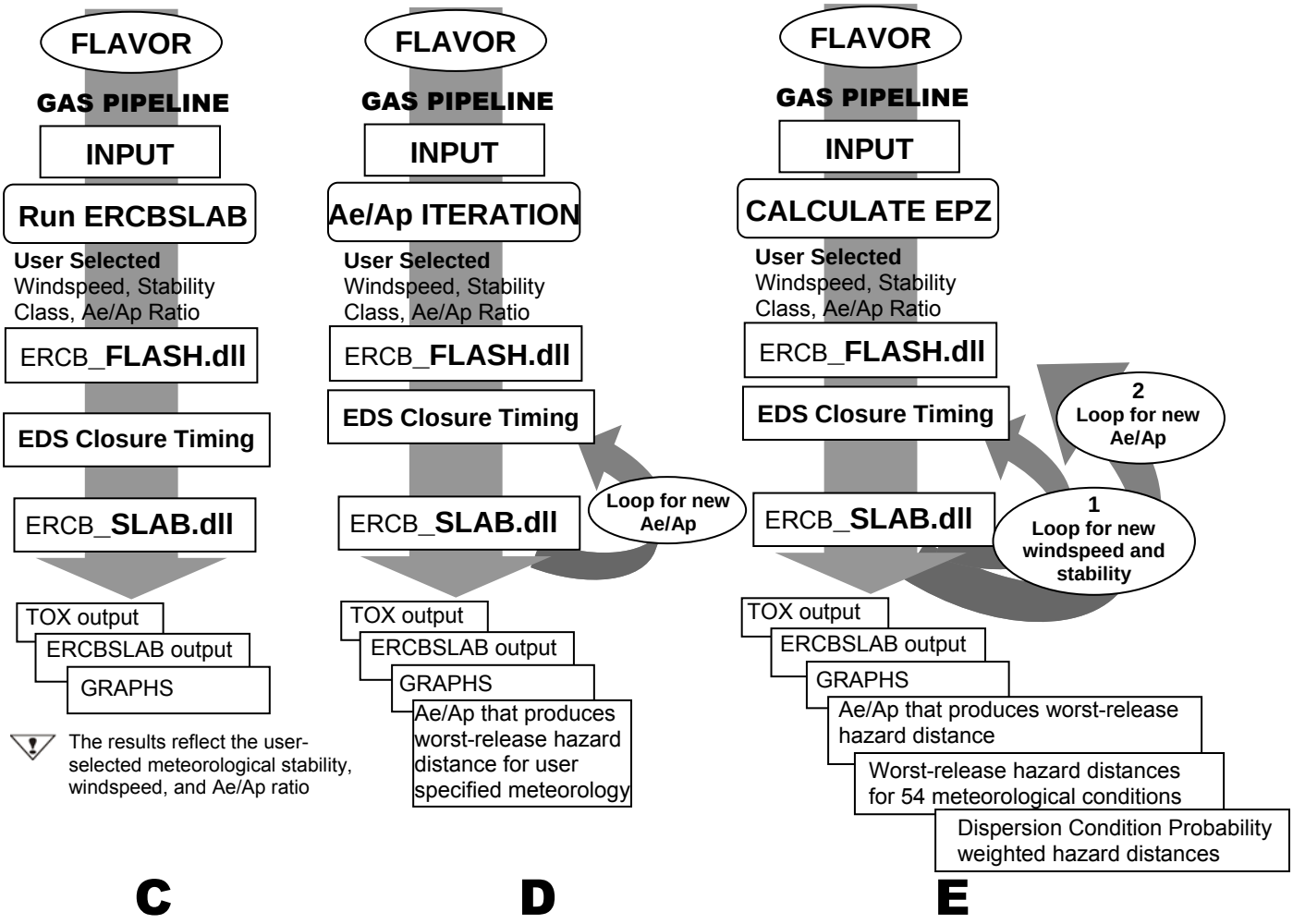
For the **PIPELINE Flavour**, a release and the calculated downwind concentrations are a function of the hole size, which is expressed as the exit area to pipeline area ratio (**Ae/Ap**). *Ae/Ap* ratios vary from 0.01 (a small hole) to 2.00 (the pipeline is severed in two). *Ae/Ap* ratio affects the rate and duration at which sour gas is released from the pipeline and input to *ERCBSLAB*.

For **large Ae/Ap ratio**, the release is a suddenly large cloud of gas with a short duration. For **small Ae/Ap ratio**, the release is long duration and relatively steady in release rate. Often the intermediate release holes can produce the largest ERP zones. To assist in the search for the worst release exit area ratio, the *ERCBH2S* program has been automated to repeat the overall calculation process for a range of hole size ratios. The calculation process is represented as the flow pattern (**D**) in the following graphic. The *Worst-Release Hazard Distance* is estimated based on the iteration for exit area ratio using the selected meteorological stability class and wind speed entered on the **INPUTS** page. The results are listed on the **METMATRIX** page (Hazard Distances for Meteorological Matrix).

A third calculation process is performed for the **PIPELINE flavour**, to iterate automatically to use the *Worst-Release* condition (the exit area ratio that produces the largest hazard zone) for each of different meteorological conditions to get different *Worst-Release Hazard Distances*. The calculation process is shown as flow pattern (**E**) in the following graphic. The overall process is similar to the process (**D**), except that the *ERCBSLAB* calculation is repeated many times for different meteorological and release conditions. The iteration process in (**E**) is

repeated 54-times for the various combinations of meteorological stability and wind speeds and 11-times for each of the exit area ratios.

For the detailed technical description of the calculations and methods used in the programs see **Volume 1 - Technical Reference Document Version 1.20.**



ESD Closure

For an **Ae/Ap ratio**, the rate of release is used to determine how fast the automated emergency shut down (ESD) valves can respond to the release rate. The ESD valves can respond in three ways: by the responding to a drop in pressure from the current operating pressure (ESD Valve Low Pressure Setting, P_{esd}, on the INPUTS page); on the rate of change of pressure (ESD Valve Pressure rate of change, *dP/dt*, on the **INPUTS** page); or by manual closure time (on the **INPUTS** page). The pressure changes at the valve are used to determine which of the two automation controls will trigger the valve closure first and then

compared to the manual valve closure time. This timing plus the time it takes to the ESD to close, is used to calculate the amount of gas that passes through the valve from the time of the release to the closing of the valve. The total release volume is the calculated standing volume between ESD valves plus the above estimated extra volume that flows by the valves before they close.

This calculation is started using the **ERCBH2S→ESD Closure**  command. Results are displayed on the **ESD CLOSURE** page for the selected hole size ratios.

The user can vary the parameters such as distance between ESD valves, pipe sizes, ESD closure settings, or hole size, to investigate the effects these parameters have on the calculated ESD Closure timing. For large holes, the results demonstrate that either pressure ratio or the pressure rate of change can trigger the closing of the valve depending on the site-specific parameters entered. Pressure rate of change settings can have a strong influence on reducing release volumes. For small holes, the ESD Closure calculations indicate that that neither the pressure ratio nor the pressure rate of change settings may trigger the closing of the valve, rather manual closure is required.

The **ESD CLOSURE** page is described in more detail on page 100.

Ae/Ap Ratio Search

For the **PIPELINE flavour** scenario, a release and the calculated downwind concentrations are a function of the hole size, which is expressed as the exit area to pipeline cross-section area ratio (**Ae/Ap**). To assist in the search for the worst case exit area ratio, the *ERCBH2S* program has been automated to repeat the overall calculation process for a range of hole size ratios. This iteration process is started using the **ERCBH2S→Ae/Ap Ratio Search**  command and intermediate calculations are displayed on the **AeAp-Iteration** page where the selected hole size ratios are listed. This calculation process calls on the **ESD Closure** routine to determine the ESD closure timing which determines the release rate and duration for each of 11 hole sizes.

The exit area ratio iteration is initialized by completing the Basic Calculation sequence, **Ae/Ap Ratio Search**. A *Worst-Release Hazard Distance* is estimated based on the iteration for exit area ratio using the single meteorological stability class and wind speed entered on the **INPUTS** page. The results are listed on the **HAZARD DISTANCES** page. Intermediate results are displayed on the **AeAp-Iteration** that also displays a tabular matrix of results and also a graphical representation. These results were calculated for a selected meteorological wind speed and stability class entered in the **INPUTS** page. The user can vary the parameters such as distance between ESD valves, pipe sizes,

ESD closure settings, hole size or meteorological parameters, to investigate the effects these parameters have on the calculated ERP zones.

The exit area ratio iteration is relatively quick but may take several moments to complete the various calculations. It is recommended that you do not use your computer for other purposes during the calculations.

If a user-specific **Ae/Ap Ratio** is entered on the INPUTS page, the **CALCULATE EPZ** calculation is performed for all meteorological cases for the user-specific **Ae/Ap Ratio**, thus by-passing the *Ae/Ap* search. **Red flag** are displayed to warn the user that results displayed do not represent the complete EPZ calculation process. The user-specific **Ae/Ap Ratio** field must be cleared in order to complete the EPZ calculation process.

The **AeAp-ITERATION** page is described in more detail on page 100.

Calculate EPZ

The ERP zones are determined for the **WELL**, **PIPELINE** and **LIQUID** flavours, by iterating to determine the meteorological stability class, wind speed and exit area ratio (for **PIPELINE flavour**) that is associated with the *Dispersion Condition Probability Weighted Hazard Distances*. The iteration process is started using the **ERCBH2S→Calculate EPZ** command.

The iteration process is repeated 54-times for the various combinations of meteorological stability and wind speeds. For the **PIPELINE flavour**, the **ESD Closure** timing and **Ae/Ap Ratio Search** calculations are also performed for 11 release area fractions.

The iteration for calculating *Worst-Release Hazard Distance* is relatively quick but may take several moments to complete the numerous calculations. It is recommended that you do not use your computer for other purposes during the calculations.

If a user-specific **Ae/Ap Ratio** is entered on the INPUTS page, the **CALCULATE EPZ** calculation is performed for all meteorological cases for the user-specific **Ae/Ap Ratio**, thus by-passing the **Ae/Ap Search**. **Red flags** are displayed to warn the user that results displayed do not represent the complete EPZ calculation process. The user-specific **Ae/Ap Ratio** field must be cleared in order to complete the EPZ calculation process.

The run progress is shown at the bottom of the Excel page. You may stop the Screening Matrix calculations at any time by clicking the **Space Bar** or the **ESC** key.

The results are listed in sections **METMATRIX** (page 97), **GRAPH-MET** (page 110), **HAZARDS** (page 107), and **HAZARD DISTANCE** (page 99).

5. INPUTS Page

Input pages have a green sheet tab (note that some versions of Windows do not display the page/sheet tabs in colour). In this section, the **INPUTS** page is described in detail. The **BATCH** page is described on page (117). There are many parameters required by *ERCBH2S* and these have been divided into the following logical sections:

SECTION	ENTRY	DESCRIPTION
Administrative	Mandatory	Information about the applicant, the location under study, the scenario name, and selection of the **Flavour** for the template and analysis type.
Gas Pipeline	Mandatory	If the Flavour is **GAS PIPELINE**, physical characteristics of the pipeline are specified.
Gas Well	Mandatory	If the Flavour is **GAS WELL**, physical characteristics of the well are specified.
Liquid Pipeline or Liquid Well	Mandatory	If the Flavour is **LIQUID PIPELINE/WELL**, physical characteristics of the liquid release are specified.
Sour Gas Composition	Mandatory	A representative chemical composition of the gas phase in the pipeline or well is specified (dry).
Advanced User Selected Case	Optional – user entries in this section are **not** acceptable for ERCB submission	**For Advanced Users Only** This section allows the user to control calculations for selected meteorological conditions and pipeline release hole size rather than running the complete screening matrix.

The **WITH MITIGATION** analysis may be helpful to determine ignition commitments or advanced technology to mitigate the hazard.

The input cells have conditional formatting that can be over-written when cells are copied from one location to another.

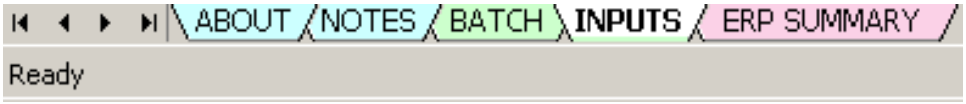
If the **INPUTS** page does not look quite right, open the blank **ERCBH2S-Inputs.xls** and re-enter the data.

Entering Data

User specific data is entered in the *ERCBH2S* program following steps below:

1. Select **Launch ERCBH2S.xla**. Then open an **ERCBH2S-Inputs.xls** file or a *ERCBH2S* example file, such as **ERCBH2S-Pipeline.xls** or **ERCBH2S-Well.xls**. These files can be found using Windows Explorer and navigating to the installation directory for the **ERCBH2S** program. Alternatively, links to these file have been included under the Windows desktop **START** menu, under the *ERCBH2S* program.

2. Navigate to the **INPUTS** page by clicking the "INPUTS" tab for the worksheet.



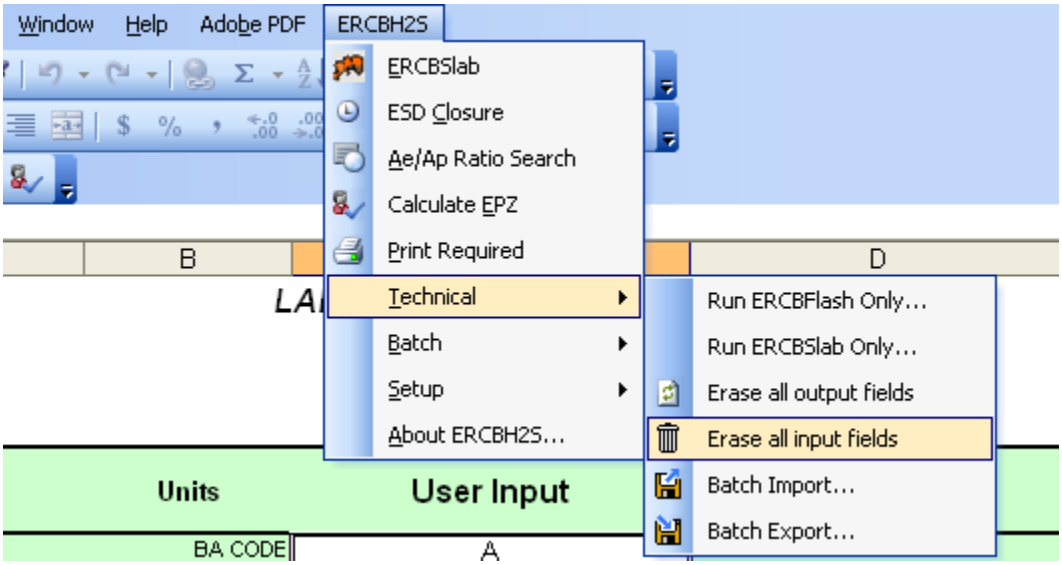
3. The cells and pages are presented in colours to assist in the data entry process. Note that earlier versions of Excel do not display the **page/sheet tabs** in colour.

LEGEND

cells	Prompt description or comment
cells	Entry prompt
cells	Protected or locked calculation
cells	Warning regarding a prompt or calculation that requires special attention
cells	Default value, Locked
cells	Protected or locked calculation output
sheet tabs	Inputs
sheet tabs	Summary/Graphics
sheet tabs	Calculations
sheet tabs	User Information

Erasing the Inputs Page

The **INPUTS** page can be completely cleared by selecting 'Erase all inputs fields' from the Technical sub-menu as shown below. This command does not erase inputs on the **BATCH** page.



Red Flags and other Warnings

Red Flag Warnings

A **red flag** warning appears as a banner at the top of many *ERCBH2S* Excel pages when user inputs are missing, outside of allowable ranges, or have changed **since the last calculation** sequence was performed. It is important to remember that at any one time, there is only one current set of calculation results displayed on the *ERCBH2S* Excel pages (other than the **BATCH** page, which can store many different sets of calculation result records).

A **BATCH** page export file, without **red flags** or other error messages, is required for a licensee/applicant' submission to the ERCB.

Missing Entry

There are two types of missing input data flags. Missing entries for ERCB Submission do not effect the calculation but are required for completeness:

(1) Missing entry(s) for ERCB Submission

Missing entries for calculations will effect the calculation. Notice that as a result, inputs to several other programs have changed so the displayed outputs do not match the inputs.

(1) Missing entry(s) for calculations,<INPUTS DO NOT MATCH DISPLAYED OUTPUT PAGES -- RECALCULATIONS REQUIRED:> ,ERCBFlash not run,ERCBSlab not run,MetMatrix not performed

Out of Bounds Entry

Out of bounds entries must be corrected before submission. The program will calculate the ERP zones based on the model inputs (either on user inputs or model 'orange re-sets' – described later in this section), but the error flag will continue.

(1) Out of bounds entry(s),<INPUTS DO NOT MATCH DISPLAYED OUTPUT PAGES -- RECALCULATIONS REQUIRED:> ,ERCBFlash not run,ERCBSlab not run,MetMatrix not performed

(1) Out of bounds entry(s)

Recalculation Required

Calculations in the *ERCBH2S* program can be computationally intensive, requiring several minutes to complete. Rather than recalculate output for every change of input or immediately erasing all output when input information changes, *ERCBH2S* displays the following:

<INPUTS DO NOT MATCH DISPLAYED OUTPUT PAGES -- RECALCULATIONS REQUIRED:> ,ERCBFlash not run,ERCBSlab not run,MetMatrix not performed

ERCBH2S describes the individual program components that must be re-run based on the changed inputs. Selecting '**Calculate EPZ'** automatically runs the necessary programs, and these descriptions in the **red flag** will be removed (if there are no other errors encountered).

If the flavour selected is a pipeline and the User Selected Case (bottom of the **INPUTS** page) includes an entry for the **Gas Pipeline Release Hole Size Fraction**, the following flag will appear if you just ran **Calculate EPZ:**

INPUTS DO NOT MATCH DISPLAYED OUTPUT PAGES -- RECALCULATIONS REQUIRED: ,AeAp Calculation

Delete the **Gas Pipeline Release Hole Size Fraction** and Run **Calculate EPZ** to remove the flag. User 'over-rides' of default entries in 'User Selected Case' on the **INPUTS** page always create a **red flag** and are therefore not suitable for ERCB submission. Work in this section of the **INPUTS** page is reserved for the advanced technical user to investigate intermediate calculations and mitigation strategies for a selected meteorological and/or Gas Pipeline Release Hole Size (Fraction).

A **red flag** can also be displayed if the user has not selected a flavour for the current scenario; either, **GAS PIPELINE, GAS WELL or LIQUID PIPELINE/WELL**. Calculations cannot proceed without selecting a flavour.

To remove **red flags** that contain calculation messages, the **CALCULATE EPZ** command must be run. This command runs all the calculations for the **GAS PIPELINE**, **GAS WELL** or **LIQUID PIPELINE/WELL** flavours for all screening meteorological cases, and will end by running the individual meteorological case specified on the **INPUTS** page.

To remove **red flags** with calculations messages, the **CALCULATE EPZ** command must be run.

If default settings in User Selected Case have been changed, a **red flag** will occur. These calculation results are not acceptable for ERCB submission.

Orange Warnings

Notice the right hand column (column E) on the *ERCBH2S* **INPUTS** page. The heading for this column (as shown in the next section on 'Administrative') is:

Warnings (if applicable)

Try deleting a few of the Administrative entries. Note that entries with the warning Required for ERCB submission are required for ERCB submission but are not required for the calculation to proceed.

Entries with the warning Required for calculation are required for *ERCBH2S* calculations to proceed and must be entered. Note that all fields accept text input and have a general format.

Orange Warnings will cause a **red flag** error message. If not addressed by the user, this flag will be attached to the calculation results. Calculation results with a **red flag** error message are not acceptable for ERCB submission.

The user must verify that the data is entered in accordance with the units specified beside each data entry location.

If not addressed by the User, Orange Warnings cause a **red flag** error message which will persist through to the calculation results. Calculation results with a **red flag** error message attached to them are not acceptable for ERCB submission.

The *ERCBH2S*-INPUTS.xls template worksheets are security protected to prevent accidental overwriting of the intermediate calculations or general formatting. Although the formulae in the worksheets cannot be changed, the formulae can be viewed by selecting the worksheet cell and tracing the logic.

Orange Resets

Many user inputs have an ERCB prescribed value range – a minimum and maximum value that can be entered. The allowable range for each row (where applicable) is shown to the right of the **INPUTS** page in columns H and I. Column J describes the 'model action' associated with user inputs that are outside of the acceptable range. Observe that some model actions are listed as 'resets'. These are referred to as 'orange resets'.

USER OVER-RIDE OF DEFAULT	DEFAULT	MODEL INPUT	Min	Max	Action	Comments 1
0	60 default	1	1	60	resets	Reset
5000	500 default	4500	500	4500	resets	Reset

For rows with orange reset actions, if the user entry is below the minimum limit, the model resets the entry to the lowest allowable value. If the entry is above the maximum limit, the model resets the entry to the highest allowable value. For model 'resets', it is important to remember that the user entry (in column C) is not changed - instead **the reset value appears in column E** and is coloured orange to warn the user that one of their entries has been reset.

If orange reset entries appear on the **INPUTS** page, *ERCBH2S* calculations will be based on these values (for the applicable field), and **NOT** the user entry. To remove the orange reset warning from column E (and subsequently a **red flag** error message attached to the calculation results); the user must change their entry to be within the allowable limits **BEFORE** activating any *ERCBH2S* program run commands.

When *ERCBH2S* resets a user entry, the 'reset' model entry (shown in column E on the **INPUTS** page) appears in orange, and planning zone calculations will be performed using the orange reset entry. To remove the orange reset warning, the user must change their entry (column C) to be within allowable limits. If this is not done, there will be a **red flag** error message attached to the calculation results, and the results are not acceptable for ERCB submission.

Green Notifications

Green notifications that appear in column E on the **INPUTS** page are for user information purposes only. A **red flag** error message **is not** generated.

An example of this notification can be found next to *Datum for Surface Locations*: Optional. The entry field is included to assist the user in data record management, but relates to location inputs in each details group.

Administrative

In the Administrative input section, shown below, input is required to identify the licensee, contact information, scenario name, sour operation type, analysis type, and certain operation location descriptions/identifiers.

ADMINISTRATIVE	Units	User Input	Comments	Warnings (if applicable)
BA CODE				Required for ERCB submission
Licensee/Applicant Name			as per license or application	Required for ERCB submission
Mailing Address				Required for ERCB submission
City and Province				Required for ERCB submission
Postal Code				Required for ERCB submission
Contact	Name			Required for ERCB submission
	Phone			Required for ERCB submission
	Fax			Required for ERCB submission
	eMail			Required for ERCB submission
SCENARIO NAME			UNIQUE description - Label 3 (i.e., Mitigation Option 1, Upstream to Downstream Node)	Required for ERCB submission
SOUR OPERATIONS TYPE			Select the Type of Sour Gas or Sour Liquid operation	**Required for calculation**
ANALYSIS TYPE		◯ NO MITIGATION ◯ WITH MITIGATION	Select "NO MITIGATION" or "WITH MITIGATION"	**Required for calculation**
Name of Well / Pipeline Licence Number			Label 1	Required for ERCB submission
Well Licence Number or Well Application Number			enter na if pipeline or new well	Required for ERCB submission
Legal Surface Location of Well or Pipeline Line Number			LSD-SEC-TWP-RGE W?M - Label 2	Required for ERCB submission
Pipeline Segment From Location (enter na if well)			LSD-SEC-TWP-RGE W?M	Required for ERCB submission
Pipeline Segment To Location (enter na if well)			LSD-SEC-TWP-RGE W?M	Required for ERCB submission
Surface Elevation	m (ASL)		at facility or average in ERP area	Required for calculation
Existing EPZ Distance	km	NA	enter na if not applicable	
Datum for Surface Locations			mapping datum for locations	Optional

The following table describes the data required in the Administrative input section.

Field	Description
BA Code	Business Associate code assigned by ERCB.
Licensee/Applicant	The name of the licensee or prospective licensee.
Mailing Address City and Province Postal Code	The complete address to be used for mail correspondence relating to the submission.
Contact Name Phone Fax E-mail	The name of the individual responsible for submitting the evaluation. This person may be contacted for additional information or supporting assessments regarding the submission.
Scenario Name	Each analysis must be given a **unique** identifying scenario name. This is especially important for operating the *ERCBH2S* program in **Batch** mode, where the Scenario Name is used as the identifier for the record in the database. If using the *ERCBH2S* 'Gathering System Analysis' feature on the **BATCH** page (Chapter 9 - Pipeline Gathering Systems), refer to the suggested scenario naming format in Chapter 9 under Pipeline Segment Label (Scenario Name). See Page Label 3.
Sour Operation Type	This selection determines which one of three modelling methods the user will activate. Depending upon the choice made, two of the three sour operations details groups (further down the **INPUTS** page) will be 'greyed out'. ***See Sour Operation Type later in this chapter for further details***.
Analysis Type	This selection turns off/on access to **SOURCE MITIGATION** entries in the applicable sour operations details group (shown further down on the **INPUTS** page). While access to **SOURCE MITIGATION** allows a user to deviate from ERCB default source mitigation values, justification, proof and/or a demonstration of the licensee/applicant's ability to conduct/apply the mitigative control within the specified time-frame (for each deviation) may be requested by the ERCB. ***See Analysis Type later in this chapter for further details.***
Name of Well or Pipeline Licence Number	As per the licence or application. For new pipeline applications without a licence number, enter "na". See Page Label 1.

Field	Description
Well Licence Number or Application Number	As per the well licence or application. For a pipeline or new well, enter "na".
Legal Surface Location of Well or Pipeline Line Number	The well's **surface** location or the pipeline line number. If modelling a portion of a pipeline line number, attach an alphabetical character to the line number - describing the sub-segment being modelled and the extent of sub-segments possible. For example, if modelling the second 'sub-segment' of line number 17 and the line is modelled in five sub-segments, enter '`Line 17b of e`'. See Page Label 2.
Pipeline From Location	As per the pipeline licence or application. If modelling a portion of a pipeline line number, enter the LSD/SEC/TWP/RGE/MER location of the upstream/start of the pipeline sub-segment. If modelling a well, enter "na".
Pipeline To Location	As per the pipeline licence or application. If modelling a portion of a pipeline line number, enter the LSD/SEC/TWP/RGE/MER location of the downstream/end of the pipeline sub-segment. If modelling a well, enter "na".
Surface Elevation	The average EPZ elevation (metres above sea level, as determined from topographical maps) is used to determine the average atmospheric pressure and is important to accurately convert mass emissions of H_2S into volume concentrations of parts per million (ppm). If this cell is left blank, a value of zero (for sea level) is used by *ERCBH2S*. For a well, enter the well's surface elevation. For a pipeline, enter the pipeline's average elevation (+/- 100 m).
Existing EPZ Distance	For the implementation phase of ERCBH2S, the existing EPZ distance for a facility, in kilometres, is required for comparison. For new facilities, enter "na".

Field	Description
Datum for surface locations	To accommodate the various mapping standards that may be applied by users, each application can specify the datum and projection adopted for the entry of mapped locations. The datum and project may be one of: • UTM NAD27 zone 11 • UTM NAD27 zone 12 • UTM NAD83 zone 11 • UTM NAD83 zone 12 • 10TM NAD83 • WGS84 (latitude/longitude) • Other This **optional entry** allows *ERCBH2S* to integrate with GIS systems used for ERP and mapping. If "`Other`" is specified • the user may elect not to enter mapping coordinates in the facility details group (further down on the **INPUTS** page), or • the applicant may choose to enter mapping coordinates in the facility details group (further down on the **INPUTS** page), however, the application **should*** clearly indicate the mapping datum and projection referenced (*if the user wishes to integrate with a graphics package).

ERCBH2S Page Labels

Each *ERCBH2S* page has a label attached to it so you can track the pages. The label is derived from certain user inputs in the Administrative group on the **INPUTS** page, described below.

For a **well**, the label is created using:

Well name (Label 1)**/**Legal surface location (Label 2)**/**Scenario name (Label 3)

For a **pipeline**, the label is created using:

Pipeline licence No. (Label 1)/Line number (Label 2)/Scenario name (Label 3)

Sour Operation Type

There are three sour operations types (analysis flavours): **GAS PIPELINE**, **GAS WELL** and **LIQUID PIPELINE/WELL**. One of the three flavours must be selected in order for calculations to proceed.

SOUR OPERATION TYPE	DESCRIPTION
GAS PIPELINE (transient jet)	Determined by the pipeline substance category as defined by ERCB *Directive 056*, with the exception of the substance 'Acid Gas'. Acid Gas is defined as Gas that is separated in the treating of solution or non-associated gas that contains hydrogen sulphide (H_2S), totally reduced sulphur compounds, and/or carbon dioxide (CO_2). For *ERCBH2S*, the ERCB requires that pipelines containing Acid Gas be identified separately from other Sour Gas pipelines, even though they are licensed as 'Sour Gas' pipelines. 'Gas Pipeline' modelling is also required for Oil Effluent pipelines with: • a Gas to Liquid Ratio (GLR) > 1000 (at stock-tank conditions of 15º C and 101.325 kPa), and • an H_2S concentration ≥0.01 % (mole percent, equivalent to 0.1 mol/kmol **or** 0.0001 mole fraction **or** 100 ppm) in the gas phase (dry). Gas pipeline releases are characterized by a high pressure transient jet (a **non-steady** release rate). Pipeline releases are assumed to occur at the midpoint of the pipeline segment. Special notice concerning HVP pipelines that contain H_2S; - these pipelines must be modelled in *ERCBH2S* to compare the size of the resulting EPZ with that derived from an HVP model (see *Directive 071*). Because HVP is NOT one of the pipeline substances listed on the *ERCBH2S* **INPUTS** page, the user must select the "LVP Products Pipeline with GLR ≤ 1000" from the Sour Operation Type drop-down list. Be aware that the gas being modelled must be from stock-tank conditions of 15°C and 101.325 kPa (dry analysis).
GAS WELL (steady jet)	Primarily used for gas wells containing sour gas (hydrogen sulphide, H_2S), 'Gas Well' modelling is also required for wells of any substance (including liquids) with: • a Gas to Liquid Ratio (GLR) > 1000 (at stock-tank conditions of 15º C and 101.325 kPa), **and** • an H_2S concentration ≥0.01 % (mole percent, equivalent to 0.1 mol/kmol **or** 0.0001 mole fraction **or** 100 ppm) in the gas phase (dry). Gas well releases are characterized by a steady flow rate jet at the specified rate. Gas well releases of sour gas are not permitted to discharge continuously and may be required to be ignited.

SOUR OPERATION TYPE	DESCRIPTION
LIQUID PIPELINE or LIQUID WELL (steady jetl)	Primarily used for oil and produced water, 'Liquid Pipeline or Liquid Well' modelling is required for any fluid with: • a Gas to Liquid Ratio (GLR) ≤ 1000 (at stock-tank conditions of 15º C and 101.325 kPa), **and** • an H_2S concentration ≥0.01 % (mole percent, equivalent to 0.1 mol/kmol **or** 0.0001 mole fraction **or** 100 ppm) in the gas phase (dry). Liquid releases are characterized by a steady flow jet of gas and a pool of liquid on the ground. The release leads to the immediate volatile liberation of sour solution gas.

If modelling a drilling well with potential to encounter both gas and liquid H_2S bearing formations (e.g. one zone is gas while another is liquid), the user must model the Cumulative H_2S Release Rate using only the Gas Well portion of the **INPUTS** page.

Analysis Type

(Source Mitigation… it's all about time)

The Analysis Type, either, **NO MITIGATION** or **WITH MITIGATION**, effectively turns off or on user access to the subsection called **SOURCE MITIGATION** contained within each of the three details groups - **GAS WELL**, **GAS PIPELINE**, and **LIQUID PIPELINE or LIQUID WELL**.

For a **NO MITIGATION** analysis, user inputs are set to *ERCBH2S* **DEFAULT** values and cannot be changed. The **SOURCE MITIGATION** descriptions and values appear greyed-out, and the values listed under the Model Input heading (column E) are used. Any user inputs are formatted to appear invisible because the model does not use them. After completing a **NO MITIGATION** analysis, the user may choose to assess the site-specific source mitigation inputs in more detail.

When the user selects a **WITH MITIGATION** analysis type, the **SOURCE MITIGATION** subsection is 'opened up' (appears non-grey) and the

input parameters are unlocked. The user may now deviate from the recommended *ERCBH2S* **DEFAULT** values in the **WITH MITIGATION**, provided the user input is within allowable limits.

SOURCE MITIGATION - General

Allowable Limits

The lower (minimum), upper (maximum) and 'Model Action' for each **SOURCE MITIGATION** row is shown to the immediate right on the **INPUTS** page, in columns H, I and J. Observe that the 'Model Action' is always 'Resets'. This means that if the user enters a value outside of the allowable limits, the model automatically 'resets' the user entry, and the reset entry is displayed in column E under **MODEL INPUT**. The resulting 'orange reset' creates a **red flag** error message. For more details on managing an 'orange reset', see Orange Resets in this chapter. There is a detailed discussion of the source mitigation options for each of the details groups within each section (Gas Pipeline, Gas Well, and Liquid Pipeline or Liquid Well).

Licensee/Applicant Responsibility

When changing ERCB default entries in the **SOURCE MITIGATION** subsection of any of the details groups, the licensee/applicant is required to document and be prepared to defend the model input values, as they must do with any of the other model inputs.

A **WITH MITIGATION** analysis may result in smaller calculated ERP zones because the source duration is reduced. As source mitigation improves, the size of the hazard decreases. Note that while some planning zones sizes decrease with changes to the source mitigation time, significant EPZ changes are not realized until mitigation time is reduced to 3 hours (180 minutes) or less.

The user should provide documented justification in the Audit Package for each entry in a **WITH MITIGATION** analysis that deviates from the ERCB default value.

Note that while some planning zones sizes decrease with changes to the source mitigation time, **significant EPZ changes are not realized until mitigation time is reduced to 3 hours (180 minutes) or less.**

For ERCB submission, applicants are required to activate the program run command 'Calculate EPZ', and submit ***either*** the **NO MITIGATION** or the **WITH MITIGATION** analysis – depending on mitigation controls available to the operation being modelled.

Remember that **source mitigation requires commitments** to earlier ignition, shut in of flow, specified emergency shutdown valve closure or other pre-planned actions that stop the release of H_2S.

Gas Pipeline

The Gas Pipeline details group is also designed for Oil Effluent pipelines with a Gas to Liquid Ratio (GLR) > 1000 as measured at stock-tank conditions of 15º C and 101.325 kPa (dry gas analysis). *Gassy* Oil Effluent pipelines are included in this group because they will have a ***transient*** blow-down.

The Gas Pipeline details group has two sections. The first section is open to any user whose initial selection (in **SOUR OPERATIONS TYPE**) brought them to this group. The second 'sub-section', titled **SOURCE MITIGATION**, is only open to those users who selected the analysis type **WITH MITIGATION**. When the **NO MITIGATON** analysis is selected, the source mitigation inputs are disabled as shown below. General details on allowable entry limits, and licensee/applicant responsibility for changing default entries in **SOURCE MITIGATION** can be found under Source Mitigation - General in this chapter. Details **specific** to the Source Mitigation subsection for the Gas Pipeline group are described later in this section.

GAS PIPELINE ***(includes oil effluent pipeline with Gas to Liquid Ratio> 1000)***	**Units**	**User Input**	**Comments**	**Warnings**
Pipeline Segment From Location Coordinates	m		X (east-west)	Optional
	m		Y (north-south)	Optional
Pipeline Segment To Location Coordinates	m		X (east-west)	Optional
	m		Y (north-south)	Optional
Licenced Maximum Operating Pressure	kPa (gauge)		used for Level Designation	Required for calculation
Expected Maximum Operating Pressure	kPa (gauge)		used for Hazard Modelling	Required for calculation
Pipeline Outside Diameter	mm			Required for calculation
Pipeline Wall Thickness	mm			Required for calculation
Segment Length	m			Required for calculation
Equivalent Segment Length between ESDs (enter **Length** or Volume below)	m		--	Required for calculation
Equivalent Cumulative Pipeline Volume (enter **Volume** or Length above)	m^3		--	Required for calculation
Modelled Solution Gas to Liquid Ratio	standard m^3 Gas to stock tank m^3 Liquid		oil effluent pipeline from oil well only	Required for calculation
Licenced Maximum H_2S Concentration	% (gas phase)		used for Level Designation	Required for calculation
Expected Maximum H_2S Concentration	%(dry), (15°C, 101.325 kPa)		used for Hazard Modelling	Required for calculation
		USER OVER-RIDE OF DEFAULT	**DEFAULT**	**MODEL INPUT**
Minimum Gas Pipeline Temperature	°C		5 default	5
SOURCE MITIGATION		**USER OVER-RIDE OF DEFAULT**	**DEFAULT**	**MODEL INPUT**
ESD Valve Closure Time once Triggered	s		60 default	60
ESD Valve Low Pressure (LP) Trigger, Pesd	kPa (gauge)		0 default	0
ESD Valve Pressure Rate of Change (PROC) Trigger, dP/dt	kPa/s		0 default	0
ESD Valve Pressure Rate of Change (PROC) Sampling Time	s		3600 default	3600
Time from initial release until ESDs manually or remotely closed	minutes		720 default	720
Time from initial release until ignition or stop flow	minutes		720 default	720

Notice the **Comments** column (column D) to the right of the user input column (column C). It contains additional information on some of the cell requirements.

