



Add-ons to IHSTAT

A Convivial Tool to Perform Descriptive and Inferential Statistics for Industrial Hygienists

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McGill



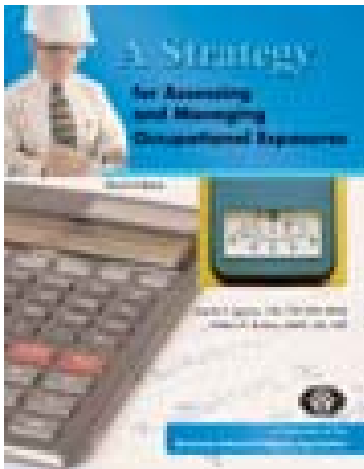
Introduction

- IHSTAT freeware ... maybe the best-known Excel file in IH;
- Introduced with the 2nd version of the *AIHA Strategy for Assessing and Managing Occupational Exposures* (Mulhausen and Damiano, eds., 1998)
- A truly remarkable work and page-design with EXCEL that performs ...
 - Descriptive statistical calculations;
 - Inferential statistics.
- IHSTAT still widely used ...internationally !
- IHSTAT is available through the AIHA Website.

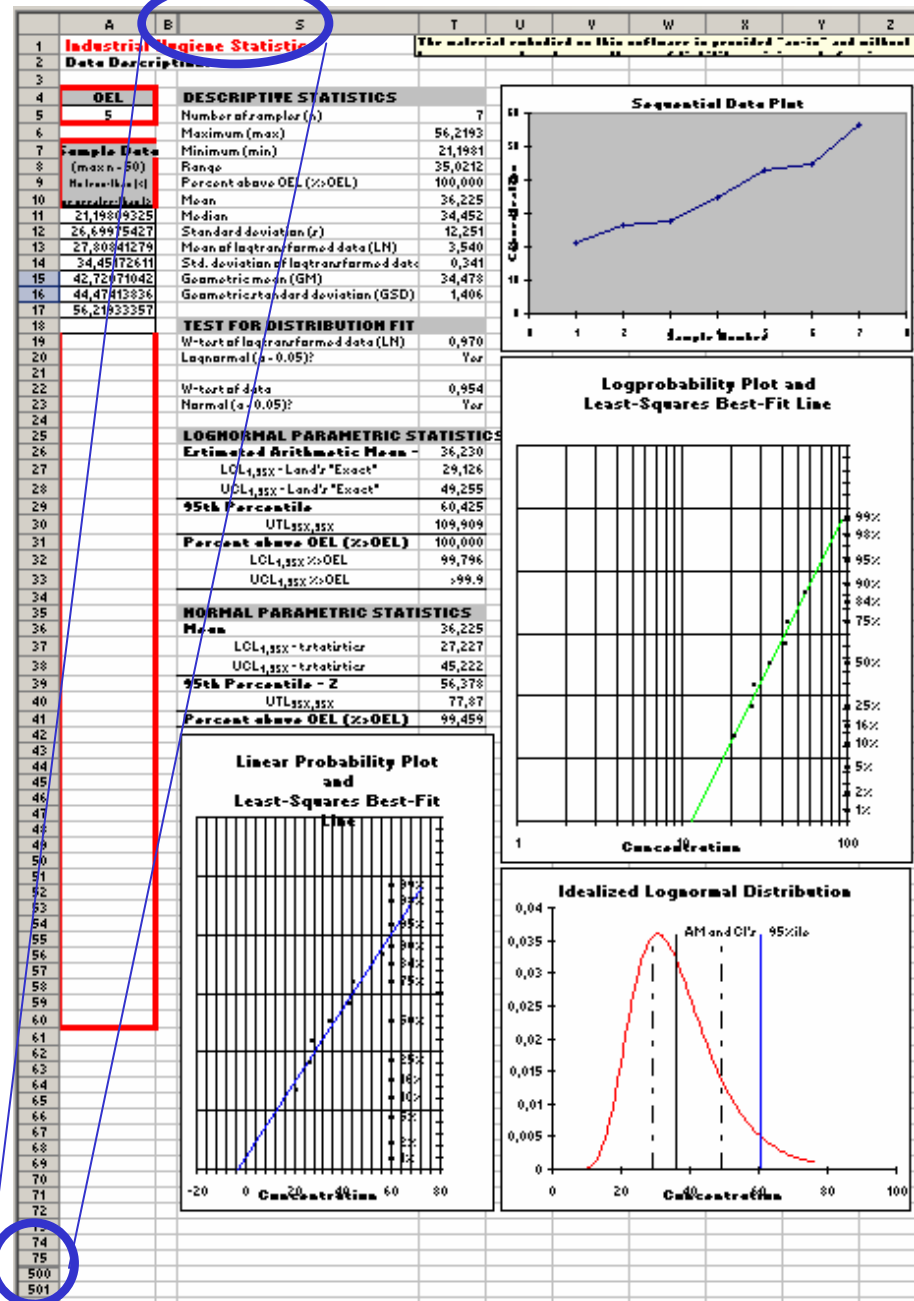


Original IHSTAT (1998)

- One worksheet;
- 50 data max;
- Statistical parameters;
- Log probit curves;
- Log-Norm distribution.



