Academia Romana -Comitetul Român de Istoria si Filsofia Ştiinţei şi Tehnicii (CRIFST)
Divizia de Logica Metodologie si Filozofia Stiintei (DLMFS)
Societatea Nationala Nuclearelectrica SA
Simpozionul Despre riscuri in stiinta si tehnica
30 iunie 2022

Despre riscurile actuale ale inovării/neinovării în știință și tehnică

– Unele lecții actuale din energetică în general și din cea nucleară în particular-

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Secretar DLMFS
DOI:10.18240/RG.2.8.89959

Informatii suplimentare in lucrarile

Dan Șerbănescu, ***Despre sistemele de energie, transformarile și riscurile lor*** DOI: 10.1744/RG.2.4.17459

Dan Șerbănescu , Natural reactors and man-made reactors Similarities, differences, lessons for last generations of nuclear reactors *Reactoare naturale și reactoare create de omAsemănări, diferențe, lecții pentru reactorii artificiali de ultima generație* DOI: 10.13544/RG.2.4.55459 https://www.researchgate.net/publication/360654035_Natural_reactors_and_man-made_reactors_Similarities_differences_lessons_for_last_generations_of_nuclear_reactors

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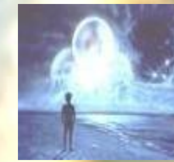

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_ Ihttps://www.researchgate.net/publication/294856257_Metode_de_corelare_a_defectelor_provocate_de_cresterea_sigurantei_in_functionare_a_unei_centrale_nucleare

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•***EXPERIENTA***
43 de ani in domeniul nuclear:

- ***constructie CNE, fabricatie echipamente CNE, pregatire si autorizare operatori CNE, proiectare CNE, autorizare CNE – punere in functoiune si functionare CNE Cernavoda u1 si u2, dezafectare, analize de risc; la nivel national 28 ani , evaluari de securitate nucleara Cernavoda si programe noi de centrale nucleare (SMR)***
- ***international 12 ani (CE-staff member 6 ani analize risc & dezafectare CNE Kozlodui 1-4,PBMR Ltd 6 ani sef proiect PRA reactor generatie IV)***

ACTIVITATI

- ***Membru titular din 2014 si din 2019 secretar interimar al Diviziei de Logica si Modele in Stiinta (DLMFS) din cadrul Comitetului Roman de Istoria si Filozofia Stiintei si Tehnicii (CRIFST)– Academia Romana***
- ***Membru ESREDA – European Safety, Reliability & Data Association.***
- ***Consultant tehnic extern in proiecte IAEA si CE - securitate nucleara, tehnologii inovative, calculatoare quantice-roboti , analize de risc***
- ***Colaborator extern ("full academic scope"-) la conducerea de teze de doctorat in domeniul nuclear Universitatea Politehnica Bucuresti. Autor al cursului de master de analize de risc nuclear in cadrul programului Seneca, UBP-Facultatea Energetica, 1996-2000***
- ***Coordonator teze de doctorat asupra modelarii sistemelor energetice nationale si a securitatii alimentarii cu energie la Universitatea Tehnica Delft (2007-2010) si Universitatea Kaunas (2007-2010) cu colaborari ulterioare cu Brookhaven National Laboratory si Lithuanian Energy Institute .***
- ***Redactor sef (contract) domeniul risc industrial Safety Science - Elsevier (2009-2011)***
- ***Autor si coautor de carti si lucrari in domeniul securitatii nucleare si analizelor de risc, modelarea in fizica si energetica nucleara***

CONTINUT

PARTEA I

O prezentare istorica a problemei
sau
Prolegomene la introspectia
“De ce avem nevoie de reactori modulari mici?”

1. IERARHIZAREA RISCURILOR ACTIUNII SI NONACTIUNII IN SISTEME ENERGETICE SUSTENABILE – CATS

CATS = Sisteme Apoietice Complexe Topologice- sisteme energetice ce cuprind surse si ciclul ei inclusiv consumatorii cu care se afla in conexiune de tip cibernetic)

1.1 NEVOIA DE MODELARE REALISTA FLEXIBILA BAZATA PE IERARHIE A RISCURILOR

- **Revoluția științifică actuală are o turnură dramatică în domeniul energiei**, **care se petrece în contextual general al societății de modificări mari, de zbateri politice, sociale și economice ce depind în mare măsură de aceasta.**
- Dezbateri intense asupra riscurilor diverselor surse de energie sunt duse în contextul atingerii țintelor de decarbonificare a mediului aflate în fața întregii planete. Deși respectarea deciziilor renunțării la utilizarea combustibilor fosili este o sarcină se pare greu de îndeplinit la nivel global, având puternice conotații politice și făcând parte dintr-un adevărat război economic mondial, totuși la nivel regional, cum este și cazul României, sunt hotărâte ținte de eliberare de CO2 care presupun renunțarea rapidă la combustibilii fosili, începând cu cărbunele mai ales.

1.2 CONSIDERAREA IERARHIEI RISCURILOR POATE EVITA EVOLUTIA/INVOLUTIA CICLICA SI CRESTEREA RISCURILOR CATS

- Cu toate acestea, în treacăt fie spus, s-a văzut că **mereu există o ierarhie a riscurilor; astfel între riscurile neluării în considerație a urmărilor unui război, aparent regional, și cele ale nivelurilor de CO2** s-a decis o înghețare partial a unora dintre măsurile ținte și astfel, o serie de reîntoarceri, chiar la producția pe carbine, par acceptabile tacit.

Dar vorba aceea CO2-ul știe? Dacă da, cum tratăm ierarhia riscurilor?
Ne gândim acum din mers cu spatele la zid? De ce nu ne-am gândit de la început ?

MOTIVATII PENTRU NECESITATEA STABILIRII UNEI IERARHII A RISCURILOR (1)
(detalii in Partea a 2-a)

- S-a văzut astfel că setarea de obiective luând ca țintă un **anumit risc-schimbările climatice nu trebuie făcută superficial (în opinia autorului) și /sau ghidată de idei fixe cu tentă politică** și mai puțin științifică, neglijând posibilitatea ca **viața reală să fie caracterizată de o adevărată rețea de riscuri interconectate, în care diminuarea unora duce la probleme prin creșterea altora, nemai**vorbind de situația în care apar riscuri immediate catastrofale – război de exemplu sau criză mondială acută financiar-alimentară. **S-a dovedit că a planifica în energie cu idei paranoide guvernate de ideologii este o strategie catastrofală**.

- În acest context, țara noastră, rămasă ân urmă, **accidental intern sau nu, la retehnologizarea centralelor pe cărbune, prin introducerea de sisteme de filtrare moderne si reînnoirea tehnologiilor, s-a găsit în fața singurei opțiuni pentru o tranziție contra cronometru la un** nivel țintă european de eliberări de CO_2: **gaz, probabil repornire pe cărbuni, ceva petrol, nucleare (dar unele se vor opri după un program anunțat de acum zece ani), regenerabile cât pot si ele (că nu răspund la directive politică să poată să acopere ce procente spune politica..)** și… **strategii și planuri** pentru ce va fi peste opt-zece ani când contăm pe energie nucleară… **Nu parea pana acum ceva foarte profund și mai ales din timp gândit, neffind considerate evaluari de riscuri și analize de reziliențe de sisteme energetice.**

MOTIVATII PENTRU NECESITATEA STABILIRII UNEI IERARHII A RISCURILOR (2)
(detalii in Partea a 2-a)

- Aceasta în contextul în care **avem programe energetice haotice, cu implementări ad hoc de surse regenerabile ca panaceu universal**, cu o **lipsă crasă a inovării și adaptării la schimbări a sistemului energetic național și a cercetării energetice (***de fapt am cam desființat facultățile, liceele de specialitate așa că avem și explicații de ce nu mai știm și nici nu vrem să știm cum se produce energia..),* **o bâlbâială greu de înțeles,** pentru care ți-ar trebui multă energie ca să nu faci comentarii neștiințifice.
- Nu au existat cercetari si dezvoltari sistematice si coordonate **pana acum**; doar planuri pe termene scurte, fara o utilizare reala implementata de utilizare a resurselor fosile cu metode de filtrare și protecție la standarde mondiale si fara perspective de rezolvare cu alte surse.
- Astfel fara un sprijin constant sustinut al statului , care se face si la multe economii de piata ce predica liberalismul in energetica, nu se pot dezvolta decat versiuni de strategii energetice, care se **schimbă la 4-5 ani, cam ca politica , în contextul în care un program energetic se dezvoltă și se întreține pe zeci de ani**.

2. METODE DE CAUTARE DE SOLUTII SI SCENARII ENERGETICE VIABILE PENTRU SISTEME ENERGETICE SUSTENABILE - CATS

2.1 Energia ca sistem de sisteme CATS

- Crizele unele catastrofale, ca cea din prezent, din energie, indica necestitatea abordarii sistematice a planificarii unui **sistem energetic, cu trasaturi specifice unui sistem functional si rezilient, pe care l-am denumit ca sistem de sisteme CATS.**
  - In acest context devine evidenta nevoia de a considera surse cu adevărat alternative cum este energia **nucleară, pentru care pana nu demult se optase la nivel național că nu este o prioritate inovarea.**
  - **Nu s-a făcut niciodată o evaluare care este riscul neinovării, dar de câteva luni se vede fără analize cât este de mare.**
  - **Similar a fost cu utilizarea bogățiilor de surse fosile, pe care cu îmbunătățiri /inovări le-am putea utiliza respectând strategiile de atingere de fel de fel de ținte impuse de alții și acceptate cu ușurință** greu de înțeles de către noi.

- **2. METODE DE CAUTARE DE SOLUTII SI SCENARII ENERGETICE VIABILE PENTRU SISTEME ENERGETICE SUSTENABILE – CATS (cont)**

2.2 Provocari pentru CATS

- Tintele climatice emise sub imperativ politic s-au dovedit recent ca total nerealiste in fata unor provocari ale sistemelor CATS. Acum când peste noi vin catastrofe, cum este un război, a face o **comparație între cele două riscuri** arată ce subțiri au fost evaluăările de strategii, **fără scenarii de rezervă,** fără analize de riscuri.
- O abordare nesistematizata si care nu ia in consideratie diverse scenarii si ierarhii ale riscurilor se dovedeste la provocari majore ca fiind catastrofala. Abordari « la moda » ca programarea unui viitor pe gaze fara carbune, cu putin nuclear si cu regenerabile de baza ne poate fi catastrofala.

« Cum este posibil să ai ca țintă sa cumperi o pălărie de soare cu bor larg iarna, cand ai rămas fără bocanci ? »

- Deși în paralel la noi s-au introdus, sub formă de import direct, soluții de producere în instalații de energie regenerabilă, aceste inovații și-au atins déjà în acest moment limita de dezvoltare ca nivel de producție. Și nici nu ar fi fost așa eficiente fără un sprijin financiar de stat ,care interesant ca nu era interzis ca pentru nuclear,. de certificate verzi…
- Exista de asemenea o lipsa a u**nei cercetări reale și cu personal calificat și al consultării specialiștilor in domeniu**

2.3 MODELAREA SI PLANIFICAREA SISTEMATICA PENTRU CATS

2.3.1 Necesitatea – sistemele devin complexe si modelarile la fel

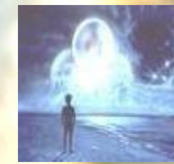
- **La nivel internațional însă se dezvoltă cercetări fundamentale științifice și se dezvoltă tehnologii energetice pentru acest secol și ce va urma**. Astfel la nivel științific se studiază **surse pentru secolul urmator: reactori de fuziune, energii neconvenționale de mare eficiență (solare pe orbite planetare cu randamente cel putin pentuple față de ce facem pe pământ, energie de fisiune de ultimă generație**

(cum sunt si SMR-urile cu apa sau nu, si bateriile nucleare)

- De mentionat. **ca la o centrală de fuziune ne va trebui să avem cel putin trei centrale de fisiune să o pornim ; cam greu de făcut cu eoliene si fotovoltaice terestre**.
- **De aici o lecție foarte importantă:**

Nu poți planifica în energie să treci de la candelă la fuziune; trecerea se face nivel de energie cu nivel de energie, acesta este sensul dezvoltării civilizației noastre

Desigur aca nu avem partipriuri politice, care ne obligă să ne adăpostim în peșteri ca să nu poluăm.
Da, să luam măsuri să nu ne poluăm, dar cred că toți speră că nu ni se cere să mergem în caverne.. Apropos atunci ar trebui să renunțăm si la animale - de exemplu bovinele, ovinele, porcinele și să cultivăm fasole și grâu fără ingrășăminte de nici un fel…Ar fi un paleolitic frumos…



CATS SYSTEMS

Subquantic	SQ=SYS7
Quantic	Q =SYS8
Molecular	M =SYS9
Molecular life	ML=SYS1
Planetary	P =SYS2
Planetary life	PL =SYS3
Planetary life intelligent	**PLI =SYS0**
Galaxy	G =SYS4
Cosmic	C =SYS5
Cosmic life	CL =SYS6
Cosmic intelligent	**CLI =SYS10**

CATS - STATICS & DINAMICS

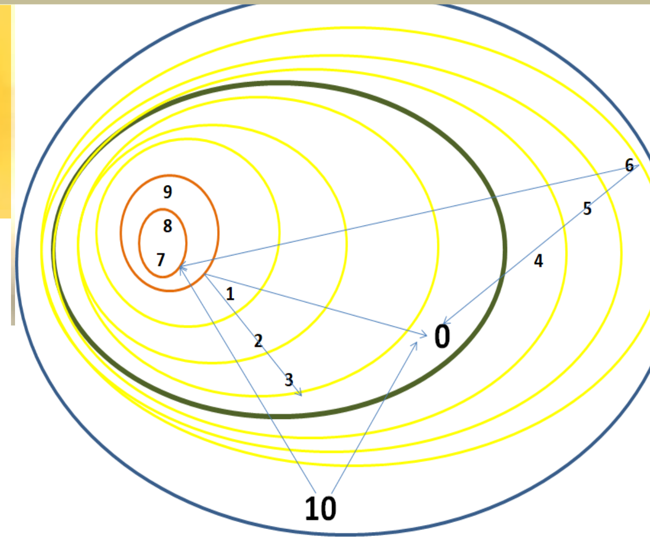
For one given case

$$s^{(k)} = \sum_{l=0}^{8}\sigma_l^{(k)} + \sum_{l=0}^{8}\omega * i_l^{(k)}$$

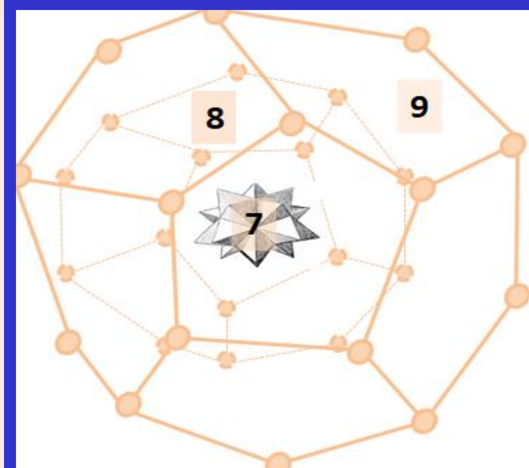
$$E^{(k)} \equiv \sum_{l=0}^{8} E_l^{(k)} i_l^{(k)}$$

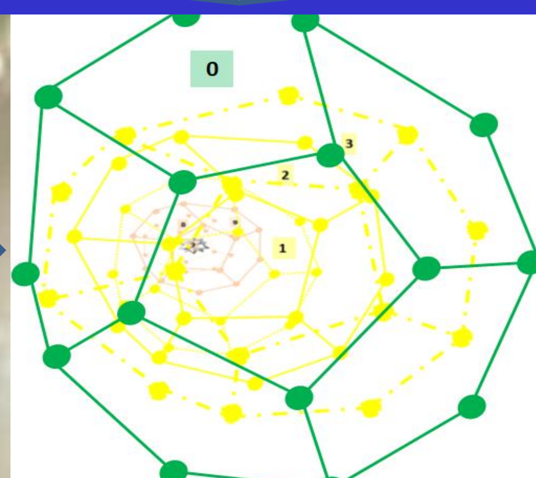
$$m^{(k)} \equiv \sum_{l=0}^{8} m_l^{(k)} i_l^{(k)}$$

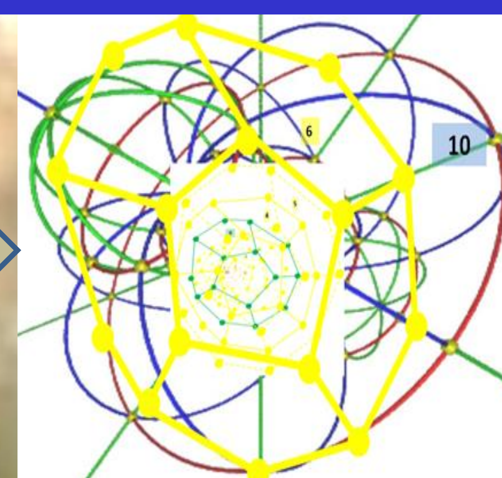
$$\psi^{2\,(k)} \equiv \sum_{l=0}^{8} \psi^{2\,(k)}_{l} i_l^{(k)}$$



CATS SYSTEMS STATES







2.3 MODELAREA SI PLANIFICAREA SISTEMATICA PENTRU CATS (CONT)

2.3.2 Modelarea staticii si dinamicii CATS – scenarii energetice si inovarea

- Planurile de viitor la nivel internațional iau în considerație **stabilitatea și reziliența asigurării de resurse, dintre care energia este fundamentală. În lume se fac astfel de calcule și unele rezultate ale autorului au fost comunicate anterior pentru Romania și țările baltice.**
- **Sursele de energie ale urmatorilor 50-100 de ani în mod sigur se vor baza pe energetica nucleară de fisiune pentru a susține pasul/ saltul următor**.
  - În acest context **apar noi generații de soluții științifice (acum suntem la generația IV) dar și noi tehnologii.**
  - **Energetica nucleară este sprijinită de o știință aplicată parte a fizicii**, care va evolua mult odată cu **apariția de noi tehnologii/descoperiri** de exemplu

    - *calculatoarele cuantice (ce vor permite calcule rapide și mult mai rapide)*
    - *nanotehnologiile*
    - *IA*
    - *centrale digitale gemene sau mai ales*
    - *noi generații de pământeni (alpha, betha etc)*

2.3 MODELAREA SI PLANIFICAREA SISTEMATICA PENTRU CATS (CONT) --2.3.2 Modelarea staticii si dinamicii CATS – scenarii energetice si inovarea

- **Optimizarea reactorilor nucleari se efectueaza si prin construirea de SMR**, raspunzand la intrebarea *"De ce avem nevoie de reactori modulari mici?"* pentru ca **reactorii nucleari ai noilor generatii, inclusiv SMR, sunt**
  - **mult mai robuști,**
  - **mai compacți,**
  - **mai eficienți**
  - **mai flexibili in utilizare și**
  - **costa tot mai puțin.**

- **Alte directii de optimizare cuprind noi metode de producere a energiei in reactor**, dar tot bazat pe fisiune (reactori rapizi sau termici cu apă sau alți agenti de racire, cu zona activă solidă sau topită).

3. MODELAREA SCENARIILOR SI NECESITATILOR INOVARII/NONINOVARII – CU APLICABILITATE LA CAZUL PARTICULAR SMR

- De**zvoltarea civilizației nu poate fi disociată de creșterea nivelului de energie pe care îl putem stăpâni și folosi fără a ne polua sau distruge.** Acesta este acum sensul cercetării științifice iîn energetică
- În acest context pasul următor este **asigurarea nivelului energetic minimal pentru susținerea energiilor secolelor următoare, de exemplu fuziunea, sau energia gravitațională, sau sprijinirea producerii de energie pe orbite terestre și nu numai și transmiterea pe Pământ.**
- **Unul dintre obiective va fi asigurarea de surse de materii prime și noi tehnologii de producere a energiei.**
- **Noile tehnologii vor avea riscurile lor și cea mai mare greșeală ar fi să declari paranoid că nu se defectează.**
- **Se va sofistica nu doar proiectul reactorului în sine, dar și modalitatea de combatere a accidentelor posibile; cu calculatoare puternice, robotizare și IA reactoristica de la cercetare la dezafectare va arăta foarte diferit, în sensul de diminuare spectaculoasă, cu ordine de mărime, a riscurilor încă din acest secol.**
- În aceasta direcție se înscrie ce aflăm și noi, importând de la alții câtă vreme nu mai cercetăm noi înșine pentru utilizare în acest deceniu, **noi filiere, cum sunt reactorii modulari mici. Aceștia de exemplu au multe din atributele de cercetare, fabricație și exploatare ale noii generații.**

3. Definirea scenariilor posibile de necesitate pentru nevoile de diverse forme de energie, cu considerarea diverselor provocari asupra surselor si retelelor

		Initiating Event	
Nuclear U1	ESN1	IE1_ESW35_CY1_E1	Initiating Event E1 for SC1 ESW35 Cy1
Nuclear U2	ESN2	IE1_ESW35_CY1_E1_0	IE E1_0 for SC1 ESW35 Cy1
Nuclear U3	ESN3	IE1_ESW35_CY1_E1_1	IE E1_1 for SC1 ESW35 Cy1
Nuclear U4	ESN4	IE1_ESW35_CY1_E1_2	IE E1_2 for SC1 ESW35 Cy1
CET Galati Grupul 3	ESH5	IE1_ESW35_CY1_E1_3	IE E1_3 for SC1 ESW35 Cy1
CET Galati Grupul 4	ESH6	IE1_ESW35_CY1_E2	Initiating Event E2 for SC1 ESW35 Cy1
CET Galati Grupul 5	ESH7	IE1_ESW35_CY1_E2_0	IE E2_0 for SC1 ESW35 Cy1
CET Galati Grupul 6	ESH8	IE1_ESW35_CY1_E2_1	IE E2_1 for SC1 ESW35 Cy1
CTE Galati (Enel)	EST9	IE1_ESW35_CY1_E2_2	IE E2_2 for SC1 ESW35 Cy1
CTE Braila 1	EST10	IE1_ESW35_CY1_E2_3	IE E2_3 for SC1 ESW35 Cy1
CTE Braila 2	EST11	IE1_ESW35_CY1_SP1	Initiating Event SP1 for SC1 ESW35 Cy1
CTE Braila	EST12	IE1_ESW35_CY1_SP1_0	IE SP1_0 for SC1 ESW35 Cy1
CCGT Tulcea (Alro)	ESC13	IE1_ESW35_CY1_SP1_1	IE SP1_1 for SC1 ESW35 Cy1
CET Palas 1	ESH14	IE1_ESW35_CY1_SP1_2	IE SP1_2 for SC1 ESW35 Cy1
CET Palas 2	ESH15	IE1_ESW35_CY1_SP1_3	IE SP1_3 for SC1 ESW35 Cy1
CEE Pestera (EDP renewables)	ESW16	IE1_ESW35_CY1_SP2	Initiating Event SP2 for SC1 ESW35 Cy1
CEE Valea Nucarilor - Tulcea (Enel)	ESW17	IE1_ESW35_CY1_SP2_0	IE SP2_0 for SC1 ESW35 Cy1
CEE Fantanele -Cogeleac	ESW18	IE1_ESW35_CY1_SP2_1	IE SP2_1 for SC1 ESW35 Cy1
CEE Silistea (Romconstruct)	ESW19	IE1_ESW35_CY1_SP2_2	IE SP2_2 for SC1 ESW35 Cy1
CEE Cernavoda 1 (EDP renewables)	ESW20	IE1_ESW35_CY1_SP2_3	IE SP2_3 for SC1 ESW35 Cy1
CEE Dorobantu, Constanta (Wind Power)	ESW21	IE1_ESW35_CY1_T1	Initiating Event T1 for SC1 ESW35 Cy1
CEE Cernavoda 2 (EDP renewables)	ESW22	IE1_ESW35_CY1_T1_0	IE T1_0 for SC1 ESW35 Cy1
CEE Salbatica 1	ESW23	IE1_ESW35_CY1_T1_1	IE T1_1 for SC1 ESW35 Cy1
CEE Mihai Viteazu, Constanta (Iberdrola)	ESW24	IE1_ESW35_CY1_T1_2	IE T1_2 for SC1 ESW35 Cy1
CEE Salbatica 2	ESW25	IE1_ESW35_CY1_T1_3	IE T1_3 for SC1 ESW35 Cy1
CEE Corugea	ESW26	IE1_ESW35_CY1_T2	Initiating Event T2 for SC1 ESW35 Cy1
CEE Sarichioi	ESW27	IE1_ESW35_CY1_T2_0	IE T2_0 for SC1 ESW35 Cy1
CEE Vutcani	ESW28	IE1_ESW35_CY1_T2_1	IE T2_1 for SC1 ESW35 Cy1
CEE CEDD CAS Regenerabile	ESW29	IE1_ESW35_CY1_T2_2	IE T2_2 for SC1 ESW35 Cy1
CEE CEED Alpha Wind Nord 1	ESW30	IE1_ESW35_CY1_T2_3	IE T2_3 for SC1 ESW35 Cy1
Proiect eolian 1	ESW31	IE1_ESW35_CY1_TR1	Initiating Event TR1 for SC1 ESW35 Cy1
Proiect eolian 2	ESW32	IE1_ESW35_CY1_TR1_0	IE TR1_0 for SC1 ESW35 Cy1
Proiect eolian 3	ESW33	IE1_ESW35_CY1_TR1_1	IE TR1_1 for SC1 ESW35 Cy1

Cod	Scenariu 1 (1 ianuarie 2013)	Gestionar	Conectare	Statia de racord	Emitent/Comentariu	Putere instalata	Putere neta	Energie primara	Ciclu	Cernavoda 400 kV	Barbosi 100 kV sau Smardan	Lacu Sarat 400 kV	Lacul Sarat 220 kV	Smardan 400kV	Tulcea Vest 400 kV	Constanta Nord 110 kV	Medgidia Sud 110kV	celula 110kV din Tulcea	Tariverde 400kV	Medgidia Nord 110kV	Rahmanu
ESN1	Nuclear U1	Nuclearelectrica	RET	Cernavoda 400 kV		706.5	650.0	Nuclear	CY2	x											
ESN2	Nuclear U2	Nuclearelectrica	RET	Cernavoda 400 kV		706.5	648.0	Nuclear	CY2	x											
ESH5	CET Galati Grupul 3	Electrocentrale Galati	RET	Barbosi 110 kV		105.0	96.0	Hidrocarburi	CY2		x										
ESH6	CET Galati Grupul 4	Electrocentrale Galati	RET	Barbosi 110 kV		60.0	58.0	Hidrocarburi	CY2		x										
ESH7	CET Galati Grupul 5	Electrocentrale Galati	RET	Barbosi 110 kV		105.0	96.0	Hidrocarburi	CY2		x										
ESH8	CET Galati Grupul 6	Electrocentrale Galati	RET	Barbosi 110 kV		105.0	96.0	Hidrocarburi	CY2		x										
EST10	CTE Braila 1	SE Braila	RET	Lacu Sarat 220 kV		227.0	213.0	Hidrocarburi	CY2				x								
EST11	CTE Braila 2	SE Braila	RET	Lacu Sarat 220 kV		210.0	195.0	Hidrocarburi	CY2				x								
ESH14	CET Palas 1	SE Constanta	RET	Constanta Nord 110 kV		50.0	42.5	Hidrocarburi	CY2							x					
ESH15	CET Palas 2	SE Constanta	RET	Constanta Nord 110 kV		50.0	42.5	Hidrocarburi	CY2							x					
ESW16	CEE Pestera	EDP Renewables	RED	Medgidia Sud - Rasova	Enel Distributie Dobrogea / Racord in derivatie s.c. din LEA 110 kV pana la st de transf 110/33 kV a utilizatorului	90.0	88.25	Vant	CY2								x				
ESW17	CEE Valea Nucarilor - Tulcea	Enel Green Power	RED	Tulcea Vest - Sarinasuf	Enel Distributie Dobrogea / Racord in derivatie simplu circuit LEA 110 kV Tulcea Vest - Sarinasuf	34.0	33.4	Vant	CY2									x			
ESW18	CEE Fantanele - Cogeleac	CEZ	RET	Tariverde	Transelectrica / statia 400/110 kV Tariverde	600.0	585.0	Vant	CY2										x		
ESW19	CEE Silistea	Romconstruct - ButanGas	RED	Harsova - Medgidia Nord	Enel Distributie Dobrogea / racord intrare - resire in LEA 110 kV, prin statie de conexiune 110 kV si LEA 110 kV pana la st de transf a utilizatorului	25.0	24.8	Vant	CY2											x	
ESW20	CEE Cernavoda 1	Cernavoda Power	RED	Mircea Voda - Medg. N.	Enel Distributie Dobrogea / racord in derivatie din LEA 110 kV pana la st de transf 110/33kV a utilizatorului	69.0	68.3	Vant	CY2											x	
ESW21	CEE Dorobantu, Constanta	Wind Power Park	RET	Rahmanu	Transelectrica / racord prin statie noua 400/110 kV Rahmanu intrare in LEA 400 kV Isaccea - Medgidia	45.0	42.7	Vant	CY2												x
ESW22	CEE Cernavoda 2	Cernavoda Power	RED	Tortomanu	Enel Distributie Dobrogea / racord radial prin LEA 110 kV s.c. in st. de transf. Baia pana la st. de transf.	69.0	67.7	Vant	CY2						x						
ESW23	CEE Salbatica 1	Enel Green Power	RED	Tulcea Vest - Tulcea Est	Enel Distributie Dobrogea / racord in derivatie d.c din LEA 110 kV pana la st de transf 110/33 kV a utilizatorului	70.0	68.5	Vant	CY2						x						
ESW24	CEE Mihai Viteazu, Constanta	Eolica Dobrogea (Iberdro	RED	?	?	80.0	79.0	Vant	CY2												
ESW25	CEE Salbatica 2	Enel Green Power	RED	Tulcea Vest - Tulcea Est	Enel Distributie Dobrogea / racord in derivatie d.c din LEA 110 kV pana la st de transf 110/33 kV a utilizatorului	70.0	68.5	Vant	CY2						x						
ESW26	CEE Corugea	Enel Green Power	RED	Cismeaua Noua	Enel Distributie Dobrogea / racord prin LEA 110 kV din statia de transf Cismeaua Noua pana la st. de transf.	70.0	69.0	Vant	CY2												
ESW27	CEE Sarichioi	EDP Renewables	RED	Tulcea Vest - Zebil	Enel Distributie Dobrogea / racord in derivatie din LEA 110 kV pana la st de transf a utilizatorului	33.0	32.4	Vant	CY2						x						
ESW28	CEE Casimcea, Tulcea CAS	CAS Regenerabile (Austr	RET	Rahmanu	Transelectrica / iesire prin statie noua 400/110 kV Rahmanu intrare - iesire in LEA 400 kV Isaccea -	50.6	49.6	Vant	CY2												x
ESW29	CEE Casimcea, Tulcea Alpha	Alpha Wind - Verbund	RET	Rahmanu	Transelectrica / iesire prin statie noua 400/110 kV Rahmanu intrare - iesire in LEA 400 kV Isaccea - Medgidia (Dobrudja)	48.3	47.5	Vant	CY2												x
ESW30	CEE Babadag	Eviva Nalbant - Martifer	RED	Babadag	Enel Distributie Dobrogea / prin LES 110 kV direct in statia Babadag	33.6	33.0	Vant	CY2												
ESW31	CEE Mihai Viteazu	Wind Farm MVY	RED	?	?	13.8	13.8	Vant	CY2												
ESW32	CEE Gemenele	Braila Winds (GDF Suez)				48.3	47.5	Vant	CY2												
ESW33	CEE Targusor (Zefir 1)	Elcomex EOL				119.6	119.0	Vant	CY2												
ESW34	CEE Topolog	Total Electric				27.0	27.0	Vant	CY2												
	Total nuclear in operare (CY2)					1413.0	1298.0														
	Total hidrocarburi in operare (CY2)					912.0	839.0														
	Total carbune in operare (CY2)					0.0	0.0														
	Total vant in operare (CY2)					1596.2	1565.0														
	Total putere in operare (CY2)					3921.2	3461.7														
ESN3	Nuclear U3	Nuclearelectrica	RET	Cernavoda 400 kV		720.0	670.0	Nuclear	CY1	x											
ESN4	Nuclear U4	Nuclearelectrica	RET	Cernavoda 400 kV		720.0	670.0	Nuclear	CY1	x											
EST9	CTE Galati	Enel	RET			800.0		Carbune	CY1												
EST12	CTE Braila	Enel	RET			880.0		Carbune	CY1					x							
ESC13	CCGT Tulcea	Alro	RET			420.0		Gaze	CY1						x						
ESW35	CEE							Vant	CY1												

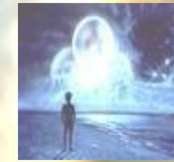
CRITERII

	O	A	B	C	D	E	F	G	H	Cerinte ale indeplinirii grupelor de criterii	O	A	B	C	D	E	F	G	H	Impactul unor conditionari dominante asupra cerintelor / TOTAL	O	A	B	C	D	E	F	G	H	Nivel satisfacere cerinte
Aspectele economice	4	1	2	4	2	4	4	4	1	Investitie totala	6	8	10	10	9	10	10	8	8	Reglementari/limitari finantare din partea CE	8 / 14	4 / 12	2 / 12	6 / 16	4 / 13	8 / 18	6 / 16	8 / 16	8 / 16	ABD
										Crestere neprevazuta initial a investitiei pe durata realizarii	6	8	10	10	10	10	10	10	8	Reglementari pe piata nationala si UE	10 / 16	4 / 12	2 / 12	6 / 16	6 / 16	6 / 16	8 / 18	8 / 18	6 / 14	AB
										Costul ponderat pe toata durata de viata a centralei	8	8	10	10	8	10	10	8	6	Scenarii energetice nationale si UE	8 / 16	4 / 12	4 / 14	4 / 16	6 / 16	4 / 16	4 / 16	6 / 18	6 / 12	AH
										Costul combustibilului	8	6	8	8	8	8	8	8	6	Rezerve si cost nationale vs variatie pret UE	10 / 18	6 / 12	6 / 14	8 / 16	8 / 16	8 / 16	8 / 16	10 / 18	6 / 12	AH
Securitatea nucleara si	4	1	1	1	1	1	2	2	2	Nivelul de securitate nucleara cerut pentru centrale noi	10	2	2	2	2	2	2	4	4	Regelementari UE(ex Directiva Securitate) centrale noi	10 / 20	2 / 4	2 / 4	2 / 4	2 / 4	2 / 4	4 / 6	4 / 8	2 / 6	ABC DEFH /O
										Nivelul de risk la evenimente interne si externe	6	2	2	2	2	2	2	4	2	Protectie pasiva crescuta la accidente severa	6 / 12	2 / 4	2 / 4	2 / 4	2 / 4	2 / 4	2 / 4	4 / 8	4 / 6	ABC DEFH G/O
Deseurile radioactive	4	3	3	4	4	4	4	4	3	Costul cu deseurile radioactive	10	8	8	8	8	8	8	8	6	Alegerea ciclului de combiustibil si a tipului de centrala	10 / 20	6 / 14	6 / 14	8 / 16	8 / 16	8 / 16	8 / 16	9 / 17	6 / 12	ABH
										Costul cu dezafectarea	10	8	8	8	8	8	8	8	6	Reglementari nationale posibil suport NDAP - UE	10 / 20	8 / 14	8 / 14	8 / 16	8 / 16	8 / 16	8 / 16	8 / 16	6 / 12	ABH
Utilizarea resurselor	4	3	3	4	4	4	4	4	4	Resurse de uraniu	10	6	6	6	6	6	6	6	6	Programe nationale suport	10 / 20	8 / 14	6 / 12	6 / 12	6 / 12	6 / 12	6 / 12	6 / 12	4 / 10	ABC DEFG H
										Resurse de thoriu	6	6	8	8	8	8	8	8	8	Programe nationale suport	6 / 12	6 / 12	8 / 16	8 / 16	8 / 16	8 / 16	8 / 16	8 / 16	8 / 16	OA
										MOX si alte cicluri combinate	10	6	6	6	6	6	6	6	6	Alegere ciclu combustibil si colaborari UE/SUA	10 / 20	6 / 12	6 / 12	6 / 12	10 / 16	10 / 16	10 / 16	10 / 16	10 / 16	ABC
Neproliferare	4	1	1	1	3	3	3	3	1	Rezistenta la neproliferare	8	4	4	6	8	8	8	8	4	Design	16	8	8	10	12	12	12	12	8	ABCH
TOTAL	4	1	1	3	3	3	3	3	2	ABH										CDEFG	O									

4. **Intarirea sectorului nuclear si cresterea contributiei sale**

   i. **Consolidarea functionarii pe termen lung a centralelor in functione care functioneaza in regim de baza de sarcina in SEN**
      a. **Retehnologizarea U1**
      b. **Punerea in functiune de noi centrale de mare putere (U3/4)**

   ii. **Considerarea energetiicii nucleare pentru a participa la reglarea in SEN prin utilizarea de centrale de puteri mai mici ce asigura acest lucru sub forma reactorilor de fisiune , de tip SMR, etapizat**
      a. **SMR cu apa**
      b. **SMR de generatie IV**



PARTEA a II-a

Studiu de caz

MODELAREA SCENARIILOR SI NECESITATILOR INOVARII/NON-INOVARII CU APLICABILITATE LA CAZUL PARTICULAR SMR

MODELE SI METODE DE EVALUARE SCENARII SMR IN CONTEXT ENERGETIC-SMR CA INOVARE

A – RIDM / ARBORI DE DECIZIE – METODA SES RISK

B – MCDA DE TIP ESREDA - CUBE

C – MODELARE ANALITIC PARAMETRICA – SISTEME ENERGETICE NUCLEARE CA FUNCTIE DE O VARIABILA SI UNU/DOI PARAMETRII -**SISTEME ENERGETICE NUCLEARE CA O TEHNOLOGIE**

D – SISTEME ENERGETICE MODELATE CATS

E - METODE INOVATIVE CALCULE DE RISC PENTRU SMR

MODELE SI METODE DE EVALUARE SCENARII SMR IN CONTEXT ENERGETIC-SMR CA INOVARE

A – RIDM / ARBORI DE DECIZIE – METODA SES RISK – detalii in ANEXA 1

MODEL - sistem complex cu interdependente (CATS) modelat sub forma arborescenta si cu diverse scenarii similar cu ridm pentru domeniul nuclear. se modeleaza insa si factorii non tehnici

METODA / REZULTATE – scenarii dominante la anumite provocari care descriu punctele slabe si indica masurile de luat

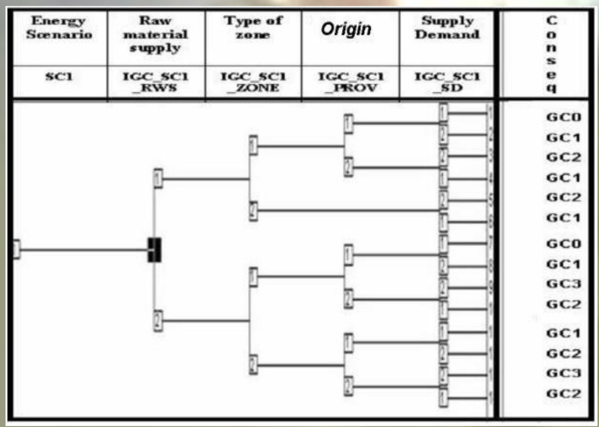
CRITERIILE - sunt de supravietuire a sistemului – spatiul solutiilor " SURV 1-3"

REZULTAT REFERITOR SMR: - Scenariile care arata non inovarea si neconsiderarea SMR pot avea contributii mari

A.1

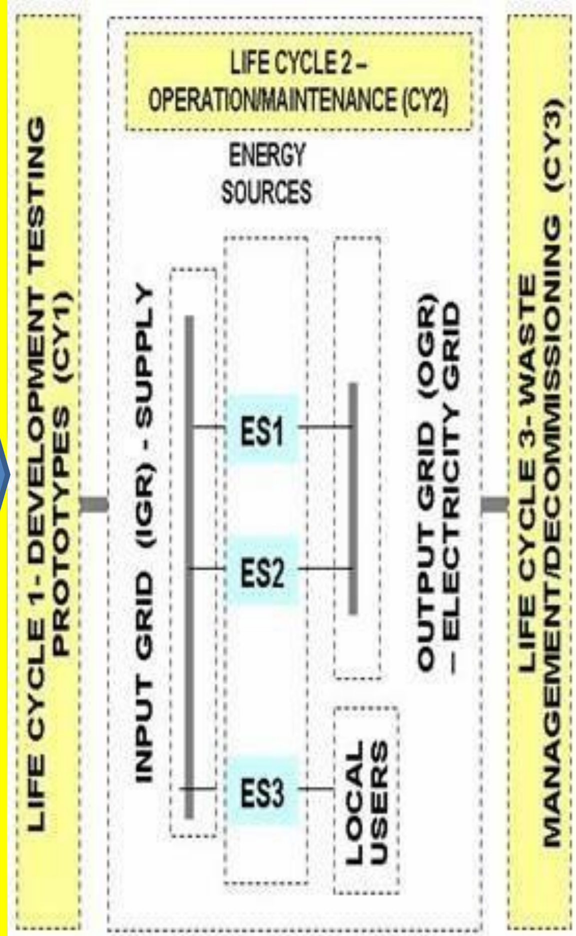
Modelul surselor si retelelor

Conditii initiale

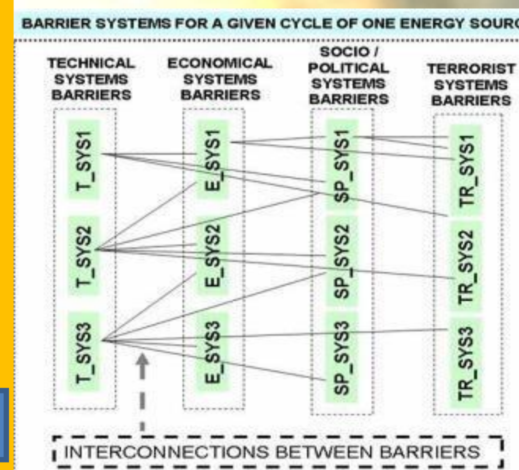


Provocari/perturbari

IE_ES1_CY2_SP1	Initiating Event SP1 for SC1 ES1 Cy2
IE_ES1_CY3_SP1	Initiating Event SP1 for SC2 ES1 CY3
IE_ES2_CY1_SP1	Initiating Event SP1 for SC2 ES2 Cy2
IE_ES2_CY2_SP1	Initiating Event SP1 for SC3 ES2 Cy2
IE_ES3_CY2_SP1	Initiating Event SP1 for SC3 ES3 Cy2
IE1_ES1_CY2_E1_0	IE ES1_0 for SC1 ES1 Cy2
IE1_ES1_CY2_E1_1	IE ES1_1 for SC1 ES1 Cy2
IE1_ES1_CY2_E1_2	IE ES1_2 for SC1 ES1 Cy2
IE1_ES1_CY2_T1_0	IE T1_0 for SC1 ES1 Cy2
IE1_ES1_CY2_T1_1	IE T1_1 for SC1 ES1 Cy2
IE1_ES1_CY2_T1_2	IE T1_2 for SC1 ES1 Cy2



Interfete interne



	T1	T2	T3	E1	E2	E3	SP1	SP2	SP3
T1	1	0	0	1	0	0	0	0	0
T2	0	1	0	1	1	1	1	1	1
T3	0	0	1	1	1	1	1	1	1
E1	1	1	1	1	0	0	0	1	1
E2	0	1	1	0	1	0	1	1	1
E3	0	1	1	0	0	1	1	1	1
SP1	0	1	1	0	1	1	1	0	0
SP2	0	1	1	1	1	1	0	1	0
SP3	1	1	1	1	1	1	0	0	1

A.2

SAMPLE RESULTS

		TCO IMP	Impact rank	Uncertainty results	Groups
137	ES2_CY1_TR_SYS2	Failure of System 2 ES2 TR Cy1	H	L	I=HL
159	IGR_CY2_E_SYS2	Failure of System 2 IGR E Cy2	H	L	
188	IE_SC1_ES2_CY2_E2	IE E2 for SC1 ES2 Cycle2	H	L	
285	ES1_CY2_T_SYS2	Failure of System 2 ES1T Cy2 considering switches	H	L	
132	ES3_CY3_TR_SYS_SWSF	Split fraction not considering switches for failure of Systems ES3 TR Cy3	H	M	II=HM
113	ES3_CY2_SP_SYS1	Failure of System 1 ES3 SP Cy2	H	M	
114	IE_SC1_IGR_CY1_E1	IE E1 for SC1 OGR Cycle1(R&D&T)	H	M	
115	IE_SC1_OGR_CY2_T2	IE T2 for SC1 OGR Cycle2	M	L	III=ML
275	ES2_CY2_T_SYS1	Failure of System 1 ES2 T Cy2	M	L	
290	ES1_CY2_T_SYS1	Failure of System 1 ES1 T Cy2 considering switches	M	L	
1	GC2_SF	Weight of choosing GC2	H	H	IV=HH
50	ES2_CY2_E_SYS_SWSF	Split fraction not considering switches for failure of Systems ES2 SP Cy2	H	H	

A.3

Survivability category	Scenarios	Rank of input	Confidence in results	Impact Group
SURV 2 Medium	A = Failure of the barrier defined by System 2 of SP type for ES1 in Cycle 2	H	M	HM
SURV 3 High	B= A failure of the barrier system 2 of Safeguards and strategic development type for a ES2 under development Cycle 1 due to blocking decisions od SP type in highly tense initial conditions GC 3 of the whole system	H	H	HH
SURV 3 High	C = Failure of the barrier defined by System 2 of T type for ES3 in Cycle 1 with initial condition GC3 of worst type	M	L	ML

Challenge consists of a failure of barrier 2 of socio- political type for ES1, i.e. nuclear (e.g. failure of reaching consensus between government, industry and public regarding the continuation of nuclear power plant prediction (cycle 2). In this scenario, the decision-maker could shut down the nuclear plant, but this could have serious repercussions to the entire survivability of the whole energy system, as nuclear is one of the important sources of the energy mix. However, this could lead to even worse public reaction when they will realize that their everyday lives may be drastically changed due to lack of electricity. Thus, as this scenario is of high-risk and high confidence, the decision-maker may have no other choice but to speedily re-open dialogue with the public to seek consensus on the best course of action

MODELE SI METODE DE EVALUARE SCENARII SMR IN CONTEXT ENERGETIC-SMR CA INOVARE

B – MCDA DE TIP ESREDA - CUBE - detalii in Anexa 2

Generalizarea metodei propusa de autor in metoda E pentru un numar de criterii mai mare de 3

MODEL - Descriere provocari ale sistemului energetic nuclear dupa doi parametrii: utilitate si nivel de risc se modeleaza si factorii non tehnici

METODA /
REZULTATE – se obtine un spatiu al solutiilor sub forma unui CUB (metodologie ESREDA)

CRITERIILE - sunt de supravietuire a sistemului – in spatiul definit de CUB pentru TREI criterii limitative

REZULTAT
REFERITOR SMR: - Neconsiderarea SMR ca inovare duce la obtinerea de solutii in afara CUB

B.1

Expected space achieving-not achieving innovation

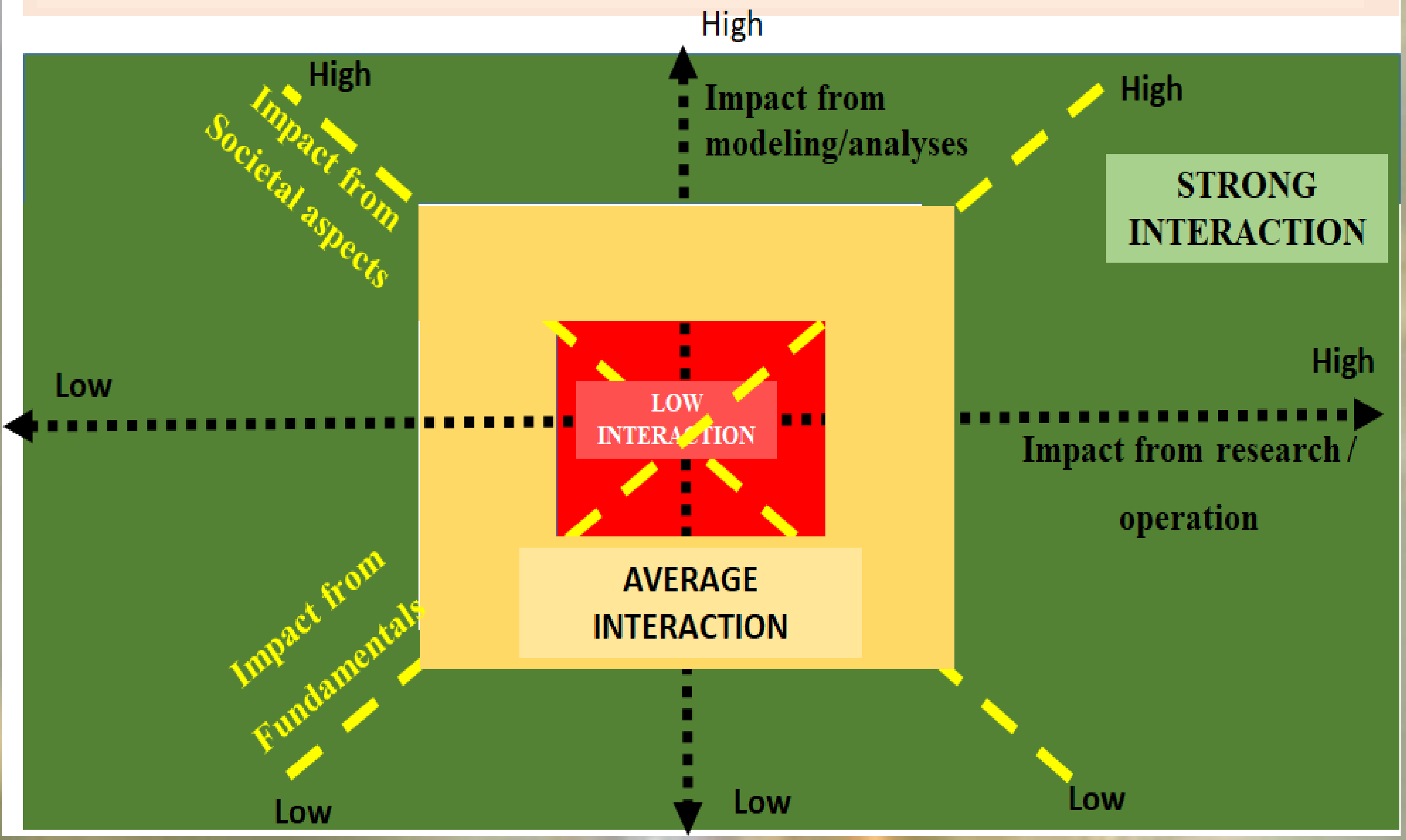


Figure 3a. Compliance Scale with best / recommended practice of an accident evaluation system

Multicriterial analysis by using ESREDA CUBE

B.2

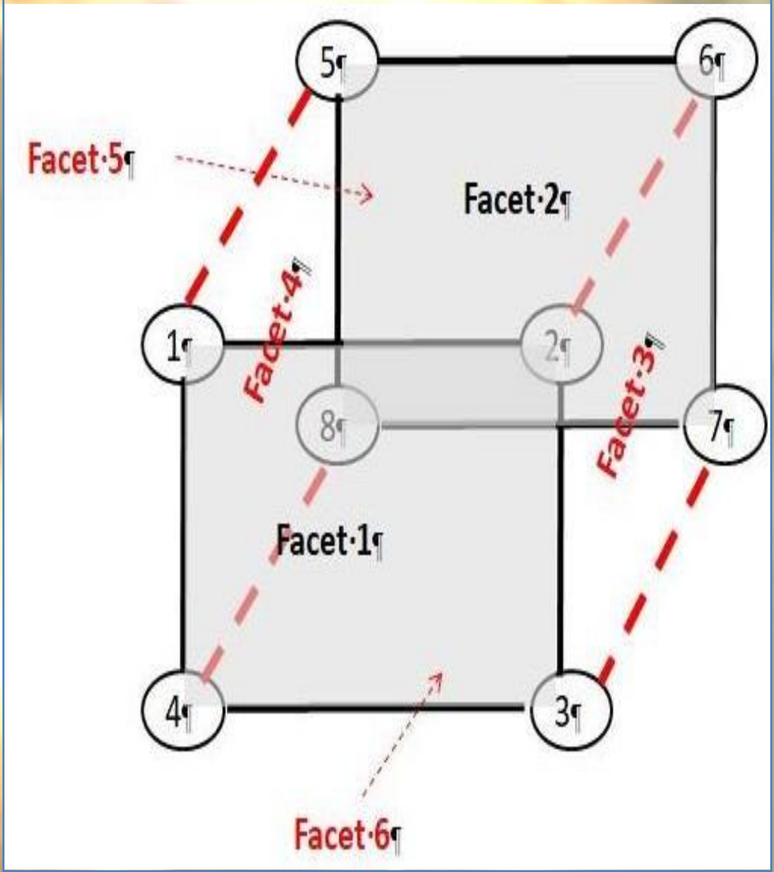
Each node is defined by intersection of three facets, which are common areas of fulfilling any two out of three criteria.