Field	Description
Pipeline Segment From Location Coordinates	The 'beginning/upstream' pipeline segment (or sub-segment) coordinates according to the mapping datum and projection selected in the Administrative inputs section. These entries are optional and may be left blank.
Pipeline Segment To Location Coordinates	The ending/downstream' pipeline segment (or sub-segment) coordinates according to the mapping datum and projection selected in the Administrative inputs section. These entries are optional and may be left blank.
Licenced Maximum Operating Pressure	The maximum operating pressure (MOP) for which the pipeline is licensed, kPa (gauge).
Expected Maximum Operating Pressure	The highest operating pressure expected – **under any circumstances**, kPa (gauge). This pressure **must not be exceeded** without first recalculating the emergency planning zones and proceeding with an ERP modification/update in accordance with ERCB *Directive 071* requirements Emergency planning zone calculations are referenced from the Expected Maximum Operating Pressure. This pressure can be lower than the licenced maximum operating pressure, but under no circumstances can it be higher.
Pipeline Outside Diameter	The diameter of the pipe outside diameter, mm
Pipeline Wall Thickness	The wall thickness of the pipe, mm
Segment Length	The length of pipeline segment being modelled (entered in metres). It must be one continuous piece of pipe with consistent characteristics such as describe a pipeline licence line number – governed by ERCB *Directive 056*. Smaller 'sub-segments' can be modelled as defined by 'node' locations (see Gas Gathering System Analysis - Tutorial in Chapter 9). Nodes are defined as changes in operating conditions, physical pipe changes, substance changes, tie-ins, ESD valves and check valves.

Field	Description
*Equivalent Segment Length between ESDs (enter **Length** or Volume below)	The equivalent length of pipeline between emergency shut down valves (entered in metres), as determined by the pipeline gathering system network analysis, or by manual calculation. See Chapter 9 - Pipeline Gathering Systems (which also describes the manual calculation). The Equivalent Segment Length can be the same as the Segment Length (above) **IF**, when all flow control valves are in a closed position, there is no additional pipeline substance material that can flow into the subject pipeline segment. Under no circumstances can the Equivalent Segment Length be less than the Segment Length. The user must **enter either** this Equivalent Segment Length **OR** the Equivalent Cumulative Pipeline Volume (next row down on the **INPUTS** page). Do not enter both values. When one value is entered, the other row is greyed-out. Emergency planning zone calculations are referenced from the Equivalent Segment Length.
*Equivalent Cumulative Pipeline Volume between ESDs (enter **Volume,** or Length above)	The equivalent cumulative pipeline volume between emergency shut down valves, as determined by the formula described in the pipeline gathering system network analysis (entered as m^3). See Equivalent Cumulative Pipeline Volume (between ESDs in Chapter 9). The user must **enter either** this Equivalent Cumulative Pipeline Volume **OR** the Equivalent Segment Length (previous row on the **INPUTS** page). Do not enter both values. When one value is entered, the other row is greyed-out. Emergency planning zone calculations are referenced from the Equivalent Segment Length calculated from the equivalent cumulative pipeline volume.
*Next to 'Equivalent Segment Length between ESDs' and 'Equivalent Cumulative Pipeline Volume', observe that the 'comment' cell in column D on the **INPUTS** page is 'active'. When one of the two entries is provided by the user, *ERCBH2S* calculates the 'missing' user entry and displays the result in column D. If the user entered the Equivalent Segment Length, column D immediately displays the calculated volume (next to the Equivalent Cumulative Pipeline Volume). If the user entered the Cumulative Pipeline Volume, column D immediately displays the calculated length (next to the Equivalent Segment Length between ESDs).	
Expected Maximum Gas to Liquid Ratio	The modelled solution gas to liquid ratio (m^3/m^3) as measured at stock tank conditions of 15° C and 101.325 kPa (dry gas). This row is only applicable to Oil Effluent pipelines. In the Sour Operations Type (Administrative section of **INPUTS** page), if the user selected a pipeline substance of Sour Gas, Natural Gas or Acid Gas, this row is greyed-out.

Field	Description
Licensed Maximum H_2S Concentration	The maximum H_2S concentration of the pipeline licence (entered in percent (%). The maximum H_2S concentration does not have to match the reference composition provided in the gas composition (lower portion of **INPUTS** page). Pipelines directed to this category with an H_2S below 0.01 % (mole percent, equivalent to 0.1 mol/kmol **or** 0.0001 mole fraction **or** 100 ppm) do not have to be modelled (ERCB *Directive 071*). If they are modelled, the results do not need to be submitted to the ERCB.
Expected Maximum H_2S Concentration	The highest H_2S expected – **under any circumstances**, entered in percent (%). This H_2S **must not be exceeded** without first recalculating the emergency planning zones and proceeding with an ERP modification/update in accordance with ERCB *Directive 071* requirements. This H_2S can be lower than the licensed maximum H_2S, but under no circumstances can it be higher. If the H_2S entry is lower than the licensed maximum, it must not be exceeded during pipeline operations. The H_2S entered must accommodate all production scenarios – with consideration given to scenarios where only the highest H_2S well is producing through the pipeline if other wells are shut-in. The Expected Maximum H_2S Concentration does not have to match the reference composition provided in the gas composition (lower portion of **INPUTS** page). Note that emergency planning zone calculations are referenced from the **Expected** Maximum H_2S Concentration, and not the Licensed Maximum. Pipelines with an Expected Maximum H_2S below 0.01 % (mole percent, equivalent to 0.1 mol/kmol **or** 0.0001 mole fraction **or** 100 ppm) do not have to be modelled (ERCB *Directive 071*). If they are modelled, the results do not need to be submitted to the ERCB.

Field	Description
Minimum Gas Pipeline Temperature (ºC)	The pipeline operating temperature in degrees Celsius (ºC). Although some pipelines may be heated to avoid hydrate formation, it is the normal minimum temperature in a pipeline segment that should be entered. If the user entry cell is left blank a default value of 5°C (ground temperature), is used. The allowable temperature range is shown to the right of the **INPUTS** page, in columns H and I. Observe that in column J, the 'model action' for this row is 'resets'. This means that if a user entry is outside the allowable range, an 'orange reset' will be applied. To understand more about orange resets (and why a user must change their entry to remove them) see Orange Resets in this chapter.

Notice that the comment in cells M38 and M39 are 'active'. They provide the H_2S release volume (m^3) based on the User Inputs of pressure (kPa), equivalent pipeline length (m), pipeline inside diameter (mm), H_2S Concentration (licenced and normal, %) and temperature (°C). The licenced release volume in Cell M38 uses atmospheric pressure of 101.325 kPa and the licenced maximum operating pressure to determine the absolute pressure, the model input temperature and the equivalent segment length. It is used for the pipeline release volume calculation and Level Designation. The actual release volume in Cell M39 uses the calculated atmospheric pressure which is less than 101.325 kPa and the expected maximum operating pressure to determine the absolute pressure, the model input temperature and the equivalent segment length. The display may note that the volumes are for an ideal gas. To determine the real gas values run **ERCBH2S→Technical→Run ERCBFlash Only...**.

Gas Pipeline Group- Source Mitigation Sub-section

If the **WITH MITIGATION** analysis was selected in the Administrative section of the **INPUTS** page, several more parameters are available for entry to manage pipeline emergency response planning. The **WITH MITIGATION** analysis entries (see below) include mitigation controls for emergency shutdown (ESD) valves on the pipeline. *ERCBH2S* accounts for five ESD valve mitigation measures: the time it takes the valve to close once it has been activated to close; the low pressure setting that will trigger the valve to close, the Pressure Rate of Change (PROC) that will trigger the valve to close (including an instrument sampling time to determine the pressure rate of change), the time to manually trigger valve closure; and the time to ignite/draw-down or otherwise terminate the release.

For additional information on a licensee/applicant's responsibility when changing default entries in the **SOURCE MITIGATION** section, see Source Mitigation - Licensee/Applicant Responsibility in this chapter.

When to Change the Default Settings

The ERCB default settings in this group result in **no effective ESD control** for a pipeline release.

A user should only change the valve settings (over-ride the default settings) **IF** the *material flow* of the pipeline segment being modelled is **completely controlled** by ESD valves, or a combination of ESD and back-flow check valves. **This includes other pipelines tying into the modelled segment** (if these other pipelines can contribute material to the subject pipeline segment in the event of a release).

At each point where material can enter the subject pipeline – both upstream and downstream – the user must follow the source(s) back until a flow control device is located. The flow control device with the **lowest setting** is the setting that can be modelled. If there is any instance where a flow control device cannot be located, then the default settings in this group must not be changed. Note that for modelling purposes, check valves are assumed to close immediately and completely.

Pre-set ERCBH2S valve settings **DO NOT PROVIDE EFFECTIVE ESD CONTROL** for a pipeline. The user must adjust the setting if the material flow (both to and from the pipeline segment) is **COMPLETELY** controlled by ESDs or a combination of ESDs and back-flow check valves.

The ERCB default settings in this group result in **no effective ESD control** for a pipeline release

When modelling a pipeline segment with multiple valve settings (as happens in some gathering systems), the lowest valve setting must be used.

Note that while some planning zones sizes decrease with changes to the source mitigation time, **significant EPZ changes are not realized until mitigation time is reduced to 3 hours (180 minutes) or less.**

The model assumes infinite flow from both upstream and downstream of a pipeline. If the ESD valve does not have a LP trigger setting, then the default of 10 % of the expected maximum operating pressure is used.

A low pressure trigger of 10 % means that the pipeline has to depressure to of its total operating MOP before the ESDs will close. This means the associated EPZ will be very large,

almost equal to a case suing no mitigation.

If the user has an ESD valve, the recommended LP trigger setting is at least 50 % of the expected maximum operating pressure.

A low pressure trigger of 90 % is generally unreasonable, as daily fluctuations in pipeline pressure would cause the ESDs to close.

SOURCE MITIGATION		USER OVER-RIDE OF DEFAULT	DEFAULT	MODEL INPUT
ESD Valve Closure Time once Triggered	s		60 default	60
ESD Valve Low Pressure (LP) Trigger, Pesd	kPa (gauge)		2500 default	2500
ESD Valve Pressure Rate of Change (PROC) Trigger, dP/dt	kPa/s		5000 default	5000
ESD Valve Pressure Rate of Change (PROC) Sampling Time	s		3600 default	3600
Time from initial release until ESDs manually or remotely closed	minutes		720 default	720
Time from initial release until ignition or stop flow	minutes		720 default	720

Field	Description
ESD Valve Closure Time once Triggered (s)	The closure time is the time it takes the ESD valve to close **once it has been activated to close**, either by low pressure setting or pressure rate of change, (seconds). If the cell is left blank then the large default value of 60 s is used.
ESD Valve Low Pressure Trigger, P_{esd} (kPa gauge)	The normal low pressure (LP) setting is entered as kPa (gauge). If the ESD valve does not have a LP trigger setting, then the cell is left blank and the default of 10 % of the expected maximum operating pressure is used. If the user has an ESD valve, the *recommended* LP trigger setting is at least 50 % of the expected maximum operating pressure. Note that the ERCB may field verify valve settings. The percent that was modelled (ratio of Valve Setting to Expected Maximum Operating Pressure) will be applied to the actual operating pressure. Licensee must ensure their pipeline is not operating with valve settings (percent/ratio) any lower than what was modelled.
ESD Valve Pressure Rate of Change (PROC) Trigger, *dP/dt* (kPa/s)	The pressure rate of change (PROC) trigger setting is used to control the closure of the ESD valve based upon how quickly the pressure is changing at the ESD. PROC is entered in units of kPa/s. If the ESD valve does not have a PROC trigger setting, then the cell must be left blank. The default pressure drop of the normal operating pressure over 1 second will be used – which effectively cancels any potential mitigation advantage due to PROC.

Field	Description
ESD Valve Pressure Rate of Change (PROC) Sampling Time (s)	The pressure rate of change (PROC) is determined by the valve instrumentation using a sampling time (seconds). If the ESD valve does not have a PROC trigger setting, then the cell is left blank and a large default is used (3600 s) – which effectively cancels any potential mitigation advantage due to PROC.
Time from initial release until ESDs manually or remotely closed (minutes)	The time it takes **from the moment the release occurs** to manually (or remotely) close the valve (minutes). The total time entered must provide time to • detect the release (usually through odour complaint), • contact the operator, • travel to the site, • verify a release is occurring, and • trigger valve closure. Unless the licensee can perform the above actions, for all related valves (that ensure complete pipeline isolation) in less than 720 minutes (12 hours), this field should be left blank.
Time from initial release until ignition or stop flow (minutes)	The time it takes **from the moment the release occurs** to igniting the release, plugging the hole or a drawdown of the pressure (minutes). Effectively the H_2S release is completely stopped. The total time entered must provide time to • detect the release (usually through odour complaint), • contact the operator, • travel to the site, • verify a release is occurring, and • perform a prescribed, pre-planned action that prevents additional H_2S from being released, such as ignition. Unless the licensee can perform the above actions in less than 720 minutes (12 hours), this field should be left blank.

Gas Pipeline Group - Orange Resets

The lower (minimum), upper (maximum) and *Model Action* for each **SOURCE MITIGATION** row is shown to the immediate right on the **INPUTS** page, in columns H, I and J. Observe that the 'Model Action' is always 'Resets'. This means that if the user enters a value outside of the allowable limits, the model automatically 'resets' the user entry, and the reset entry is displayed in column E under **MODEL INPUT**. The resulting 'orange reset' creates a **red flag** error message which must be dealt with.

For details on why orange resets occur, why they must be managed and how, see Orange Resets in this chapter.

Gas Well

The Gas Well details group is also designed for liquid and other wells with a Gas to Liquid Ratio (GLR) > 1000 as measured at stock-tank conditions of 15ºC and 101.325 kPa. These *gassy* wells are included in this group because they will have a ***steady jet*** release.

The Gas Well details group has two sections. The first section is open to any user whose initial selection (in **SOUR OPERATIONS TYPE**) brought them to this group. The second 'sub-section', titled **SOURCE MITIGATION**, is only open to those users who selected the analysis type **WITH MITIGATION**. When the **NO MITIGATON** analysis is selected, the source mitigation inputs are disabled as shown below. For general details on allowable entry limits and licensee/applicant responsibility for changing default entries in **SOURCE MITIGATION**, see Source Mitigation - General in this chapter. Details **specific** to the Source Mitigation subsection for the Gas Well group are described later in this section.

GAS WELL (includes oil well and other well with Gas to Liquid Ratio>1000)	Units	User Input	Comments	Warnings
Phase of Well Operations ?				Required for calculation
Is Well Classified as Critical ?		◯ Critical ◯ Non-critical	as per Directive 056	Required for ERCB submission
Unique Well Identifier			??/LSD-SEC-TWP-RGE W?/?	Required for ERCB submission
Well Centre Surface Location Coordinates	#VALUE!		X (east-west)	Optional
	#VALUE!		Y (north-south)	Optional
Casing or Tubing Inside Diameter at Exit	mm			Required for calculation
Expected Maximum H_2S Concentration	%(dry), (15°C, 101.325 kPa)			Required for calculation
H_2S Release Rate (Cumulative if Multi-zone)	m^3/s (15°C, 101.325 kPa)			Required for calculation
SOURCE MITIGATION		**USER OVER-RIDE OF DEFAULT**	**DEFAULT**	**MODEL INPUT**
Is Surface Controlled Sub Surface Safety Valve Installed ?		◯ SCSSSV ◯ No SCSSSV		
Time from initial release until ignition or stop flow	minutes		#VALUE!	#VALUE!

Notice the **Comments** column (column D) to the right of the user input column (column C). It contains additional information on some of the cell requirements.

Field	Description
Phase of Well Operations?	Specify drilling, completion/servicing/workover or producing/injection/suspended from the dropdown list.
Is Well Classified as Critical?	Specify Yes or No using the buttons provided. This classification is determined from the criteria in Guide 56–Schedule 4
Unique Well Identifier	Specify the unique well identifier as per the well licence or application.

Field	Description
Well Centre Surface Location Coordinates	The well's **surface** location coordinates according to the mapping datum and projection selected in the Administrative inputs section. These entries are optional and may be left blank.
Casing or Tubing Inside Diameter at Exit	The inside diameter at the exit (in mm), of either the casing or tubing. For Oil Effluent wells modelled as gas wells, the area taken up by the diameter of the sucker rod (pumping wells only) can be ignored; just use the tubing inside diameter.
*Expected Maximum H_2S Concentration	The highest H_2S possible (appropriate to the phase of well operation being modelled), entered in percent (%). **For new wells**, this is the H_2S provided in the well licence application. **For existing wells**, it is the highest possible H_2S from any formation capable of flowing to surface. The Hazard Modelling H_2S Concentration does not have to match the reference composition provided in the gas composition (lower portion of **INPUTS** page). Note that emergency planning zone calculations are referenced from the Hazard Modelling H_2S Concentration. Wells with an H2S below 0.01 % (mole percent, equivalent to 0.1 mol/kmol or 0.0001 mole fraction or 100 ppm) do not have to be modelled (ERCB *Directive 071*). If they are modelled, the results do not need to be submitted to the ERCB.

Field	Description
*H_2S Release Rate (m^3/s) (Cumulative if Multi-zone)	The volumetric H_2S release rate at reference conditions (m^3/s at 15ºC and 101.325 kPa). While surface rates are preferred (more representative), sand-face rates can be entered (less representative, but more conservative because they will be somewhat higher). For new wells with an ERCB approved pre-submission release rate, enter the pre-approved rate appropriate to the phase of well operations being modelled. For new wells without an ERCB approved pre-submission release rate, enter the cumulative release rate estimate provided in the well licence application – appropriate to the phase of well operations being modelled. If the well has potential to encounter both gas and liquid H_2S bearing formations (e.g. one zone is gas while another is liquid), the user must model the Cumulative H_2S Release Rate using only the Gas Well portion of the INPUTS page. For existing (drilled) wells, enter a cumulative release rate based on all formations capable of flowing to surface. If the well has a flow control device that restricts flow AND the flow control device is inside the well's tubing (therefore not vulnerable to unexpected damage) AND the user is modelling a 'producing' well scenario, the H_2S release rate may be based on the restricted flow rate at surface. In this case, the flow control device only affects the H_2S release rate, not the well's casing or tubing inside diameter at exit. Note - *ERCBH2S* is designed for calculating ERP zones, not well release rates. Requirements/guidelines for calculating well release are in other ERCB publications.

ERCBH2S-Gas Well does not recalculate the H_2S release rate when the casing or tubing diameter is changed. If you are exploring different scenarios by changing the well diameter, remember to adjust the H_2S release rate accordingly.

Gas Well - Source Mitigation Sub-section

If the **WITH MITIGATION** analysis was selected in the Administrative section of the **INPUTS** page, two more parameters are available for entry to manage

'well' emergency response planning. The **WITH MITIGATION** analysis entries (see below) include mitigation controls for Surface Controlled Sub-Surface Safety Valves (SCSSSV) – a yes/no entry for producing wells only, and time from initial release until ignition or stop flow (input value).

For additional information on a licensee/applicant's responsibility when changing a default entry in the **SOURCE MITIGATION** section, see Source Mitigation - Licensee/Applicant Responsibility in this chapter.

SOURCE MITIGATION		USER OVER-RIDE OF DEFAULT	DEFAULT	MODEL INPUT
Is Surface Controlled Sub Surface Safety Valve Installed ?		(●) SCSSSV ( ) No SCSSSV	No SCSSSV	SCSSSV
Time from initial release till ignition or stop flow	minutes		3 default	3

When to Change the Default Settings

A user should only change the default settings (over-ride the default settings) in this group **IF** the licensee can perform/coordinate the following actions within the time frame indicated in this section of the model:

- detect the release,
- contact the operator (if the well operation is un-manned),
- travel to the site (if the well operation is un-manned),
- verify a release is occurring (if the well operation is un-manned), and
- perform a prescribed, pre-planned action that prevents additional H_2S from being released (such as igniting the well or closing a valve).

Unless the licensee can perform the above actions in less than the time shown as a default entry for this group, this field should be left blank. Note that the default setting for 'Time from initial release until ignition or stop flow' changes with the phase of well operation – which indicates if the site is manned or un-manned (subsequently affecting the time to implement mitigation measures). In addition, **producing** wells with a Surface- Controlled Sub-Surface Safety Valve (SCSSSV) have a significantly reduced default setting.

Note that while some planning zones sizes decrease with changes to the source mitigation time, **significant EPZ changes are not realized until mitigation time is reduced to 3 hours (180 minutes) or less.**

The ERCB may request documentation that supports a licensee's non-default **Time from Initial Release until Ignition or Stop Flow** values

Gas Well Group - Orange Resets

The lower (min.), upper (max.) allowable values for 'Time from initial release until ignition or stop flow' change with the phase of well operation, and with the presence of a SCSSSV. The allowable limits are shown to the immediate right on the **INPUTS** page, in columns H and I. Observe that in column 'J' the 'Model Action' is 'Resets'. This means that if the user enters a value outside of the allowable limits, the model automatically 'resets' the user entry, and the reset entry is displayed in column E under **MODEL INPUT**. The resulting 'orange reset' creates a **red flag** error message which must be dealt with.

For details on why orange resets occur, why they must be managed and how, see Orange Resets in this chapter.

Liquid Pipeline or Liquid Well

The Liquid Pipeline or Liquid Well details group is designed for both pipelines and wells with a Gas to Liquid Ratio (GLR) ≤ 1000 as measured at stock-tank conditions of 15º C and 101.325 kPa. These fluid releases contain no free gas – the solution gas is released from the pool of liquid that forms as the liquid pumps onto the ground. The release is modelled as a ***steady jet***.

The Liquid Pipeline or Liquid Well details group has two sections. The first section is open to any user whose initial selection (in **SOUR OPERATIONS TYPE**) brought them to this group. The second 'sub-section', titled **SOURCE MITIGATION**, is only open to those users who selected the analysis type **WITH MITIGATION**. When the **NO MITIGATON** analysis is selected, the source mitigation inputs are disabled as shown below. For general details on allowable entry limits and licensee/applicant responsibility for changing default entries in **SOURCE MITIGATION**, see Source Mitigation - General in this chapter. Details **specific** to the Source Mitigation subsection for the Liquid Pipeline or Liquid Well group are described later in this section. The following 'screen capture' is for a pipeline.

LIQUID PIPELINE or LIQUID WELL (includes oil effluent pipeline, oil well, other pipeline and other well) with Gas to Liquid Ratio≤1000	Units	User Input	Comments	Warnings
Phase of Well Operations ?				
Is Well Classified as Critical ?		◯ Critical ◯ Non-critical		
Unique Well Identifier				
Well Centre Surface Location Coordinates or	m		X (east-west)	Optional
Pipeline Segment From Location Coordinates	m		Y (north-south)	Optional
Pipeline Segment To	m		X (east-west)	Optional
Location Coordinates	m		Y (north-south)	Optional
Licenced Maximum Operating Pressure, if oil effluent pipeline	kPa (gauge)		used for Level Designation	Required for calculation
Pipe Outside Diameter	mm			Required for calculation
Pipe Wall Thickness	mm			Required for calculation
Segment Length, if oil effluent pipeline	m			Required for calculation
Equivalent Segment Length between ESDs, if oil effluent pipeline (enter **Length** or Volume below)	m		--	Required for calculation
Equivalent Cumulative Pipeline Volume between ESDs, if oil effluent pipeline (enter **Volume** or Length above)	m^3		--	Required for calculation
Expected Maximum Liquid Flow Rate of Pipeline Fluid	m^3/d (15°C, 101.325 kPa)		H2S Release Rate of Pipeline = 0.0000 m^3/s at 15°C, 101.325 kPa	Required for calculation
Expected Maximum Gas to Liquid Ratio of Pipeline Fluid	standard m^3 Gas to stock tank m^3 Liquid			Required for calculation
Licenced Maximum H_2S Concentration, if oil effluent pipeline	% (gas phase)		used for Level Designation	Required for calculation
Expected Maximum H_2S Concentration	%(dry), (15°C, 101.325 kPa)		used for Hazard Modelling	Required for calculation
H_2S Release Rate of Well (Cumulative if Multi-zone)	m^3/s (15°C, 101.325 kPa)			
		USER OVER-RIDE OF DEFAULT	**DEFAULT**	**MODEL INPUT**
Expected Minimum Liquid Temperature	°C		5 default	5
SOURCE MITIGATION		**USER OVER-RIDE OF DEFAULT**	**DEFAULT**	**MODEL INPUT**
Is Surface Controlled Sub Surface Safety Valve Installed ?		◯ SCSSSV ◯ No SCSSSV		
Time from initial release until stop flow or ignition	minutes		720 default	720

The look changes if a well is selected, as shown below:

LIQUID PIPELINE or LIQUID WELL (includes oil effluent pipeline, oil well, other pipeline and other well) with Gas to Liquid Ratio≤1000	Units	User Input	Comments	Warnings
Phase of Well Operations ?				Required for calculation
Is Well Classified as Critical ?		◯ Critical ◯ Non-critical	as per Directive 056	Required for ERCB submission
Unique Well Identifier			??/LSD-SEC-TWP-RGE W?/?	Required for ERCB submission
Well Centre Surface Location Coordinates or	m		X (east-west)	Optional
Pipeline Segment From Location Coordinates	m		Y (north-south)	Optional
Pipeline Segment To	m			
Location Coordinates	m			
Licenced Maximum Operating Pressure, if oil effluent pipeline	kPa (gauge)			
Pipe Outside Diameter	mm			Required for calculation
Pipe Wall Thickness	mm			Required for calculation
Segment Length, if oil effluent pipeline	m			
Equivalent Segment Length between ESDs, if oil effluent pipeline (enter **Length** or Volume below)	m			
Equivalent Cumulative Pipeline Volume between ESDs, if oil effluent pipeline (enter **Volume** or Length above)	m^3			
Expected Maximum Liquid Flow Rate of Pipeline Fluid	m^3/d (15°C, 101.325 kPa)			
Expected Maximum Gas to Liquid Ratio of Pipeline Fluid	standard m^3 Gas to stock tank m^3 Liquid			
Licenced Maximum H_2S Concentration, if oil effluent pipeline	% (gas phase)			
Expected Maximum H_2S Concentration	%(dry), (15°C, 101.325 kPa)		used for Hazard Modelling	Required for calculation
H_2S Release Rate of Well (Cumulative if Multi-zone)	m^3/s (15°C, 101.325 kPa)			Required for calculation
		USER OVER-RIDE OF DEFAULT	**DEFAULT**	**MODEL INPUT**
Expected Minimum Liquid Temperature	°C		5 default	5
SOURCE MITIGATION		**USER OVER-RIDE OF DEFAULT**	**DEFAULT**	**MODEL INPUT**
Is Surface Controlled Sub Surface Safety Valve Installed ?		◯ SCSSSV ◯ No SCSSSV		
Time from initial release until stop flow or ignition	minutes		#VALUE!	#VALUE!

Notice the **Comments** column (column D) to the right of the user input column (column C). It contains additional information on some of the cell requirements.

Depending on the user's selected **SOUR OPERATIONS TYPE** (in the Administrative section of the **INPUTS** page), certain cells/rows will appear greyed-out. While some rows pertain only to pipelines and others to wells, most rows are pertinent to both pipelines and wells.

Field	Description
Phase of Well Operations?	Specify drilling, completion/servicing/workover or producing/injection/suspended from the dropdown list. For pipelines, this entry is greyed-out.
Is Well Classified as Critical?	Specify Yes or No using the buttons provided. This classification is determined from the criteria in Guide 56–Schedule 4 For pipelines, this entry is greyed-out.
Unique Well Identifier	Specify the unique well identifier as per the well licence or application. For pipelines, this entry is greyed-out.
Well Centre Surface Location Coordinates, or Pipeline Segment From Location Coordinates	The well surface coordinates or the 'beginning/upstream' pipeline segment (or sub-segment) coordinates, according to the mapping datum and projection selected in the Administrative inputs section. These entries are optional and may be left blank.
Pipeline Segment To Location Coordinates	The 'ending/downstream' pipeline segment (or sub-segment) coordinates, according to the mapping datum and projection selected in the Administrative inputs section. These entries are optional and may be left blank. For wells, these entries are greyed-out.
Licenced Maximum Operating Pressure **if oil effluent pipeline**	For oil effluent pipelines only. For other pipeline substances and wells, this entry is greyed-out. The maximum operating pressure (MOP) for which the pipeline is licensed, kPa (gauge). The Land Use Setback volume calculations use **Licenced** Maximum Operating Pressure.
*Pipe Outside Diameter	The pipe outside diameter, (mm). For wells, this is the tubing (for the producing phase) or the casing (for the drilling or servicing phase). For pumping wells with a 'producing' well phase, the area taken up by the diameter of the sucker rod can be ignored; just use the tubing inside diameter.
*Pipe Wall Thickness	The pipe wall thickness, (mm). For wells, this will be the tubing (for the producing phase) or the casing (for drilling or servicing phase).

Field	Description
Segment Length **if oil effluent pipeline**	For oil effluent pipelines only. For other pipeline substances and wells, this entry is greyed-out. Length of oil effluent pipeline segment being modelled (m). It must be one continuous piece of pipe with consistent characteristics such as described by a pipeline licence line number – governed by ERCB *Directive 056*. Smaller 'sub-segments' can be modelled as defined by 'node' locations (see Gas Gathering System Analysis - Tutorial in Chapter 9). Nodes are defined as changes in operating conditions, physical pipe changes, substance changes, tie-ins, ESD valves and check valves.
Equivalent Segment Length between ESDs, **if oil effluent pipeline (enter **Length** or Volume below)	For oil effluent pipelines only. For other pipeline substances and wells, this entry is greyed-out. The equivalent length of **oil effluent** pipeline between emergency shut down valves, as determined by the pipeline gathering system network analysis (m), or by manual calculation. See Chapter 9 Pipeline Gathering Systems, which also describes the manual calculation. The Equivalent Segment Length can be the same as the Segment Length (above) **IF**, when all flow control valves are in a closed position, there is no additional pipeline substance material that can flow into the subject pipeline segment. Under no circumstances can this Equivalent Segment Length be less than the Segment Length. The user must **enter either** this Equivalent Segment Length **OR** the Equivalent Cumulative Pipeline Volume (next row down on the **INPUTS** page). Do not enter both values. When one value is entered, the other row is greyed-out.
Equivalent Cumulative Pipeline Volume between ESDs, **if oil effluent pipeline (enter **Volume** or Length above)	For oil effluent pipelines only. For other pipeline substances and wells, this entry is greyed-out. The equivalent cumulative **oil effluent** pipeline volume between emergency shut down valves, as determined by the formula described in the pipeline gathering system network analysis (m^3) see Chapter 9 Equivalent Cumulative Pipeline Volume (between ESDs). The user must **enter either** this Equivalent Cumulative Pipeline Volume **OR** the Equivalent Segment Length (previous row on the **INPUTS** page). Do not enter both values. When one value is entered, the other row is greyed-out.

Field	Description
Next to 'Equivalent Segment Length between ESDs' and 'Equivalent Cumulative Pipeline Volume', observe that the 'comment' cell in column D on the **INPUTS page is 'active'. When one of the two entries is provided by the user, *ERCBH2S* calculates the 'missing' user entry and displays the result in column D. If the user entered the Equivalent Segment Length, column D immediately displays the calculated volume (next to the Equivalent Cumulative Pipeline Volume). If the user entered the Cumulative Pipeline Volume, column D immediately displays the calculated length (next to the Equivalent Segment Length between ESDs).	
Expected Maximum Liquid Flow Rate of Pipeline Fluid [m^3/d]	Enter the maximum liquid flow rate (oil and water or other liquid), [m^3/d] for PIPELINE fluids. For wells, this entry is greyed-out.
Expected Maximum Gas to Liquid Ratio	The modelled solution gas to liquid ratio (m^3) as measured at stock tank conditions of 15º C and 101.325 kPa (dry gas). If the liquid is pressurized and heated, the gas release is from the liquid that has been cooled to near atmospheric conditions. This approach allows for any gas that stays in the liquid.
Licensed Maximum H_2S Concentration **if oil effluent pipeline**	For oil effluent pipelines only. For all other pipeline substances and wells, this row is greyed out. The maximum H_2S concentration of the pipeline licence (entered in percent (%). The maximum H_2S concentration does not have to match the reference composition provided in the gas composition (lower portion of **INPUTS** page). Note that emergency planning zone calculations are referenced from the **Expected** Maximum H_2S Concentration, not the Licensed Maximum. The Land Use Setback volume calculations use the **Licenced** Maximum H_2S Concentration.

Field	Description
Expected Maximum H_2S Concentration	**FOR PIPELINES** (DESCRIPTIONS FOR WELLS IN NEXT SECTION) The highest H_2S expected – **under any circumstance**, entered in percent (%). This H_2S **must not be exceeded** without first recalculating the emergency planning zones and proceeding with an ERP modification/update in accordance with ERCB *Directive 071* requirements. For pipelines where the licensed H_2S is not representative of the actual H_2S maximum (due to previous requirements of *Directive 056* regarding certain pipeline substances), this H_2S entry can be higher than the pipeline licence. For pipelines with licences that have representative H_2S maximums, this H_2S entry cannot exceed the licensed maximum. For all pipelines, this H_2S entry can be lower than the licensed maximum provided it is not exceeded during pipeline operations. The H_2S entered must accommodate all production scenarios – with consideration given to scenarios where only the highest H_2S well is producing through the pipeline if other wells are shut-in. The Expected Maximum H_2S Concentration does not have to match the reference composition provided in the gas composition (lower portion of **INPUTS** page). Pipelines with an Expected Maximum H_2S below 0.01 % (mole percent, equivalent to 0.1 mol/kmol **or** 0.0001 mole fraction **or** 100 ppm) do not have to be modelled (ERCB *Directive 071*). If they are modelled, the results do not need to be submitted to the ERCB. Note that emergency planning zone calculations are referenced from the **Expected** Maximum H_2S Concentration, not the Licensed Maximum.

Field	Description
Expected Maximum H_2S Concentration	**FOR WELLS** (DESCRIPTIONS FOR PIPELINES IN PREVIOUS SECTION) The highest H_2S possible (appropriate to the phase of well operation being modelled), entered in percent (%). **For new wells**, this is the H_2S provided in the well licence application. **For all existing wells**, it is the highest possible H_2S from any formation capable of flowing to surface. For pumping wells, it is the highest possible H_2S from any formation being pumped to surface. For injection or disposal wells, it is the highest possible H_2S that can be released at the surface. The Expected Maximum H_2S Concentration does not have to match the reference composition provided in the gas composition (lower portion of **INPUTS** page). Wells with an H_2S below 0.01 % (mole percent, equivalent to 0.1 mol/kmol **or** 0.0001 mole fraction **or** 100 ppm) do not have to be modelled (ERCB *Directive 071*). If they are modelled, the results do not need to be submitted to the ERCB. Note that emergency planning zone calculations are referenced from the Expected Maximum H_2S Concentration.

Field	Description
H2S Release Rate of Well (Cumulative if Multi-zone) (m^3/s)	The volumetric H_2S release rate at reference conditions (m^3/s at 15ºC and 101.325 kPa). While surface rates are preferred (more representative), sand-face rates can be entered (less representative, but more conservative because they will be somewhat higher). For new wells with an ERCB approved pre-submission release rate, enter the pre-approved rate appropriate to the phase of well operations being modelled. For new wells without an ERCB approved pre-submission release rate, enter the cumulative release rate estimate provided in the well licence application – appropriate to the phase of well operations being modelled. If the well has potential to encounter both gas and liquid H_2S bearing formations (e.g. one zone is gas while another is liquid), the user must model the Cumulative H_2S Release Rate using only the Gas Well portion of the INPUTS page. For existing (drilled) wells, enter a cumulative release rate based on all formations capable of flowing to surface. Note - *ERCBH2S* is designed for calculating ERP zones, not well release rates. Requirements/guidelines for calculating well release are in other ERCB publications.
Expected Minimum Liquid Temperature	The minimum liquid temperature in degrees Celsius (ºC) should be entered. If the user entry cell is left blank a default value of 5°C (ground temperature), is used. The allowable temperature range is shown to the right of the **INPUTS** page, in columns H and I. Observe that in column J, the 'model action' for this row is 'resets'. This means that if a user entry is outside the allowable range, an 'orange reset' will be applied. To understand more about orange resets (and why a user must change their entry to remove them) see Orange Resets in this chapter.

Liquid Pipeline and Liquid Well Group - Source Mitigation Sub-section

If the **WITH MITIGATION** analysis was selected in the Administrative section of the **INPUTS** page, two more parameters are available for entry to manage 'liquid well' emergency response planning, and one more entry for 'liquid pipeline' emergency planning.