No significant changes with the 3rd version of the AIHA manual



Particular needs in Québec ...

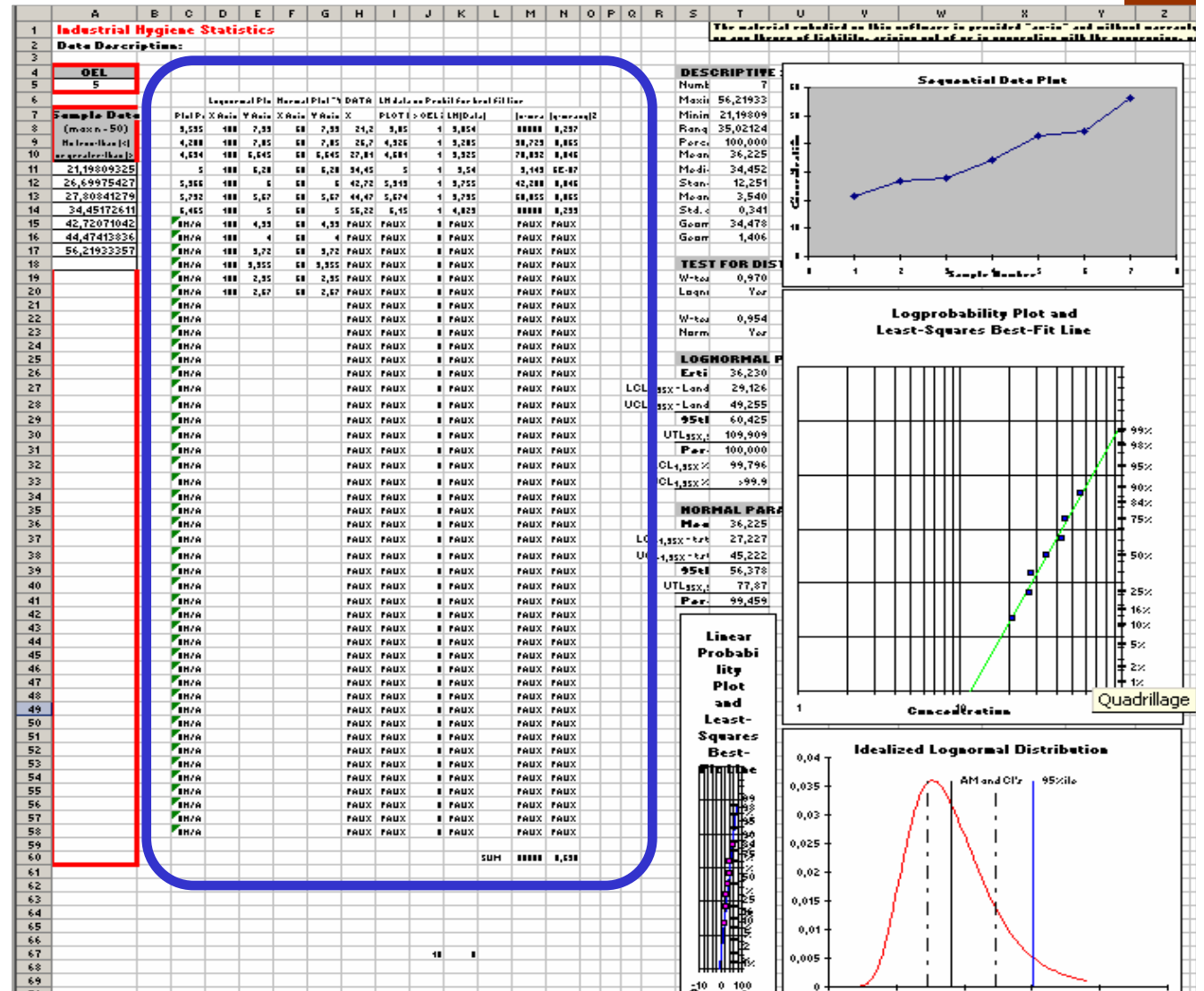
- A french version;
- More data;
- Comments and contextual help;
- Censored data management.