The resultant geometrical form is of cube type, as presented in Figure

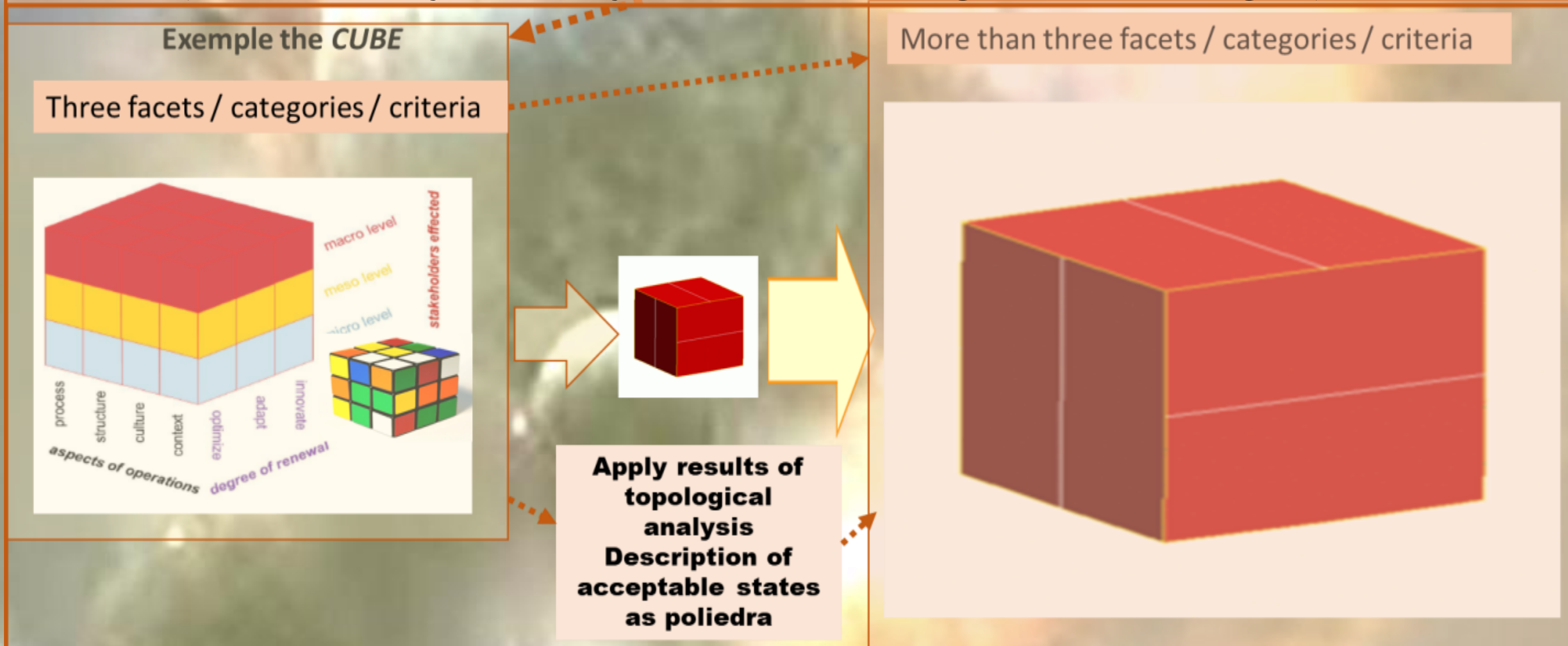
The nodes and the facets may be described in an Interdependence Matrix of the 3 criteria.

This principle is valid for any number of criteria. The resultant geometrical form is of more complex polyhedral type

CORRELATION WITH METHOD E – CATS approach



B.3 However, if there will be more than 3 criteria, then the acceptable space od optimal solutions will be described by a more complex type of polyhedral, as the Type D of evaluation will illustrate (and which is symbolically illustrated in the right side of the Figure).



Use of ESREDA CUBE to evaluate optimal solutions in safety/reliability optimization based on 3 criteria

MODELE SI METODE DE EVALUARE SCENARII SMR IN CONTEXT ENERGETIC-SMR CA INOVARE

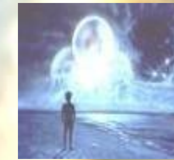
C – MODELARE ANALITIC PARAMETRICA – SISTEME ENERGETICE NUCLEARE CA FUNCTIE DE O VARIABILA SI UNU/DOI PARAMETRII SISTEME ENERGETICE NUCLEARE CA O TEHNOLOGIE

MODEL - Descriere provocari ale sistemului energetic nuclear dupa doi parametrii: utilitate si nivel de risc se modeleaza si factorii non tehnici

METODA / REZULTATE – se obtine un spatiu al solutiilor definit de curba riscului si cea a utilitatii , care se evalueaza pentru fiecare parametru

CRITERIILE - sunt de supravietuire a sistemului – in spatiul definit de infasuratoarea tuturor volumelor desemnate pentru un criteriu dat

REZULTAT REFERITOR SMR: - Neconsiderarea SMR ca inovare duce la obtinerea de solutii in afara volumului infasurator



C.1

Type C - Analytical evaluations of the space (volumes of acceptable optimal solutions), i.e. a parametric modelling – *function of one variable and one parameter*

This type of approaches is based on the evaluation of the dependencies of the optimal space (in a two dimensional representation) for each criteria defined. This results in a set of acceptable spaces (as illustrated in Figure for each criterion. The resultant acceptable space will be considered as an envelope of all spaces for a given situation (Energy system with SMR vs Energy system without SMR).

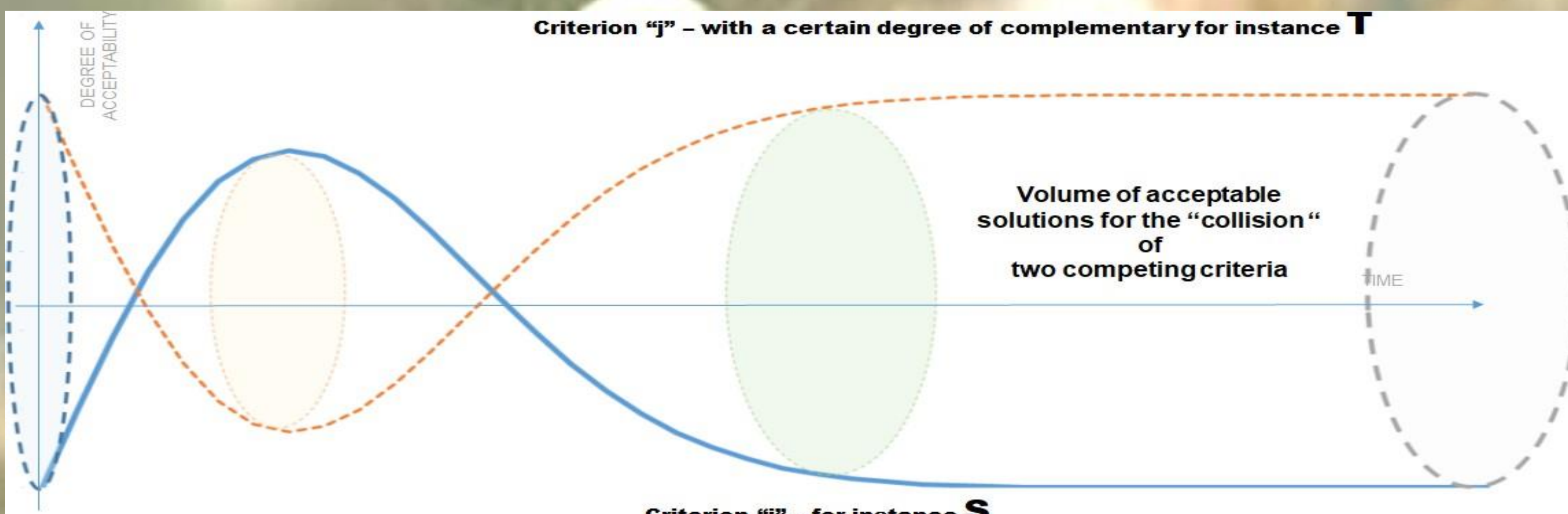
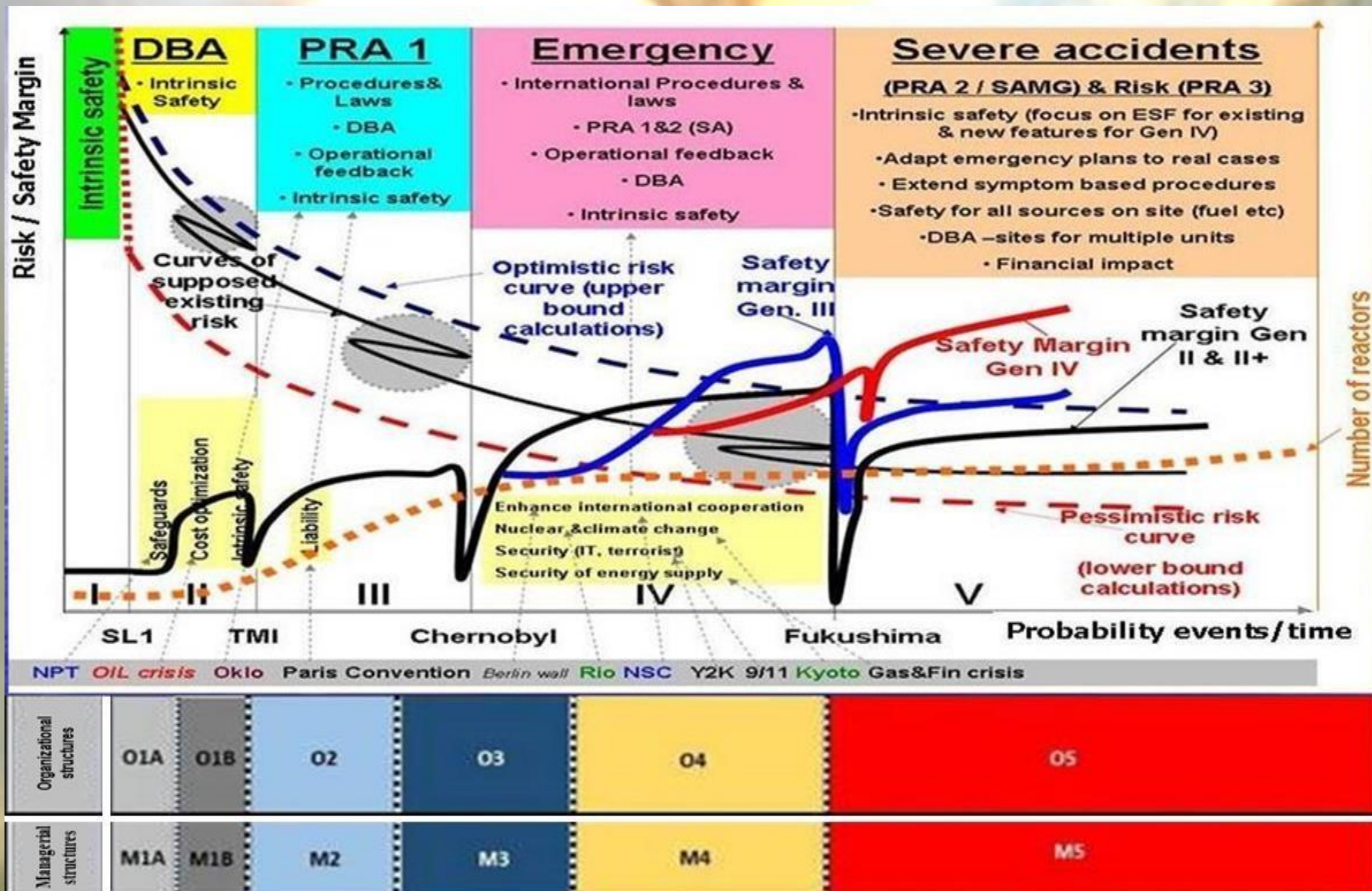


Figure 6. Evaluation of cross dependencies for extensive implementation in accident analysis of technical systems

C.2



Type C approach event review for nuclear case

C.3


EN in erele 3.0 si 4.0
GNENERATION II
1970's
GNENERATION II+
II+
1985-2020s
GNENERATION IV
1950's on
NUCLEAR PLANT CONTROL ROOM
NUCLEAR PLANT
HUMAN FACTORS
GNENERATION SG+ BB
GNENERATION BB+X+Y
GNENERATION Y+Z+ALPHA
GEN Z 2.0

METODE DE EVALUARE SCENARII SMR IN CONTEXT ENERGETIC-SMR CA INOVARE

D – SISTEME ENERGETICE MODELATE CATS – General approach for CUBE (method B)

MODEL - Descriere provocari ale sistemului energetic nuclear pentru mai mult de trei criterii inclusiv non tehnice

METODA / REZULTATE – se obtine un spatiu al solutiilor definit de de un poliedru de diverse configuratii. Pentru 3 criterii se obtine un hipercub. Pentru mai mult de 4 criterii se obtin spatii definite de alte poliedre

CRITERIILE - sunt de supravietuire a sistemului – in spatiul definit de interiorul poliedrului

REZULTAT REFERITOR SMR: - Neconsiderarea SMR ca inovare duce la obtinerea de solutii in afara volumului intern al poliedrului pentru oricate de multe criterii considerate

D.1

Features that are common and features different for two industries

NO	COMMON FEATURES	NO	FEATURES THAT DIFFER
C1	Critical infrastructures	D1	Degree of dependence from political and social influences (R=Low; N=Medium)
C2	Organizational structure required.	D2	Phase of technology mature operation versus research (R=High; N=Medium)
C3	Interface with societal organization	D3	Different timings for the technology lifecycles (R=Short; N=Long)
C4	Societal environment	D4	Resources allocated – material, training, organizational structure (R=Low, N=Medium)
C5	Learning from similar technological implementation	D5	Cross industries / planetary connection (R=Medium, N=High)
C6	Risks of systems	D6	Implementation of lessons from similar technologies (R=Low, N=High)
C7	Commercial/safety/security implications considered	D7	Feedback systems CATS type (R=Low, N=High)

D.2 The solutions of the topological approach for the evaluation of the spaces of optimal results for a multi criteria decision in a complex system are represented by the matrix in Figure

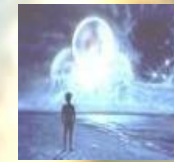
Code	Short
S	**Similitude**
E	**Evaluation**
L	**Learning**
C	**Cycle**
P	**Political**
T	**Technologies**

$$A = \begin{pmatrix} 0 & 1 & 1 & 1 & 1 & 1 \\ 1 & 0 & 1 & -1 & -1 & 1 \\ 1 & 1 & 0 & 1 & -1 & -1 \\ 1 & -1 & 1 & 0 & 1 & -1 \\ 1 & -1 & -1 & 1 & 0 & 1 \\ 1 & 1 & -1 & -1 & 1 & 0 \end{pmatrix}.$$

$$\| a_{ij} \| =$$

ss a11	**se** a12	**sl** a13	**sc** a14	**sp** a15	**st** a16
es a21	**ee** a22	**el** a23	**ec** a24	**ep** a25	**et** a26
ls a31	**le** a31	**ll** a33	**lc** a34	**lp** a35	**lt** a36
cs a41	**cs** a41	**cl** a43	**cc** a44	**cp** a45	**ct** a46
ts a61	**te** a62	**tl** a63	**tc** a64	**tp** a65	**tt** a66

Figure10. Interdependence matrix for evaluating criteria (in table 1) leading to acceptable spaces as defined by polyhedral type



D.3

In general, a multiple set of evaluations for an increased number of criteria leads to a set of solutions, which are in matrix format as per the Figure 10. **However, there is a connection shown in [3] between the matrix format a geometrical representation, illustrated also in Figure 1**1.

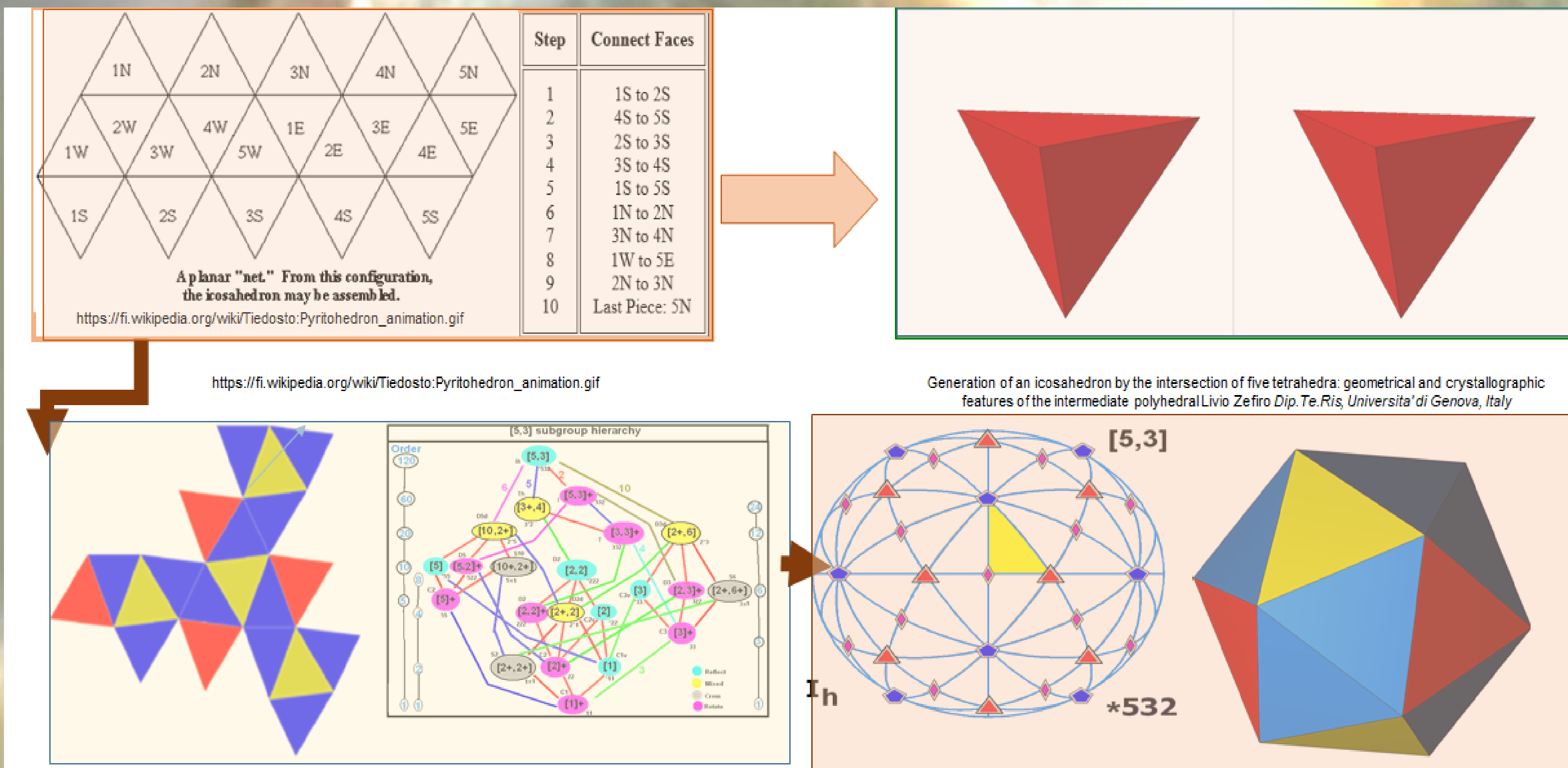
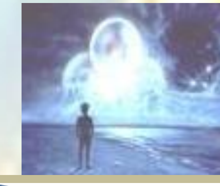


Figure 11. The polyhedral representation of the matrix of multi criteria decision for a complex system [3]



D.4

ubquantic	SQ=SYS7
uantic	Q =SYS8
Molecular	M =SYS9
Molecular life	ML=SYS1
Planetary	P =SYS2
Planetary life	PL =SYS3
Planetary life intelligent	**PLI =SYS0**
Galaxy	G =SYS4
Cosmic	C =SYS5
Cosmic life	CL =SYS6
Cosmic intelligent	**CLI =SYS10**

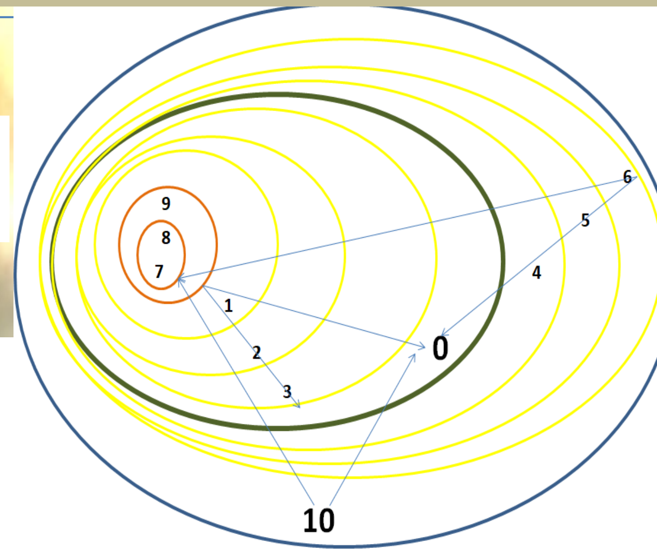
For one given case

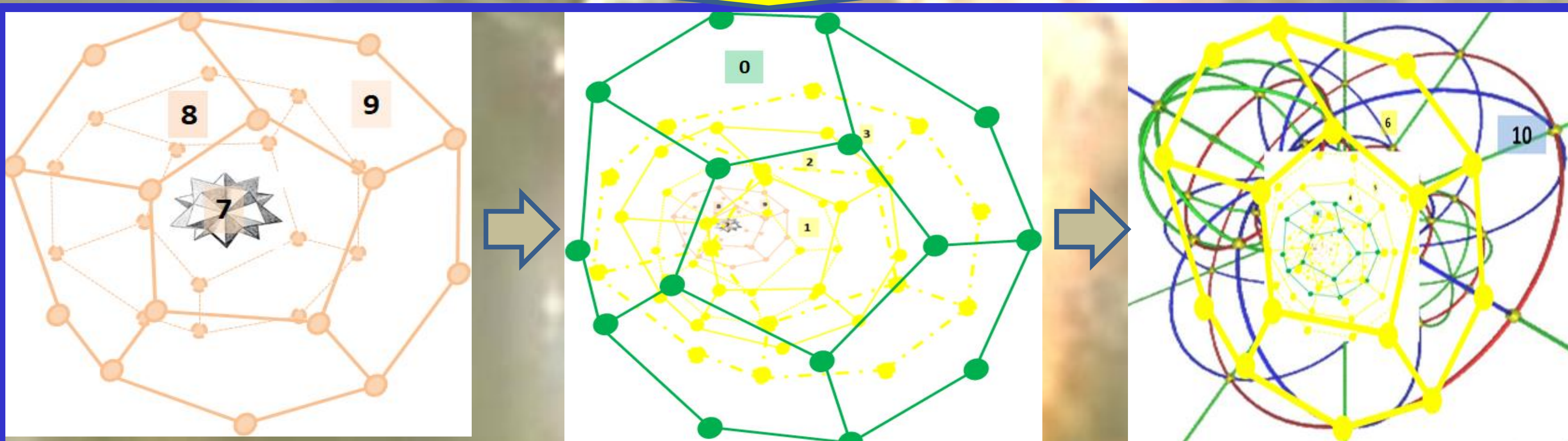
$$s^{(k)} = \sum_{l=0}^{8} \sigma_l^{(k)} + \sum_{l=0}^{8} \omega * i_l^{(k)}$$

$$E^{(k)} \equiv \sum_{l=0}^{8} E_l^{(k)} i_l^{(k)}$$

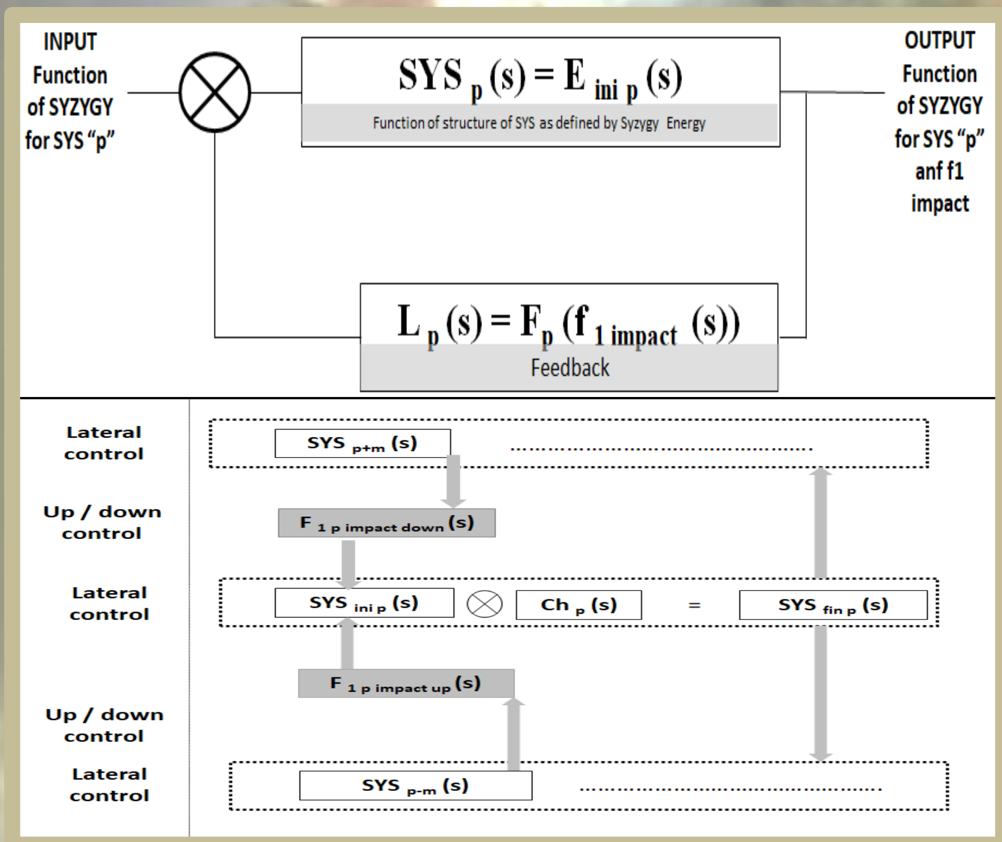
$$m^{(k)} \equiv \sum_{l=0}^{8} m_l^{(k)} i_l^{(k)}$$

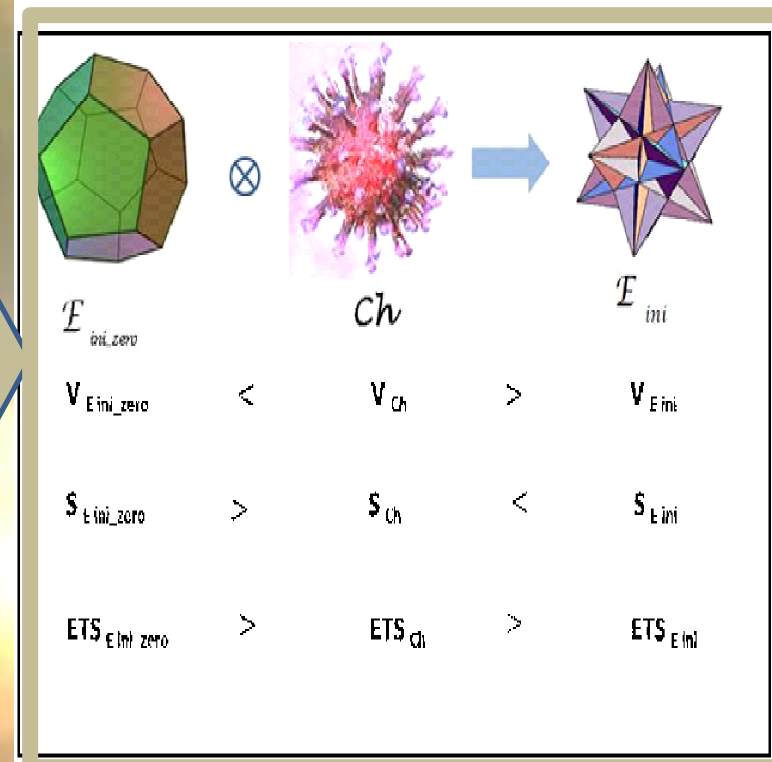
$$\psi^{2\,(k)} \equiv \sum_{l=0}^{8} \psi^{2}{}_l^{(k)} i_l^{(k)}$$





D.5


INPUT Function of SYZYGY for SYS "p"
SYS p (s) = E ini p (s)
Function of structure of SYS as defined by Syzygy Energy
OUTPUT Function of SYZYGY for SYS "p" anf f1 impact
L p (s) = F p (f 1 impact (s))
Feedback
Lateral control
SYS p+m (s)
Up / down control
F 1 p impact down (s)
Lateral control
SYS ini p (s)
Ch p (s)
=
SYS fin p (s)
F 1 p impact up (s)
Up / down control
Lateral control
SYS p-m (s)


E ini_zero
Ch
E ini
V E ini_zero
<
V Ch
>
V E ini
S E ini_zero
>
S Ch
<
S E ini
ETS E ini zero
>
ETS Ch
>
ETS E ini

METODE INOVATIVE PENTRU CALCULE DE RISC CENTRALE NUCLEARE DE TIP SMR

E – SISTEME ENERGETICE MODELATE CATS – General approach for CUBE (method B)

MODEL - Descriere provocari ale unei centrale SMR si definirea unor metode pentru nivelul 5 al protectiei in adancime- Planul de Urgenta

METODA /
REZULTATE – se obtine un model al descrierii unitare a provocarilor de securitate posibile de probabilitate foarte redusa si a masurilor ce trebuie luate ca parte a uni program special- Plan de Urgenta

CRITERIILE - se definesc etapale definirii provocarilor extreme si a masurilor ce trebuie luate pentru protejarea integrala si completa a mediului si populatiei.

REZULTAT
REFERITOR SMR: - Metoda dezvoltata este inovativa si se poate aplica la SMR. Detalii in Anexa 5

CONCLUZII

Avem două opțiuni referitoare la implementarea SMR

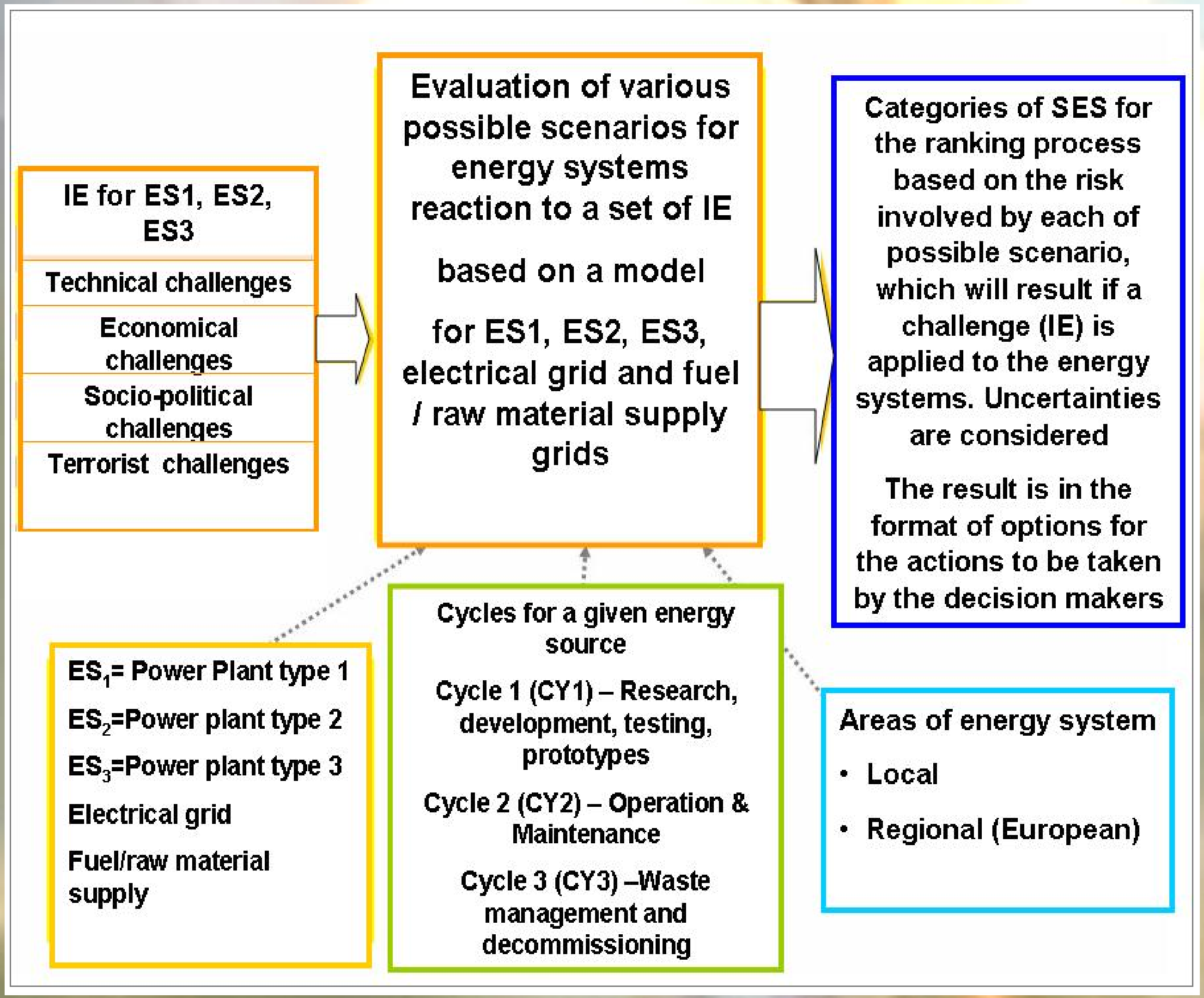
1. **Putem să resetăm programul nuclear și să consolidăm ce avem déjà, să cercetăm noi înșine pornind de la ceva déjà studiat, să ne pregătim fabrici și oameni și să exploatăm centralele gândind la următoarele lor generații.**
2. **Sau putem comenta, discuta, scrie programe, dezbateri, critici, dezvolta teorii conspirative și să nu facem nimic.**

Pentru că se discută despre riscuri : fiecare dintre aceste decizii are riscurile sale.
Dar riscul opțiunii II - de a nu face nimic dezbătând și criticând este letal.
Nu cred că asta vrem

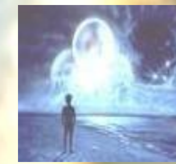
Este necesara o viziune **pentru Romania acestui secol .**
O viziune pentru Romania acestui secol este sa devina un hub energetic – stiintific si tehnologic bazat pe tehnologii revolutionare ale fizicii reactorului, IT si mecanicii cuantice .
Un hub cel putin regional este o viziune pe masura resurselor materiale si umane , a traditiei si realizarilor noastre, a structurii fine a fiintei noastre culturale.
Si DA, o noua tehnologie de reactori este un pas solid in aceasta directie

ANEXA 1
SES RISK

SES - The Model



The model considers first the challenges presented, and then the energy system itself as a system of barriers to these challenges. Finally, results (risk levels and recommended actions) are presented to the decision maker



SES - The Model

IE *for* ES_1, ES_2, ES_3

- Technical Challenges
- Economical challenges
- Socio political challenges
- Terrorist challenges

Evaluation of various possible scenarios for energy system reaction to IE based on a

MODEL *for*

ES_1, ES_2, ES_3, electrical grid and fuel supply

Categories of SES for

Ranking based on risk of scenarios and uncertainty calculations

Proposed options for decision makers

ES_1= Power Plant type 1

ES_2= Power Plant type 2

ES_3= Regenerative resources

Electrical Grid

Fuel supply

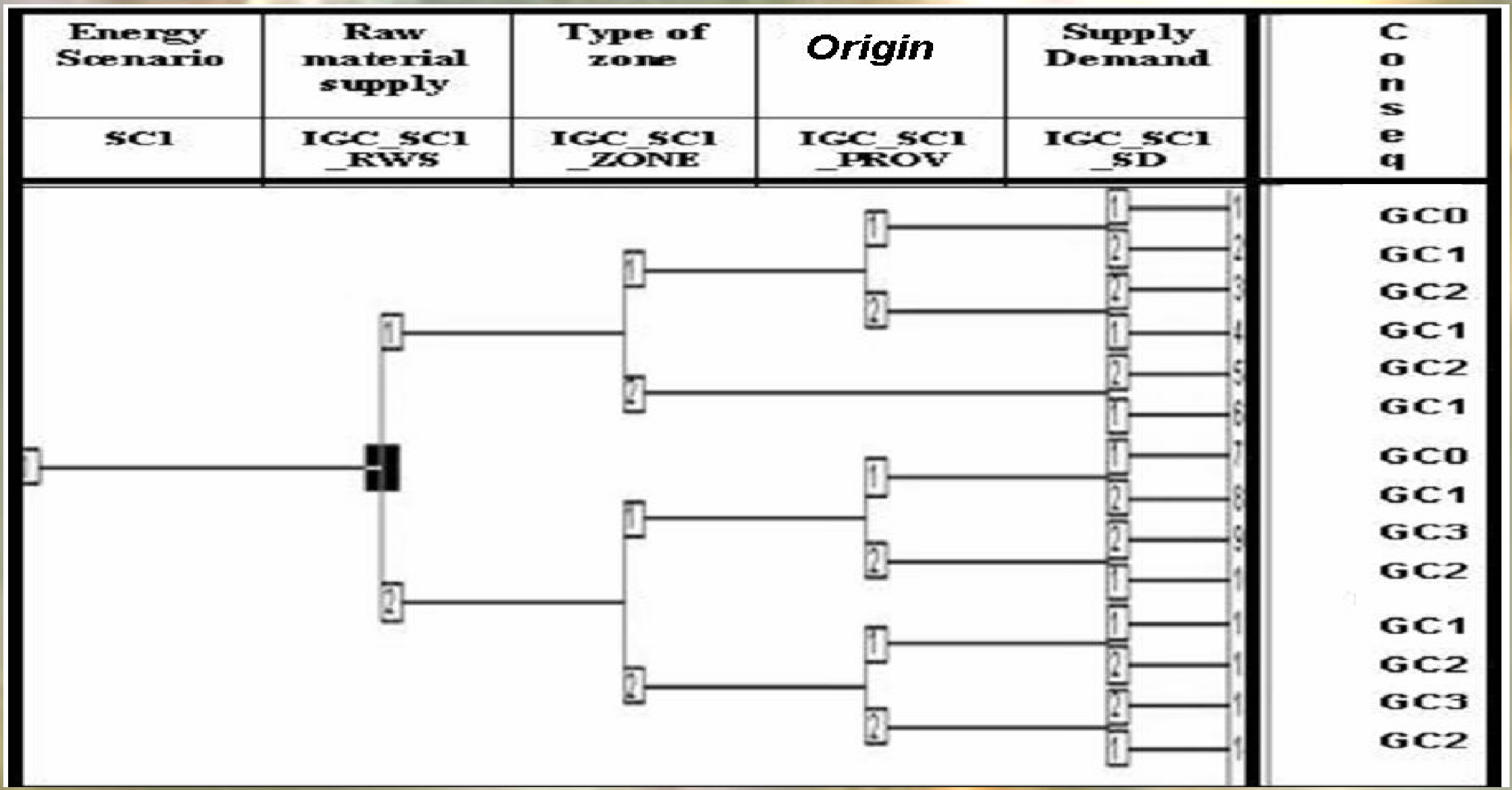
Cycles for energy source

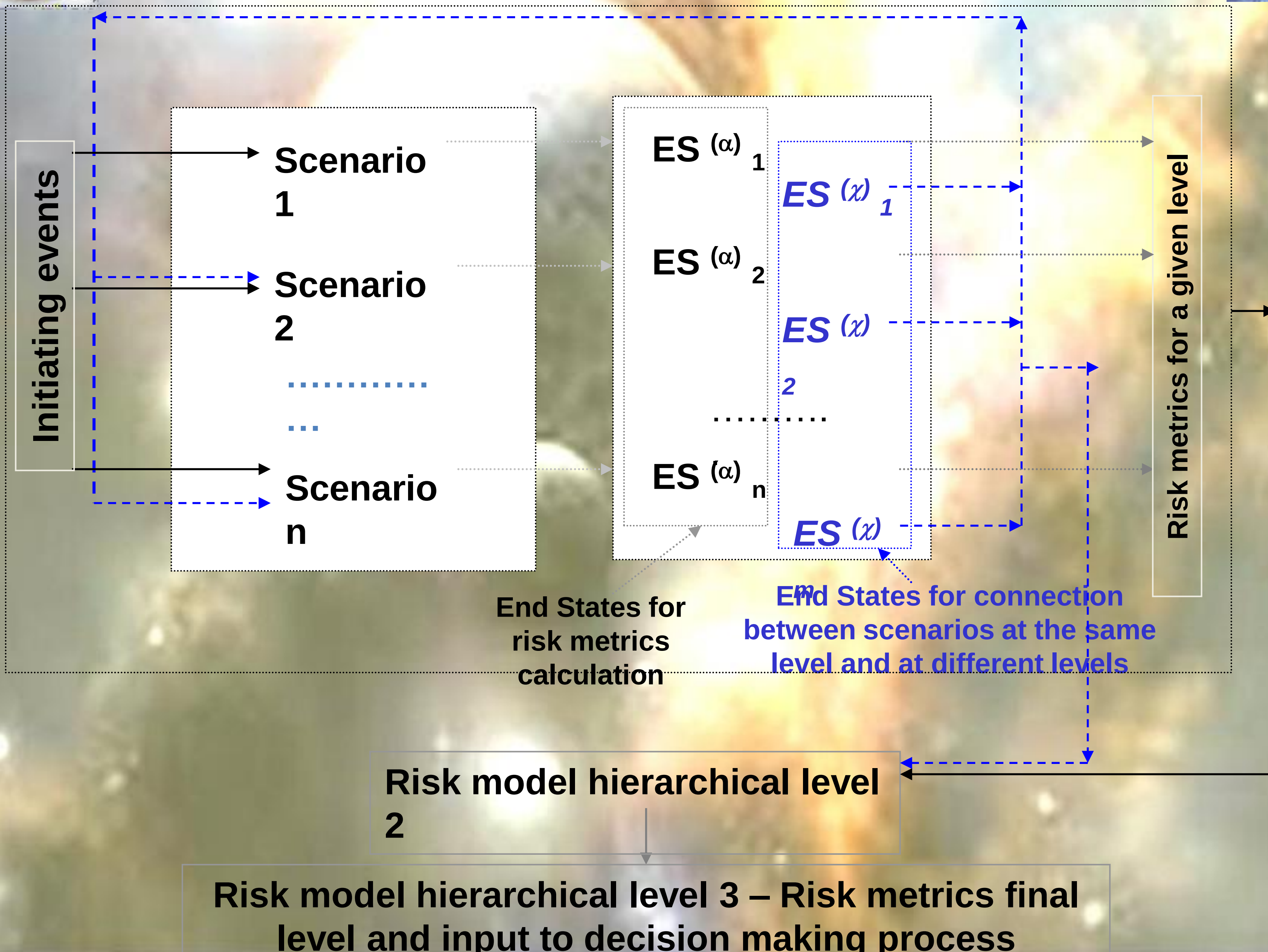
- *Research and development*
- *Operation & MTCE – normal and accident*
- Decommissioning & Waste management

