Creating Equivalent Probit Values Using ERPG Data

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When evaluating the toxicity levels of chemicals it often requires the use of specialized software to calculate the distances over which a toxic effect occurs and then compare median lethal doses. Process Safety Office® SuperChems™ can quickly and easily extract the probit parameters needed for a Quantitative Risk Assessment (QRA) study using ERPG or AEGL data.

What is Probit

The probit equation is not about fatality; rather, it is concerned with the likelihood of reaching an AEGL or ERPG value. Probit is the response to a stimulus obtained through statistical probability and deviation from the mean of a normal distribution. In toxicity studies, the normally distributed random variable has a mean of 5 and a standard deviation of 1. The idea of the probit function, transforming the probability of death into a probability unit or 'probit', was first published in a Science Magazine article by **Chester Ittner Bliss** in 1934. The method introduced by Bliss was expanded upon in the book Probit Analysis by **David J. Finney**, an important text on toxicological applications.

What is ERPG

Emergency Response Planning Guidelines (ERPG) are based on 1 hour of exposure time. They do not explicitly provide the nonlinearity of dose-response to use directly in transient dispersion models. Because of the quality and level of peer review provided by the American Industrial Hygiene Association (AIHA), concentration-based criteria such as ERPG are recommended.

- **ERPG-1:** The maximum airborne concentration below which it is believed nearly all individuals could be exposed for up to one hour without experiencing other than mild transient adverse health effects or perceiving a clearly defined objectionable odor.
- **ERPG-2:** The maximum airborne concentration below which it is believed nearly all individuals could be exposed for up to one hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair an individual's ability to take protective action.
- **ERPG-3:** The maximum airborne concentration below which it is believed nearly all individuals could be exposed for up to one hour without experiencing or developing life-threatening health effects.

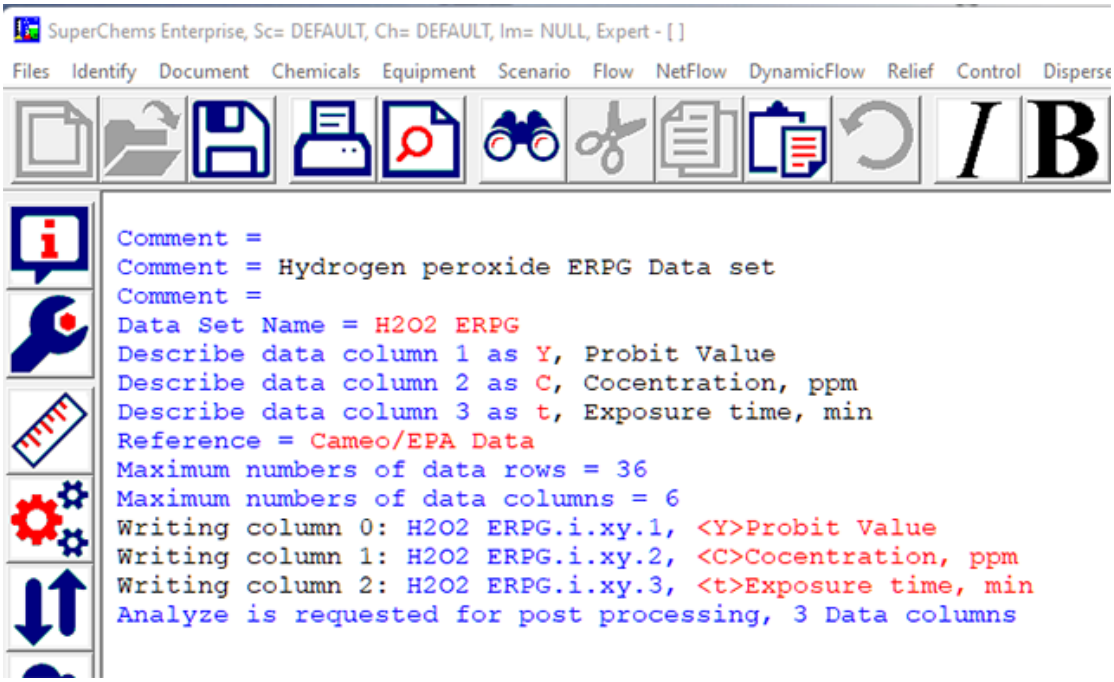
Chemical	ERPG-1	ERPG-2	ERPG-3
Hydrogen Cyanide (74-90-B)	N/A	10 PPM	25 PPM