**5 years ago, I opened the hood ...
to have a look at the engine !**

Hidden parts of IHSTAT

Exploded view of columns

- Surprise, the file is *unprotected*
- Hidden columns showing intermediate calculations ;

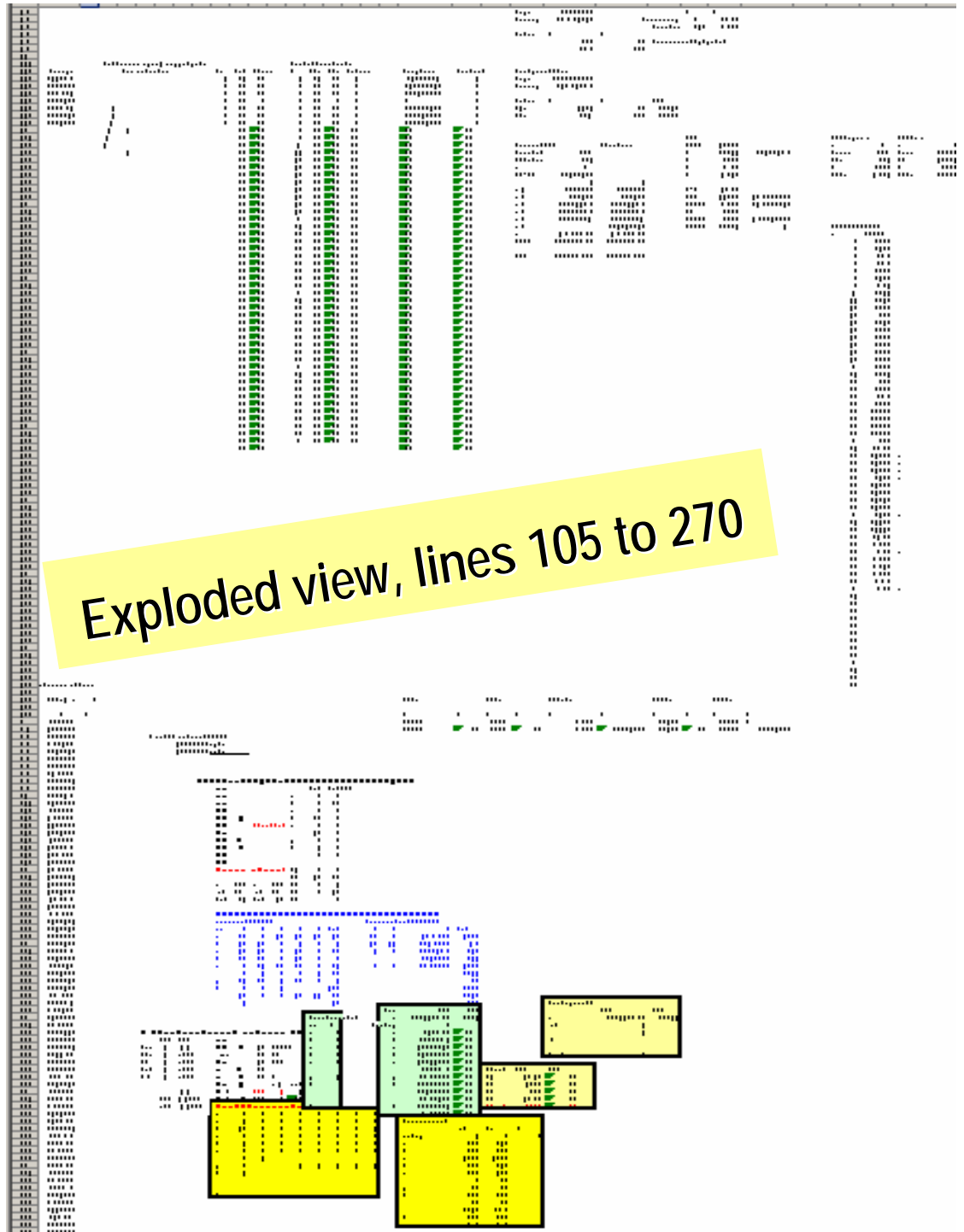


Engine parts of IHSTAT (cont'd)

- Behind what you see ... are located numerous informations, tables, stat. tables and functions.

