EJEMPLO 2A: Exposure to solvents

The aim is to assess the exposure of five workers (SEG, similar exposure group) from the company KOLOREAK to the solvents used on the preparation of industrial paints.

After studying the exposure scenario, it was considered that the solvent concentration, and therefore the worker's exposure along the working shift, did not change significantly over time so it was considered to be constant

For the paint preparation the solvents xylene and toluene are used.

Workers work eight hours from 8:00 to 17:30, with one hour lunch break from 13:00 to 14:00 (exposure time=480 mins.)

To assess the exposure of the SEG, three samples were taken for each shift (2 samples at mid-morning, and one in the afternoon) using activated carbon tubes of 100/50 and a pump with a flow rate of 0.2 litres/min over 40 minutes. Workers exposure was assessed on three separate shifts.

RESULTS

Exposure Data:

Similar exposure group: 5 workers

Exposure time (full working shift): 480 minutes

Exposure pattern: Constant

Sampling time: 40 x 3 = 120 min.

*Chemical agent: **Toluene***

OELV (8hrs TWA): 192 mg/m^3

Loq (laboratory limit of quantification): 0,075 µ/sample

LOQ (limit of quantification): Loq / V; LOQ = 0,075 µg / (0,2 l/min x 40 min)=0,0094 mg/m^3

Chemical Agent Xylene

OELV (8hrs TWA): 221 mg/m^3

Loq (laboratory limit of quantification):0,101 µg/sample

LOQ (limit of quantification): Loq/ V = 0,0126 mg/m^3

The concentration of solvents analysed in the laboratory for the different samples and working shifts are shown in Table 1.

Table 1.Results

Shift	Sample	Reference	Agent	Concentration (mg/m³)	Sampling time (min)
1	1	Kolore1-1	Toluene	9	40
			Xylene	37	
	2	Kolore 1-2	Toluene	13	40
			Xylene	34	
	3	Kolore 1-3	Toluene	11	40
			Xylene	29	
2	1	Kolore 2-1	Toluene	16	40
			Xylene	41	
	2	Kolore 2-2	Toluene	23	40
			Xylene	49	
	3	Kolore 2-3	Toluene	19	40
			Xylene	43	
3	1	Kolore 3-1	Toluene	7	40
			Xylene	26	
	2	Kolore 3-2	Toluene	5	40
			Xylene	31	
	3	Kolore 3-3	Toluene	9	40
			Xylene	29	

EXPOSURE ASSESSMENT USING THE CALCULATOR

Preliminary Test

Solvents effects are considered additive. In these cases, the exposure assessment for each working shift is carried out using the exposure index (I), which is estimated from the sum of the partial exposure index from each solvent ($I_T + I_X$) and it is compared with the limit value of 1.

$$I_{(jornada\ 1)} = I_{T(jornada\ 1)} + I_{X(jornada\ 1)}$$

$$I_T = \frac{ED_T}{VLA - ED_T}$$

$$I_X = \frac{ED_X}{VLA - ED_X}$$

Having this into account, the preliminary test for assessment of the compliance of the exposure concentration with the OELV is carried out in accordance with the Standard UNE-EN 689. The assessment can be done using the calculator as follows:

1. Access the webpage of INSST https://herramientasprl.insst.es/
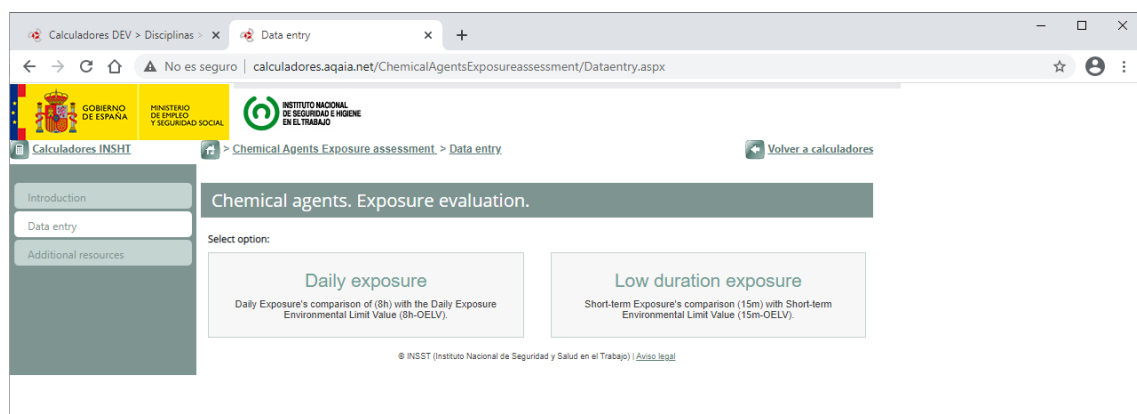2. Click on the tab "Hygiene" "