The **WITH MITIGATION** analysis entries (see below) include mitigation controls for Surface Controlled Sub-Surface Safety Valves (SCSSSV) – a yes/no entry (producing wells only), and time from initial release until ignition or stop flow (input value for pipelines or wells).

For additional information on a licensee/applicant's responsibility when changing a default entry in the **SOURCE MITIGATION** section, see Source Mitigation - Licensee/Applicant Responsibility in this chapter.

SOURCE MITIGATION		USER OVER-RIDE OF DEFAULT	DEFAULT	MODEL INPUT
Is Surface Controlled Sub Surface Safety Valve Installed ?		○ SCSSSV ◉ No SCSSSV	No SCSSSV	No SCSSSV
Time from initial release till stop flow or ignition	minutes		720 default	720

When to Change the Default Settings

A user should only change the default settings (over-ride the default settings) in this group **IF** the licensee can perform/coordinate the following actions within the time frame indicated in this section of the model:

- detect the release,
- contact the operator (for wells, consider whether or not it is a manned operation),
- travel to the site (for wells, again consider whether or not it is a manned operation),
- verify a release is occurring (for wells, again consider whether or not it is a manned operation), and
- perform a prescribed, pre-planned action that prevents additional H_2S from being released (such as igniting the well or pipeline, closing a valve, or 'drawing down' a pipeline).

Unless the licensee can perform the above actions in less time than shown as a default entry for this group, this field should be left blank. Note that for wells, the default setting for 'Time from initial release until ignition or stop flow' changes with the phase of well operation – which indicates if the site is manned or un-manned (subsequently affecting the time to implement mitigation measures). In addition, **producing** wells with a Surface- Controlled Sub-Surface Safety Valve (SCSSSV) have a significantly reduced default setting. To change the SCSSSV option, a 'with mitigation' analysis must be selected.

For pipelines, the default entry and the allowable value range for 'Time from initial release until ignition or stop flow' remain constant. The SCSSSV row is greyed-out for pipelines.

Note that for liquid pipelines, the duration of the release is a function of whether the release has been manually detected - since emergency shutdown valves are not normally employed on this type of pipeline. Consequently, production pumps continue at capacity until the release is detected. For this reason, *ERCBH2S* assumes the maximum modelling time of 12 hours before the leak is detected. Durations longer than 12 hours will not impact the size of the ERP zones. If site-specific controls are available to limit this time, a **WITH MITIGATION** analysis allows the user to change the **Time from Initial Release till Stop Flow or Ignition**.

In all cases where **SOURCE MITIGATION** default values are changed, the ERCB may request documentation to support a licensee's entries.

Note that while some planning zones sizes decrease with changes to the source mitigation time, **significant EPZ changes are not realized until mitigation time is reduced to 3 hours (180 minutes) or less.**

The ERCB may request documentation that supports a licensee's non-default **Time from Initial Release until Ignition or Stop Flow** values

Liquid Pipeline or Liquid Well Group - Orange Resets

The lower (min.), upper (max.) allowable values for 'Time from initial release until ignition or stop flow' change with the phase of well operation, and with the presence of a SCSSSV. For pipelines, they remain the same (the SCSSSV row is greyed-out for pipelines).

The allowable limits are shown to the immediate right on the **INPUTS** page, in columns H and I. Observe that in column 'J' the 'Model Action' is 'Resets'. This means that if the user enters a value outside of the allowable limits, the model automatically 'resets' the user entry, and the reset entry is displayed in column E under **MODEL INPUT**. The resulting 'orange reset' creates a **red flag** error message which must be dealt with.

For details on why orange resets occur, why they must be managed and how, see Orange Resets in this chapter.

Sour Gas Composition

In the Sour Gas Composition input section, enter a representative composition of the sour gas stream according to a reference analysis. The data format is in component molar fractions input on a *dry basis*. For the analysis should be for the gas phase, at standard conditions of 15º C and 101.325 kPa – *dry basis*.

If a well has multiple zones, if possible - choose the zone with the highest H_2S. Otherwise, as long as the analysis composition is representative of at least one of the zones, differences from one analysis to another make little difference in the calculated size of the planning zones. *ERCBH2S* adjusts the user entered analysis H_2S value to equal the H_2S entered for modelling purposes (in the Gas Pipeline, Gas Well, or Liquid Pipeline or Liquid Well section of the **INPUTS** page – the Expected Maximum H_2S). All other composition components are pro-rated according to their new fractional contribution to the total (renormalized). The adjusted analysis can be immediately viewed on the ERP summary page because the calculations performed by Excel – no *ERCBH2S* program 'run' commands are needed for this conversion. All *ERCBH2S* calculations will reference the adjusted analysis.

Representative gas composition requirements are as described in other current ERCB publications, such as *Directive 056* and *Directive 040*.

Sour Gas Composition ***(gas phase at 15°C & 101.325 kPa, dry, representative analysis)***	**Units**	**User Input**	**Comments**	**Warnings**
H_2	mole fraction			
He	mole fraction	0.0006		
N_2	mole fraction	0.0283		
CO_2	mole fraction	0.0427		
H_2S	mole fraction	0.0259	Adjusted to Maximum H_2S Input for Level and Modelled H_2S Input for EPZ	
CH_4	mole fraction	0.8137		
C_2H_6	mole fraction	0.0488		
C_3H_8	mole fraction	0.0208		
i-C_4H_{10}	mole fraction	0.0036		
n-C_4H_{10}	mole fraction	0.0065		
i-C_5H_{12}	mole fraction	0.002		
n-C_5H_{12}	mole fraction	0.0021		
n-C_6H_{14}	mole fraction	0.002		
n-$C_7H_{16}^+$	mole fraction			
Total	mole fraction	0.997	Sum must equal one	ERROR: must sum to 1

Data entered *must* be normalized; that is, the molar fractions of the listed components **must sum to 1.0**. *ERCBH2S* will not correct the data for you. A warning error next to the will appear when values are not normalized as shown in the illustration above. This warning is used to prevent user entry errors if gas components are skipped or miss-entered. Sometimes, due to rounding, a gas analysis may add up to slightly more than 1. In this event, subtract the 'extra' mass from whichever component has the highest mole fraction, and entered the adjusted values.

If the maximum H_2S value specified in the Details section is different than the value specified in the gas composition field, *ERCBH2S* readjusts the composition specified to use the specified value. The stream composition will be renormalized and then this new composition will be used for all subsequent calculations.

Advanced User Selected Case

For ERCB submission, the default entries in this section **must not be changed**. User over-ride of the default entries creates a **red flag** error message that will remain attached to the calculation results.

This section provides an opportunity for the advanced technical user to investigate intermediate calculations and mitigation strategies for a selected meteorological and/or Gas Pipeline Release Hole Size (Fraction).

Advanced User Selected Case (DO NOT USE for ERCB Submissions)	Units	ADVANCED USER INPUT (leave blank for ERCB submission)	DEFAULT	ADVANCED USER INPUT for Selected Case of Interest (Non-Regulatory Mode)
Ambient Wind Speed at measurement height, Uref	m/s		2 default	2
Stability Class (A=1, B=2, C=3, D=4, E=5, F=6, none=7)	--		6 default	6
Gas Pipeline Release Hole Size Fraction, Ae/Ap	--		2 default	2

Field	Description
Ambient Wind Speed at measurement height, Uref	Ambient wind speed, in m/s. The DEFAULT value is 2.0 m/s.
Stability Class	Atmospheric turbulence conditions as defined by Pasquill Gifford stability classes. The DEFAULT stability is Class F (also represented by a numerical value of 6). The Pasquill-Gifford scale is: 1 = A: very unstable (very turbulent) 2 = B: moderately unstable 3 = C: slightly unstable 4 = D: neutral conditions (breezy, overcast) 5 = E: moderately stable 6 = F: very stable (calm) 7 = none (default)
Pipeline Release Hole Size Fraction, *Ae/Ap*	The *Ae/Ap* ratio entered includes the discharge coefficient due to compressibility effects at the exit orifice.

All rows in the User Selected Case group have pre-determined entry limits shown to the immediate right on the **INPUTS** page, in columns H and I. Observe that in column 'J' the 'Model Action' is 'Resets'. This means that if the user enters a value outside of the allowable limits, the model automatically 'resets' the user entry, and the reset entry is displayed in column E under **MODEL INPUT**.

For details on why orange resets occur, why they must be managed and how, see Orange Resets in this chapter.

ERCBH2S **normally** iterates through 54-combinations of stability class and wind speed for 11 pipeline hole size fractions to calculate the largest ERP zones (i.e., worst-release hazard distances) for each of 54 different meteorological conditions.

To enable the user to perform 'what-if' analyses, a user selected case may be entered to override the automatic search. These inputs are **for the technical user only**.

Default over-rides in the **User Selected Case** group are not acceptable for ERCB submission. A **red flag** error message will be attached to the calculation results.

6. Calculation Pages

Calculation pages have a yellow sheet tab. Intermediate calculation pages are not displayed for normal operation of the *ERCBH2S* program. A list of the intermediate calculation pages is provided in Chapter 4 under "**User-Interface".**

Intermediate calculation pages are not displayed for normal operation of the *ERCBH2S* program operation. The **Hide Technical Pages** switch can be toggled to display these pages in the *ERCBH2S* template file.

Some of the intermediate calculation pages are general in nature and are displayed whenever the **Hide Technical Pages** toggle is deactivated. Other pages are only visible depending on the assessment flavour. For example, if the *ERCBH2S* flavour has been set to **SOUR GAS PIPELINE**, then the **SOUR GAS WELL** and **SOUR OIL** related pages will remain hidden.

Common Pages

CONSTANTS

The **CONSTANTS** page has a green sheet tab for inputs because it contains a variety of ERCB mandated default input values as well as physical and chemical constants required for the calculations. There are many parameters in *ERCBH2S* that require advanced scientific expertise and judgement. The selected default values are mandatory parameters for *ERCBH2S* to avoid arbitrary selection while providing a common assessment basis for ERP zones calculations. The values on this page are security protected and are not editable.

ERCB Default Inputs

The following table describes the parameters that have been selected by the ERCB as default entries.

Source	UNITS	OVERRIDE	DEFAULT	INPUT
Release Angle		○ HORIZONTAL ○ VERTICAL	HORIZONTAL	HORIZONTAL
D Plane Drag Coefficient, Cd	0 (no drag) to 1 (full stop)		0.5	0.5
Water Content of Sour Gas	mg of water/Sm³ of wet gas		0	0
Meteorology	**UNITS**	**OVERRIDE**	**DEFAULT**	**INPUT**
Ambient Temperature, Ta	°C		5	5
Relative Humidity, rh	%		60	60
Ambient Measurement Height, za	m		4	4
Surface Roughness Height, zo	m		0.1	0.1
Exposure	**UNITS**	**OVERRIDE**	**DEFAULT**	**INPUT**
Planning Endpoint, TLeCp (TLeC=Toxic Load Equivalent Concentration)	H_2S ppm		100	100
Planning Endpoint Duration tp	minutes		60	60
Response Endpoint, TLeCr (TLeC=Toxic Load Equivalent Concentration)	H_2S ppm		100	100
Response Endpoint Duration tr	minutes		150	150
Concentration Exponent for Toxic Load, n			3.5	3.5
Building Air Changes per Hour, ACH			0.5	0.5
Maximum Exposure Time	s		10800	10800
Reference Total Fluctuation Intensity iref			0.25	0.25
Reference Time for Reference Total Fluctuation Intensity	s		180	180
Gas Pipeline	**UNITS**	**OVERRIDE**	**DEFAULT**	**INPUT**
Gas Pipeline Release Height, hs	m		0	0
Pipe Absolute Roughness	mm		0.05	0.05
Blowdown Inertial Delay Factor, Ki			0.5	0.5
Gas Well	**UNITS**	**OVERRIDE**	**DEFAULT**	**INPUT**
Gas Well Release Height, hs	m		1	1
Stagnation Temperature, Ti	°C		-21	-20.9
Liquid Pipeline/Well	**UNITS**	**OVERRIDE**	**DEFAULT**	**INPUT**
Liquid Release Height, hs	m		0.0	0.0

Source	Description
Release Angle	Orientation of the source release. HORIZONTAL means that the release is parallel to the ground surface. VERTICAL means that the release is directed upwards, away from the ground surface. The DEFAULT is horizontal
D Plane Drag Coefficient, CD	Drag Coefficient is an empirical factor to account for losses of momentum due to the jet release interactions with surfaces, such as the ground or obstacles. The Drag Coefficient can affect the dispersion results, especially in the near field, because of the momentum loss, plume rise and travel time effects. The drag coefficient is between 0 and 1. The default value is 0.5. Producing wells are typically free of well site infrastructure; therefore 0.25 is used as the default.
Water Content of Sour Gas	The water (moisture) content in the gas stream is specified. The DEFAULT water content of gas is 0 mg of water per standard m^3 of wet gas.
Meteorology	**Description**
Ambient Temperature, Ta	Ambient air temperature. The DEFAULT value is 5°C, a typical

	annual average temperature in Alberta.
Relative Humidity, rh	Relative humidity of air. The DEFAULT value is 60 %.
Ambient Measurement Height za	Height at which the wind speed is measured. The DEFAULT value is 4 m to be consistent with plume dispersion parameterization used in ERCBSLAB.
Surface Roughness Height, Zo	Surface roughness height is an effective height of surface conditions as they affect atmospheric turbulence. Typical values range from 0.001 m (very smooth) to 2.0 m (hilly or urban). The DEFAULT value is 0.10 m.
Exposure	**Description**
Planning Endpoint, TLeCp (TLeC=Toxic Load Equivalent Concentration)	Concentration used in calculating the equivalent toxic load threshold for planning purposes. The DEFAULT value is 100 ppm.
Planning Endpoint Duration tp	Duration used in calculating the equivalent toxic load threshold for planning. The DEFAULT value is 60 minutes.
Response Endpoint, TLeCr (TLeC=Toxic Load Equivalent Concentration)	Concentration used in calculating the equivalent toxic load threshold for response purposes. The DEFAULT value is 100 ppm.
Response Endpoint Duration tr	Duration used in calculating the equivalent toxic load threshold for Response. The DEFAULT value is 150 minutes.
Concentration Exponent for Toxic Load, n	Exponent used in calculation of toxic load. The DEFAULT value is 3.5.
Building Air Changes per Hour, ACH	Building air changes is the ventilation rate of the building and is used to estimate indoor H_2S concentrations for sheltering. Values range from 0 (no exchange) to more than 35 (lots of exchange, automobile). For buildings, the range is 0.1 to 5 building air changes per hour. The DEFAULT value of 0.5 is for leaky residential buildings.
Maximum Exposure Time	Maximum duration, exposure and averaging time for the release. The DEFAULT value is 10800 seconds (3 hours).
Reference Total Fluctuation Intensity iref	A measure of how much the concentration varies from the average for a given averaging time. The DEFAULT value is 0.25.
Reference Time for Reference Total Fluctuation Intensity	The DEFAULT value is 180 seconds (3 minutes)
Gas Pipeline	**Description**
Gas Pipeline Release Height, hs	Source height for sour gas pipeline releases. The DEFAULT value is 0 m.
Pipe Absolute Roughness	Roughness of the inside wall of the pipeline. The DEFAULT value is 0.05 mm.
Blowdown Inertial Delay Factor, Ki	Constant used in calculations to determine the mass release rate. The DEFAULT value is 0.5.
Gas Well	**Description**
Gas Well Release Height, hs	Height from which the well release occurs, measured in m. The DEFAULT value is 1 m.

Stagnation Temperature, Ti	Stagnation temperature of the wellhead release includes the temperature rise that would occur if the flowing gas were stopped to a velocity of zero. The DEFAULT value is calculated based upon the average of the ideal gas properties of the release to result in a dense release and the typical ground temperature of 5 °C.
Liquid Pipeline/Well	**Description**
Liquid Release Height, hs	Source height for sour liquid pipeline/well releases. The DEFAULT value is 0 m for pipelines and 1 m for wells.

See *ERCBH2S* document **Volume 1: Technical Reference Document** and *ERCBH2S* document **Volume 2: Emergency Response Planning Endpoint** for more information.

Physical Constants

ERCBH2S makes use of several chemical-physical constants. The values used in *ERCBH2S, ERCBFLASH* and *ERCBSLAB* are listed below.

Physical Constants	UNITS	OVERRIDE	DEFAULT	INPUT
Reference Temperature	°C		15	15
Reference Pressure	kPa		101.325	101.325
Universal Gas Constant, Ru	J/(kmol·K) or Pa·m³/(K·kmol)		8314.5	8314.5
Molar Volume at reference conditions	m³/kmol		23.64493634	23.64493634
Gravitational Constant	m/s^2		9.80665	9.80665
Average Vertical Temperature Gradient in Atmosphere	K/m		0.0065	0.0065

ERCBH2S also calculates the thermodynamics for moist air as listed below.

Moist Air Properties	UNITS	OVERRIDE	DEFAULT	INPUT
Site Atmospheric Pressure (function of elevation)	kPa		89.876	89.876
Ambient temperature, Tair ta	K		278.15	278.15
Relative Humidity, rh	%		60	60
Molar mass dry air, wma*1000	kg/kmol		28.9625	28.96
Cp dry Air, cpa	J/(kg·K)		1004.0	1004.0
Molar mass water, wmw*1000	kg/kmol		18.0153	18.02
Density Water Liquid, rhowl	kg/m³		999.1	999.1
Cp Water Vapour, cpwv	J/(kg·K)		1861.7	1861.7
Cp Water Liquid, cpwl	J/(kg·K)		4186.3	4186.3
Latent Heat Water, dhw	J/kg		2465900	2465900
SPAW intercept			14.12	14.12
SPBW slope	K		5209	5209
SPCW correction	K		-1.08	-1.08
Water Boiling Point for Site Pressure	°C		96.84	96.84
Water partial pressure, rpwa			0.56%	0.56%
Mass fraction water, cmwa			0.35%	0.35%
Mass fraction dry air, cmdaa			99.65%	99.65%
Cp moist air, cpaa	J/(kg·K)		1006.98	1006.98
Molar mass moist air, 1000*wmae	kg/kmol		28.9016	28.9016
rho moist air, rhoa	kg/m³		1.1232	1.1232

SHARED

The **SHARED** page contains gas calculations that are common to all *ERCBH2S* analysis flavours. The page includes calculations of chemical/physical properties and gas composition. The values on this page are security protected and are not editable.

ERCBFLASH

The **ERCBFLASH** page lists the inputs to the *ERCBFLASH* program. The *ERCBFLASH* program calculates 'real gas' chemical/physical properties for the well or pipeline release exit conditions. Real gas properties can vary significantly from 'ideal gas' properties due to extreme conditions such as pressure or temperature. The values on this page are security protected and are not editable.

ERCBFLASH OUTPUT

The **ERCBFLASH OUTPUT** page displays the *ERCBFLASH* program output information. The output consists of a listing of the calculated 'real gas' properties. The values on this page are security protected and are not editable.

ERCBSLAB

The **ERCBSLAB** page lists the inputs to the *ERCBSLAB* program for H_2S dispersion modeling. A note at the top of the page indicates if the run is dense or passive/ buoyant. The values on this page are security protected and are not editable.

The *ERCBSLAB* input file is similar to the original US EPA Slab program input file. The input variables that are different than the original program are highlighted by bold typeface

ERCBSLAB OUTPUT

The **ERCBSLAB OUTPUT** page displays output from the *ERCBSLAB* program. The output from *ERCBSLAB* is a modified version of the original USEPA *SLAB* format, but maintains the same concepts. The values on this page are security protected and are not editable.

The *ERCBSLAB* output file can be produced by activating the ERCBSLAB debug switch **ERCBH2S→ Setup→ERCBSLAB Debug**. The output file is written to the default folder.

TOX OUTPUT

The **TOX OUTPUT** page displays the *ERCBSLAB* program secondary output file for toxic load calculations for the **User Selected Case** of meteorology and pipeline release fraction. The listing shows concentrations and toxic load equivalent concentrations with distance for each of the indoor and outdoor, planning and alert criteria combinations. The values on this page are security protected and are not editable.

The *ERCBSLAB* secondary output ToxOutput file can be produced by activating the ERCBSLAB debug switch **ERCBH2S→ Setup→ERCBSLAB Debug**. The output file is written to the default folder.

MAX OUTPUT

The **MAX OUTPUT** page displays the *ERCBSLAB* program secondary output file for toxic load calculations for *all* screening meteorology cases and the user selected pipeline release fraction. The listing shows the *maximum* concentrations and toxic load equivalent concentrations with distance for each of the indoor and outdoor, planning and alert criteria combinations. The values on this page are security protected and are not editable.

The *ERCBSLAB* secondary output MaxOutput file can be produced by activating the ERCBSLAB debug switch **ERCBH2S→ Setup→ERCBSLAB Debug**. The output file is written to the default folder.

METMATRIX

The **METMATRIX** page displays output from screening matrix calculations. That stability class and wind speed values specified on the **INPUTS** page have a significant effect on the calculated hazard distances. To help efficiently examine the worst-release hazard distances incurred by varying the stability class and wind speed values over the possible combinations, the various hazard distances are

calculated and presented in tabular format. In total 54-combinations of stability class and wind speed based on the regulatory screening matrix are calculated. The calculation matrix is displayed on the **METMATRIX** page. If the Pipeline flavour is selected, then the **METMATRIX** page will also display the results of the **Ae/Ap Ratio Search** for each meteorological condition.

HAZARD DISTANCES

The **HAZARD DISTANCES** page displays the calculation matrix and predicted output of the **Dispersion Condition Probability Weighted Hazard Distance** that supports the calculated distances for the **Planning** and **Response** zones.

The *Dispersion Condition Probability Weighted Hazard Distance* is a weighted-averaged value of 54 *Worst-Release Hazard Distances*, which is calculated by multiplying the hazard distance in each of 54 categories by fraction of time that each meteorological condition occurs.

The results of *Maximum of Primary and Secondary Hazard Distances* from the **METMATRIX** page are displayed as the *Worst-Release Hazard Distances* in the **HAZARD DISTANCES** page. The model uses the *Average Probability of PG Stability Class and Wind Speed in Alberta* (historical data from Alberta Environment) to determine the fraction of time that each of the dispersion conditions occurs and weights the *Worst-Release Hazard Distances* to produce the *Dispersion Condition Probability Weighted Hazard Distance*.

Note: The *Worst-Release with Worst-Dispersion Distance* is also displayed in the **HAZARD DISTANCES** page. However, these values are not displayed in the **ERP SUMMARY** page.

The Hazard distances are not rounded, but show distances to a resolution of 1 m. The ERP planner should use these distances in conjunction with other planning information (egress routes, population density, etc...) and finalize the ERP zones to a logical site-specific distance.

Although the *ERCBH2S* models may predict Hazard distances greater than 30000 m (30km) the maximum suggested EPZ, IIZ, or PAZ is 30000 m (30km). This is the largest distance to where the model predictions can be applied.

Gas Pipeline Pages

SOUR GAS PIPELINE

The *ERCBH2S* calculation pages for each sour operations type are divided into the following sections:

Section Title	Description
Release Description	General data describing pipeline segment and factors needed for subsequent calculations.
Source Calculations	Input and outputs from *ERCBFLASH* used to calculate the Mass Release Rate and Duration and Receptor Exposure.
Receptor Exposure Calculations	Exposure calculation data, as defined by user and release.
From ERCBFLASH	Output data from *ERCBFLASH*. This information will only be updated after the program has been run.
Data calculated from real fluid properties	Compares choked flow properties to *ERCBSLAB* inputs to determine flow type.
Buoyancy Flux	A comparison of buoyancy values using different methods to ensure consistency.
Inputs to ERCBSLAB	Input data for the *ERCBSLAB* program. Uses the second *ERCBFLASH* data.
Jet Expansion Planes, Both Jets	Comparison of gas stream properties for jet expansion planes (I, E, Q, D and R). R plane data is used as input for *ERCBSLAB*.
Drag Test Calculations	This section allows the user to determine what drag coefficient to use based on a velocity or velocity ratio. It also gives the force required to slow down and change directions of the jet. Note the default drag coefficient can not be changed by the user.

The calculations are security protected and are not editable. These calculations are displayed in order to provide information about the calculation process and aid in understanding the theory behind the models. You may note that some cells have the labels “not used” beside them in the page. This is because although *ERCBFLASH* calculates these properties they are not used in the *ERCBH2S* program. They are presented here for your information only.

The **SOUR GAS PIPELINE** page uses the input data to calculate the physical characteristics of the release. Refer to the section on Gas Pipeline Calculation Process for a general overview of the calculation process. The approach and

assumptions involved in the estimates are described in **Volume 1 - Technical Reference Document.**

ESD CLOSURE

The amount of mass released during a pipeline failure can be a function of the spacing of emergency shut-down (ESD) valves. The blow-down of the pipeline takes some time for the pipeline to depressurize. The pipeline does not depressurize uniformly, but in a non-linear fashion from the release location. It may take some time before the pressure at the location of the ESD is sufficient to trigger the closure of the valve and will also depend on the pressure set-point of the valve and its sensitivity. The time required for the triggering of the ESD is estimated on the **ESD Closure** page. See also the description of the ESD Closure on page 49.

AeAp-ITERATION

The **AeAp-ITERATION** page shows the calculation matrix used to determine the sensitivity of the ERP Zones for the meteorological case (single wind speed and stability class) tested and *Ae/Ap* ratios listed in the table. The results of the exit area ratio are displayed in a graph below the table showing the variation of ERP zones with change in *Ae/Ap* ratio. See also the description of the Ae/Ap calculation process on page 50.

Gas Well Page

SOUR GAS WELL

The *ERCBH2S* calculation page sections were described in the SOUR GAS PIPELINE section of this chapter. The **SOUR GAS WELL** page uses the input data to calculate the physical characteristics of the release. Refer to Gas Well Calculation Process in Chapter 4 for a general overview of the calculations on this page. The approach and assumptions involved in the estimates are described in **Volume 1 - Technical Reference Document.**

Liquid Pipeline/Well Page

SOUR LIQUID

The *ERCBH2S* calculation page sections were described in the SOUR GAS PIPELINE section of this chapter. The **SOUR LIQUID** page uses the input data to calculate the physical characteristics of the release. Refer to the section on Liquid Pipeline and Liquid Well Calculation Process for a general overview of the calculation process. The approach and assumptions involved in the estimates are described in **Volume 1 - Technical Reference Document.**

7. Output Pages

Output pages have a pink sheet tab. Several other output pages are provided and provide a varying level of sophistication for the technical user. These pages are briefly described below:

Page Name	Purpose	Description
ERP SUMMARY	Output	Summary of Inputs and Emergency Response and Planning Zones. This page to be included for each well and pipeline segment in the Emergency Response Plan.
HAZARDS	Tabular Summary	Summary of Release Description, User Selected Case Hazard Distances, Maximum of Screening Hazard Cases ERP Zones.
GRAPH-MET	Graphic Summary	Tabular and graphical representation of the METMATRIX data. Hazard distances for the range of meteorological conditions and wind speeds. Presented in tabular and graphical format. The maximum computed distance is highlighted.
GRAPH-ERCBSLAB(x)	Graphic Summary	Graph showing how variables change as the release moves away from the source.
GRAPH-STEADY(x) WELL and LIQUID	Graphic Summary	Graphical representation of the TOX OUTPUT and MAX OUTPUT concentrations. The Planning and Alert Criteria are highlighted on the graph
GRAPH-TRANSIENT(x) PIPELINE ONLY	Graphic Summary	Graphical representation of the TOX OUTPUT and MAX OUTPUT concentrations. The Planning and Alert Criteria are highlighted on the graph

ERP SUMMARY

The *ERCBH2S* program results are summarized on a single output page called **ERP SUMMARY** that displays an executive summary of the information displayed on the **INPUTS** and **HAZARD DISTANCES** pages. It lists administrative data, the calculated ERP zones for the pipeline, well or liquid release, and a graphic that represents the relative relationship between calculated distances.

The **red flags** may continue to appear if the User has specified a Gas Pipeline Release Hole Size Fraction on the INPUTS page. Delete the entry and run **Calculate EPZ** to remove the **red flags**.

The Advanced User Selected Case on the INPUTS page can include the wind speed and stability class but not the Pipeline Release Hole Fraction. Delete the wind speed and stability class and run **Calculate EPZ** to remove the **red flags**.

The Administrative and Facility Inputs table displays information that was entered on the **INPUTS** page. Next the **Gas Pipeline Details**, **Gas Well Details** or **Liquid Pipeline/Well Details** information that was entered on the **INPUTS** page is echoed. A sample is provided below:

ERP SUMMARY *ERCBH2S Ver 1.20*

ERCBH2S Ver 1.20
ERP DISPERSION MODELLING SPREADSHEET
Energy Resources Conservation Board

Administrative

Licensee/Applicant Name	B
Name of Well / Pipeline Licence Number	Label 1
Legal Surface Location of Well or Pipeline Line Number	Label 2
Pipeline From Location (na if well)	M
Pipeline To Location (na if well)	N
Surface Elevation (m ASL)	1000

Source Details

Scenario Name	Label 3 Gas Well
Sour Operations Type	**Gas Well**
Calculation Type	GAS WELL (steady horizontal jet)
Analysis Type	**NO-MITIGATION** **Uncontrolled H2S Release** **Buoyant**

GAS WELL (includes oil well and other well with Gas to Liquid Ratio>1000)	**Units**	**User Input**	**Warnings**
Phase of Well Operations ?	--	Drilling	
Is Well Classified as Critical ?	--	Critical	
Unique Well Identifier	--	0	
Casing or Tubing Inside Diameter at Exit	mm	165.6	
Expected Maximum H2S Concentration	% (dry), (15°C, 101.325	14	
H2S Release Rate (Cumulative if Multi-zone)	m³/s (15°C, 101.325	2	
SOURCE MITIGATION		**MODEL INPUT**	
--	--	--	
Time from initial release until ignition or stop flow	minutes	720	
--	--	--	
--	--	--	
--	--	--	
--	--	--	
--	--	--	
--	--	--	
--	--	--	
--	--	--	
--	--	--	

GAS PHASE FRACTIONS	**INPUT**	**EXPECTED**	**LICENCED**
H_2	0.0000	0.0000	0.0000
He	0.0006	0.0005	0.0005
N_2	0.0283	0.0250	0.0250
CO_2	0.0427	0.0377	0.0377
H_2S	0.0259	0.1400	0.1400
CH_4	0.8137	0.7184	0.7184
C_2H_6	0.0488	0.0431	0.0431
C_3H_8	0.0208	0.0184	0.0184
$i\text{-}C_4H_{10}$	0.0036	0.0032	0.0032
$n\text{-}C_4H_{10}$	0.0065	0.0057	0.0057
$i\text{-}C_5H_{12}$	0.0020	0.0018	0.0018
$n\text{-}C_5H_{12}$	0.0021	0.0019	0.0019
$n\text{-}C_6H_{14}$	0.0020	0.0018	0.0018
$n\text{-}C_7H_{16}+$	0.0030	0.0026	0.0026
H_2O	--	0.0000	0.0000
Total	1.0000	1.0000	1.0000

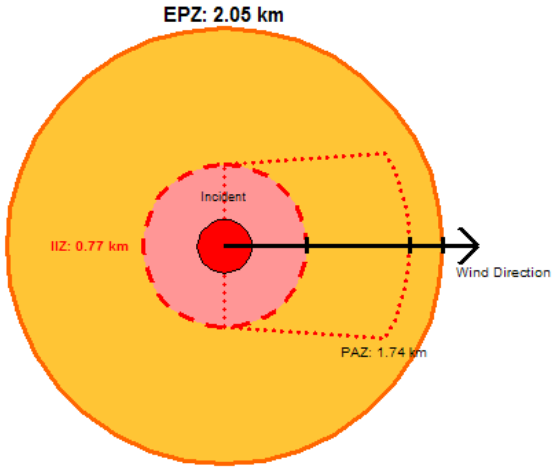
The Results table (see below) displays the calculated Land Use Setback H_2S release rate or volume (if applicable), the Level Designation (if applicable) and the compressibility factor used based on user input licenced conditions. The Existing EPZ (user entry on the INPUTS page – Administrative) and the Normograph EPZ calculation (based on the H_2S release rate or volume) are also provided.

RESULTS

Land Use H2S Release Rate	m³/s	na
Land Use Setback Level	--	Level na
Compressibility Factor z for Level at Licenced Conditions	--	na
Existing EPZ Distance	km	na
Nomograph EPZ Calculation	km	3.68

The predictions from the Worst-Release with Averaged-Dispersion Distances on the **HAZARD DISTANCES** page are displayed graphically on the **ERP SUMMARY** page (see example below).

Emergency Response and Planning Zones



LABEL 1|LABEL 2|LABEL 3 GAS WELL

LEGEND		CALCULATED
IIZ	Initial Isolation Zone	0.77 km
PAZ	Protective Action Zone	1.74 km
EPZ	Emergency Planning Zone	2.05 km

IMPORTANT: Each zone submitted as part of an ERP must reflect site-specific features such as population density, topography, access/egress routes and any other identifiable factors that may affect timely implementation of emergency response procedures. Thus each zone distance calculated by ERCBH2S may require further consideration for planning or during response. The implied shape of the combined planning zones represented here, therefore, is a schematic simplification for display purposes.

The graphic displays four predicted distances and represents several concepts:

- **IIZ** (Initial Isolation Zone) is colour coded in pink. Within this circle, sheltering-in place may not be a viable public protection measure; all persons within this zone should be evacuated immediately. Therefore sheltering-in place within this zone can only be considered a temporary response measure. It is based upon the indoor toxic load criteria.

- **EPZ** (Emergency Planning Zone) is a colour coded in orange. It is the distance requiring specific emergency response planning, preparedness and response and is based upon the outdoor toxic load criteria. The *ERCBH2S* **EPZ** must include all people within this radius. The final **EPZ** submitted to the ERCB will reflect other considerations such as egress and local population densities.

- **PAZ** (Protective Action Zone) is a pie-wedge area within the EPZ with a red dash border. It indicates an area downwind of a hazardous release where outdoor pollutant concentrations may result in life-threatening or serious and possibly irreversible health effects on the public. The PAZ endpoint is defined as a 130 ppm concentration of H_2S over a 60-minute exposure time. The PAZ endpoint is protective of unconsciousness. The **PAZ** is an emergency response distance and therefore is dependent upon the meteorology (wind blowing to) at the time of the incident and must be assessed frequently for change of direction.

  The width of the sectors in the graphic is for presentation purposes only. The width of the sector during emergency response must be determined by responders based on field measurements.

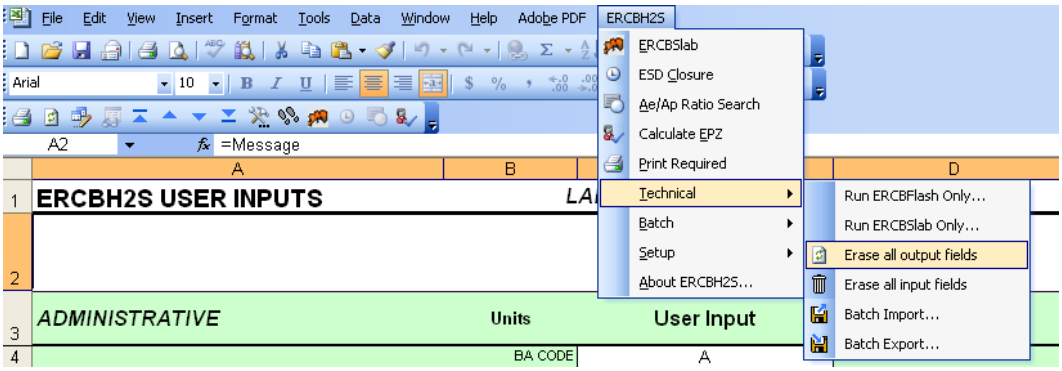
The **ERP Zones** are the *Worst-Release with Averaged-Dispersion Distances* from the **HAZARD DISTANCES** page. For reference, the faction of time that of each of the dispersion conditions occurs is displayed in the *Average Probability of PG Stability Class and Wind Speed in Alberta* table on the **HAZARD DISTANCES** page.

Each Emergency Planning and Response zone submitted as part of an ERP must reflect site-specific features such as population density, topography, access/egress routes and any other identifiable factors that may affect timely implementation of emergency response procedures. Thus each zone distance calculated by *ERCBH2S* may require further consideration for planning or during response. The implied shape of the combined planning zones represented by the *ERCBH2S* outputs, therefore, is a schematic simplification for display purposes.

Erasing Calculation Results

Calculation results (outputs) on the **ERP SUMMARY** page can be erased by selecting "Erase all output fields' from the technical sun-menu as shown below or

by selecting the 'Erase all output fields' button  from the button bar. This command also erases outputs from other *ERCBH2S* 'Summary/Graphics' pages, but does not erase outputs stored on the **BATCH** page.



HAZARDS

The **Hazards** page displays output for a single selected meteorological condition results and the EPZ screening meteorological results that supports the calculated distances for the **Planning** zones.