from lines 60 to 455

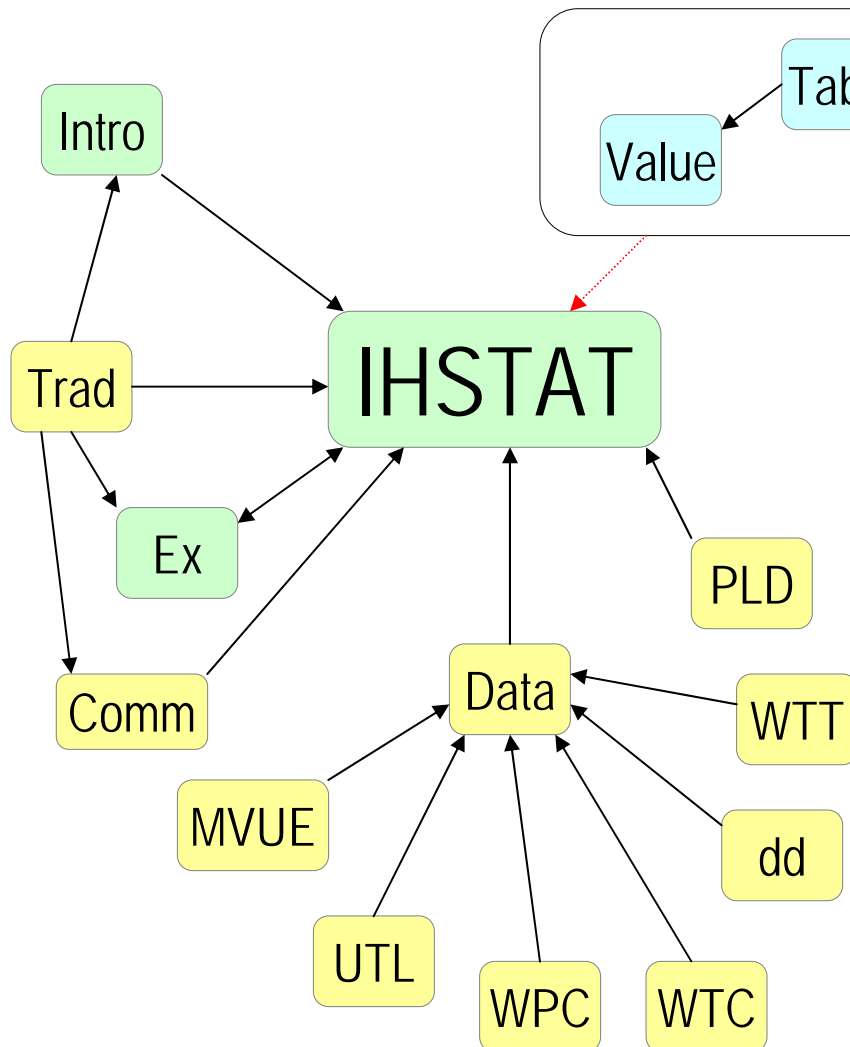
- It was truly hard to understand the relations between all these information and tables and the results seen above.



IHSTAT re-organization

- Content *re-engineering* in different sheet tabs;
- Comments and contextual help implemented;
- File *functions* and *subs.* supported by *Visual Basic*;
- Selective protection implemented;
- 200 data maximum;
- Multi-language interface;
- Censored data management.

IHSTAT new structure



Visual Basic subs and functions

```

Function DesStat(rangedata As Range)
Dim coeff(1 To 8, 1 To 1) As Double
coeff(1, 1) = WorksheetFunction.Count(rangedata) 'Nb sample
If coeff(1, 1) = 0 Then
DesStat = ""
Else
coeff(2, 1) = WorksheetFunction.Max(rangedata) 'maximum
coeff(3, 1) = WorksheetFunction.Min(rangedata) 'minimum
coeff(4, 1) = coeff(2, 1) - coeff(3, 1) 'range
coeff(5, 1) = WorksheetFunction.Average(rangedata) 'Mean
coeff(6, 1) = WorksheetFunction.Median(rangedata) 'Median
coeff(7, 1) = WorksheetFunction.StDev(rangedata) 'Std dev
coeff(8, 1) = WorksheetFunction.GeoMean(rangedata) 'Geomean
DesStat = coeff
End If
End Function
  
```


Censored data management

statistical methods commonly used to analyze censored data

● Imputation methods

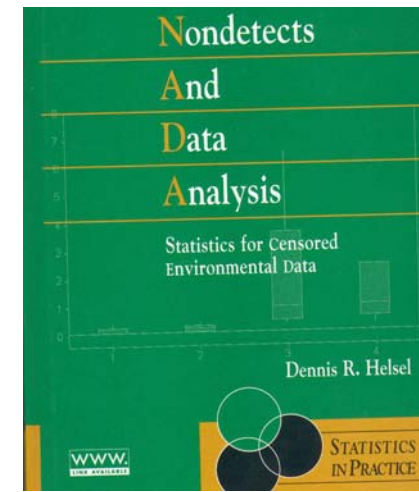
1. Substitution by $LOQ/2$ or $LOQ/\sqrt{2}$ (Hornung, 1990)
2. Regression on order statistics (ROS, similar to log-probit regression in AIHA manual, *Ignacio and Bullock 2006*)

● Direct parameter estimation methods

1. Maximum likelihood estimation
 - *Finkelstein and Verma, 2001*, propose an EXCEL way of implementing MLE estimation)
 - Gibbs sampling / bootstrap and MLE (*Wild et al. 1996*), Implemented in French software ALTREX
2. *Kaplan Meier* method (for arithmetic mean estimation, comes from survival analysis, *Helsel, 2005*)

What method did we choose to handle non detects ?