Areas of energy system

- ***Local***
- ***Regional (European)***

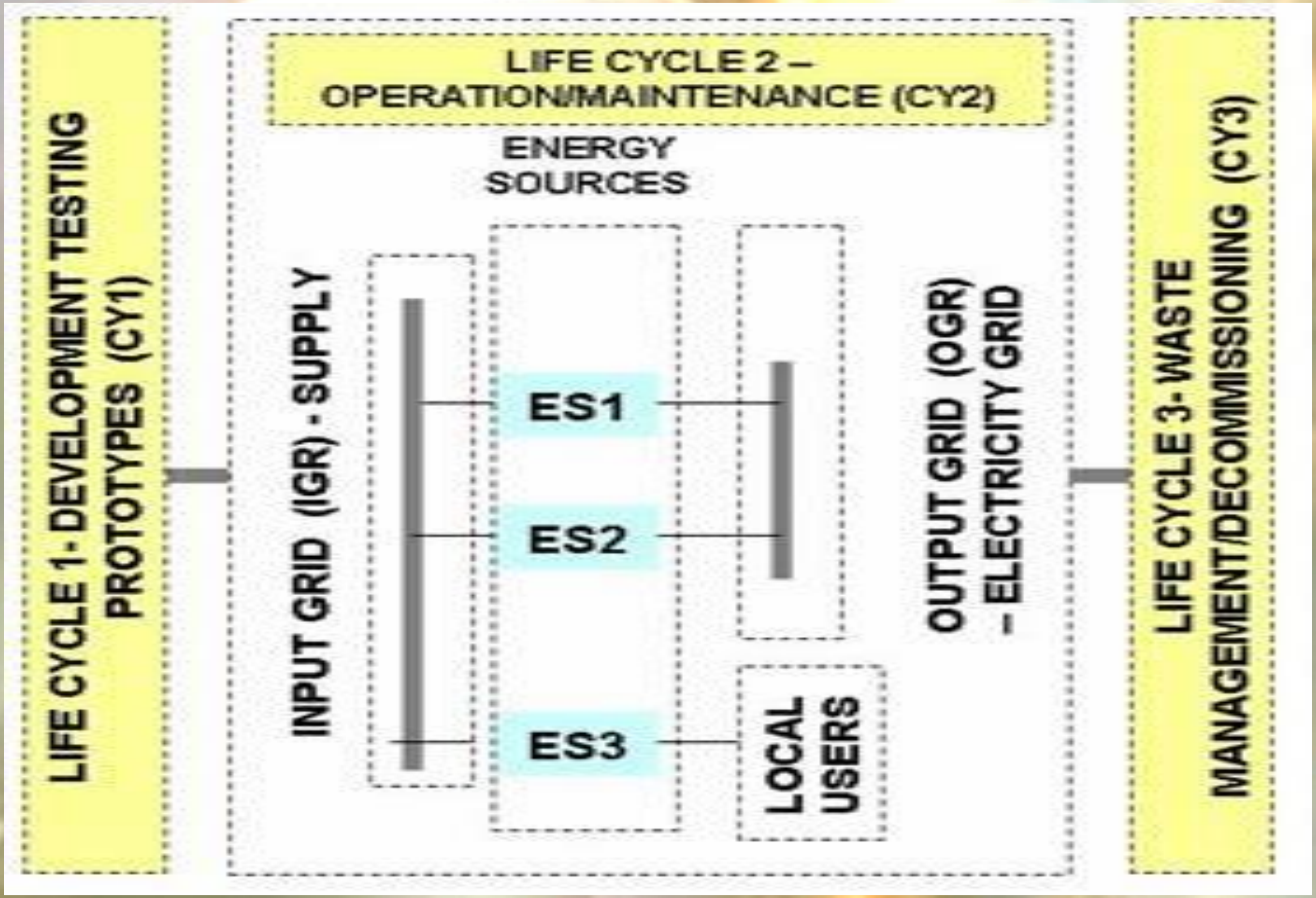
Initial conditions of the energy system



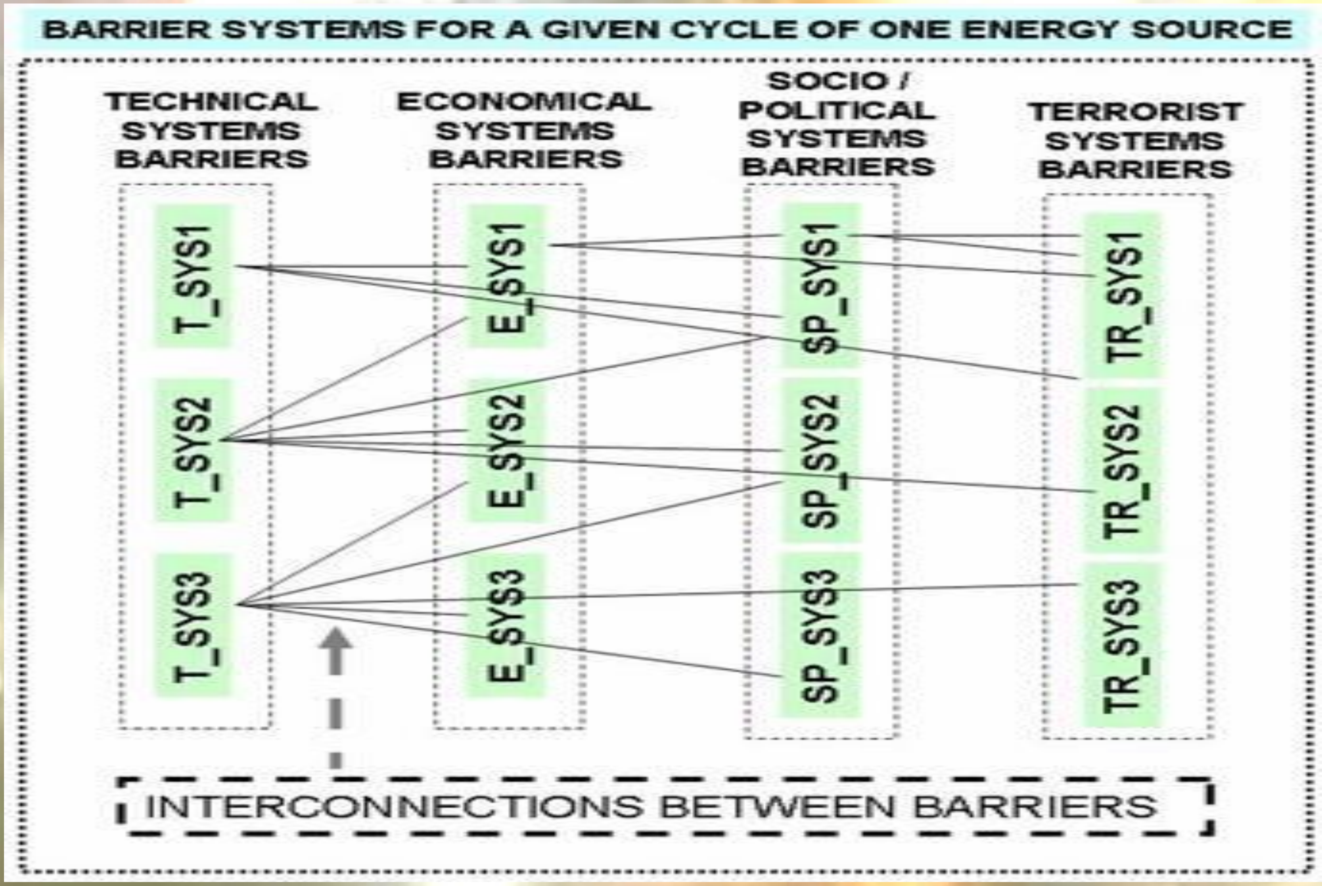


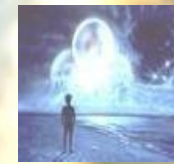
Initiating events
Scenario 1
Scenario 2
Scenario n
ES (α) 1
ES (α) 2
ES (α) n
ES (χ) 1
ES (χ) 2
ES (χ) m
End States for risk metrics calculation
End States for connection between scenarios at the same level and at different levels
Risk metrics for a given level
Risk model hierarchical level 2
Risk model hierarchical level 3 – Risk metrics final level and input to decision making process

The energy system as a system of barriers



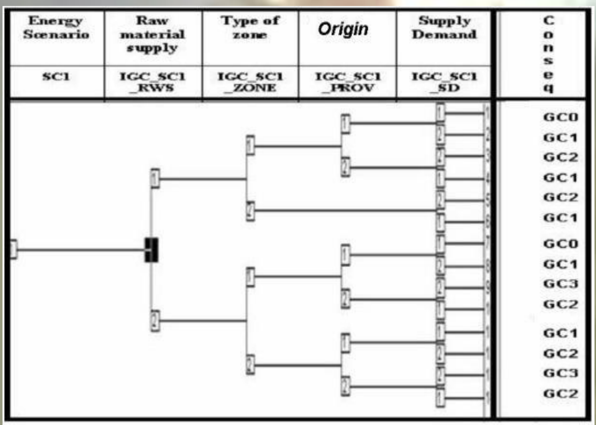
The energy system as a system of barriers





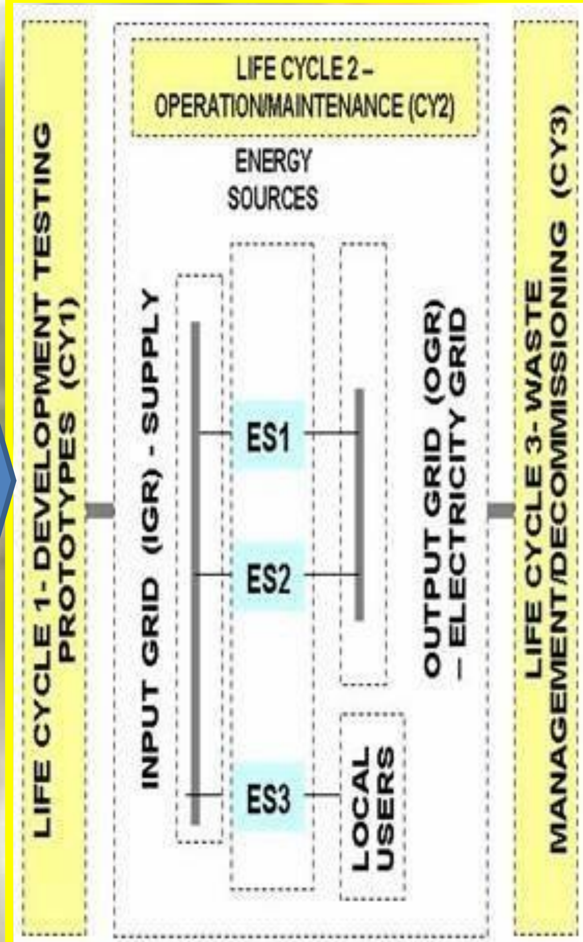
Modelul surselor si retelelor

Conditii initiale

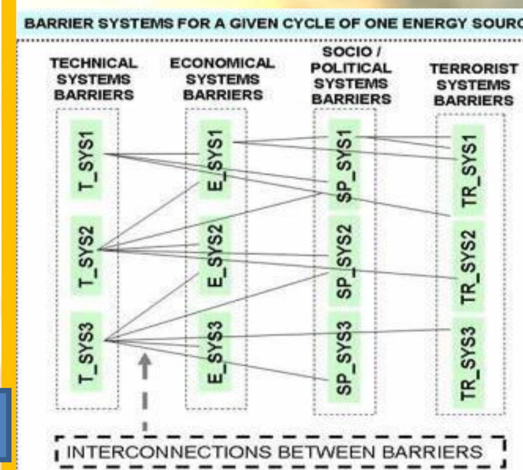


Provocari/perturbari

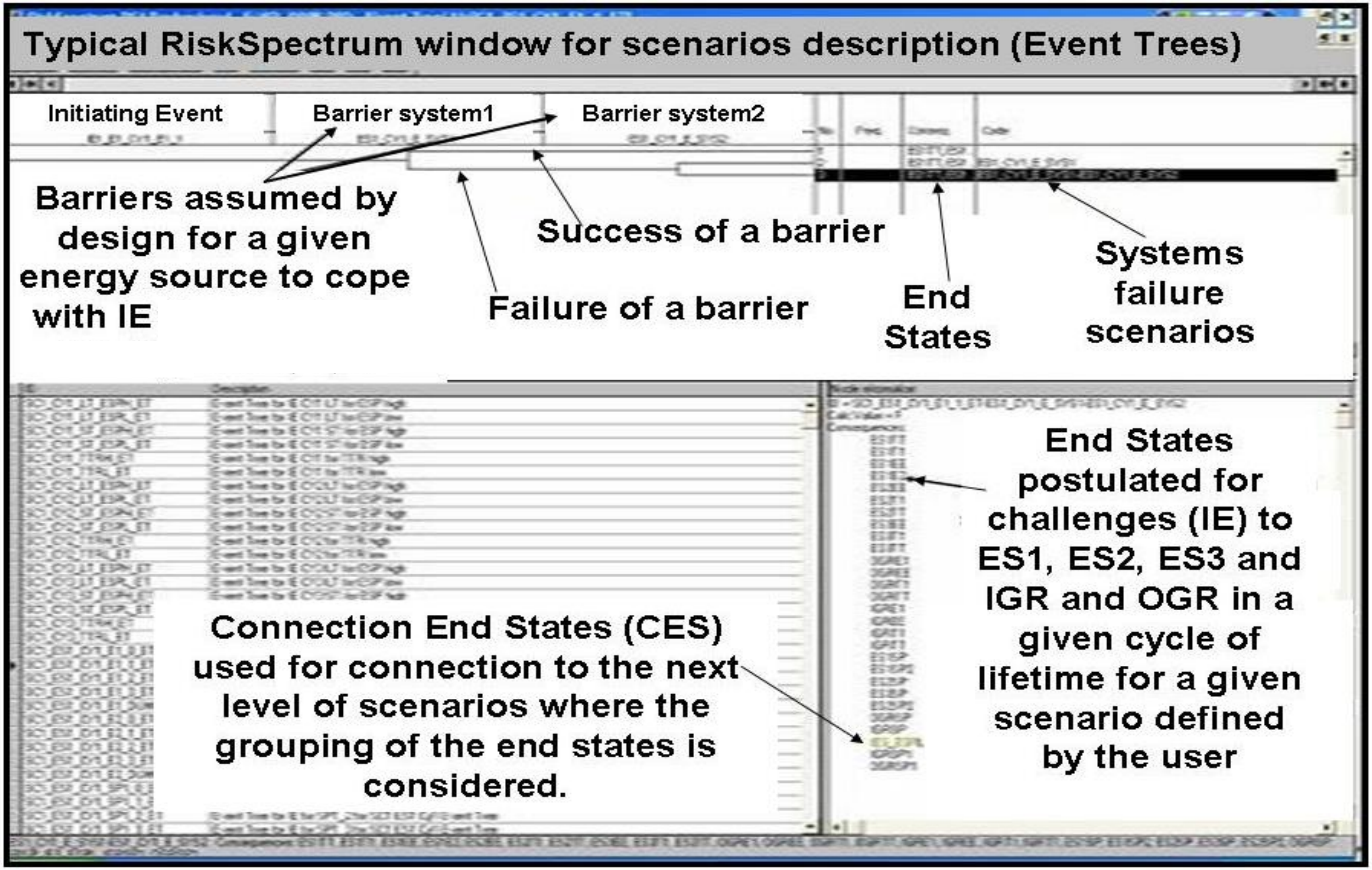
IE_ES1_CY2_SP1	Initiating Event SP1 for SC1 ES1 Cy2
IE_ES1_CY3_SP1	Initiating Event SP1 for SC2 ES1 CY3
IE_ES2_CY1_SP1	Initiating Event SP1 for SC2 ES2 Cy2
IE_ES2_CY2_SP1	Initiating Event SP1 for SC3 ES2 Cy2
IE_ES3_CY2_SP1	Initiating Event SP1 for SC3 ES3 Cy2
IE1_ES1_CY2_E1_0	IE ES1_0 for SC1 ES1 Cy2
IE1_ES1_CY2_E1_1	IE ES1_1 for SC1 ES1 Cy2
IE1_ES1_CY2_E1_2	IE ES1_2 for SC1 ES1 Cy2
IE1_ES1_CY2_T1_0	IE T1_0 for SC1 ES1 Cy2
IE1_ES1_CY2_T1_1	IE T1_1 for SC1 ES1 Cy2
IE1_ES1_CY2_T1_2	IE T1_2 for SC1 ES1 Cy2

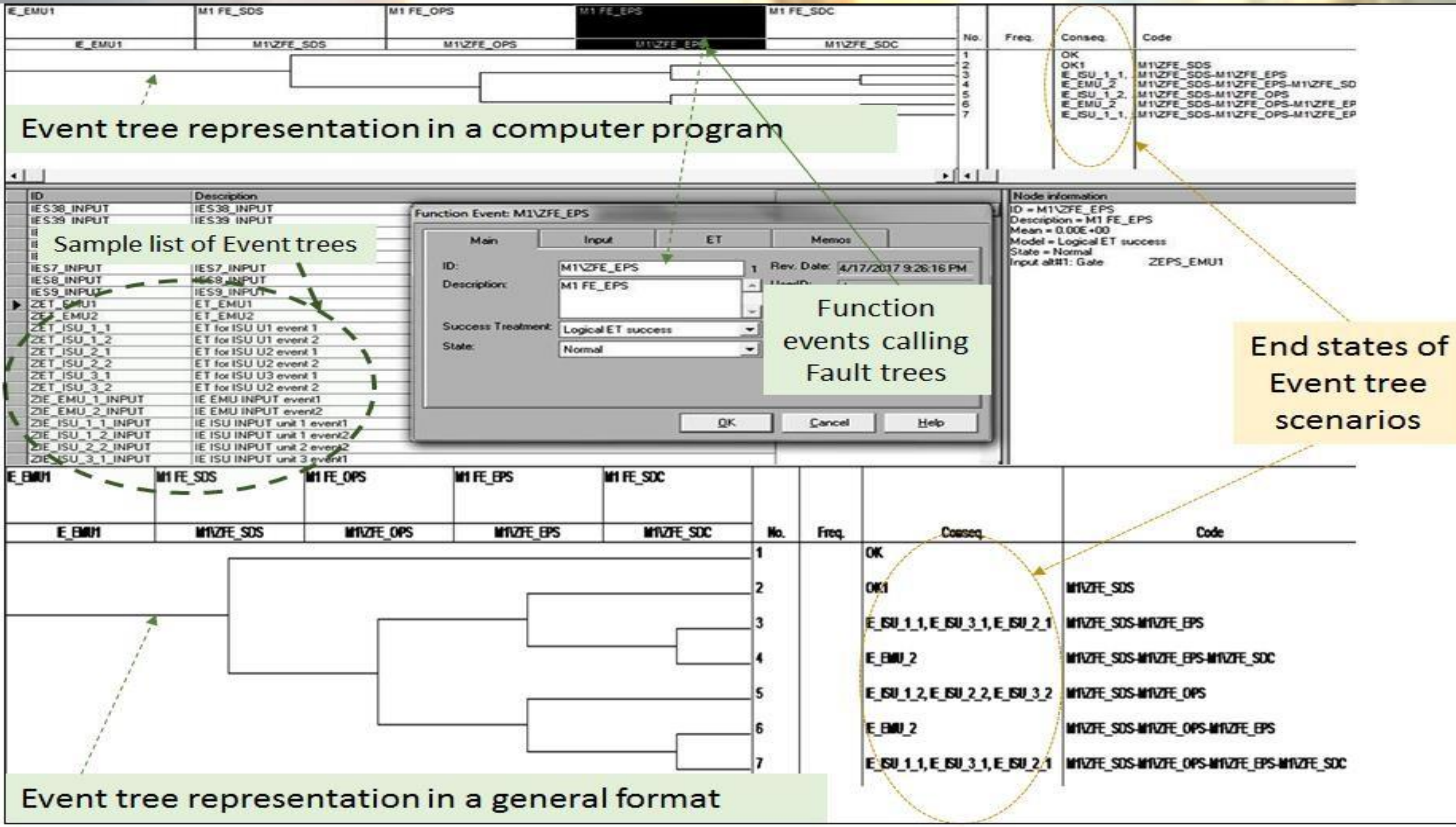


Interfete interne

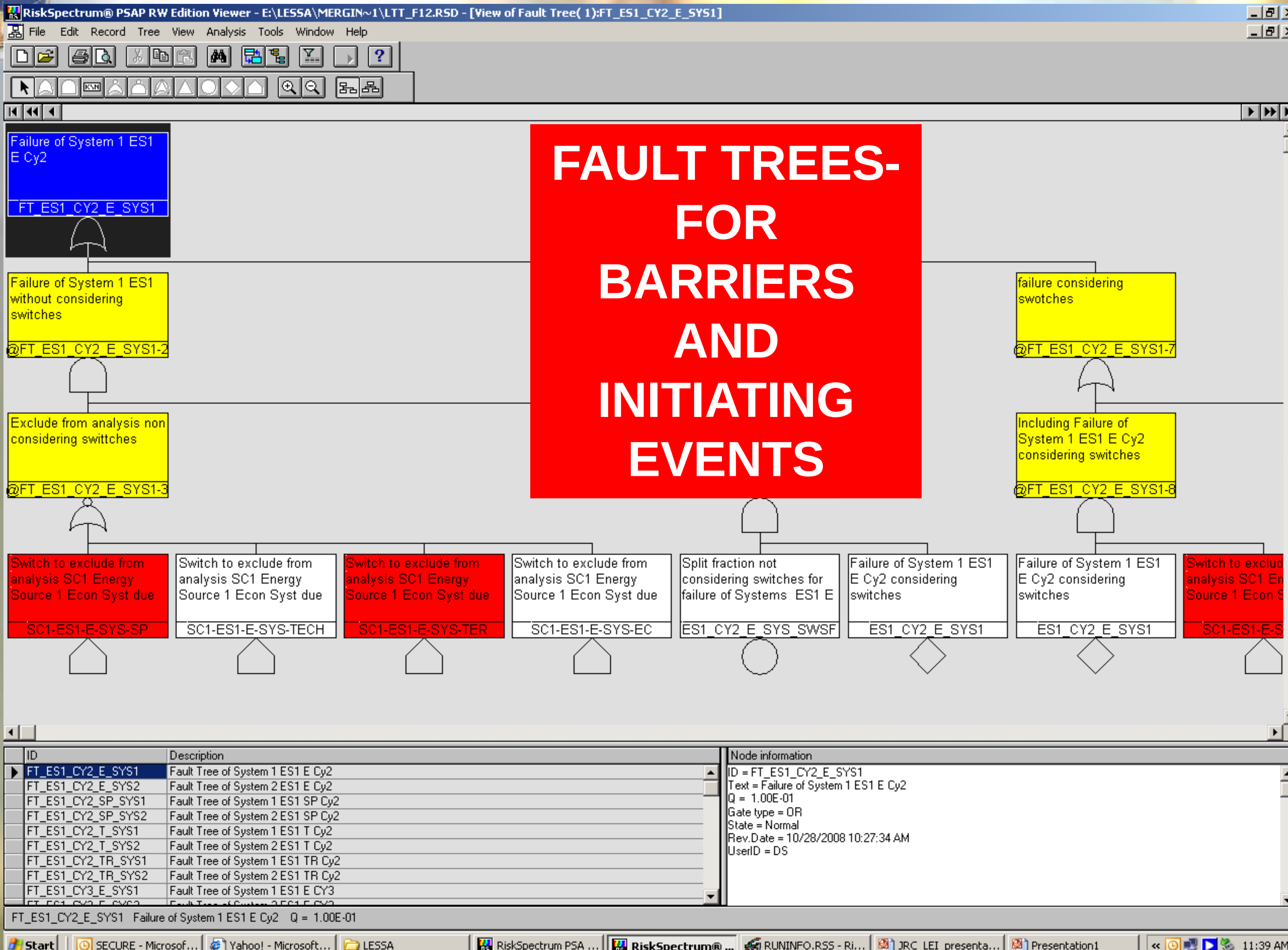


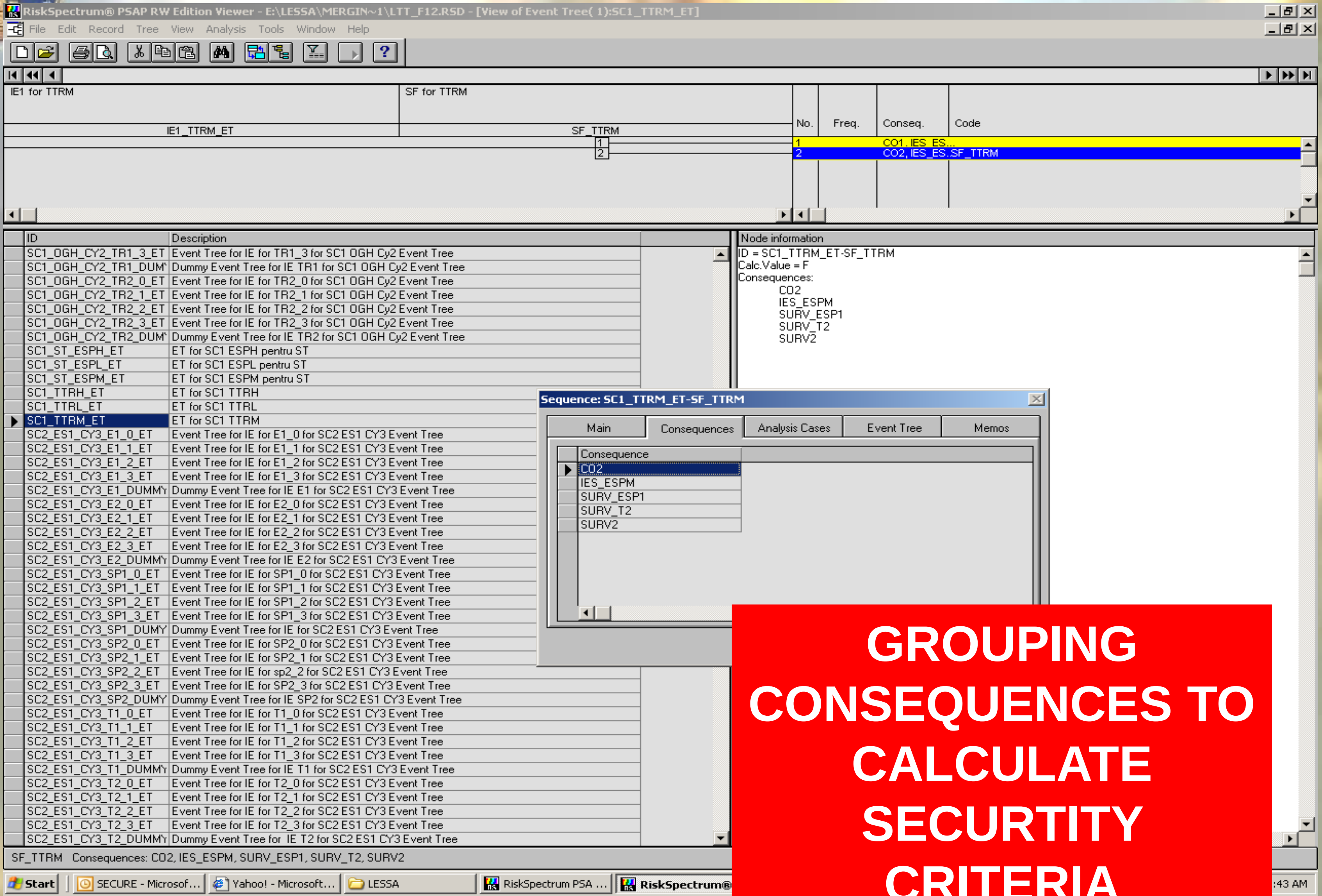
	T1	T2	T3	E1	E2	E3	SP1	SP2	SP3
T1	1	0	0	1	0	0	0	0	0
T2	0	1	0	1	1	1	1	1	1
T3	0	0	1	1	1	1	1	1	1
E1	1	1	1	1	0	0	0	1	1
E2	0	1	1	0	1	0	1	1	1
E3	0	1	1	0	0	1	1	1	1
SP1	0	1	1	0	1	1	1	0	0
SP2	0	1	1	1	1	1	0	1	0
SP3	1	1	1	1	1	1	0	0	1


Typical RiskSpectrum window for scenarios description (Event Trees)
Initiating Event
Barrier system1
Barrier system2
Barriers assumed by design for a given energy source to cope with IE
Success of a barrier
Failure of a barrier
End States
Systems failure scenarios
End States postulated for challenges (IE) to ES1, ES2, ES3 and IGR and OGR in a given cycle of lifetime for a given scenario defined by the user
Connection End States (CES) used for connection to the next level of scenarios where the grouping of the end states is considered.


Event tree representation in a computer program
Sample list of Event trees
Function events calling Fault trees
End states of Event tree scenarios
Event tree representation in a general format
Function Event: M1\ZFE_EPS
Main
Input
ET
Memos
ID:
M1\ZFE_EPS
Description:
M1 FE_EPS
Success Treatment
Logical ET success
State
Normal
Rev. Date:
4/17/2017 9:26:16 PM
OK
Cancel
Help
Node information
ID = M1\ZFE_EPS
Description = M1 FE_EPS
Mean = 0.00E+00
Model = Logical ET success
State = Normal
E_EMU1
M1 FE_SDS
M1 FE_OPS
M1 FE_EPS
M1 FE_SDC
M1\ZFE_SDS
M1\ZFE_OPS
M1\ZFE_EPS
M1\ZFE_SDC
No.
Freq.
Conseq.
Code
1 OK
2 OK1 M1\ZFE_SDS
3 E_ISU_1_1, E_ISU_3_1, E_ISU_2_1 M1\ZFE_SDS-M1\ZFE_EPS
4 E_EMU_2 M1\ZFE_SDS-M1\ZFE_EPS-M1\ZFE_SDC
5 E_ISU_1_2, E_ISU_2_2, E_ISU_3_2 M1\ZFE_SDS-M1\ZFE_OPS
6 E_EMU_2 M1\ZFE_SDS-M1\ZFE_OPS-M1\ZFE_EPS
7 E_ISU_1_1, E_ISU_3_1, E_ISU_2_1 M1\ZFE_SDS-M1\ZFE_OPS-M1\ZFE_EPS-M1\ZFE_SDC
ID
Description
IES38_INPUT
IES39_INPUT
IES7_INPUT
IES8_INPUT
IES9_INPUT
ZET_EMU1 ET_EMU1
ZET_EMU2 ET_EMU2
ZET_ISU_1_1 ET for ISU U1 event 1
ZET_ISU_1_2 ET for ISU U1 event 2
ZET_ISU_2_1 ET for ISU U2 event 1
ZET_ISU_2_2 ET for ISU U2 event 2
ZET_ISU_3_1 ET for ISU U3 event 1
ZET_ISU_3_2 ET for ISU U2 event 2
ZIE_EMU_1_INPUT IE EMU INPUT event1
ZIE_EMU_2_INPUT IE EMU INPUT event2
ZIE_ISU_1_1_INPUT IE ISU INPUT unit 1 event1
ZIE_ISU_1_2_INPUT IE ISU INPUT unit 1 event2
ZIE_ISU_2_2_INPUT IE ISU INPUT unit 2 event2
ZIE_ISU_3_1_INPUT IE ISU INPUT unit 3 event1

JRC –IE – LEI bilateral cooperation on Security of Energy Supply Workshop on the JRC IE methodology for security of energy supply - INTRODUCTION





GROUPING CONSEQUENCES TO CALCULATE SECURTITY CRITERIA

REZULTATE

	SURV3 MCS		Q = 6.574E-01		
6	ES1_CY3_E_SYS1	GC2_SF	IE_SC1_ES2_CY3_TR1		
31	ES2_CY3_E_SYS1	ES2_CY3_E_SYS_SWSF	GC2_SF	IE_SC1_ES2_CY3_TR1	
33	ES2_CY3_SP_SYS1	ES2_CY3_SP_SYS_SWSF	GC2_SF	IE_SC1_ES2_CY3_TR1	
45	GC2_SF	IE_SC1_ES2_CY3_TR1	IGR_CY3_E_SYS1	IGR_CY3_E_SYS_SWSF	
77	GC2_SF	IE_SC1_ES2_CY3_TR1	OGR_CY3_SP_SYS1	OGR_CY3_SP_SYS_SWSF	
78	GC2_SF	IE_SC1_ES2_CY3_TR1	OGR_CY3_E_SYS1	OGR_CY3_E_SYS_SWSF	
95	ES1_CY3_E_SYS1	GC1_SF	IE_SC1_ES2_CY3_TR1		
435	GC2_SF	IE_SC1_ES2_CY3_TR2	IGR_CY3_SP_SYS1	IGR_CY3_SP_SYS_SWSF	
442	ES2_CY3_SP_SYS1	ES2_CY3_SP_SYS_SWSF	GC2_SF	IE_SC1_ES2_CY1_TR2	
2651	ES3_CY3_SP_SYS1	ES3_CY3_SP_SYS_SWSF	GC1_SF	IE_SC1_ES2_CY3_T2	
2669	ES1_CY3_E_SYS2	GC1_SF	IE_SC1_ES2_CY3_T2		
3811	ES2_CY3_E_SYS1	ES2_CY3_E_SYS_SWSF	GC0_SF	IE_SC1_ES2_CY3_T1	
4141	ES1_CY3_SP_SYS2	ES1_CY3_SP_SYS_SWSF	GC2_SF	IE_SC1_ES2_CY3_TR2	
6952	ES3_CY3_SP_SYS2	ES3_CY3_SP_SYS_SWSF	GC0_SF	IE_SC1_ES2_CY3_T1	
10834	ES1_CY3_T_SYS1	ES1_CY3_T_SYS2	ES3_CY3_T_SYS_SWSF	GC0_SF	IE_SC1_ES2_CY3_T1
507	ES2_CY3_E_SYS1	ES2_CY3_E_SYS_SWSF	GC2_SF	IE_SC1_ES2_CY1_TR2	
508	ES2_CY3_E_SYS1	ES2_CY3_E_SYS_SWSF	GC2_SF	IE_SC1_ES2_CY2_TR2	

	Components and their occurrence / failure impact for a SES state of type SURV3 (as defined in Table 1)	Rank of Impact	Confidence in results	Group of impact
	Failure of the barrier defined by System 2 of TR type for ES2 in cycle CY1	H	L	I - HL
A	Failure of the barrier defined by System 2 of SP type for ES2 in cycle CY2	H	L	
	Failure of the barrier defined by System 2 of T type for ES1 in cycle CY2	H	L	
	Failure of the barrier defined by System 2 of E type for ES1 in cycle CY3	H	M	II - HM
B	Occurrence of an IE (Challenge) to OGR of TR2 type in cycle CY2	H	M	
	Failure of the barrier defined by System 1 of TR type for ES1 in cycle CY1	H	M	
	Occurrence of an IE (Challenge) to OGR of T2 type in cycle CY2	M	L	III - ML
C	Failure of the barrier defined by System 1 of T type for OGR in cycle CY2	M	L	
	Failure of the barrier defined by System 2 of T type for ES3 in cycle CY1	M	L	
	Initial condition of worst type (GC3)	H	H	IV - HH
D	Failure of the barrier defined by System 2 of SP type for ES1 in cycle CY2	H	H	

		SURV3 IMP	Impact rank	Uncertainty results	Groups
137	ES2_CY1_TR_SYS2	Failure of System 2 ES2 TR Cy1	H	L	I=HL
159	IGR_CY2_E_SYS2	Failure of System 2 IGR E Cy2	H	L	
166	ES2_CY2_SP_SYS2	Failure of System 2 ES2 SP Cy2	H	L	
167	IE_SC1_OGR_CY3_SP2	IE SP2 for SC1 OGR Cycle3	H	L	
285	ES1_CY2_T_SYS2	Failure of System 2 ES1T Cy2 considering switches	H	L	
35	ES1_CY3_E_SYS2	Failure of System 2 ES1 E Cy3	H	M	II=HM
39	IE_SC1_OGR_CY2_TR2	IE TR2 for SC1 OGR Cycle2	H	M	
145	ES3_CY1_TR_SYS1	Failure of System 1 ES3 TR Cy1	H	M	
180	ES1_CY1_E_SYS1	Failure of System 1 ES1 E Cy1 considering switches	H	M	
115	IE_SC1_OGR_CY2_T2	IE T2 for SC1 OGR Cycle2	M	L	III=ML
116	IE_SC1_IGR_CY2_T2	IE T2 for SC1 IGR Cycle2	M	L	
258	OGR_CY2_T_SYS1	Failure of System 1 OGR T Cy2	M	L	
292	ES3_CY1_T_SYS2	Failure of System 2 ES3 T Cy1	M	L	
3	GC3_SF	Weight of chossing GC3	H	H	IV=HH
98	ES3_CY2_SP_SYS_SWSF	Split fraction not considering switches for failure of Systems ES3 SP Cy2	H	H	

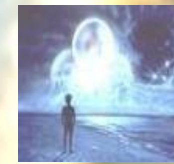
SAMPLE RESULTS

	SURV3 MCS		Q = 6.574E-01		
6	ES1_CY3_E_SYS1	GC2_SF	IE_SC1_ES2_CY3_TR1		
31	ES2_CY3_E_SYS1	ES2_CY3_E_SYS_SWSF	GC2_SF	IE_SC1_ES2_CY3_TR1	
33	ES2_CY3_SP_SYS1	ES2_CY3_SP_SYS_SWSF	GC2_SF	IE_SC1_ES2_CY3_TR1	
45	GC2_SF	IE_SC1_ES2_CY3_TR1	IGR_CY3_E_SYS1	IGR_CY3_E_SYS_SWSF	
77	GC2_SF	IE_SC1_ES2_CY3_TR1	OGR_CY3_SP_SYS1	OGR_CY3_SP_SYS_SWSF	
78	GC2_SF	IE_SC1_ES2_CY3_TR1	OGR_CY3_E_SYS1	OGR_CY3_E_SYS_SWSF	
95	ES1_CY3_E_SYS1	GC1_SF	IE_SC1_ES2_CY3_TR1		
435	GC2_SF	IE_SC1_ES2_CY3_TR2	IGR_CY3_SP_SYS1	IGR_CY3_SP_SYS_SWSF	
442	ES2_CY3_SP_SYS1	ES2_CY3_SP_SYS_SWSF	GC2_SF	IE_SC1_ES2_CY1_TR2	
2651	ES3_CY3_SP_SYS1	ES3_CY3_SP_SYS_SWSF	GC1_SF	IE_SC1_ES2_CY3_T2	
2669	ES1_CY3_E_SYS2	GC1_SF	IE_SC1_ES2_CY3_T2		
3811	ES2_CY3_E_SYS1	ES2_CY3_E_SYS_SWSF	GC0_SF	IE_SC1_ES2_CY3_T1	
4141	ES1_CY3_SP_SYS2	ES1_CY3_SP_SYS_SWSF	GC2_SF	IE_SC1_ES2_CY3_TR2	
6952	ES3_CY3_SP_SYS2	ES3_CY3_SP_SYS_SWSF	GC0_SF	IE_SC1_ES2_CY3_T1	
10034	ES1_CY3_T_SYS1	ES1_CY3_T_SYS2	ES3_CY3_T_SYS_SWSF	GC0_SF	IE_SC1_ES2_CY3_T1
507	ES2_CY3_E_SYS1	ES2_CY3_E_SYS_SWSF	GC2_SF	IE_SC1_ES2_CY1_TR2	
508	ES2_CY3_E_SYS1	ES2_CY3_E_SYS_SWSF	GC2_SF	IE_SC1_ES2_CY2_TR2	

SAMPLE RESULTS

						SURV_T2 MCS	Q =6.574E-01	
1	4.00E-03	0.61	ES1_CY3_E_SYS1	GC2_SF	IE_SC1_ES1_CY3_TR1			
3	4.00E-03	0.61	ES1_CY3_E_SYS1	GC2_SF	IE_SC1_OGR_CY1_TR1			
4	4.00E-03	0.61	ES1_CY3_E_SYS1	GC2_SF	IE_SC1_ES3_CY2_TR1			
14	3.60E-03	0.55	ES2_CY3_E_SYS1	ES2_CY3_E_SYS_SWSF	GC2_SF	IE_SC1_ES2_CY3_TR1		
15	3.60E-03	0.55	ES2_CY3_SP_SYS1	ES2_CY3_SP_SYS_SWSF	GC2_SF	IE_SC1_ES3_CY1_TR1		
16	3.60E-03	0.55	ES2_CY3_SP_SYS1	ES2_CY3_SP_SYS_SWSF	GC2_SF	IE_SC1_IGR_CY1_TR1		
40	3.60E-03	0.55	GC2_SF	IE_SC1_IGR_CY1_TR1	OGR_CY3_E_SYS1	OGR_CY3_E_SYS_SWSF		
91	3.60E-03	0.55	GC2_SF	IE_SC1_ES2_CY2_TR1	OGR_CY3_E_SYS1	OGR_CY3_E_SYS_SWSF		
92	3.00E-03	0.46	ES1_CY3_E_SYS1	GC1_SF	IE_SC1_ES2_CY2_TR1			
105	3.00E-03	0.46	ES1_CY3_E_SYS1	GC1_SF	IE_SC1_OGR_CY1_TR1			
106	2.70E-03	0.41	ES2_CY3_E_SYS1	ES2_CY3_E_SYS_SWSF	GC1_SF	IE_SC1_IGR_CY2_TR1		
133	2.70E-03	0.41	ES2_CY3_SP_SYS1	ES2_CY3_SP_SYS_SWSF	GC1_SF	IE_SC1_ES3_CY2_TR1		
188	2.70E-03	0.41	GC1_SF	IE_SC1_ES3_CY2_TR1	OGR_CY3_SP_SYS1	OGR_CY3_SP_SYS_SWSF		
189	2.70E-03	0.41	GC1_SF	IE_SC1_ES1_CY3_TR1	IGR_CY3_SP_SYS1	IGR_CY3_SP_SYS_SWSF		
190	2.00E-03	0.3	ES1_CY3_E_SYS1	GC3_SF	IE_SC1_ES3_CY2_TR1			
202	2.00E-03	0.3	ES1_CY3_E_SYS1	GC3_SF	IE_SC1_ES1_CY1_TR1			
215	1.80E-03	0.27	ES2_CY3_TR_SYS1	ES2_CY3_TR_SYS_SWSF	GC3_SF	IE_SC1_ES2_CY3_TR1		
227	1.80E-03	0.27	ES2_CY1_TR_SYS1	ES2_CY1_TR_SYS_SWSF	GC3_SF	IE_SC1_ES2_CY1_SP1		
235	1.80E-03	0.27	GC3_SF	IE_SC1_IGR_CY1_TR1	OGR_CY3_E_SYS1	OGR_CY3_E_SYS_SWSF		
236	1.80E-03	0.27	GC3_SF	IE_SC1_OGR_CY3_TR1	IGR_CY3_SP_SYS1	IGR_CY3_SP_SYS_SWSF		
298	1.00E-03	0.15	ES1_CY3_E_SYS1	GC0_SF	IE_SC1_ES1_CY1_TR1			
299	1.00E-03	0.15	ES1_CY3_E_SYS1	GC0_SF	IE_SC1_IGR_CY1_TR1			
316	9.00E-04	0.14	ES2_CY3_E_SYS1	ES2_CY3_E_SYS_SWSF	GC0_SF	IE_SC1_ES1_CY3_TR1		
317	9.00E-04	0.14	ES2_CY3_E_SYS1	ES2_CY3_E_SYS_SWSF	GC0_SF	IE_SC1_ES2_CY2_TR1		
319	9.00E-04	0.14	ES2_CY3_SP_SYS1	ES2_CY3_SP_SYS_SWSF	GC0_SF	IE_SC1_ES3_CY1_TR1		
320	9.00E-04	0.14	ES2_CY3_E_SYS1	ES2_CY3_E_SYS_SWSF	GC0_SF	IE_SC1_OGR_CY3_TR1		
393	4.00E-04	0.06	ES3_CY3_SP_SYS1	ES3_CY3_SP_SYS_SWSF	GC2_SF	IE_SC1_ES2_CY1_TR1		
394	4.00E-04	0.06	ES3_CY3_SP_SYS1	ES3_CY3_SP_SYS_SWSF	GC2_SF	IE_SC1_ES3_CY3_TR1		
407	4.00E-04	0.06	ES1_CY3_E_SYS1	GC2_SF	IE_SC1_ES1_CY2_TR2			
408	4.00E-04	0.06	ES1_CY3_E_SYS2	GC2_SF	IE_SC1_OGR_CY2_TR1			
432	3.60E-04	0.05	ES1_CY3_E_SYS1	ES2_CY2_E_SYS1	ES2_CY2_E_SYS_SWSF	GC2_SF	IE_SC1_ES2_CY2_E1	
433	3.60E-04	0.05	ES2_CY3_SP_SYS1	ES2_CY3_SP_SYS_SWSF	GC2_SF	IE_SC1_ES1_CY2_TR2		
449	3.60E-04	0.05	ES2_CY3_SP_SYS1	ES2_CY3_SP_SYS_SWSF	GC2_SF	IE_SC1_OGR_CY1_TR2		
450	3.60E-04	0.05	GC2_SF	IE_SC1_ES1_CY3_TR2	OGR_CY3_E_SYS1	OGR_CY3_E_SYS_SWSF		
537	3.24E-04	0.05	ES2_CY2_E_SYS1	ES2_CY2_E_SYS_SWSF	ES2_CY3_E_SYS1	ES2_CY3_E_SYS_SWSF	GC2_SF	IE_SC1_ES2_CY2_E1
538	3.24E-04	0.05	ES2_CY2_E_SYS1	ES2_CY2_E_SYS_SWSF	ES2_CY3_SP_SYS1	ES2_CY3_SP_SYS_SWSF	GC2_SF	IE_SC1_ES2_CY2_E1
539	3.24E-04	0.05	ES2_CY2_E_SYS1	ES2_CY2_E_SYS_SWSF	GC2_SF	IE_SC1_ES2_CY2_E1	OGR_CY3_SP_SYS1	OGR_CY3_SP_SYS_SWSF
540	3.24E-04	0.05	ES2_CY2_E_SYS1	ES2_CY2_E_SYS_SWSF	GC2_SF	IE_SC1_ES2_CY2_E1	OGR_CY3_E_SYS1	OGR_CY3_E_SYS_SWSF
580	3.00E-04	0.05	ES1_CY3_E_SYS1	GC1_SF	IE_SC1_ES2_CY2_TR2			
583	3.00E-04	0.05	ES1_CY3_E_SYS2	GC1_SF	IE_SC1_IGR_CY2_TR1			
584	2.70E-04	0.04	ES1_CY3_E_SYS1	ES2_CY2_E_SYS1	ES2_CY2_E_SYS_SWSF	GC1_SF	IE_SC1_ES2_CY2_E1	
585	2.70E-04	0.04	GC1_SF	IE_SC1_ES1_CY3_TR2	OGR_CY3_SP_SYS1	OGR_CY3_SP_SYS_SWSF		
586	2.70E-04	0.04	GC1_SF	IE_SC1_ES1_CY3_TR2	OGR_CY3_E_SYS1	OGR_CY3_E_SYS_SWSF		
743	1.80E-04	0.03	ES1_CY3_E_SYS1	ES2_CY2_E_SYS1	ES2_CY2_E_SYS_SWSF	GC3_SF	IE_SC1_ES2_CY2_E1	
753	1.80E-04	0.03	ES1_CY3_E_SYS1	GC3_SF	IE_SC1_OGR_CY2_E1	OGR_CY2_E_SYS1	OGR_CY2_E_SYS_SWSF	
754	1.80E-04	0.03	ES1_CY3_E_SYS1	GC3_SF	IE_SC1_IGR_CY2_SP1	IGR_CY2_SP_SYS1	IGR_CY2_SP_SYS_SWSF	
755	1.80E-04	0.03	GC3_SF	IE_SC1_OGR_CY2_TR2	OGR_CY3_E_SYS1	OGR_CY3_E_SYS_SWSF		
881	1.62E-04	0.02	ES2_CY3_SP_SYS1	ES2_CY3_SP_SYS_SWSF	ES3_CY2_E_SYS1	ES3_CY2_E_SYS_SWSF	GC3_SF	IE_SC1_ES3_CY2_E1
889	1.62E-04	0.02	ES3_CY2_SP_SYS1	ES3_CY2_SP_SYS_SWSF	GC3_SF	IE_SC1_ES3_CY2_SP1	OGR_CY3_SP_SYS1	OGR_CY3_SP_SYS_SWSF
1330	3.24E-05	0	ES2_CY2_E_SYS1	ES2_CY2_E_SYS_SWSF	ES2_CY3_SP_SYS2	ES2_CY3_SP_SYS_SWSF	GC2_SF	IE_SC1_ES2_CY2_E1
1331	3.24E-05	0	ES2_CY2_E_SYS1	ES2_CY2_E_SYS_SWSF	ES2_CY3_E_SYS2	ES2_CY3_E_SYS_SWSF	GC2_SF	IE_SC1_ES2_CY2_E1
1332	3.00E-05	0	ES1_CY3_E_SYS1	GC1_SF	IE_SC1_ES3_CY2_T2			
1456	2.70E-05	0	GC1_SF	IE_SC1_ES2_CY1_T2	IGR_CY3_SP_SYS1	IGR_CY3_SP_SYS_SWSF		
1458	2.70E-05	0	GC1_SF	IE_SC1_OGR_CY1_T2	OGR_CY3_E_SYS1	OGR_CY3_E_SYS_SWSF		
2041	1.62E-05	0	GC3_SF	IE_SC1_OGR_CY1_E1	OGR_CY1_E_SYS2	OGR_CY1_E_SYS_SWSF	OGR_CY3_SP_SYS1	OGR_CY3_SP_SYS_SWSF

SAMPLE RESULTS



		TCO IMP	Impact rank	Uncertainty results	Groups
137	ES2_CY1_TR_SYS2	Failure of System 2 ES2 TR Cy1	H	L	I=HL
159	IGR_CY2_E_SYS2	Failure of System 2 IGR E Cy2	H	L	
188	IE_SC1_ES2_CY2_E2	IE E2 for SC1 ES2 Cycle2	H	L	
285	ES1_CY2_T_SYS2	Failure of System 2 ES1T Cy2 considering switches	H	L	
132	ES3_CY3_TR_SYS_SWSF	Split fraction not considering switches for failure of Systems ES3 TR Cy3	H	M	II=HM
113	ES3_CY2_SP_SYS1	Failure of System 1 ES3 SP Cy2	H	M	
114	IE_SC1_IGR_CY1_E1	IE E1 for SC1 OGR Cycle1(R&D&T)	H	M	
115	IE_SC1_OGR_CY2_T2	IE T2 for SC1 OGR Cycle2	M	L	III=ML
275	ES2_CY2_T_SYS1	Failure of System 1 ES2 T Cy2	M	L	
290	ES1_CY2_T_SYS1	Failure of System 1 ES1 T Cy2 considering switches	M	L	
1	GC2_SF	Weight of choosing GC2	H	H	IV=HH
50	ES2_CY2_E_SYS_SWSF	Split fraction not considering switches for failure of Systems ES2 SP Cy2	H	H	