The **Release Description** displays some of the input information and calculated properties of the defined case. The release type indicates whether the release was modelled as transient blow-down (pipeline) or a constant rate release (well).

Release Description

Title	LABEL 1|LABEL 2|LABEL 3 GAS WELL
Sour Facility Type	Gas Well
Calculation Type	GAS WELL (steady jet)
Release Type	Short Duration Horizontal Jet
Analysis Type	NO-MITIGATION

User Selected Case

The third table, titled **Selected Meteorology Case,** displays the hazard zone distances for both planning and alert limits for the single stability and single wind speed case. An example is shown below.

User Selected Case		
Wind Speed at measurement height, Uref	m/s	2
Stability Class	--	Class F
Release Hole Size Fraction, Ae/Ap Total	--	--
Calculated Values		
--	--	
Maximum plume rise, HPr	m	33
H_2S Release Amount	m³	86400
H_2S Release Rate	m³/s	2.0000
H_2S Release Duration	s	43200
Near Field Density Ratio	0.873	Initially Buoyant
Far Field Density Ratio	0.883	Buoyant

H_2S Hazard for User Selected Case	Primary Hazard				Secondary Hazard			
Endpoint	Distance (m)	Wind Speed (m/s)	Stability Class	Ae/Ap	Distance (m)	Wind Speed (m/s)	Stability Class	Ae/Ap
Outdoor Response Toxic Load Equivalent H2S Concentration (100 ppm for 150 minutes with n= 3.50)	3996	2	Class F	--	--	--	--	--
Outdoor Planning Toxic Load Equivalent H2S Concentration (100 ppm for 60 minutes with n= 3.50)	4759	2	Class F	--	--	--	--	--
Indoor Planning Toxic Load Equivalent H2S Concentration (100 ppm for 60 minutes with n= 3.50)	1626	2	Class F	--	--	--	--	--

ERCBH2S-Well & Liquid

The *Ae/Ap* ratio columns are not relevant for the *ERCBH2S*-Well or Liquid flavours.

The Hazard distances are not rounded, but show distances to a resolution of 1 m. The ERP planner should use these distances in conjunction with other planning information (egress routes, population density, etc...) and finalize the ERP zones to a logical site-specific distance.

Although the *ERCBH2S* models may predict Hazard distances greater than 30000 m (30km) the maximum suggested EPZ, IIZ, or PAZ is 30000 m (30km). This is the largest distance to where the model predictions can be applied.

This table displays results for a single selected meteorological case (in the example shown above: stability Class F and wind speed 2 m/s). The predictions show in the example are for the Wind Speed and Stability Class specified in the **User Selected Case** input group on the **INPUTS** page. The wind speed and stability class columns in the Primary Zone section have identical values for each row based upon the selected meteorology entered and are therefore disabled (greyed) to avoid confusion.

The **Secondary Hazard** columns will display data for a situation that can sometimes occur if the release is initially near the ground and then rises further down wind (see example below). When a secondary hazard is predicted the table will populate the **Secondary Hazard** zone columns and colour code the prediction (warning-orange). Otherwise, these columns will be blank as shown above. For more information on the calculation of secondary zones, see **Volume 1: Technical Reference Document**. In the example below, EPZ is shown to have a **Secondary Hazard** zone with distance prediction having both a primary distance (1547 m) and a secondary distance (1560 m).

User Selected Case		
Wind Speed at measurement height, Uref	m/s	2
Stability Class	--	Class F
Release Hole Size Fraction, Ae/Ap Total	--	--
Calculated Values		
Release Hole Size Fraction, Ae/Ap Total	--	0.02
Maximum plume rise, HPr	m	48
H_2S Release Amount	m³	7961
H_2S Release Rate	m³/s	0.2200
H_2S Release Duration	s	35780
Near Field Density Ratio	0.876	Initially Buoyant
Far Field Density Ratio	0.888	Buoyant

H_2S Hazard for User Selected Case	Primary Hazard				Secondary Hazard			
Endpoint	Distance (m)	Wind Speed (m/s)	Stability Class	Ae/Ap	Distance (m)	Wind Speed (m/s)	Stability Class	Ae/Ap
Outdoor Response Toxic Load Equivalent H2S Concentration (100 ppm for 150 minutes with n= 3.50)	1305	2	Class F	0.02	--	--	--	--
Outdoor Planning Toxic Load Equivalent H2S Concentration (100 ppm for 60 minutes with n= 3.50)	1547	2	Class F	0.02	1560	2	Class F	0.05
Indoor Planning Toxic Load Equivalent H2S Concentration (100 ppm for 60 minutes with n= 3.50)	547	2	Class F	0.02	--	--	--	--

The classification of Near Field and Far Field densities, displayed in the Source Conditions table are determined by the density of the release relative to the air density.

- **Near field** characteristics are defined by the exit conditions of the release. The plume trajectory is dominated by the initial conditions.
- **Far field** is defined when an infinite amount of air is added to the release. At this point, the plume has reached the final rise.

There is a transition from near-field to far-field for each release, which depends on the release properties.

Classification	Gas Density *is greater* than Air Density	Gas Density *is less than* Air Density
Near Field (density at exit)	Initially dense	Initially buoyant
Far Field (equivalent density)	Dense	Buoyant

Maximum of Screening Hazard Cases

The data in this table is only updated when the **Calculate EPZ** command has been run. The **Calculate EPZ** command searches through all the meteorological cases and selects the largest predicted hazard distance. As a result, each row of the Maximum of Screening Hazard Cases table may have different values in the Wind Speed or Stability Class columns. If there is a Secondary Hazard detected, these values will be displayed in the Secondary Hazard columns.

Maximum of Screening Hazard Cases

H_2S Planning and Response Zones	Primary Hazard				Secondary Hazard			
Endpoint	Maximum Distance (m)	Wind Speed (m/s)	Stability Class	Ae/Ap	Maximum Distance (m)	Wind Speed (m/s)	Stability Class	Ae/Ap
Outdoor Response Toxic Load Equivalent H2S Concentration (100 ppm for 150 minutes with n= 3.50)	3996	2	Class F	--	--	--	--	--
Outdoor Planning Toxic Load Equivalent H2S Concentration (100 ppm for 60 minutes with n= 3.50)	4759	2	Class F	--	--	--	--	--
Indoor Planning Toxic Load Equivalent H2S Concentration (100 ppm for 60 minutes with n= 3.50)	1626	2	Class F	--	--	--	--	--

GRAPH-MET

Once the **Calculate EPZ** command has been run, the Maximum of the Screening Hazard Cases section of the **HAZARDS** page will be updated. The **GRAPH-MET** page contains a graphic representation of the **METMATRIX** page. The user may select the desired data to display using the drop down list. The table and the graph are then populated with corresponding data from the **METMATRIX** page. An example of the table and graph are shown below.

Many of the matrix cells are greyed (disabled). Within the Pasquill-Gifford (PG) meteorological classification, these combinations of wind speed and atmospheric stability have been demonstrated to not occur. Additionally, within Alberta, Class A stability with winds above 1 m/s does not occur; and therefore have been removed from the ERP screening matrix for selection of the maximum hazard distances.

Also, many studies have shown that for ground-based releases, the regulatory dispersion parameters do not account for plume meandering during low wind speed stable dispersion conditions resulting in unreasonably high predictions. Therefore the predictions for Class E at 1 m/s and Class F below 1.5 m/s, have been removed from the ERP screening matrix for selection of the maximum hazard distances.

The graph shows the sensitivity of the hazard distances to the meteorological conditions as a family of curves grouped by atmospheric stability class. Although this example shows relatively well behaved (i.e., explained curves) the family of curves can often show complex relationships; in which case, careful consideration of plume buoyancy, plume rise and dispersion must be included in the interpretation.

The screening matrix calculation must be performed and included as part of your submission to the ERCB.

Wind speeds above 1 m/s for Class A do not occur at meteorological stations within Alberta, thus these meteorological conditions are removed from ERP zone calculation.

The effect of meandering is underestimated in the turbulence parameterization for 1 m/s Class E and F and 1.5 m/s Class F, thus these meteorological conditions are removed from ERP zone calculation.

Calculations for Scenario: EXAMPLE|1-2-3-4 W5M|

Hazard Distances for Meteorological Matrix

Outdoor Toxic Load Equivalent H2S Concentration

(100 ppm for 60 minutes with n= 3.50)

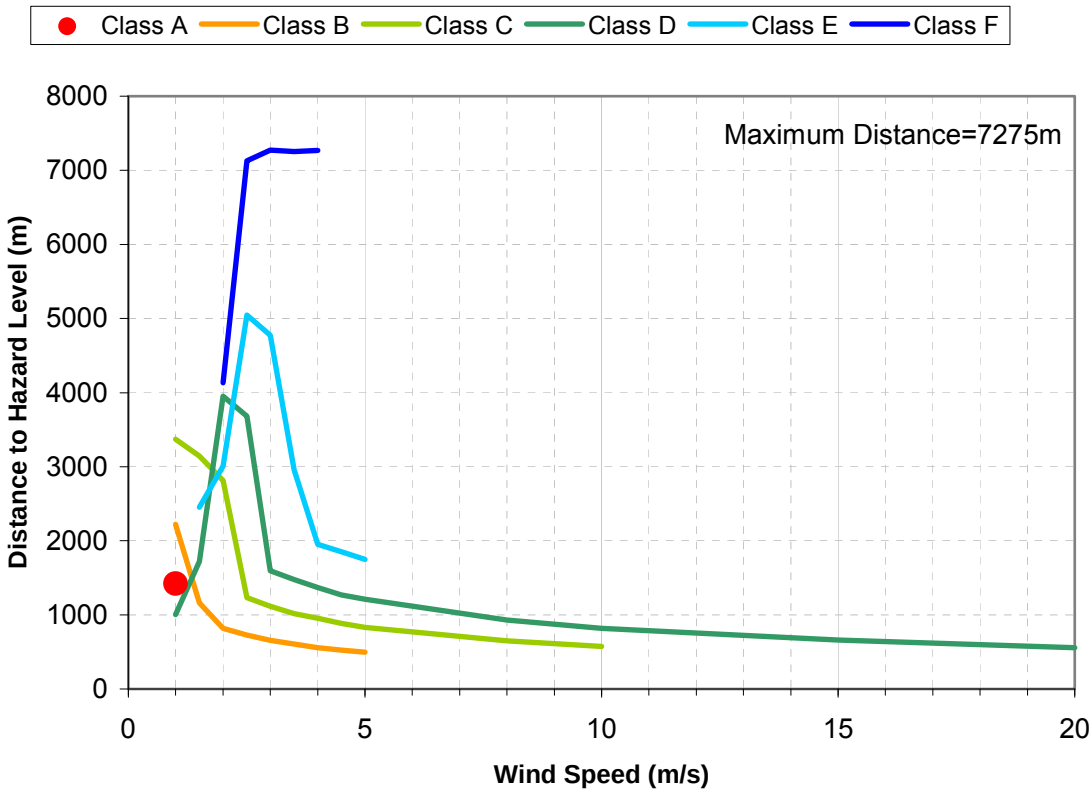
EPZ1: Outdoor Planning (m)

Wind Speed (m/s)	Class A	Class B	Class C	Class D	Class E	Class F
1	1422	2225	3370	1005	~~808~~	~~54~~
1.5	~~619~~	1161	3146	1720	2454	~~2155~~
2	~~527~~	818	2812	3951	3008	4132
2.5	~~464~~	725	1231	3683	5048	7129
3	~~423~~	655	1115	1593	4776	**7275**
3.5		605	1016	1478	2960	7253
4		554	952	1368	1952	7268
4.5		526	887	1269	1850	
5		499	832	1208	1747	
8			649	933		
10			572	819		
15				657		
20				557		

windspeed that is unlikely for the given stability class

meandering of ground based release underestimated

EPZ1: Outdoor Planning (m)



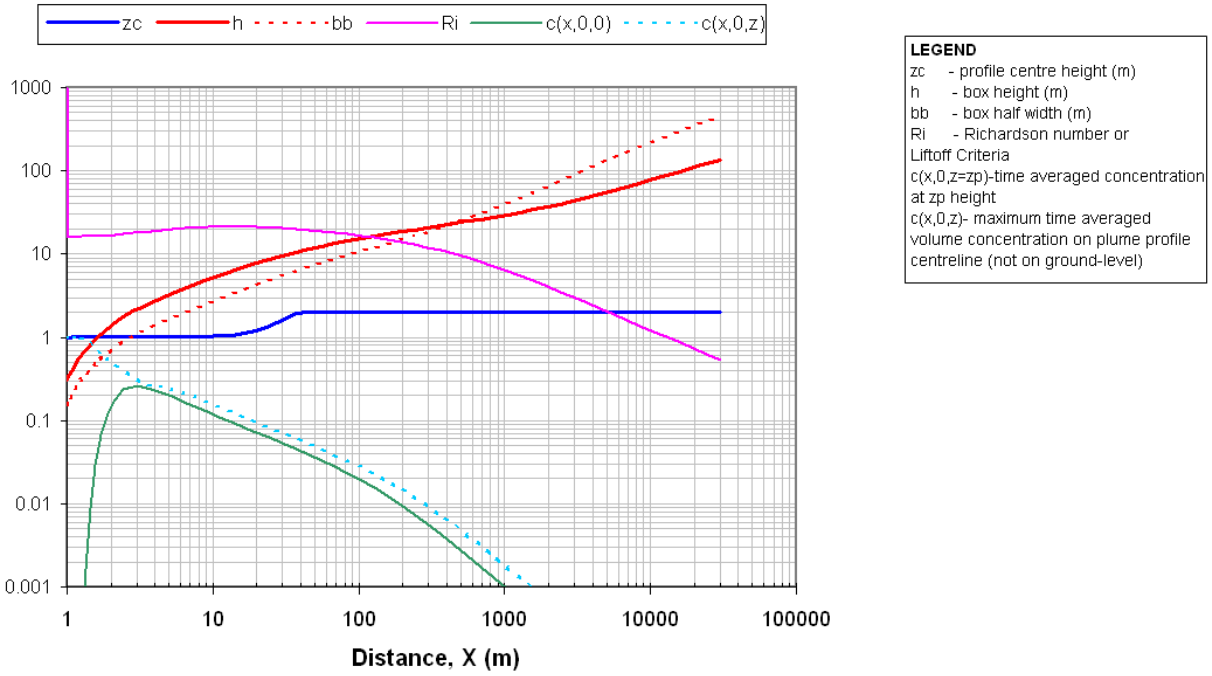
GRAPH-ERCBSLAB (x)

The **GRAPH-ERCBSLAB (x)** page presents a graphical display of some of the technical values calculated by *ERCBSLAB*. The graph shows the change in various parameters as the release moves away from the source (instantaneously spatially averaged cloud parameters). The values for this graph are taken from the **ERCBSLAB Output** page. An example is shown below.

ERCBH2S Ver 1.20

Calculations for Scenario: LABEL 1\|LABEL 2\|LABEL 3 GAS WELL

86400 m³ of H2S released at 2 m³/s for 720 minutes Class F @ 2 m/s
Buoyancy Flux based on WS Method is 4.9 m4/s3
Release is Buoyant



The graph displays the information summarized in the following table.

Symbol	Parameter	Units
zc	Profile centre height: the height above ground of the centre of the vertical concentration profile.	m
h	Box height: vertical dimension of the simplified concentration profile.	m
bb	Box half width: the half-width of the across-wind dimension of	m

Symbol	Parameter	Units
	the simplified concentration profile.	
Ri	Absolute value of Richardson number: ratio of strength of buoyancy forces compared to mechanical mixing forces. The Richardson number can be used as one indicator of the likelihood that a plume will rise or disperse parallel to the ground surface.	Unit-less
C(x,0,zp=0)	Time averaged volume concentration on plume profile centre line and ground level representing the maximum concentration at each x location downwind and ground level.	m^3 source gas / m^3 mix
C(x,0,z)	Time averaged volume concentration on plume profile centre line and profile Zc height above ground representing the maximum concentration at each x location downwind.	m^3 source gas / m^3 mix

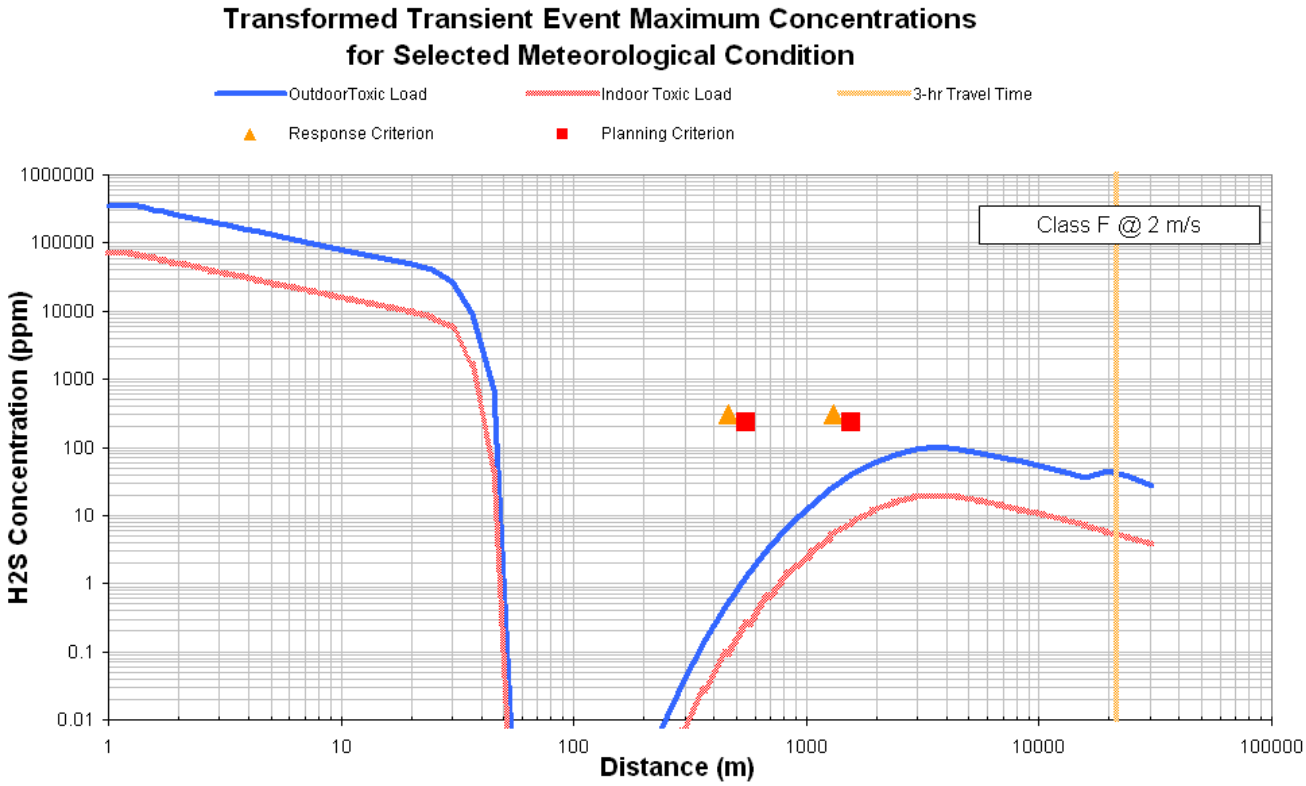
GRAPH-TRANSIENT(x)

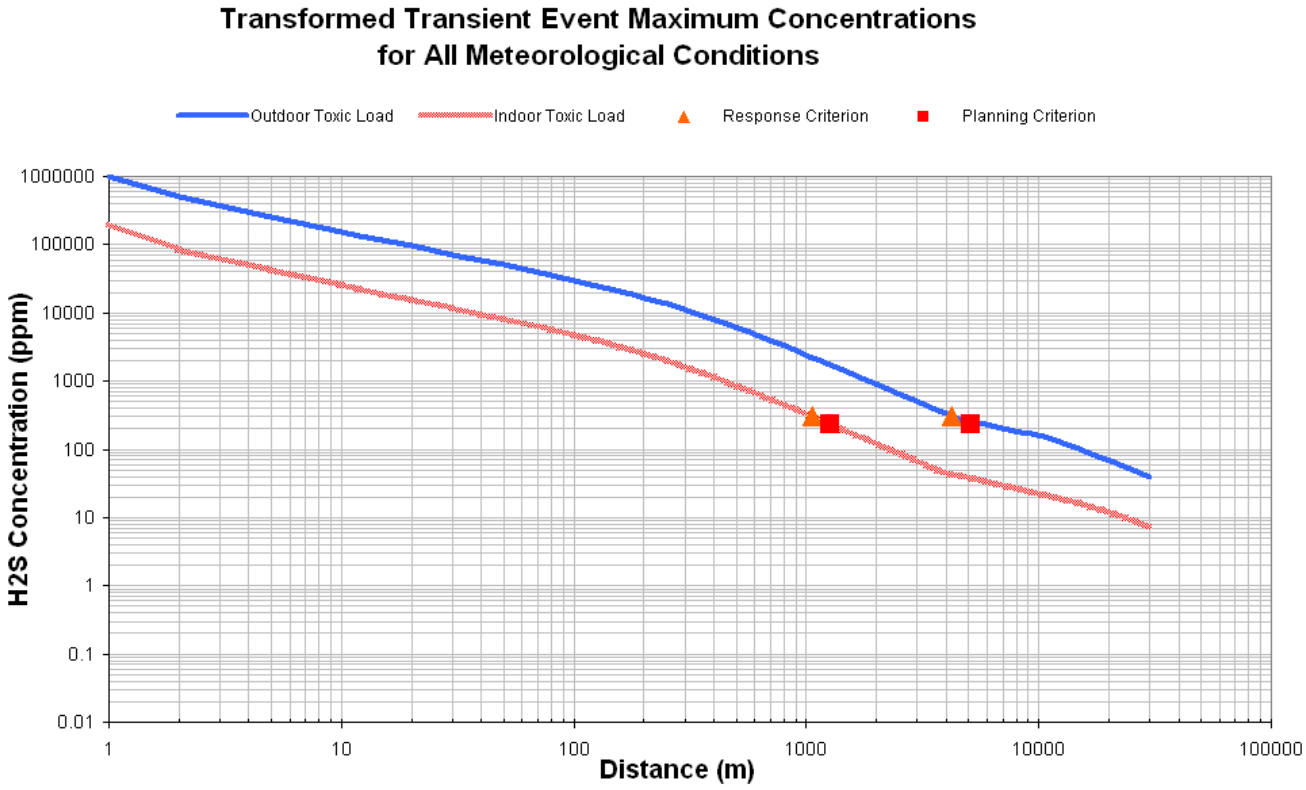
The **GRAPH-TRANSIENT(x)** page shows a graph for variation in the toxic load equivalent concentrations and time averaged concentrations (both indoor and outdoor) as a function of downwind distance from the release source for the selected meteorology (top) and for meteorological conditions (bottom). The distance at which these values exceed the endpoints for planning and alert levels are indicated by a **circle** or a **square**, respectively. An example of the transient maximum concentrations graph for the selected and all meteorological conditions is shown below.

The yellow line indicates where the release will be after 180 minutes traveling at the specified wind speed (in this case, 2 m/s).

Two peaks may occur in the graphs for some of the predictions. The primary peak (near field or nearest the source) may occur because: the plume is initially dense; or the release is near the ground and horizontal. The secondary (furthest downwind) peak may occur because the plume reached its final rise height (buoyant plumes) and dispersion conditions result such that the ground level concentrations are increasing from the lofted plume.

Secondary peaks flagged by *ERCBH2S* program must be carefully considered by the planner.


Transformed Transient Event Maximum Concentrations
for Selected Meteorological Condition
OutdoorToxic Load
Indoor Toxic Load
3-hr Travel Time
Response Criterion
Planning Criterion
Class F @ 2 m/s
H2S Concentration (ppm)
1000000
100000
10000
1000
100
10
1
0.1
0.01
1
10
100
1000
10000
100000
Distance (m)


Transformed Transient Event Maximum Concentrations
for All Meteorological Conditions
Outdoor Toxic Load
Indoor Toxic Load
Response Criterion
Planning Criterion
H2S Concentration (ppm)
1000000
100000
10000
1000
100
10
1
0.1
0.01
1
10
100
1000
10000
100000
Distance (m)

GRAPH-STEADY(x)

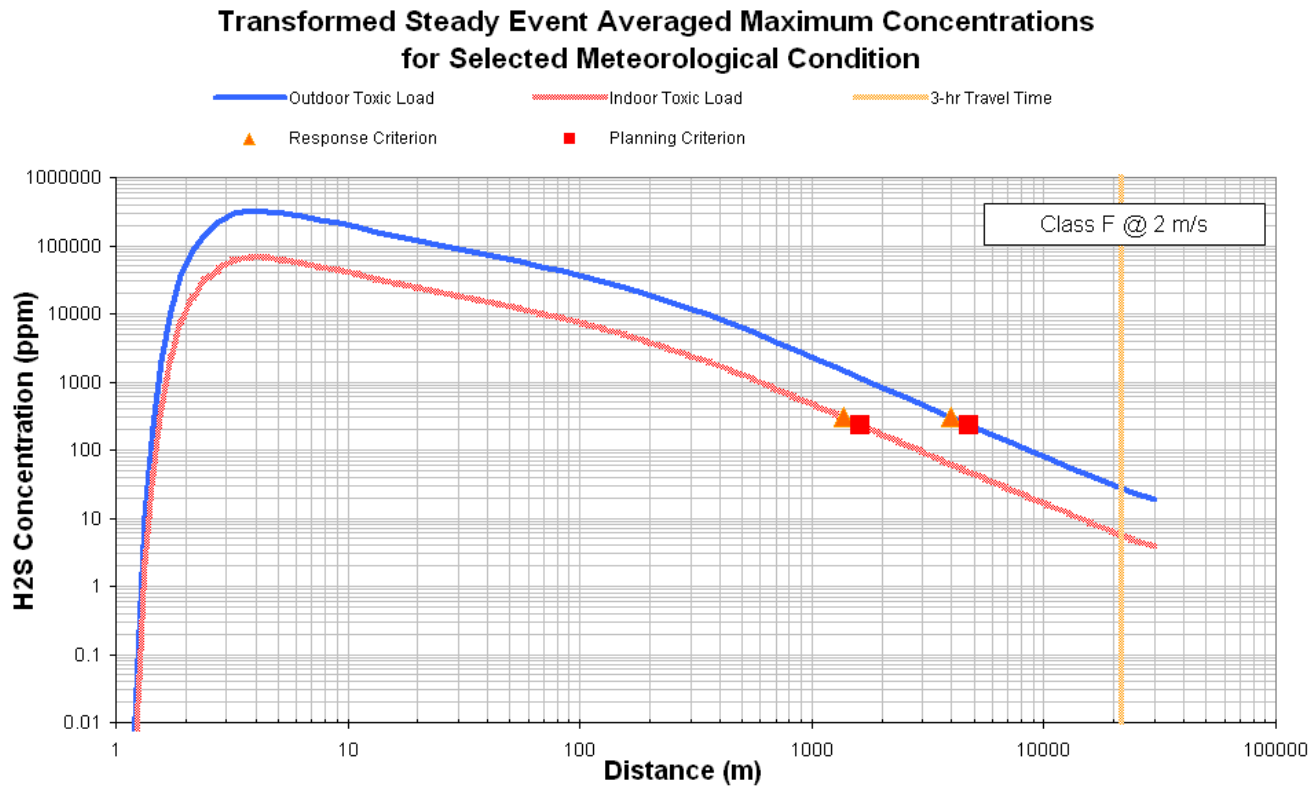
The **GRAPH-STEADY(x)** shows the variation in the toxic load equivalent concentrations and time averaged concentrations (both indoor and outdoor) as a function of downwind from the release source for the selected meteorology (top) and for meteorological conditions (bottom). The distance at which they exceed the endpoints for planning and response are indicated by a **circle** or a **square**, respectively. An example of a GRAPH-STEADY(x) result for selected and all meteorological conditions is shown below.

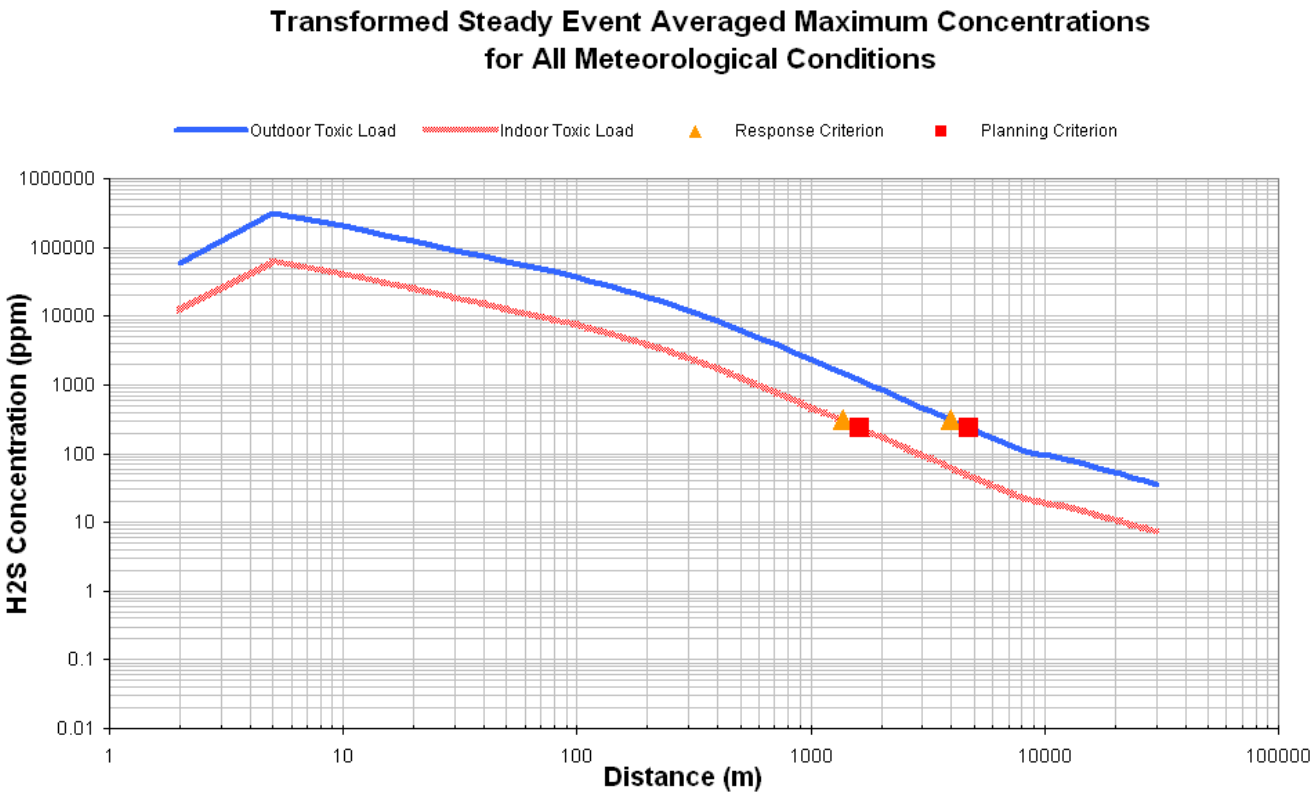
The yellow line indicates where the release will be after 180 minutes traveling at the specified wind speed (in this case, 2 m/s).

An example of the hazard distances for all meteorological conditions is shown. The figure was generated from the same conditions as the selected meteorology. The meteorological conditions that lead to the maximum concentration at a distance are not related to the meteorological conditions that lead to the maximum concentration at an adjacent location. Therefore, the predictions are not necessarily smoothly continuous.

Two peaks may occur in the graphs for some of the predictions. The primary peak (near field or nearest the source) may occur because: the plume is initially dense; or the release is near the ground and horizontal. The secondary (furthest downwind) peak may occur because the plume reached its final rise height (buoyant plumes) and dispersion conditions result such that the ground level concentrations are increasing from the lofted plume.

Secondary peaks flagged by *ERCBH2S* program must be carefully considered by the planner.


Transformed Steady Event Averaged Maximum Concentrations
for Selected Meteorological Condition
Outdoor Toxic Load
Indoor Toxic Load
3-hr Travel Time
Response Criterion
Planning Criterion
Class F @ 2 m/s
H2S Concentration (ppm)
1000000
100000
10000
1000
100
10
1
0.1
0.01
1
10
100
1000
10000
100000
Distance (m)


Transformed Steady Event Averaged Maximum Concentrations
for All Meteorological Conditions
Outdoor Toxic Load
Indoor Toxic Load
Response Criterion
Planning Criterion
H2S Concentration (ppm)
1000000
100000
10000
1000
100
10
1
0.1
0.01
1
10
100
1000
10000
100000
Distance (m)

8. Batch Page

Introduction

ERCBH2S has a batch processing feature to accommodate calculation of the ERP zones in sequence for several facilities without user intervention. It functions like a database wherein each row of data is an input/output record (row in spreadsheet) and each column is an input/output field (variable on inputs page).

The batch processing database (input/output list) is found on the **BATCH** page. Variables on the **BATCH** page are arranged (horizontally) – in a similar order to those found on the **INPUT** page (arranged vertically – column C).

A new input group (Batch Control) appears at the front of the input fields to control **BATCH** operations. Two other new groups appear at the end of the input fields - one for calculating ERP zones for gas and liquid gathering systems (see 'Performing a Gas Pipeline Network Analysis – Tutorial' on page 141), and the other to record *ERCBH2S* calculation outputs. **BATCH** processing groups are listed below.

GROUP	DESCRIPTION
Batch Control	Integer variables to control the operation of the batch process
Administrative	Information about the applicant and the location under study
Calculation Controls	Selection of the **Flavour** for the template, analysis type and scenario name.
Pipeline Details	If the Flavour is **GAS PIPELINE**, physical characteristics of the gas pipeline are specified.
Well Details	If the Flavour is **GAS WELL**, physical characteristics of the gas well are specified.
Liquid Details	If the Flavour is **LIQUID PIPELINE/WELL**, physical characteristics of the oil/produced water pipeline/well are specified.
Sour Gas Composition	The chemical composition of the gas released is specified.
Advanced User Selected Case	This section allows advanced users to control calculations for selected meteorological conditions

	and pipeline release hole fraction rather than the complete screening matrix.
Gas Gathering System Pipeline Networking	Input variables and calculations for pipeline networks (see Chapter 9 - Pipeline Gathering Systems)
Liquid Gathering System Pipeline Networking	Input variables and calculations for pipeline networks (see Chapter 9 - Pipeline Gathering Systems)
Output	Calculation predictions of the ERP zones from the HAZARD DISTANCES page are recorded.

Working with the BATCH Page – Summary Overview

Data Entry

Data Entry (and data removal) is discussed in more detail further on.

Data may be entered directly into the **BATCH** page, or data may be entered on the **INPUT** page and saved to the **BATCH** page using the **SAVE TO BATCH** command on the *ERCBH2S* menu or button-bar,  . Similarly, the user can select a row on the **BATCH** page and copy the input fields to the **INPUT** page using the **READ** command,  . The user can also scroll through **BATCH** records **FROM** the **INPUTS** page by using the **FIRST**  , **PREVIOUS**  , **NEXT**  or **LAST**  commands.

The user may enter numeric values, text or functions for any of the input fields. This allows the *ERCBH2S* program to be linked to user specific databases or calculation spreadsheets. Deleting or moving columns (fields) and re-formatting is not permitted.

The **BATCH** page may contain any mixture of Sour Operations Types (Gas Pipeline, Gas Well or Liquid Pipeline/Well), or pipeline gathering system records.

Calculating Emergency Response and Planning Zones

Similar to pressing the **CALCULATE EPZ** command,  , the batch equivalent is the **Batch Calculate EPZ**,  . **Batch Calculate EPZ** steps through

the entire batch page database of input records, loads each record to the **INPUTS** page, executes the **CALCULATE EPZ** command, and then copies the calculation results (along with any error codes) back to the 'Output' section of the **BATCH** record/row.

Because the calculations can be time consuming, the user is prompted "Are you sure you want to run this ..." before starting the assessment. The user may turn off this prompt by toggling the **SILENT START** option from the menu-bar **ERCBH2S→Setup→Silent Start**. A progress meter displays the progress of the **BATCH** operation calculations. Pressing the **CANCEL** button on the dialog or the **ESC** keyboard button will terminate the batch analysis.

Batch Page / Inputs Page Relationship

General

Before using the batch processing feature, it is **vital** that the user understand the relationship between the **INPUTS** page and the **BATCH** page.

The **INPUTS** page is never erased. It always displays whatever data was LAST entered to it.

- If the last *ERCBH2S* action was **Calculate EPZ**, the **INPUTS** page displays the inputs that coordinate with calculation results displayed on the **ERP SUMMARY** page.
- If the last *ERCBH2*S action was **BATCH Calculate EPZ**, the **INPUTS** page displays the last **BATCH** record 'run' by *ERCBH2S*.
- If the last action involved user entries directly to the **INPUTS** page, then that page is displayed.
- If the last action was transferring a **BATCH** record to the **INPUTS** page, then that **BATCH** record is displayed.