Reflections based on monograph by *Dennis Helsel* (2005) : *Non detects and data analysis – Statistics for censored environmental data* : the first comprehensive reference in the field of airborne exposure levels interpretation.



Criteria :


- linkable to IHSTATS internal physics;
- Proven to provide reliable results;
- Able to handle complex censored sample;
- Permitting estimation of multiple parameters (AM, GM, GSD, P95...) and use of hypothesis tests such as goodness of fit tests.

Regression on order statistics – *as recommended by Helsel*

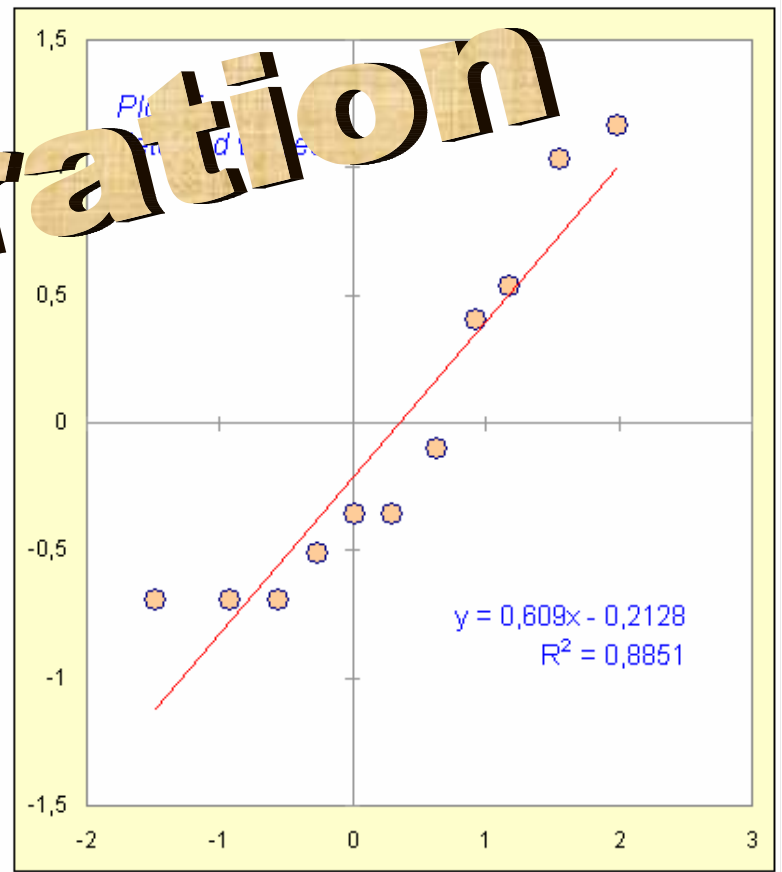
- Transfer data in ‘gaussian’ mode, by taking Ln ;
- Assign plotting positions (PP) to each value (Dets and NDs) ;
- Calculate normal scores for Dets and NDs ;
- Regress Ln(Dets) on their normal scores ;
- Predict the ND values from the regression using their normal scores ;
- Use the ‘complete’ dataset created to perform the required analyses.

Censored data worksheet

Helsel Example (2005)