SAMPLE RESULTS

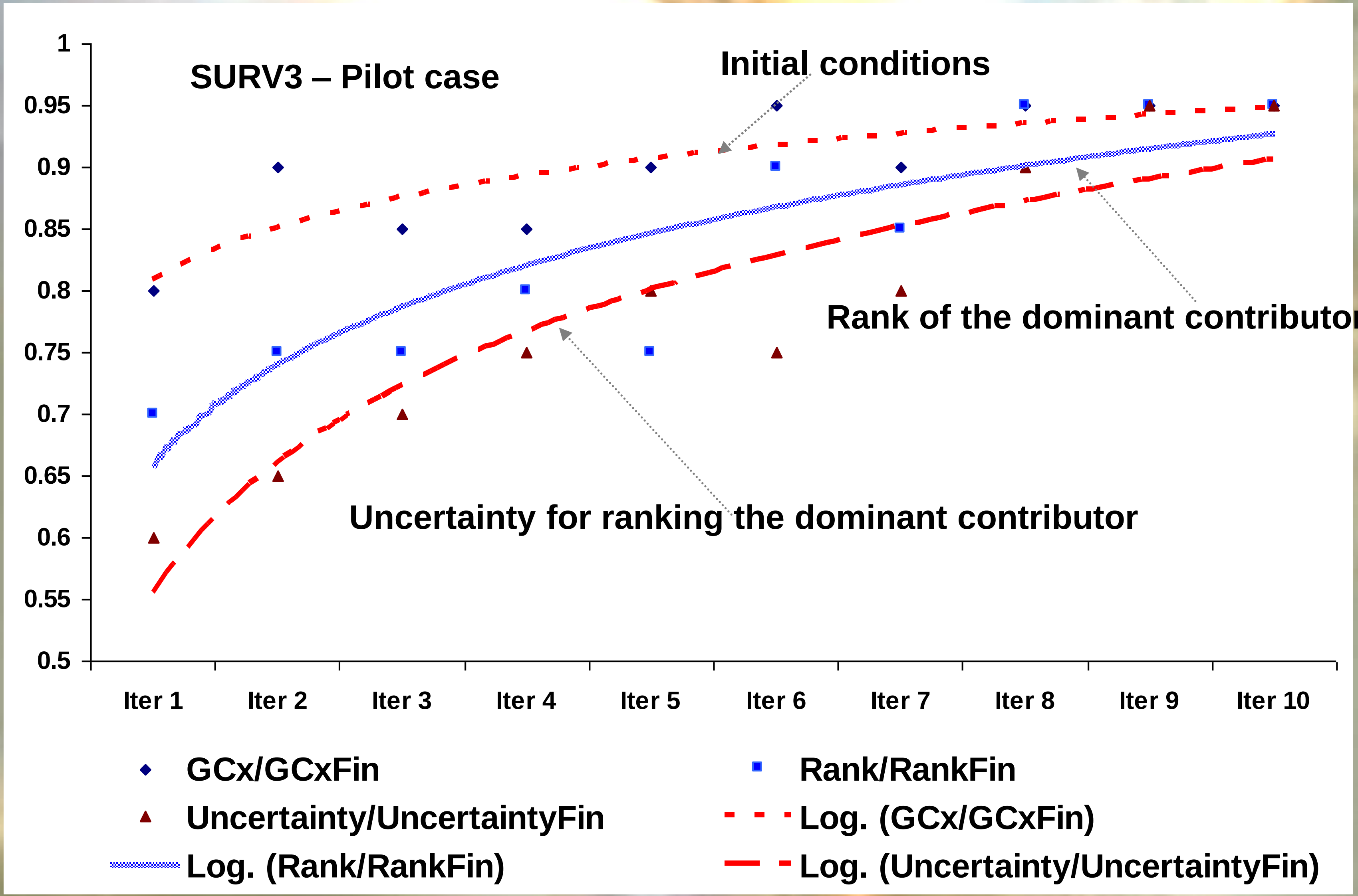
No	Sample of presenting results from a chosen challenge (Initiating Event) from the list, which is ranked as a high risk, accompanied by suggested actions to be considered by the decision makers
1	Challenge consists in a technical failure of barrier 2 of ES1 (e.g. failure of safety systems discovered during operation on nuclear power plant, i.e. CY2) leading to the preventive shut down of the plant. This then results in the disruption of electricity supply to the grid, even if there is no impact on environment, workers and public. The decision-maker could consider as a priority just to improve the safety systems. However, this may not be the best course action from the perspective of assuring survivability of category 3 of the entire energy system, as this scenario has a high-risk impact but low confidence (see Table 5, row **A). Thus, based on his/her boundary conditions, the decision-maker may decide to choose another scenario.**
2	Challenge consists of a terrorist attack of average magnitude on a high voltage switchyard within the EU electrical grid. This leads to an unstable electrical grid and a possible blackout across Europe, with a high impact on the base load sources (nuclear [ES1] or fossil [ES2]). This in turn could lead to failures of technical, political and economic barriers for these energy sources. In this scenario, the decision-maker could consider as a priority to improve the security (including preventive measures) of the key infrastructures of the grid. This could be a better course of action because this scenario has a high-risk impact with a medium confidence in the results (see Table 5, row **B).**
3	Challenge consists of a technical failure of barrier 1 of the electricity grid (e.g. technical failure of a switchyard due to severe weather conditions). The system will switch to the next level of protection (barrier 2) but may still have minor impact on users and other energy sources connected to the grid. In this scenario, the decision-maker could prioritise to fix barrier 1 of the electrical grid. However, this may not be the best course action, as this scenario has a medium-risk impact and low confidence (see Table 5, row **C). Thus, based on his/her boundary conditions, the decision-maker may decide to choose another scenario.**
4	Challenge consists of a failure of barrier 2 of socio-political type for ES1, i.e. nuclear (e.g. failure of reaching consensus between government, industry and public regarding the continuation of nuclear power plant production (cycle 2). In this scenario, the decision-maker could shut down the nuclear plant, but this could have serious repercussions to the entire survivability of the whole energy system, as nuclear is one of the important sources of the energy mix. However, this could lead to even worse public reaction when they will realize that their everyday lives may be drastically changed due to lack of electricity. Thus, as this scenario is of high-risk and high confidence, the decision-maker may have no other choice but to speedily re-open dialogue with the public to seek consensus on the best course of action (see Table 5, row **D).**

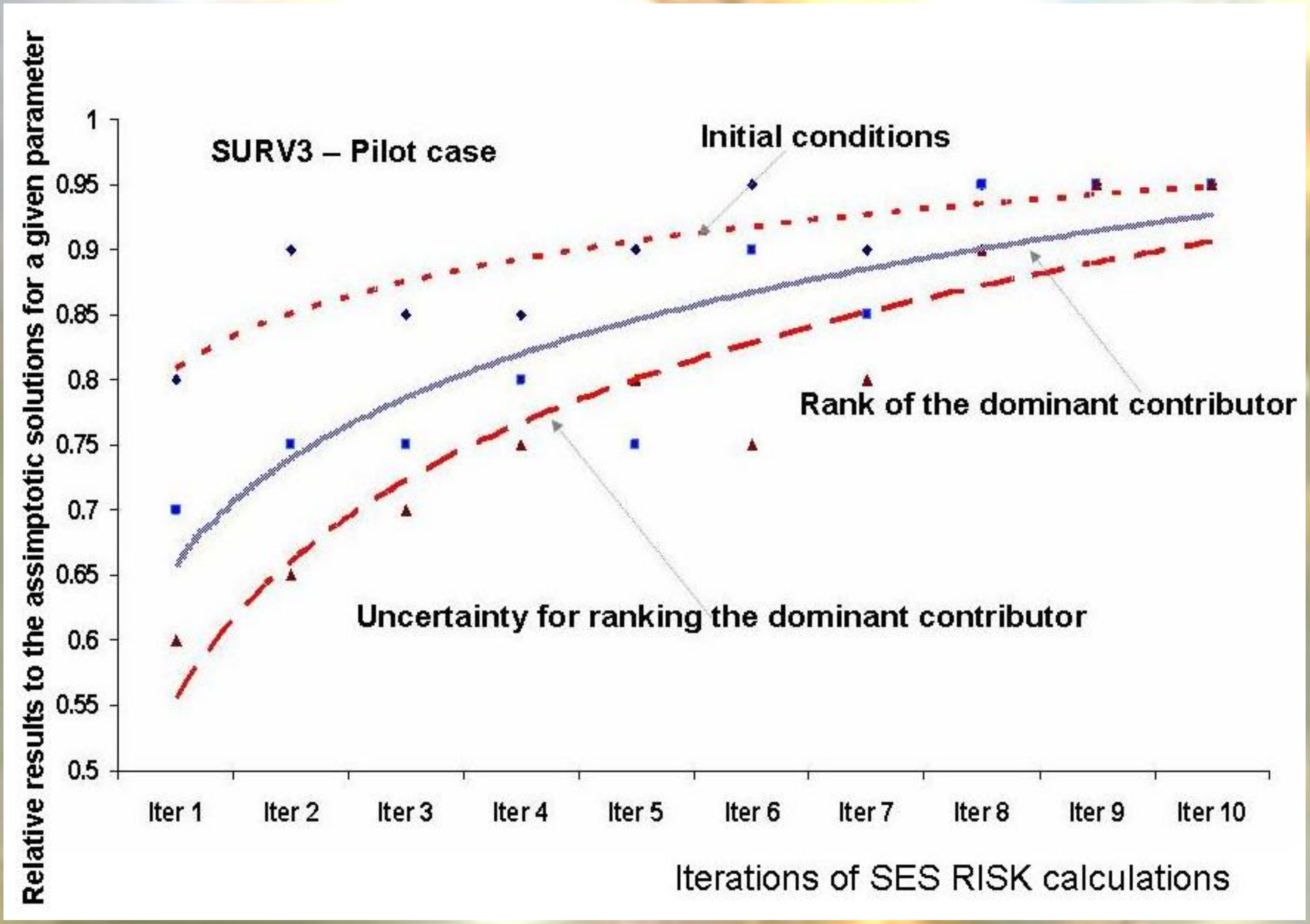
		Initiating Event	
Nuclear U1	ESN1	IE1_ESW35_CY1_E1	Initiating Event E1 for SC1 ESW35 Cy1
Nuclear U2	ESN2	IE1_ESW35_CY1_E1_0	IE E1_0 for SC1 ESW35 Cy1
Nuclear U3	ESN3	IE1_ESW35_CY1_E1_1	IE E1_1 for SC1 ESW35 Cy1
Nuclear U4	ESN4	IE1_ESW35_CY1_E1_2	IE E1_2 for SC1 ESW35 Cy1
CET Galati Grupul 3	ESH5	IE1_ESW35_CY1_E1_3	IE E1_3 for SC1 ESW35 Cy1
CET Galati Grupul 4	ESH6	IE1_ESW35_CY1_E2	Initiating Event E2 for SC1 ESW35 Cy1
CET Galati Grupul 5	ESH7	IE1_ESW35_CY1_E2_0	IE E2_0 for SC1 ESW35 Cy1
CET Galati Grupul 6	ESH8	IE1_ESW35_CY1_E2_1	IE E2_1 for SC1 ESW35 Cy1
CTE Galati (Enel)	EST9	IE1_ESW35_CY1_E2_2	IE E2_2 for SC1 ESW35 Cy1
CTE Braila 1	EST10	IE1_ESW35_CY1_E2_3	IE E2_3 for SC1 ESW35 Cy1
CTE Braila 2	EST11	IE1_ESW35_CY1_SP1	Initiating Event SP1 for SC1 ESW35 Cy1
CTE Braila	EST12	IE1_ESW35_CY1_SP1_0	IE SP1_0 for SC1 ESW35 Cy1
CCGT Tulcea (Alro)	ESC13	IE1_ESW35_CY1_SP1_1	IE SP1_1 for SC1 ESW35 Cy1
CET Palas 1	ESH14	IE1_ESW35_CY1_SP1_2	IE SP1_2 for SC1 ESW35 Cy1
CET Palas 2	ESH15	IE1_ESW35_CY1_SP1_3	IE SP1_3 for SC1 ESW35 Cy1
CEE Pestera (EDP renewables)	ESW16	IE1_ESW35_CY1_SP2	Initiating Event SP2 for SC1 ESW35 Cy1
CEE Valea Nucarilor - Tulcea (Enel)	ESW17	IE1_ESW35_CY1_SP2_0	IE SP2_0 for SC1 ESW35 Cy1
CEE Fantanele -Cogeleac	ESW18	IE1_ESW35_CY1_SP2_1	IE SP2_1 for SC1 ESW35 Cy1
CEE Silistea (Romconstruct)	ESW19	IE1_ESW35_CY1_SP2_2	IE SP2_2 for SC1 ESW35 Cy1
CEE Cernavoda 1 (EDP renewables)	ESW20	IE1_ESW35_CY1_SP2_3	IE SP2_3 for SC1 ESW35 Cy1
CEE Dorobantu, Constanta (Wind Power)	ESW21	IE1_ESW35_CY1_T1	Initiating Event T1 for SC1 ESW35 Cy1
CEE Cernavoda 2 (EDP renewables)	ESW22	IE1_ESW35_CY1_T1_0	IE T1_0 for SC1 ESW35 Cy1
CEE Salbatica 1	ESW23	IE1_ESW35_CY1_T1_1	IE T1_1 for SC1 ESW35 Cy1
CEE Mihai Viteazu, Constanta (Iberdrola)	ESW24	IE1_ESW35_CY1_T1_2	IE T1_2 for SC1 ESW35 Cy1
CEE Salbatica 2	ESW25	IE1_ESW35_CY1_T1_3	IE T1_3 for SC1 ESW35 Cy1
CEE Corugea	ESW26	IE1_ESW35_CY1_T2	Initiating Event T2 for SC1 ESW35 Cy1
CEE Sarichioi	ESW27	IE1_ESW35_CY1_T2_0	IE T2_0 for SC1 ESW35 Cy1
CEE Vutcani	ESW28	IE1_ESW35_CY1_T2_1	IE T2_1 for SC1 ESW35 Cy1
CEE CEDD CAS Regenerabile	ESW29	IE1_ESW35_CY1_T2_2	IE T2_2 for SC1 ESW35 Cy1
CEE CEED Alpha Wind Nord 1	ESW30	IE1_ESW35_CY1_T2_3	IE T2_3 for SC1 ESW35 Cy1
Proiect eolian 1	ESW31	IE1_ESW35_CY1_TR1	Initiating Event TR1 for SC1 ESW35 Cy1
Proiect eolian 2	ESW32	IE1_ESW35_CY1_TR1_0	IE TR1_0 for SC1 ESW35 Cy1
Proiect eolian 3	ESW33	IE1_ESW35_CY1_TR1_1	IE TR1_1 for SC1 ESW35 Cy1

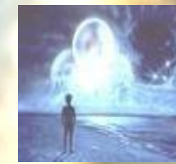
Cod	Scenariu 1 (1 ianuarie 2013)	Gestionar	Conectare	Statia de racord	Emitent/Comentariu	Putere instalata	Putere neta	Energie primara	Ciclu	Cernavoda 400 kV	Barbosi 100 kV sau Smardan	Lacu Sarat 400 kV	Lacul Sarat 220 kV	Smardan 400kV	Tulcea Vest 400 kV	Constanta Nord 110 kV	Medgidia Sud 110kV	celula 110kV din Tulcea	Tariverde 400kV	Medgidia Nord 110kV	Rahmanu
ESN1	Nuclear U1	Nuclearelectrica	RET	Cernavoda 400 kV		706.5	650.0	Nuclear	CY2	x											
ESN2	Nuclear U2	Nuclearelectrica	RET	Cernavoda 400 kV		706.5	648.0	Nuclear	CY2	x											
ESH5	CET Galati Grupul 3	Electrocentrale Galati	RET	Barbosi 110 kV		105.0	96.0	Hidrocarburi	CY2		x										
ESH6	CET Galati Grupul 4	Electrocentrale Galati	RET	Barbosi 110 kV		60.0	58.0	Hidrocarburi	CY2		x										
ESH7	CET Galati Grupul 5	Electrocentrale Galati	RET	Barbosi 110 kV		105.0	96.0	Hidrocarburi	CY2		x										
ESH8	CET Galati Grupul 6	Electrocentrale Galati	RET	Barbosi 110 kV		105.0	96.0	Hidrocarburi	CY2		x										
EST10	CTE Braila 1	SE Braila	RET	Lacu Sarat 220 kV		227.0	213.0	Hidrocarburi	CY2				x								
EST11	CTE Braila 2	SE Braila	RET	Lacu Sarat 220 kV		210.0	195.0	Hidrocarburi	CY2				x								
ESH14	CET Palas 1	SE Constanta	RET	Constanta Nord 110 kV		50.0	42.5	Hidrocarburi	CY2							x					
ESH15	CET Palas 2	SE Constanta	RET	Constanta Nord 110 kV		50.0	42.5	Hidrocarburi	CY2							x					
ESW16	CEE Pestera	EDP Renewables	RED	Medgidia Sud - Rasova	Enel Distributie Dobrogea / Racord in derivatie s.c. din LEA 110 kV pana la st de transf 110/33 kV a utilizatorului	90.0	88.25	Vant	CY2								x				
ESW17	CEE Valea Nucarilor - Tulcea	Enel Green Power	RED	Tulcea Vest - Sarinasuf	Enel Distributie Dobrogea / Racord in derivatie simplu circuit LEA 110 kV Tulcea Vest - Sarinasuf	34.0	33.4	Vant	CY2									x			
ESW18	CEE Fantanele - Cogeleac	CEZ	RET	Tariverde	Transelectrica / statia 400/110 kV Tariverde	600.0	585.0	Vant	CY2										x		
ESW19	CEE Silistea	Romconstruct - ButanGas	RED	Harsova - Medgidia Nord	Enel Distributie Dobrogea / racord intrare - resire in LEA 110 kV, prin statie de conexiune 110 kV si LEA 110 kV pana la st de transf a utilizatorului	25.0	24.8	Vant	CY2											x	
ESW20	CEE Cernavoda 1	Cernavoda Power	RED	Mircea Voda - Medg. N.	Enel Distributie Dobrogea / racord in derivatie din LEA 110 kV pana la st de transf 110/33kV a utilizatorului	69.0	68.3	Vant	CY2											x	
ESW21	CEE Dorobantu, Constanta	Wind Power Park	RET	Rahmanu	Transelectrica / racord prin statie noua 400/110 kV Rahmanu intrare in LEA 400 kV Isaccea - Medgidia	45.0	42.7	Vant	CY2												x
ESW22	CEE Cernavoda 2	Cernavoda Power	RED	Tortomanu	Enel Distributie Dobrogea / racord radial prin LEA 110 kV s.c. in st. de transf. Baia pana la st. de transf.	69.0	67.7	Vant	CY2						x						
ESW23	CEE Salbatica 1	Enel Green Power	RED	Tulcea Vest - Tulcea Est	Enel Distributie Dobrogea / racord in derivatie d.c din LEA 110 kV pana la st de transf 110/33 kV a utilizatorului	70.0	68.5	Vant	CY2						x						
ESW24	CEE Mihai Viteazu, Constanta	Eolica Dobrogea (Iberdro	RED	?	?	80.0	79.0	Vant	CY2												
ESW25	CEE Salbatica 2	Enel Green Power	RED	Tulcea Vest - Tulcea Est	Enel Distributie Dobrogea / racord in derivatie d.c din LEA 110 kV pana la st de transf 110/33 kV a utilizatorului	70.0	68.5	Vant	CY2						x						
ESW26	CEE Corugea	Enel Green Power	RED	Cismeaua Noua	Enel Distributie Dobrogea / racord prin LEA 110 kV din statia de transf Cismeaua Noua pana la st. de transf.	70.0	69.0	Vant	CY2												
ESW27	CEE Sarichioi	EDP Renewables	RED	Tulcea Vest - Zebil	Enel Distributie Dobrogea / racord in derivatie din LEA 110 kV pana la st de transf a utilizatorului	33.0	32.4	Vant	CY2						x						
ESW28	CEE Casimcea, Tulcea CAS	CAS Regenerabile (Austr	RET	Rahmanu	Transelectrica / iesire prin statie noua 400/110 kV Rahmanu intrare - iesire in LEA 400 kV Isaccea -	50.6	49.6	Vant	CY2												x
ESW29	CEE Casimcea, Tulcea Alpha	Alpha Wind - Verbund	RET	Rahmanu	Transelectrica / iesire prin statie noua 400/110 kV Rahmanu intrare - iesire in LEA 400 kV Isaccea - Medgidia (Dobrudja)	48.3	47.5	Vant	CY2												x
ESW30	CEE Babadag	Eviva Nalbant - Martifer	RED	Babadag	Enel Distributie Dobrogea / prin LES 110 kV direct in statia Babadag	33.6	33.0	Vant	CY2												
ESW31	CEE Mihai Viteazu	Wind Farm MVY	RED	?	?	13.8	13.8	Vant	CY2												
ESW32	CEE Gemenele	Braila Winds (GDF Suez)				48.3	47.5	Vant	CY2												
ESW33	CEE Targusor (Zefir 1)	Elcomex EOL				119.6	119.0	Vant	CY2												
ESW34	CEE Topolog	Total Electric				27.0	27.0	Vant	CY2												
	Total nuclear in operare (CY2)					1413.0	1298.0														
	Total hidrocarburi in operare (CY2)					912.0	839.0														
	Total carbune in operare (CY2)					0.0	0.0														
	Total vant in operare (CY2)					1596.2	1565.0														
	Total putere in operare (CY2)					3921.2	3461.7														
ESN3	Nuclear U3	Nuclearelectrica	RET	Cernavoda 400 kV		720.0	670.0	Nuclear	CY1	x											
ESN4	Nuclear U4	Nuclearelectrica	RET	Cernavoda 400 kV		720.0	670.0	Nuclear	CY1	x											
EST9	CTE Galati	Enel	RET			800.0		Carbune	CY1												
EST12	CTE Braila	Enel	RET			880.0		Carbune	CY1					x							
ESC13	CCGT Tulcea	Alro	RET			420.0		Gaze	CY1						x						
ESW35	CEE							Vant	CY1												

CRITERII

	O	A	B	C	D	E	F	G	H	Cerinte ale indeplinirii grupelor de criterii	O	A	B	C	D	E	F	G	H	Impactul unor conditionari dominante asupra cerintelor / TOTAL	O	A	B	C	D	E	F	G	H	Nivel satisfacere cerinte
Aspectele economice	4	1	2	4	2	4	4	4	1	Investitie totala	6	8	10	10	9	10	10	8	8	Reglementari/limitari finantare din partea CE	8 / 14	4 / 12	2 / 12	6 / 16	4 / 13	8 / 18	6 / 16	8 / 16	8 / 16	ABD
										Crestere neprevazuta initial a investitiei pe durata realizarii	6	8	10	10	10	10	10	10	8	Reglementari pe piata nationala si UE	10 / 16	4 / 12	2 / 12	6 / 16	6 / 16	6 / 16	8 / 18	8 / 18	6 / 14	AB
										Costul ponderat pe toata durata de viata a centralei	8	8	10	10	8	10	10	8	6	Scenarii energetice nationale si UE	8 / 16	4 / 12	4 / 14	4 / 16	6 / 16	4 / 16	4 / 16	6 / 18	6 / 12	AH
										Costul combustibilului	8	6	8	8	8	8	8	8	6	Rezerve si cost nationale vs variatie pret UE	10 / 18	6 / 12	6 / 14	8 / 16	8 / 16	8 / 16	8 / 16	10 / 18	6 / 12	AH
Securitatea nucleara si	4	1	1	1	1	1	2	2	2	Nivelul de securitate nucleara cerut pentru centrale noi	10	2	2	2	2	2	2	4	4	Regelementari UE(ex Directiva Securitate) centrale noi	10 / 20	2 / 4	2 / 4	2 / 4	2 / 4	2 / 4	4 / 6	4 / 8	2 / 6	ABC DEFH /O
										Nivelul de risk la evenimente interne si externe	6	2	2	2	2	2	2	4	2	Protectie pasiva crescuta la accidente severa	6 / 12	2 / 4	2 / 4	2 / 4	2 / 4	2 / 4	2 / 4	4 / 8	4 / 6	ABC DEFH G/O
Deseurile radioactive	4	3	3	4	4	4	4	4	3	Costul cu deseurile radioactive	10	8	8	8	8	8	8	8	6	Alegerea ciclului de combiustibil si a tipului de centrala	10 / 20	6 / 14	6 / 14	8 / 16	8 / 16	8 / 16	8 / 16	9 / 17	6 / 12	ABH
										Costul cu dezafectarea	10	8	8	8	8	8	8	8	6	Reglementari nationale posibil suport NDAP - UE	10 / 20	8 / 14	8 / 14	8 / 16	8 / 16	8 / 16	8 / 16	8 / 16	6 / 12	ABH
Utilizarea resurselor	4	3	3	4	4	4	4	4	4	Resurse de uraniu	10	6	6	6	6	6	6	6	6	Programe nationale suport	10 / 20	8 / 14	6 / 12	6 / 12	6 / 12	6 / 12	6 / 12	6 / 12	4 / 10	ABC DEFG H
										Resurse de thoriu	6	6	8	8	8	8	8	8	8	Programe nationale suport	6 / 12	6 / 12	8 / 16	8 / 16	8 / 16	8 / 16	8 / 16	8 / 16	8 / 16	OA
										MOX si alte cicluri combinate	10	6	6	6	6	6	6	6	6	Alegere ciclu combustibil si colaborari UE/SUA	10 / 20	6 / 12	6 / 12	6 / 12	10 / 16	10 / 16	10 / 16	10 / 16	10 / 16	ABC
Neproliferare	4	1	1	1	3	3	3	3	1	Rezistenta la neproliferare	8	4	4	6	8	8	8	8	4	Design	16	8	8	10	12	12	12	12	8	ABCH
TOTAL	4	1	1	3	3	3	3	3	2	ABH										CDEFG	O									


SURV3 – Pilot case
Initial conditions
Rank of the dominant contributor
Uncertainty for ranking the dominant contributor
1
0.95
0.9
0.85
0.8
0.75
0.7
0.65
0.6
0.55
0.5
Iter 1
Iter 2
Iter 3
Iter 4
Iter 5
Iter 6
Iter 7
Iter 8
Iter 9
Iter 10
GCx/GCxFin
Rank/RankFin
Uncertainty/UncertaintyFin
Log. (GCx/GCxFin)
Log. (Rank/RankFin)
Log. (Uncertainty/UncertaintyFin)


SURV3 – Pilot case
Initial conditions
Rank of the dominant contributor
Uncertainty for ranking the dominant contributor
Relative results to the assimptotic solutions for a given parameter
1
0.95
0.9
0.85
0.8
0.75
0.7
0.65
0.6
0.55
0.5
Iter 1
Iter 2
Iter 3
Iter 4
Iter 5
Iter 6
Iter 7
Iter 8
Iter 9
Iter 10
Iterations of SES RISK calculations



SES - General[2] Survivability Group (SES - GSG)	Short Description of General Survivability Group	SES - Specific Survivability Subgroup Combination of categories defined in Table 2 (Binning)
SURV 0	Very Low Impact leading to no significant follow up corrective actions needed (NCO)	T0 E0 E1 T1
SURV 1	Small Impact leading to Minor follow up corrective actions needed (CO1)	E2 T2 E0T1 E0E1 E0T1 E0T0 E0T1 E1T0
SURV 2	Medium Impact leading to Some Important follow up corrective actions needed (CO2)	E1E2 E1T1 E1T2 E2T1
SURV 3	High Impact leading to Major follow up corrective actions needed (TCO)	E2T2

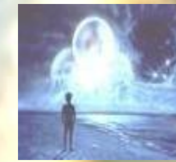
	Components and their occurrence / failure impact for a SES state of type SURV3 (as defined in Table 1)	Rank of Impact	Confidence in results	Group of impact
	Failure of the barrier defined by System 2 of TR type, for ES2 in cycle CY1	H	L	I = HL
A	Failure of the barrier defined by System 2 of SP type, for ES2 in cycle CY2	H	L	
	Failure of the barrier defined by System 2 of T type, for ES1 in cycle CY2	H	L	
	Failure of the barrier defined by System 2 of E type, for ES1 in cycle CY3	H	M	II = HM
B	Occurrence of an IE (Challenge) to OGR of TR2 type in cycle CY2	H	M	
	Failure of the barrier defined by System 1 of TR type, for ES1 in cycle CY1	H	M	
	Occurrence of an IE (Challenge) to OGR of T2 type in cycle CY2	M	L	III = ML
C	Failure of the barrier defined by System 1 of T type, for OGR in cycle CY2	M	L	
	Failure of the barrier defined by System 2 of T type, for ES3 in cycle CY1	M	L	
	Initial condition of worst type (GC3)	H	H	IV = HH
D	Failure of the barrier defined by System 2 of SP type, for ES1 in cycle CY2	H	H	

Challenge consists of a failure of barrier 2 of socio- political type for ES1, i.e. nuclear (e.g. failure of reaching consensus between government, industry and public regarding the continuation of nuclear power plant prediction (cycle 2). In this scenario, the decision-maker could shut down the nuclear plant, but this could have serious repercussions to the entire survivability of the whole energy system, as nuclear is one of the important sources of the energy mix. However, this could lead to even worse public reaction when they will realize that their everyday lives may be drastically changed due to lack of electricity. Thus, as this scenario is of high-risk and high confidence, the decision-maker may have no other choice but to speedily re-open dialogue with the public to seek consensus on the best course of action

Survivability category	Scenarios	Rank of input	Confidence in results	Impact Group
SURV 2 Medium	A = Failure of the barrier defined by System 2 of SP type for ES1 in Cycle 2	H	M	HM
SURV 3 High	B= A failure of the barrier system 2 of Safeguards and strategic development type for a ES2 under development Cycle 1 due to blocking decisions od SP type in highly tense initial conditions GC 3 of the whole system	H	H	HH
SURV 3 High	C = Failure of the barrier defined by System 2 of T type for ES3 in Cycle 1 with initial condition GC3 of worst type	M	L	ML

Challenge consists of a failure of barrier 2 of socio- political type for ES1, i.e. nuclear (e.g. failure of reaching consensus between government, industry and public regarding the continuation of nuclear power plant prediction (cycle 2). In this scenario, the decision-maker could shut down the nuclear plant, but this could have serious repercussions to the entire survivability of the whole energy system, as nuclear is one of the important sources of the energy mix. However, this could lead to even worse public reaction when they will realize that their everyday lives may be drastically changed due to lack of electricity. Thus, as this scenario is of high-risk and high confidence, the decision-maker may have no other choice but to speedily re-open dialogue with the public to seek consensus on the best course of action

ANEXA 2
ESREDA CUBE



Comparisons of diverse technologies

The goal of the evaluation is to:

- Highlight the role of global approaches (crossing conventionally set limits in usual practices) on issues related to the evaluation of accidents and the learning process
- Consider impact of cross ties between various
  - lifecycle phases
  - socio political environments
  - diverse technologies
- Highlight the specifics of such cross dependencies for extensive implementation of results available in accident analysis of technical systems, as available in
  - *The series of activities and publications*
  - *Various technical areas at national and international level*
- Consider remarks as potential input for future activities of *the safety and reliability think tanks , on* topics like critical infrastructures and systems resilience

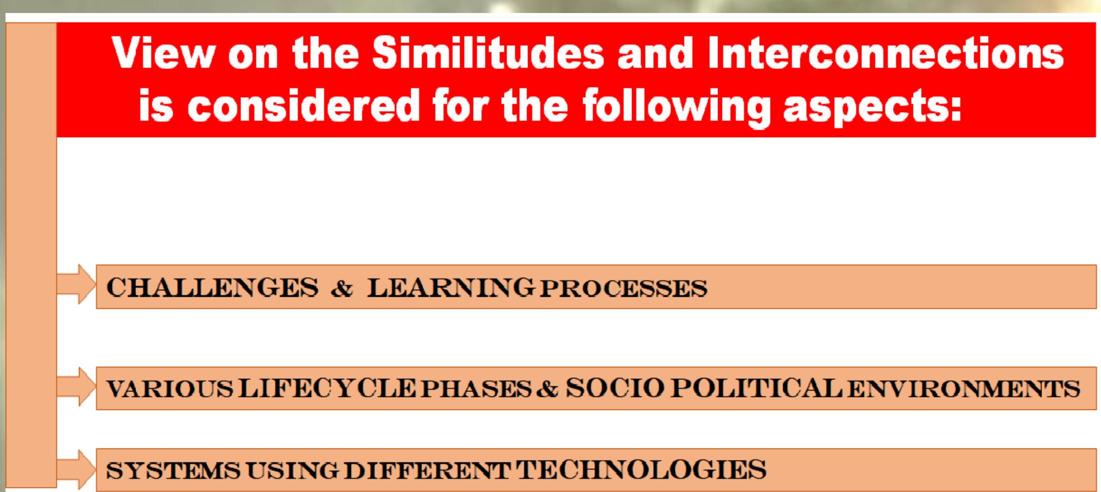


Figure 1The goals of the review of various complex systems

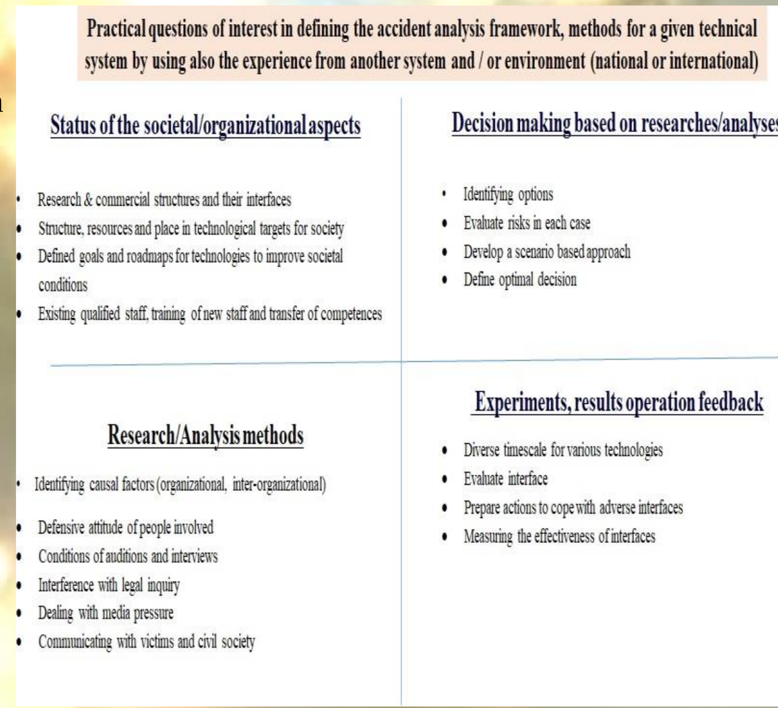


Figure 2. Quadrant of the types of methods for the accident evaluations – as considered in the paper

In order to reach the goal of evaluating similitudes and differences for various types of complex systems a scale was used to represent the compliance with the best / recommended practice for a technology interface (Figure 3).

Expected QM-NE Interaction Scale

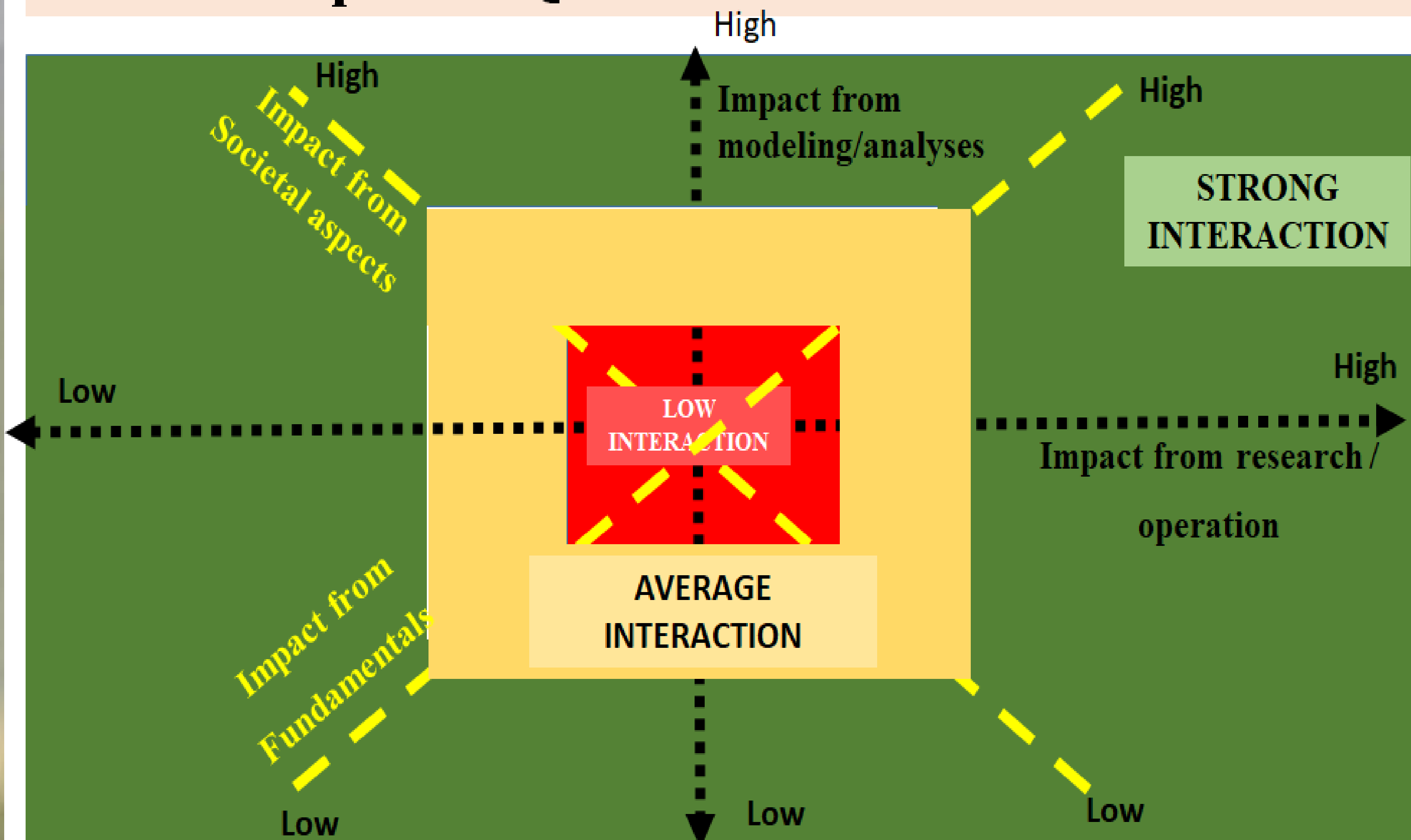
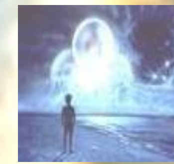


Figure 3a. Compliance Scale with best / recommended practice of an accident evaluation system



The characteristics considered of interest in defining topics and strategies for accident analysis for a complex system are (Table 1) are as follows:

- Interaction between the two technologies QM and NE (I)
- Research validation, expected technology failures and their management (R)
- Supply chain operation and cooperation (S)
- Impact of the system lifecycle (C)
- Impact of societal -socio political environment (P)
- Interference with other technologies then NE (T)

These characteristics define a matrix of evaluation of various options/situations, which might be encountered. The options in matrix format describe space states, for which a corresponding geometrical representation as nodes and facets of polyhedral form, as shown in previous papers [3; 4] .

In this paper the approach is used in order to identify specific features and evaluate the interface of two technologies Quantum Mechanics (QM) and Nuclear Engineering(NE). In Table 2 there is a more detailed representation of the common aspects and differences between the two technologies, which have an impact (in the situation evaluated in the paper) on the comparison criteria from Table 1.

Table 1.The characteristics considered of interest in defining topics and strategies for accident analysis for a complex system

Code	Short description	Characteristics of criteria
I	**Interaction QM-NE**	Interaction between the two technologies QM and NE (I) S
R	**Research failures**	Research validation, expected technology failures and their management (R) E
S	**Supply chain performance**	Supply chain operation and cooperation (S) L
C	**Lifecycle joint impact**	Impact of the system lifecycle for the joint evolution QM-NE(C)
P	**Societal environment**	Impact of societal -socio political environment (P)
T	**Interface with other technologies**	Interference with other technologies then NE (T)

Table 2.Features that are common and features different for two industries

NO	COMMON FEATURES	NO	FEATURES THAT DIFFER
C1	Critical infrastructures	D1	Degree of dependence from political and social influences (R=Low; N=Medium)
C2	Organizational structure required.	D2	Phase of technology mature operation versus research (R=High; N=Medium)
C3	Interface with societal organization	D3	Different timings for the technology lifecycles (R=Short; N=Long)
C4	Societal environment	D4	Resources allocated – material, training, organizational structure (R=Low, N=Medium)
C5	Learning from similar technological implementation	D5	Cross industries / planetary connection (R=Medium, N=High)
C6	Risks of systems	D6	Implementation of lessons from similar technologies (R=Low, N=High)
C7	Commercial/safety/security implications considered	D7	Feedback systems CATS type (R=Low, N=High)

The sources of evaluations in table 2 are as follows:

- For **the Nuclear area –** the papers containing information to support the expert evaluations from and summarized in previous work ([1];[3];[4]):
  - *Evaluation of the impact of using risk driving evaluation criteria*
  - *Presentation of an example of event review and OPEX*
  - *Evaluation of a case study on cross industries impact (from R to N)*
  - *Presentation of emergency organizational structures at national and industry (N) level*
  - *Presentation of some specific safety evaluation techniques (N)*
- For the QM – (see Annex A) .

In order to describe the interdependencies between various features / criteria specifics in cases N and R, used to develop the interdependence matrix the evaluation considered the existing results mentioned in papers listed before on the topic.

Type A of approach- Multicriterial analysis by using specialized tools as the ESREDA CUBE

Type A is in accordance with the series of activities and publications under *ESREDA -Dynamic Learning from Accidents Bridging the gap between accident investigations and learning*

Each node is defined by intersection of three facets, which are common areas of

fulfilling any two out of three criteria.

The resultant geometrical form is of cube type, as presented in Figure .

The nodes and the facets may be described in an Interdependence Matrix of the 3 criteria.

This principle is valid for any number of criteria. However, the resultant geometrical

form is of more complex polyhedral type, as it will be shown under the type D of approaches.

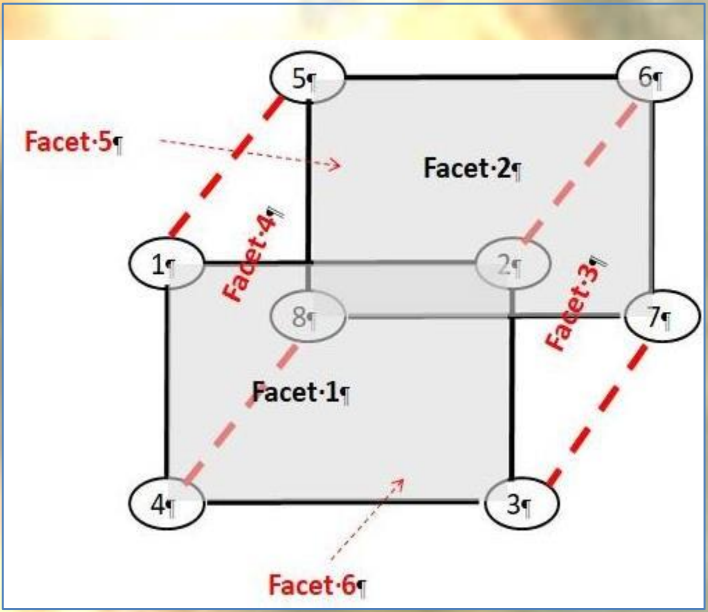
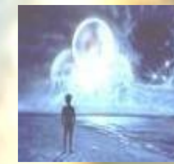
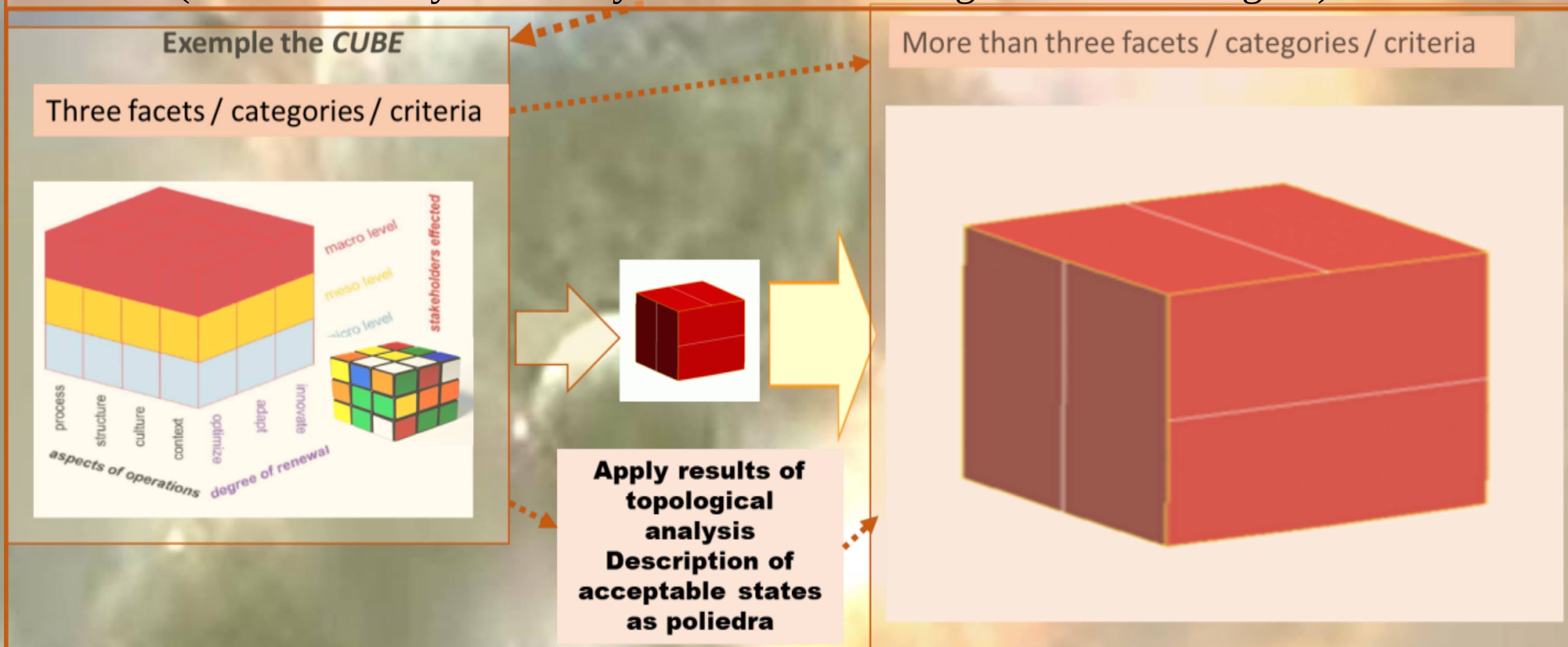


Figure 4.The facets of the multicriteria evaluations

The ESREDA CUBE is, from this perspective, a particular case of geometrical representation of the space of acceptable solutions for the optimization based on 3 criteria (Figure 5).
As mentioned in the introduction the evaluation needs to consider more than 3 criteria (in the QM-NE comparison case 6 criteria were considered).
For this case a new approach is needed and/or a generalization of the CUBE approach, based on mathematical modeling.



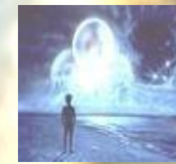
However, if there will be more than 3 criteria, then the acceptable space od optimal solutions will be described by a more complex type of polyhedral, as the Type C of evaluation will illustrate (and which is symbolically illustrated in the right side of the Figure).



.Use of ESREDA CUBE to evaluate optimal solutions in safety/reliability optimization based on 3 criteria

ANEXA 3

MODELARE ANALITIC PARAMETRICA – SISTEME ENERGETICE NUCLEARE CA FUNCTIE DE O VARIABILA SI UNU/DOI PARAMETRII –**SISTEME ENERGETICE NUCLEARE CA O TEHNOLOGIE**



Type B of approaches – Analytical evaluations of the space (volumes of acceptable optimal solutions), i.e. a parametric modelling – *function of one variable and one parameter*

This type of approaches is based on the evaluation of the dependencies of the optimal space (in a two dimensional representation) for each criteria defined in Table 1. This results in a set of acceptable spaces (as illustrated in Figure 6) for each criterion. The resultant acceptable space will be considered as an envelope of all spaces for a given situation (QM or NE for instance).