Input Data Connection Between the Pages

For user inputs, data entry is not linked between the **INPUTS** page and the **BATCH** page. While data can be moved from one page to the other, changes to one page do not affect the other page, even if the scenario names match.

The following commands move data between the **BATCH** and **INPUTS** pages:


The **READ** command


Fetch the **FIRST** record to the **INPUTS** page


Fetch the **PREVIOUS** record to the **INPUTS** page.


Fetch the **NEXT** record to the **INPUTS** page


Fetch the **LAST** record to the **INPUTS** page


Save **INPUTS** to the **BATCH** page

Input data on the **BATCH** page is only changed by either 'over-writing' an existing scenario on the **BATCH** page with a new **INPUTS** page (same scenario name), or by directly making the data change on the **BATCH** page. For any given scenario, there is no user-input 'live/active link' between the **BATCH** and **INPUTS** page.

Calculation Results (Outputs) Data Connection Between the Pages

From INPUTS to BATCH

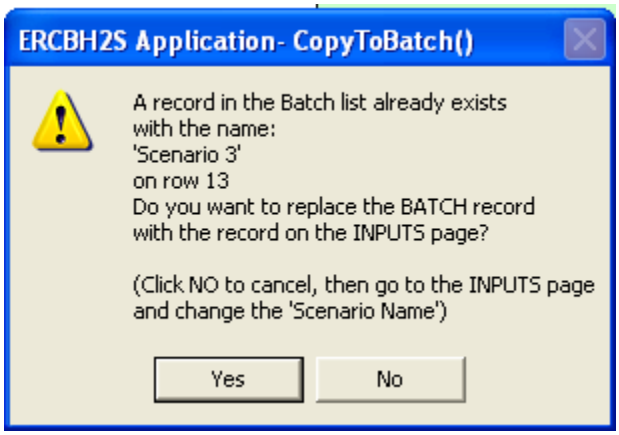
When using the 'Save **INPUTS** to the **BATCH** page' command  , calculation results (outputs) ALWAYS go too - even if the calculation results do not match the inputs. Therefore use caution when activating this command. If saving a completed 'run' scenario (has no **red flag** banner across the top of the **INPUTS** page), this is an appropriate command to use.

When saving an input scenario that hasn't been 'run' yet (has a **red flag** banner across the top of the **INPUTS** page), first activate the 'erase all output fields'  button to re-set calculation results to '0' before moving the **INPUTS** to the **BATCH** page. To store valid results, you must activate the **CALCULATE EPZ** command  , wait until calculations have been completed, and then move the scenario to the **BATCH** page.

The 'Erase all output fields' button does not erase calculation results stored on the **BATCH** page – it erases them from the other *ERCBH2S* pages.

When the 'erase all output fields' command is activated, a **red flag** banner appears at the top of the **INPUTS** page, cautioning the user that calculation results do not match user inputs. This is because calculation results now show '0' distances.

When using the 'Save **INPUTS** to the **BATCH** page' button ,a prompt will appear if the scenario name on the **INPUTS** page matches a scenario name already recorded on the **BATCH** page.



STOP AND THINK – do you want to completely overwrite this particular record on the **BATCH** page with this new data 'set' (Input AND Calculation Results)? Remember that if there is output data stored on the **BATCH** page for this particular scenario, it will be over-written with whatever calculation results (outputs) are currently displayed on the other Excel pages.

From BATCH to INPUTS

The following commands will move a record (row) from the **BATCH** page to the **INPUTS** page:

The **READ** command (done from the **BATCH** page).

Fetch the **FIRST** record to the **INPUTS** page (done from the **INPUTS** page).

Fetch the **PREVIOUS** record to the **INPUTS** page (done from the **INPUTS** page).

Fetch the **NEXT** record to the **INPUTS** page (done from the **INPUTS** page).

Fetch the **LAST** record to the **INPUTS** page (done from the **INPUTS** page).

When a record or row is brought from the **BATCH** page to the **INPUTS** page, only the inputs are copied – not the calculation results (outputs). The only way to change calculation results shown at the bottom of the **ERP SUMMARY** page is to activate a program 'run' command such as **CALCULATE EPZ** or **BATCH CALCULATE EPZ**.

When copying an **INPUTS** page to a **BATCH** page, ALL calculation results (**OUTPUTS**) are appended/copied to the **BATCH** row/record for the particular scenario identified.

However, when copying/reading/fetching a **BATCH** record/row to the **INPUTS** page, only the **BATCH** input records are copied over. Any associated calculation results for the **BATCH** row/record are not brought along.

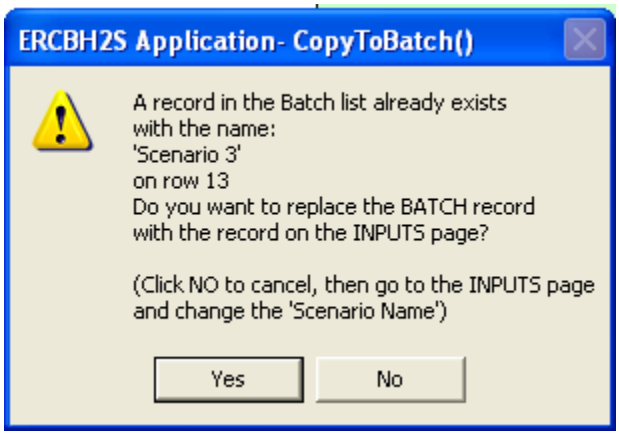
Entering Data to the Batch Page

The 'safest' way to enter data to the **BATCH** page is to use the **INPUT** page as the user interface. Enter data to the input fields the same way as for a standard analysis. Particular attention should be directed towards the **SCENARIO NAME**, since the batch processing uses this field as the unique row identifier. That is, each record in the batch processing database must have a different (unique) **SCENARIO NAME**. By using the **INPUTS** page to enter data for each scenario – standard error checking, orange warnings, orange resets and general comments appear to help the user correct invalid entries. These features do not appear on the **BATCH** page.

Red flag warning banners, orange warnings and orange resets related to user inputs do not appear on the **BATCH** page.

Once the **INPUTS** page entries have been completed, the data may be saved to the **BATCH** page using the **SAVE TO BATCH** command  . The **SAVE TO BATCH** button is only visible when the **INPUT** page is active, preventing accidental saves.

If the **INPUTS** page data is saved to the **BATCH** page and the **SCENARIO NAME** already exists, the user is prompted to accept the save operation or to cancel.



- If the user cancels the operation, then the **SCENARIO NAME** should be changed to a unique name and the operation attempted again.

- If the user accepts the save operation, then the record on the **BATCH** page with the same **SCENARIO NAME** is COMPLELETY overwritten with new data from the **INPUTS** page – along with all calculation results (outputs) that appear on the other Excel pages. Therefore any existing calculation results on the **BATCH** page (with the same **SCENARIO NAME**) are erased and replaced.

Copying, Deleting, and Editing Rows of Data on the BATCH Page

Once data has been saved to the **BATCH** page, the user may make changes to the data by editing the variables directly on the **BATCH** page. This is particularly useful for sensitivity or uncertainty testing of input variables.

To perform a sensitivity test, records (rows) on the **BATCH** page can be duplicated several times (use the Excel copy and paste functions) and the test variable can be changed for each copy to perform the test. Remember to change the **SCENARIO NAME** for each duplicate copy. If the scenario is for a pipeline AND the 'Pipeline Gathering System' portion of the **BATCH** page has been used (see Pipeline Gathering Systems in Chapter 9), do not copy the row/scenario any further than column CN.

Be extra careful when copying or duplicating rows. For instance, the Excel auto-fill button and mouse drag can create errors in the input file by auto-incrementing numeric fields

Use caution when copying rows on the **BATCH** page – you may end up copying calculation results you don't want, and/or gathering system details (segments and nodes).

If you chose to copy the **OUTPUT** results from the original scenario and apply them to the new scenarios (unless the output results are zeros), the safest option is to simply delete the results for the new rows/scenarios (**OUTPUTS** group on the **BATCH** page - beginning at column **DO**). Otherwise, future input changes to the new rows will appear to coordinate with 'old' calculation results. Eventually the new inputs will be used for new calculations, but until then - it is better not to list 'false' results.

Deleting Rows of Data

To delete a row of data on the **BATCH** page, left 'click' on the row number you wish to remove, then 'right click' and select 'clear contents'. To move other rows of data 'up' to fill in empty spaces on the **BATCH** page (not required), use the Excel cut and paste functions.

Empty data rows in between rows of data on the **BATCH** page are acceptable, but the user must remember to label these rows with a "`0`" in column A. Otherwise, when the **BATCH CALCULATE EPZ** process identifies rows on the **BATCH** page that require processing, it will stop when it comes to a blank in this column, and assume there is no further data on the **BATCH** page. Blank data rows (other than at the end of a spreadsheet) must not be left in when creating an *ERCBH2S* export file. Other rows of data must be moved up to fill in blank rows (use the Excel cut and paste features).

Checking for Red Flag and Other Warnings

Red flags, orange warnings, orange resets and other comments are visible on the **INPUTS** page and are not shown on the **BATCH** page. Further, orange flags for entries that have been reset by *ERCBH2S* (column E on the **INPUTS** page) cannot be seen on the **BATCH** page. To view these important warnings, a **BATCH** row/scenario must be brought to the **INPUTS** page.

red flag warning banners, orange warnings and orange resets related to user inputs do not appear on the **BATCH** page.

When *ERCBH2S* assigns a different value to a user entry (an 'orange reset'), the 'reset' value does not appear on the **BATCH** page. The only way to see an orange reset for a **BATCH** page scenario/record is to view the record on the **INPUTS** page.

Unless a user is well experienced with *ERCBH2S* inputs, it is recommended to use these user input error checking features on the **INPUTS** page by viewing each **BATCH** record before activating  (**Batch Calculate EPZ**). This helps avoid most calculation error messages.

Red flags, orange warnings and orange resets are described in more detail in Chapter 5 under Red Flags and other Warnings.

To view a **BATCH** scenario on the **INPUTS** page

- From the **BATCH** page, input fields on the **BATCH** page can be copied to the **INPUT** page using the **READ** command,  . The **READ** command is only visible while the **BATCH** page is the active page, to prevent copying data unknown records from the **BATCH** page. The active row on the **BATCH** page is copied with the **READ** command. The active row is the row with the cursor, the highlighted row or the row selected with the mouse.

- From the **INPUTS** page, the user can scroll through **BATCH** records using the **FIRST**  , **PREVIOUS**  , **NEXT**  or **LAST**  commands. These commands use the **SCENARIO NAME** for each record and look for the record before or the record after the scenario name listed on the **INPUTS** page.

Batch operations work on all fields on the **BATCH** page. This means that if some of the records are not visible because of the AutoFilter settings, the records will still be evaluated in the batch operation depending on the Batch Control setting for each record.

Batch Control Group

Run or Not Run

The **RUN** or **NOT RUN** field is used to include or exclude the record (row) from the Batch Operation. The setting is either "0" (do not include this record in the Batch operation) or "1" (include this record in the Batch operation).

If there are any blank rows in between rows of data on the **BATCH** page, they must be labelled with a "0" in this column. Otherwise, when the **BATCH CALCULATE EPZ** process identifies rows on the **BATCH** page that require processing, it will stop when it comes to a blank in this column, and assume there is no further data on the **BATCH** page.

Print/Save

The Print/Save field is used to perform operations between Batch Calculation Operations. It tells *ERCBH2S* what to do while a **BATCH Calculate EPZ** (or other **BATCH** run function) is operating. The command entered will perform at the end of each row/scenario execution.

The field entry is cumulative and is described in the table below.

1	Print ERP Summary Pages to the default printer after each Batch Operation
2	Save the entire spreadsheet after the Batch Operation
3 (=1+2)	By summing the values, a combination of the commands is performed, e.g., a field entry of 3 performs both print and a save after the record has been evaluated.

The **file save operation** is useful for large assessments with many rows in the database. Making use of frequent file saves ensures that the results of the

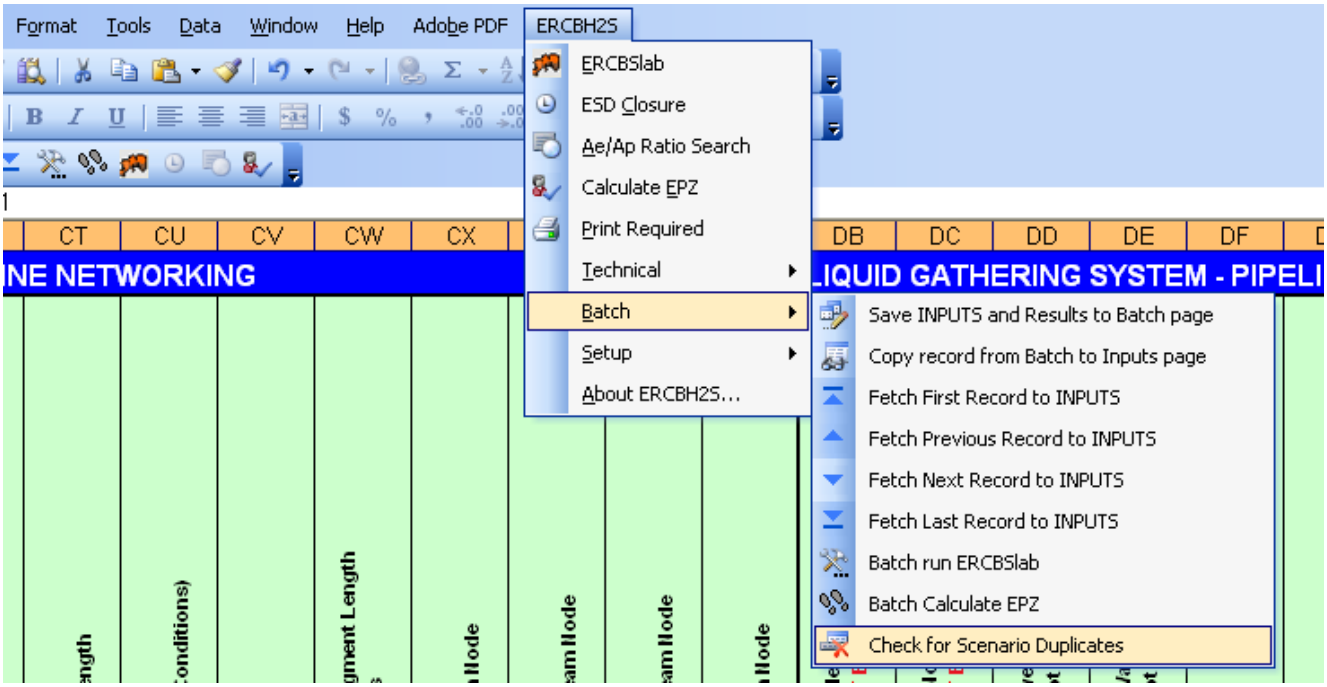
computations are backed up in the unfortunate event of a computer malfunction during subsequent computations. It is not necessary to save the results after the analysis for each record (it slows down the process), but perhaps after every tenth analysis. If one of the records is marked to be saved for a batch operation, then during the initialization phase of the batch command, a save operation is immediately performed. This ensures the save operations perform effectively before the user leaves during the batch process.

When performing batch operations, save your work before you start the time consuming runs, and include the save command (2, in Column B) occasionally.

Batch Operations

Check for Scenario Duplicates

Duplicate scenario names can lead to confusion when interpreting the results. Before performing any batch program 'run' command, it is recommended that you first use the 'Check for Scenario Duplicates' menu item as shown below.



If scenarios were saved to the **BATCH** page from the **INPUTS** page, a scenario duplication check was already preformed. If scenarios were created directly on the **BATCH** page (especially when using Excel's copy and paste functions), then no scenario duplication check will have been performed by the program.

Batch Run ERCBSLAB

The **Batch Run ERCBSLAB** command,  , runs the ERCBSLAB calculation for each record in the batch processing list. The ERCBSLAB program is run for the single meteorological wind speed and atmospheric stability class entered in the User Selected Case input fields or the ERCB default values. Calculation results using this feature are not acceptable for ERCB submission.

Because the single meteorological case calculation is considerably faster than the screening matrix calculations, this command is useful for sensitivity testing of input variables or for testing inputs for large databases. For testing purposes, once the **Batch Run ERCBSLAB** command has been completed, the error messages can be reviewed to check for issues with inputs to the model.

Batch Calculate EPZ

The **Batch Calculate EPZ** command,  , executes the complete set of 54-meteorological cases in the screening matrix calculation for each record in the database. For pipelines, the screening matrix calculation also includes 11-*Ae/Ap* exit hole assessments and ESD timing calculations. The ignited release calculations are also performed.

The **Batch Calculate EPZ** command calculations are extensive and may take some time to complete, especially for large databases. It is recommended that assessments for large databases be assessed in smaller sets (such as several hundreds of records) and or in combination with the use of the **PRINT/SAVE** settings. It is not necessary to divide the assessment into different spreadsheets.

To assist the user in avoiding excuses, save your work!

Batch Output Group

Errors

		OUTPUT	ERP SUMMARY		
Backflow Into Downstream Node	Backflow Into Upstream Node	ERRORS RECEIVED 1=ERCBFlash 2=ERCBSlab 4=MetMatrix 16=AeAp Iteration 32=Cancelled 64=Nonregulatory other=Fatal	EPZ Emergency Planning Zone	IIZ Initial Isolation Zone	PAZ Protective Action Zone
kg	kg	copy format down	km	km	km
0	0	1			
		0	2.05	0.77	1.74
		0	2.01	0.65	1.71
		0	0.3	0.13	0.26

Error message dialogs are suppressed during batch operations, and instead, errors are recorded in the **ERROR** output column on the **BATCH** page (column DO). The error output column is illustrated below.

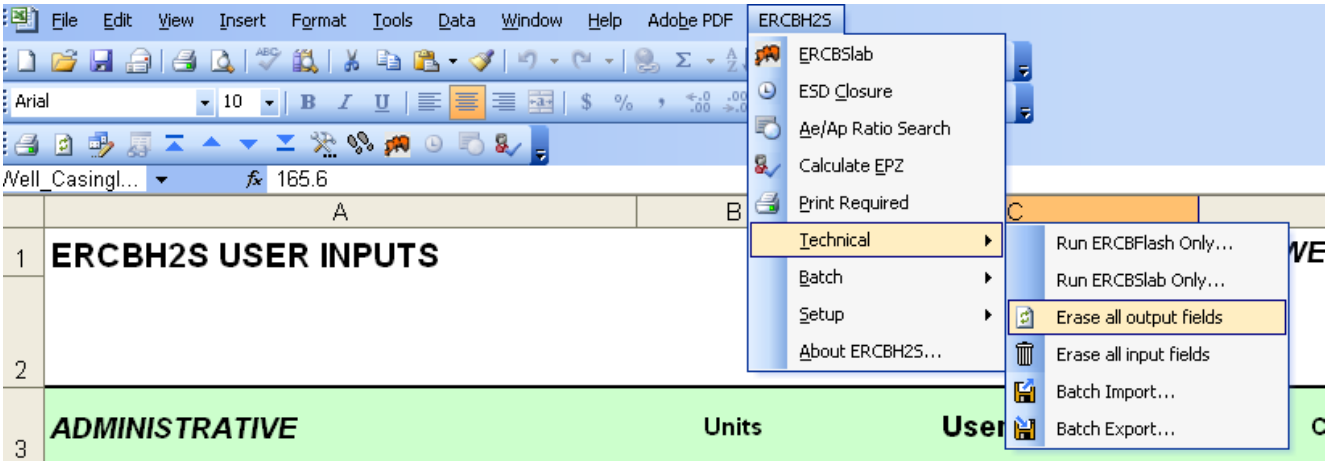
Errors codes below 1000 are listed as a cumulative index as described in the **ERROR CODES** page of *ERCBH2S* and summarized in the following table. Therefore, an error index of 7 means that *ERCBFLASH* (code=1), *ERCBSLAB* (code=2) and *MetMatrix* (code=4) were not executed successfully. Error codes starting at 5000 are for *ERCBSLAB*. Error codes starting at 9000 are for *ERCBFLASH*.

ERROR CODE	DESCRIPTION
1	ERCBFlash failed to complete successfully
2	ERCBSLAB failed to complete successfully
4	MetMatrix failed to complete successfully
16	AeAp Iteration failed to complete successfully
32	Calculation process was cancelled by user or system interruption
64	*ERCBH2S* was run in a nonregulatory mode
1000+	Other Fatal Error; see ERROR CODES PAGE in *ERCBH2S*

Output Data Fields

The output data fields are the same as the **HAZARD DISTANCES** page. Refer to **Chapter 6 – Calculation** Pages under 'Erasing Calculation Results'.

Calculation results (outputs) on the **ERP SUMMARY** page can be erased by selecting 'Erase all output fields' from the technical sub-menu as shown below or by selecting the 'Erase all output fields' button  from the button bar. This command also erases output from other ERCBH2S 'Summary/Graphics' pages, but does not erase outputs stored on the **BATCH** page.



Saving a Batch Page as an Excel File

Saving *ERCBH2S* scenarios as Excel files is described in Chapter 3 under Saving Scenarios as Excel Files.

It is strongly recommended that you save your work!

Creating a Batch Export File for ERCB Submission

The input and key ERP output data stored on the **BATCH** page can be exported to an *ERCBH2S* batch export file for convenient email transfer or backup.

From the menu-bar, **ERCBH2S→Technical→ Batch Export…** prompts the user using common windows file dialog wind for a folder and a file name. For ERCB submission, licensees/applicants are required to use the following file naming protocol:

BA code - ERP Plan Ref# - Date (DD/MMM/YY)

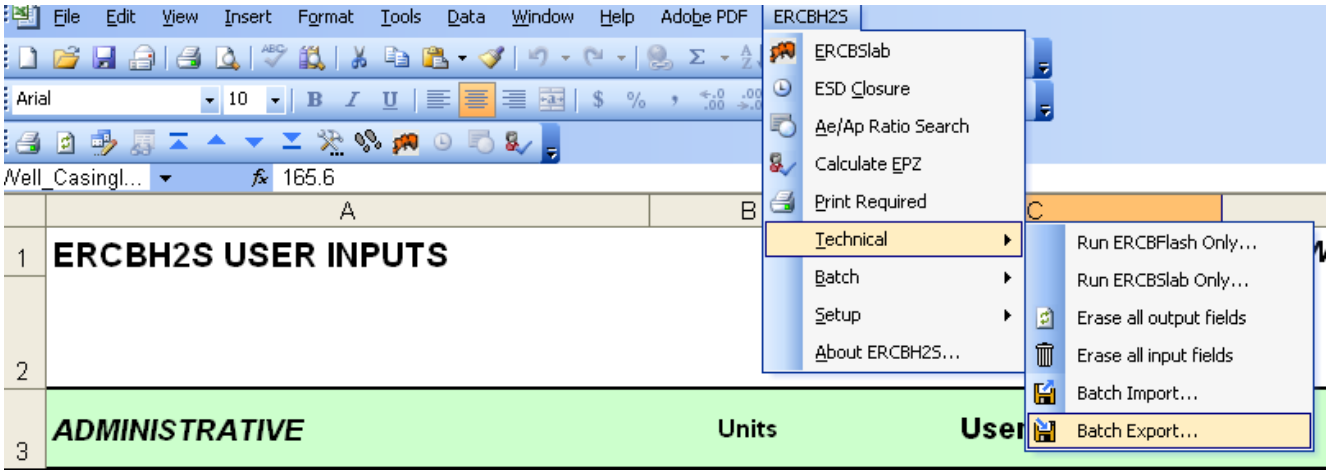
For example, if a company with the BA code of WXYZ submits a file on July 5th, 2008, the file would be named:

WXYZ-1234-05Jul08.csv

The **.csv** file extension - '**c**omma **s**eparated **v**ariable - is automatically attached to the file name. The variable names are those expected by *ERCBH2S* to match the **INPUTS** page - the order of the variables in the file is not important.

The export file can be viewed using **Excel** or **Notepad** or other text editor.

An *ERCBH2S* batch export file can be reloaded to a **BATCH** page using the batch-import function **ERCBH2S→Technical→Batch Import…** from the menu bar.



The .csv file does not contain user information added to the **NOTES** page.

BATCH page submissions to the ERCB must not have any error codes in column DO!

Batch Page Tutorial

Part of the Gas Well Tutorial in Chapter 10 (beginning at step 11) describes how to work with the **BATCH** page.

9. Pipeline Gathering Systems

Overview

The *ERCBH2S* Gas[1] Gathering System analysis feature calculates the Equivalent Segment Length for sour gas, acid gas and oil effluent pipelines with a GLR>1000. The equivalent length is used to determine both the ERP zones using gas pipeline calculations, and ERCB Sour Gas Level Designation.

The *ERCBH2S* Liquid[2] Gathering System analysis feature calculates the Equivalent Segment Length for oil effluent pipelines with a GLR ≤ 1000. The equivalent length is used only to determine an ERCB Sour Gas Level Designation, and is not used to determine the ERP zones using liquid pipeline calculations. Currently, the only liquid pipeline substance with potential to have an ERCB Sour Gas Level Designation is oil effluent.

ERCBH2S calculates emergency response and planning zones for individual gas pipeline segments, assuming there is an Emergency Shut Dow (ESD) valve at each end. Calculations also assume that the only source of gas (or other material) available for release is contained within the described segment plus whatever additional material can be provided from **each end** - upstream and downstream, before the ESD valves close[3].

Real pipeline gathering systems frequently do not fit this description because there are pipeline tie-ins in-between pipeline 'from' and 'to' locations – tie-ins that may not have a flow control device to prevent product flow into the modelled pipeline segment.

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[1] Liquid pipelines with a GLR > 1000 are modelled in the **Gas Pipeline** group. The User is directed there automatically on the *ERCBH2S* **INPUTS** page when the pipeline substance is selected.

[2] Liquid pipelines with a GLR ≤ 1000 are modelled in the **Liquid Pipeline** group. The User is directed there automatically on the *ERCBH2S* **INPUTS** page when the pipeline substance is selected.

3 Additional flow to the segment is determined by ERCBH2S (during **Calculate EPZ** calculations) based on *expected* MOP and H_2S, and the ESD closure time setting specified by the user on the **INPUTS** page. The ESD closure setting must represent the SLOWEST valve closure setting. If there is even one *no flow control node*, ERCB **SOURCE MITIGATION** default valve settings must not be *over-ridden* by user inputs unless the licensee has pre-planned actions to ignite, *draw-down* or otherwise stop the flow of H_2S to atmosphere. ERCBH2S **default SOURCE MITIGATION** settings provide no effective ESD valve closure.

To allow for this additional source of material, *ERCBH2S* inputs for gas or liquid pipelines require either:

1. Equivalent Segment Length (between ESDs),

   OR

2. Equivalent Cumulative Pipeline Volume (between ESDs)

These entries account for the total mass of H_2S (based on licensed levels) in a pipeline segment PLUS segments upstream and downstream, to points where flow control devices that can prevent additional flow to the modelled segment are encountered, or the pipeline start or end is encountered (e.g., well, plant, battery, etc.). When the user supplies one of these two entries, *ERCBH2S* calculates the other value. Therefore, only one of the entries is needed.

This approach (total mass of H_2S based on licensed levels) is consistent with the previous ERCB approach of cumulative H_2S release volumes for pipelines.

A gas pipeline gathering system segment has an equivalent cumulative pipeline length determined by the total mass of H_2S (based on licensed levels) in the segment and in segments upstream or downstream, to points where flow control devices that can prevent additional flow to the modelled segment are encountered, or the pipeline limit is encountered (e.g., well, plant, battery, etc.).

The release from a segment is modelled using the gas characteristics of the segment, not the average of adjoining segments.

The chemical and physical properties used in the *ERCBH2S* analysis for ERP zone determination are the specific values entered for the modelled segment. These are reasonable estimates for the screening level analysis given that the ERP zones are dependent on the high initial flow rates form the rupture.

Equivalent Segment Length (between ESDs)

Equivalent Segment Length is easily calculated IF the interconnecting pipelines (followed **ALL THE WAY** back to points where flow control devices that can prevent additional flow to the modelled segment are encountered, or the pipeline limit is encountered, e.g., well, plant, battery, etc.), have precisely the same qualities as the pipeline being modelled (**inside** diameter, licensed pressure, and

licensed H_2S %). In these cases, segment lengths can just be summed to arrive at the Equivalent Length entry for *ERCBH2S*.

When **any** pertinent, interconnecting pipeline has one or more different qualities (as already described), equivalent length calculations are much more complicated. For these cases, the user may choose to either supply the alternate entry (Equivalent Cumulative Pipeline Volume), or use the 'Gathering System Analysis Feature' provided on the *ERCBH2S* **BATCH** page (described later in this chapter) to calculate the equivalent segment length. The Gathering System Analysis feature is essentially a calculator used to arrive at an equivalent segment length, and it must be used BEFORE *ERCBH2S* dispersion modelling (Calculate EPZ) is performed.

If a gathering system is described on the Gathering System Analysis portion of the ERCBH2S **BATCH** page, and one or more portions of the system have Equivalent Segment Lengths 'manually' calculated, refer to the next section in this chapter for important details.

Illustrations 1 and 2 in this chapter (to follow) further describe why pipeline H_2S volumes must sometimes be cumulative.

Equivalent Cumulative Pipeline Volume (between ESDs)

Similar to Equivalent Segment Length between ESDs, the Equivalent Cumulative Pipeline Volume accounts for a volume of the modelled segment PLUS additional 'volumes' available to the segment from upstream and downstream, to points where flow control devices that can prevent additional flow to the modelled segment are encountered, or the pipeline limit is encountered (e.g., well, plant, battery, etc.).

Performing the calculations needed for this entry is sometimes preferable to using the 'Gathering System Analysis Feature' provided on the *ERCBH2S* **BATCH** page (described later in this chapter).

The formula for this calculation is provided in the *ERCBH2S* Technical Reference Document in section 5.4. Note that if the licensed maximum operating pressure, minimum operating temperature and licensed maximum H_2S concentration is the same for all segments, the calculation is the straightforward sum of segment lengths 'times' the pipe area.

Equivalent Cumulative Pipeline Volume may be entered as an input to *ERCBH2S* instead of Equivalent Segment Length.

Equivalent Cumulative Pipeline Volume calculations are performed manually by the user according to the formula described in the *ERCBH2S* Technical Reference document, section 5.4.

This method may be preferred for gathering systems with multiple, complex interconnections that are cumbersome to describe on the **BATCH** page for the *ERCBH2S* Gathering System Analysis feature.

This method must be used for any portions of a gathering system that have more than one *outlet* (e.g., a lateral used occasionally to divert pipeline flow).

Gathering System Analysis

To use the *ERCBH2S* Gathering System Analysis feature, a simple schematic of the gathering system should be prepared. The schematic assists the user in creating a labelling scheme based on *nodes* and *pipeline segments*. The labels are listed in a summary table that provides the user with entries required for the *ERCBH2S* Gathering System Analysis feature on the **BATCH** page. The labels, numbering scheme and summary tables are described later in this chapter under Gas Gathering System Analysis - Tutorial.

Preliminary discussions (based on two example illustrations that follow) reference the following terms. These terms are used throughout this chapter and in other sections of the *ERCBH2S* User Guide.

NODE

- The start of a modelled pipeline segment or sub-segment (from location)
- The end of a modelled pipeline segment or sub-segment (to location)
- An ESD valve
- A back-flow check valve (CV)

- A tie in with another pipeline
- A change in pipeline modelling conditions such as pressure, H2S concentration, outside diameter, wall thickness, or temperature.

PIPELINE SEGMENT

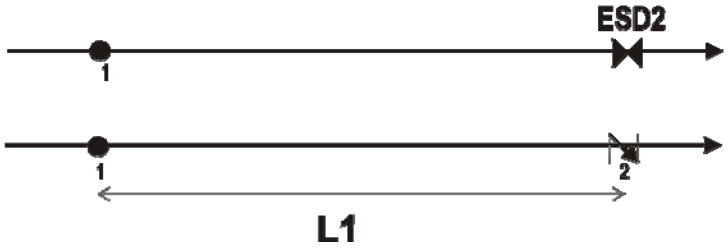
- Has ONLY one node at each end.
- Does not have nodes between the beginning and ending nodes.

A pipeline segment length is entered as the distance between nodes. If using the Gathering System Analysis portion of the **BATCH** page, the equivalent segment length is left blank for now.

The following two illustrations and discussions are provided only to explain why some H_2S volumes must be 'summed' before performing ERCBH2S dispersion modelling. They are presented here only as background for subsequent discussions, and require no action by the user.

Example Illustration 1 (Single Segment)

Two pipeline segments shown in the following diagram are defined by a start node tag "1" and terminated with an end node tag "2". The top segment starts with an open flow condition at node-1 and ends with an ESD valve at node-2. In the event of a rupture of this pipeline segment (between nodes-1 and-2), gas could flow continuously from beyond node-1 (upstream) into the segment, and could 'back-flow' for some time from beyond node-2 (downstream) into the segment until the ESD valve detects a pressure sufficient to close the valve and stop the flow (or until the valve is manually closed).



The second pipeline segment in the preceding diagram (the lower line) also begins with an open flow condition at node-1, but ends with a 'back-flow check valve' at node-2. In the event of a rupture of this pipeline segment (between nodes-1 and-2), whereas gas could flow continuously from beyond node-1 (upstream) into the segment, back-flow from beyond node-2 is prevented by the check valve. In *ERCBH2S*, check valves are assumed to function (perfectly and immediately) when a downstream flow reversal is detected.

Illustration 1 - Summary Discussion

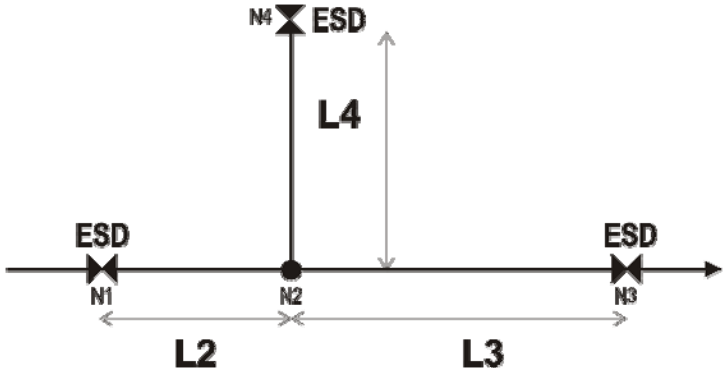
When pipeline segments are connected, a pipeline network analysis is used to estimate the amount of material that could be released. The analysis of high pressure blow-down in pipeline networks is *complex*, and the analysis used in *ERCBH2S* is a simplification using 'ideal gas' properties to determine the approximate combined volumes in pipeline networks. The 'ideal gas' model provides an estimate of the total volume available for release by assuming adjacent segments have similar compressibility. The ERP zone calculations for the release modelled in *ERCBH2S* for each segment uses 'real gas' properties.

Summary discussions continue following Illustration 2.

A gas pipeline gathering system analysis assumes that each segment has similar compressibility. If the compressibility significantly changes within the gathering system, the system should be divided into separate analyses 'groups'.

Example Illustration 2 (Connecting Segments)

Now consider the simple joining of two pipelines as shown in the following diagram. The example shows ESD valves at nodes 1, 3 and 4. The two pipelines are joined at node 2 – where there is no flow control device. If a rupture occurred in segment N1-N2 (node 1 to node 2), material could escape through the rupture from upstream of the segment (node 1) until it closed. Because there is no flow control device at node 2, material could 'back-flow' from both downstream segments (N2-N3 and N4-N3). These segments would provide material to the emission scenario until the respective ESD valves closed, (nodes 3 and 4).



The 'Equivalent Segment Length between ESDs' used by *ERCBH2S*, is determined by

1. summing the material/product that could escape between flow-control devices (or the physical limits of the pipeline), and

2. using the total/cumulative volume calculation to re-calculate individual segment lengths (node to node), based on the characteristics of the individual segments.

When the pipeline dimensions and gas compositions are the same for all segments, equivalent segment lengths can be readily determined by summing segment lengths. However, for real pipeline networks, pipeline dimensions change as well as gas compositions and pressure levels. Therefore, the mass of material escaping must be accounted for from each segment.

> The *ERCBH2S* Gathering System Analysis feature on the **BATCH** page is designed for these calculations by acting as a 'calculator'; summing H_2S volumes from interconnecting segments according to the segments and nodes described to it by the user. This 'user directed' action is done BEFORE *ERCBH2S* dispersion modelling (Calculate EPZ) is performed.

If there were a pipeline failure in segment N1 – N2:

- Segment N1-N2 would have the total mass of H_2S determined for segments N1-N2, N2-N3, and N4-N2. Subsequently
- the Equivalent Segment Length between ESD valves is determined using the total mass of H_2S, and the pressure, diameter and gas composition for segment N1-N2 that equates to the total H_2S mass.

ERP zones for pipeline segment N1-N2 must therefore based upon an *ERCBH2S* analysis using the characteristics of segment N1-N2, but with an Equivalent Segment Length determined by the total mass of H_2S from adjoining segments.

