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THE USE OF *"SAFETY ECOLOGICAL INTEGRATORS"* FOR THE ASSESS MENT OF THE ATMOSPHERE CONTAMINATION DEGREE IN ORDER TO ENHANCE THE POPULATION LEVEL OF HEALTH

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Abstract
"Safety ecological Integrators" are tools used to check the ecological security for the health of the population in research – development activities of the ecological systems, which allow the designer to develop the specific functions of ecological security in the assessed environmental system and they require the approach of the specific environmental risks, the warning measures as well as the cost restrictions for implementing these measures, allowing:

- *checking the coverage of the identified environmental risks;*
- *analyze of the required ecological security functions relative to expenses;*
- *solutions proposals for the integration of the ecological safety in the analyzed environmental system.*

The use of the method "Safety ecological Integrators" provides necessary information and data regarding the level of contamination of the atmosphere referable to the designed environmental system ass well as the enacting the decision to submit this system (or its components) to the procedures for the performing of the special audit of ecological security.

Key words
Environmental, ecological integrators, population level, safety ecological

Generalities regarding the safety ecological integrators

Safety ecological integrators are numerical calculus tools used in research-development activities, in order to check the environmental systems. These, stand for a new approach concept in the field of research – development tools, which allow the designer to develop specific safety ecological functions for components, subassemblies and assemblies. The use of these tools requires taking into account the specific environmental risks, which allow the designer to develop specific safety ecological functions for components, subassemblies and assemblies. The use of these tools requires taking in to account the specific environmental risks, the warning measures, ass well as the cost restrictions for implementing of this, allowing:

- checking the coverage of the identified environmental risks for components and subassemblies;

- analyze of the required ecological security functions relative to the expenses agreed for the achieving of these;
- solutions proposals for the integration of the ecological safety in the analyzed environmental system.

After the designer has developed the project, the safety ecological integrators are initiated in order to analyse the designed environmental system considering its components.

In order to fundament the concepts used in these paper, we define the following functions:

The safety ecological function of a component / environmental system is the function responsible for the dismission of the environmental risk factors.

The dangerous function of a component / environmental system represents any associated function of the component which generates an environment contamination danger.

In order to achieve the ecological safety, when designing the environmental systems, it is essential to study these relative to the safety ecological functions and dangerous functions of an environmental component so as to ensure the quality protection of the environmental factor trough out the existence of the designed system.

Analyzing this system, from the environmental factors quality ensurance point of view it can be determined:

- an admissible environmental risk;
- an environmental risk that can be reached, having in mind the ecological safety objectives and the required expenses;
- a real environmental risk that can be estimated and assessed.

It is obvious that the environmental risk cannot be entirely eliminated, but considering the project it is possible to define an admissible environmental risk represented by the ecological safety objective agreed for the analyzed project. For this, if the safety ecological integrators are not capable to develop functions that can minimise the entire project has to be audited from the ecological safety point if view.

The use of the mathematic model for calculus of the safety ecological integrators

The application of a multi-criteria analysis type assessment model of the environmental risk is independent of the type of method, methodology and range of application, because it uses only the information provided by subjective assessments and gives a gradate final result.

The main parameters used for the calculus of the safety ecological integrators are:

- *Air contamination gravity parameter* "I_G" – is a parameter which describes the importance of the identified risk factors;

- *Risks coverage parameter "I_R"* – is a parameter which describes the risk coverage by the connexed safety ecological function
- *Supplementary cost parameter "I_C"* – is a parameter which describes the suplimentarry costs imposed by the achieving of the ecological safety functions.