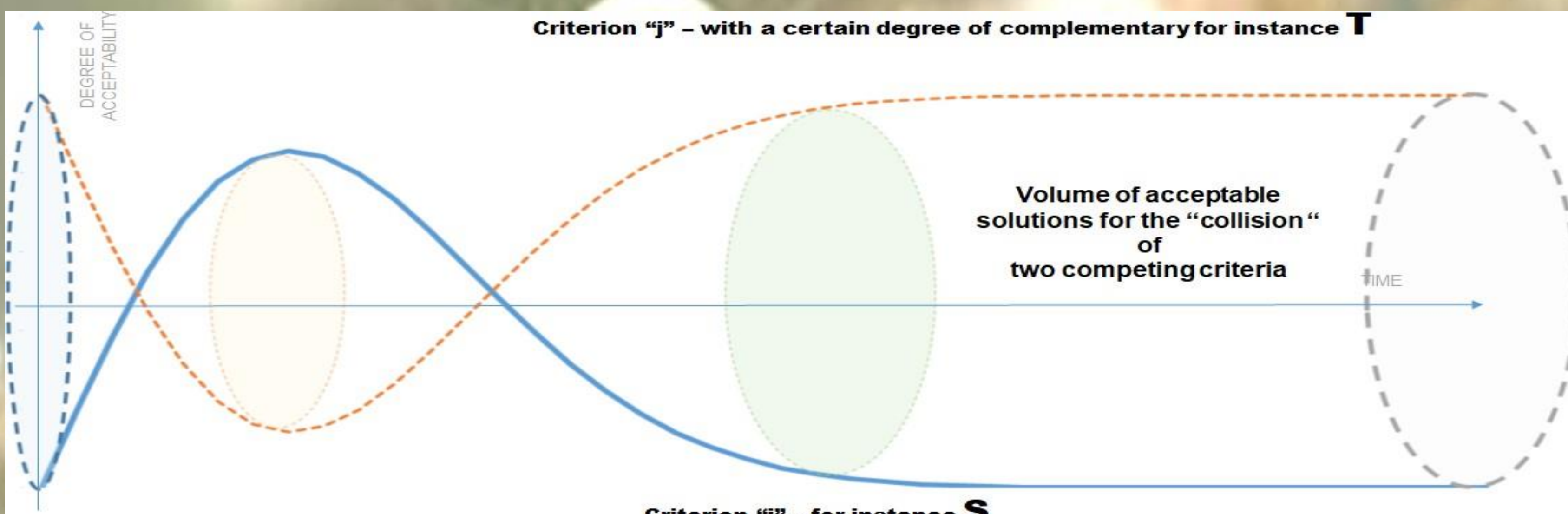


Figure 6. Evaluation of cross dependencies for extensive implementation in accident analysis of technical systems

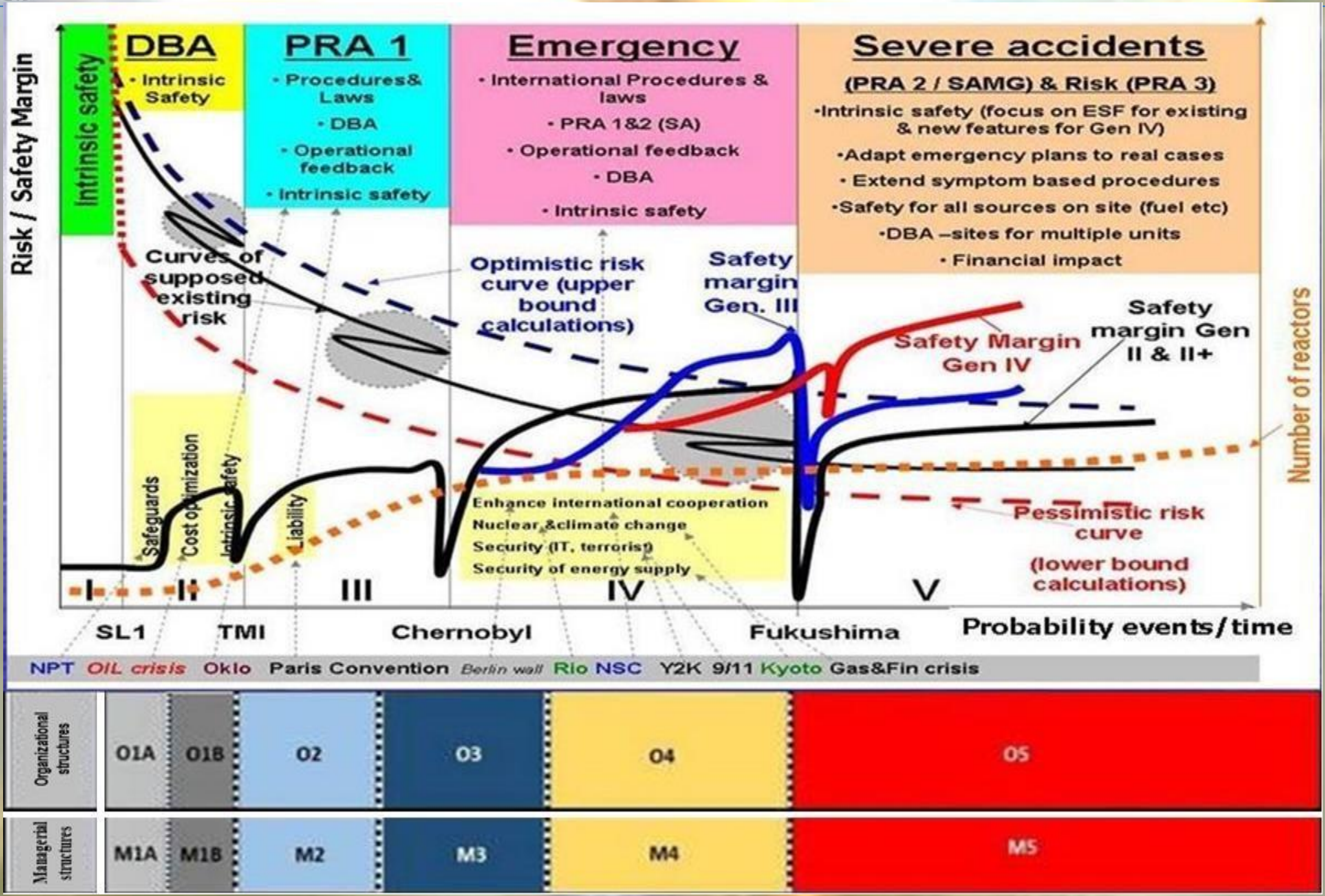


Figure 7. Type C approach event review for nuclear case [3]

Evaluation of cross dependencies for extensive implementation in accident analysis of technical systems is similar for various technologies

In Figure 6 a nuclear NPP case is represented, while in Figures 8 and 9 a railway technology is shown) ([3]

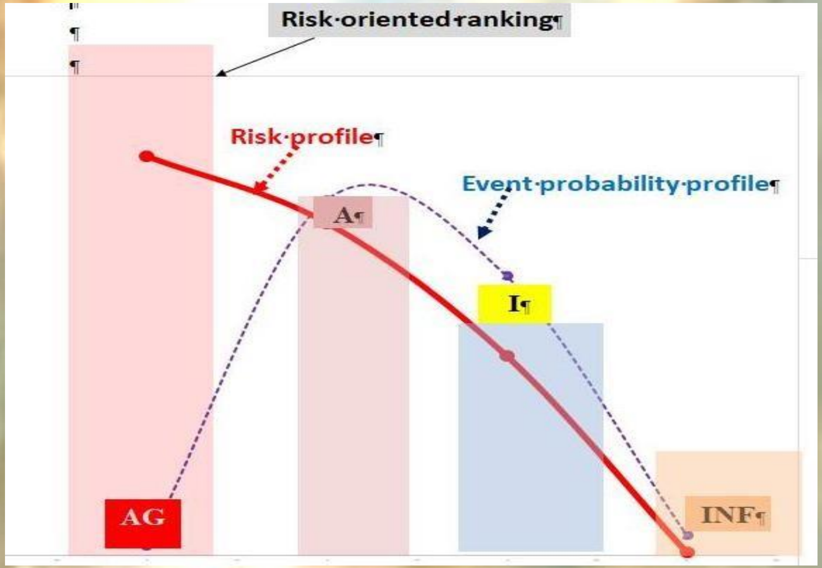


Figure 8. Type C approach event review for railway case [2] (1)

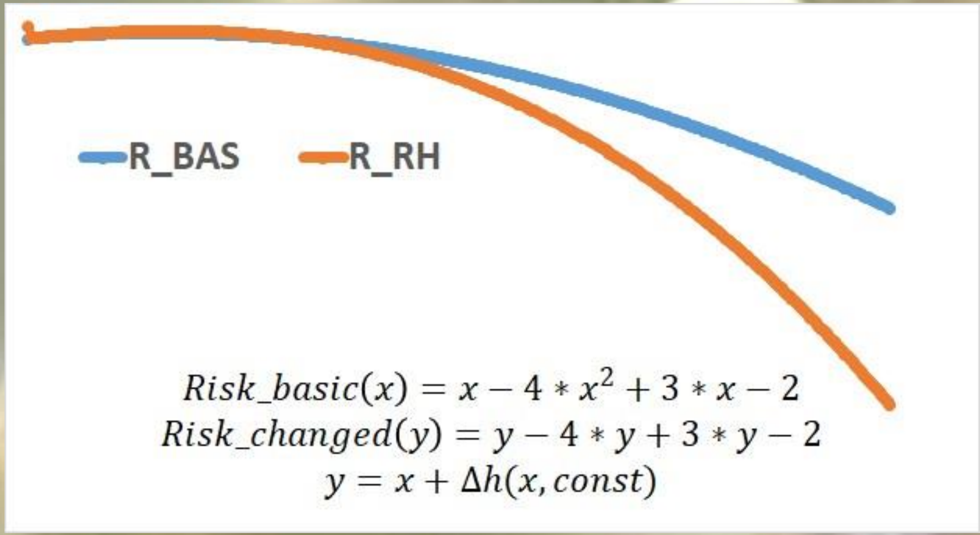
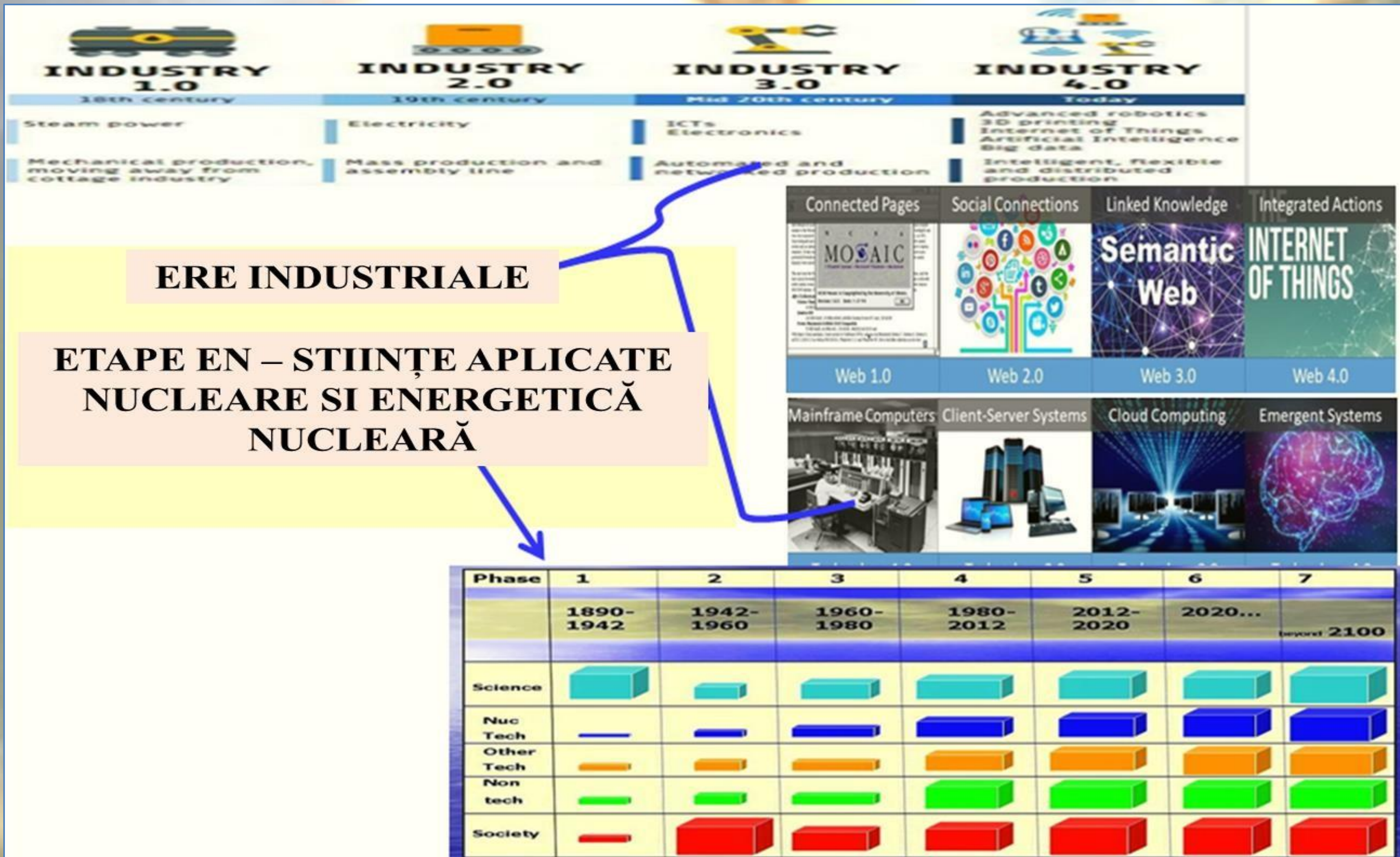


Figure 9. Risk profiles for NE not affected by QM and affected by QM

NE in era 3.0 & 4.0

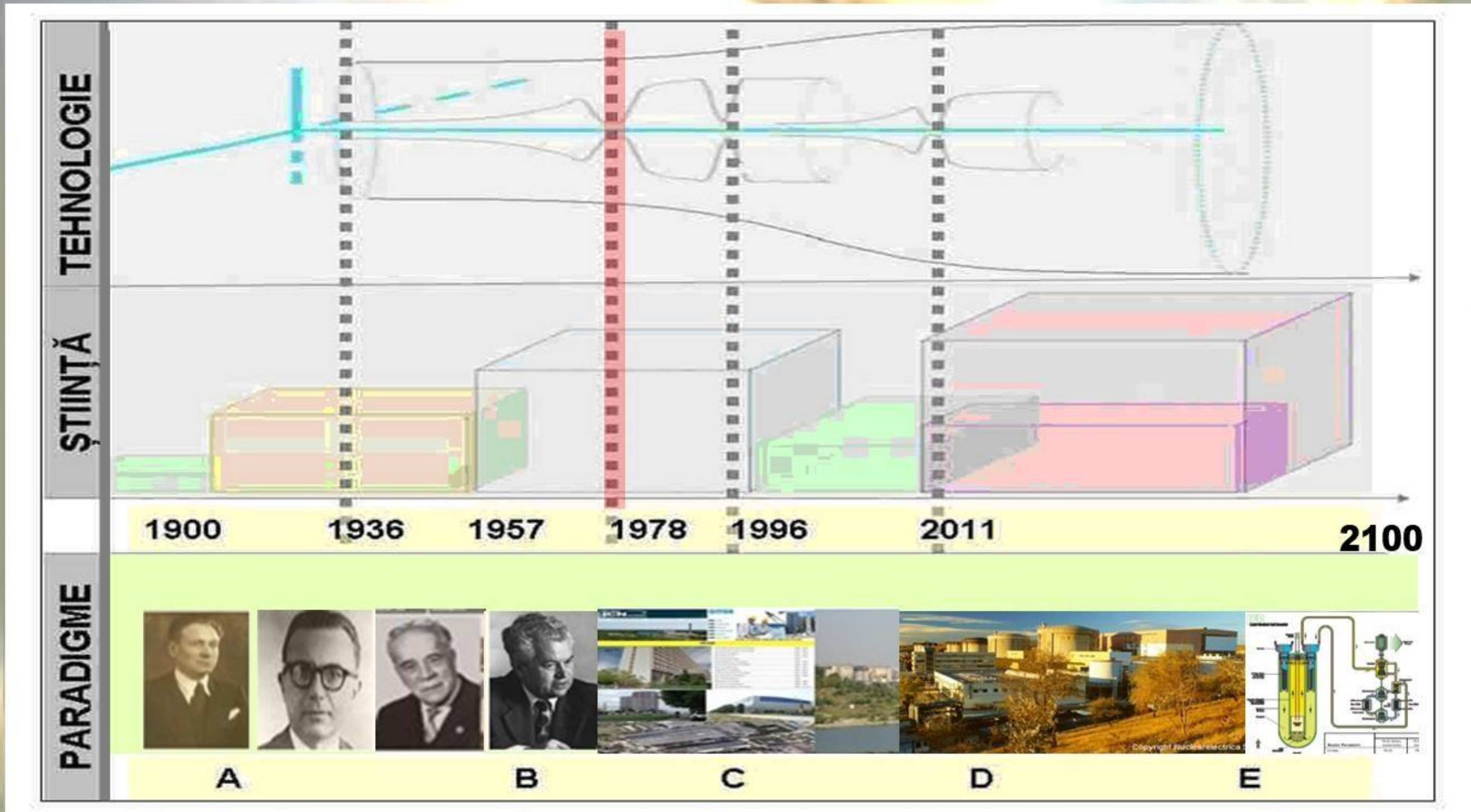
GENERAȚIA II 1970ţs	GENERAȚIA II+ III 1985-2020	GENERAȚIA III+ IV 2020 ----
EN PARTEA CONTROL	EN PARTEA CONTROL	EN PARTEA CONTROL
EN PARTEA HARD	EN PARTEA HARD	EN PARTEA HARD
FACTOR UMAN & MANAGEMENT & LEADERSHIP	FACTOR UMAN & MANAGEMENT & LEADERSHIP	FACTOR UMAN & MANAGEMENT & LEADERSHIP
GENERAȚIA SG BB	GENERAȚIA BB +X + Y	GENERAȚIA Y+Z+ALPHA BETA

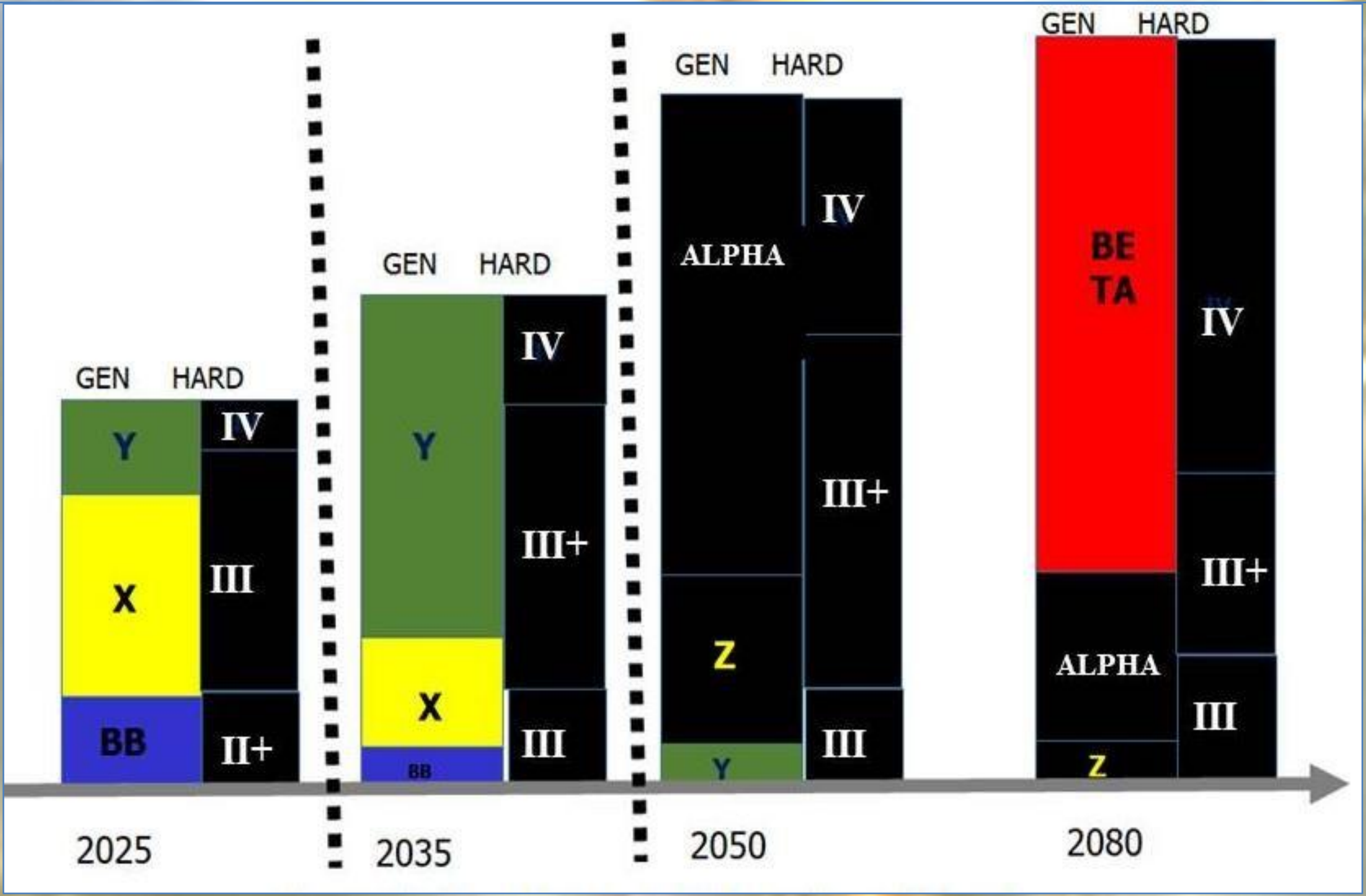

INDUSTRY 1.0
18th century
Steam power
Mechanical production, moving away from cottage industry
INDUSTRY 2.0
19th century
Electricity
Mass production and assembly line
INDUSTRY 3.0
Mid 20th century
ICTs
Electronics
Automated and networked production
INDUSTRY 4.0
Today
Advanced robotics
3D printing
Internet of Things
Artificial Intelligence
Big data
Intelligent, flexible and distributed production
ERE INDUSTRIALE
ETAPE EN – STIINȚE APLICATE NUCLEARE SI ENERGETICĂ NUCLEARĂ
Connected Pages
Social Connections
Linked Knowledge
Integrated Actions
MOSAIC
Semantic Web
INTERNET OF THINGS
Web 1.0
Web 2.0
Web 3.0
Web 4.0
Mainframe Computers
Client-Server Systems
Cloud Computing
Emergent Systems
Phase
1
2
3
4
5
6
7
1890-1942
1942-1960
1960-1980
1980-2012
2012-2020
2020...
beyond 2100
Science
Nuc Tech
Other Tech
Non tech
Society

EN in erele 3.0 si 4.0

Locul fizicii si energeticii nucleare in Romania intr-un secol si jumatate (2)

Un secol și jumătate de fizică teoretică (A-E) și patru decenii de energetică nucleară (C-E)




GEN
HARD
Y
IV
X
III
BB
II+
2025
GEN
HARD
IV
Y
III+
X
III
BB
2035
GEN
HARD
IV
ALPHA
III+
Z
III
Y
2050
GEN
HARD
BE
TA
IV
III+
ALPHA
III
Z
2080

ANEXA 4
CATS

Type C Use of topological spaces for the evaluation cases with more than three criteria

A new approach is proposed for the case when there are more than three criteria for the evaluation of an optimal space of solutions for the risk management in a complex system. The method, called the **method of the topological spaces**, was used in previous tasks [3;4] and it is described in detail with examples of use in previous works [3;4].
The set of solutions of acceptable optimal choices in a complex system with multicriterial set of challenges is defined for various areas of the Interdependence matrix as per formulas (1) to (3). The acceptable space of solutions is defined as per formula (4)

$M^{s} = M^{s1}(e \rightarrow l \rightarrow c \rightarrow p) \cup M^{s2}(e \rightarrow t \rightarrow p)$ (1)

Where x→y = x is a function of y

$M^{w} = [M^{w1}(e \rightarrow p) \cup M^{w2}(l \rightarrow p)] \cup [M^{w3}(e \rightarrow c \rightarrow p) \cup M^{w3}(e \rightarrow c \rightarrow p)]$ (2)

$M^{tot} = M^{s} \cup M^{w}$ (3)

$Acceptable\ space\ of\ solutions = M^{tot} = Volume\ Polyhedral$ (4)

Evolution of the Performance and Risk functions for a technology during its lifetime

Use of topological spaces for the evaluation cases with more than three criteria

Acceptable space of solutions $= M^{tot} =$ *Volume Poliedra*

$M^s = M^{s1}$ $(i \to s \to c \to p) \cup M^{s2}$ $(i \to t \to p)$

$x \to y =$ x is a function of y

$M^w = [M^{w1} (i \to p) \cup M^{w2} (i \to p)] \cup [M^{w3} (i \to c \to p) \cup M^{w3} (i \to c \to p)]$

$M^{tot} = M^s \cup M^w$

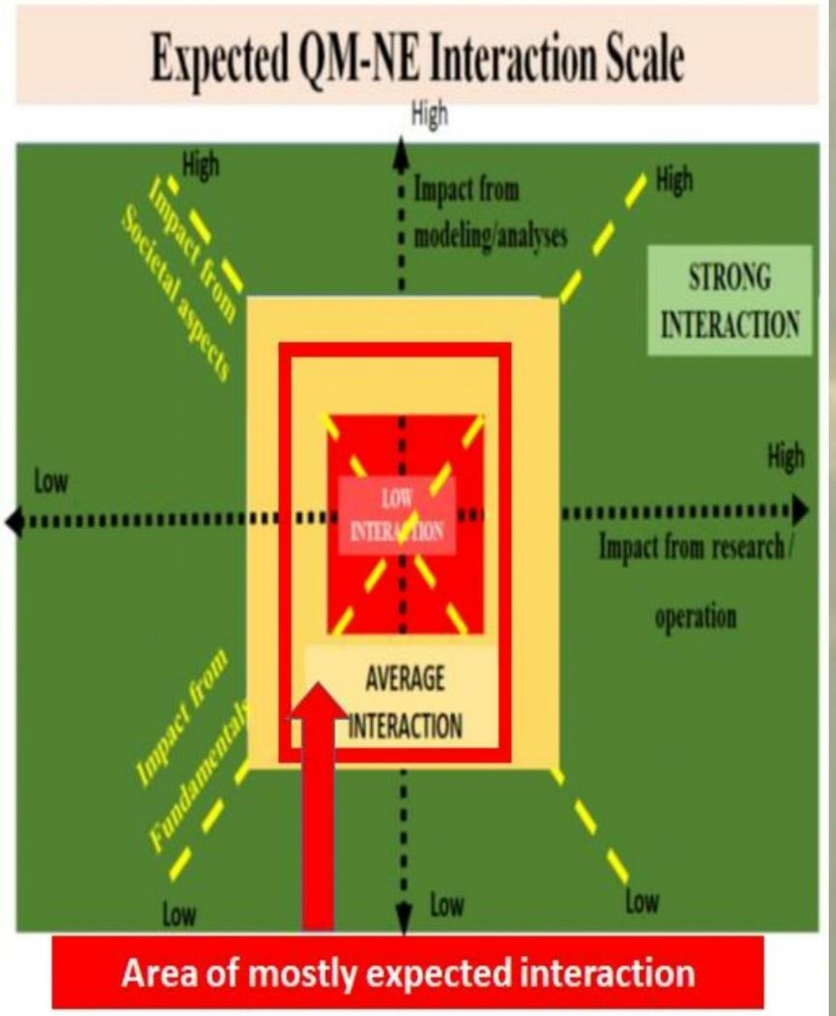
Interaction QM-NE is governed by

MAINLY

- **Clear and timely in the lifecycles of the both technologies of**
  - *Supply chain for smooth implementation of QM applications in NE*
  - *Correlation with other technologies (material fabrication, maintenance etc)*
  - *Identification of the areas of applications of QM in desktop design /safety activities and in NE lifecycle phases correlated with the QM research and implementation*
- **By increasing the independence on political factors**
  - *better structure at societal level,*
  - *more resources and*
  - *administrative independence to the review organizations*

SECONDLY

- **By interference of the societal factors in the evaluation process**
- **Improving interface and orientation to applications of the researches and possible fundamental new scientific connections**



The solutions of the topological approach for the evaluation of the spaces of optimal results for a multi criteria decision in a complex system are represented by the matrix in Figure 10.

Code	Short
S	Similitude
E	Evaluation
L	Learning
C	Cycle
P	Political
T	Technologies

$$A = \begin{pmatrix} 0 & 1 & 1 & 1 & 1 & 1 \\ 1 & 0 & 1 & -1 & -1 & 1 \\ 1 & 1 & 0 & 1 & -1 & -1 \\ 1 & -1 & 1 & 0 & 1 & -1 \\ 1 & -1 & -1 & 1 & 0 & 1 \\ 1 & 1 & -1 & -1 & 1 & 0 \end{pmatrix}.$$

$$\| a_{ij} \| =$$

ss a11	se a12	sl a13	sc a14	sp a15	st a16
es a21	ee a22	el a23	ec a24	ep a25	et a26
ls a31	le a31	ll a33	lc a34	lp a35	lt a36
cs a41	cs a41	cl a43	cc a44	cp a45	ct a46
ts a61	te a62	tl a63	tc a64	tp a65	tt a66

Figure10. Interdependence matrix for evaluating criteria (in table 1) leading to acceptable spaces as defined by polyhedral type

In general, a multiple set of evaluations for an increased number of criteria leads to a set of solutions, which are in matrix format as per the Figure 10. **However, there is a connection shown in [3] between the matrix format a geometrical representation, illustrated also in Figure 1**1.

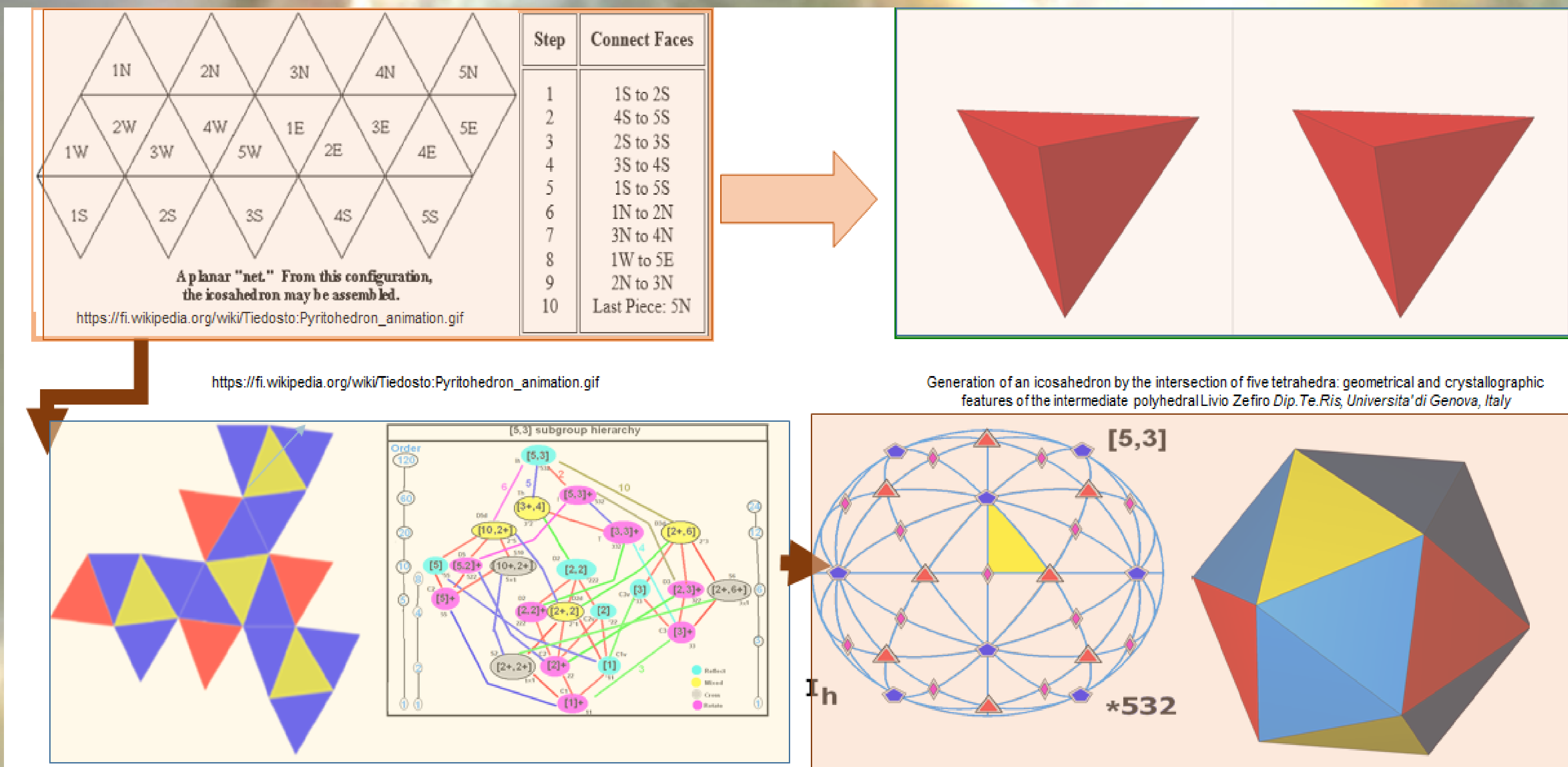


Figure 11. The polyhedral representation of the matrix of multi criteria decision for a complex system [3]

Academia Romana
Comitetul Român de Istoria si Filsofia Ştiinţei şi Tehnicii (CRIFST)
Divizia de Logică, Metodologie şi Filosofia Ştiinţei (DLMFS)
Grupul de Cercetari Interdisciplinare, 10 martie 2021, sesiune ZOOM

s y s t e m s

Subquantic	SQ=SYS7
Quantic	Q =SYS8
Molecular	M =SYS9
Molecular life	ML=SYS1
Planetary	P =SYS2
Planetary life	PL =SYS3
Planetary life intelligent	**PLI =SYS0**
Galaxy	G =SYS4
Cosmic	C =SYS5
Cosmic life	CL =SYS6
Cosmic intelligent	**CLI =SYS10**

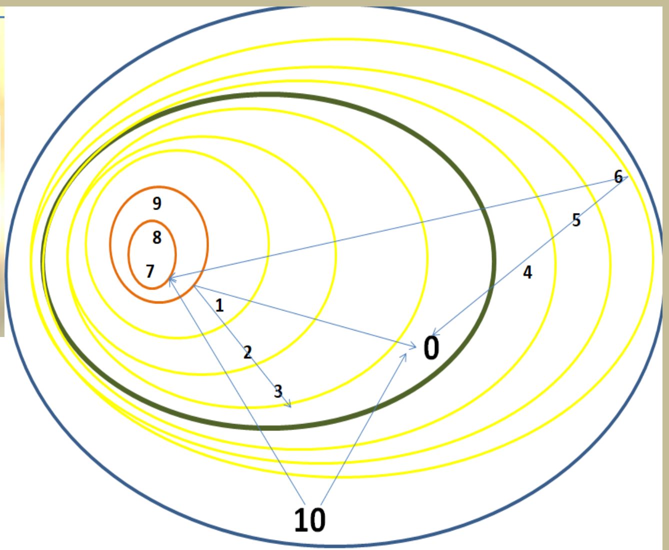
For one given case

$$s^{(k)} = \sum_{l=0}^{8}\sigma_l^{(k)} + \sum_{l=0}^{8}\omega * i_l^{(k)}$$

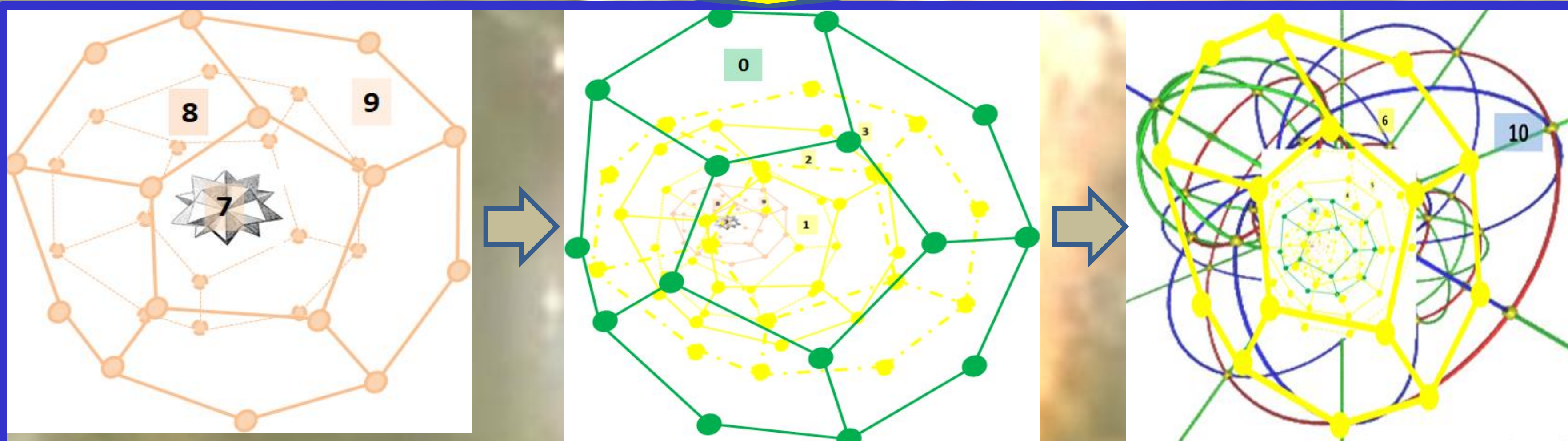
$$E^{(k)} \equiv \sum_{l=0}^{8} E_l^{(k)} i_l^{(k)}$$

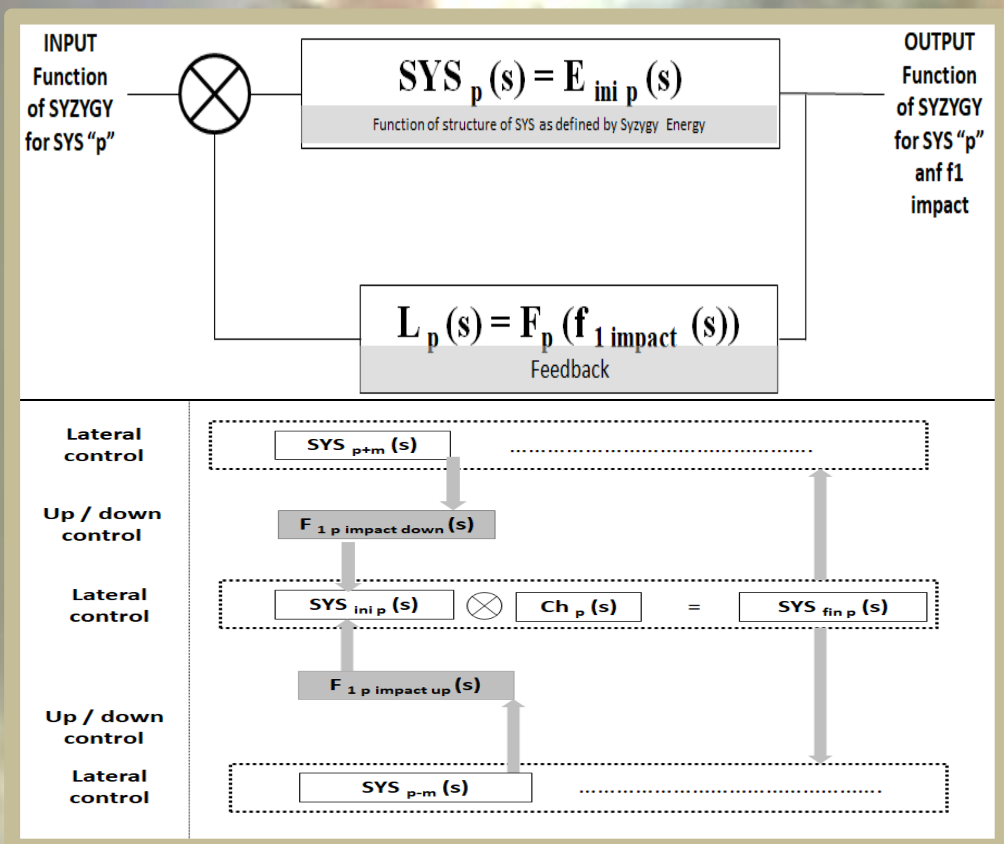
$$m^{(k)} \equiv \sum_{l=0}^{8} m_l^{(k)} i_l^{(k)}$$

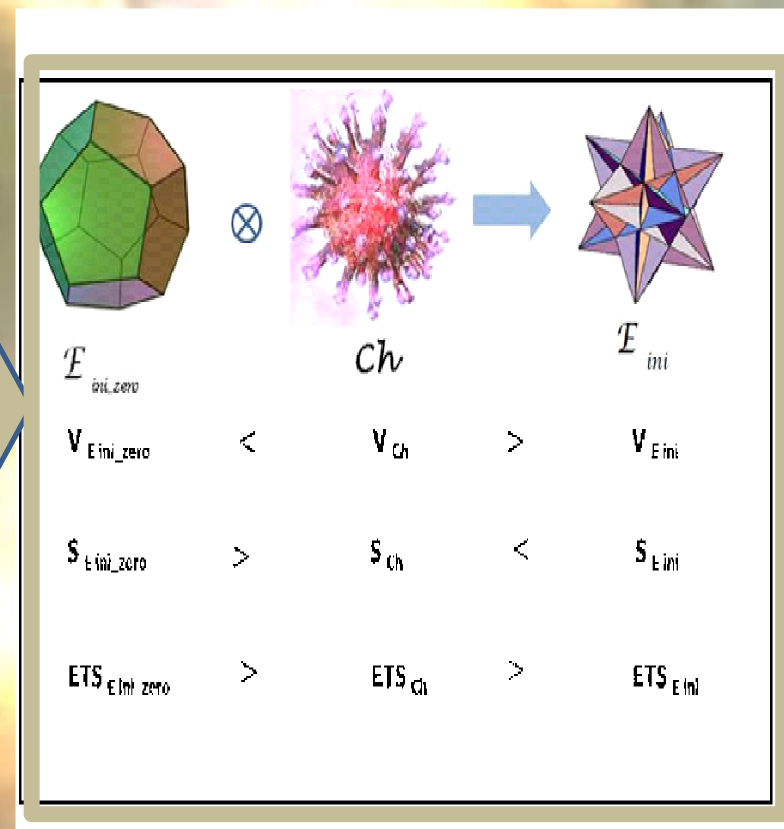
$$\psi^{2\,(k)} \equiv \sum_{l=0}^{8} \psi^{2\,(k)}_l i_l^{(k)}$$



s p a c e st at e s




INPUT Function of SYZYGY for SYS "p"
SYS p (s) = E ini p (s)
Function of structure of SYS as defined by Syzygy Energy
OUTPUT Function of SYZYGY for SYS "p" anf f1 impact
L p (s) = F p (f 1 impact (s))
Feedback
Lateral control
SYS p+m (s)
Up / down control
F 1 p impact down (s)
Lateral control
SYS ini p (s)
Ch p (s)
=
SYS fin p (s)
F 1 p impact up (s)
Up / down control
Lateral control
SYS p-m (s)


Ch
V E ini_zero < V Ch > V E ini
S E ini_zero > S Ch < S E ini
ETS E ini zero > ETS Ch > ETS E ini

ANEXA 5

Calculul de risc si dezvoltarea Planurilor de Urgenta pentru centrale SMR – metode inovative aplicate intr-un caz particular

Main elements defined to support the development of Emergency Action Levels (EAL) and of Emergency Plan as a whole for SMR NPP

DOI:10.18840/RG.2.8.29959

Dan Serbanescu
Petre Min

Workshop on SMR IAEA – CNCAN – SNN
Bucharest, Romania
August 25-26

Objectives

- Develop the basic elements of the process for Emergency Planning definition for SMR
- Provide calibration of the approach on a known already defined EP case for NPP
- Adapt the process for SMR

PHASES of the PROCESS of *SMR-EP*

A. Define the **input** to **the EP categories definition based on plant design-List of input initiating events to the EP process** as defined in documents like TECDOC 955 – Generic Methodology

B. Evaluate in a systematic manner **the Emergency Action Levels (EAL) – As developed by SNN-CNCAN**

C. **Built the Decision Trees for EP categories – as developed by CNCAN**

D. **Evaluate impact on EP management systems – model the interactions in a systematic manner**

E. **Define the cases for evaluation of radiation impact at various distances**

F. **Calibrate methodology with a known case with results in an alternative approach**

G. **Case study SMR**

H. **Dispersion calculations**

I. **Conclusions on definition of impact and zones based on radiation release impact**

GENERIC PRESENTATION OF METHODOLOGY PHASES A to E

CRP J15002- RCM 2, 2021

Romanian GLERUNR/CNCAN presentation Progress report

DOI: 10.13260/RG.2.8.22659

Petre Min

Dan Serbanescu

Objective, Status and next steps

- **Initial objective** to perform a comparison of various results obtained from a set of test cases rather than for one test case with more methods.
- **Updated objective**: Use one integrated method of the whole decision making process for several test sources entries into the emergency planning. Used already developed tools for various steps of the decision-making process.
- **Updated team**

Steps for the on-going next phase

B1. Main focus:

Integrate existing tools, chose details on source cases and perform the whole decision one through evaluation for the cases.
Define the sensitivity of the possible advises as a support tool proposed by GLERUNR group (Nuclear and Radiological Emergency Risk Assessment Working Group) to the emergency structure components at national level.

B2. Integrated method of already used tools in previous projects

Consolidation of the list of existing tools

T1 Model of Emergency Action Levels (EAL) derived in a systematic manner in accordance with symptom-based approach (as per DOE-NRC-NEI procedures) – based on the use of Riskspectrum modeling

Steps for the on-going next phase

B2. Integrated method of already used tools in previous projects

T2 Correlation of the safety analyses and safety documentation in general with the definition of EAL and development of a unitary approach / strategy document to define the emergency situations for a real plant, based on combined deterministic and probabilistic approaches

T3 Use of computer code RODOS and development in house postprocessing computing tools to evaluate impact of a certain source

T4 Development of an integrated risk evaluation tool of the whole decision-making process in an emergency situation – Risk evaluation tool using decision trees developed by GLERUNR and tested for one real case

B3. The test cases are defined

B4. The steps of the decision-making process

C. The sensitivity calculations are performed

B2. Integrated method of already used tools in previous projects

T1 Model of Emergency Action Levels (EAL) derived in a systematic manner in accordance with symptom-based approach (as per DOE-NRC-NEI procedures) – based on the use of Riskspectrum modeling

T2 Correlation of the safety analyses and safety documentation in general with the definition of EAL and development of a unitary approach / strategy document to define the emergency situations for a real plant, based on combined deterministic and probabilistic approaches

T3 Use of computer code RODOS and development in house postprocessing computing tools to evaluate impact of a certain source

T4 Development of an integrated risk evaluation tool of the whole decision-making process in an emergency situation – Risk evaluation tool using decision trees developed by GLERUNR and tested for one real case

Potential scenarios and their asociated probabilities are considered. The entries into the Emergency Plan (EP) are defined by the Emergency Action levels (EAL). (1)

The EAL's for which situations and actions are defined start from three types of inputs:

Safety analyses based on which the operating licence is issued, defined as follows:

- Safety Analyses used for the NPP licensing (FSR chapter 15 and upport)
- Specialized suupport analyses for FSR, PSA levels 1 and 2 for internal and external events
- OPEX for normal operation
- Advanced severe accidents research results for specific plant
- New requirements for classification of events (DEC A, DEC B)

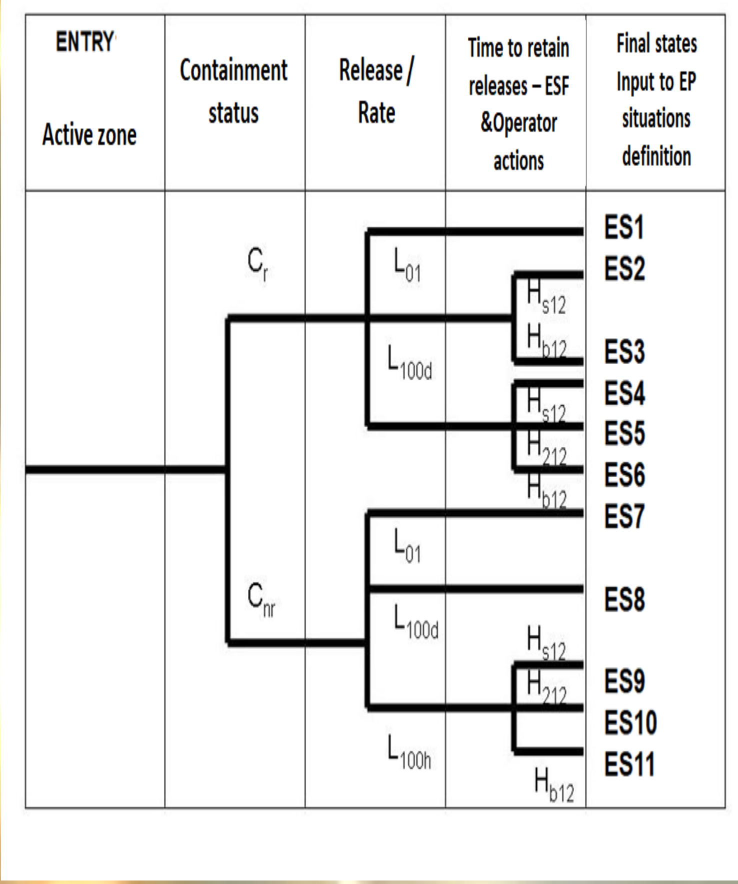
Requirements of developing inputs to the EP situations

- Requirements to define NPP and its installations as being in one of the categories of EP (CEP) for which
- Graded hierarchical approach to detailed plant-on site and off site EP are to be defined .

Previous national and international experience for various types of incidents/accidents, including results from national and international benchmark exercises.

Potential scenarios and their asociated probabilities are considered. The entries into the Emergency Plan (EP) are defined by the Emergency Action levels (EAL) (2)

- The process of including together, in an unitary approach, categories I and II was used for a particular case and ***a methodology was developed***. The approach has the following features:
- The sources of events inputs (types I, II and II) were initially screened and grouped by considering the use of the symptom-based approach (as per DOE-NEA approach) to the highest extent possible.
- The groups of events are considering to trigger the typical for EP approaches barriers:
    - Reactor core degradation level
    - Containment degradation and status of its leaktightness
    - Timing available for human recovery and other Engineering Safety Features to cope with potential agravation of the plant release status
- Potential actions for emergency situations resulted are included as a barrier to manage the effects of the failures of the other barriers as defined in the Defence in Depth concept.
- Recovery actions, graded approch in the definition of emergency situations and hierarchical reaction of the whole structure at plant, regional and national levels are also modelled as barriers in the Decision Trees (developed as per TECDOC 955).



Romania-first report

T1

Potential scenarios and their asociated probabilities are considered. The entries into the EP are defined by the Emergency Action levels (EAL).

The EAL's for which Emergency Plan (EP) situations and actions are defined start from <u>three types of inputs</u>:

A. **<u>Safety analyses based on which the operating licence</u>** is issued, defined as follows:

i. Safety Analyses used for the NPP licensing (FSR chapter 15 and upport)
ii. Specialized suupport analyses for FSR, PSA levels 1 and 2 for internal and external events
iii. OPEX for normal operation
iv. Advanced severe accidents research results for specific plant
v. New requirements for classification of events (DEC A, DEC B)

B. <u>Requirements of developing inputs to the EP situations</u>

- Requirements to define NPP and its installations as being in one of the categories of EP (CEP) for which
- Graded hierarchical approach to detailed plant-on site and off site EP are to be defined .

C. **<u>Previous national and international experience</u>** for various types of incidents/accidents, including results from national and international benchmark exercises.

The process of including together, in an unitary approach, categories A and B was used for a particular case and <u>a methodology was developed</u>. The approach has the following features:

- **The sources of events inputs (types A, B and C) are initially screened and grouped by** considering the use of the symptom based approach (as per DOE-NEA approach) to the highest extent possible.
- The groups of events are considering to trigger the typical **for EP approaches barriers**:
  - **Reactor core** degradation level
  - **Containment degradation** and status of its leaktightness
  - **Timing** available for human recovery and other Engineering Safety Features to cope with potential agravation of the plant release status
- Potential **actions for emergency situations resulted are included as a barrier to manage the effects of the failures of the other barriers as defined in the Defence in Depth** concept.