AZ  Helsel Helsel Model

#	ND ?	Val. Det	LOQ	Vol.	Value	Pack name	Indice	Score X "Normal"	Ln Dets Y	Score ND	ND Extrap.	Export to IHSTAT
22	FAUX	0,5			0,5	Det-1	1	-1,4851655	-0,6931472			0,5
23	FAUX	0,5			0,5	Det-1	2	-0,9201392	-0,6931472			0,5
24	FAUX	0,5			0,5	Det-1	3	-0,5570401	-0,6931472			0,5
21	FAUX	0,6			0,6	Det-1	4	-0,2565839	-0,5108256			0,6
19	FAUX	0,7			0,7	Det-1	5	0,02193476	-0,3566749			0,7
20	FAUX	0,7			0,7	Det-1	6	0,30219948	-0,3566749			0,7
15	VRAI		0,9	1	0,9	ND-1	1					
17	FAUX	0,9			0,9	Det-2	1	0,6300000	0,0000000			0,9
13	VRAI		1	1	1	ND-2	1			0,4311956	0,4311956	0,431195612
16	VRAI		1	1	1	ND-2	2			-0,27188	0,6849509	0,684950894
18	VRAI		1	1	1	ND-2	3			0,344102	0,9967593	0,996759311
14	VRAI		1,001	1	1,001	ND-3	1			-0,27188	0,6849509	0,684950894
12	FAUX	1,5			1,5	Det-4	1	0,92335909	0,40546511			1,5
11	FAUX	1,7			1,7	Det-4	2	1,17644277	0,53062825			1,7
3	VRAI		2	1	2	ND-4	1			-1,411674	0,3421192	0,342119202
4	VRAI		2	1	2	ND-4	2			-0,822277	0,489865	0,489865023
5	VRAI		2	1	2	ND-4	3			-0,434682	0,6202936	0,620293635
6	VRAI		2	1	2	ND-4	4			-0,104633	0,7583979	0,758397862
7	VRAI		2	1	2	ND-4	5			0,214112	0,9208885	0,920888537
8	VRAI		2	1	2	ND-4	6			0,556914	1,1346976	1,13469765
9	VRAI		2	1	2	ND-4	7			0,98482	1,4725283	1,472528305
10	VRAI		2,001	1	2,001	ND-5	1			-0,104633	0,7583979	0,758397862
2	FAUX	2,8			2,8	Det-6	1	1,5532209	1,02961942			2,8
1	FAUX	3,2			3,2	Det-6	2	1,99268185	1,16315081			3,2
25												



Multi-language interface for IHSTAT

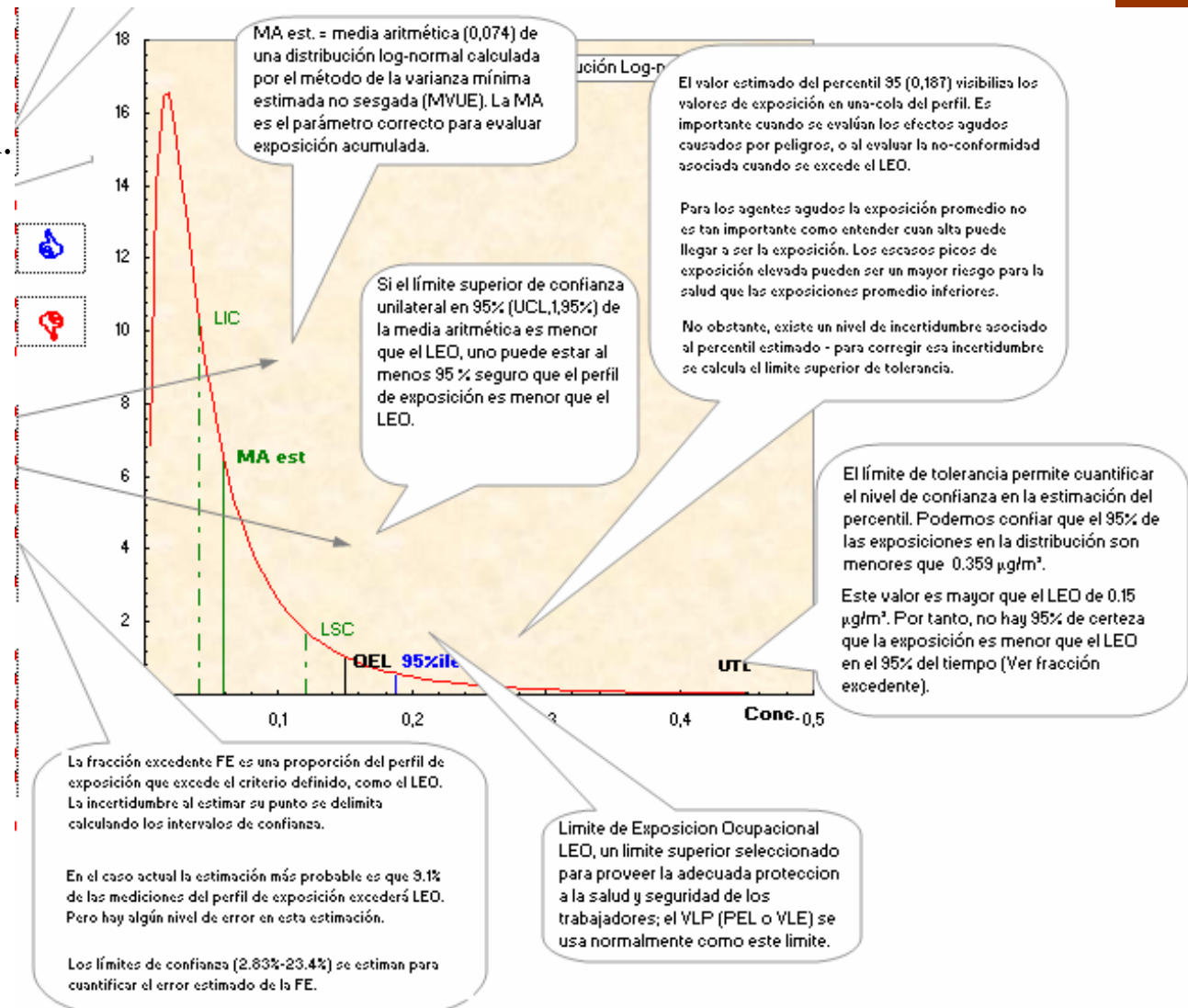
- Already implemented : **English, Spanish, French;**
- To come : **Italian and German** (summer 2007)

