DIPARTIMENTO DI INGEGNERIA MECCANICA, NUCLEARE E DELLA PRODUZIONE – GRNSPG (San Piero a Grado)

UNIVERSITA' DI PISA
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PERSPECTIVES FROM IMPROVING NUCLEAR REACTOR SAFETY

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INTERNATIONAL NUCLEAR ATLANTIC CONFERENCE

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LIST OF CONTENT

SUBJECT HEREAFTER IS NPP TECHNOLOGY BASED ON WATER COOLED REACTORS

FOREWORD 1 of 3

SUBJECT HEREAFTER IS NPP TECHNOLOGY BASED ON WATER COOLED REACTORS

'Possible' status of NPP Technology

- Does not match the **expectations of the '50's**
- **Declining** in a number of 'former' industrialized Countries (most of the EU)
- **In 'stand-by'** in key former nuclear Countries like France, US and noticeably Japan
- Development perspectives in **three big Countries**, China, Russia and India
- **Questionable future** (at least in terms of the "amount of the exploitation") in Countries like Argentina, Brasil, Canada, UK.
- Living expectations in **Embarking Countries** like Turkey, Vietnam, Bielorussia.

FOREWORD 2 of 3

SUBJECT HEREAFTER IS NPP TECHNOLOGY BASED ON WATER COOLED REACTORS

Motivations for declining NPP Technology:

- The Fukushima Technological Tragedy (and the TMI and Chernobyl events)
- The lack of certainty for Costs and Times (not last, the Finnish Plant)
- The availability and the competition of Other Energy sources

	Value (US $)
Installation	2 - 5 B
Lifetime Production	< 60 B
Potential Env Damage	… T

FOREWORD 3 of 3

SUBJECT HEREAFTER IS NPP TECHNOLOGY BASED ON WATER COOLED REACTORS

Entering the present vision:

- …. *(I like to state)* **Nuclear Energy = Political Energy.** Nuclear scientists have little role in promoting the technology. Rather, they may identify and remove weaknesses.
- Contrary to TMI-2 and Chernobyl-4, where operator failures were decisive, in the case of Fukushima1-4 **a chain of human failures** (some understandable) contributed to the tragedy.
- Additional (fifth) safety barrier constituted by **Emergency Rescue Team** seems unavoidable to prevent T-$ damages.

… an ambitious vision …

FOREWORD 3-bis

THE EMERGENCY RESCUE TEAM

Necessary, complementary to what follows:

In case of Sabotage, Terroristic Act, Severe Environment Conditions, or Unit Not-Under-Control,

to constitute a national (or regional) Emergency Rescue Team (ERT) capable of physically intervening in a failed NPP Unit having own devices and access locations in each unit: this might be seen as a new (active) barrier part of the defense-in-depth and summing up with the current (mostly passive) standard barriers.

… ERT would have helped in the case of TMI-2, Chernobyl-4 and Fukushima-1-4

… the ambitious vision follows …

BACKGROUND

NON-TECHNOLOGICAL, UN-NECESSARY BASES FOR THE PRESENT VISION

To re-gain the public trust toward NPP Technology:

- Not any of the existing NPP may withstand the fall of a (powerful) meteorite
- The probability can be estimated of a (powerful) meteorite hitting a NPP
- A nuclear disaster shall have the same probability of the ‘hitting’ meteorite
- The population shall accept the ‘meteorite’ risk & be aware of the connection <‘meteorite’ risk> vs <benefits of the NPP>

THE (NEW) VISION

A NECESSARY, NOT SUFFICIENT EFFORT, TO RE-GAIN THE PUBLIC TRUST TOWARDS NRST

Objective for the vision (= THE TARGET):

TOTAL NPP RISK ≤ METEORITE RISK

How to guarantee THE TARGET.