- **Recovery actions, graded approch in the definition of emergency situations and hierarchical reaction** of the whole structure at plant, regional and national levels are also modelled as barriers in the **Decision Trees (developed as per TECDOC 955).**

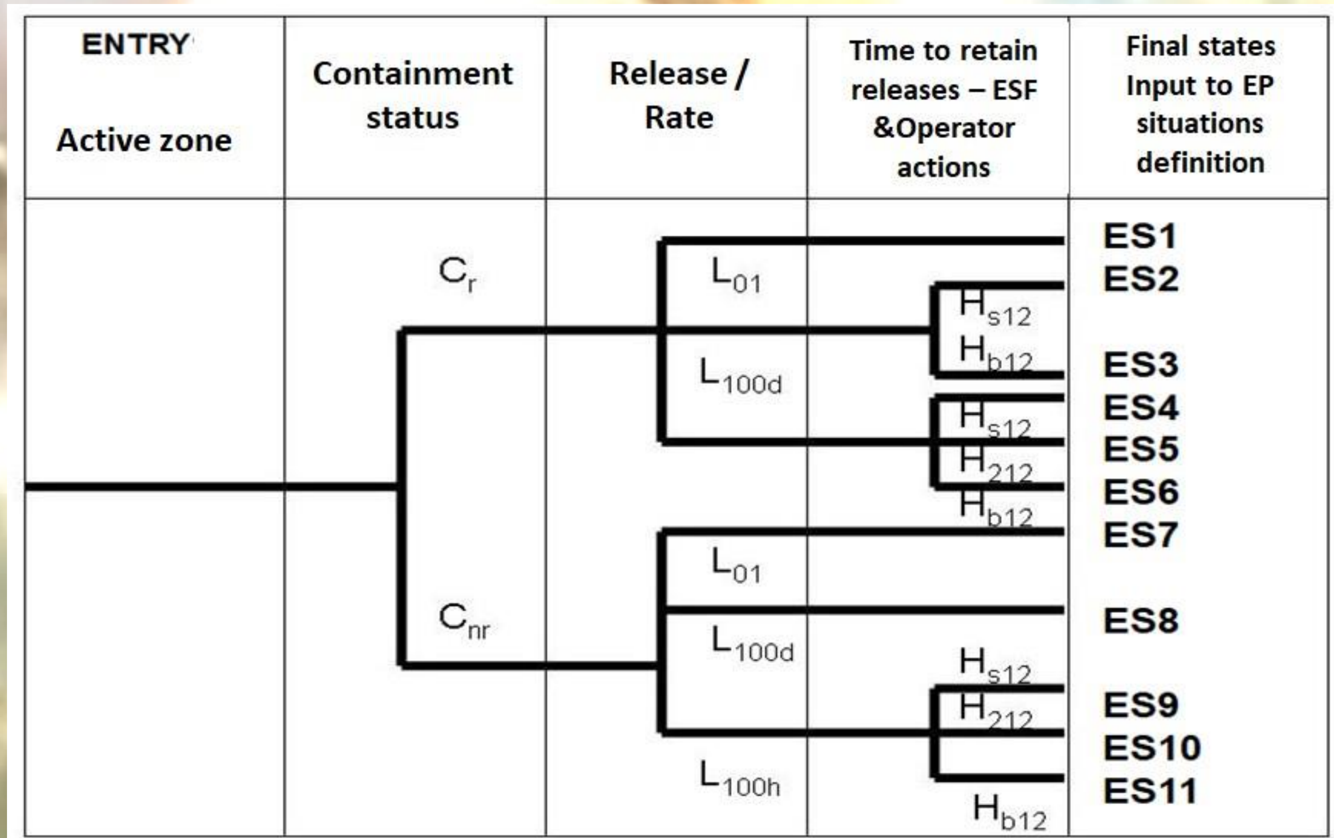
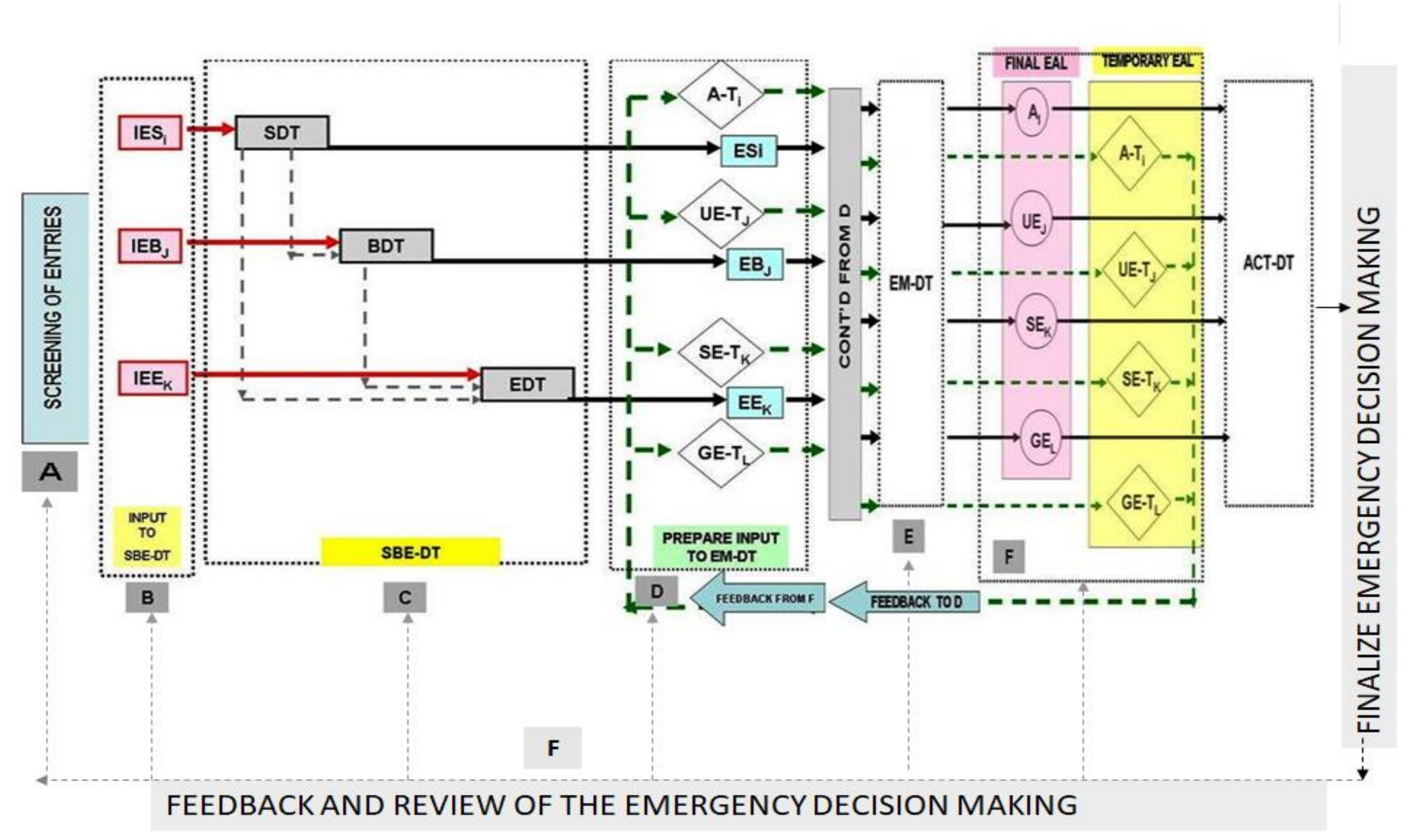


Figure 1 Decision tree as per TECDOC 955

- The d**ecision Tree model is developed in Riskspectrum computer code**
- **The process is desscribed in Figure 2**

The decision Tree model is developed in Riskspectrum computer code



The EAL model in Riskspectrum format and in compliance with DOE-NEI Sample case

Entry description – in coded format

EAL conditions

Other conditions

ALERT ENTRY1							
SCENARIO FOR CORE ALERT CASES	ENTRY		EAL CONDITIONS		OTHER CONDITIONS		
					STATUS OF CONTAINMENT	STATUS OF CORE / RISK LEVEL/METRICS	TIMING OF EMERGENCY PROGRESSION
I	ENTRY_INC_BR	ENTRY_MOD_AVAIL	EAL_CONT_PRES3KPA	EAL_WIND_ALARM	EAL_CONT_INTEGR	EAL_LDM	EAL_TIMING
II	ENTRY_EXC_BR	ENTRY_MOD_AVAIL	EAL_CONT_PRES3KPA	EAL_WIND_ALARM	EAL_CONT_INTEGR	EAL_LDM	EAL_TIMING
III	ENTRY_INC_BR	ENTRY_MOD_AVAIL	EAL_CONT_PRES3KPA	EAL_WIND_ALARM	EAL_CONT_INTEGR	EAL_LDM	AL_NO_TIMIN(
IV	ENTRY_EXC_BR	ENTRY_MOD_AVAIL	EAL_CONT_PRES3KPA	EAL_WIND_ALARM	EAL_CONT_INTEGR	EAL_LDM	AL_NO_TIMIN(

- **The rsults of EAL possible combinations are in a format of various options** (Figure 3) and need support from Riskspectrum and /or similar code to manage the high number possible. A set of screening andranking tools specific to decision type code are use to get a set of ranking final EAL of impact for a h=given emergency situation

Minimal Cutsets

Top Event probability Q = 5.687E-01

No.	Prob.	%	Event							
1	1.25E-01	21.98	EAL_DOSE_VL	ENTRY9_INDIC_CR	ENTRY_EXT_SITE_DOSE					
2	6.25E-02	10.99	EAL_RAD_EQ_AIRLOCK_H	EM_REL_SITE_VL	ENTRY12_INDIC_CR	ENTRY_RAD_EQ_AIRLOCK				
3	6.25E-02	10.99	EAL_RAD_EQ_AIRLOCK_M	EM_REL_SITE_VL	ENTRY12_INDIC_CR	ENTRY_RAD_EQ_AIRLOCK				
4	6.25E-02	10.99	EAL_DOSE_L	EAL_TIME_SH	ENTRY9_INDIC_CR	ENTRY_EXT_SITE_DOSE				
5	6.25E-02	10.99	EAL_RAD_EQ_AIRLOCK_L	EM_REL_SITE_VL	ENTRY12_INDIC_CR	ENTRY_RAD_EQ_AIRLOCK				
6	6.25E-02	10.99	EAL_ENTRY24_IND_CR	EAL_LOSS_COMMUNIC	ENTRY24_INDIC_CR	ENTRY24_LOSS_COMMUNI				
7	6.25E-02	10.99	EAL_ENTRY20_INDIC_CR	EAL_MED_EMERG	ENTRY20_INDIC_CR	ENTRY_MED_EMERG				
8	3.13E-02	5.5	EAL_DIDR_TR_ACCIDENT	EAL_ENTRY21_INDIC_CR	EM_DIDR_TRANSPORT	ENTRY21_INDIC_CR	ENTRY_DIDR_WASTE_TR			
9	3.13E-02	5.5	EAL_ENTRY21_INDIC_CR	EAL_REL_WASTE_DIDR	EM_DIDR_TRANSPORT	ENTRY21_INDIC_CR	ENTRY_DIDR_WASTE_REL			
10	3.13E-02	5.5	EAL_ENTRY21_INDIC_CR	EAL_REL_WASTE_DIDR	EM_DIDR_TRANSPORT	ENTRY21_INDIC_CR	ENTRY_DIDR_WASTE_TR			
11	3.13E-02	5.5	EAL_D2_DEFL_COVERGAS	EAL_ENTRY25_IND_CR	EM_REL_SITE_VL	ENTRY25_INDIC_CR	ENTRY25_TRIT_OFF_SIT			
12	3.13E-02	5.5	EAL_ENTRY25_IND_CR	EAL_TRIT_MOD_REL_CON	EM_REL_SITE_VL	ENTRY25_INDIC_CR	ENTRY25_TRIT_ON_SITE			
13	3.13E-02	5.5	EAL_ENTRY25_IND_CR	EAL_TRIT_MOD_REL_CON	EM_REL_SITE_VL	ENTRY25_INDIC_CR	ENTRY25_TRIT_OFF_SIT			
14	3.13E-02	5.5	EAL_ENTRY25_IND_CR	EAL_TRIT_ON_SITE	EM_REL_SITE_VL	ENTRY25_INDIC_CR	ENTRY25_TRIT_OFF_SIT			
15	3.13E-02	5.5	EAL_DIDR_TR_ACCIDENT	EAL_ENTRY21_INDIC_CR	EM_DIDR_TRANSPORT	ENTRY21_INDIC_CR	ENTRY_DIDR_WASTE_REL			
16	3.13E-02	5.5	EAL_DIDR_TR_ACCIDENT	EAL_ENTRY21_INDIC_CR	EM_DIDR_REL	ENTRY21_INDIC_CR	ENTRY_DIDR_WASTE_REL			
17	3.13E-02	5.5	EAL_DIDR_TR_ACCIDENT	EAL_ENTRY21_INDIC_CR	EM_DIDR_REL	ENTRY21_INDIC_CR	ENTRY_DIDR_WASTE_TR			
18	3.13E-02	5.5	EAL_ENTRY23_IND_CR	EAL_SEC	EM_MED_LIMITED	ENTRY22_23_INDIC_CR	ENTRY22_SEC_EVENT			
19	3.13E-02	5.5	EAL_D2_DEFL_COVERGAS	EAL_ENTRY25_IND_CR	EM_REL_SITE_VL	ENTRY25_INDIC_CR	ENTRY25_TRIT_ON_SITE			
20	3.13E-02	5.5	EAL_CHEM_RELSITE_HI	EAL_ENTRY19_INDIC_CR	EM_CHEM_GAS	ENTRY19_INDIC_CR	ENTRY_CHEM_RELEASE			
21	3.13E-02	5.5	EAL_ENTRY21_INDIC_CR	EAL_REL_WASTE_DIDR	EM_DIDR_REL	ENTRY21_INDIC_CR	ENTRY_DIDR_WASTE_REL			
22	3.13E-02	5.5	EAL_ENTRY21_INDIC_CR	EAL_REL_WASTE_DIDR	EM_DIDR_REL	ENTRY21_INDIC_CR	ENTRY_DIDR_WASTE_TR			
23	3.13E-02	5.5	EAL_ENTRY25_IND_CR	EAL_TRIT_OFF_SITE	EM_REL_SITE_VL	ENTRY25_INDIC_CR	ENTRY25_TRIT_ON_SITE			
24	3.13E-02	5.5	EAL_ENTRY25_IND_CR	EAL_TRIT_OFF_SITE	EM_REL_SITE_VL	ENTRY25_INDIC_CR	ENTRY25_TRIT_OFF_SIT			
25	3.13E-02	5.5	EAL_ENTRY25_IND_CR	EAL_TRIT_ON_SITE	EM_REL_SITE_VL	ENTRY25_INDIC_CR	ENTRY25_TRIT_ON_SITE			
26	1.56E-02	2.75	EAL_EM_ENTRY22_UNC	EAL_ENTRY22_INDIC_CR	EAL_SAFSYS_SEC	ENTRY22_23_INDIC_CR	ENTRY22_SAFSYS_SEC	ENTRY22_SEC_EVENT	NULL_LEVEL0_SEC	
27	7.81E-04	0.14	EAL_CONT_INTEGR	EAL_CONT_PRES3KPA	EAL_ENTRY1_INDIC_CR	EAL_LDM	EAL_TIMING	EAL_WIND_ALARM	EM_CONT_HS&WMUP	ENTRY1_CR
28	7.81E-04	0.14	EAL_CONT_INTEGR	EAL_CONT_PRES3KPA	EAL_ENTRY1_INDIC_CR	EAL_LDM	EAL_NO_TIMING	EAL_WIND_ALARM	EM_CONT_HS&WMUP	ENTRY1_CR
29	7.81E-04	0.14	EAL_CONT_INTEGR	EAL_CONT_PRES3KPA	EAL_ENTRY1_INDIC_CR	EAL_LDM	EAL_TIMING	EAL_WIND_ALARM	EM_CONT_HS&WMUP	ENTRY1_CR
30	7.81E-04	0.14	EAL_CONT_INTEGR	EAL_CONT_PRES3KPA	EAL_ENTRY1_INDIC_CR	EAL_LDM	EAL_NO_TIMING	EAL_WIND_ALARM	EM_CONT_HS&WMUP	ENTRY1_CR

Figure 3 EAL sample combinations for ENTRY 9- releases on site

EAL obtained are grouped and further magnaged as per probabilistic codes methods. A sample of EAL's is in Table 1

ENTRY CONDITIONS	Description of ENTRY conditions
EAL_AL_DOORDR04_OPEN	*Airlock door DR04 open*
EAL_AL_DOORDR06_OPEN	*Airlock door DR06 open*
EAL_BIAS_SUBC_LZERO	*Biased subcooling margin less than 0 degree*
EAL_CD_SCA	*Any core damage higher than 1 and conditions requiring to leave MCR*
EAL_CDS1	*CDS1*
EAL_CDS2	*CDS2*
EAL_CDS3	*CDS3*
EAL_CDS4	*CDS4*
EAL_CDS5	*CDS5*
EAL_CHEM_RELSITE_HI	*Chemical releases on site high*
EAL_CONT_INTEGR	*Containment integer*
EAL_CONT_INTEGR_UNTR	*Apparent containment integrity not possible to be trusted*
EAL_CONT_NOINTEGR	*Containment not integer*
EAL_CONT_PRES3KPA	*Containment pressure higher than 3 kpa(g)*
EAL_CONT_PRESS	*Containment pressure increased*
EAL_CONTR_CONT_PRESR	*Containment pressure rising (potential rapid rise depending on containment suppression capability)*
EAL_CONTR_H2_HSAMPLE	*H2 increase indicated by Severe Accident Sampling and Monitoring System (SASMS)*
EAL_CONTR_IND_MODL_D	*Moderator level indication dropping*
EAL_CONTR_RADFIELD_H	*Increase in radiation fields*
EAL_CONTRIB_CONTHBOX	*Contributing factor cont hi pressure spike and boxed up*
EAL_CONTRIB_CONTPR_H	*Containment pressure elevated*
EAL_CONTRIB_ECCS_INI	*Contributing factor ECCS initiation*
EAL_CONTRIB_H2_HI	*H2 concentration increased*

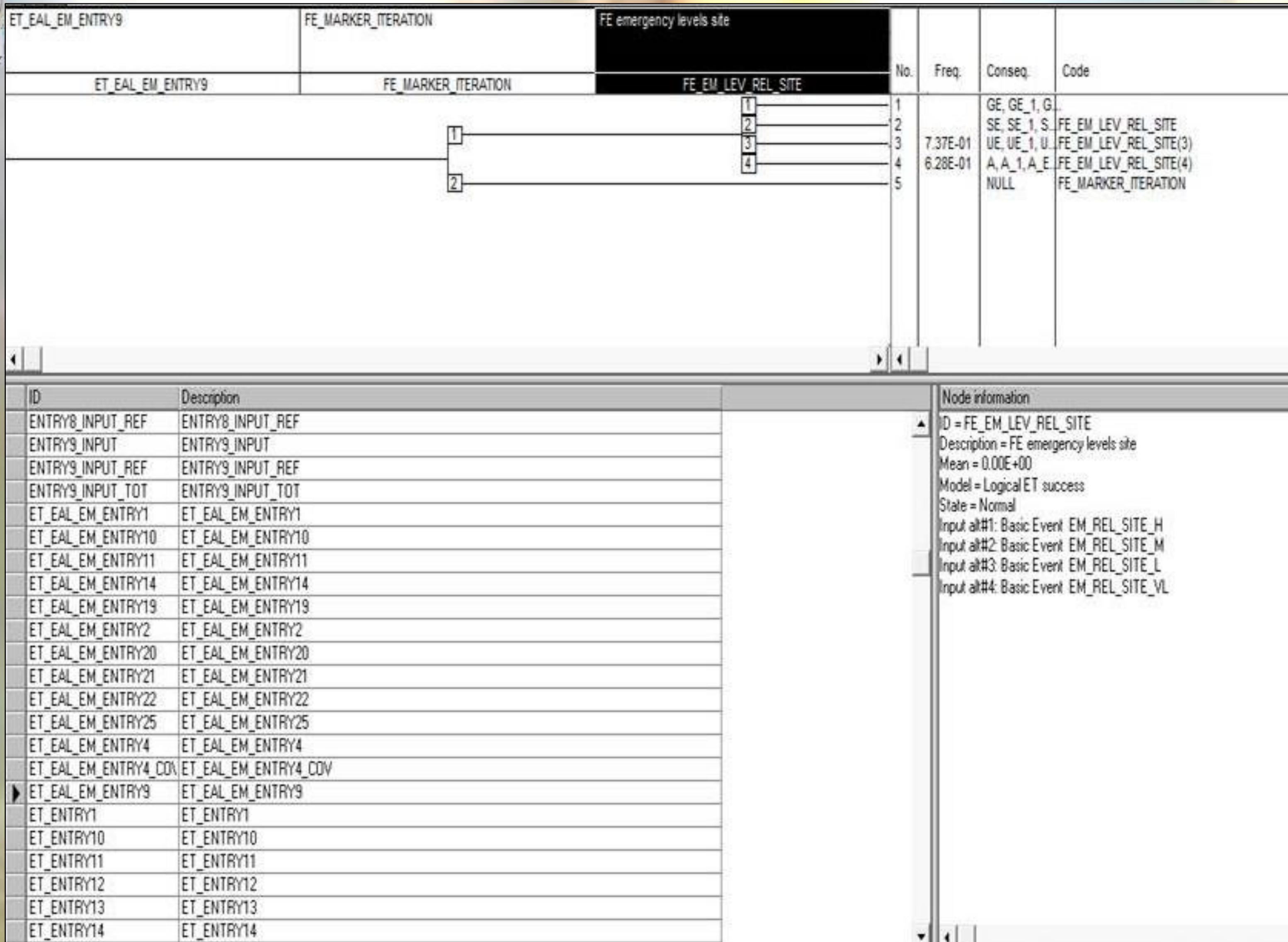
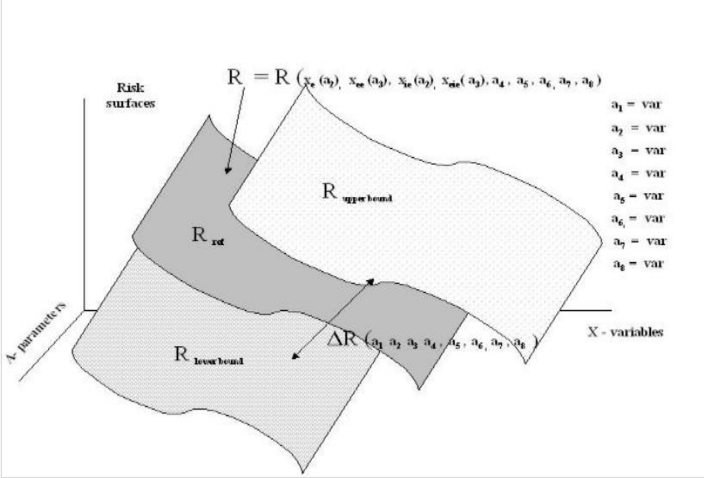


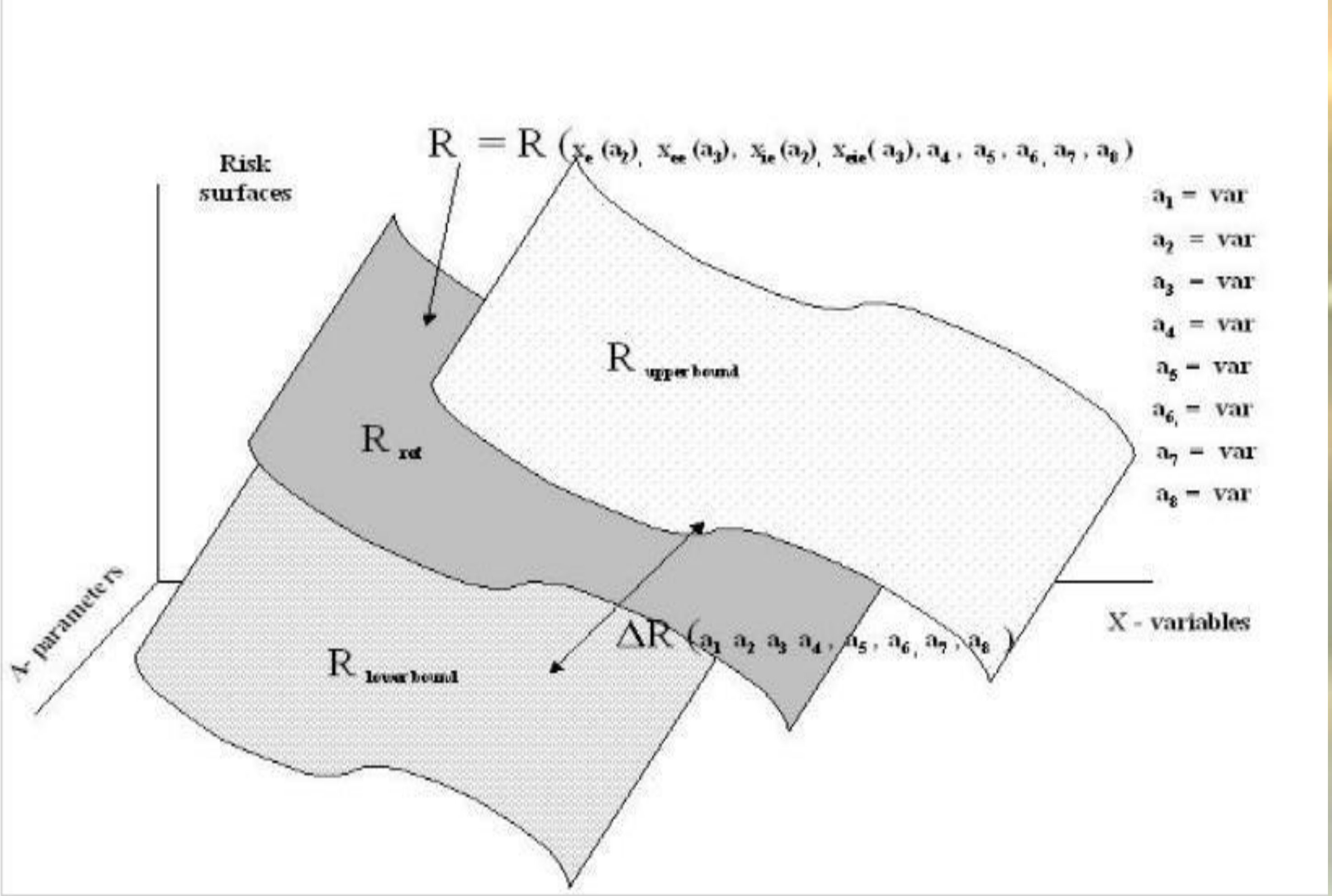
Figure 5 EP states – sample calculations for ENTRY9- releases on site

- **The_tool used by GLERUNR group (Nuclear and Radiological Emergency Risk Assessment Working Group) is able to support decision makers on the less uncertain decisions during an emergency, based on the information existent and on the interfaces of various structural elements of the emergency management**.
- **The method itself needs to be and it is subject to sensitivity analyses.in a format** of benchmark like type for the diverse participants in the project. The sensitivity analyses have some important features, as it is
    - comparing the results and the existing differences in different cases
    - performing systematic risk review of the whole chain in the process of the use of the dose projection tools for the decision making
    - analysis of the sensitivity of the said computer codes, related to the uncertainty of the input parameters.
    - development of a guideline concerning the methodology to be applied
- **For all the elements the sensitivity is performed using parametric approach to sensitivity. The risk as defined and decided as a guiding tool for EP, represented in Figure 16 is evaluated for each parameter and their combinations variations as in table 3. The final results indicate the range of uncertainty in the proposed strategy by GLERUNR to the EP decision makers.**



CASE CODE	Group I of Sensitivity Analyses - EVALUATION OF THE IMPACT OF MAJOR ASSUMPTIONS	PARAMETER 1	PARAMETER 2	3..."J-1"	PARAMETER "J"	"J+1"..."N-1"	PARAMETER "N"
0	Base case model	Dummy values/optimistic & not correlated betweenthem	Dummy values/optimistic & not correlated betweenthem		Dummy values/optimistic & not correlated between them		Dummy values/optimistic & not correlated between them
A1	Sensitivity case variating PARAMETER1 by comparison with BASE CASE	Set all values to those figures, configuringthe HIGHEST impact of the PARAMETER1	Set all values to those figures, configuringthe lowest impact of the PARAMETER2		Set all values to those figures, configuring the lowest impact of the PARAMETER "J"		Set all values to those figures, configuringthe lowest impact of the PARAMETER "N"
A2	Sensitivity case variating PARAMETER2 by comparison with CASE A1	Set all values to those figures, configuringthe HIGHEST impact of the PARAMETER1	Set all values to those figures, configuringthe HIGHEST impact of the PARAMETER2		Set all values to those figures, configuring the lowest impact of the PARAMETER "J"		Set all values to those figures, configuringthe lowest impact of the PARAMETER "N"
..							
AJ	Sensitivity case variating PARAMETER J by comparison with CASE A(J-1)	Set all values to those figures, configuringthe HIGHEST impact of the PARAMETER1	Set all values to those figures, configuringthe HIGHEST impact of the PARAMETER2		Set all values to those figures, configuringthe HIGHEST impact of the PARAMETER "J"		Set all values to those figures, configuringthe lowest impact of the PARAMETER "N"

C. **The sensitivity calculations are performed to evaluate the degree of confidence of the whole methodology.**



CASE CODE	**Group I of Sensitivity Analyses - *EVALUATION OF THE IMPACT OF MAJOR ASSUMPTIONS***	PARAMETER 1	PARAMETER 2	3..."J-1"	PARAMETER "J"	"J+1"..."N-1"	PARAMETER "N"
0	Base case model	Dummy values/optimistic & not correlated between them	Dummy values/optimistic & not correlated between them		Dummy values/optimistic & not correlated between them		Dummy values/optimistic & not correlated between them
A1	Sensitivity case variating PARAMETER 1 by comparison with BASE CASE	Set all values to those figures, configuring the HIGHEST impact of the PARAMETER 1	Set all values to those figures, configuring the lowest impact of the PARAMETER 2		Set all values to those figures, configuring the lowest impact of the PARAMETER "J"		Set all values to those figures, configuring the lowest impact of the PARAMETER "N"
A2	Sensitivity case variating PARAMETER 2 by comparison with CASE A1	Set all values to those figures, configuring the HIGHEST impact of the PARAMETER 1	Set all values to those figures, configuring the HIGHEST impact of the PARAMETER 2		Set all values to those figures, configuring the lowest impact of the PARAMETER "J"		Set all values to those figures, configuring the lowest impact of the PARAMETER "N"
..							
AJ	Sensitivity case variating PARAMETER J by comparison with CASE A(J-1)	Set all values to those figures, configuring the HIGHEST impact of the PARAMETER 1	Set all values to those figures, configuring the HIGHEST impact of the PARAMETER 2		Set all values to those figures, configuring the HIGHEST impact of the PARAMETER "J"		Set all values to those figures, configuring the lowest impact of the PARAMETER "N"

T2
Correlation of the safety analyses and safety documentation in general with the definition of EAL

- **Development of a unitary approach / strategy document to define the emergency situations for a real plant, based on combined deterministic and probabilistic approaches. The approach is based on:**
  - The screening of the events is done using **combined deterministic (as per results from FSR) and probabilistic (as resulted from PSA level 2 and 2+)** for a real case considered. The combination of those events are performed automnatically and managed by computer codes in the format as per Figure 6 and 7.

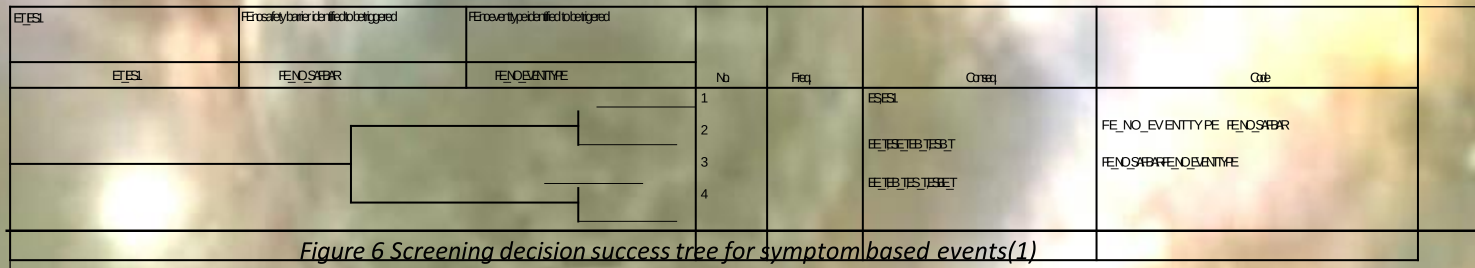


Figure 6 Screening decision success tree for symptom based events(1)

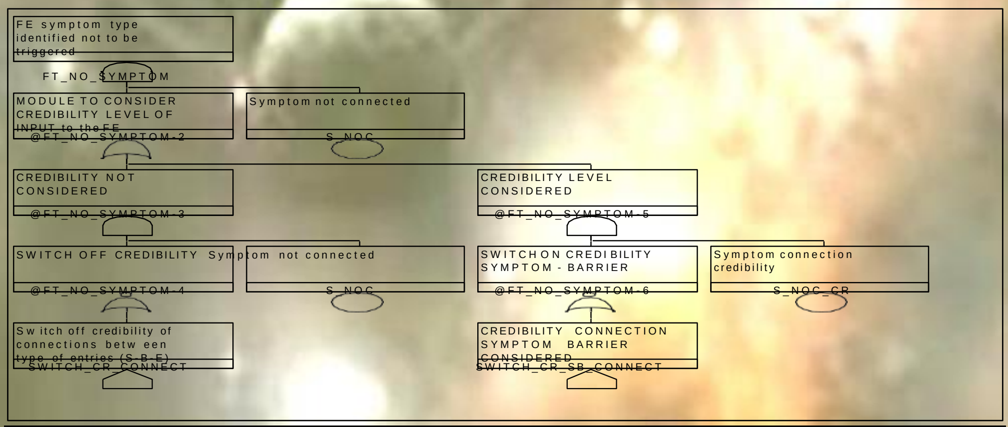
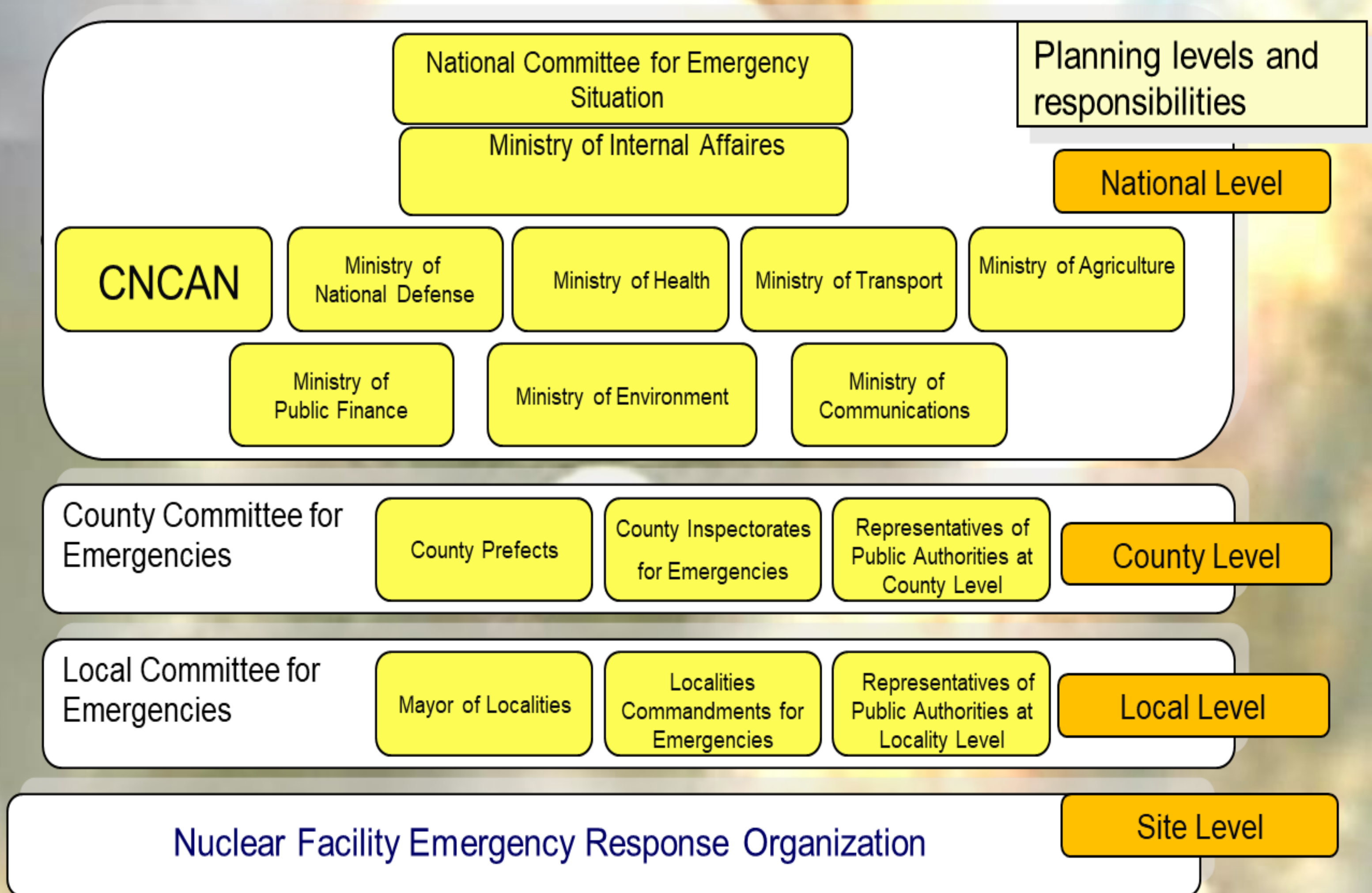


Figure 5 Screening decision fault tree for symptom based events (2)

EMS


Planning levels and responsibilities
National Committee for Emergency Situation
Ministry of Internal Affaires
National Level
CNCAN
Ministry of National Defense
Ministry of Health
Ministry of Transport
Ministry of Agriculture
Ministry of Public Finance
Ministry of Environment
Ministry of Communications
County Committee for Emergencies
County Prefects
County Inspectorates for Emergencies
Representatives of Public Authorities at County Level
County Level
Local Committee for Emergencies
Mayor of Localities
Localities Commandments for Emergencies
Representatives of Public Authorities at Locality Level
Local Level
Nuclear Facility Emergency Response Organization
Site Level

- o The screening includes **in unitary approach all types of challenges (on safety, chemical, physical protection, medical), being guided by DOE-NEI approach and decision trees as per TECDOC 955**

- **The model is developed as a Decision Tree using Riskspectrum logic to cope with a high number of combinations using selective criteria.**

T4

Development of an integrated risk evaluation tool of the whole decision making process in an emergency situation – Risk evaluation tool using decision trees developed by GLERUNR and tested for one real case

For a selected case of the EP management system (Figure …) The interfaces are defined to evaluate their impact on the evaluation and perception of risk (Figure…)

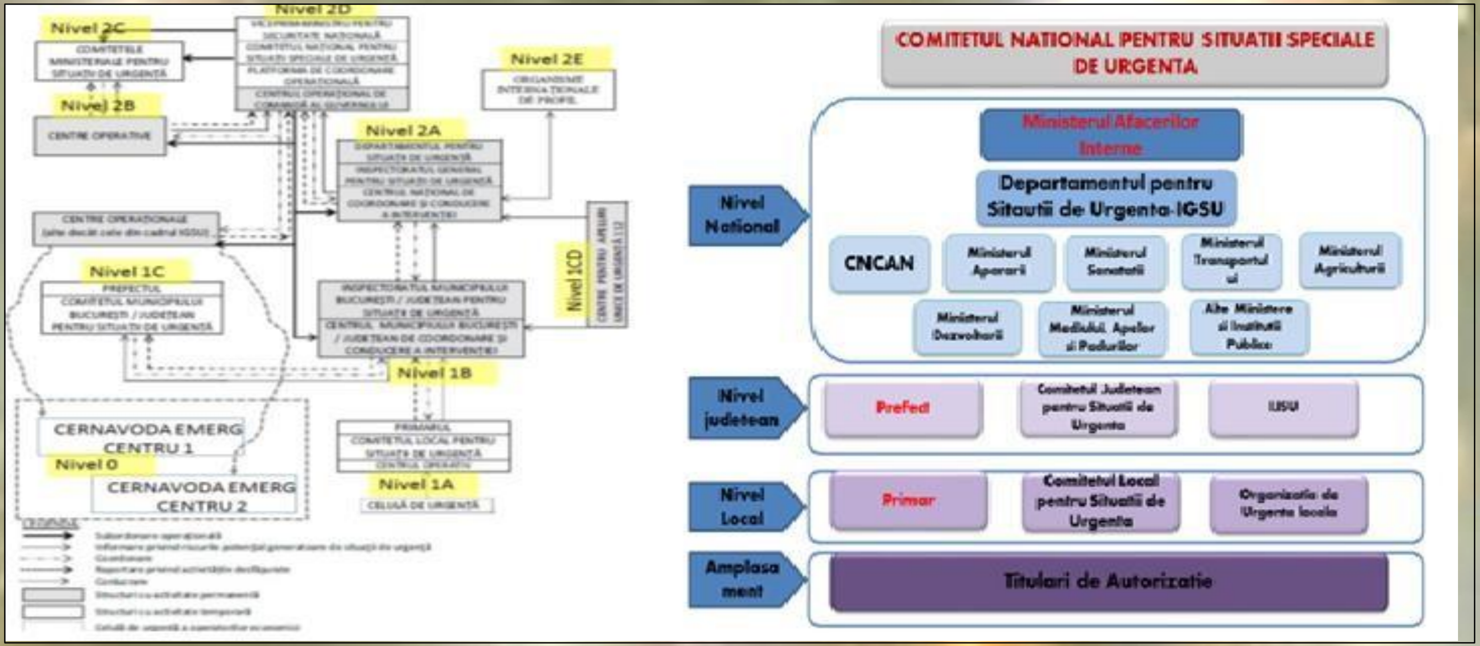
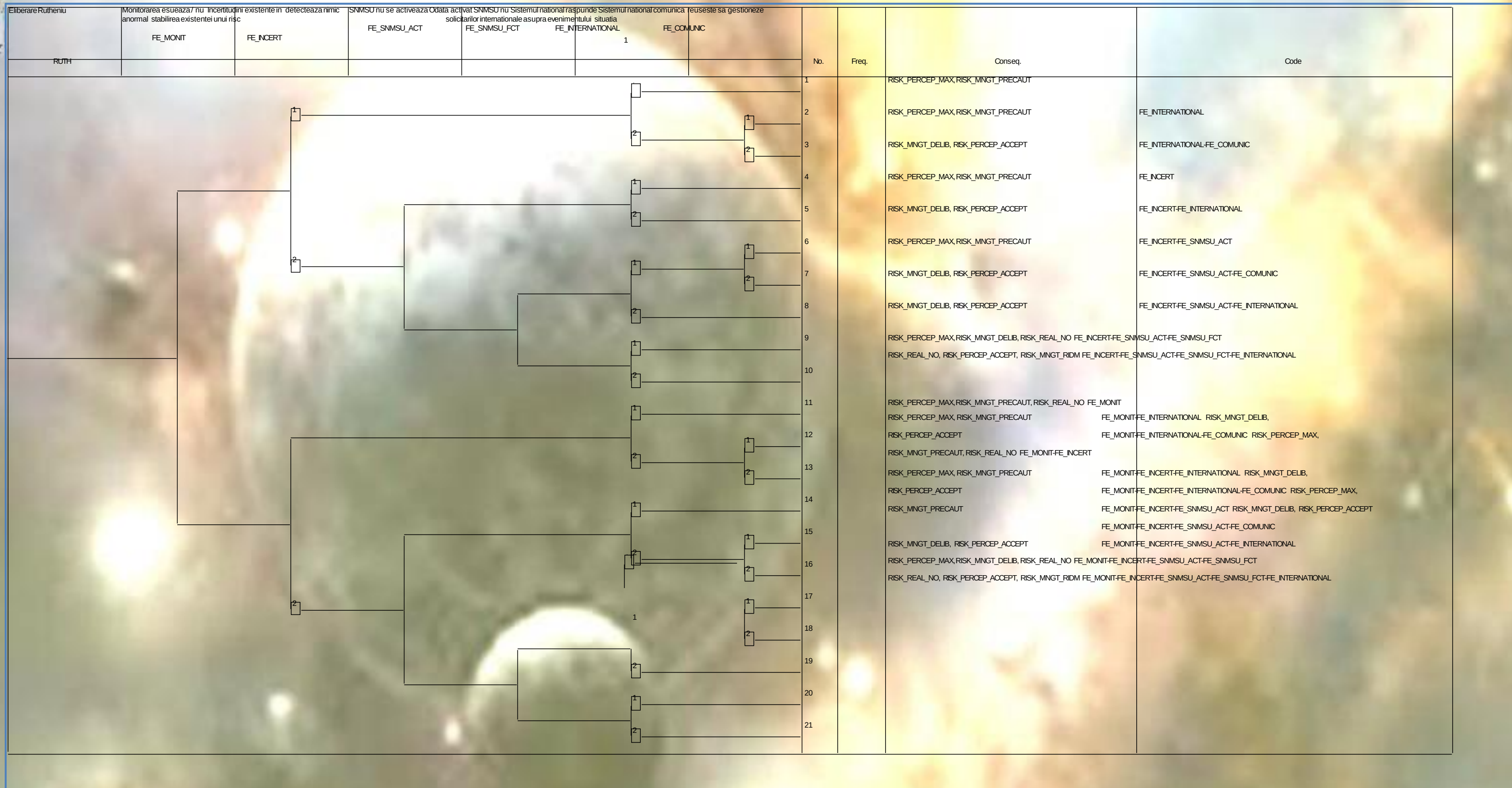


Figure … Structure of EP management – Sample case



The results of using such approach indicate on the impact of the dominant components of the risk definition process and decisions on risk , as illustrated in table bellow. These results are used as advises to the decision makers.