All field texts are driven through a translation table allowing the possibility of adding other languages

#	Type	English	Español	Français
3				
4	1 INTRO	Multilingual IHSTAT+	HIStat+Multilingüe	IHSTAT+ multilingue
5	2 INTRO	IMPORTANT : Enable macros when opening this file.	IMPORTANTE: Habilite los macros cuando abra este archivo.	IMPORTANT : Activer les macros à l'ouverture du fichier.
	3 INTRO	The material embodied on this software is provided "as-is" and without warranty of any kind, expressed, implied or otherwise, including without limitation any warranty of merchantability or fitness for a particular purpose. In no event shall John R. Mulhausen, Ph.D., CIH, or the American Industrial Hygiene Association (AIHA) be liable for any direct, indirect, special, incidental, or consequential damages of any kind, or any damages whatsoever, including without limitation loss of profit, loss of use, savings or revenue, or the claims of third parties, whether or not John Mulhausen or the AIHA has been advised of the possibility of such loss, however caused, and on any theory of liability, arising out of or in connection with the possession, use, or performance of this software.	El material incorporado en este software se provee "tal-cual", sin garantía de ninguna clase, expresa, implícita u otra, incluyendo sin limitación cualquier garantía para mercadeo o propiedad para un propósito particular. En ningún evento, John R. Mulhausen, Ph.D., CIH, o la Asociación Americana de Higiene Industrial (American Industrial Hygiene Association AIHA) son responsables de cualquier daño causado en forma directa, indirecta, especial, fortuito, inmateriales de cualquier clase, o cualquier tipo de daño incluyendo y sin limitación las pérdidas de ganancia, pérdida de aplicaciones, ahorros o rentas, o los reclamos de terceros, bien sea que John Mulhausen o la AIHA hayan o no advertido sobre la posibilidad de tales pérdidas de alguna manera causadas, y bajo alguna teoría de responsabilidad que surja o en conexión con la posesión, uso, o ejecución de éste software.	Le matériel inclus dans ce logiciel est fourni "tel quel" sans aucune garanti mentionnée, implicite ou autre, incluant sans limitation toute garantie sur l. valeur marchande ou l'utilisation pour une application particulière. Sous aucune circonstance, John R. Mulhausen, Ph.D., CIH ou l'American Indus Hygiene Association (AIHA) ne peut être tenu responsable de dommages directs, indirects, spéciaux, fortuits ou immatériels de toute nature, incluan sans limitation toute perte de profit, d'utilisation, d'épargne ou de revenu o toute réclamation d'une tierce partie, que John Mulhausen ou l'AIHA ait été informé ou non de la possibilité d'une telle perte, de quelque manière causé et sur toute théorie de responsabilité résultant de ou en lien avec la possession, l'utilisation ou la performance de ce logiciel.
6				
7	4 Title	Industrial Hygiene Statistics	Estadísticas de Higiene Ocupacional	Statistiques en hygiène du travail
8	5 Title	Occupational Exposure Limit	Valor Límite de Exposición Ocupacional (OEL)	Valeur limite d'exposition professionnelle
9	6 Title	Sample data	Información de la muestra	Données
10	7 Title	OEL	LEO o OEL	VLE

Comments and help features

- Conceptual comments are available in IHSTAT for all the statistical parameters
- Help worksheet with *an example* that include statistical interpretation.