➔ **back to the origins of NRST, i.e. the principles**

- ♥ **ALARA** ***(As Low as Reasonably Achievable)***
- ♥ **ISD** ***(Independence of Safety Demonstration)***

THE (NEW) VISION

A NECESSARY, NOT SUFFICIENT EFFORT, TO RE-GAIN THE PUBLIC TRUST TOWARDS NRST

➔INDEPENDENT SAFETY ANALYSES *(& POSSIBLE NEW HARDWARE)*

PART 1 BELOW

Producing the I-FSAR. Confirming the consistency and suitability of the structure of current FSAR, and

- **Considering ALARA ←→ the best available assessment techniques (= BEPU)**
- **Identifying (all) FSAR 'analytical parts' and adopting the BEPU-equivalent approach**
- **Performing analyses independent of the designer/owner of facility**

➔NEW HARDWARE & CONTROL

PART 2 BELOW

SM-DC: Safety Margins - Detection & Control.

THE (NEW) VISION: THE I-FSAR

THE CURRENT SAFETY APPROACH & THE PROPOSAL – PART 1
THE LIST OF CONTENT

1) (FOCUSED) SYNTHESIS OF NRST

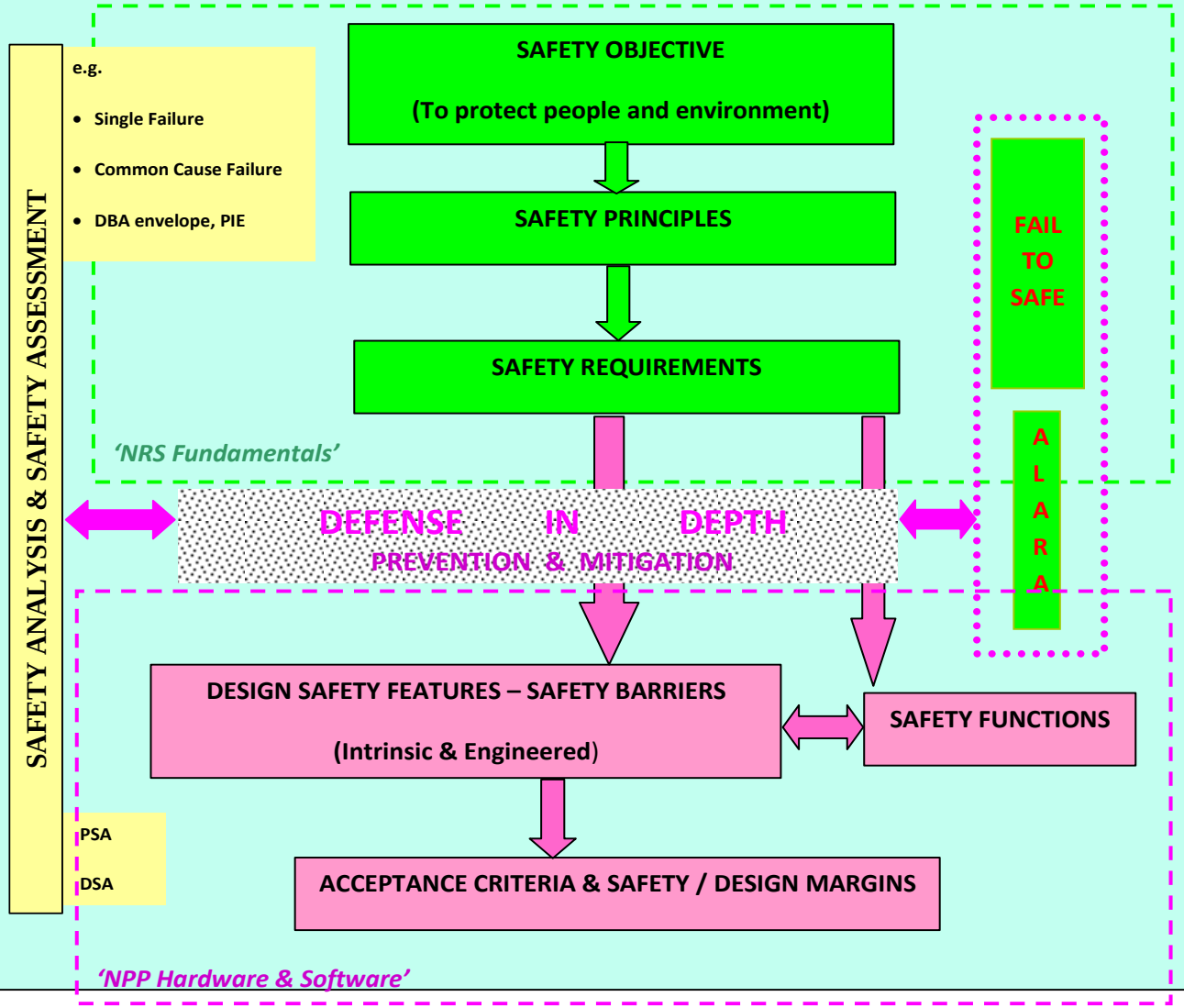
- The View
- The Licensing Connection
- The Accident Analysis
- The FSAR Topics (a Snap-shot)
- The Time-Frame Landmarks
- Strengths & Weaknesses of FSAR