3. Click on the Chemical Agents Exposure Calculator (UNE-EN 689:2019)
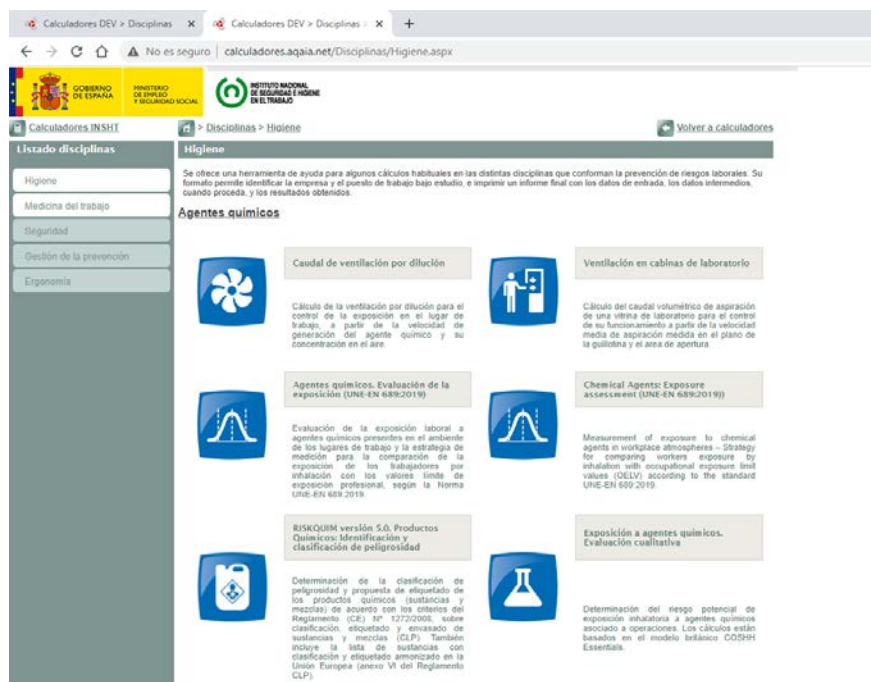
4. Click on "data input"

5. There are two choices: daily exposure and short-term exposure. Click on "daily exposure" since this is the exposure period being assessed

6. For the assessment of daily exposures, the change of the chemical agent concentration over time has to be entered, prior to the data input. The default choice is "variable" but there is other option "Constant" that can be selected from the dropdown list.

This window allows to input:

- A retrieval code that the program generates to recover the data saved. The first time data is entered this box is left blank. The code can be entered the next time to retrieve the data.
- Contextual information on the company name, date, job type, GES, etc. although this is not a requirement.

In this example, Click on "CONSTANT EXPOSURE" and leave the remaining fields blank.

Click on "NEXT".

7. In this window enter the name of one of the chemical agents (Toluene), the OELV 8-hrs TWA, exposure time and LOQ. Then, click on "Add chemical agent" and enter the name of the other chemical agent (xylene), the OELV 8-hrs TWA, exposure period and the LOQ. The program allows to input more chemical agents and considers an additive effect. In this example there is simultaneous exposure only to two agents.

The input of the LOQ is optional, unless data is below the LOQ. There is a note with information on how to estimate the LOQ.

Enter the data for each chemical agent and click "NEXT".

Toluene; OELV 8-hrs TWA = 192 mg/m^3; exposure time = 480 min; LOQ = 0,0094 mg/m^3

Xylene; OELV 8-hrs TWA = 221 mg/m^3; exposure time = 480 min; LOQ = 0,0126 mg/m^3

8. This window allows to enter data on the different samples taken for each shift (sample reference, sampling time, chemical agent concentration). For each chemical agent is possible to add several samples. Once a shift has been completed click on "add shifts" to input the data on the different shifts.