Example of ERPG values for hydrogen cyanide

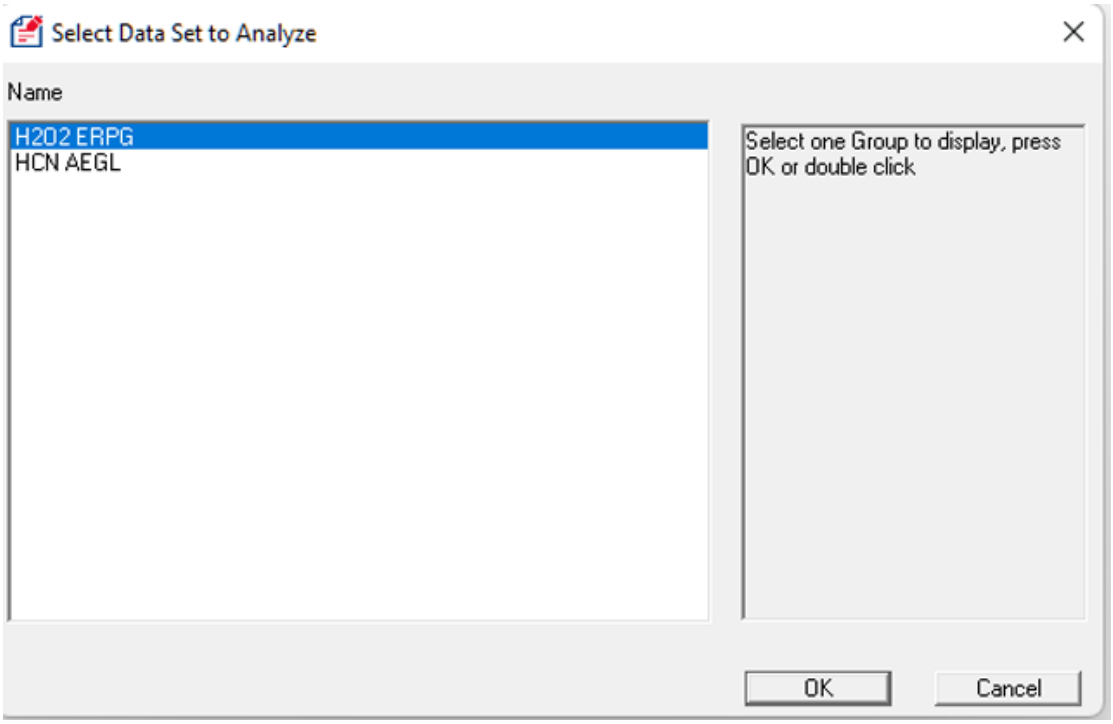
Calculating with ERPG Data

To perform the calculations in Process Safety Office® SuperChems™, you will need to first create an ASCII Data set. To see an example of this, download this **sample file of hydrogen peroxide data**. Note the sample file contains 9 rows of data. The ERPG values are 60 minute values, so the first 3 rows display the same dosage for ERPG1 using 3 different exposure durations. The same applies to ERPG-2 for the second data of 3 rows. The final 3 rows of data are for the ERPG-3 dosage equivalent.

- Launch SuperChems™
- Go to the main menu under Tools
- Select > Import ASCII Data and select >ERPG Data Sample.txt file
- SuperChems™ will then load the data set.



- Go to the main menu under Tools again
- Select >Analyze Data elect the ERPG data set