2) THE I-FSAR PROPOSAL

- The BEPU Motivations & Features
- The BEPU-based I-FSAR
- *The Institution to manage the I-FSAR (Appendix)*

THE (NEW) VISION: THE I-FSAR

THE CURRENT SAFETY APPROACH & THE PROPOSAL – PART 1
>>>> THE (CURRENT) VIEW <<<<



THE (NEW) VISION: THE I-FSAR

THE CURRENT SAFETY APPROACH & THE PROPOSAL – PART 1
>>>> THE LICENSING CONNECTION <<<<

LICENSING … THE LEGAL SIDE OF NRST

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

A CONSISTENT REGULATORY FRAMEWORK

NRC Regulations (10 CFR)

U.S. NUCLEAR REGULATORY COMMISSION

June 2007

REGULATORY GUIDE
OFFICE OF NUCLEAR REGULATORY RESEARCH

REGULATORY GUIDE 1.206
(Draft was issued as DG-1145, dated September 2006)

COMBINED LICENSE APPLICATIONS FOR NUCLEAR POWER PLANTS (LWR EDITION)

Standard Review Plan
for the Review of
Safety Analysis Reports
for Nuclear Power Plants

LWR Edition

NUREG-0800
(formerly issued as NUREG-75/087)

U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation

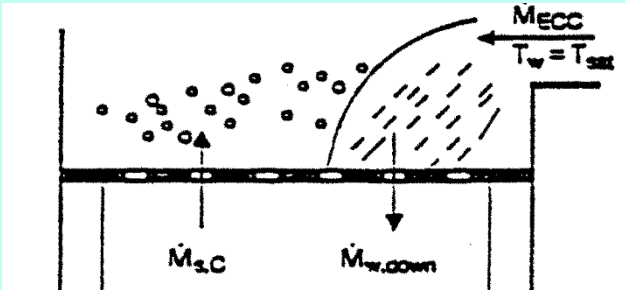
June 1987

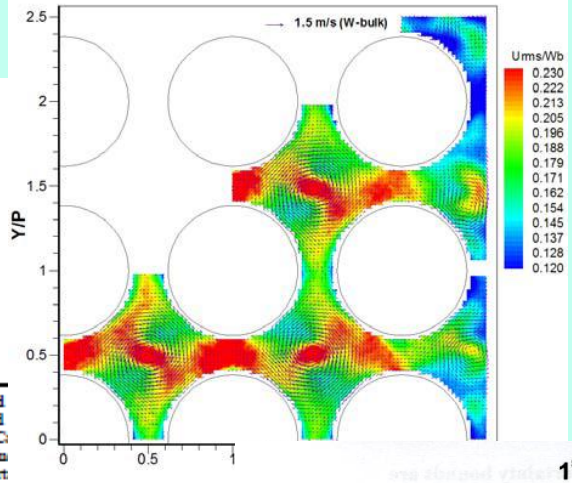
THE (NEW) VISION: THE I-FSAR

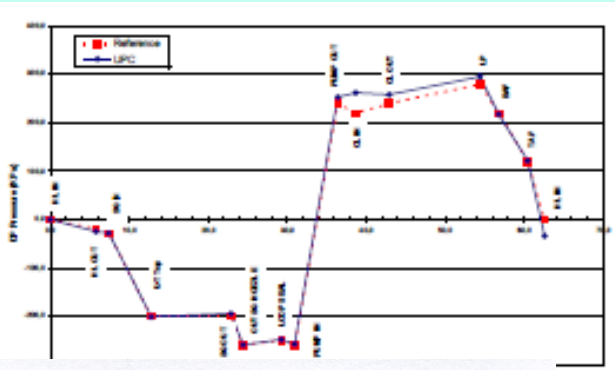
THE CURRENT SAFETY APPROACH & THE PROPOSAL – PART 1
>>>> THE ACCIDENT ANALYSIS <<<<

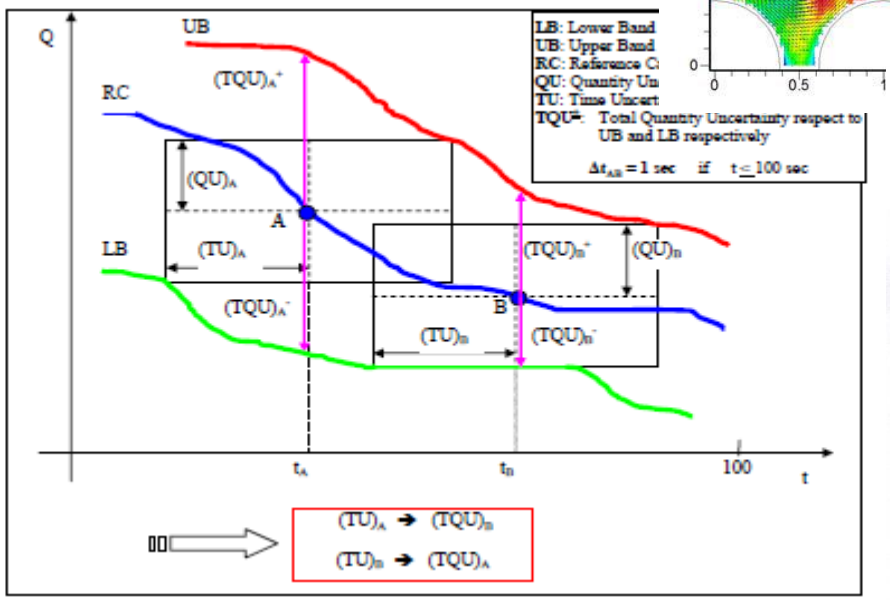
SAMPLE LIST OF AA TOPICS

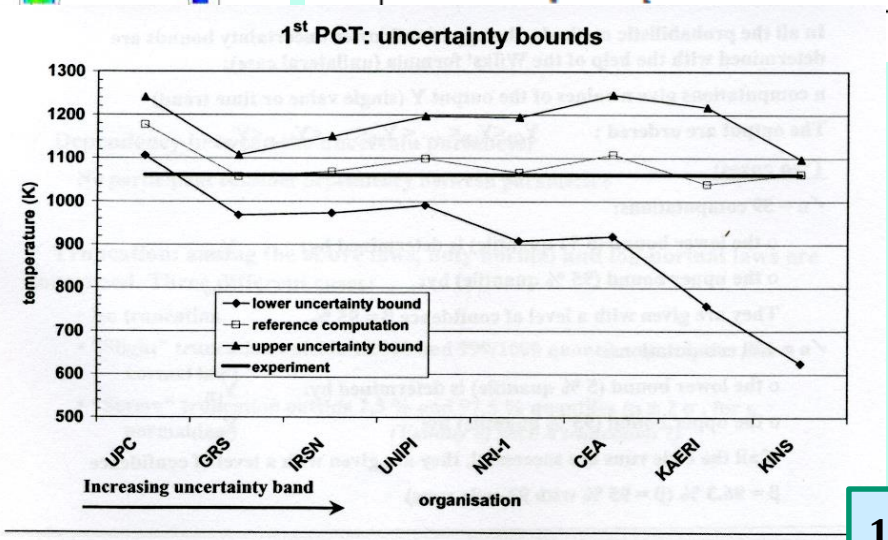
SYS exp; sub-channels exp, nodalization qualification, BE calculation, uncertainty evaluation