In order to fit the model in the problems of analyze and assessments of environmental risks, the definitions and examples presented in the paper will be particularized and will become specific to this field.

a) Assessment criteria

Any multicriteria analysis is made on the basis of some appreciation or evaluation criteria. This way, we will call "evaluation or appreciation criteria ", a multitude C_i of criteria with which it can be characterized the situation of a state of fact, of an environmental system.

b)Group of decision (diagnosis / analysis and assessment)

Let D_p be a group of decision, called "diagnosis group" made up of "p" assessors which know and can evaluate the environmental system state of fact.

c) Appreciation variables

Let x_{KRi} be the appreciation variable (x_{KRi}= 0 ... 1) agreed by each member K of the diagnosis group, when assessing the way the evaluation factors affect the general state of the environmental system. The assessment is made analyzing and evaluating subjectively the situations, where the parameters:

K_R = I_G, I_R, I_C- the nature of the assessed parameter (risk gravity, risk coverage, suplimentarry costs); i =1 ... n - number of assessment criteria.

d)The value of the appreciation variable and its character

Each member of the diagnosis group, has to assign a value, from 0 to 1 to the variable x_{KRi}, which represents the individual perception way, of how the state of fact in the system is affected, from each criterion C_i point o view. The appreciation variable can be fuzzy when it conveys a gradate subjective consideration about the belonging to a property of the system.

e) The value of the variable proper to the criterion

If each criterion C is assigned an appreciation value from the "p" assessors that made up the decisional group, then the value of the proper variable is an arithmetic mean. Thus, each evaluation criterion "C_i" will be characterized by an average value of the variable, calculated according to the formula:

$$\overline{x}_{KRi} = \sum_{j=1}^{p} \frac{x_{KRi}}{j} \quad (1)$$

f)Characteristic line matrix

Each member of the diagnosis group can assign proper values to the way of achieving each "C_i". For each member of the decisional group, for each evaluation criterion, a linear matrix will result for the values of the characteristic variables, calculated according to the formula:

$$D_p: (C_i) \Rightarrow x_{1.i}, x_{2,i}, \ldots x_{p,i}, \qquad (2)$$

g)The matrix of the decisional group

By methodical arrangement in the form of matrix of all the results obtained from the decisional group according to the relation proper to each subject it results a matrix of proper values, in the form:

Subject /criteria	1	2	...	0
C1	x_{11}	x_{12}	...	x_{1p}
C2	x_{21}	x_{22}	...	x_{2p}
....				
Cn	x_{n1}	x_{n2}	...	x_{np}

, (3)

h)Degree of belonging to a property

According to the theoretical definitions, the degree of belonging to a property is a function conveyed via subjective values.

Assuming that the non accomplishing of each criterion C_i can be characterized by a feature, for example: "the feature of being affected" let us name the contamination degree G_{Ki}, the degree of belonging to this property, calculated according to a reverse exponential function of the form:

$$G_{KRi} = e^{-\delta_i \left|1-\bar{x}_{KRi}\right|}, \qquad (4)$$

δ_i – importance parameter assigned to each criterion with values included in the interval $2 \le \delta_i \le 5$

The exponential function presented in the above formula is a function recommended in the subject literature for modelling of phenomena with an antitone evolution, the maximum value of the function begin 1,00, and the bent of the function depends on the exponent, and can be chosen, so as, the phenomena having a more rapid involution can be assigned a higher bent. All the exponential family of curves, according to the values δ_I is convergent to the maximum value of 1,0

i) Importance parameter

The importance parameter δ_i is established according to the indication given in the subject literature:

- the evaluation criteria C_i are aligned in antitone, by each subject function of its importance, with the help of some balances, so as to fulfil the relations:

$$C_1\,\alpha_1 \geq C_2\,\alpha_2 \geq .... \geq C_n\,\alpha_n \qquad (\textit{preference order}), (5)$$

- a correspondence is made between the value scale 2,0...5,0 and the balance scale in an ascending way, so that the most important evaluation factor should reach the value of 5.0, and the least important the value 2.0.

j)The matrix of the group belonging degrees

By calculating the value of the contamination degree G_{Ki}, corresponding to each factor $\overline{x}_{Ki}$ from the decisional group matrix, we obtain a column matrix of the individual contamination degrees, so:

$$\begin{matrix} G_{K1} \\ G_{K2} \\ .... \\ G_{Kn} \end{matrix}\ , \qquad (6)$$

k) Global contamination degree

Let us call "global contamination degree" in the achieving of all evaluation criteria, an average type operator, a relation for composing the factors of the matrix of the group belonging degrees, of the form:

$$\overline{G}_K = \sum_{i=1}^{n} \frac{G_{Ki}}{i} \qquad (7)$$

l)Evaluation scale

Let us call the evaluation scale of the "contamination degree" a panel in which a lexical nuance is associated, that expresses the contamination degree and a fuzzy values interval.