In this example we add the data for toluene and xylene showed in Table 1. Click on "Save and calculate". The program generates a retrieval code that can be used next time to recover the data.

Important note: when "constant exposure" has been selected the total sampling time for a shift has to be at least 2 hours of the exposure time, except in those cases when the exposure period is below 2 hours. In the latter case, the sampling time has to be the same as the exposure time. If this condition is not met the program will indicate that there is an error and it is not possible to continue.

9. Click on "Save and calculate" the calculator shows the result of the exposure assessment: the contextual information (if it has been entered), the decision on the compliance or not with the OELV, the retrieval code and a summary with the data entered for the different shifts: the daily exposures and the partial exposure index (I_T, I_X) and the total index (I_T)..

In this example, the preliminary test is not conclusive. The result is "NO DECISION" and it is necessary to evaluate the exposure over three other shifts and run the statistical test. The program also shows the retrieval code, in this example 7879950 (with this code is possible to access again to the data entered and edit it).

This information can be printed.

EXAMPLE 2B: Exposure to solvents

We continue with the same example, since the result has been NO-DECISION. The exposure assessment of the five workers from the company KOLOREAK has not been finalised. It is necessary to evaluate the exposure during three more shifts so as to have at least of six shifts and then run the statistical test.

The exposure of the five workers to toluene and xylene is evaluated over three new working shifts. Sampling takes place using the same procedure. The results are shown in Table 2.

Tabla 2. Results

Shift	Sample	Reference	Agent	Concentration (mg/m³)	Sampling time (min)
4	1	Kolore4-1	Toluene	21	40
			Xylene	77	
	2	Kolore 4-2	Toluene	25	40
			Xylene	69	
	3	Kolore 4-3	Toluene	18	40
			Xylene	84	
5	1	Kolore 5-1	Toluene	6	40
			Xylene	34	
	2	Kolore 5-2	Toluene	3	40
			Xylene	40	
	3	Kolore 5-3	Toluene	5	40
			Xylene	38	

6	1	Kolore 6-1	Toluene	12	40
			Xylene	29	
	2	Kolore 6-2	Toluene	14	40
			Xylene	25	
	3	Kolore 3-3	Toluene	15	40
			Xylene	21	

Repeat the previous steps in Example 2A from step 1 to 6.

7. Enter the retrieval code (1877816) to load the data already saved and click on "LOAD DATA".

8. The saved data on exposure assessment to the workers from the KOLOREAK company over the three working shifts is loaded.

9. Click on "NEXT" and the program shows the screen with the data from shift 1. To see the data from other shifts click on the dropdown list.