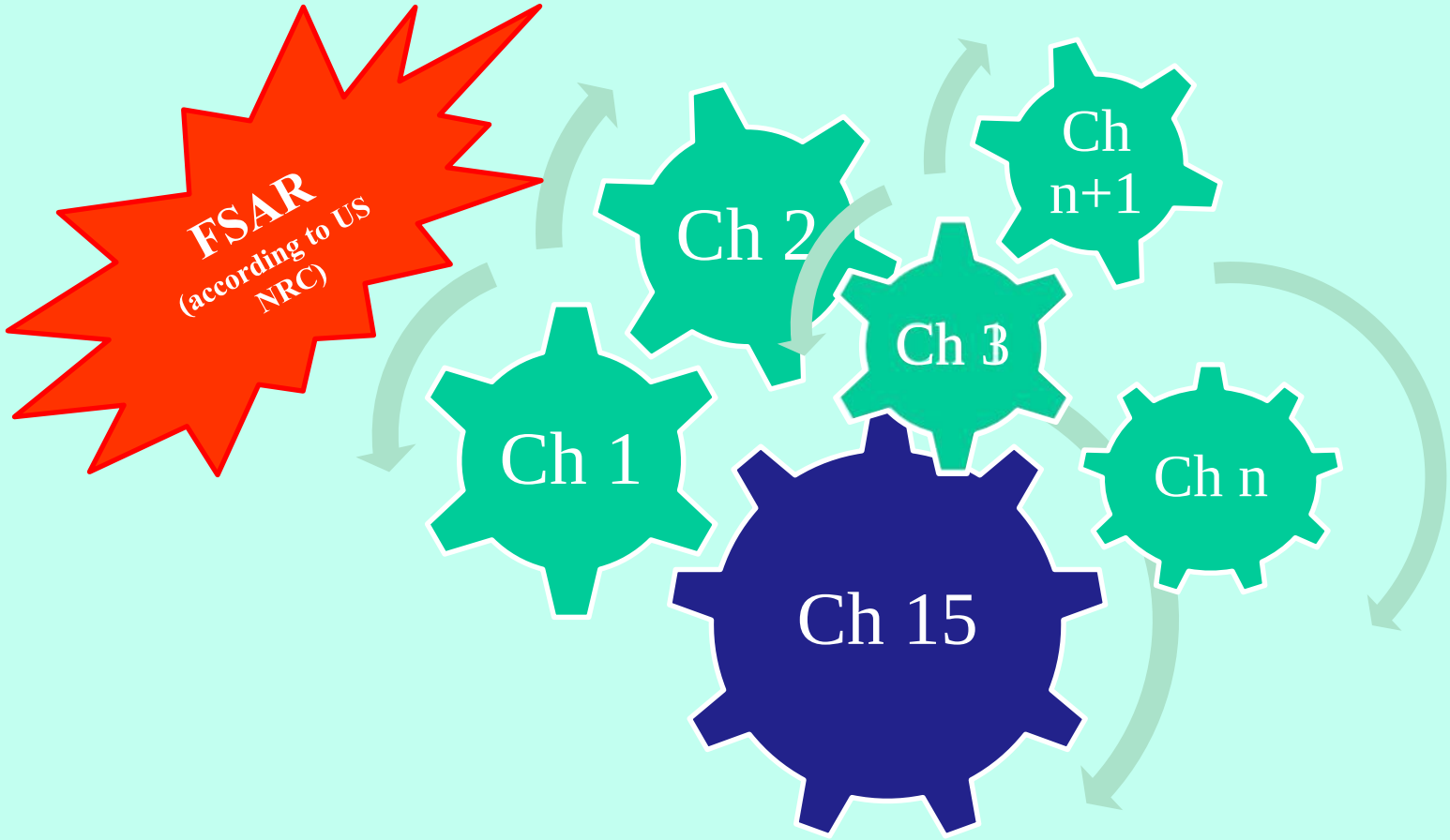




THE (NEW) VISION: THE I-FSAR

THE CURRENT SAFETY APPROACH & THE PROPOSAL – PART 1
>>>> THE ACCIDENT ANALYSIS <<<<

AA and FSAR: FSAR built around Chapter 15 – all chapters consistent with Chapter 15



THE (NEW) VISION: THE I-FSAR

THE CURRENT SAFETY APPROACH & THE PROPOSAL – PART 1
>>>> THE FSAR TOPICS <<<<

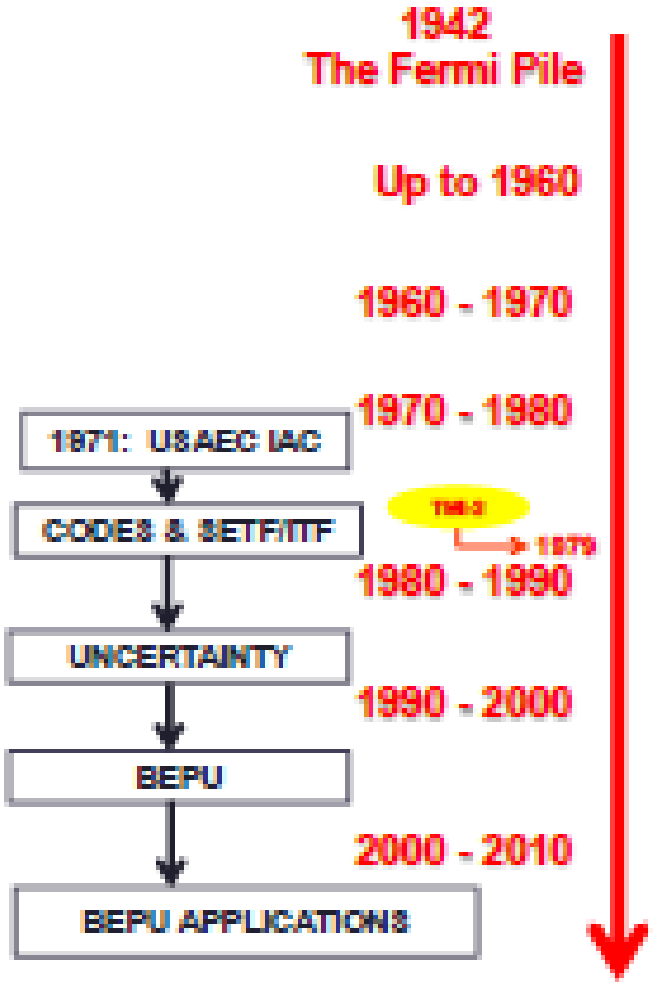
ALPHABETICAL LIST OF SUBJECTS OF COMPETENCE
(… > 100 …)

Civil Engineering
Climatology (including siting needs)
Control Rod mechanisms
Corrosion
Component (nuclear) qualification and …
Computational tools…

- Atmospheric diffusion
- Computational Fluid Dynamics (CFD)
- Containment

THE (NEW) VISION: THE I-FSAR

THE CURRENT SAFETY APPROACH & THE PROPOSAL – PART 1
>>>> THE TIME FRAME LANDMARKS <<<<



The Thermal Capacity of Graphite.

Heat Transfer & Pressure Drops.

TH Fundamentals; TPCF; Blow-down; CHF/DNB.

LBLOCA – 'Conservatism'; TPCF; CHF/DNB; Code Design.

SBLOCA – BE / 'Realism'; Scaling; 2D/3D; CCFL; NC; Code V & V.