Each value $\overline{G}_K$ calculated according to the above relation is compared with predefined values of some efficiency functions, called – contamination levels (eg. level of risk, danger levels, etc), the fuzzy values intervals having correspondence with lexical nuances.

Table nr. 1.

Lexical nuance	**Interval**
(A) Maximum	$e^{-\delta_{med}\lvert 1-0,8\rvert} < \overline{G}_K \leq e^{-\delta_{med}\lvert 1-1,0\rvert}$

(B)	$e^{-\delta_{med}\|1-0,6\|} < \overline{G}_K \leq e^{-\delta_{med}\|1-0,8\|}$
(C)	$e^{-\delta_{med}\|1-0,4\|} < \overline{G}_K \leq e^{-\delta_{med}\|1-0,6\|}$
(D)	$e^{-\delta_{med}\|1-0,2\|} < \overline{G}_K \leq e^{-\delta_{med}\|1-0,4\|}$
(E) Minimum	$e^{-\delta_{med}\|1-0,0\|} \leq \overline{G}_K \leq e^{-\delta_{med}\|1-0,2\|}$

Air contamination gravity parameter"I_G"

It is a parameter which is calculated using the formula:

$$\overline{G}_{IG} = f(\overline{x}_{IGi}, \alpha_i)$$

The balance parameter α_i:(0.3,0.25,0.25,0.2) is assigned function of the importance of criteria C_i:(C_1,C_2,C_3,C_4), taken into consideration when calculating the parameter G_{IG}, so that $\alpha_1 C_1 \leq \alpha_2 C_2 \leq ... \leq ... \alpha_n C_n$, where $\sum_i \alpha_i = 1$.

The main criteria used for the calculus of the G_{IG}, parameter, as well as the interval of values assigned to the evaluation variable x_{IGi}, are shown next:

Table nr. 2.

(C_1) Possible gravity of air contamination	
x_{IGi}=0,0	Minimum
0,0<x_{IGi}≤0,2	Low
0,2<x_{IGi}≤0,4	Medium
0,4<x_{IGi}≤0,6	High
0,6< x_{IGi} ≤0,8	Very high
x_{IGi}=1,0	Maximum
(C_2) Possibilities to reduce the harmfulness of contaminants	
x_{IGi} =0,0	Minimum
0,0< x_{IGi} ≤0,2	Less possible
0,2< x_{IGi} ≤0,4	Almost
0,4< x_{IGi} ≤0,6	Possible
0,6< x_{IGi} ≤0,8	Highly possible
x_{IGii}=1,0	Integral
(C_3) Predominant type of contaminant	
x_{IGi}=0,0	Contaminant with a concentration that involves no risk
0,0< x_{IGi} ≤0,2	Contaminant with a concentration that involves a low risk
0,2< x_{IGi} ≤0,4	Contaminant with a concentration that involves a medium risk
0,4< x_{IGi} ≤0,6	Contaminant with a concentration that involves a high risk
0,6< x_{IGi} ≤0,8	Contaminant with a concentration that involves a very high risk
x_{IGi} =1,0	Contaminant with a concentration that involves a maximum risk
(C_4) Previous events	
x_{IGi}=0,0	No events
0,0< x_{IGi} ≤0,6	Contamination with significant potential impact
0,6< x_{IGi} ≤1,0	Contamination with significant impact