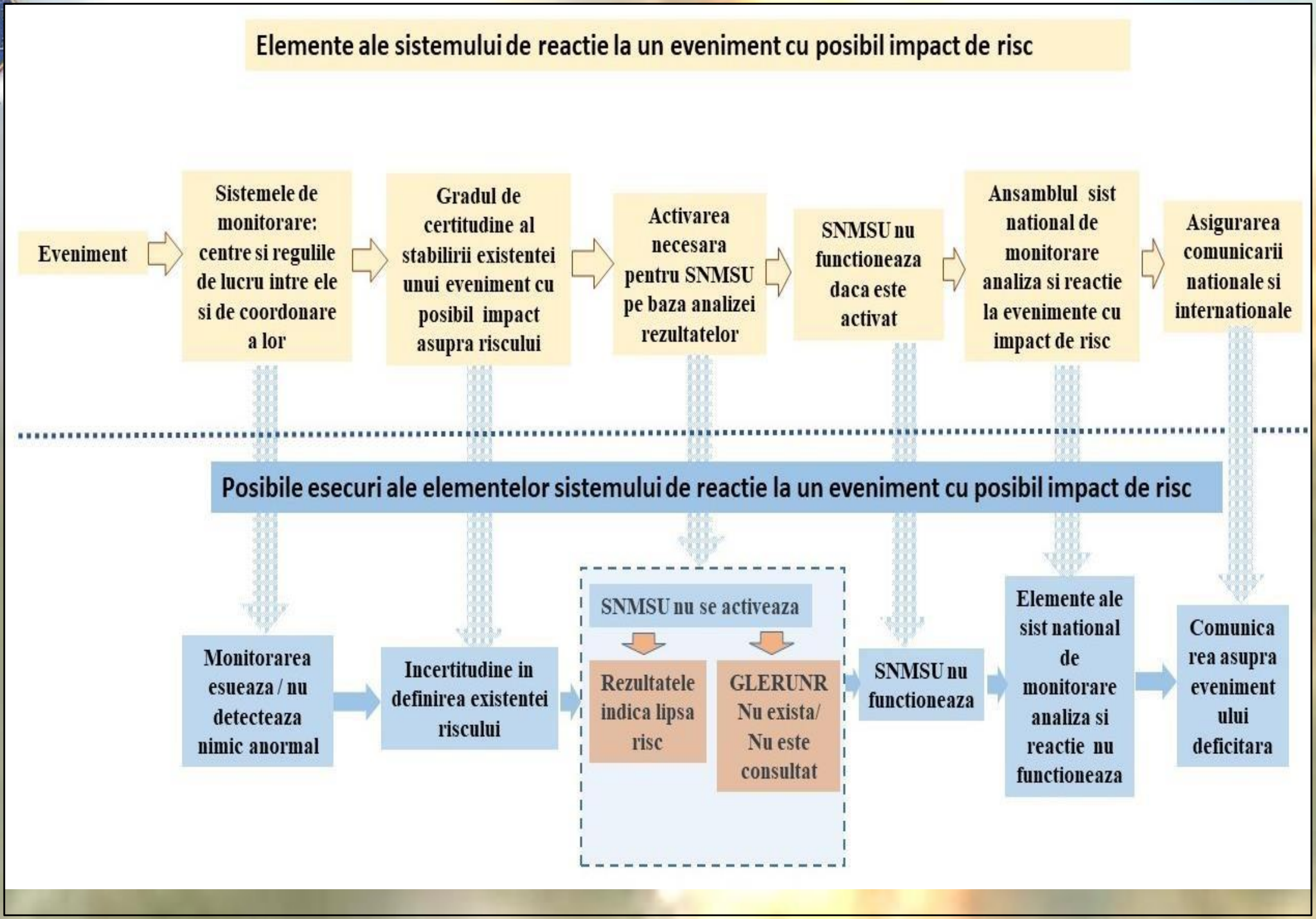
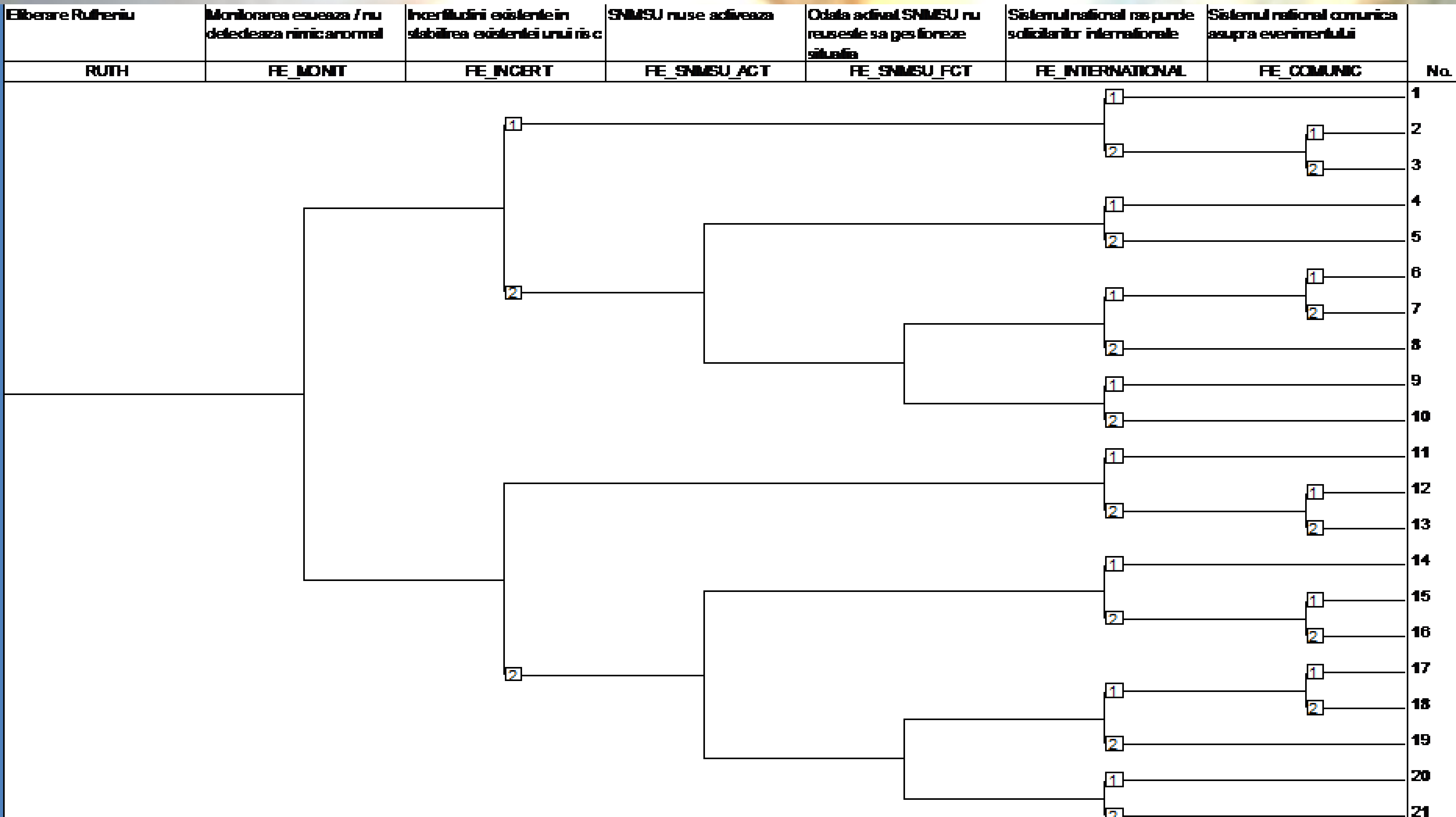


Figure … Interface between various elements of the EP management and risk evaluation/perception


Eliberare Rutheniu
Monitorarea esueaza / nu detecteaza nimic anormal
Incertitudini existente in stabilirea existentei unui risc
SNMSU nu se activeaza
Odata activat SNMSU nu reuseste sa gestioneze situatia
Sistemul national raspunde solicitarilor internationale
Sistemul national comunica asupra evenimentului
RUTH
FE_MONIT
FE_INCERT
FE_SNMSU_ACT
FE_SNMSU_FCT
FE_INTERNATIONAL
FE_COMUNIC
No.
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21

No	Conseq.	Code
1	RISK_PERCEP_MAX, RISK_MNGT_PRECAUT	
2	RISK_PERCEP_MAX, RISK_MNGT_PRECAUT	FE_INTERNATIONAL
3	RISK_MNGT_DELIB, RISK_PERCEP_ACCEPT	FE_INTERNATIONAL-FE_COMUNIC
4	RISK_PERCEP_MAX, RISK_MNGT_PRECAUT	FE_INCERT
5	RISK_MNGT_DELIB, RISK_PERCEP_ACCEPT	FE_INCERT-FE_INTERNATIONAL
6	RISK_PERCEP_MAX, RISK_MNGT_PRECAUT	FE_INCERT-FE_SNMSU_ACT
7	RISK_MNGT_DELIB, RISK_PERCEP_ACCEPT	FE_INCERT-FE_SNMSU_ACT-FE_COMUNIC
8	RISK_MNGT_DELIB, RISK_PERCEP_ACCEPT	FE_INCERT-FE_SNMSU_ACT-FE_INTERNATIONAL
9	RISK_PERCEP_MAX, RISK_MNGT_DELIB, RISK_REAL_NO	FE_INCERT-FE_SNMSU_ACT-FE_SNMSU_FCT
10	RISK_REAL_NO,RISK_PERCEP_ACCEPT, RISK_MNGT_RID	FE_INCERT-FE_SNMSU_ACT-FE_SNMSU_FCT-FE_INTERNATIONAL
11	RISK_PERCEP_MAX, RISK_MNGT_PRECAUT, RISK_REAL_N	FE_MONIT
12	RISK_PERCEP_MAX, RISK_MNGT_PRECAUT	FE_MONIT-FE_INTERNATIONAL
13	RISK_MNGT_DELIB, RISK_PERCEP_ACCEPT	FE_MONIT-FE_INTERNATIONAL-FE_COMUNIC
14	RISK_PERCEP_MAX, RISK_MNGT_PRECAUT, RISK_REAL_N	FE_MONIT-FE_INCERT
15	RISK_PERCEP_MAX, RISK_MNGT_PRECAUT	FE_MONIT-FE_INCERT-FE_INTERNATIONAL
16	RISK_MNGT_DELIB, RISK_PERCEP_ACCEPT	FE_MONIT-FE_INCERT-FE_INTERNATIONAL-FE_COMUNIC
17	RISK_PERCEP_MAX, RISK_MNGT_PRECAUT	FE_MONIT-FE_INCERT-FE_SNMSU_ACT
18	RISK_MNGT_DELIB, RISK_PERCEP_ACCEPT	FE_MONIT-FE_INCERT-FE_SNMSU_ACT-FE_COMUNIC
19	RISK_MNGT_DELIB, RISK_PERCEP_ACCEPT	FE_MONIT-FE_INCERT-FE_SNMSU_ACT-FE_INTERNATIONAL
20	RISK_PERCEP_MAX, RISK_MNGT_DELIB, RISK_REAL_NO	FE_MONIT-FE_INCERT-FE_SNMSU_ACT-FE_SNMSU_FCT
21	RISK_REAL_NO,RISK_PERCEP_ACCEPT, RISK_MNGT_RID	FE_MONIT-FE_INCERT-FE_SNMSU_ACT-FE_SNMSU_FCT-FE_INTERNATIO

In the process of identification and definition on risk and later while taking decisions based on those results, a decision process was modeled. Some of the features of this model for the decision on risk are as follows:

- Three types of risk evaluation were considered:
  - Precautionary
  - Deliberative
  - Risk Informed Decision Making (RIDM)
- For any risk evaluation approach risk was considered as being
  - Perceived risk
  - Real risk
- Three types of main scenarious as an outcome of the risk definition process were considered:

A Decision on risk precautionary, perception of risk maximum B Decision on risk deliberated perception of risk acceptable
C Decision on risk RIDM perception of risk acceptable

Each structure of the risk evaluation and decisions on risk presented in figures above were considered as possible decision points on the validity of the decisions. The possible uncertainties for some structure elements were considered, too. As a result the decision process resulted as a decision tree as described in Figure…

Components and their impact on the decision rules (N= no impact; H=high; M=medium; MH= Medium to high; L=Low; VL=very low; A,B,C = Categories as per sequences)	Precautionary principle PREC	Deliberative Principle DELIB	Risk Informed Decision Making RIDM	Aggregate conclusion AGGREG
Comunication	H	H	N	MH
Structures interface	H	H	H	H
Monitoring	L	L	N	L
Monitoring Coordonation	L	VL	N	L
Results	N	M	M	M
Analysis (independent) available	N	MH	MH	MH
Dominant sequences	A	B	C	ABC

C. The sensitivity calculations are performed to evaluate the degree of confidence of the whole methodology.

- **Therefore the** tool used by G**LERUNR group (Nuclear and Radiological Emergency Risk Assessment Working Group) is able to support decision makers on the less uncertain decisions during an emergency, based on the information existent and on the interfaces of various structura;l elements of the emergency management.**
- **However, the method itself needs to be and it is subject to sensitivity analyses.in a format of benchmark like type** for the diverse participants in the project. The sensitivity analyses have some important features, as it is

    a. comparing the results and the existing differences in different cases

    b. performing systematic risk review of the whole chain in the process of the use of the dose projection tools for the decision making

    c. analysis of the sensitivity of the said computer codes, related to the uncertainty of the input parameters.

    d. development of a guideline concerning the methodology to be applied

- **For all the elements the sensitivity is performed using parametric approach to sensitivity. The risk as defined and decided as a guiding tool for EP (represented in Figure ….) is evaluated for each parameter and their combinations variations as in table 1. The final results indicate the range of uncertainty in the proposed strategy by GLERUNR to the EP decision makers.**

F . CALIBRATE METHODOLOGY WITH A KNOWN CASE WITH RESULTS IN AN ALTERNATIVE APPROACH

For Methodology as implemented in Strategy for EP CNPP ref link

F . CALIBRATE METHODOLOGY WITH A KNOWN CASE WITH RESULTS IN AN ALTERNATIVE APPROACH

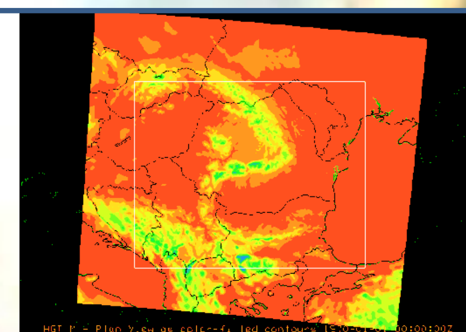
Cases for RODOS in CRP project

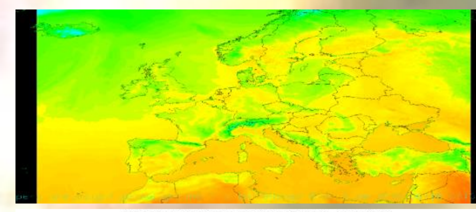
Calibration cases are defined as

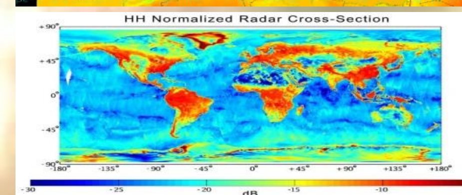
Scenario: LOCA and core damages of various degrees of magnitude defined as per EAL correlated with the PSA level 2 and SAMG in a situation comparable with a real case plant.

The study was accomplished using the following input data:
Unit: CERNAVODA-1,
Source term: PSA level 2
Start of release: dd.mm.202y, hh:mm [UTC], End of release: dd.mm.202y hh+1:mm [UTC]
Calculation Nuclides Kr- 85m Kr- 85 Kr- 88 Rb- 88 Sr- 89 Sr- 90 Y - 90 Zr- 95 Ru-103 Ru-106 Rh-106 Te-131m Te-132 I -131 I -132 I -133 I -135 Xe-133 Xe-135 Cs-134 Cs-136 Cs-137 Ba-137m Ba-140 La-140 Pu-238 Pu-241 Cm-242 Cm-244
Weather: NWP data from WRF-3k integrated in COSMO-7 km model 00:00 [UTC] provided by NMA, Romania
Weather: NWP data from ICON model 00:00 [UTC] provided by (DWD), Germany
The RODOS running were performed during 2020 -June, July, August, September, October, November and December and 2021- January and February

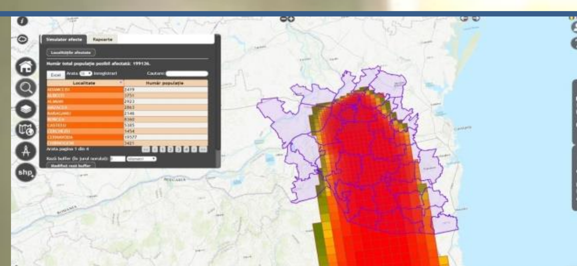
RODOS installed on CNCAN server:
On CNCAN server the jRODOS 2019 version is operational and is configured to use the same database from the old version. The system is available for other stakeholders based on user and password via VPN tunel. Beside CNCAN staff other organization like Cernavoda NPP, General Inspectorate for Emergency Situation, National Meteorological Administration, National Environmental Protection Agency.





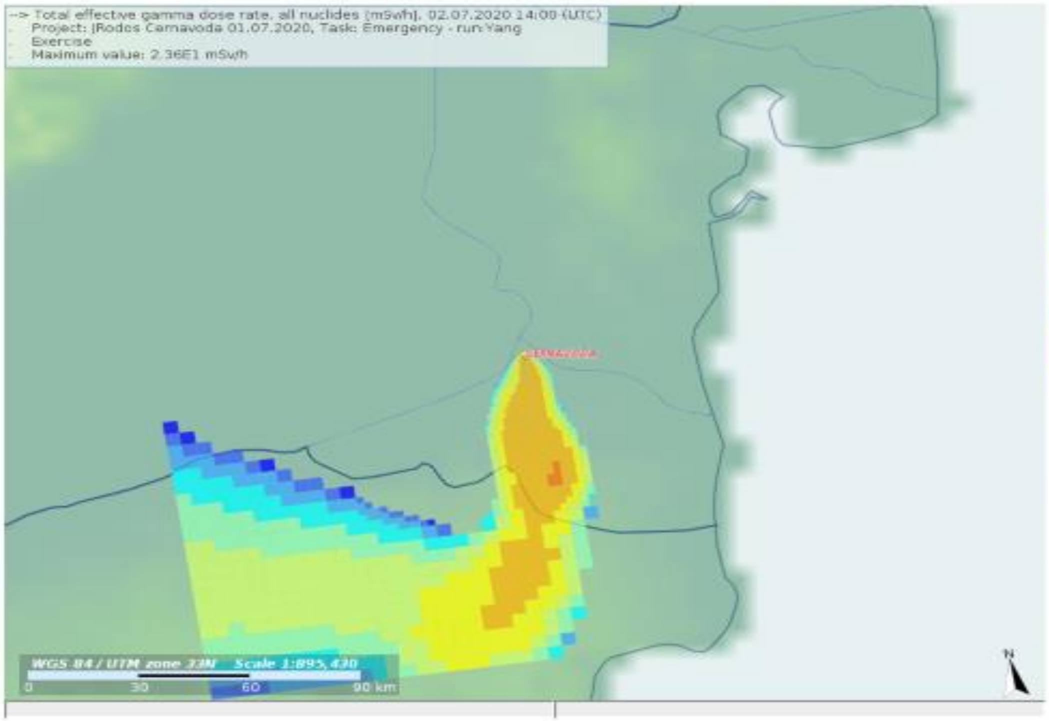


- **numerical whether prediction data provided by Deutscher Wetterdienst (DWD), Germany**
- **numerical whether prediction data provided by National Centers for Environmental Prediction (NCEP) – NOAA**
- **meteorological parameters from Cernavoda NPP tower**



GIS for Rodos

EP



EXERCISE

Total effective gamma dose rate, all nuclides [mSv/h], 02.07.2020 14:00 (UTC)

mSv/h

- >1E1
- 1E0 - 1E1
- 1E-1 - 1E0
- 1E-2 - 1E-1
- 1E-3 - 1E-2
- 1E-4 - 1E-3
- 1E-5 - 1E-4
- 1E-6 - 1E-5
- 1E-7 - 1E-6
- 1E-8 - 1E-7

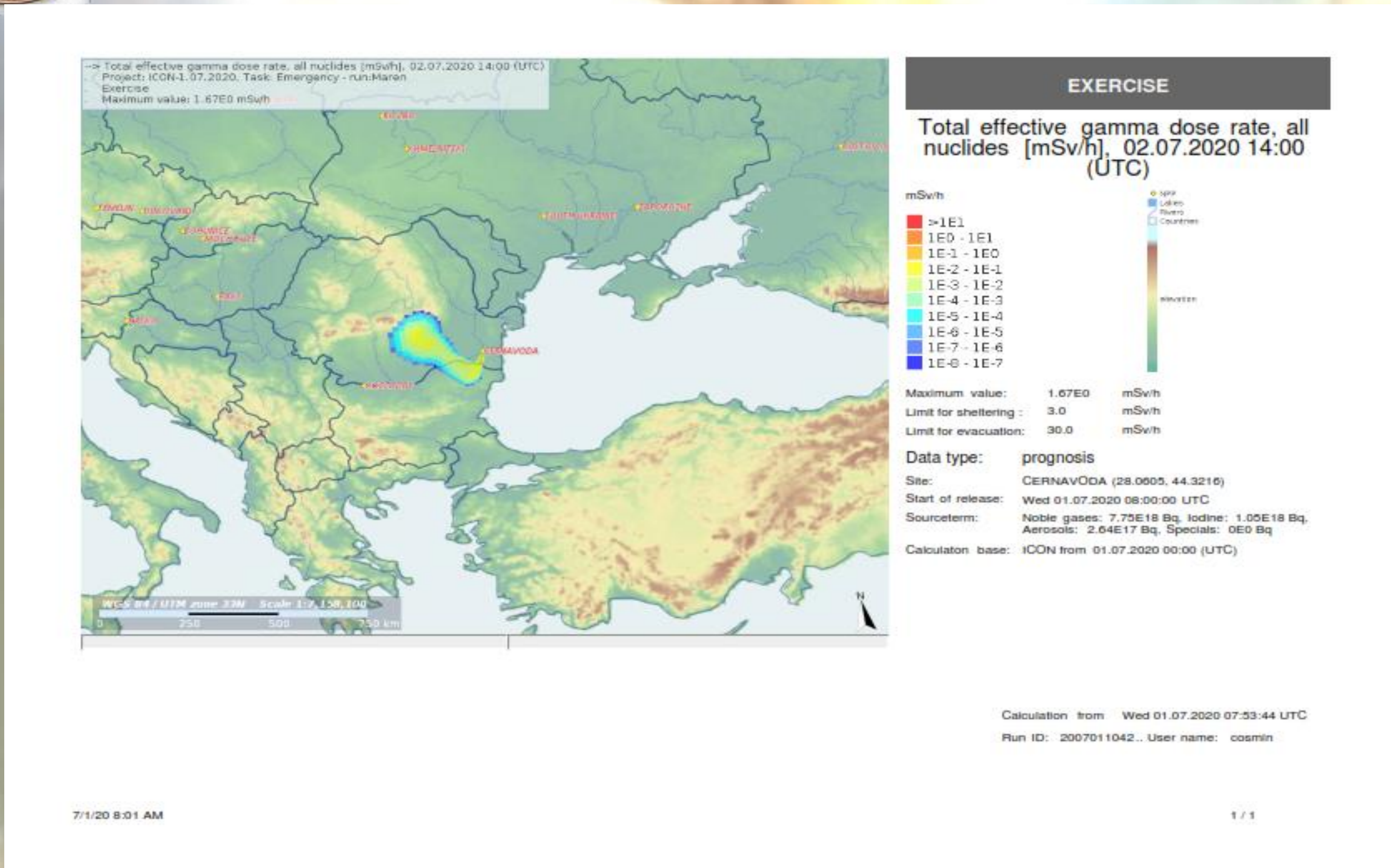
Maximum value:	2.36E1	mSv/h
Limit for sheltering :	3.0	mSv/h
Limit for evacuation:	30.0	mSv/h

Data type:	prognosis
Site:	CERNAVODA (28.0605, 44.3216)
Start of release:	Wed 01.07.2020 08:00:00 UTC
Sourceterm:	Noble gases: 7.75E18 Bq, Iodine: 1.05E18 Bq, Aerosols: 2.64E17 Bq, Specials: 0E0 Bq
Calculaton base:	anm from 01.07.2020 00:00 (UTC)

Calculation from Wed 01.07.2020 09:00:58 UTC
Run ID: 2007010847.. User name: cosmin

7/1/20 9:05 AM 1 / 1

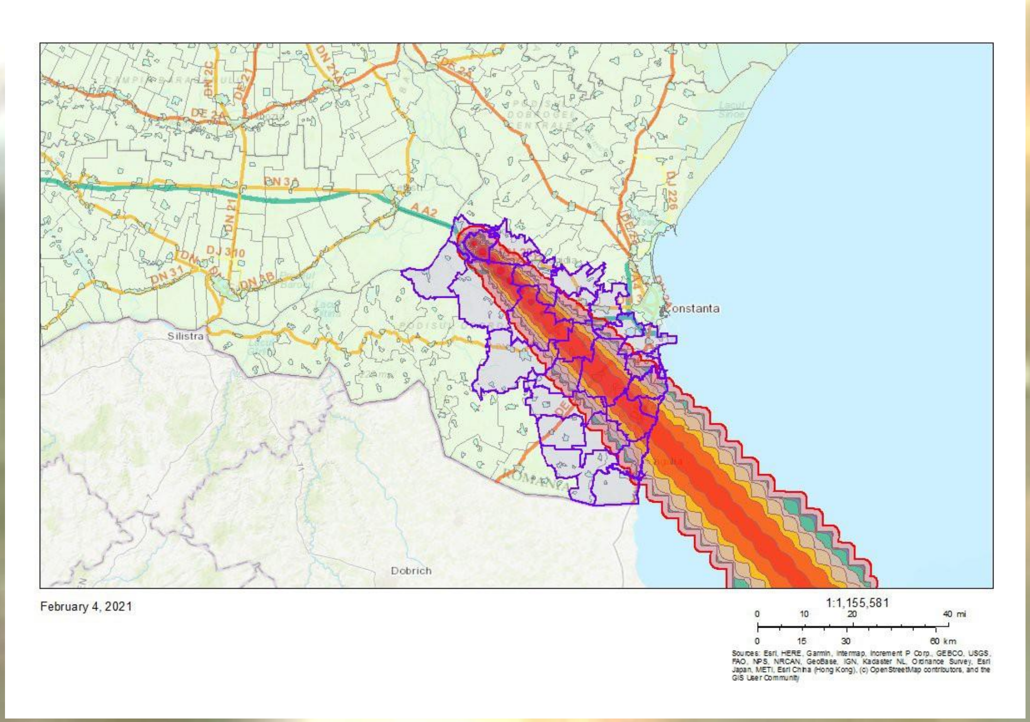
RODOS Automatic report using NWP-WRF model



RODOS Automatic report using NWP-ICON model

Example of Information Report for decision makers

Information Report
– GLERURN-



1. General information

Atmospheric dispersion map

Legend

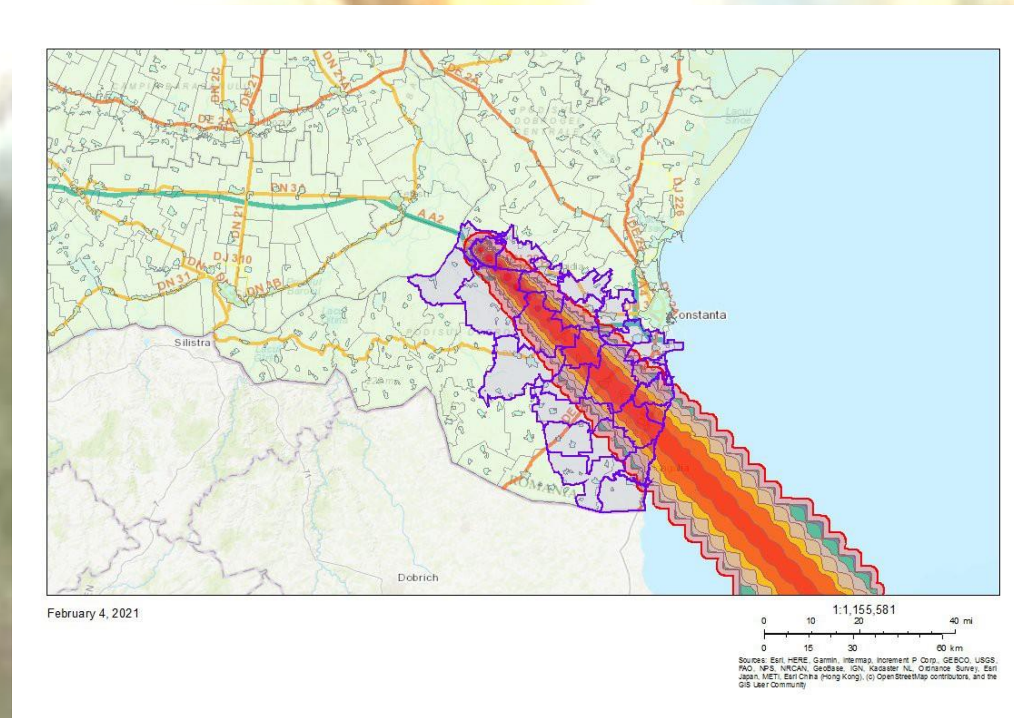
Localitaty

Roads
highway European road national road count road values in micro sievert

0.000000 0.000001 0.000002 - 0.000010 0.000011 - 0.000100
0.000101 - 0.001000 0.001001 - 0.010000 0.010001 - 0.100000 0.100001 - 1.000000
1.000001 - 10.000000 10.000001 - 999900.000000

Example of Information Report for decision makers

Information Report
– GLERURN-



1. General information

Atmospheric dispersion map

Legend

Localitaty

Roads
highway European road national road count road values in micro sievert

0.000000
0.000001
0.000002 - 0.000010
0.000011 - 0.000100
0.000101 - 0.001000
0.001001 - 0.010000
0.010001 - 0.100000
0.100001 - 1.000000
1.000001 - 10.000000
10.000001 - 999900.000000

F. CASE STUDY SMR


Raul Ialomita
Strada Constantin Brâncoveanu
904
71
C3 Cet Doicesti
Strada Armoniei
SNN
Task 3 Report
C3 Cet Doicesti
Site Map
SNN Site
CITON Site
Site Boundary
N
0
0.2
0.3
Km
Sargent & Lundy
Title: Site Map
Report No.: SL-016574
Site: C3 Cet Doicesti
Prepared: S. McEwen-Barbas
County: Dâmbovița
Reviewed: J. Crumlish
Appendix: A
Date: 2/8/2022
Sheet: 10 of 30
Revision: 0

GENERIC INFORMATION AS INPUT IN ACCORDANCE WITH NUSCALE AVAILABLE DATA

3	IALOMITA RIVER	Nearest river	45°0'9.18"N 25°23'31.81"E	0.17	0.47
4	MAGISTRALA CFR 904	Nearest railroad	45°0'2.69"N 25°24'3.21"E	0.01	0.27
5	HENRI COANDA INTERNATIONAL AIRPORT	Nearest public-use airport or airfield	44°34'16.15"N 26° 4'37.40"E	Approximately 72	Approximately 72
6	SCHOOL NO.3 DOICESTI	Sensitive receptors (school)	44°59'42.05"N 25°24'1.62"E	0.16	0.81
7	KINDERGARTEN NO.2 DOICESTI	Sensitive receptors (kindergarten)	44°59'24.03"N 25°24'13.76"E	0.78	1.42
8	VULCANA PANDELE SECONDARY SCHOOL	Sensitive receptors (school)	45°1'3.21"N 25°23'52.29"E	0.95	1.70
9	STADIUM DOICESTI	Sensitive receptors	44°59'37.30"N 25°23'57.80"E	0.29	0.92
10	CHURCH OF THE NATIVITY OF THE MOTHER OF GOD DOICESTI	Sensitive receptors (church)	44°59'35.19"N 25°23'35.06"E	0.58	1.08
11	CHURCH OF THE HOLY ARCHANGELS MICHAEL AND GABRIEL DOICESTI	Sensitive receptors (church)	44°59'37.42"N 25°23'45.09"E	0.38	0.95
12	PUCIOASA CITY HOSPITAL	Facilities with special emergency evacuations needs	45° 4'30.61"N 25°26'6.05"E	7.76	8.61
13	SC FERRO PIGMENTS ROMÂNIA SRL DOICEȘTI	Hazardous land-use facilities	44°59'8.72"N 25°24'54.94"E	1.70	2.27
14	TEIS	Oil or gas	44°57'4.22"N	5.23	5.87

			25°25'3.92"E		
15	ASH STORAGE	Nearest potential soil contamination	44°58'15.34"N 25°22'44.29"E	3.23	3.79
16	DOICESTI POLICE STATION	Nearest offices of the local police	44°59'44.91"N 25°23'51.20"E	0.12	0.70
17	DAMBOVITA COUNTY AMBULANCE SERVICE	Nearest emergency responder (ambulance)	44°55'17.08"N 25°27'3.01"E	Approximately 9	Approximately 9
30	BASARAB I EMERGENCY SITUATIONS INSPECTORATE	Nearest emergency responder (fire)	44°54'40.03"N 25°27'1.06"E	Approximately 10	Approximately 10
31	TÂRGOVIȘTE COUNTY EMERGENCY HOSPITAL	Nearest large trauma-center hospital	44°55'21.80"N 25°27'0.50"E	Approximately 9	Approximately 9

Summary of findings

a) Sensitive receptors, such as parks, churches, schools or similar locations within 1 km of site:

- SCHOOL NO.3 DOICESTI;
- KINDERGARTEN NO.2 DOICESTI;
- VULCANA PANDELE SECONDARY SCHOOL;
- STADIUM DOICESTI;
- CHURCH OF THE NATIVITY OF THE MOTHER OF GOD DOICESTI;
- CHURCH OF THE HOLY ARCHANGELS MICHAEL AND GABRIEL DOICESTI.

b) Estimated / approximate number of houses and homes within 1 km of the site boundary:

- Doicesti ~ 1600 houses;
- Sotânga ~ 600 houses;

- Vulcana - Pandele ~ 1600 houses.

c) All hospitals, clinics, prisons or other facilities with special emergency evacuations needs within 8 km of site:

- PUCIOASA CITY HOSPITAL.

d) Hazardous land-uses, such as chemical plants or other industrial facilities that use bulk hazards chemicals, or similar hazardous facilities, within 5 km of site:

- SC FERRO PIGMENTS ROMÂNIA SRL DOICEŞTI.

e) Known or visible oil or gas extraction activities within 10 km of site:

- TEIŞ.

f) Facilities or sites with known, suspected or potential soil and groundwater contamination within 8 km of the site:

- ASH STORAGE.

g) Nearest emergency responders, including ambulance and fire:

- DOICEŞTI POLICE STATION;
- BASARAB I EMERGENCY SITUATIONS INSPECTORATE;
- DAMBOVITA COUNTY AMBULANCE SERVICE.

h) Nearest large trauma-center hospital that can handle industrial injuries and contaminated individuals:

- TÂRGOVIŞTE COUNTY EMERGENCY HOSPITAL .

No information on the capacity of this hospital to treat contaminated patients.

IE EVENTS FOR ENTRY EVALUATION TO INPUT TO EP CATEGORIES CALCULATIONS

data are orientative for calculation purposes

No.	System	MUPSA affected
1	RWB heating, ventilation, and air conditioning (HVAC) system	12
2	Diesel generator building HVAC system	12
3	**Turbine building HVAC system**	6
4	Annex building HVAC system	12
5	Containment flooding and drain system	12 (6 each for two independent subsystems)
6	Normal control room HVAC system	12
7	RXB HVAC system	12
8	Control room habitability system	12
9	Boron addition system	12
10	Reactor component cooling water system	12 (6 each for two independent subsystems)
11	Circulating water system	12 (6 each for two independent subsystems)
12	Site cooling water system	12
13	Demineralized water system	12
14	Auxiliary boiler system	12
15	Potable water systems	12
16	Ultimate Heat Sink	12
17	13.8 KV and switchyard system, medium voltage AC electrical distribution system (EMVS), low voltage AC electrical distribution system (ELVS)	12
18	Highly reliable DC power system (EDSS) common (EDSS-C)	12
19	Normal DC power system (EDNS)	12
20	Safety display and indication system (SDIS)	12
21	Plant Protection System (PPS)	12
22	Plant Control System (PCS)	12
23	Utility water system	12

	IE for EP ENTRY INITIAL LIST As per NUSCALE 50 information
2	Potential Dam Failures
3	Cooling Water Canals and Reservoirs
4	Low Water events
5	Ground Water
6	Accidental Releases of Radioactive Liquid Effluents in Ground and Surface Waters
7	Operator actions in emergency
8	Vibratory Ground Motion
9	Stability of Subsurface Materials and Foundations

CODE	IE
IES1	External Flooding
IES2	Water leak outside containment
IES3	Water leak into ground
IES4	Loss of one module control
IES5	Release into atmosphere
IES6	Operator errors
IES7	Seismic event
IES8	Crane related events
IES9	Hydrogen explosion at one module
	MUPSA IE
IEM1	RWB heating, ventilation, and air conditioning (HVAC) system
IEM2	Diesel generator building HVAC system
IEM3	**Turbine building HVAC system**
IEM4	Annex building HVAC system
IEM5	Containment flooding and drain system
IEM6	Normal control room HVAC system
IEM7	RXB HVAC system
IEM8	Control room habitability system
IEM9	Boron addition system
IEM10	Reactor component cooling water system
IEM11	Circulating water system
IEM12	Site cooling water system
IEM13	Demineralized water system
IEM14	Auxiliary boiler system
IEM15	Potable water systems
IEM16	Ultimate Heat Sink
IEM17	13.8 KV and switchyard system, medium voltage AC electrical distribution system (EMVS), low voltage AC electrical distribution system (ELVS)
IEM18	Highly reliable DC power system (EDSS) common (EDSS-C)
IEM19	Normal DC power system (EDNS)
IEM20	Safety display and indication system (SDIS)
IEM21	Plant Protection System (PPS)
IEM22	Plant Control System (PCS)
IEM23	Hydrogen explosion impact on more modules
IEM24	Seismic event with impact all site
IEM25	Utility water system

IE EVENTS FOR ENTRY EVALUATION TO INPUT TO EP CATEGORIES CALCULATIONS

	IE	Events from initial IE FT
	SUPSA IVENTS	
IES1	External Flooding	Natural
		Dam failures
		Ground water
IES2	Water leak outside containment	Leak in the penetrations of module
IES3	Water leak into ground	Ground Water
		Leak from the pool
IES4	Loss of one module control	
IES5	Release into atmosphere	Accidental Releases of Radioactive Liquid Effluents in Ground and Surface Waters
IES6	Operator erros	Operator erros in recovering during Emergency at at least one module
IES7	Seismic event	Seismic event beyond DBA
		Vibratory Ground Motion
		Stability of Subsurface Materials and Foundations
IES8	Crane related events	Crane catastrofic failure
		Crans failure due to aircraft crash
IES9	Hydrogen explosion at one module	

	MUPSA IE	
IEM1	RWB heating, ventilation, and air conditioning (HVAC) system	
IEM2	Diesel generator building HVAC system	
IEM2	**Turbine building HVAC system**	
IEM3	Annex building HVAC system	
IEM4	Containment flooding and drain system	
IEM5	Normal control room HVAC system	
IEM6	RXB HVAC system	
IEM7	Control room habitability system	
IEM8	Boron addition system	
IEM9	Reactor component cooling water system	
IEM10	Circulating water system	
IESM11	Site cooling water system	Low Water events
		Cooling Water Canals and Reservoirs
IEM12	Demineralized water system	
IEM13	Auxiliary boiler system	
IEM14	Potable water systems	
IEM14	Ultimate Heat Sink	
IEM15	13.8 KV and switchyard system, medium voltage AC electrical distribution system (EMVS), low voltage AC electrical distribution system (ELVS)	
IEM16	Highly reliable DC power system (EDSS) common (EDSS-C)	
IEM17	Normal DC power system (EDNS)	
IEM18	Safety display and indication system (SDIS)	
IEM19	Plant Protection System (PPS)	
IEM20	Plant Control System (PCS)	
IEM21	Utility water system	

IE EVENTS AND ENTRY EVALUATION

CODE	IE	ENTRY	ENTRY COVERED BY	IMPACT	EMERGENCY TYPE	CASE STUDY SMR
	SUPSA IE					
IES1	Water leak outside containment	ENTRY S2	N	H	UA	C
IES2	Water leak into ground	ENTRY S3	N	H	UA	C
IES3	Loss of one module control	ENTRY S4	M22			
IES4	Release into atmosphere	ENTRY S5	N	H	UG	C
IES5	Operator errors	ENTRY S6	N	L	A	B
IES6	Seismic event	ENTRY S7	M24			
IES7	Crane related events	ENTRY S8	N	H	UA	C
IES8	Hydrogen explosion at one module	ENTRY S9	M23			

	MUPSA IE					
IEM1	RWB heating, ventilation, and air conditioning (HVAC) system	ENTRY M1	N	L	A	COVERED BY A
IEM2	Diesel generator building HVAC system	ENTRY M2	N	L	A	COVERED BY A
IEM3	**Turbine building HVAC system**	ENTRY M3	N	H	UA	C
IEM4	Annex building HVAC system	ENTRY M4	N	L	A	COVERED BY A
IEM5	Containment flooding and drain system	ENTRY M5	N	H	UA	C
IEM6	Normal control room HVAC system	ENTRY M6	N	L	A	COVERED BY A
IEM7	RXB HVAC system	ENTRY M7	N	L	A	COVERED BY A
IEM8	Control room habitability system	ENTRY M8	N	H	UA	C
IEM9	Boron addition system	ENTRY M9	N	M	A	COVERED BY A
IEM10	Reactor component cooling water system	ENTRY M10	N	M	A	COVERED BY A
IEM11	Circulating water system	ENTRY M11	N	H	UA	C
IEM12	Site cooling water system	ENTRY M12	N	H	UA	C
IEM13	Demineralized water system	ENTRY M13	N	H	UA	C
IEM14	Auxiliary boiler system	ENTRY M14	N	H	UA	C
IEM15	Potable water systems	ENTRY M15	N	L		COVERED BY A
IEM16	Ultimate Heat Sink	ENTRY M16	N	H	UG	C
IEM17	13.8 KV and switchyard system, medium voltage AC electrical distribution system (EMVS), low voltage AC electrical distribution system (ELVS)	ENTRY M17	N	H	UG	C
IEM18	Highly reliable DC power system (EDSS) common (EDSS-C)	ENTRY M18	N	H	UA	C
IEM19	Normal DC power system (EDNS)	ENTRY M19	N	L	A	COVERED BY A
IEM20	Safety display and indication system (SDIS)	ENTRY M20	N	L	A	COVERED BY A
IEM21	Plant Protection System (PPS)	ENTRY M21	N	H	A	C
IEM22	Plant Control System (PCS)	ENTRY M22	N	H	A	C
IEM23	Hydrogen explosion impact on more modules	ENTRY M23	N	H	UG	C
IEM24	Seismic event with impact all site	ENTRY M24	N	H	UG	C
IEM25	External Flooding	ENTRY M25	N	H	UA	C
IEM26	Utility water system	ENTRY M26	N	L	M	COVERED BY A

CASES OF SMR CASE STUDY

SOURCE ONE MODULE	**SOURCE A** **six modules**	**SOURCE B** **three modules**	**SOURCE C** **two modules in first three days followed by other four in 30 days**

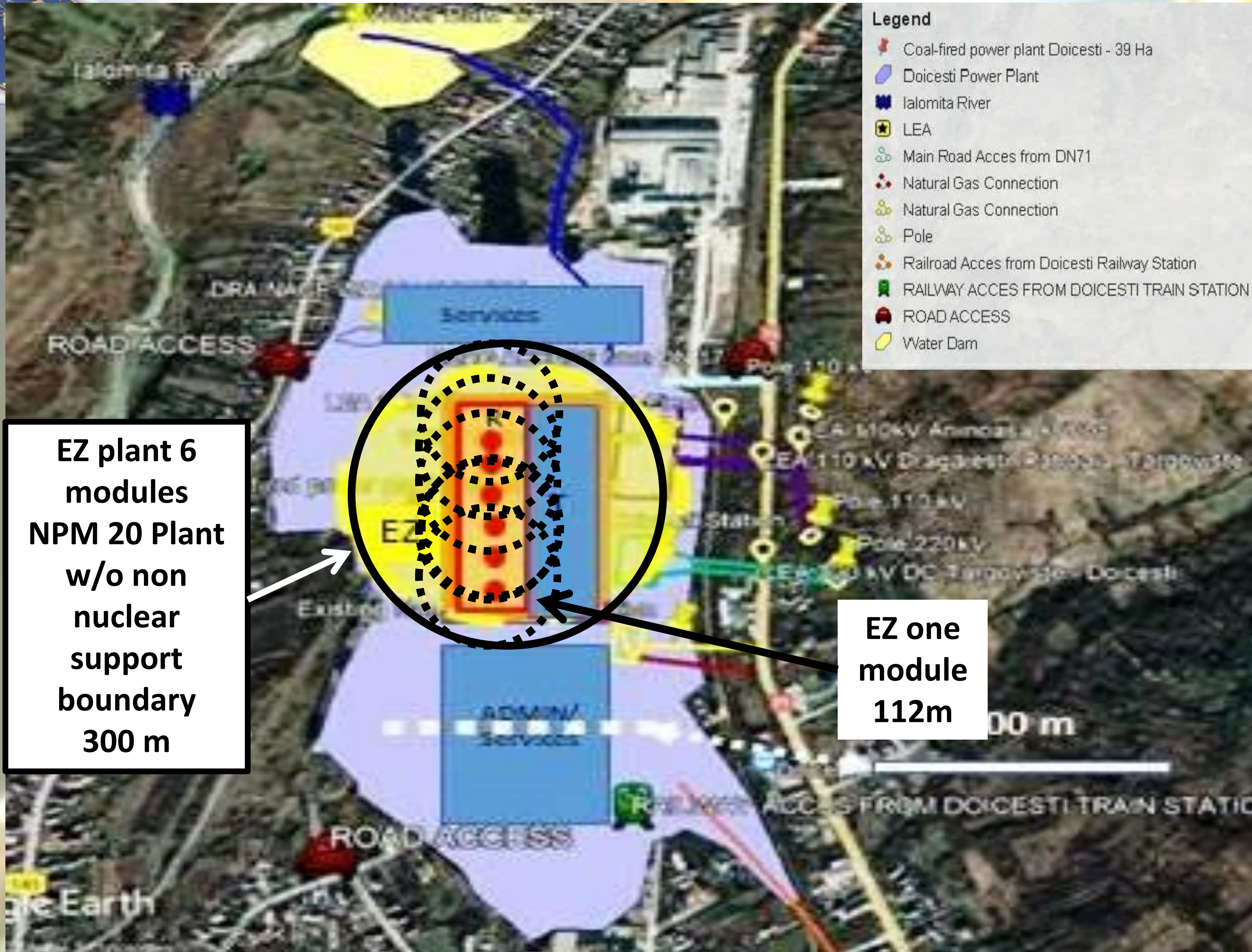
REFERENCE INI LARGE												
Some fission and activation product radionuclides in core inventory		Some fission and activation products radionuclides released from the containment		**SOURCE ONE MODULE**		**SOURCE A = six modules**		**SOURCE B three modules**		**SOURCE C two modules in first three days followed by other four in 30 days**		
Radionuclide	Inventory (Bq) Q_i	Radionuclide	Source Term (Bq) S	Radionuclide	Source Term (Bq)	Radionuclide	Source Term (Bq)	Radionuclide	Source Term (Bq)	Radionuclide	Source Term (Bq) First 3 dyas	Source Term (Bq) ADDED after 30 days
H 3	8.84E+14	H 3	1.21E+14	H 3	6.05E+12	H 3	3.63E+13	H 3	1.82E+13	H 3	1.21E+13	2.42E+13
C 14	2.08E+12	C 14	2.85E+11	C 14	1.43E+10	C 14	8.55E+10	C 14	4.28E+10	C 14	2.85E+10	5.70E+10
Na 24	2.40E+14	Na 24	3.13E+13	Na 24	1.57E+12	Na 24	9.39E+12	Na 24	4.70E+12	Na 24	3.13E+12	6.26E+12
Cr 51	3.31E+16	Cr 51	3.63E+14	Cr 51	1.82E+13	Cr 51	1.09E+14	Cr 51	5.45E+13	Cr 51	3.63E+13	7.26E+13
Mn 54	6.44E+14	Mn 54	7.07E+12	Mn 54	3.54E+11	Mn 54	2.12E+12	Mn 54	1.06E+12	Mn 54	7.07E+11	1.41E+12
Fe 59	2.45E+14	Fe 59	2.69E+12	Fe 59	1.35E+11	Fe 59	8.07E+11	Fe 59	4.04E+11	Fe 59	2.69E+11	5.38E+11
Co 60	9.99E+11	Co 60	1.10E+10	Co 60	5.50E+08	Co 60	3.30E+09	Co 60	1.65E+09	Co 60	1.10E+09	2.20E+09
Se 79	6.88E+11	Se 79	9.45E+10	Se 79	4.73E+09	Se 79	2.84E+10	Se 79	1.42E+10	Se 79	9.45E+09	1.89E+10
Kr 85	1.71E+16	Kr 85	2.27E+15	Kr 85	1.14E+14	Kr 85	6.81E+14	Kr 85	3.41E+14	Kr 85	2.27E+14	4.54E+14
Kr 85m	1.84E+16	Kr 85m	2.45E+15	Kr 85m	1.23E+14	Kr 85m	7.35E+14	Kr 85m	3.68E+14	Kr 85m	2.45E+14	4.90E+14
Kr 87	3.03E+12	Kr 87	4.03E+11	Kr 87	2.02E+10	Kr 87	1.21E+11	Kr 87	6.05E+10	Kr 87	4.03E+10	8.06E+10
Kr 88	5.81E+15	Kr 88	7.74E+14	Kr 88	3.87E+13	Kr 88	2.32E+14	Kr 88	1.16E+14	Kr 88	7.74E+13	1.55E+14
Rb 88	6.48E+15	Rb 88	8.44E+14	Rb 88	4.22E+13	Rb 88	2.53E+14	Rb 88	1.27E+14	Rb 88	8.44E+13	1.69E+14
Sr 89	2.76E+18	Sr 89	4.16E+16	Sr 89	2.08E+15	Sr 89	1.25E+16	Sr 89	6.24E+15	Sr 89	4.16E+15	8.32E+15
Sr 90	1.31E+17	Sr 90	1.98E+15	Sr 90	9.90E+13	Sr 90	5.94E+14	Sr 90	2.97E+14	Sr 90	1.98E+14	3.96E+14
Sr 91	5.88E+17	Sr 91	8.88E+15	Sr 91	4.44E+14	Sr 91	2.66E+15	Sr 91	1.33E+15	Sr 91	8.88E+14	1.78E+15
Sr 92	3.54E+18	Y 91	6.32E+15	Sr 92	3.16E+14	Sr 92	1.90E+15	Sr 92	9.48E+14	Sr 92	6.32E+14	1.26E+15
Y 90	1.39E+17	Sr 92	1.18E+14	Y 90	5.90E+12	Y 90	3.54E+13	Y 90	1.77E+13	Y 90	1.18E+13	2.36E+13
Zr 95	4.85E+18	Zr 95	8.65E+15	Zr 95	4.33E+14	Zr 95	2.60E+15	Zr 95	1.30E+15	Zr 95	8.65E+14	1.73E+15
Zr 97	4.85E+18	Zr 97	3.10E+15	Zr 97	1.55E+14	Zr 97	9.30E+14	Zr 97	4.65E+14	Zr 97	3.10E+14	6.20E+14
Nb 95	1.74E+18	Nb 95	8.65E+15	Nb 95	4.33E+14	Nb 95	2.60E+15	Nb 95	1.30E+15	Nb 95	8.65E+14	1.73E+15
Nb 97	1.75E+18	Nb 97	3.12E+15	Nb 97	1.56E+14	Nb 97	9.36E+14	Nb 97	4.68E+14	Nb 97	3.12E+14	6.24E+14