10. Click on "ADD SHIFT" and enter the data obtained for shift 4.

11. Once done, click again on "ADD SHIFT" and enter the data for shift 5 and then for shift 6.

12. Once data on all the six shifts have been entered, click on "SAVE AND CALCULATE" to get the results.

In this case, the exposure to solvents according to the statistical test is ACCEPTABLE. The program shows the information on the type of distribution, the values for the different statistical parameters and recommendations for the periodic evaluation of the exposure.
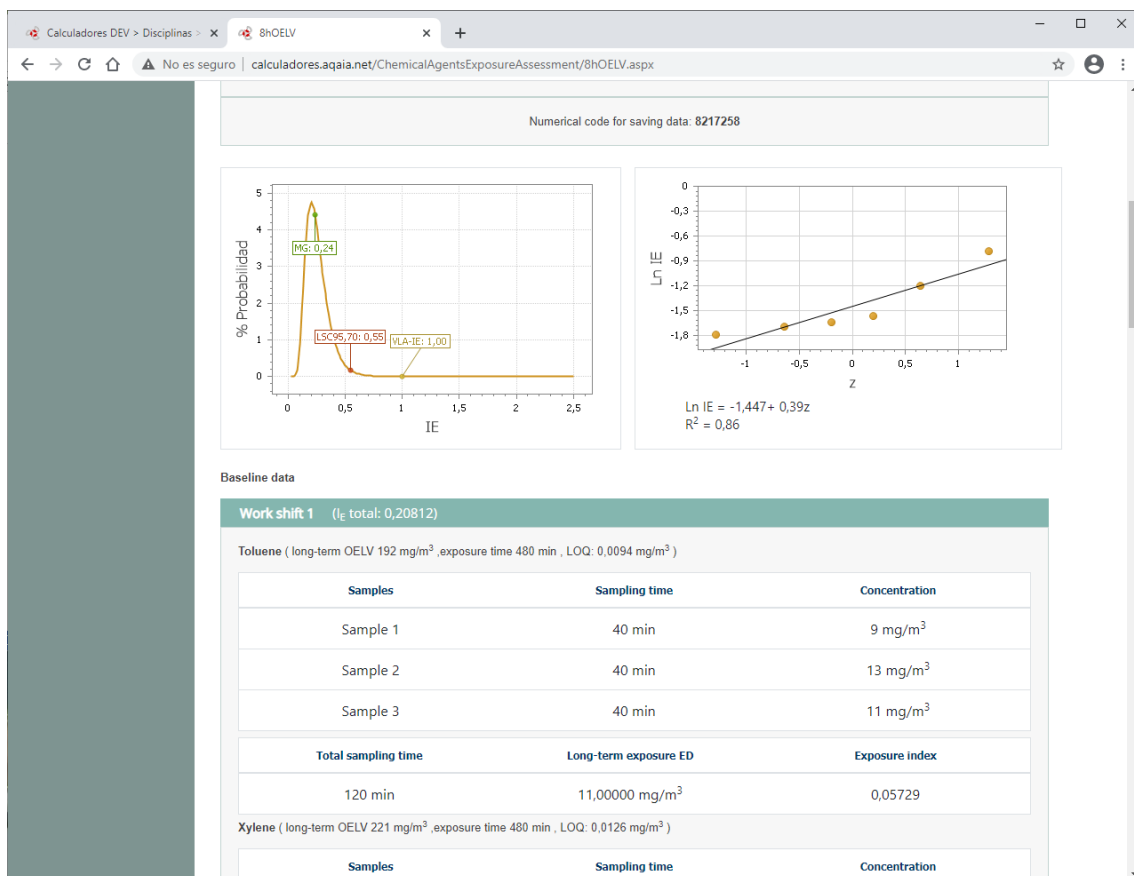
Finally, the screen shows the graphs, all the data entered and the results for the daily exposures and exposure indices.

The program allows to print the information.

Numerical code for saving data: **8217258**

Ln IE = -1,447+ 0,39z
$R^2 = 0,86$

Baseline data

Work shift 1   (I_E total: 0,20812)

Toluene (long-term OELV 192 mg/m^3 ,exposure time 480 min , LOQ: 0,0094 mg/m^3)

Samples	Sampling time	Concentration
Sample 1	40 min	9 mg/m^3
Sample 2	40 min	13 mg/m^3
Sample 3	40 min	11 mg/m^3

Total sampling time	Long-term exposure ED	Exposure index
120 min	11,00000 mg/m^3	0,05729

Xylene (long-term OELV 221 mg/m^3 ,exposure time 480 min , LOQ: 0,0126 mg/m^3)

Samples	Sampling time	Concentration

| 120 min | 55,55555 mg/m^3 | 0,15085 |

Work shift 2   (I_E total: 0,30130)

Toluene (long-term OELV 192 mg/m^3 ,exposure time 480 min , LOQ: 0,0094 mg/m^3)

Samples	Sampling time	Concentration
Sample 1	40 min	16 mg/m^3
Sample 2	40 min	23 mg/m^3
Sample 3	40 min	19 mg/m^3

Total sampling time	Long-term exposure ED	Exposure index
120 min	19,33333 mg/m^3	0,10069

Xylene (long-term OELV 221 mg/m^3 ,exposure time 480 min , LOQ: 0,0126 mg/m^3)

Samples	Sampling time	Concentration
Sample 1	40 min	41 mg/m^3
Sample 2	40 min	49 mg/m^3
Sample 3	40 min	43 mg/m^3

Total sampling time	Long-term exposure ED	Exposure index
120 min	44,33333 mg/m^3	0,20060

Work shift 3   (I_E total: 0,16617)

Toluene (long-term OELV 192 mg/m^3 ,exposure time 480 min , LOQ: 0,0094 mg/m^3)

Samples	Sampling time	Concentration
Sample 1	40 min	7 mg/m^3