Acording to the data previously shown, the air contamination gravity parameter can be described by the following heuristic formula:

$$\overline{G}_{IG}=\sum_{i=1}^{4}\frac{G_{IGi}}{i}=\frac{1}{4}\left(e^{-\delta_1\left|1-\overline{x}_{IG1}\right|}+e^{-\delta_2\left|1-\overline{x}_{IG2}\right|}+e^{-\delta_3\left|1-\overline{x}_{IG3}\right|}+e^{-\delta_4\left|1-\overline{x}_{IG4}\right|}\right)$$

After calculating $\overline{G}_{IG}$, the admissible value of this parameter is determined using the relation:

$$\overline{G}_{IGadmisibil}=e^{-\delta_{med}\left|1-\overline{x}_{IGi}\right|}\text{, where } \delta_{med}=\sum_{i=1}^{4}\frac{\delta_i}{i}$$

after which the values of the two parameters are compared to one another.

Application example : Environmental factor : air (Assessment of the contamination level of a fixed source – chimneys)

Table nr. 3.

Criteria, C_i	Estimation / evaluation value
(C_1)Possible gravity of air contamination	x_{IG1}=0,6/Hight
(C_2) Possibilities of reducing the harmfulness of contaminants	x_{IG2}=0,6/ Possible
(C_3) Type of predominant contaminant	x_{IG3}=0,8/ Contaminant having a concentration that involves a very high rick– CO_2
(C_4) Previous events	x_{IG4}=0,6/ Contamination having a significant potential impact

(C_1)	(C_2)	(C_3)	(C_4)
α_1= 0,3	α_2= 0,25	α_3= 0,25	α_4= 0,2
δ_1=2,90	δ_2=2,75	δ_3=2,75	δ_4=2,60
G_{IG1}=0,31	G_{IG2}=0,33	G_{IG3}=0,57	G_{IG4}=0,35

$$\overline{G}_{IG}=\sum_{i=1}^{4}\frac{G_{IGi}}{i}=\frac{1}{4}\left(G_{IG1}+G_{IG2}+G_{IG3}+G_{IG4}\right)=0{,}39\text{ , }\delta_{med}=\sum_{i=1}^{4}\frac{\delta_i}{i}=2{,}75$$

$\overline{G}_{IGadmisibil}=e^{-\delta_{med}\left|1-\overline{x}_{IGi}\right|}$	$\overline{x}_{IGi}=0{,}0$	$\overline{G}_{IGadmisibil}=0{,}063$	Minimum
	$0{,}0<\overline{x}_{IGi}\le 0{,}2$	$0{,}063<\overline{G}_{IGadmisibil}<0{,}110$	Very low
	$0{,}2<\overline{x}_{IGi}\le 0{,}4$	$0{,}110<\overline{G}_{IGadmisibil}<0{,}192$	Low
	$0{,}4<\overline{x}_{IGi}\le 0{,}6$	$0{,}192<\overline{G}_{IGadmisibil}<0{,}332$	Medium
	$0{,}6<\overline{x}_{IGi}\le 0{,}8$	$0{,}332<\overline{G}_{IGadmisibil}<0{,}576$	High
	$0{,}8<\overline{x}_{IGi}<1{,}0$	$0{,}576<\overline{G}_{IGadmisibil}<1{,}000$	Very high
	$\overline{x}_{IGi}=1{,}0$	$\overline{G}_{IGadmisibil}=1{,}000$	Maximum
$0{,}332<\overline{G}_{IG}<0{,}576$		The importance of the risk factor **: High**	

Risk covering parameter "I_R"

It is a parameter which is calculated using the formula:

$$\overline{G}_{IR} = f\left(\overline{x}_{IRi}, \alpha_i\right)$$

The balancing parameter α_i:(0.35,0.3,0.15,0.1,0.1) is agreed function of the importance of the criteria C_i:(C_1,C_2,C_3,C_4,C_5), Taken into consideration when calculating the parameter I_R, so that $\alpha_1 C_1 \le \alpha_2 C_2 \le ... \le ... \alpha_n C_n$, where $\sum_i \alpha_i = 1$.