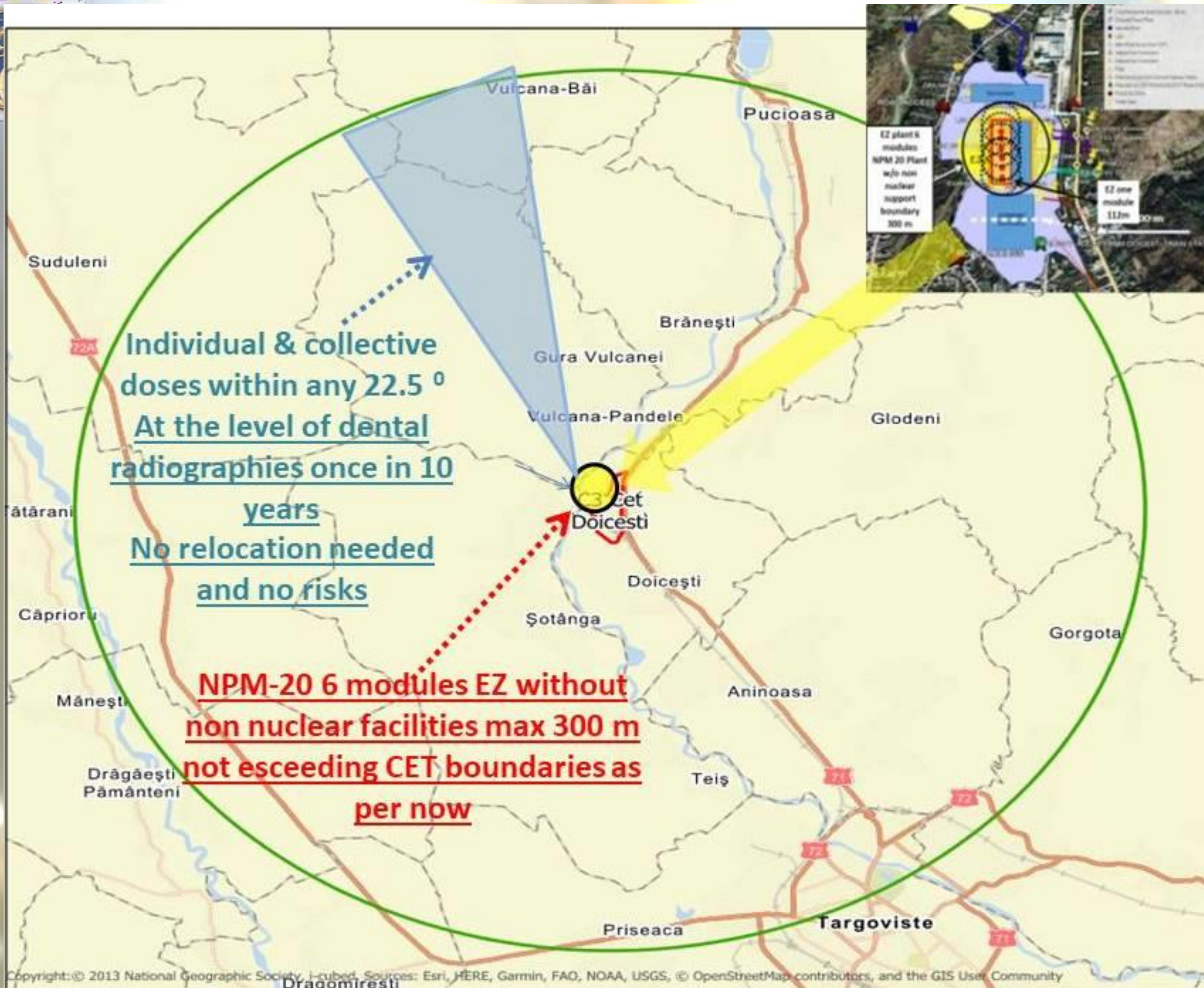
Mo 99	3.74E+18		Mo 99	4.10E+16
Tc 99	2.23E+13		Tc 99	2.45E+11
Ru 103	3.81E+18		Ru 103	4.19E+16
Ru 106	9.07E+17		Ru 106	9.96E+15
Te 131	4.92E+16		Te 131	6.76E+15
Te 132	2.44E+18		Te 131m	2.99E+16
Te 131m	2.18E+17		Te 132	4.14E+17
I 131	2.44E+18		I 131	3.30E+17
I 132	3.12E+18		I 132	4.20E+17
I 133	2.49E+18		I 133	3.36E+17
I 134	5.22E+18		I 134	1.81E+10
I 135	1.34E+11		I 135	5.49E+16
Xe 133	1.66E+17		Xe 133	6.95E+17
Xe 133m	1.52E+17		Xe 133m	2.02E+16
Xe 135	1.31E+18		Xe 135	1.74E+17
Xe 135m	6.51E+16		Xe 135m	8.67E+15
Cs 134	1.66E+17		Cs 134	2.17E+16
Cs 136	8.14E+16		Cs 136	1.06E+16
Cs 137	1.71E+17		Cs 137	2.23E+16
Ba 137m	1.62E+17		Ba 137m	2.44E+15
Ba 139	3.15E+13		Ba 139	4.76E+11
Ba 140	4.44E+18		Ba 140	6.70E+16
La 140	4.70E+18		La 140	8.39E+15
Ce 141	4.44E+18		Ce 141	7.92E+15
Ce 144	2.91E+18		Ce 144	5.20E+15
Pr 144	2.91E+18		Pr 144	5.20E+15
Eu 155	7.51E+15		Eu 155	1.34E+13
Eu 156	2.04E+17		Eu 156	3.64E+14
Eu 157	1.50E+16		Eu 157	2.67E+13

Mo 99	2.05E+15	Mo 99	1.23E+16	Mo 99	6.15E+15	Mo 99	4.10E+15	8.20E+15
Tc 99	1.23E+10	Tc 99	7.35E+10	Tc 99	3.68E+10	Tc 99	2.45E+10	4.90E+10
Ru 103	2.10E+15	Ru 103	1.26E+16	Ru 103	6.29E+15	Ru 103	4.19E+15	8.38E+15
Ru 106	4.98E+14	Ru 106	2.99E+15	Ru 106	1.49E+15	Ru 106	9.96E+14	1.99E+15
Te 131	3.38E+14	Te 131	2.03E+15	Te 131	1.01E+15	Te 131	6.76E+14	1.35E+15
Te 132	1.50E+15	Te 132	8.97E+15	Te 132	4.49E+15	Te 132	2.99E+15	5.98E+15
Te 131m	2.07E+16	Te 131m	1.24E+17	Te 131m	6.21E+16	Te 131m	4.14E+16	8.28E+16
I 131	1.65E+16	I 131	9.90E+16	I 131	4.95E+16	I 131	3.30E+16	6.60E+16
I 132	2.10E+16	I 132	1.26E+17	I 132	6.30E+16	I 132	4.20E+16	8.40E+16
I 133	1.68E+16	I 133	1.01E+17	I 133	5.04E+16	I 133	3.36E+16	6.72E+16
I 134	9.05E+08	I 134	5.43E+09	I 134	2.72E+09	I 134	1.81E+09	3.62E+09
I 135	2.75E+15	I 135	1.65E+16	I 135	8.24E+15	I 135	5.49E+15	1.10E+16
Xe 133	3.48E+16	Xe 133	2.09E+17	Xe 133	1.04E+17	Xe 133	6.95E+16	1.39E+17
Xe 133m	1.01E+15	Xe 133m	6.06E+15	Xe 133m	3.03E+15	Xe 133m	2.02E+15	4.04E+15
Xe 135	8.70E+15	Xe 135	5.22E+16	Xe 135	2.61E+16	Xe 135	1.74E+16	3.48E+16
Xe 135m	4.34E+14	Xe 135m	2.60E+15	Xe 135m	1.30E+15	Xe 135m	8.67E+14	1.73E+15
Cs 134	1.09E+15	Cs 134	6.51E+15	Cs 134	3.26E+15	Cs 134	2.17E+15	4.34E+15
Cs 136	5.30E+14	Cs 136	3.18E+15	Cs 136	1.59E+15	Cs 136	1.06E+15	2.12E+15
Cs 137	1.12E+15	Cs 137	6.69E+15	Cs 137	3.35E+15	Cs 137	2.23E+15	4.46E+15
Ba 137m	1.22E+14	Ba 137m	7.32E+14	Ba 137m	3.66E+14	Ba 137m	2.44E+14	4.88E+14
Ba 139	2.38E+10	Ba 139	1.43E+11	Ba 139	7.14E+10	Ba 139	4.76E+10	9.52E+10
Ba 140	3.35E+15	Ba 140	2.01E+16	Ba 140	1.01E+16	Ba 140	6.70E+15	1.34E+16
La 140	4.20E+14	La 140	2.52E+15	La 140	1.26E+15	La 140	8.39E+14	1.68E+15
Ce 141	3.96E+14	Ce 141	2.38E+15	Ce 141	1.19E+15	Ce 141	7.92E+14	1.58E+15
Ce 144	2.60E+14	Ce 144	1.56E+15	Ce 144	7.80E+14	Ce 144	5.20E+14	1.04E+15
Pr 144	2.60E+14	Pr 144	1.56E+15	Pr 144	7.80E+14	Pr 144	5.20E+14	1.04E+15
Eu 155	6.70E+11	Eu 155	4.02E+12	Eu 155	2.01E+12	Eu 155	1.34E+12	2.68E+12
Eu 156	1.82E+13	Eu 156	1.09E+14	Eu 156	5.46E+13	Eu 156	3.64E+13	7.28E+13
Eu 157	1.34E+12	Eu 157	8.01E+12	Eu 157	4.01E+12	Eu 157	2.67E+12	5.34E+12

Some Actinides Radionuclides in Core Inventory		Some Actinides Radionuclides Released from the Containment	
Radionuclide	Inventory (Bq) Q_i	Radionuclide	Source Term (Bq) S
Th 234	9.73E+11	Th 234	5.34E+09
U 234	4.48E+12	U 234	2.46E+10
U 235	1.07E+11	U 235	5.87E+08
U 238	9.73E+11	U 238	5.34E+09
Np 238	2.50E+17	Np 238	4.47E+14
Np 239	3.96E+19	Np 239	7.07E+16
Pu 238	1.52E+15	Pu 238	2.72E+12
Pu 239	9.21E+14	Pu 239	1.64E+12
Pu 241	2.25E+17	Pu 241	4.01E+14
Am 240	1.93E+11	Am 240	3.45E+08
Am 241	1.39E+14	Am 241	3.45E+081
Am 242	2.56E+16	Am 242	4.57E+13
Cm 242	2.42E+16	Cm 242	4.33E+13
Cm 244	3.42E+14	Cm 244	6.10E+11


Legend
Coal-fired power plant Doicesti - 39 Ha
Doicesti Power Plant
Ialomita River
LEA
Main Road Acces from DN71
Natural Gas Connection
Natural Gas Connection
Pole
Railroad Acces from Doicesti Railway Station
RAILWAY ACCES FROM DOICESTI TRAIN STATION
ROAD ACCESS
Water Dam
Ialomita River
ROAD ACCESS
Services
R
T
EZ
ADMIN/
Services
300 m
ROAD ACCESS


Legend
Coal-fired power plant Doicesti - 39 Ha
Doicesti Power Plant
Ialomita River
LEA
Main Road Acces from DN71
Natural Gas Connection
Natural Gas Connection
Pole
Railroad Acces from Doicesti Railway Station
RAILWAY ACCES FROM DOICESTI TRAIN STATION
ROAD ACCESS
Water Dam
Ialomita River
ROAD ACCESS
Services
EZ
Pole 110 kV
Pole 220 kV
ADMIN/
Services
ROAD ACCESS
EZ plant 6 modules NPM 20 Plant w/o non nuclear support boundary 300 m
EZ one module 112m



Individual & collective doses within any 22.5 0
At the level of dental radiographies once in 10 years
No relocation needed and no risks
NPM-20 6 modules EZ without non nuclear facilities max 300 m not esceeding CET boundaries as per now
CET Doicesti
Vulcana-Băi
Pucioasa
Suduleni
Brănești
Gura Vulcanei
Vulcana-Pandele
Glodeni
Doicești
Șotânga
Gorgota
Aninoasa
Mănești
Drăgăești Pământeni
Teiș
Priseaca
Targoviste
Dragomirești
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G. DISPERSION CALCULATIONS
H. CONCLUSIONS ON DEFINITION OF IMPACT AND ZONES BASED ON RADIATION RELEASE IMPACT

CNCAN jRODOS server: input data

- *NWP data*
  - *– provided by NMA (National Meteorological Administration of Romania)*

WRF model at 3km resolution:

- **1 run/day (48hrs forecast) with data interpolated from COSMO-7km at 00 UTC**
- **automatically transferred from NMA to CNCAN server via SSH**

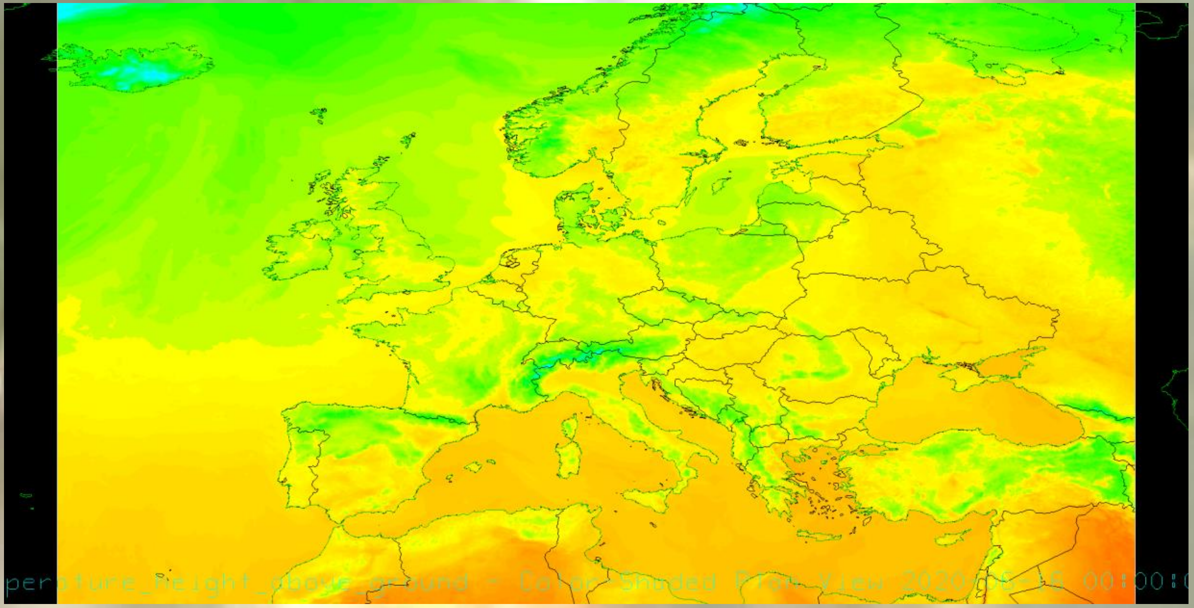
COSMO-7km **WRF 3km**

CNCAN jRODOS server: input data

- *NWP data*
  - *– public FTP provided by Deutscher Wetterdienst (DWD), Germany*

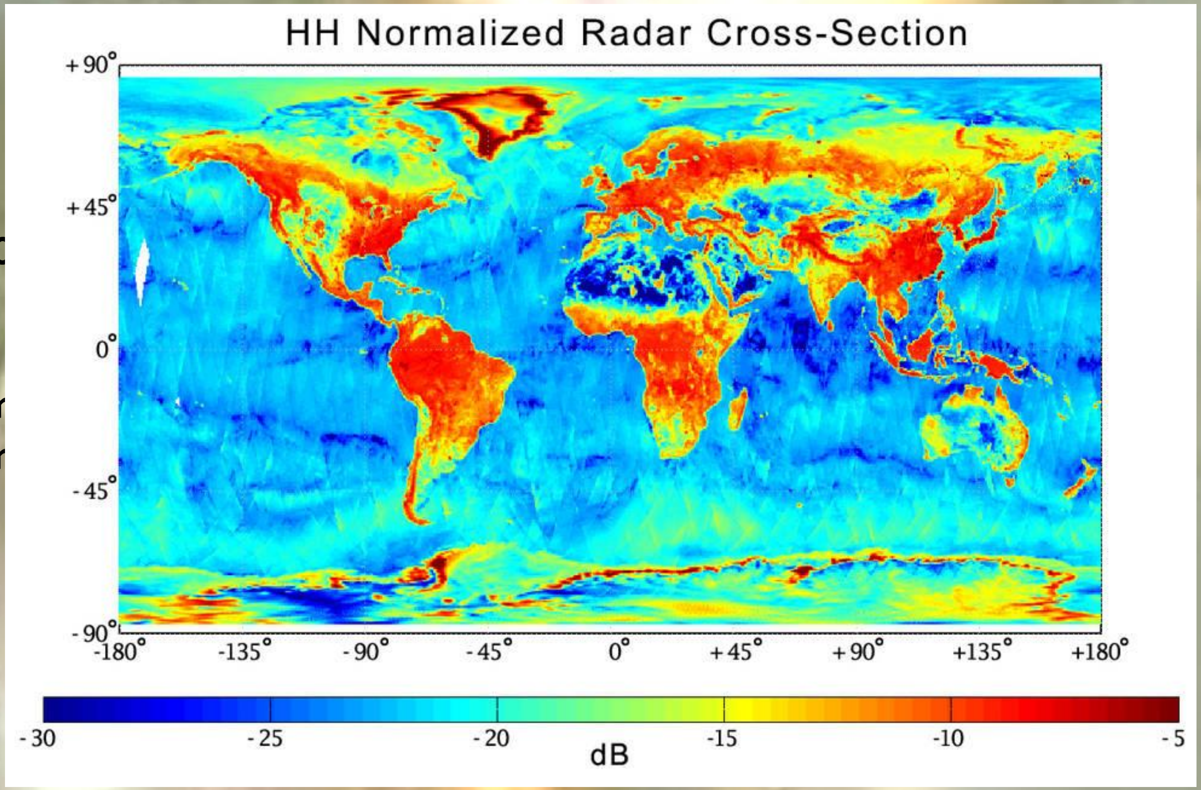
ICON-EU model at 7km resolution:

- **2 runs/day (48hrs forecast) 00 UTC and 12 UTC**
- **automatically downloaded from public DWD FTP server, then preprocessed with CDO tool**



CNCAN jRODOS server: input data

- *NWP data*
  - *public NOMADS FTP provided by National Centers for Environmental Prediction (NCEP) - NOAA*



GFS global model at 50 km resolution:

- **1 runs/day (48hrs forecast) at 00 UTC**
- **automatically downloaded from public NOMADS FTP server, ther preprocessed**

GIS for RODOS server

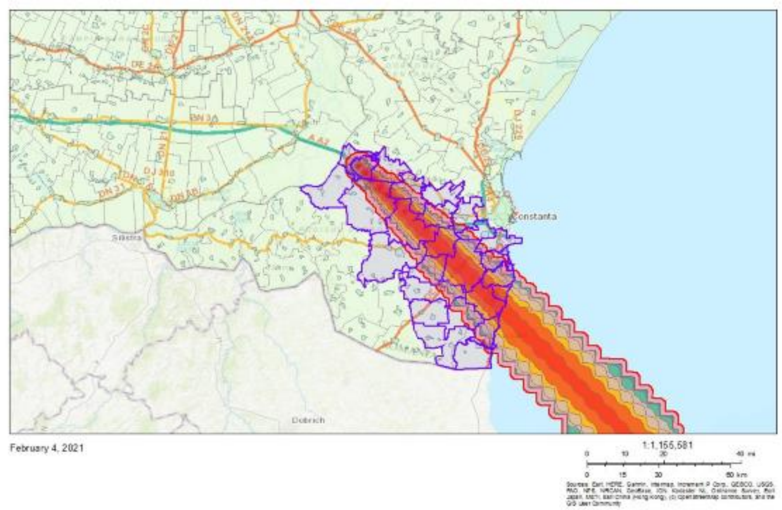
Detailed information about the affected population, localities, counties, roads, rivers, lakes, hospitals, etc

2/4/2021 Raport nor

Raport informativ nor - "1 (29/01/21 12:53)"

1. Informații generale

Run type: Exercise
Unit: CERNAVODA-1,
Start of release: 29.01.2021 11:14 [UTC], End of release: 29.01.2021 12:14 [UTC]
Calculation Nuclides Kr- 85m Kr- 85 Kr- 88 Rb- 88 Sr- 89 Sr- 90 Y - 90 Zr- 95 Ru-103 Ru-106 Rh-106 Te-131m Te-132 I -131 I -132 I -133 I -135 Xe-133 Xe-135 Cs-134 Cs-136 Cs-137 Ba-137m Ba-140 La-140 Pu-238 Pu-241 Cm-242 Cm-244
Weather: ICON 29.01.2021 00:00 [UTC]



Methodology:

Determination of Emergency Planning Zones

Requirements: 61/113 CNCAN and MoI Commun Order

Reference Level= 100 mSv (Residual Dose)

Generic Crireria

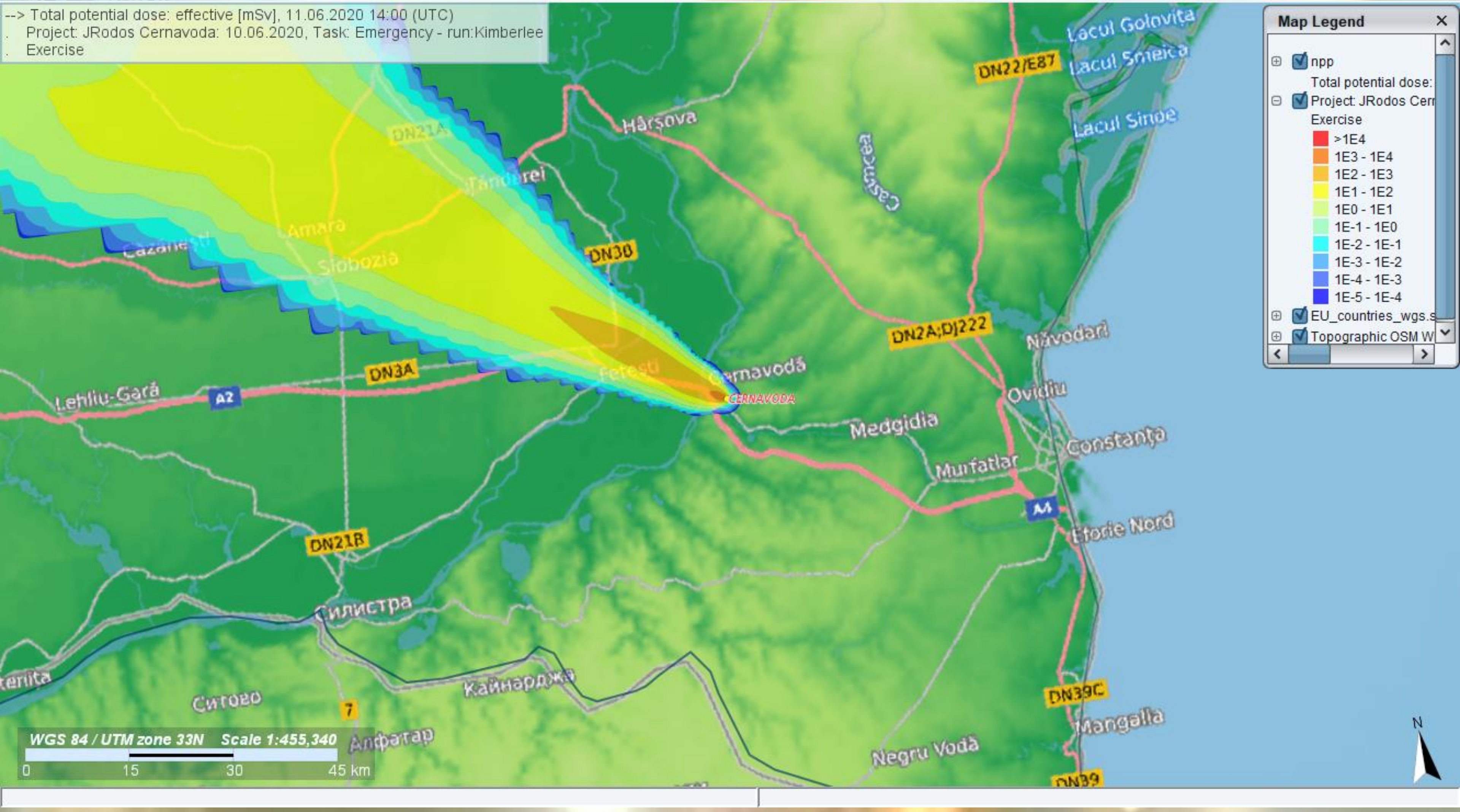
Zones and Distances	Dosimetric quantity	Dose level
PAZ	E-total effective dose	100 mSv in the first 7 days
UPZ	E-total effective dose	100 mSv in the 30 days
EPD	E-total effective dose	100 mSv in a year
ICPD	E-total effective dose	10 mSv in a year

Scenarion for prediction

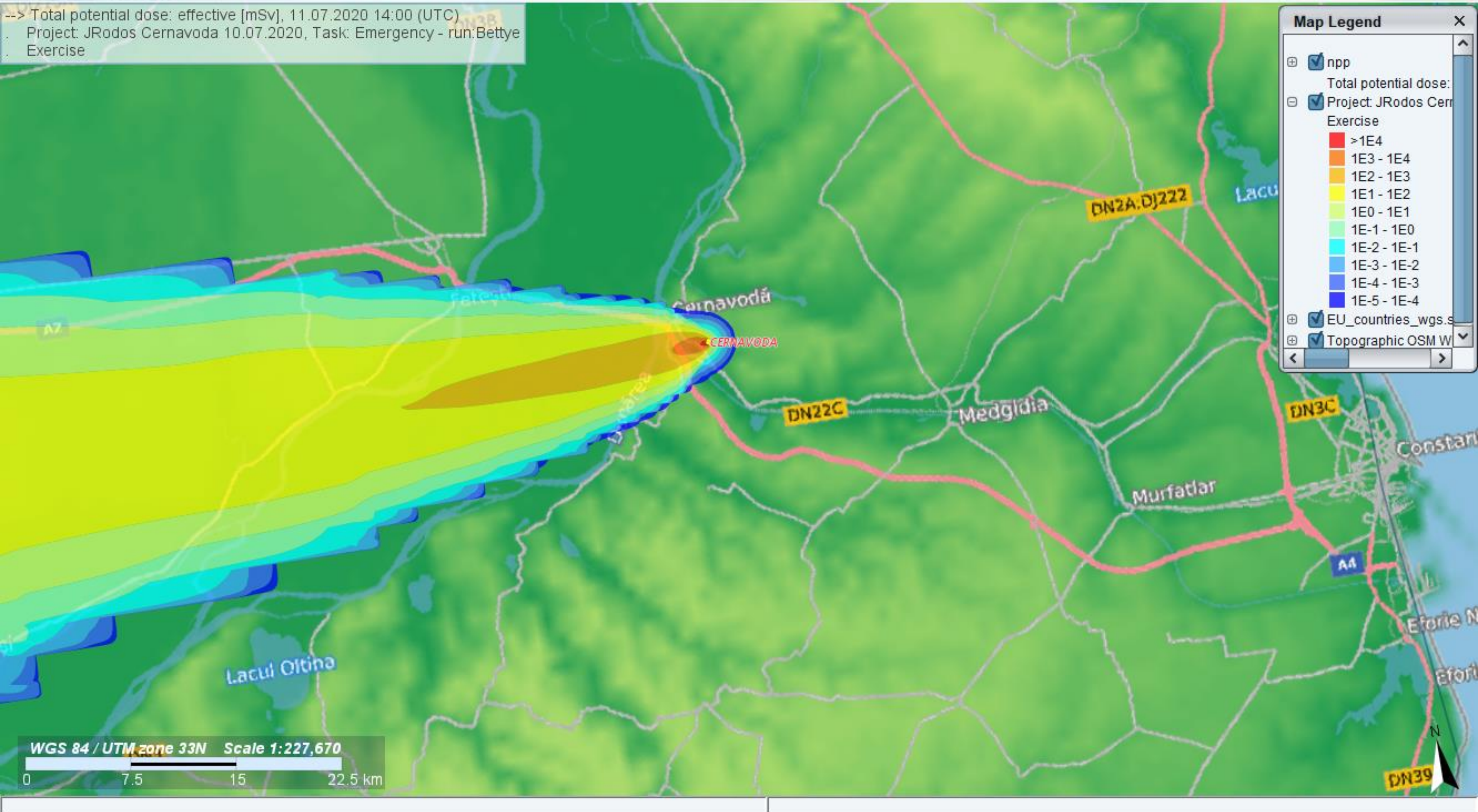
Site: Cernavoda NPP	
Dispersion Model	RODOS- RIMPUFF
Secenario	Station Blackout
Source term	PSA level 2
Weather prediction	ANM (36 hours)
Duration of release	10 hours
Height of release	10 m
Duration of prediction	24 hours

One year calculations

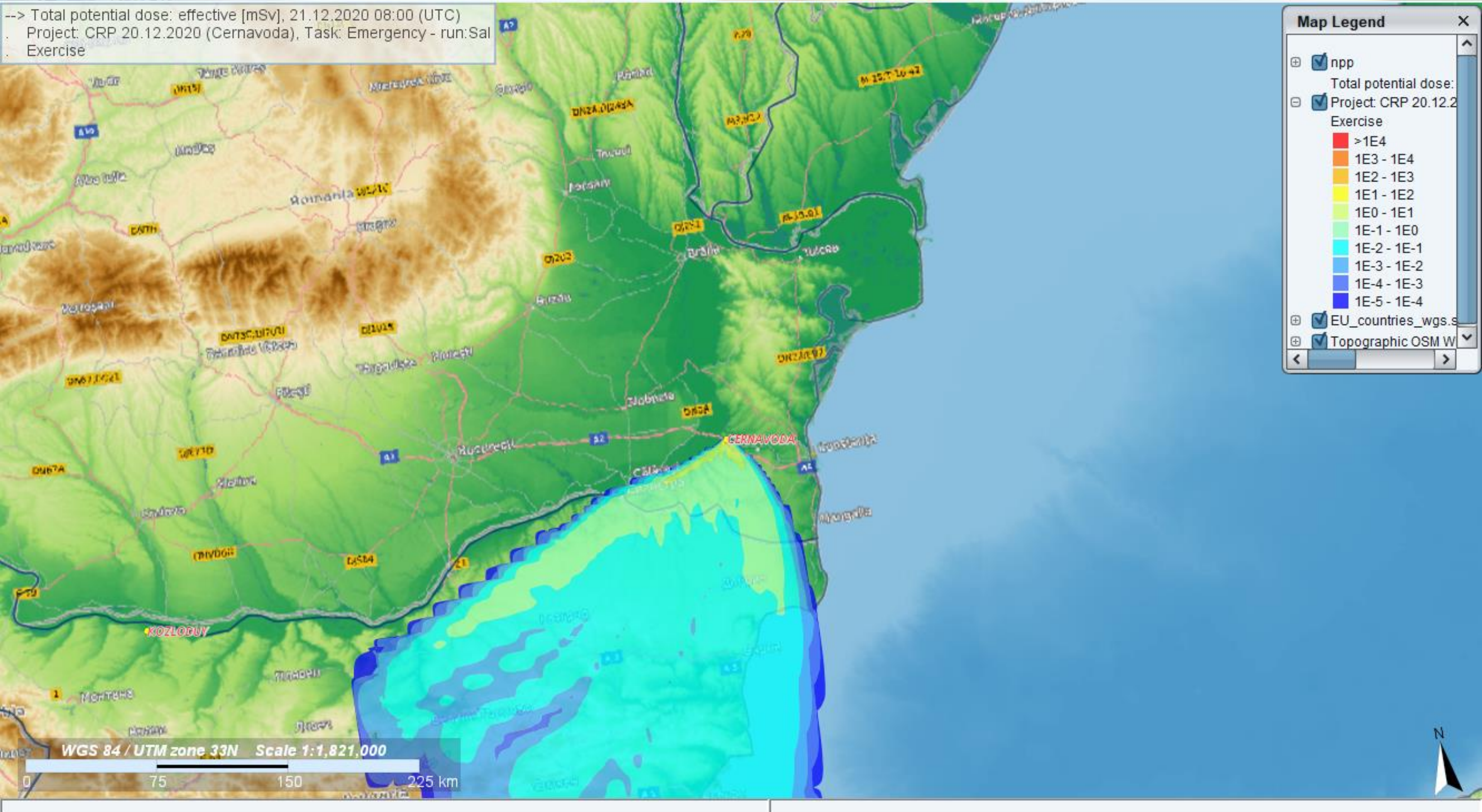
Calculation



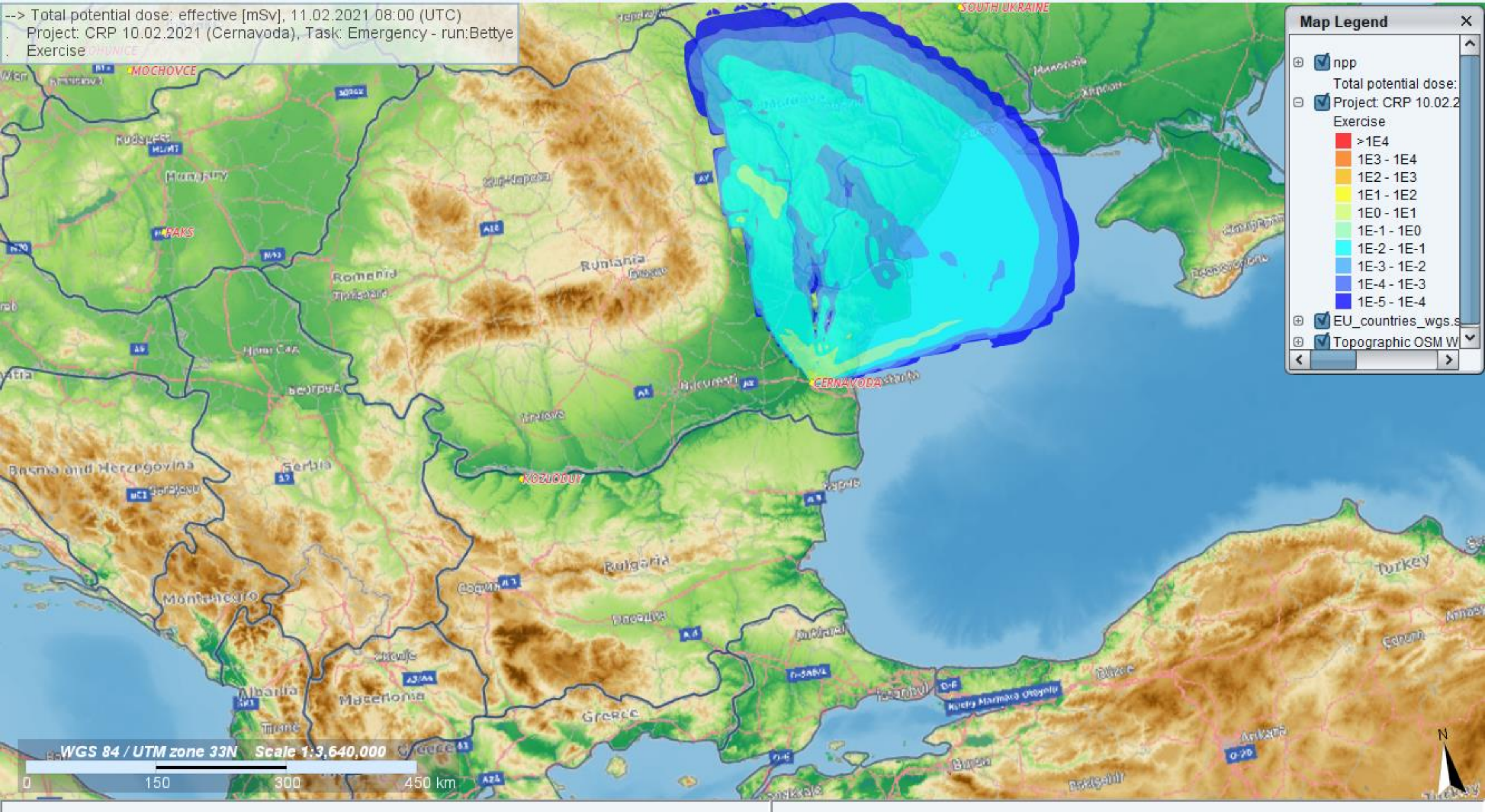
*Calculation



*Calculation



Calculation



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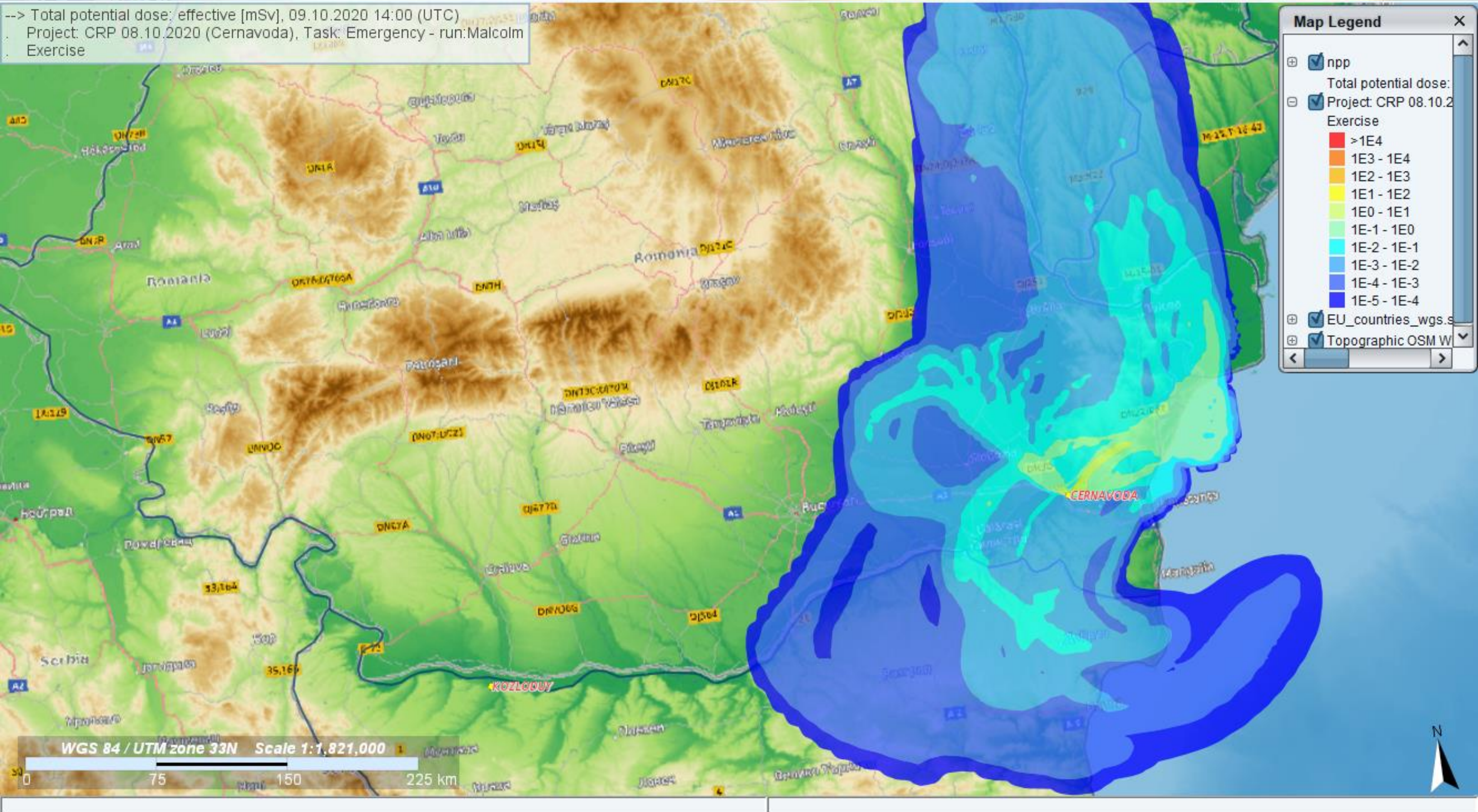


*Calculation

Optimization process

- Methodology: scenario, input data

- Meteorological observation data for 10 years

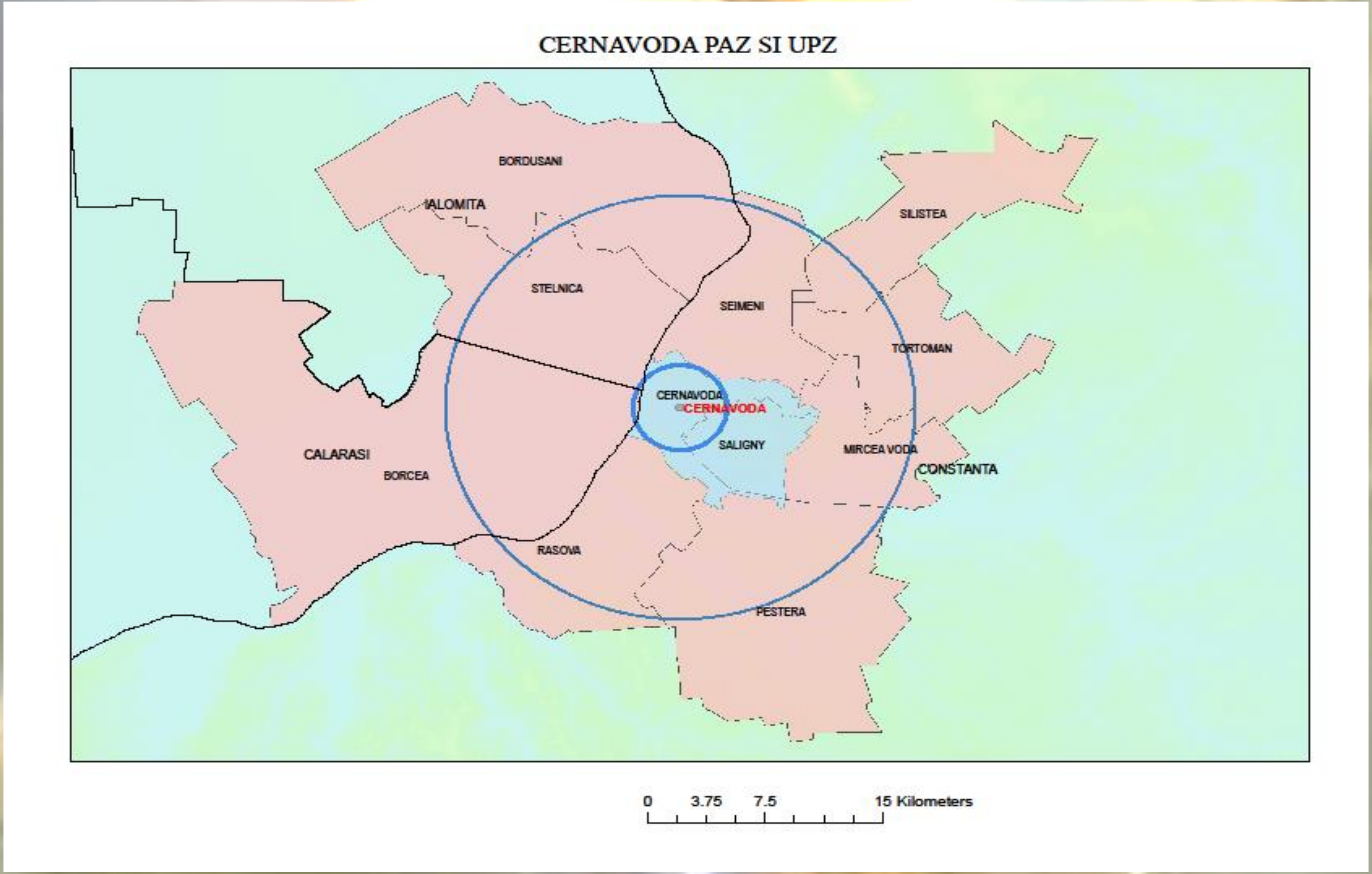
• wind speed at 10m (m/s); •Wind direction 10m (degrees); •total nebulosity; •Global radiation (KJ/m2); •clouds CL (cod optimi); •clouds CM (cod optimi); •clouds CH (cod optimi); •cloud ceiling height(tabela cod 1600); •precipitation (mm); •temperature (Celsius degrees); •presiunea atmosferica (mB).

statistical calculations →

Wind speed- pattern Wind direction – pattern Temperature - pattern Class of stability -

- Using GIS for RODOS

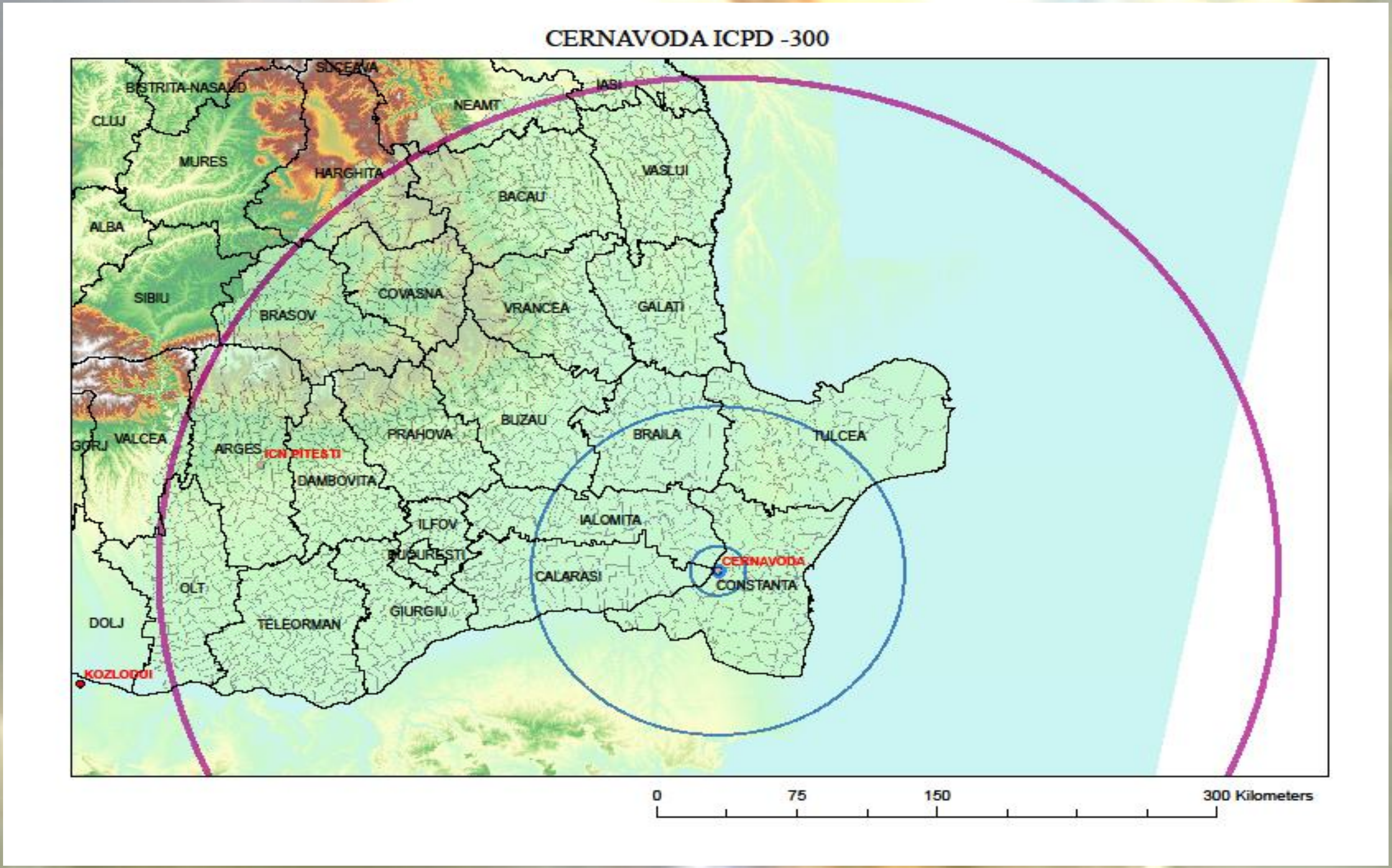
Emergency Planning Zones



Emergency Planning Zones

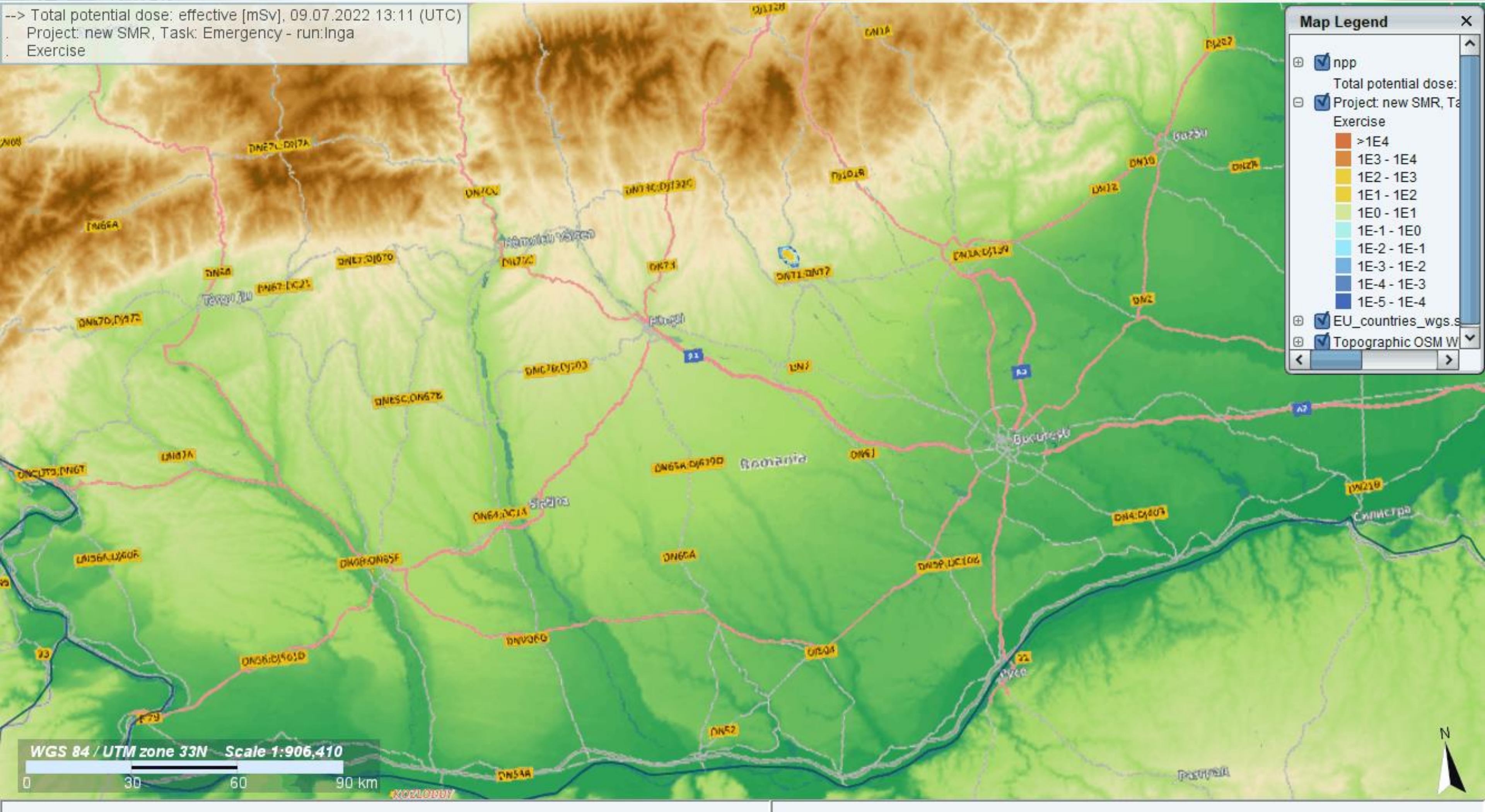
CERNAVODA EPD -100

Emergency Planning Zones



Using the same methodology EPZ for SMR will be determined

*Calculation



*Calculation