> Again, the *ERCBH2S* Gathering System Analysis feature on the **BATCH** page is designed to automatically perform these calculations, and can be utilized by properly describing the gathering system in terms of 'segments' and 'nodes' as described in the tutorial later in this chapter.

Similarly, for a failure in segment N4–N2, the total mass of H_2S is the same as already determined for segment N1-N2's calculation (previous), but the Equivalent Segment Length is determined using the pressure, diameter and gas composition for segment N4-N2 that equates to the total H_2S mass that could potentially escape. ERP zones for this pipeline segment are therefore, based upon the characteristics of segment, but with an Equivalent Segment Length determined by the total mass of H_2S from adjoining segments.

Illustration 2 – Summary Discussion

The network model used in *ERCBH2S* uses an *ideal gas* assumption to determine the total mass of H_2S within the segment *group* bounded by flow control valves or the pipeline physical limits (e.g., well, plant, battery, etc).

Conclusion

The *ERCBH2S* Gathering System Analysis feature (on the **BATCH** page) determines Equivalent Segment Lengths for each individual segment described to it, using the gas composition and described pipeline characteristics for the individual segment. In order to get reliable calculation results, users must carefully follow the directions provided in this chapter of the *ERCBH2S* User Guide when describing a gathering system on the *ERCBH2S* **BATCH** page.

The Gathering System Analysis feature is essentially a calculator used to arrive at an Equivalent Segment Length BEFORE *ERCBH2S* dispersion modelling (Calculate EPZ) is performed.

'Node descriptions' provided in the 'gathering system analysis' section of the BATCH page are not referenced in ERCBH2S dispersion modelling. They are used only to identify when pipeline H_2S mass should (and should not) be summed together. This is done by logic built into the spreadsheet - activated by the user as described in the tutorial later in this chapter.

A pipeline gathering system segment has an Equivalent Segment Length determined by the total mass of H_2S in the segment and in segments upstream or downstream (based on **licensed levels**), to points where flow control devices that can prevent additional flow to the modelled segment are encountered, or the pipeline limit is encountered (e.g., well, plant, battery, etc.).

The release from a segment is modelled using the gas characteristics of the segment. Modelling (e.g., **Calculate EPZ**) is based on **expected maximum** MOP and H_2S.

The amount of material available for release from a particular segment is therefore a function of the joined segments and their flow controls at the nodes. The simplified total Equivalent Segment Length is modelled in *ERCBH2S*. The chemical and physical properties used in the *ERCBH2S* analysis for the determination of the ERP zones are based on the specific values entered for the segment. These are reasonable estimates for the screening level analysis given that the ERP zones are dependent on the high initial flow rates from a failure.

Gas Gathering System Analysis – Tutorial

Introduction

To work through this tutorial, in addition to the terms 'Node' and 'Pipeline Segment', the following terms are used:

NODE LABEL

Each Node Number has only one Node Label. Node Label and Node Position (identified by the **BATCH** column the Node Number is entered in – either upstream or downstream) are essential for *ERCBH2S* 'total H_2S-mass' calculations, and subsequent Equivalent Segment Length calculations.

Label choices are:

ESD	Emergency Shut-down Valve
CV	Back-flow check valve
- -[4]	Open flow- no flow control

NODE NUMBER

Unique

A node number is unique. It identifies a physical place and has a specific characteristic (the Node Label). As long as a pipeline segment is physically connected to a particular Node, the Node Number can be re-referenced. It can be referenced as many times as there are pipeline segments physically connected to it.

Numbering Protocol

Because Node Numbers may become part of the Pipeline Segment Label, users may wish to keep Node Numbers brief; e.g. N1, N2, N3 and so on. However,

[4] *ERCBH2S* 'Equivalent Segment Length' calculations 'look' for ESD or CV when determining what H_2S masses to sum together. If ANYTHING else is entered, the calculations consider it an 'open flow'. Therefore it is acceptable to label, for example, a manual valve as 'MAN'. For 'summing' calculation purposes, *ERCBH2S* considers this an 'open flow' since it is labeled neither as ESD or CV. Manual valves are considered 'open flow' because they do not close automatically.

Node Numbering can follow any protocol chosen by the user. A suggested format is an alpha character followed by a number. Some gathering systems may already have an ESD, Back-flow Check-valve, tie-in numbering convention; e.g., ESD1, ESD2, or CV15, CV16, or TY22, TY23, and so on. As long as the number is UNIQUE - only references one exact location with one exact characteristic (the Node Label), anything can be chosen.

Sequential or Out-of-Order?

While it is recommended that Node Numbers generally increase in the direction of flow, it is not essential. If new tie-ins occur, or if additional flow controls are installed thereby creating a 'new Node' amongst 'existing Nodes', the existing Node Numbering does not have to be changed as long as the new Node is given a unique Node Number, and the **BATCH** gathering system descriptions of pipeline segments connected to/interrupted by the new Node are changed accordingly.

Multiple Analyses on a BATCH page

There can be multiple gathering system analyses on a **BATCH** page provided Node Numbers are not re-used to label different locations.

Ambiguous Nodes

Re-using a Node Number for a 'new' physical location, or assigning *ambiguous* Node Labels to a Node Number on the same **BATCH** page can cause circular references and/or calculation errors. Subsequent equivalent segment length calculations will either fail or the results may be unreliable.

Other Licensee Tie-ins

If material can be contributed to the user's pipeline from another licensee's pipeline (e.g. not connected at a flow control device that prevents flow into the user's pipeline), additional material must be accounted for when determining Equivalent Segment Length or Equivalent Cumulative Pipeline Volume. For pipelines such as these, the user must

1. Perform a manual calculation for any of the user's pipelines to which it is applicable (see Formulae for Pipeline Networks), or

2. Use the Gathering System Analysis portion of an *ERCBH2S* **BATCH** page to arrive at the Equivalent Segment Length, and then manually enter this number for any of the user's pipelines to which it is applicable. When doing this, use a separate BATCH page as you will need to include details of the other licensee's pipeline(s). This page does not need to be submitted to the ERCB, you are only using it to arrive at the Equivalent Segment Length for your pipeline(s). See 'Tutorial Variation 2' later in this chapter.

To do this, the other licensee must be contacted regarding the location and type of flow control devices and other licensing details (to enable calculations). Both licensees must consider this material contribution to their respective gathering systems.

NODE POSITION

A Node is either at the upstream end of a pipeline segment or sub-segment (segment *from location*), or the downstream end (segment *to location*). This is described to *ERCBH2S* by whatever **BATCH** column the Node Number is entered to.

PIPELINE SEGMENT LABEL (SCENARIO NAME)

Pipeline Segment Labels allows users to identify gathering system segments as modelled Node by Node on the *ERCBH2S* **BATCH** page.

For each segment, this label is entered as the Scenario Name (Administrative details group on the **INPUTS** page, or column 'L' on the **BATCH** page). Each label must be unique and should identify the segment according to the described *from location* Node Number and *to location* Node Numbers; e.g., N1 – N2, or N35 – N27, or ESD1 – CV 14, and so on. If the subject segment is 'lease piping', modelled so that the gathering system continues to be 'connected' for purposes of summing volumes, then the user should use slightly different scenario names. Names such as 'Lease Piping N3 – N4' highlight that the modelled segment does not have a pipeline line number or is not licensed by the ERCB. In these cases, 'Lease Piping' would also be entered for the pipeline line number. Even if the pipeline is not licensed by the ERCB, it should be assigned the same pipeline licence number as the connecting gathering system.

Tutorial

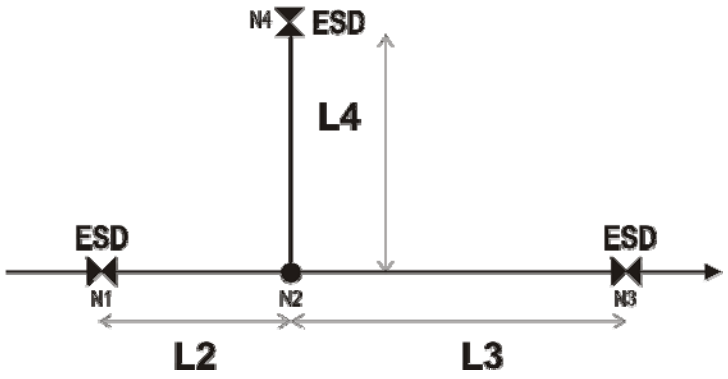
The same three-segment pipeline group shown in **Example Illustration 2** is used here to build an example gas gathering system analysis. The file **ERCBH2S-eg-Net1.xls** contains these example calculations. This example is for pipelines modelled as 'Gas Pipelines'. There is a similar area on the BATCH page for 'Liquid Gathering Systems' (columns DB – DN).

Before using the Gathering System Analysis calculation feature, users must first fill out the pipeline details portion of the **BATCH** page, with the exception of 'Equivalent Segment Length between ESDs'. For the following example, these details have are filled out for you.

1. Step 1 – Table Preparation

Flow Schematic and Tables: Describing a gathering system in terms of Nodes and Pipeline Segments is easier with a schematic of the system to be analyzed, clearly showing all of the 'Node' locations.

Using the schematic, carefully prepare a table listing each Node by Node Number and Node Label. The Node Numbers should be added to the schematic as illustrated in the following example.



NODE TABLE	
Node Number	**Node Label (Flow Control)**
N1	ESD
N2	- -
N3	ESD
N4	ESD

Finally, using the labelled schematic and the Node Table, the gathering system can be described in a larger table, as shown in this example. This table will be used for the inputs to the *ERCBH2S* **BATCH** page. Remember to keep both tables and the schematic for future reference.

A user may wish to prepare a bigger table, with more references such as pipeline licence number, and line number (or line number segment portion – as per the Administrative group of the inputs), 'from' and 'to location', etc.

BATCH Page Input Table

BATCH page row	Scenario Name Column L	Upstream Node Number	Downstream Node Number	Upstream Node Label (Valve Type)	Downstream Node Label (Valve Type)

number		Column CO	Column CP	Column CQ	Column CR
Row 11	N1-N2	N1	N2	ESD	--
Row 12	N2-N3	N2	N3	--	ESD
Row 13	N4-N2	N4	N2	ESD	--

Careful preparation of a Node Table, a **BATCH** Page Input Table and a system schematic (complete with labels) will help a user to avoid ambiguous Nodes.

Once labelled and described, it is a good idea to keep the gathering system schematic and the tables for future reference. They will be particularly useful if any of the gathering system changes (new Nodes, changed Nodes, etc.)

2. On the **BATCH** page, scroll across to the Gas Gathering System-Pipeline Networking input group (begins at column **CO**).

There are two parts to the input group which are colour coded white (user input-column "CO to CR") and orange (calculations column "CS to DA").

3. Enter user input. When entering Node Labels, *ERCBH2S* requires exact text for "ESD" and "CV" in order to perform calculations. The text string for open flow or other can be any text the user selects, although two dashes can easily alert the viewer to flow control 'gaps'.

For each record in the pipeline gathering system database, enter corresponding Node information as described in the table from Step **1**.

Copy the formulas

The first record on the **BATCH** page (row 10 – orange-coloured cells in the 'Gas Gathering System – Pipeline Networking' group of the **BATCH** page) contains formulae that must be copied/applied to the user's pipeline gathering system analysis rows.

Use the mouse to highlight range "CS10:DA10". Right click and select **COPY**. Then, using the mouse, left click and drag on the range of rows for the analysis, e.g., CS11:CS13 (for this tutorial example). Right click and select **PASTE**. *ERCBH2S* has just calculated 'Equivalent Segment Lengths' for each pipeline segment included in this analysis group.

The formulae can be copied to more rows for later use.

If you have rows of pipeline data for which you do NOT want to calculate Equivalent Segment Lengths (because they have manual calculations), copy the formulae with care. Simply 'dragging' it may apply the formulae to rows of data you are not including in the analysis.

4. You Should See

After entering the data and pasting the formula (step 4), you should see calculated **Equivalent Segment Length Between ESD Valves,** as shown in the illustration below. Compare these values to the **Segment Length Between ESD Valves**. Because of the pipeline networking, the equivalent segment lengths can be much larger than the original segment.

In the example below, the tutorial case gas composition was used with 10 % H_2S in segments N1-N2 and N2-N3, and a 20 % H_2S used for segment N4-N2 (licensed maximum H_2S and pressure are used in the calculations).

GAS GATHERING SYTEM - PIPELINE NETWORKING												
Upstream Node (LABEL MUST BE UNIQUE TO COLUMN)	Downstream Node	Upstream Valve Type (a node cannot have multiple types)	Downstream Valve Type (a node cannot have multiple types)	Segment Length	Pipe Volume in Segment Length	H2S Density (at Licenced Conditions)	Mass of H_2S	Equivalent Segment Length between ESDs	Downflow Into Upstream Node	Downflow Into Downstream Node	Backflow Into Downstream Node	Backflow Into Upstream Node
--	--	ESD CV --	ESD CV --	m	m^3	kg/m^3	kg	m	kg	kg	kg	kg
				0	0	0	0	#DIV/0!	0	0	0	0
N1	N2	ESD	--	1000	50.87	14.783	752.03	7000	0	752.03	4512.2	5264.2
N2	N3	--	ESD	2000	101.74	14.783	1504.1	7000	3760.1	5264.2	0	1504.1
N4	N2	ESD	--	2000	101.74	29.566	3008.1	3500	0	3008.1	2256.1	5264.2

5. Don't forget to Link the results!

There is a formula that links the Gathering System Analysis Calculation Result (the **Equivalent Segment Length between ESDs**) to the input cell(s) *ERCBH2S* references for the ERP zone calculations (column AF). The user must complete this step in order to have the 'Effective Segment Length' in a place where *ERCBH2S* can find it when dispersion modelling calculations are performed.

Left click on cell "AF10", then right click and select **COPY**. Then, using the mouse, left click and drag on the range of rows for the analysis (AF11:AF13 for this tutorial example). Right click and select **PASTE**.

Use care when copying this action down the column, as it causes entries in the column to be replaced with coordinating entries from the Gathering System Analysis portion of the **BATCH** page. Any rows of pipeline data that have manual calculations should NOT be included in the 'dragging' action. Instead, the formula should be selectively 'copied' to the data rows it applies to. Applying it to rows of data with Manual length calculations will result in Equivalent Segment Lengths of 0 overwriting any lengths manually entered.

The user must remember to complete this step in order for *ERCBH2S* to reference the Equivalent Segment Length when the ERP zone calculations are performed.

ERCBH2S ERP calculations do not use Equivalent Segment Lengths unless the user has properly provided certain key information and activated certain calculation sequences on the **BATCH** page.

The formula entered in field range AF: "**Equivalent Segment Length between ESD Valves**" can be overwritten if the user selects the **SAVE TO BATCH** command from the **INPUTS** page (if the **INPUTS** page has the same scenario name as the **BATCH** row!)

It is therefore important to remember to re-enter the formula (column AF) if it has been over-written.

Using the **PREVIOUS** and **NEXT** commands does not write to the **BATCH** page, therefore these commands can be safely used without affecting the formula.

ERCBH2S warns the user if it is about to overwrite a formula.

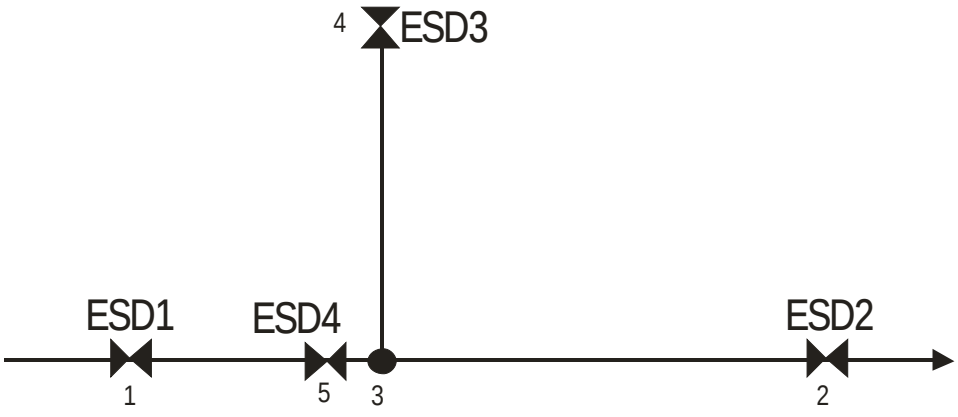
6. Change the Pipe Diameter

To illustrate how segment lengths are adjusted for a given H_2S volume, try changing the Outside Diameter of one of the pipelines. Because the cells are now 'linked' in a calculation sequence, changes to key cells cause immediate changes to the Equivalent Segment Length.

As the Outside Diameter becomes smaller, the Equivalent Segment Length becomes longer. As the Outside Diameter becomes larger, the Equivalent Segment Length becomes shorter.

Tutorial Variation 1 – Complex Node Location

For this example, we examine how to organize, number, and label an input table for a complex tie-in location.



NODE TABLE	
Node Number	**Node Label (Flow Control)**
N1	ESD
N2	ESD
N3	--
N4	ESD
N5	ESD

In this example, nodes 5 and 3 are actually at the same location.

BATCH Page Input Table

BATCH page row number	Scenario Name Column L	Upstream Node Number Column CO	Downstream Node Number Column CP	Upstream Node Label (Valve Type) Column CQ	Downstream Node Label (Valve Type) Column CR
Row 11	N1-N5	N1	N5	ESD	ESD
Row 12	N5-N3	N5	N3	ESD	--
Row 13	N4-N3	N4	N3	ESD	--
Row 14	N3-N2	N3	N2	--	ESD

In this example, if only one node is described at the tie-in location, only one node description can be assigned (remember that nodes **must be** unique). If the tie-in is labelled as ESD, it indicates that **all** pipelines tying-into this location begin or end with this ESD, which in this case is incorrect (e.g.: the pipeline coming from node 4 does not end at the ESD). If we label the location as 'open flow', then it indicates that **all** pipelines tying into this location begin or end with an 'open flow', which is also incorrect (e.g.: the pipeline coming from node 1 ends at an ESD). The only solution is to create two nodes at the tie-in location, labelling one as an ESD, and the other as an 'open flow'. Remember that the actual 'physical flow control' for the beginning and ending of a pipeline segment must be accurately described.

When describing complex tie-ins, the user must describe 'short' pieces of pipeline connecting one node to another. These segments can be no shorter than 1 metre. Beyond this, users should use actual lengths whenever possible. If the piping in question is not part of the licensed system (as may be the case with certain lease piping) it must be described anyway. Without it, the *ERCBH2S* 'Gathering

System Analysis' calculation feature cannot correctly 'sum' the H_2S mass of the gathering system because the system is effectively 'disconnected' at this location.

Because lease piping may not have an ERCB licence number, the user can indicate this in the Administrative section of the Inputs page (or the **BATCH** page). For the line number, the user can indicate which pipelines are being 'connected' by the lease piping (helps to understand how the gathering system is put together).

Name of Well / Pipeline Licence Number	123456 - Unlicensed Lease Piping	Label
Well Licence Number or Well Application Number	na	enter
Legal Surface Location of Well or Pipeline Line Number	connecting lines 17, 18 and 36	LSD-S

The last column in the following table illustrates how *ERCBH2S* 'sums' the H_2S mass described in this example.

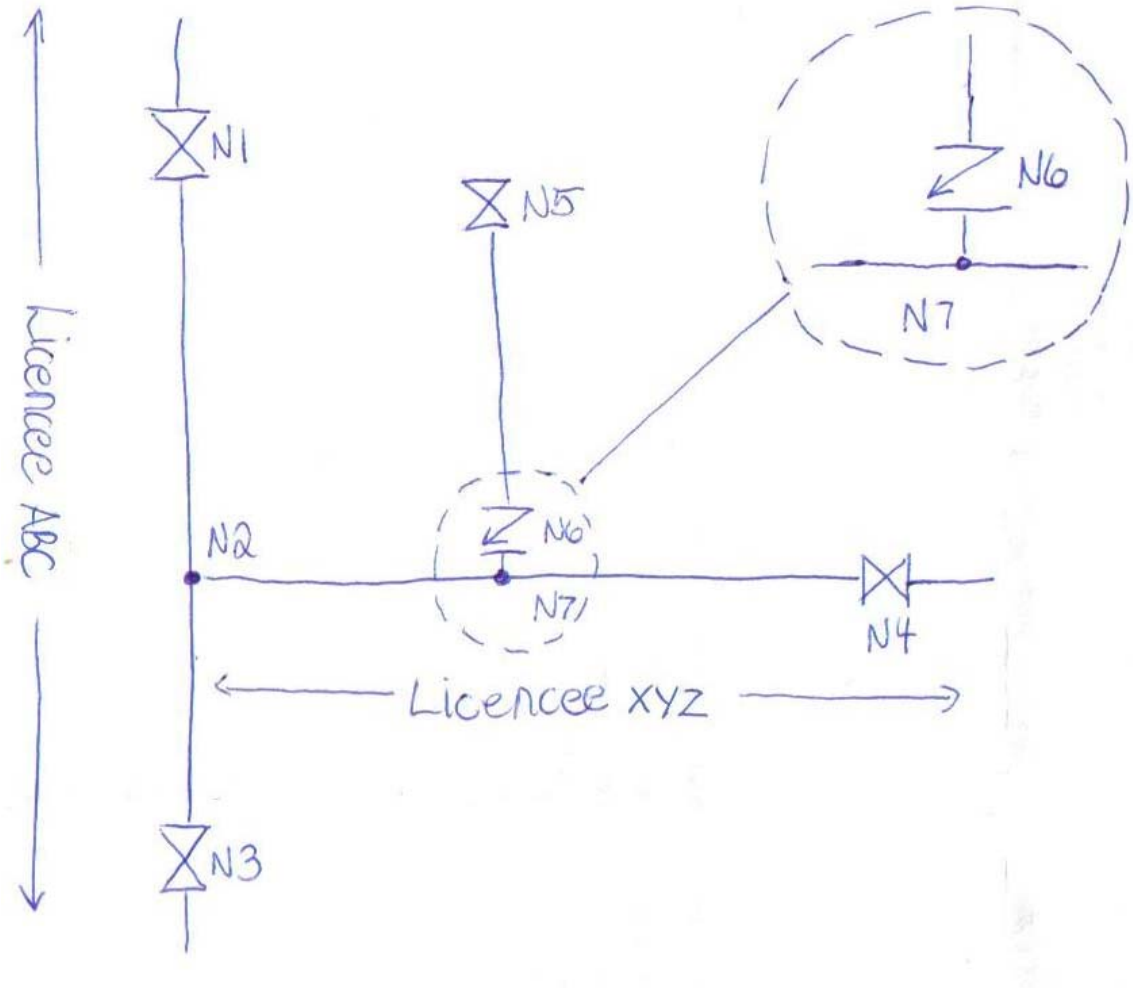
BATCH Page Table

BATCH page row number	Scenario Name Column L	Upstream Node Number Column CO	Downstream Node Number Column CP	Upstream Node Label (Valve Type) Column CQ	Downstream Node Label (Valve Type) Column CR	*How ERCBH2S* 'sums' the H_2S Mass
Row 11	N1-N5	N1	N5	ESD	ESD	**= N1-N5**
Row 12	N5-N3	N5	N3	ESD	--	**= N5-N3 + N4-N3 +N3-N2**
Row 13	N4-N3	N4	N3	ESD	--	**= N5-N3 + N4-N3 +N3-N2**
Row 14	N3-N2	N3	N2	--	ESD	**= N5-N3 + N4-N3 +N3-N2**

Tutorial Variation 2 – Other Licensee Tie-in

In the following example, two different licensees are tied-in together at Node 2, where there is no flow control. This means that each licensee must account for H_2S from the other licensee's gathering system – to a point where flow control

devices are encountered that stop additional material from entering the subject group of pipelines. In this example, each licensee is submitting a separate *ERCBH2S* file to the ERCB.



To arrive at an Equivalent Segment Length for each pipeline in this group, the user can perform manual calculations according to section 5.4 of the **VOLUME 1 Technical Reference Document**. Alternatively, the Gathering System Analysis portion of a 'separate' **BATCH** page can be used as a 'calculator' to save time. This page will not be submitted to the ERCB because each licensee is submitting a separate file pertaining to their respective pipelines.

Below is the **BATCH** page table for this pipeline group. The last column identifies how *ERCBH2S* sums the H_2S mass for this group. Notice that although the check-valve at Node 6 prevents additional mass from being added back to Row 15, mass from Row 15 is added to the rest of the pipelines in this group.

Also notice that although Nodes 6 and 7 are at the same location, they must be identified separately (with a short piece of pipeline connecting them). If only the check-valve was identified at this location, then the pipeline coming from Node 4

would directly tie-into a check-valve, which is incorrect. Describing this location in the manner shown 'links' all of the pipelines together, thereby allowing *ERCBH2S* to correctly 'sum' the H_2S mass.

BATCH Page Table						
BATCH page row number	**Scenario Name Column L**	**Upstream Node Number Column CO**	**Downstream Node Number Column CP**	**Upstream Node Label (Valve Type) Column CQ**	**Downstream Node Label (Valve Type) Column CR**	***How ERCBH2S* 'sums' the H_2S Mass**
Row 11	N1-N2	N1	N2	ESD	- -	**=N1-N2 +N2-N3 + N4-N7 + N7-N2 + N5-N6 + N6-N7**
Row 12	N2-N3	N2	N3	- -	ESD	**=N1-N2 +N2-N3 + N4-N7 + N7-N2 + N5-N6 + N6-N7**
Row 13	N4-N7	N4	N7	ESD	- -	**=N1-N2 +N2-N3 + N4-N7 + N7-N2 + N5-N6 + N6-N7**
Row 14	N7-N2	N7	N2	- -	- -	**=N1-N2 +N2-N3 + N4-N7 + N7-N2 + N5-N6 + N6-N7**
Row 15	N5-N6	N5	N6	ESD	CV	**= N5-N6**
Row 16	N6-N7	N6	N7	CV	- -	**=N1-N2 +N2-N3 + N4-N7 + N7-N2 + N5-N6 + N6-N7**

Remember, this particular **BATCH** page is being used only as a 'calculator'; it will not be submitted to the ERCB.

Once the Equivalent Segment Lengths have been calculated, they can be entered manually in column AF on each licensee's respective **BATCH** page. For example, the pipeline described on this page as Row 12 may in fact be Row 185 on Licensee ABC's **BATCH** page.

Remember that when manual calculation are entered in column AF, the user MUST NOT 'drag' the formula from Cell AF10 over the manual entries (see Step 6 in the first Tutorial example in this chapter).

Formulae for Pipeline Networks

The formulae for the pipeline gathering system calculations in Excel are provided in **VOLUME 1 Technical Reference Document** (section 5.4). The *ERCBH2S* Gathering System Analysis feature determines the H_2S mass of each pipeline segment (determined using ideal gas properties, and based on licensed maximums). The simplification ignores compressibility effects (z factor), and assumes compressibility is similar between each segment. Actual compressibility becomes a factor once dispersion modelling is performed.

Remember, for Equivalent Segment Length, if the pipeline inside diameter, licensed maximum operating pressure and licensed H_2S are the same, then the segment lengths can be simply added together to arrive at the correct number. If any of these factors are not the same, refer to section 5.4 of the Technical Reference Document.

For Equivalent Cumulative Pipeline Volume, if the licensed maximum operating pressure, minimum operating temperature and licensed H_2S are the same for ALL segments, then the calculation is the straightforward 'sum' of the segment lengths times the pipe area. If any of these factors are not the same, refer to section 5.4 of the **VOLUME 1 Technical Reference Document**.

10. EXAMPLE 1: Gas Pipeline

Tutorial

By working through pre-loaded example files, you will become acquainted with:

- the *ERCBH2S* screen in Excel,
- some of the pages in *ERCBH2S* (Inputs and ERP Summary Page),
- user controlled input data, and
- terminology used throughout the guide.

If you have not done the tutorial '**QUICK-START TUTORIAL**' (Chapter 3 - page 16) please do it now.

If you have not read Chapter 5 - **INPUTS PAGE** (page 53), please do it now (it is pre-requisite familiarity for the tutorials).

In *ERCBH2S*, emergency response and planning (ERP) zone calculations have certain assumptions and processes to model the sour gas well release and its subsequent behaviour. To acquaint the user with some of these attributes and terminology, the following summary is provided:

Sour Gas Release Characteristics

- Source conditions are determined for a high-pressure pipeline blow down.
- Flow rate decreases as the high-pressure decreases as the release progresses. Because the flow rate is not steady (not constant with time), a sour gas pipeline release is called a 'transient release' (transient jet).
- Flow from the pipeline (failure site) occurs at the mid-length location of the pipeline segment to simplify the analysis.

Individual Pipeline Analysis versus a Gathering System Analysis

- For an individual pipeline segment analysis:

- At each end of the pipeline segment there is an ESD valve or other flow control device that can completely stop product flow into the subject,

- the only source of product for the segment being modelled comes from upstream and downstream of the segment (there are no other pipelines tying-into the segment), and

- up-stream and downstream pipelines have identical specifications as the segment being modelled – including expected maximum operating pressure and expected maximum H_2S concentration.

- In *real* gathering systems where some pipeline segments may not begin and/or end with a flow control device, or for segments that have other pipelines 'tying-in' in-between the beginning and end of the pipeline segment, *ERCBH2S* has a **Pipeline Gathering System** analysis feature to account for these circumstances. This process is described in Chapter 9 - Pipeline Gathering Systems. If you are modelling pipelines, we STRONGLY recommend you read Chapter 9.

What a pipeline segment means to ERCBH2S

- There are identical flow control devices at each end of the pipeline, and both flow control devices close at the same time. Therefore, pipelines that begin and end with 'non-identical' ESD valve settings, or have non-identical types of flow control must be modelled with the 'lowest' valve setting. Check valves are assumed to work correctly and completely.

- There are no pipelines tying into the pipeline segment in-between the start and end of the segment*. In the event of a failure, additional product flow can only come from each end of the pipeline.

    - *F.Y.I. - This is why segment lengths must sometimes be adjusted ('Equivalent' Segment Length); because other pipelines tie into the modelled pipeline in between the beginning and ending of the modelled pipeline. Again, this is described in Chapter 9 - Pipeline Gathering Systems. For this example, there are no pipelines tying in between the beginning and ending of the segment, AND the pipeline begins and ends with an ESD valve.

Flow Control

- User inputs to *ERCBH2S* provide for the following types of flow control:

    - 'Low-pressure set point' ESD control trigger - if pressure falls below a pre-determined set point, the valve will close.

- 'Pressure rate of change' (PROC) ESD control trigger - if a pre-determined pressure drop occurs over a pre-set sampling time – the valve will close.

- Manual closure at a specified time after the release begins. The time must include detection of the release, notification of the operator, travel to the segment, verifying the release by locating it, and shutting the valves.

- No flow control.

- ESD valves have a specified time to shut-in (once activated to close - the amount of time it takes them to close). This operation of the valve means that gas from the pipeline will exit from both between the ESD valves (volume based on the segment length), **and** from upstream and downstream of the two ESD valves until closure is triggered (additional gas volume). *ERCBH2S* calculates the total release volume – which depends on the time it takes the valve closure to be activated.

- Following valve closure, a pipeline continues to blow-down until the two halves have drained to atmospheric pressure, unless the pipeline is ignited or 'drawn-down'. *ERCBH2S* inputs also provide for these very specific pre-planned user actions.

Ground-level Release

A nominal height of 0 m is used in the air quality modelling simulations, as most pipelines are buried and the release exits at ground-level. A large/high pressure sour gas pipeline rupture is typically a catastrophic release that removes surface soils and flattens the ground around the release site. Failures from leaks (small holes) can also remove surface soils with their high-pressure 'jet' release (created by the 'choked flow' effect).

Horizontal or Vertical Release

Sour gas pipeline releases are assumed to be horizontal releases resulting from a catastrophic rupture of the pipeline. Less damaging ruptures or lower pressure sour gas pipelines may have a deflected jet releasing vertically through soils (or overburden), the resultant jet could be either horizontal (parallel to the ground surface) or vertical (perpendicular to the ground surface). Because horizontal releases do not rise as much as vertical releases, the horizontal release errs on the side of caution.

Dense or Buoyant

A buried sour gas pipeline is typically at or near ground temperature of 5ºC. When the flow exits the source (failure site) to atmospheric pressure, a 'choked

flow' condition occurs. Due to the expansion effects of the released material, its temperature drops and initial dispersion conditions may be dense. *ERCBH2S* uses real gas effects and determines whether the release is dense or buoyant.

Hole Size (Ae/Ap Ratio)

Pipelines can fail by a complete sever (guillotine rupture) - in catastrophic fashion, or by leaks from a hole in a pipeline. Leaks from holes in sour gas pipelines are also high-pressure releases (the 'choked flow' effect), but the pipeline blow-down takes much longer than with a guillotine rupture. Consequently, while the **rate** of release may be significantly smaller, the release **duration** may be much longer. This is because ESD valve automatic closure trigger 'times' may be significantly longer (i.e., ESD valves will not trigger closure because the pressure drop is not significant enough, so a manual trigger must occur).

In the case of a guillotine rupture, gas escapes through equally sized holes from each half of the ruptured pipeline (200 % of the pipeline's flow area). All other failure hole size scenarios examined by *ERCBH2S* are considered as single holes (≤100 % of the pipe area), also expressed as a release hole size fraction (A_{exit}/A_{pipe} or A_e/A_p).

Failure (Release) Location

For modelling, the failure (release) site is always the pipeline midpoint.

Step-By-Step Procedure

To follow along with this hands-on sour gas pipeline release example:

> If you have pre-set the install option for *ERCBH2S.xla* (**STEP 2: Activating the ERCBH2S Add-In** on page 12) go directly to step **2** in this tutorial. Otherwise, begin at step **1**.

1. Click on the **Start** menu button on your computer desktop.

Select **Programs**

Select **ERCBModels**

Select **ERCBH2S**

Select **Launch ERCBH2S.xla**

(The *ERCBH2S* menu in **Excel** is now launched)

Choose '**Enable Macros**'

2. Click on the **Start** menu button on your computer desktop.

Select **Programs**

Select **ERCBModels**

Select **ERCBH2S-Inputs(V120).xls**

3. The *Gas Pipeline* example file already contains in the row 12 in the BATCH page. Alternatively, you can move this record (row) from **BATCH** page to **INPUTS** page follow the instruction in '**From BATCH to INPUTS**' (page 120). A complete description of all the entry cells is in Chapter 5 - **INPUTS PAGE** (page 53).

ERP zones have already been calculated for the example file, and the results are shown on the **ERP SUMMARY** page. If the user changes certain key entries on the **INPUTS** page, the wording inside a **red flag** warning banner (that will appear at the top and bottom of both the **INPUT** and **ERP SUMMARY** pages) warns the user that re-calculations are required (because user inputs are not = to the program outputs). If this type of warning appears at anytime during this tutorial do not be alarmed. The ERP zones (outputs) will be re-calculated in the last steps of the tutorial (using the new inputs), thereby removing these particular **red flag** warnings.

<INPUTS DO NOT MATCH DISPLAYED OUTPUT PAGES -- RECALCULATIONS REQUIRED:> ,ERCBFlash not run,ERCBSlab not run,MetMatrix not performed,AeAp Calculation,ESD Closure Timing

red flag warnings are described in more detail in Chapter 5 under Red Flags and other Warnings.

4. **Administrative** Input Group

ADMINISTRATIVE		Units	User Input	Comments	Warnings (if applicable)
BA CODE			A		
Licensee/Applicant Name			B	as per license or application	
Mailing Address			C		
City and Province			D		
Postal Code			E		
Contact	Name		F		
	Phone		G		
	Fax		H		
	eMail		I		
SCENARIO NAME			Label 3 Gas Pipeline	UNIQUE description - Label 3 (i.e., Mitigation Option 1, Upstream to Downstream Node)	
SOUR OPERATIONS TYPE			Sour Gas Pipeline with H2S >10	Select the Type of Sour Gas or Sour Liquid operation	
ANALYSIS TYPE			(•) NO MITIGATION ( ) WITH MITIGATION	Select "NO MITIGATION" or "WITH MITIGATION"	**Uncontrolled H2S Release**
Name of Well / Pipeline Licence Number			Label 1	Label 1	
Well Licence Number or Well Application Number			K	enter na if pipeline or new well	
Legal Surface Location of Well or Pipeline Line Number			Label 2	LSD-SEC-TWP-RGE W?M - Label 2	
Pipeline Segment From Location (enter na if well)			M	LSD-SEC-TWP-RGE W?M	
Pipeline Segment To Location (enter na if well)			N	LSD-SEC-TWP-RGE W?M	
Surface Elevation		m (ASL)	1000	at facility or average in ERP area	
Existing EPZ Distance		km	na	enter na if not applicable	
Datum for Surface Locations			OTHER	mapping datum for locations	
Selected Inputs Flavour			1	**GAS PIPELINE (transient horizontal jet)**	

The entry titled 'Surface Elevation' is for an *average* EPZ elevation near the pipeline based upon a review of topographical maps of the area within a radius of about 5 km (determined from maps), or based on well-site elevations. Pipelines with significant elevation changes must be modelled in separate segments if elevation changes are more than +/- 100m. Additional details concerning this and all other user inputs are in Chapter 5 - **INPUTS PAGE** (page 53).