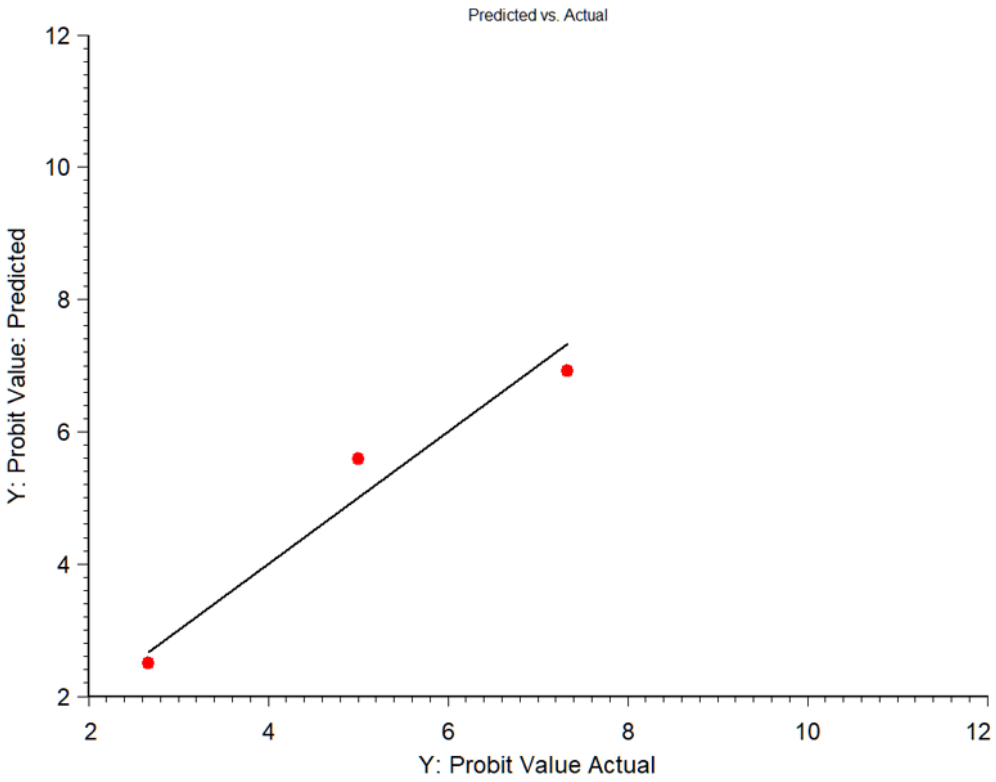


- The Selective Regression Menu will appear
- Click on Select -> Dependent Variable ->Y: probit Value
- Click on Select-> Independent Variable-> C: Concentration ppm and t:Exposure time in min (you have to highlight both items)
- Click on Variables->Add ln(x) and log10(X)-> C: Concentration ppm (this creates ln(C) data)
- Click on Variables->Add ln(x) and log10(X)-> t: Exposure (this creates ln(t) data)
- Go back to Select->Independent Variable-> ln© andln(t) (highlight simultaneously using CTRL-CLICK)
- Go to Analyze->Run

Equation [1]

ID	Variable Name	R^2 with Eq. Var.	Reduction in SSQ	Regression Coefficients	Std. Dev. of Reg. Coeff.	F-ratio	Variable Description
005	ln(C)	-0.00000	25.3365	1.5742	0.3180	24.5069	<-- ***Cocentration, ppm
007	ln(t)	0.00008		2.1559E-14	1.5852	1.8496E-28	<-- Exposure time, min
	Intercept	0.00000		5.0000	0.6726	55.2598	
001	Y	-0.00000	32.5734		2.0178	10000.0000	<-- Probit Value

- Go to Analyze->Select Model Candidates->ln(C) and ln(t) (highlight both)
- Go To Analyze->Run



Note that the 9 points are grouped into 3 dosage points.

This tutorial demonstrates how to get SuperChems™ to display distances and risk contours to specific ERPG dosage value. When specifying the probit fatality percent, select 1, 50, and 99 percent.

Why Use the AEGL Method

Acute Exposure Guideline Level (AEGL) limits can be used to establish nonlinear dose response criteria to be used with transient dispersion models to develop safe exclusion zones for emergency response planning. AEGL values represent threshold levels for the general public, including susceptible subpopulations such as infants, children, the elderly, persons with asthma, and those with other illnesses.

AEGL provides clear advantages over ERPG for establishing safe discharge location for short duration releases because it provides concentration limits for different exposure durations: 10 minutes, 30 minutes, 1 hour, 4 hours, and 8 hours.

- **AEGL-1:** Notable discomfort, irritation, or certain asymptomatic non-sensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure
- **AEGL-2:** Irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape
- **AEGL-3:** Life-threatening health effects or death

Guideline	10 Min	30 Min	1 Hour	4 Hours	8 Hours
AEGL-1	2.5 PPM	2.5 PPM	2.0 PPM	1.3 PPM	1.0 PPM
AEGL-2	17.0 PPM	10.0 PPM	7.1 PPM	3.5 PPM	2.5 PPM
AEGL-3	27.0 PPM	21.0 PPM	15.0 PPM	8.6 PPM	6.6 PPM

Example of AEGL values for hydrogen cyanide

Download the White Paper

At ioMosaic, we do toxicity calculations based on Acute Exposure Guideline Level (AEGL) unless that data is unavailable. For guidance on how to calculate probit using AEGL data, read the white paper, **Usage of AEGL Dosage in Safety and Risk Studies** by Georges A. Melhem, Ph.D., FAIChE. A table with the AEGL compiled values is included in this paper along with a case study.

Questions?

To ask questions or get help from our highly trained technical support experts, please contact us at 1.844.ioMosaic or submit a ticket to our online support center. We'll be glad to assist.

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