Industrial Hygiene Statistics

OEL
0.15

Sample data

- 0.06
- 0.0119
- 0.01587
- 0.00738
- 0.01
- 0.09
- 0.04
- 0.2
- 0.04
- 0.08
- 0.08
- 0.03
- 0.09
- 0.03
- 0.07

Descriptive statistics

Number of samples (n)	15
Maximum (max)	0.2
Minimum (min)	0.0074
Range	0.1926
Mean	0.057
Median	0.040
Standard deviation (s)	0.049
Geometric mean	0.039
Geometric standard deviation	2.583
Percent above OEL	6.7%

Test for distribution fit

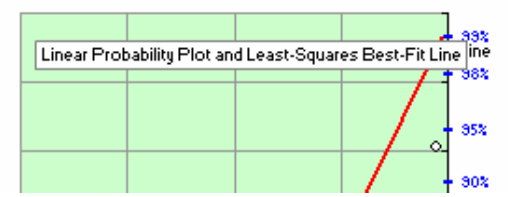
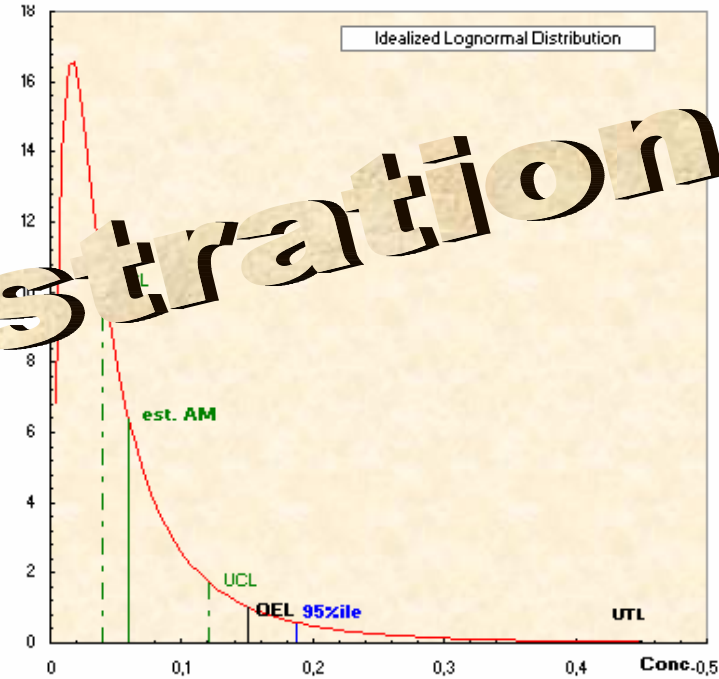
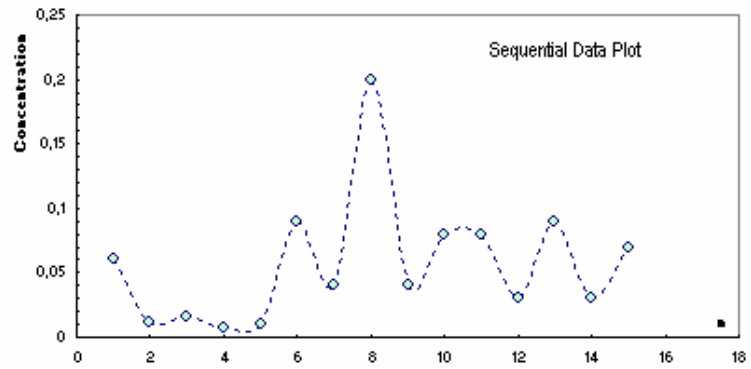
W-test of log-transformed data	0.949	<input checked="" type="checkbox"/>
Lognormal ($\alpha = 0.05$) ?	Yes	<input checked="" type="checkbox"/>
W-test of data	0.826	<input type="checkbox"/>
Normal ($\alpha = 0.05$) ?	No	<input type="checkbox"/>

Lognormal parametric statistics

Estimated Arithmetic Mean - AM est.	0.059
LCL1,95% - Land's "Exact"	0.040
UCL1,95% - Land's "Exact"	0.113
95th Percentile	0.138
UTL95%,95%	0.18
UTL95%,95% / OEL	2.290
UCL1,95% / OEL	21.633

Normal parametric statistics

Mean	0.057
LCL1,95% - t statistics	0.035
UCL1,95% - t statistics	0.080
95th Percentile - Z	0.138
UTL95%,95%	0.18
Percent above OEL	3.01



Demonstration

Conclusion

- IHSTAT is still a relevant tool to manage exposure assessment data.
- Approach of result treatment remains the same as the previous version (except for censored data)

As any computer tool, this one will never, in any case, replace an enlightened professional judgement of IH.

Availability ...

Any comments : **daniel.drolet @irsst.qc.ca**

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