Try deleting some of the entries, and observe the warnings that appear in column 'E'. This column provides warnings for the user. Warnings also appear inside a **red flag** warning banner across the top and bottom of the page.

Select the 'undo' button to replace the entries, and the warnings will be removed. Warnings are described in more detail in Chapter 5 under Red Flags and other Warnings.

5. Calculation Controls portion of the **ADMINISTRATIVE** Group

SCENARIO NAME	Label 3 Gas Pipeline	UNIQUE description - Label 3 (i.e., Mitigation Option 1, Upstream to Downstream Node)	
SOUR OPERATIONS TYPE	Sour Gas Pipeline with H2S >10 m	Select the Type of Sour Gas or Sour Liquid operation	
ANALYSIS TYPE	(•) NO MITIGATION ( ) WITH MITIGATION	Select "NO MITIGATION" or "WITH MITIGATION"	**Uncontrolled H2S Release**

For pipelines, *Sour Operations Type* is determined by a pipeline's ERCB *Directive 056* licensed substance, with the exception of Acid Gas. Acid Gas pipelines must be identified separately, even though they are licensed as *Sour Gas* pipelines.

Use the drop-down box to select a pipeline substance. By trying different selections, you will see that some choices move you to the *Liquid Pipeline/Well* group. Replace the original selection of *Sour Gas Pipeline*.

6. **Gas Pipeline** Details Input Group

GAS PIPELINE *(includes oil effluent pipeline with Gas to Liquid Ratio>1000)*	**Units**	**User Input**	**Comments**	**Warnings**
Pipeline Segment From	--	O	X (east-west)	
Location Coordinates	--	P	Y (north-south)	
Pipeline Segment To	--	Q	X (east-west)	
Location Coordinates	--	R	Y (north-south)	
Licenced Maximum Operating Pressure	kPa (gauge)	9930	used for Level Designation	
Expected Maximum Operating Pressure	kPa (gauge)	5000	used for Hazard Modelling	
Pipeline Outside Diameter	mm	273.1		
Pipeline Wall Thickness	mm	9.3		
Segment Length	m	1000		
Equivalent Segment Length between ESDs (enter **Length** or Volume below)	m	5420	--	
Equivalent Cumulative Pipeline Volume between ESDs (enter Volume or Length above)	m^3		275.7177598	
Expected Maximum Gas to Liquid Ratio	standard m^3 Gas to stock tank m^3 Liquid		oil effluent pipeline from oil well only	
Licenced Maximum H_2S Concentration	% (gas phase)	14	used for Level Designation	
Expected Maximum H_2S Concentration	% (dry), (15°C, 101.325 kPa)	7	used for Hazard Modelling	
		USER OVER-RIDE OF DEFAULT	**DEFAULT**	**MODEL INPUT**
Expected Minimum Gas Temperature	°C		5 default	5
SOURCE MITIGATION		**USER OVER-RIDE OF DEFAULT**	**DEFAULT**	**MODEL INPUT**
ESD Valve Closure Time once Triggered	s		60 default	60
ESD Valve Low Pressure (LP) Trigger, Pesd	kPa (gauge)		500 default	500
ESD Valve Pressure Rate of Change (PROC) Trigger, dP/dt	kPa/s		5000 default	5000
ESD Valve Pressure Rate of Change (PROC) Sampling Time	s		3600 default	3600
Time from initial release until ESDs manually or remotely closed	minutes		720 default	720
Time from initial release until ignition or stop flow	minutes		720 default	720

Notice that the *Licensed Maximum Operating Pressure* (**MOP**) is `9930` kPa (gauge), but the 'Expected Maximum Operating Pressure' is only `5000` kPa. There is a similar difference for the H_2S entries – the *Licenced Maximum H2S Concentration* is 14 %, but the *Expected Maximum H2S Concentration* is only 7 %. Representative operating maximum values that are lower than licensed limits and **will not be exceeded** can be used instead of licensed maximums.

Now look at the two pipeline length entries. If this pipeline had ESD valves (or equivalent) at each end, and there was no other pipeline tying into it, the two length entries would be the same. For this example, it appears there is either no ESD at one (or both) ends of the pipeline, and/or there are other pipelines tying into the subject segment. 'Equivalent Segment Length' is described in more detail in Chapter 9 - Pipeline Gathering Systems.

The *Equivalent Cumulative Pipeline Volume* cell appears greyed-out. This is because a user must enter only **ONE** of either the Equivalent Segment Length between ESDs (ESL) **OR** *Equivalent Cumulative Pipeline Volume* (ECPV). Notice the entry in column D for the ECPV row - *ERCBH2S* has calculated the equivalent volume based on other user entries.

Delete the `4973` entry for ESL, and both the ESL and ECPV cells are now open for user input. Enter `253` for ECPV, and observe that the ESL entry is greyed-out and column D displays the calculated length.

Delete the entry for ECPV. Enter `900` for ESL. An Entry out of bounds warning appears in column E because the ESL between ESDs' cannot be less than the Segment Length (allowable entry ranges are displayed to the right of the **INPUTS** page – in columns H and I). Also notice the **red flag** banner that appears at the top and bottom of the page. The user entry is obviously an 'out of bounds' error and has to be corrected for the model to run. Re-enter the `4973` and the 'Entry out of bounds' warning disappears.

The 'Modelled Solution Gas to Liquid Ratio' cell is greyed-out because the pipeline substance is not Oil Effluent (selected in 'Sour Operations Type' - the Administrative section).

Additional details concerning these (and all other) user inputs are in Chapter 5 - **INPUTS PAGE** (page 53).

7. Minimum Pipeline Temperature

Even though this pipeline has a line heater installed to prevent hydrate formation, the normal minimum operating temperature is ground temperature. Therefore, the default setting of 5° C is not changed.

Enter a value of `160`, and the model input changes to 150; as indicated by the 'orange reset' in column E. This is because the user entry is above the allowable range for this field – as indicated in columns H and I (to the right). Notice that column J describes the associated model action (for entries outside the allowable range) as 'resets'. This means that instead of the user entry, the model will use the closest allowable value. Unless the user entry is changed to be within allowable limits, a **red flag** will be attached to the calculation results, and they will not be acceptable for ERCB submission.

		USER OVER-RIDE OF DEFAULT	DEFAULT	MODEL INPUT	Min	Max	Action
Expected Minimum Gas Temperature	°C	160	5 default	150	-50	150	resets

Delete the `160` entry, and the *orange reset* is removed. The model will again use the default value of 5° C.

Warnings are described in more detail in Chapter 5 under Red Flags and other Warnings.

8. Source Mitigation

The **SOURCE MITIGATION** sub-section is not currently 'open' because the **NO MITIGATION** analysis type is selected in the **ADMINISTRATIVE** section of the **INPUTS** page. The model will use the default values as shown.

SOURCE MITIGATION		USER OVER-RIDE OF DEFAULT	DEFAULT	MODEL INPUT
ESD Valve Closure Time once Triggered	s		60 default	60
ESD Valve Low Pressure (LP) Trigger, Pesd	kPa (gauge)		500 default	500
ESD Valve Pressure Rate of Change (PROC) Trigger, dP/dt	kPa/s		5000 default	5000
ESD Valve Pressure Rate of Change (PROC) Sampling Time	s		3600 default	3600
Time from initial release until ESDs manually or remotely closed	minutes		720 default	720
Time from initial release until ignition or stop flow	minutes		720 default	720

Note that the ERCB default settings in this group result **in no effective ESD control** for a pipeline release.

GAS PIPELINE source mitigation is discussed in more detail under Gas Pipeline Group- Source Mitigation Section in Chapter 5.

9. Sour Gas Composition Input Group

The gas composition (mole fraction) for the example pipeline segment release is provided. This particular sample represents a composite average of sour wells in Alberta, and is intended for use only in this tutorial (users must supply appropriate representative analysis data for the sour gas pipeline being modeled).

Sour Gas Composition ***(gas phase at 15°C & 101.325 kPa, dry, representative analysis)***	Units	User Input	Comments	Warnings
H_2	mole fraction	0		
He	mole fraction	0.0006		
N_2	mole fraction	0.0283		
CO_2	mole fraction	0.0427		
H_2S	mole fraction	0.0259	Adjusted to Maximum H_2S Input for Level and Modelled H_2S Input for EPZ	
CH_4	mole fraction	0.8137		
C_2H_6	mole fraction	0.0488		
C_3H_8	mole fraction	0.0208		
i-C_4H_{10}	mole fraction	0.0036		
n-C_4H_{10}	mole fraction	0.0065		
i-C_5H_{12}	mole fraction	0.002		
n-C_5H_{12}	mole fraction	0.0021		
n-C_6H_{14}	mole fraction	0.002		
n-$C_7H_{16}^+$	mole fraction	0.003		
Total	mole fraction	1	Sum must equal one	

Observe the comment in column D beside the H_2S entry. For this particular example file, this comment means that although the gas analysis H_2S content is less than 3 %, the analysis will be re-adjusted to the Expected Maximum H_2S Concentration of 14 % (entered in the **GAS PIPELINE** details group). The Licensed Maximum H_2S Concentration (14 %) is used for setback calculations, and not for planning zone calculations.

In adjusting a gas analysis composition, *ERCBH2S* changes the reference H_2S entry to equal the 'Maximum Expected H_2S' entry, and then pro-rates all other reference gas analysis components according to their new fractional contribution to the total analysis (renormalized). The adjusted analysis can be immediately viewed on the **ERP SUMMARY** page, because the calculations are performed by Excel – no *ERCBH2S* program 'run' commands are needed for the conversion. All *ERCBH2S* program modelling calculations will reference the adjusted analysis.

GAS PIPELINE (includes oil effluent pipeline with Gas to Liquid Ratio>1000)	Units	User Input	Warnings
Licenced Maximum Operating Pressure	kPa (gauge)	9930	
Expected Maximum Operating Pressure	kPa (gauge)	5000	
Pipeline Outside Diameter	mm	273.1	
Pipeline Wall Thickness	mm	9.3	
Segment Length	m	1000	
Equivalent Segment Length between ESDs (enter Length or Volume below)	m	5420	
Equivalent Cumulative Pipeline Volume between ESDs (enter Volume or Length above)	m3	275.7177598	
--	--	--	
Licenced Maximum H2S Concentration	% (gas phase)	14	
Expected Maximum H2S Concentration	% (dry), (15°C, 101.325 kPa)	7	
Expected Minimum Gas Temperature	°C	5	
SOURCE MITIGATION		MODEL INPUT	
ESD Valve Closure Time once Triggered	s	60	
ESD Valve Low Pressure (LP) Trigger, Pesd	kPa (gauge)	500	
ESD Valve Pressure Rate of Change (PROC) Trigger, dP/dt	kPa/s	5000	
ESD Valve Pressure Rate of Change (PROC) Sampling Time	s	3600	
Time from initial release until ESDs manually or remotely closed	minutes	720	
Time from initial release until ignition or stop flow	minutes	720	

GAS PHASE FRACTIONS	INPUT	EXPECTED	LICENCED
H_2	0.0000	0.0000	0.0000
He	0.0006	0.0006	0.0005
N_2	0.0283	0.0270	0.0250
CO_2	0.0427	0.0408	0.0377
H_2S	0.0259	0.0700	0.1400
CH_4	0.8137	0.7769	0.7184
C_2H_6	0.0488	0.0466	0.0431
C_3H_8	0.0208	0.0199	0.0184
i-C_4H_{10}	0.0036	0.0034	0.0032
n-C_4H_{10}	0.0065	0.0062	0.0057
i-C_5H_{12}	0.0020	0.0019	0.0018
n-C_5H_{12}	0.0021	0.0020	0.0019
n-C_6H_{14}	0.0020	0.0019	0.0018
n-C_7H_{16}+	0.0030	0.0029	0.0026
H_2O	--	0.0000	0.0000
Total	1.0000	1.0000	1.0000

See Sour Gas Composition in Chapter 5 for more information.

10. Run Calculate EPZ

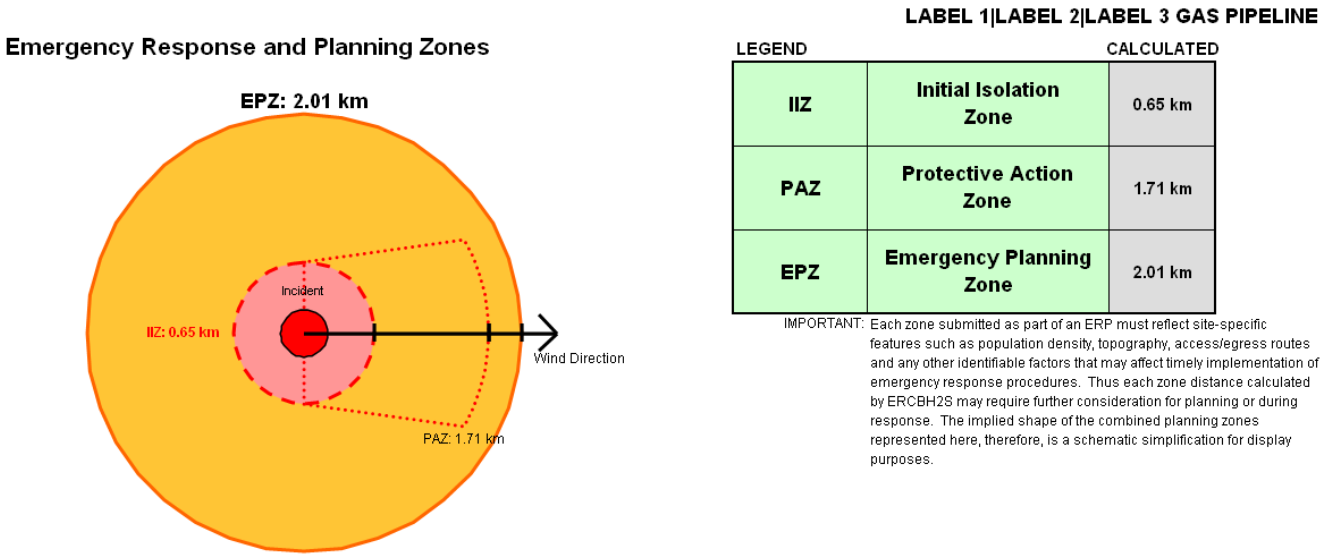
After pressing the **Calculate EPZ** button,  , a confirmation dialog is presented, asking if you are sure you want to continue. The calculations

may take several moments to perform depending on the processing power of the computer used. Select **OK** to continue.

After the *ERCBH2S* calculations are completed, the **ERP SUMMARY** page is displayed to view a summary of the calculation results.

11. ERP SUMMARY Page Results

The **ERP SUMMARY** page displays a planning and response zone graphic, as shown below.



The table to the right of the schematic lists each of the emergency response and planning zones.

Variation 1: Segment Length

The Equivalent Segment Length considered above was 4973 m between ESD valves. Next we consider another segment of the same pipeline. The distance between ESD valves is 1000 m in this segment, whereas all of the other conditions are the same. ERP zones must be defined for each segment of the pipeline, because the blow-down calculations for each segment will be different.

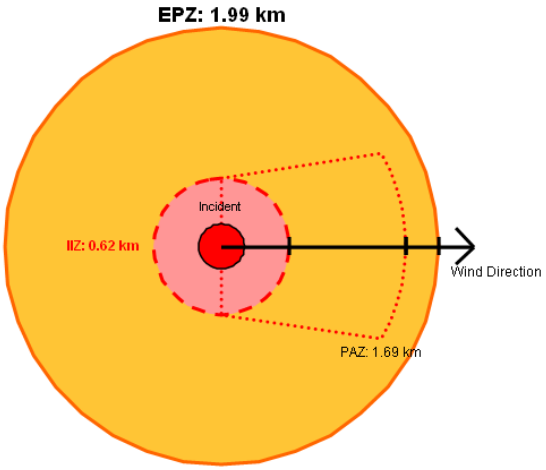
Click on the **INPUTS** page and change *Segment Length* and *Equivalent Segment Length* in the **Gas Pipeline** details input group to `1000`.

Segment Length	m	1000
Equivalent Segment Length between ESDs (enter **Length** or Volume below)	m	1000

Click on the **Calculate EPZ** command,  , from the button-bar or menu to re-run the calculations for the new segment. The new results will look like the table displayed on the **ERP SUMMARY** page and shown below:

LABEL 1|LABEL 2|LABEL 3 GAS PIPELINE

Emergency Response and Planning Zones



LEGEND		CALCULATED
IIZ	**Initial Isolation Zone**	0.62 km
PAZ	**Protective Action Zone**	1.69 km
EPZ	**Emergency Planning Zone**	1.99 km

IMPORTANT: Each zone submitted as part of an ERP must reflect site-specific features such as population density, topography, access/egress routes and any other identifiable factors that may affect timely implementation of emergency response procedures. Thus each zone distance calculated by ERCBH2S may require further consideration for planning or during response. The implied shape of the combined planning zones represented here, therefore, is a schematic simplification for display purposes.

Notice that the EPZ distance has decreased but not as much as you were expecting. All of the zones have decreased but not in the same proportions.

V1. Variation 2: WITH MITIGATION Analysis (PROC Valves)

You are contemplating purchase of new ESD valves. Before you purchase the valves, you examine whether this new technology has any impact on the calculated emergency response planning zones.

Because ESD valves are now a consideration, the user has checked with appropriate company personnel for the **maximum** time to manually close ALL valves for this pipeline segment (in the actual location/locale) from the time a leak **begins**. Very small pipeline release failures may not activate ESD valve closure settings.

V2. On the **INPUTS** page in the **ADMINISTRATIVE** inputs group – Analysis Type, select a **WITH MITIGATION** analysis.

SCENARIO NAME	Label 3 Gas Pipeline	UNIQUE description - Label 3 (i.e., Mitigation Option 1, Upstream to Downstream Node)	
SOUR OPERATIONS TYPE	Sour Gas Pipeline with H2S >10 m	Select the Type of Sour Gas or Sour Liquid operation	
ANALYSIS TYPE	○ NO MITIGATION ◉ WITH MITIGATION	Select "NO MITIGATION" or "WITH MITIGATION"	**User Specified Source Mitigation**

In the **GAS PIPELINE** details group, change 'Equivalent Segment Length' back to 4973.

Segment Length	m	1000
Equivalent Segment Length between ESDs (enter **Length** or Volume below)	m	4973

Because this is a tutorial, the user inputs for **SOURCE MITIGATION** in **GAS PIPELINE** have been already entered. Notice the 'over-ride' of most of the default entries (ERCB default settings in this group result in **no effective ESD control** for a pipeline release).

To see the effect the new ESD valves could have on the planning zone sizes, the pipeline will be modelled with flow completely controlled using PROC-ESD's of identical settings. Also, the time for manual closure applies to ALL of the valves for the pipeline segment. (Remember that the flow control device with the **lowest setting** must be modelled. **GAS PIPELINE** source mitigation is discussed in more detail under Gas Pipeline Group- Source Mitigation Section in Chapter 5.)

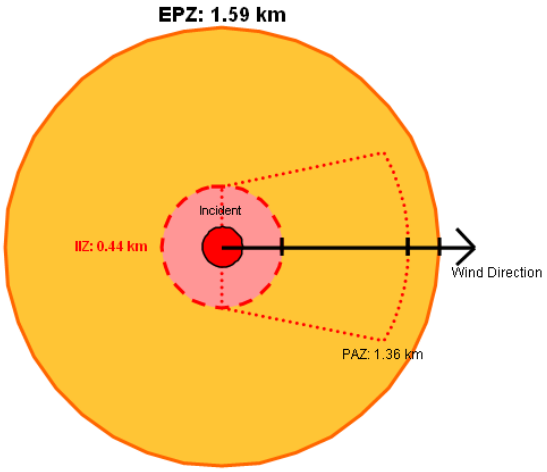
The entries correspond to the ESD specification of a Valve Closure time of 1 s and a sensitive PROC trigger of 100 kPa/s that is sampled every 60 s. In addition, the valves have a low pressure setting, which (to be effective) will not be set at less than 50 % of the Expected Maximum Operating Pressure (this is the ERCB expectation for sour gas pipelines with greater than 1 % H_2S).

SOURCE MITIGATION		USER OVER-RIDE OF DEFAULT	DEFAULT	MODEL INPUT	Min	Max	Action
ESD Valve Closure Time once Triggered	s	1	60 default	1	1	60	resets
ESD Valve Low Pressure (LP) Trigger, Pesd	kPa (gauge)	2500	500 default	2500	500	4500	resets
ESD Valve Pressure Rate of Change (PROC) Trigger, dP/dt	kPa/s	100	5000 default	100	1	5000	resets
ESD Valve Pressure Rate of Change (PROC) Sampling Time	s	60	3600 default	60	1	3600	resets
Time from initial release until ESDs manually or remotely closed	minutes	180	720 default	180	60	720	resets
Time from initial release until ignition or stop flow	minutes		720 default	720	60	720	resets

V3. **Click on the Calculate EPZ command,  , from the button-bar or menu to re-run the calculations for the new entries. The new results will look like the table displayed on the ERP SUMMARY page and shown below:**

LABEL 1|LABEL 2|LABEL 3 GAS PIPELINE

Emergency Response and Planning Zones



LEGEND		CALCULATED
IIZ	Initial Isolation Zone	0.44 km
PAZ	Protective Action Zone	1.36 km
EPZ	Emergency Planning Zone	1.59 km

IMPORTANT: Each zone submitted as part of an ERP must reflect site-specific features such as population density, topography, access/egress routes and any other identifiable factors that may affect timely implementation of emergency response procedures. Thus each zone distance calculated by ERCBH2S may require further consideration for planning or during response. The implied shape of the combined planning zones represented here, therefore, is a schematic simplification for display purposes.

On the **ERP SUMMARY** page, the hazard zones are significantly reduced from the **NO MITIGATION** ESD instrumentation settings. These results may be advantageous from an emergency planning perspective and for general public safety. It remains to be examined by the operator if the normal fluctuation of pressure through the pipeline segment (due to process or load fluctuations) may trigger false ESD closures.

11. EXAMPLE 2: Gas Well

Tutorial

By working through pre-loaded example files, you will become acquainted with:

- the *ERCBH2S* screen in Excel,
- some of the pages in *ERCBH2S* (Inputs, Batch and ERP Summary Page),
- user controlled input data, and
- terminology used throughout the guide.

If you have not done the tutorial '**QUICK-START TUTORIAL**' (Chapter 3 - page 16) please do it now.

If you have not read Chapter 5 - **INPUTS PAGE** (page 53), please do it now (it is pre-requisite familiarity for the tutorials).

In *ERCBH2S*, emergency response and planning (ERP) zone calculations have certain assumptions and processes to model the sour gas well release and its subsequent behaviour. To acquaint the user with some of these attributes and terminology, the following summary is provided:

Sour Gas Release Characteristics

- Source conditions are determined by reservoir engineering. Flow rate to surface is not regulated by engineering controls and the failure is typically an uncontrolled-high pressure, high flow rate, low temperature release.
- A sour gas well release is typically a steady flow rate (constant with time) release (steady jet).

Release Height

A nominal height of 1 m is used in the air quality modelling simulations. Well releases typically result from a loss of control situation (during drilling, work-overs, completion or re-completion), or during production, with the emission point to atmosphere at or near ground level.

Horizontal or Vertical Release

A sour gas well release jet could be re-directed as a result of interaction with nearby obstacles such as the rig itself or piping. The release jet could also be from a malfunction or piping failure at the well head. Therefore, the resultant jet could be horizontal (parallel to the ground surface) or vertical (perpendicular to ground surface). A horizontal release, which errs on the side of caution, is assumed in *ERCBH2S*.

Dense or buoyant

A sour gas well is supplied by a reservoir at high pressure and high temperature. As the release flows up the well bore it cools due to expansion and transfers heat to the ground. Using a stagnation temperature, *ERCBH2S* determines the exit pressure according to the specified flow rate. When the flow exits the well bore to atmospheric pressure, a choked flow condition occurs. Resulting expansion effects cause temperature drop, creating initial dispersion conditions that may be dense. *ERCBH2S* selects the stagnation temperature which results in a dense release, thereby erring on the side of caution.

Step-By-Step Procedure

To follow along with this hands-on sour gas well release example:

> If you have pre-set the install option for *ERCBH2S.xla* (**STEP 2: Activating the ERCBH2S Add-In** on page 12) go directly to step **2** in this tutorial. Otherwise, begin at step **1**.

1. Click on the **Start** menu button on your computer desktop.

Select **Programs**

Select **ERCBModels**

Select **ERCBH2S**

Select **Launch ERCBH2S.xla**

(The *ERCBH2S* menu in **Excel** is now launched)

Choose '**Enable Macros**'

2. Click on the **Start** menu button on your computer desktop.

Select **Programs**

Select **ERCBMODELS**

Select **ERCBH2S**

Select **ERCBModels**

Select **ERCBH2S-Inputs(V120).xls**

3. The *Gas Well* example file already contains in the row 11 in the BATCH page. Alternatively, you can move this record (row) from **BATCH** page to **INPUTS** page follow the instruction in '**From BATCH to INPUTS**' (page 120). A complete description of all the entry cells is in Chapter 5 - **INPUTS PAGE** (page 53).

ERP zones have already been calculated for the example file, and the results are shown on the **ERP SUMMARY** page. If the user changes certain key entries on the **INPUTS** page, the wording inside a **red flag** warning banner (that will appear at the top and bottom of both the **INPUT** and **ERP SUMMARY** pages) warns the user that re-calculations are required (because user inputs are not = to the program outputs). If this type of warning appears at anytime during this tutorial do not be alarmed. The ERP zones (outputs) will be re-calculated in the last steps of the tutorial (using the new inputs), thereby removing these particular **red flag** warnings.

Red flag warnings are described in more detail in Chapter 5 under Red Flags and other Warnings.

4. **Administrative** Input Group

ADMINISTRATIVE	Units	User Input	Comments	Warnings (if applicable)
Contact	Phone	G		
	Fax	H		
	eMail	I		
SCENARIO NAME		Label 3 Gas Well	UNIQUE description - Label 3 (i.e., Mitigation Option 1, Upstream to Downstream Node)	
SOUR OPERATIONS TYPE		Gas Well	Select the Type of Sour Gas or Sour Liquid operation	
ANALYSIS TYPE		(•) NO MITIGATION ( ) WITH MITIGATION	Select "NO MITIGATION" or "WITH MITIGATION"	**Uncontrolled H2S Release**
Name of Well / Pipeline Licence Number		Label 1	Label 1	
Well Licence Number or Well Application Number		K	enter na if pipeline or new well	
Legal Surface Location of Well or Pipeline Line Number		Label 2	LSD-SEC-TWP-RGE W?M - Label 2	
Pipeline Segment From Location (enter na if well)		M	LSD-SEC-TWP-RGE W?M	
Pipeline Segment To Location (enter na if well)		N	LSD-SEC-TWP-RGE W?M	
Surface Elevation	m (ASL)	1000	at facility or average in ERP area	
Existing EPZ Distance	km	na	enter na if not applicable	
Datum for Surface Locations		OTHER	mapping datum for locations	
Selected Inputs Flavour		2	**GAS WELL (steady horizontal jet)**	

Try deleting some of the entries, and observe the warnings that appear in column 'E'. This column provides warnings for the user. Warnings also appear inside a **red flag** warning banner across the top and bottom of the page.

Select the 'undo' button to replace the entries, and the warnings will be removed. Warnings are described in more detail in Chapter 5 under Red Flags and other Warnings.

Use the drop-down box to select the pipeline substance category according to ERCB *Directive 056*. Acid Gas pipelines must be identified separately, even though they are licensed as 'Sour Gas' pipelines.

5. Calculation Controls portion of the **ADMINISTRATIVE** Group

SCENARIO NAME	Label 3 Gas Well	UNIQUE description - Label 3 (i.e., Mitigation Option 1, Upstream to Downstream Node)	
SOUR OPERATIONS TYPE	Gas Well	Select the Type of Sour Gas or Sour Liquid operation	
ANALYSIS TYPE	(•) NO MITIGATION ( ) WITH MITIGATION	Select "NO MITIGATION" or "WITH MITIGATION"	**Uncontrolled H2S Release**

For wells, 'Sour Operations Type' is determined by the well's 'ERCB *Directive 056*' substance, and the wells' Gas to Liquid Ratio (GLR).

Use the drop-down box to select the substance. By trying different selections, you will see that some choices move you to the 'Liquid Pipeline/Well' group. Replace the original selection of 'Sour Gas Well'.

6. **Gas Well** Details Input Group

GAS WELL (includes oil well and other well with Gas to Liquid Ratio>1000)	Units	User Input	Comments	Warnings
Phase of Well Operations ?		Drilling		
Is Well Classified as Critical ?		(•) Critical ( ) Non-critical	as per Directive 056	
Unique Well Identifier		0	??/LSD-SEC-TWP-RGE W?/?	
Well Centre	m	P	X (east-west)	
Surface Location Coordinates	m	Q	Y (north-south)	
Casing or Tubing Inside Diameter	mm	165.6		
Expected Maximum H2S Concentration	%(dry), (15°C, 101.325 kPa)	14		
H_2S Release Rate (Cumulative if Multi-zone)	m^3/s (15°C, 101.325 kPa)	2		
SOURCE MITIGATION		**USER OVER-RIDE OF DEFAULT**	**DEFAULT**	**MODEL INPUT**
Is Surface Controlled Sub Surface Safety Valve Installed ?		( ) SCSSSV (•) No SCSSSV		
Time from initial release till ignition or stop flow	minutes		720 default	720

There are three types of '**Phase of Well Operations**': **Drilling**, **Completion/Servicing/Workover**, and **Producing/Injection/Suspended**.

ADMINISTRATIVE	Units	User Input	Comments
Phase of Well Operations ?		Drilling	
Is Well Classified as			as per Directive 056
Unique Well			??/LSD-SEC-TWP-RGE W?/?
Well Centre	--	P	X (east-west)
Surface Location Coordinates	--	Q	Y (north-south)
Casing or Tubing Inside Diameter at Exit	mm	165.6	
Expected Maximum H_2S Concentration	% (dry), (15°C, 101.325 kPa)	14	
H_2S Release Rate (Cumulative if Multi-zone)	m^3/s (15°C, 101.325 kPa)	2	

Drilling
Completion/Servicing/Workover
Producing/Injection/Suspended

Try deleting the `165.6` entry and entering `1656`, a typo. Notice the Entry out of bounds warning appears in column E because the Casing or Tubing Inside-Diameter must not be greater than 500 mm (allowable entry ranges are displayed to the right of the **INPUTS** page – in columns H and I). Also notice the **red flag** banner that appeared at the top and bottom of the page. The user entry is obviously an 'out of bounds' error and has to be corrected for the model to run. Re-enter the `165.6`, and the 'Entry out of bounds' warning disappears.

GAS WELL (includes oil well and other well with Gas to Liquid Ratio>1000)	Units	User Input	Comments	Warnings
Phase of Well Operations ?		Drilling		
Is Well Classified as Critical ?		(•) Critical ( ) Non-critical	as per Directive 056	
Unique Well Identifier		O	??/LSD-SEC-TWP-RGE W?/?	
Well Centre	--	P	X (east-west)	
Surface Location Coordinates	--	Q	Y (north-south)	
Casing or Tubing Inside Diameter at Exit	mm	1656		Entry out of bounds
Expected Maximum H_2S Concentration	% (dry), (15°C, 101.325 kPa)	14		
H_2S Release Rate (Cumulative if Multi-zone)	m³/s (15°C, 101.325 kPa)	2		

7. Source Mitigation

The **SOURCE MITIGATION** sub-section is not currently 'open' because the **NO MITIGATION** analysis type is selected in the **ADMINISTRATIVE** section of the **INPUTS** page. The model will use the default SCSSSV option and mitigation time as shown.

See **Gas Well – Source Mitigation Sub-section** in **Chapter 5** for more information.

SCENARIO NAME	Label 3 Gas Well	UNIQUE description - Label 3 (i.e., Mitigation Option 1, Upstream to Downstream Node)	
SOUR OPERATIONS TYPE	Gas Well	Select the Type of Sour Gas or Sour Liquid operation	
ANALYSIS TYPE	( ) NO MITIGATION (•) WITH MITIGATION	Select "NO MITIGATION" or "WITH MITIGATION"	User Specified Source Mitigation

GAS WELL (includes oil well and other well with Gas to Liquid Ratio>1000)	Units	User Input	Comments	Warnings
Phase of Well Operations ?		Drilling		
Is Well Classified as Critical ?		(•) Critical ( ) Non-critical	as per Directive 056	
Unique Well Identifier		O	??/LSD-SEC-TWP-RGE W?/?	
Well Centre	--	P	X (east-west)	
Surface Location Coordinates	--	Q	Y (north-south)	
Casing or Tubing Inside Diameter at Exit	mm	165.6		
Expected Maximum H_2S Concentration	% (dry), (15°C, 101.325	14		
H_2S Release Rate (Cumulative if Multi-zone)	m³/s (15°C, 101.325	2		
SOURCE MITIGATION		USER OVER-RIDE OF DEFAULT	DEFAULT	MODEL INPUT
Is Surface Controlled Sub Surface Safety Valve Installed ?		(•) SCSSSV ( ) No SCSSSV		
Time from initial release until ignition or stop flow	minutes		720 default	720

Note that for wells, the default setting for 'Time from initial release until ignition or stop flow' changes with the Phase of Well Operation – which indicates if the site is manned or un-manned (subsequently affecting the time to implement mitigation measures).

For *Producing/Injection/Suspended* wells with a SCSSSV, the default minimum 'Time from initial release until ignition or stop flow' is 3-minutes. For *Drilling* or *Completion/Servicing/Workover* wells with a SCSSSV, the

default minimum 'Time from initial release until ignition or stop flow' is 15-minutes.

If the *User Input* is out of the range of the default settings, the *MODEL INPUT* cell gives an Orange Warnings. For example, for a *Drilling* well, if the user inputs 3-minutes for 'Time from initial release until ignition or stop flow', the *MODEL INPUT* cell shows a warning. Because the user input is less than the default minimum 15-minutes ignition time for a drilling phase.

GAS WELL ***(includes oil well and other well with Gas to Liquid Ratio>1000)***	**Units**	**User Input**	**Comments**	**Warnings**	**Min**	**Max**
Phase of Well Operations ?		Drilling			--	--
Is Well Classified as Critical ?		◉ Critical ○ Non-critical	as per Directive 056		--	--
Unique Well Identifier		0	??/LSD-SEC-TWP-RGE W?/?		--	--
Well Centre	--	P	X (east-west)		--	--
Surface Location Coordinates	--	Q	Y (north-south)		--	--
Casing or Tubing Inside Diameter at Exit	mm	165.6			10	1000
Expected Maximum H_2S Concentration	% (dry), (15°C, 101.325 kPa)	14			0.01	100
H_2S Release Rate (Cumulative if Multi-zone)	m^3/s (15°C, 101.325 kPa)	2			0.000001	100
SOURCE MITIGATION		**USER OVER-RIDE OF DEFAULT**	**DEFAULT**	**MODEL INPUT**	**Min**	**Max**
Is Surface Controlled Sub Surface Safety Valve Installed ?		◉ SCSSSV ○ No SCSSSV			--	--
Time from initial release until ignition or stop flow	minutes	3	720 default	15	15	720

However, if the user chooses a *Producing* phase instead of a *Drilling* phase, the 3-minutes ignition time is acceptable because the minimum ignition time for a *Producing* phase is 3-minutes. The *MODEL INPUT* cell does not show any warnings here.

GAS WELL ***(includes oil well and other well with Gas to Liquid Ratio>1000)***	**Units**	**User Input**	**Comments**	**Warnings**	**Min**	**Max**
Phase of Well Operations ?		Producing/Injection/Suspended			--	--
Is Well Classified as Critical ?		◉ Critical ○ Non-critical	as per Directive 056		--	--
Unique Well Identifier		0	??/LSD-SEC-TWP-RGE W?/?		--	--
Well Centre	--	P	X (east-west)		--	--
Surface Location Coordinates	--	Q	Y (north-south)		--	--
Casing or Tubing Inside Diameter at Exit	mm	165.6			10	1000
Expected Maximum H_2S Concentration	% (dry), (15°C, 101.325 kPa)	14			0.01	100
H_2S Release Rate (Cumulative if Multi-zone)	m^3/s (15°C, 101.325 kPa)	2			0.000001	100
SOURCE MITIGATION		**USER OVER-RIDE OF DEFAULT**	**DEFAULT**	**MODEL INPUT**	**Min**	**Max**
Is Surface Controlled Sub Surface Safety Valve Installed ?		◉ SCSSSV ○ No SCSSSV	No SCSSSV	SCSSSV	--	--
Time from initial release until ignition or stop flow	minutes	3	3 default	3	3	3

The default setting for '**Time from initial release until ignition or stop flow**' changes with the **Phase of Well Operation**.

It is user's responsibility to choose the correct **Phase of Well Operation**.