The main criteria for calculating the parameter G_{IR}, as well the range of values agreed for the evaluation variable x_{IRi}, are shown next:

Table nr. 4.

(C_1) Implementing the safety ecological function specific to the risk factor	
X_{IRi}=0,0	No safety ecological function is implemented
0,0<x_{IRi}≤0,2	Bad situation
0,2<x_{IRi}≤0,4	Less favourable situation
0,4<x_{IRi}≤0,6	Almost favourable situation
0,6<x_{IRi}≤0,8	Favourable situation
X_{IRi}=1,0	Very favourable situation
(C_2)Covering of the avoidance of negative effects on people's health and the environment in general	
X_{IRi}=0,0	No possibility of avoidance
0,0<x_{IRi}≤0,2	Very small possibility of avoidance
0,2<x_{IRi}≤0,4	Almost possible to avoid
0,4<x_{IRi}≤0,6	Possible to avoid
0,6<x_{IRi}≤0,8	Very possible to avoid
X_{IRi}=1,0	Certain avoidance
(C_3) Coverance by the use of prime materials (coal)	
0,0≤x_{IRi}≤0,2	Very bad choice of prime materials
0,2< x_{IRi} ≤0,4	Bad choice of prime materials
0,4< $x_{IRi\ i}$≤0,6	Almost good choice of prime materials
0,6< x_{IRi} ≤0,8	Good choice of prime materials
x_{IRi} =1,0	Very good choice of prime materials
(C_4) Coverance by use of chosen technology	
x_{IRi} =0,0	Negative
0,0< x_{IRi} ≤0,2	Very bad choice of technology
0,2< x_{IRi} ≤0,4	Bad choice of technology
0,4< x_{IRi} ≤0,6	Almost good choice of technology
0,6< x_{IRi} ≤0,8	Good choice of technology
x_{IRi} =1,0	Very good choice of technology
(C_5) Coverage by the project	
x_{IRi} =0,0	Negative
0,0< x_{IRi} ≤0,2	Very bad choice of design
0,2< x_{IRi} ≤0,4	Bad choice of design
0,4< x_{IRi} ≤0,6	Almost good choice of design
0,6< x_{IRi} ≤0,8	Good choice of design
x_{IRi} =1,0	Very good choice of design

According to the data previously presented, the risk covering parameter can be described by the following heuristic formula:

$$\overline{G}_{IR} = \sum_{i=1}^{5} \frac{G_{IRi}}{i} = \frac{1}{5}\left(e^{-\delta_1\left|1-\overline{x}_{IR1}\right|} + e^{-\delta_2\left|1-\overline{x}_{IR2}\right|} + e^{-\delta_3\left|1-\overline{x}_{IR3}\right|} + e^{-\delta_4\left|1-\overline{x}_{IR4}\right|} + e^{-\delta_5\left|1-\overline{x}_{IR5}\right|}\right)$$

Having calculated $\overline{G}_{IR}$, the admissible value of this parameter is determined with the relation:

$$\overline{G}_{IRadmisibil} = e^{-\delta_{med}\left|1-\overline{x}_{IRi}\right|}, \text{ where } \delta_{med} = \sum_{i=1}^{5} \frac{\delta_i}{i}$$

after that the values of the two parameters are compared to one another.

Supplementary cost parameter imposed by the achieving of safety ecological functions "I_C"

It is a parameter that is calculated using the formula:

$$\overline{G}_{IC} = f\left(\overline{x}_{ICi}, \alpha_i\right)$$

The balancing parameter α_i:(0.25,0.25,0.2,0.2,0.1) is agreed function of the importance of the criteria C_i:(C_1,C_2,C_3,C_4,C_5), taken into consideration when calculating the parameter I_C, so that $\alpha_1 C_1 \leq \alpha_2 C_2 \leq \ldots \leq \ldots \alpha_n C_n$, where $\sum_i \alpha_i = 1$.

The main criteria for calculating the parameter I_C, as well as the range of values agreed for the evaluation variable x_{ICi}, are shown next:

Table nr. 5.