8. **Sour Gas Composition** Input Group

The gas composition (mole fraction) for the example well file is provided. This particular sample represents a composite average of sour wells in Alberta, and is intended only for use in this tutorial (users must supply appropriate representative analysis data for the sour gas well being modeled).

Sour Gas Composition ***(gas phase at 15°C & 101.325 kPa, dry, representative analysis)***	**Units**	**User Input**	**Comments**	**Warnings (if applicable)**
H_2	mole fraction			
He	mole fraction	0.0006		
N_2	mole fraction	0.0283		
CO_2	mole fraction	0.0427		
H_2S	mole fraction	0.0259	Adjusted to Maximum H_2S Input for Level and Modelled H_2S Input for EPZ	
CH_4	mole fraction	0.8137		
C_2H_6	mole fraction	0.0488		
C_3H_8	mole fraction	0.0208		
i-C_4H_{10}	mole fraction	0.0036		
n-C_4H_{10}	mole fraction	0.0065		
i-C_5H_{12}	mole fraction	0.002		
n-C_5H_{12}	mole fraction	0.0021		
n-C_6H_{14}	mole fraction	0.002		
n-$C_7H_{16}^+$	mole fraction	0.003		
Total	mole fraction	1	Sum must equal one	

Observe the comment in column D beside the H_2S entry. For this particular example file, this comment means that although the gas analysis H_2S content is less than 3 %, the analysis will be re-adjusted to the expected maximum H_2S concentration of 14 % (entered in the **GAS WELL** details group).

In adjusting a gas analysis composition, *ERCBH2S* changes the reference H_2S entry to equal the 'maximum expected H_2S' entry, and then pro-rates all other reference gas analysis components according to their new fractional contribution to the total analysis (renormalized). The adjusted analysis can be immediately viewed on the ERP summary page, because the calculations are performed by Excel – no *ERCBH2S* program 'run' commands are needed for the conversion. All *ERCBH2S* program calculations will reference the adjusted analysis.

GAS WELL (includes oil well and other well with Gas to Liquid Ratio>1000)	Units	User Input	Warnings	GAS PHASE FRACTIONS	INPUT	EXPECTED	LICENCED
Phase of Well Operations ?	--	Drilling		H_2	0.0000	0.0000	0.0000
Is Well Classified as Critical ?	--	Critical		He	0.0006	0.0005	0.0005
Unique Well Identifier	--	0		N_2	0.0283	0.0250	0.0250
Casing or Tubing Inside Diameter at Exit	mm	165.6		CO_2	0.0427	0.0377	0.0377
Expected Maximum H2S Concentration	% (dry), (15°C, 101.325 kPa)	14		H_2S	0.0259	0.1400	0.1400
H2S Release Rate (Cumulative if Multi-zone)	m³/s (15°C, 101.325 kPa)	2		CH_4	0.8137	0.7184	0.7184
SOURCE MITIGATION		MODEL INPUT		C_2H_6	0.0488	0.0431	0.0431
--	--	--		C_3H_8	0.0208	0.0184	0.0184
Time from initial release until ignition or stop flow	minutes	720		i-C_4H_{10}	0.0036	0.0032	0.0032
--	--	--		n-C_4H_{10}	0.0065	0.0057	0.0057
--	--	--		i-C_5H_{12}	0.0020	0.0018	0.0018
--	--	--		n-C_5H_{12}	0.0021	0.0019	0.0019
--	--	--		n-C_6H_{14}	0.0020	0.0018	0.0018
--	--	--		n-C_7H_{16}+	0.0030	0.0026	0.0026
--	--	--		H_2O	--	0.0000	0.0000
--	--	--		Total	1.0000	1.0000	1.0000
--	--	--					
--	--	--					

See Sour Gas Composition in Chapter 5 for more information.

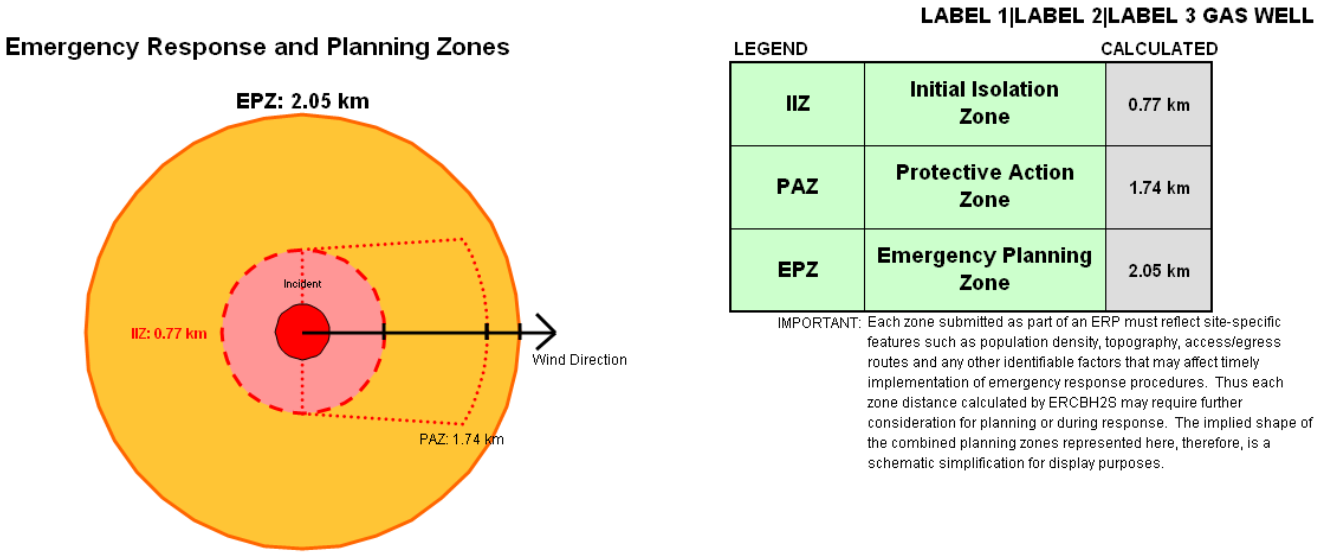
9. Run Calculate EPZ

After pressing the **Calculate EPZ** button,  , a confirmation dialog is presented, asking if you are sure you want to continue. The calculations may take several moments to perform depending on the processing power of the computer used. Select **OK** to continue.

After the *ERCBH2S* calculations are completed, the **ERP SUMMARY** page is displayed to view a summary of the calculation results.

10. ERP SUMMARY Page Results

The **ERP SUMMARY** page displays a planning and response zone graphic, as shown below.



The table to the right of the schematic lists each of the emergency response and planning zones.

11. Saving data to the BATCH Page

Save entries from the **INPUTS** page to the **BATCH** page, by pressing the **Save INPUTS and Results to Batch Page** button,  , while on the **INPUTS** page. This command also **saves all calculation results** – including the **OUTPUT** data.

Select the **BATCH** page tab. Notice that row 11 has entries. Scroll across the sheet to see the inputs and outputs. Further changes to this scenario can now be made directly on the **BATCH** page. When the new scenarios are 'run', the calculation results can be easily compared to each other because the results will be listed one over the other – all within one column and all of one page. For example, calculated EPZ results are listed in column DO on the **BATCH** page.

Variation 1, performed from the **BATCH** page, provides important practice in working between the **BATCH** and **INPUTS** pages. The actions described are applicable to other *ERCBH2S* applications – not just sour gas wells.

Variation 1: Sour Gas Well – Change Time to Ignition

Additional information has been obtained for this sour gas well through expert training and testing on-site. The report suggests that the well could be ignited if required in 12 minutes. Although your expert testing and

documentation indicates 12 minute ignition time is possible, ERCB *Directive 071* does not allow for ignition times of less than 15 minutes.

On the **BATCH** page, duplicate the first scenario/row you entered (previous step **11**) using Excel's usual 'click and copy' feature to copy the row's **INPUT** details (which end at column DN); then append/paste them to the same range in row 12. Now avoid making changes to row 11 on the **BATCH** page to maintain the input and output data integrity of this row.

Change the scenario name for the new row (row 12) in column **L** on the **BATCH** page.

Use caution if you chose to copy the **OUTPUT** results from the original scenario and apply them to the newest scenario. If you did, the safest option is to simply delete them for the new row/scenario (**OUTPUTS** begin at column **DO**). Otherwise, future input changes for the new row may appear to coordinate with 'old' output results since they are also on the same row on the **BATCH** page. Eventually, the new inputs will be used for new calculation but until then, it is better not to list false results.

The 'Erase all output fields' button  does not erase anything stored on the **BATCH** page – it erases outputs from other *ERCBH2S* pages.

V1a. Scroll over to column **BA** in the Well Details Group (Time from initial release till ignition or stop flow) and enter `12` (do not include units of minutes).

V1b. Now ensure the new scenario/row is flagged appropriately for 'run/not run'. The **Run/Not Run** column (column 'A') should have a **1** in it to ensure the new scenario is 'run' when one of the *ERCBH2S* program-**RUN** commands is activated. You may wish to change the **Run/Not Run** indicator of the last scenario/row to a **0** since calculations for this scenario do not need to be repeated.

V1c. Click on the row number for the new row/scenario (extreme left side of the **BATCH** page). Then click on the **Copy current batch record to INPUTS** command,  from the button bar. This copies the entries for the new scenario over to the **INPUTS** page. The screen automatically changes to show the **INPUTS** page, populated with input data from whatever row was highlighted on the **BATCH** page.

Note - this is the only way to view any data entry warnings and/or 'orange re-sets'.

Red flag warning banners, orange warnings and orange resets related to user inputs do not appear on the **BATCH** page.

V1d. Scroll down the **INPUTS** page to 'Time from initial release till ignition or stop flow' in the Gas Well details group under Source Mitigation. Notice that although you entered 12 minutes for this entry on the **BATCH** page, the field is 'greyed out' on the **INPUTS** page; and the 'Model Input' value assigned to this field is 720 minutes (shown in the right-hand column).

This is because in the Administrative section, the Analysis Type selected is still **NO MITIGATION**. Change it **WITH MITIGATION**.

Now your entry of 12 minutes is allowed to appear. This input was brought over from the **BATCH** page with all of the other inputs, but appeared 'greyed-out' because access to Source Mitigation was not activated.

Observe that in the right-hand column under Model Input, *ERCBH2S* has an 'orange reset' entry of 15 minutes.

SOURCE MITIGATION		USER OVER-RIDE OF DEFAULT	DEFAULT	MODEL INPUT	Min	Max	Action
Is Surface Controlled Sub Surface Safety Valve Installed ?		○ SCSSSV ◉ No SCSSSV			--	--	--
Time from initial release till ignition or stop flow	minutes	12	720 default	15	15	720	resets

This is because 15 minutes is the minimum allowed value for this field.

Toggle back over to the **BATCH** page. Notice that the option selected in column N (Analysis Type) is still a 1 (**NO MITIGATION**). When this option was changed on the **INPUTS** page, the change was **not** automatically reflected on the **BATCH** page.

Input data on the **BATCH** page is only changed by either 'over-writing an existing scenario on the **BATCH** page with a new **INPUTS** page (same scenario name), or by directly making the data change on the **BATCH** page. For any given scenario, there is no 'live/active link' between the **BATCH** and **INPUTS** page.

Also notice that the user input for column BA (Time from initial release till ignition or stop flow) is still 12 minutes, even though you know the model will use 15 minutes.

When *ERCBH2S* assigns a different value to a user entry (an 'orange reset'), the 'reset' value does not appear on the **BATCH** page. The only way to see an 'orange reset' for a **BATCH** page scenario/record is to view the record on the **INPUTS** page.

V1e. For practice, make the needed changes from the **INPUTS** page rather than making them directly on the **BATCH** page.

Toggle back over to the **INPUTS** page. It appears **EXACTLY** as you last left it. Because 'Analysis Type' is already changed to **WITH MITIGATION**, the only other needed change is the user input in 'Source Mitigation'. Change the entry from 12 to 15, and the 'orange reset' is removed.

V1f. Now you will 'over-write' a scenario on the **BATCH** page with a new **INPUTS** page.

Recall that when an **INPUTS** page is saved to the **BATCH** page, **ALL** calculation results (including **OUTPUTS**) go with it. Right now the **ERP SUMARY** page still has calculation results from the last scenario that was 'run', and you do NOT want these results to be saved for your new row on the **BATCH** page.

When copying an **INPUTS** page to a **BATCH** page, ALL calculation results (including **OUTPUTS**) are appended/copied to the **BATCH** row/record.

However, when copying/reading a **BATCH** record/row to the **INPUTS** page, only the **BATCH** input records are copied over. Any associated calculation results for the **BATCH** row/record are not brought along.

Activate the 'erase all output fields'  button to re-set calculation results to '0' before moving the **INPUT**S page to a **BATCH** record.

From the **INPUTS** page, activate the **SAVE TO BATCH** button  . Because the scenario name already exists on the **BATCH** page, the user is prompted to either accept the save operation or to cancel. Choose the 'save' operation, and the record on the **BATCH** page with the identical **SCENARIO NAME** is **completely** overwritten with the new data from the **INPUTS** page (including whatever calculation results and output data is tied to the **INPUTS** page).

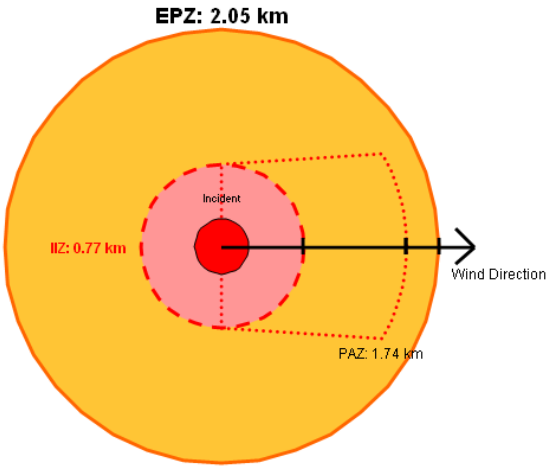
V1g. View the changed row on the **BATCH** page. Go to the outputs area (column **DO**) and observe the recorded outputs. Recall that you erased the outputs before you performed the save. Also notice the error messages in column **DO**, cautioning the user that the outputs listed do not match the inputs. This message appears because it was copied over when you performed the save. Messages in this column are not activated by simply changing information on the **BATCH** page. They are recorded only through either a '**SAVE TO Batch**' operation, or when a scenario on the **BATCH** page has received a '**Batch Calculate EPZ**' command (or other program 'run' commands).

V1h. Finally, activate the **Batch Calculate EPZ** command,  from the button-bar at the top of the **BATCH** page. This executes the complete set of 54-meteorological cases in the screening matrix calculation for each scenario/row on the **BATCH** page that is included in the 'run' (has a '1' in column 'A' on the **BATCH** page).

V1i. The new results will look like the table displayed on the **ERP SUMMARY** page as shown below:

LABEL 1|LABEL 2|LABEL 3 GAS WELL

Emergency Response and Planning Zones



LEGEND		CALCULATED
IIZ	Initial Isolation Zone	0.77 km
PAZ	Protective Action Zone	1.74 km
EPZ	Emergency Planning Zone	2.05 km

IMPORTANT: Each zone submitted as part of an ERP must reflect site-specific features such as population density, topography, access/egress routes and any other identifiable factors that may affect timely implementation of emergency response procedures. Thus each zone distance calculated by ERCBH2S may require further consideration for planning or during response. The implied shape of the combined planning zones represented here, therefore, is a schematic simplification for display purposes.

V1j. To compare the EPZ results from the first scenario to the new scenario, go to column DP on the **BATCH** page. Notice that the EPZ distance has decreased. In fact, all of the zones have decreased but not in the same proportions.

12. Troubleshooting and FAQs

Non-reportable Error Messages

Many of the error messages are shown to assist the user. They have been generated as a result of user inputs that create calculation errors or that something non-routine has occurred and the program is trying to recover. Most of these types of errors follow from inputs that exceed normal ranges of the parameter. To problem solve these error messages, follow the steps below:

1. Review the inputs relating to the error message. Ensure that the inputs are within the normal ranges for the field-operation and within the normal range suggested in the spreadsheet input. Check for missing inputs. Re-read the User Guide or Technical Reference Document to ensure that you have interpreted the inputs correctly for what the program expects.

2. Use the example inputs provided in the User Guide as a starting point for your assessment of the operation. Then change the example inputs to match your conditions. (Remember to save the file with a new name so the original template file is not changed).

3. Compare each input to one of your own assessments that works correctly.

4. If all of your inputs appear satisfactory, but an error message still occurs, then report the error message and provide a copy of the inputs to ERCB. See section 'Reportable Error Messages'.

Reportable Error Messages

While every attempt has been made to ensure programming errors and compatibility issues don't arise, computer configurations vary by personal preferences and therefore issues may arise. If an issue is discovered, please report it to ERCB for inclusion in the next *ERCBH2S* release along with a copy of the spreadsheet that may duplicate the error, to:

EPAssessment@ercb.ca

ERROR #9

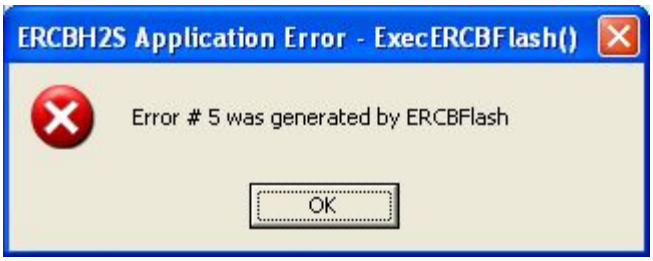
This error message could result from a software compatibility error. Contact ERCB and send the ERCB a copy of your spreadsheet that duplicates the error message occurrence along with a description of how to duplicate the error message.

ERROR #1004

This error message may occur due to a programming error or compatibility issue.

If modelling pipelines with very short line lengths (less than 10 m), try increasing the line length 1 metre at a time to see if 'Calculate EPZ' can be executed without getting the same message. You shouldn't need to go higher than about 10 metres. If this solves the problem, then simply subtract the extra line length from the adjoining pipelines.

ERROR #9005



This error message is a result of the *ERCBH2S* **FLASH** program encountering 'solving' difficulties based on user inputs.

First, user inputs should be reviewed for accuracy. If all inputs are correct, sometimes small changes to the inputs will help the **FLASH** program overcome

the ‘solving’ difficulties. Although the following recommended ‘alterations’ require a user to deviate from the actual ‘real’ input scenario, the deviations are very minor and would not be considered in any ERCB enforcement action. If slight alterations to a user’s inputs are necessary to help the **FLASH** program solve, the input changes should be noted in a letter to the ERCB that accompanies the *ERCBH2S* submission.

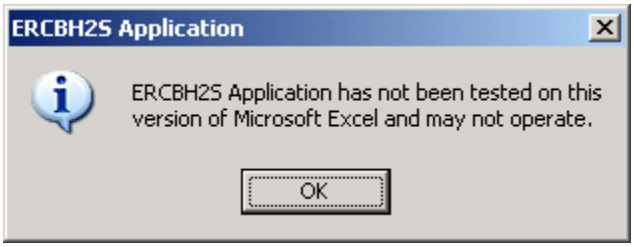
Suggested input ‘alterations’ and acceptable degree of variation from ‘actual’ values:

1. Tubing or Casing Inside-Diameter affects the back pressure – first make sure the input diameter, H_2S release rate and H_2S concentration are reasonable. Does the cac pressure in INUTS K57 seem reasonable? Try increasing the diameter slightly. Sometimes a change of only 1 mm solves the **FLASH** problem. Do not change this input more than 10 %.

2. Gas Analysis – try changing some of the heavy ends. Add the C7’s to the C6’s. If this doesn’t work, add the C7’s and C6’s, to the C5’s. If this doesn’t work, add the C7’s, C6’s and the C5’s, to the C4’s. Do not change an analysis anymore than this. While analysis changes like these do not normally affect the size of the EPZ, they may help the **FLASH** program to solve.

3. Temperature – if temperature was available as a user input, try changing the temperature a few degrees. Do not change the temperature by more than a few degrees.

Version Issue



ERCBH2S was tested to operate with Excel 2000 (Excel Version 9), 2002 (Excel Version 10), 2003 (Excel Version 11), 2007 (Excel Version 12), and 2010. While every attempt has been made to ensure compatibility issues don’t arise, computer configurations vary by personal preferences and therefore compatibility issues may arise. If an issue is discovered, please report it to ERCB for inclusion in the next *ERCBH2S* release.
There have been reported issues related to running the *ERCBH2S* Application with Excel 97. The *ERCBH2S* Application is not supported on Excel 97.

Installation Troubleshooting

1. Administration Privilege for Windows

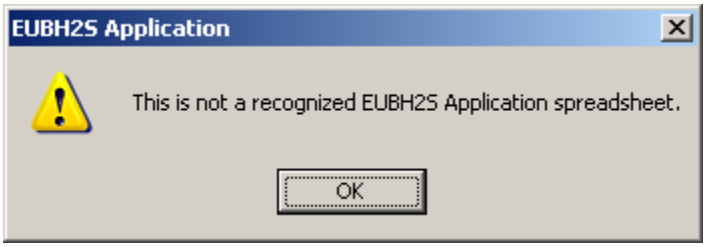
During software installation, the Windows operating system may display a message regarding a requirement for **Administrator Privilege** to install the software. To check if you have **Administrator Privileg**e for the account you use to *Logon* into Windows, follow these steps:

a. Click the Windows **Start** button, select **Settings**, choose **Control Panel**.
b. Double click the **User Accounts** icon.
c. If you account *Logon* is displayed at the bottom of this window with the description: **Computer Administrator**, you have the correct administrator privileges to install the software.

Program Troubleshooting

Not an ERCBH2S Spreadsheet

This error message may be displayed if a *ERCBSLAB* application menu or calculation was attempted on an Excel spreadsheet that was not a recognized *ERCBSLAB* spreadsheet.



General Troubleshooting

Excel Security Levels and Running the *ERCBSLAB* Application

If your Excel security setting is High, the *ERCBH2S* application may be prevented from running. You can either reset your security level to allow it

to run or add the *ERCBH2S* add-in via the Add-In manager. Check with your computer network administrator regarding security level protection and running add-in macros on your computer.

Interfacing with other User Spreadsheets

The **Batch** page is designed to be flexible and adaptable to user modifications for linking to in-house databases or networks. Data in the *Batch* page:

- can be a stand alone database for user;
- can be expressions referencing values in the user database;
- although columns cannot be created or destroyed, cells to the right of the Batch records can be modified as the user requires to link their database to this required input cells;
- rows cannot be created or destroyed due to the security protection on the datasheet. However, information in the row can be erased (cleared) and gaps between rows can be filled by moving the data in the rows up or down to accommodate the gaps;
- use of the *Silent Start* option allows interfacing of *ERCBH2S* with programs such as *Crystal Ball*© and *@Risk*©.

ERCBFLASH ERRORS

The following error numbers may be returned from the ERCBFLASH program. These errors typically result from extreme gas compositions where chemical-physical properties are difficult to predict or where critical levels are reached and phase changes may occur. To correct the problem, the gas composition may be documented and modified slightly.

ERCBH2S ERROR CODE	ERCBFLASH ERROR CODE	DESCRIPTION
9000	0	Normal termination
9001	1	Error: Pure Helium specified Complete Data not available in database
9002	2	Bad source type specification: It can be only 1 or 2 for Pipeline or Well respectively
9003	3	Error All Input Components' Compositions are Zero
9004	4	The initial conditions of the source type not set properly
9005	5	Flash Calculation Failure Please Check the Input Data
9006	6	Failure in Bubble Temperature Calculations. Please Check the Input Data
9007	7	Cp Vapour Calculation Failure Please Check the Input Data
9008	8	Maximum Iterations Exceeded during ambient pressure critical flow checking
9009	9	Error Calculating Isentropic Back Pressure for subsonic flow

ERCBSLAB ERRORS

The following error codes are returned from ERCBSLAB. These Error codes in *ERCBH2S* are prefixed by 5000.

ERCBH2S ERROR CODE	ERCBSLAB ERROR CODE	DESCRIPTION
5000	0	Normal program termination. No errors detected
5001	1	Zo <0 termination flag set. The original SLAB program used Zo to control looping. This flag has been maintained for consistency.
5003	3	Source height too tall. Input source height (hs) is greater than the calculated mixing layer height (hmx) minus the stack half width (bs).
		Invalid Input Parameter Errors
6001	1001	WMS Molar mass of source material was <=0. or >1.0 kg/mole
6002	1002	CPS, Vapour heat capacity was <=100. or >10000.0 J/kg/K
6003	1003	TBP, Boiling point temperature was <=1. or >1000.0 K
6004	1004	CMEDO, Initial liquid mass fraction was <0. or >1.0
6005	1005	DHE, Heat of vaporization was <1.E2 or >1.E12 J/kg
6006	1006	CPSL, Liquid specific heat was <100. or >1.E6 J/kg/K
6007	1007	RHOSL, liquid density was <.1 or >1.E4 kg/m^3
6008	1008	xxALPHA, Time factor was <0.
6009	1009	xxBETA, time constant was <0., s
6010	1010	TN, Concentration exponent for toxic load was <0. or >10.
6011	1011	TKL, Toxic load factor to account for fluctuations was <0.
6012	1012	TACH, Building air changes per hour was <0.
6013	1013	TH2S, Percent H_2S in source mixture was <=0. or >100 %
6014	1014	TS, Temperature of source material was <23.K or >1273.K
6015	1015	QS, Mass source rate was <0.0 kg/s
6016	1016	AS, Source area was <0.0 m^2
6017	1017	TSD, Continuous source duration was < 0 kg
6018	1018	QTIS, Instantaneous source mass released was <0. kg
6019	1019	HS, Source height was < 0 m
6020	1020	HS, Source height was < 0 m
6021	1021	XFFM, Maximum downwind distance for ERCBSLAB calculations was <1 or > 30000 m
6022	1022	ZA, Reference height for ambient wind speed anemometer was <1 or >100 m
6023	1023	UA, Ambient wind speed was <0 or >100 m/s
6024	1024	TA, Ambient temperature was <173K or >373K
6025	1025	RH, Relative Humidity was <0 or >100 %
6026	1026	PA, Atmospheric pressure was <60000. or >105000.0 Pa
6027	1027	STAB, Stability class number was <0 or > 7

FAQs

Issue: Sweet pipeline tie-in to a sour gathering system.

A company is tying a sweet pipeline into one containing H_2S. Since the model assumes flow from either end of the pipeline until the ESD shuts, the company assumes that there will be a possibility of H_2S flowing back into the sweet line, and that therefore there could be a release. The company has tried to model this sweet line and the sour one, assuming the model will account for the backflow and provide a small EPZ for the sweet line.

Answer:

ERCBH2S only has the capability of modelling gas that contains H2S. When a company enters 0 % H2S into the model, it is forced to divide by zero, producing no answer. The key message is that the ERCB has never asked companies to account for backflow and calculate EPZs for sweet lines. The model is not built to handle that calculation. Therefore companies should assume 0 m EPZ on all sweet lines.

Issue: How do ESDs and check valves (CV) differ in the model?

A company indicates in its model that a pipeline has an ESD on one end of its line and a CV on the other end. Given that a CV immediately prevents backflow, the company assumed that any additional flow to the line between the time of a pipeline release and the time the ESD shut would only come from the end of the line where the ESD is located. However, when the company ran the model, a much larger EPZ than anticipated was predicted.

Answer:

ERCBH2S treats ESD valves and check valves the same for EPZ calculations. This means that the model assumes there could be backflow into a line, when in reality there would not be. The model was written this way for simplicity. If there is enough concern from industry, we may recommend that the model be changed.

Issue: Large EPZs on very short lines.

In some instances a line that is only 5 or 10 m in length can have EPZs several kilometres in diameter.

Answer:

There are three main things to look for here:

- whether the company has used mitigation or not,
- what the pressure rate of change on the ESDs is, and
- what the upstream and downstream line properties are.

The model assumes infinite flow from both upstream and downstream of a pipeline. Therefore a short line with no mitigation or a very low pressure rate of change (10 %) will have continual flow into it from both upstream and downstream. To mitigate this, the applicant must increase its pressure rate of change to ensure that the ESDs close sooner.

Issue: What does the ESD valve low pressure trigger mean?

Answer:

The low pressure trigger is the pressure set point where the ESDs on a pipeline close. The model asks companies to enter this value as a pressure value (kPa), but it is commonly discussed in terms of percentages. A low pressure trigger of 10 % means that the pipeline has to depressure to 10 % of its total operating MOP before the ESDs will close. Essentially, the pipeline must be empty before the ESDs close. This means the associated EPZ will be very large, almost equal to a case using no mitigation. A low pressure trigger of 90 % is generally unreasonable, as daily fluctuations in pipeline pressure would cause the ESDs to close. Many companies choose to use a low pressure trigger somewhere in the range of 50 %.

Issue: Lines with differing lengths having very similar EPZs.

All other input being equal, why do lines with differing lengths have virtually the same EPZ?

Answer:

The first this to do is check whether the company has modelled the lines using mitigation or not. If they have not (which will most likely be the case in these scenarios), the model assumes that the line will flow for 12 hours before the ESDs shut. If they have chosen “With Mitigation” but have a very low “low pressure trigger” (say, 10%), this is virtually the same as having no mitigation at all. The model assumes that the sections upstream and downstream of the ESD are infinite and will supply as much gas as needed until the pressure drops to the set point or the valves are closed manually. By selecting “With Mitigation” and entering values above the default, the EPZ becomes more sensitive to the line length.

Issue: The .csv file will not import into the model.

After importing, the model provides a message that states “Batch import successful! 0 records imported.”

Answer:

First, open the .csv file to make sure it looks correct and is the proper version (v1.19). The company may not have exported it correctly on its end. Instructions on how to export model runs are found on page 40 of the user guide.

If the .csv looks correct, the company may have accidentally saved it as an Excel file. Once a model run is exported, changes cannot be made to it. If you open the .csv, change something (or not), and then press "Save," Excel will automatically change it to Excel format. Even though the suffix is still .csv, it is actually now an Excel file. The only way to make changes to a .csv file is to import it back into the model, make changes on the input page, and then reexport it.

Issue: MOP input values.

Should the MOP values be for a sustained rate or should they include very short duration high pressure anomalies?

Answer:

The intent of the program is to calculate EPZs based on normal operating conditions, not anomalous or maintenance conditions. Therefore, all values entered should be reflective of normal operating conditions.

Issue: Companies want to use values lower than the default in the model.

There are cases where companies want to use values that are lower than the default. Specifically, they would like to use lower than 10 % for the low pressure trigger.

Answer:

The defaults in the model are there as safety measures; therefore, even if a company enters a lower value, the model will default to the higher number. If the company feels that the default is unreasonable, it can send feedback to EPAssessment@ercb.ca, and ERCB staff will look at it for future model revisions.

In the case of wanting a low pressure trigger less than 10 %, this number is already so low that it means the line will be virtually depressured before the ESDs close. If the company would like to use a lower value, it should choose "No Mitigation" instead.

Issue: Gas lift wells.

Answer:

Gas lift wells must be entered into the model using the release rate and H_2S when the lift is operating.

Issue: Wells that are "suspended" but do not meet the requirements of *Directive 013*.

Answer:

As these wells have not been suspended in accordance with *Directive 013*, companies must use the last available flow rate and gas analysis to calculate an EPZ.

Issue: CO2 modelling

Does the model take into account hazards associated with CO2?

Answer:

The model does have an input for CO2; however, it is meant to create an EPZ for hazards associated with H_2S only. If a company wishes to create a corporate-level plan to deal with CO2 hazards, it will have to do its own modelling to determine an EPZ.

Issue: Setback designation on summary page.

Why does the setback level sometimes indicate N/A?

Answer:

Setbacks only apply to sour gas pipelines with greater than 1 % H_2S, not natural gas pipelines. For model runs less that 1 %, N/A appears.

Issue: Different EPZ sizes for drilling and completions.

Applicants run the model for both drilling and completions and get different results. Which .csv should be submitted with the ERP? Which EPZ should be used for the ERP?

Answer:

If it is a drilling and completions ERP, it must be based on the larger EPZ of the two operations. The .csv for the larger operation must be submitted along with the ERP.

Issue: The EPZ on the *Directive 056* application is for production. Does that mean the ERP should be based on that EPZ?

Directive 056 requires that companies input the EPZ for the largest of (a) drilling, (b) completions/servicing, or (c) producing/suspended in the Schedule 4.3 application. In some cases, the largest EPZ will be associated with production.

Answer:

Though *Directive 056* requires notification to be based on the largest zone, *Directive 071* requirements are for drilling/completions only. Therefore, the ERCB does not expect a company's drilling/completions plan to be based on a production EPZ, nor does it expect applicants to do their *Directive 071* consultation out to the estimated production EPZ. The applicant will have to provide an explanation of why the EPZ in the application does not match that in the ERP.

Issue: What is the largest EPZ that the model will calculate?

Answer:

The largest EPZ the model will calculate is 30 km. Companies can change their operating procedures to try to reduce this value. Using mitigation, especially in populated areas, is strongly recommended. In remote areas, companies will have to do an analysis of whether the benefits of a reduced planning zone outweigh the costs of additional mitigation.

Issue: What release rate/release volume from the model should be used for the *Directive 056* application?

There are several different release rates/release volumes in the model. Which one is the correct one to use for the licence application?

Answer:

The Land Use Setback and OLD EPZ H_2S Release Rate or Volume at Licensed Conditions in column DV on the batch sheets is the number that should be used.

Issue: Low-end cut-off point for EPZ sizes.

In the old directive, there was a low-end cut off for EPZ sized. For example, if the H_2S RR was below 0.01m3/s H2S, the only requirement was for a corporate ERP (and the EPZ was 0 km as the release was likely contained on lease). In the new *Directive 071*, it is not clear if the minimum criteria still exists.

Answer:

At this point, there is no low-end cut off other than those referred to in *Directive 071*. The ERCB recognizes that there are concerns around this issue and that a process will need to be created to deal with it. However, until this issue is dealt

with through the implementation plan (in July 2009), all EPZs are valid, regardless of size.

Issue: Expected maximum liquid flow rate of pipeline fluid.

The expected maximum liquid flow rate influences the EPZ size for the GLR<1000 model and companies are concerned that it may be difficult to derive this value for a complex system.

Answer:

The operator should have this information available based on production accounting. For example, if well A is assigned flow A and well B assigned flow B, then the pipeline that is joined to each well is modelled with flows A and B respectively. At the tie-in of the two lines, the flow would just be A + B.

To be conservative, one could use the total cumulative flow rate at the discharge of the gathering system for each pipeline segment in the system. For example:

Well 1 is producing 10 m3/d of oil, 5 m3/d of water, and 50 m3/d of gas
Well 2 is producing 20 m3/d of oil, 10 m3/d of water, and 50 m3/d of gas

Flow 1 = 15 m3/d
Flow 2 = 30 m3/d
Flow 3 (combined 2 & 3) = 45 m3/d

So the GLR inputs are:

Well 1 GLR = 50/15
Well 2 GLR = 50/30
Combined GLR = (50 + 50)/(15 + 30) = 100/45

Issue: Pipelines with larger H_2S concentrations giving EPZs smaller than pipelines with smaller H_2S concentrations.

All other things being equal, why would a pipeline with 60 % H_2S give a smaller EPZ than one with 20 % H_2S?

Answer:

The reason for this centres around buoyancy. Basically, the more H2S in a mixture, the denser it is and the less buoyant it is. Therefore, the gas would have the tendency to spread out over an area rather than disperse horizontally. In very basic terms, with 55 % H_2S your plume would be more circular, with 20 % H_2S it would be long and skinny.

Issue: New pipeline tying into an existing system. Is recalculation of the system required?

Answer:

When the directive was released, the ERCB stated that for well supplements or pipeline tie-in, the new operation has to be modelled and that EPZ adopted. The existing pipelines don't have to be modelled and the ERP does not have to be rewritten. Therefore, the ERCB does not require that the entire system be recalculated unless there is a significant change to the H_2S or release volume. However, should a company choose to remodel the entire system (the ERCB always encourages being proactive), then it would have to complete its notification in accordance with the directive. This may result in a review and variance (R&V) application from local residents, which would be dealt with by the ERCB Law Branch.

13. References

Energy Resources Conservation Board (ERCB). 2010. *ERCBH2S A Model for Calculating Emergency Response and Planning Zones for Sour Gas Facilities. Volume 2: Emergency Response Planning Endpoints.* http://www.ercb.ca/docs/public/sourgas/eubmodelsdraft/Volume2_ERPEndPoints.pdf

Energy Resources Conservation Board (ERCB). 2010. *ERCBH2S A Model for Calculating Emergency Response and Planning Zones for Sour Gas Facilities. Volume 1: Technical Reference Document Version 1.20.* http://www.ercb.ca/docs/public/sourgas/eubmodelsdraft/Volume1_TechnicalReference.pdf

Energy Resources Conservation Board (ERCB). 2008. *Directive 071– Emergency Preparedness and Response Requirements for the Petroleum Industry.* http://www.ercb.ca/docs/documents/directives/Directive071_draft_200712.pdf