(C_1) The cost for implementing the safety ecological function	
x_{ICi}=0,0	No supplementary costs
0,0< x_{ICi} ≤0,2	Very small supplementary costs
0,2< x_{ICi} ≤0,4	Small supplementary costs
0,4< x_{ICi} ≤0,6	High supplementary costs
0,6< x_{ICi} ≤0,8	Very high supplementary costs
x_{ICi} =1,0	Maximum supplementary costs
(C_2) The cost for the insurance of safe prime materials	
x_{ICi}=0,0	No supplementary costs
0,0< x_{ICi} ≤0,2	Very small supplementary costs
0,2< x_{ICi} ≤0,4	Small supplementary costs
0,4< x_{ICi} ≤0,6	High supplementary costs
0,6< x_{ICi} ≤0,8	Very high supplementary costs
x_{ICi} =1,0	Maximum supplementary costs
(C_3) The cost for the insurance of a safe technological process	
x_{ICi}=0,0	No supplementary costs
0,0< x_{ICi} ≤0,2	Very small supplementary costs
0,2< x_{ICi} ≤0,4	Small supplementary costs
0,4< x_{ICi} ≤0,6	High supplementary costs
0,6< x_{ICi} ≤0,8	Very high supplementary costs
x_{ICi} =1,0	Maximum supplementary costs

(C$_4$) The cost for avoidance of negative effects on people's health and the environment in general	
x_{ICi}=0,0	No supplementary costs
0,0< x_{ICi} ≤0,2	Very small supplementary costs
0,2< x_{ICi} ≤0,4	Small supplementary costs
0,4< x_{ICi} ≤0,6	High supplementary costs
0,6< x_{ICi} ≤0,8	Very high supplementary costs
x_{ICi} =1,0	Maximum supplementary costs
(C$_5$) The cost for a safe design	
x_{ICi}=0,0	No supplementary costs
0,0< x_{ICi} ≤0,2	Very small supplementary costs
0,2< x_{ICi} ≤0,4	Small supplementary costs
0,4< x_{ICi} ≤0,6	High supplementary costs
0,6< x_{ICi} ≤0,8	Very high supplementary costs
x_{ICi} =1,0	Maximum supplementary costs

According to the data previously presented, the gravity of risk parameter can be described by the following heuristic formula:

$$\overline{G}_{IC} = \sum_{i=1}^{5} \frac{G_{ICi}}{i} = \frac{1}{5}\left(e^{-\delta_1\left|1-\overline{x}_{IC1}\right|} + e^{-\delta_2\left|1-\overline{x}_{IC2}\right|} + e^{-\delta_3\left|1-\overline{x}_{IC3}\right|} + e^{-\delta_4\left|1-\overline{x}_{IC4}\right|} + e^{-\delta_5\left|1-\overline{x}_{IC5}\right|} \right)$$

Having calculated $\overline{G}_{IC}$, the admissible value of this parameter is determined with the relation:

$$\overline{G}_{ICadmisibil} = e^{-\delta_{med}\left|1-\overline{x}_{ICi}\right|}, \text{ where } \delta_{med} = \sum_{i=1}^{5} \frac{\delta_i}{i}$$

after that the values of the two parameters are compared to one another.

The results obtained are conveyed by the following indicators:

Table nr. 6.

Indicators	Formula
Environment global risk coverage coefficient - analyzed environmental factors - environmental system	$k_{gi} = \frac{\overline{G}_{SR}}{\overline{G}_{GR}}$ $K_g = \frac{\sum_{i=1}^{n} k_i k_{gi}}{\sum_{i=1}^{n} k_i}$
Global risk coverage coefficient relative to cost - analyzed environmental factors - environmental system	$\psi_i = \frac{k_{gi}}{\overline{G}_{CR}}$ $\Psi = \frac{K_g}{\overline{G}_{CR}}$
If $k_g(K_g) \geq 0,85$ the environmental system does not require a special ecological safety audit	

3. Bibliografy

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