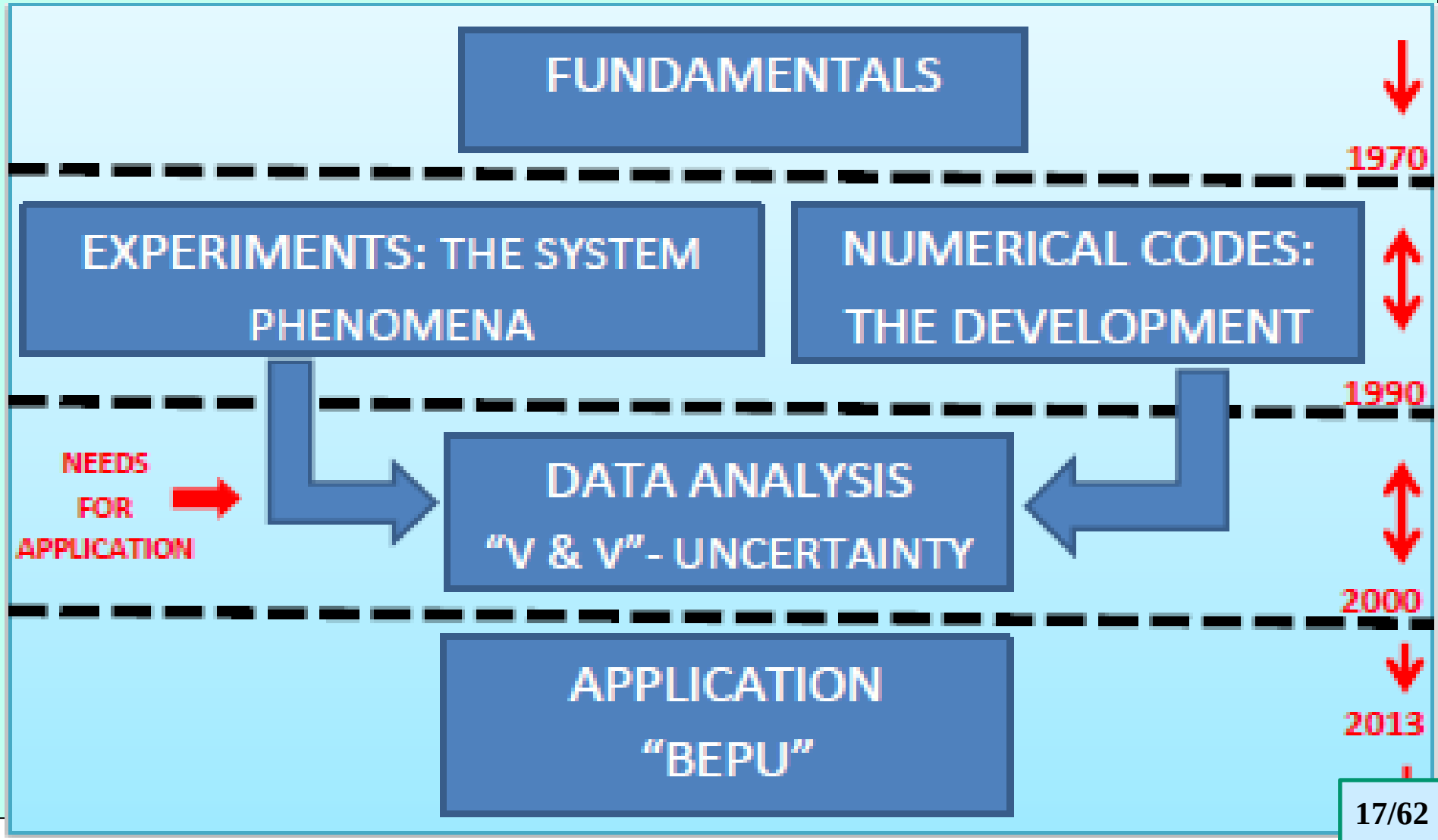
AM; CFD; Uncertainty; Code V & V; Code Application.

Licensing: BEPU (Code Application & Scaling); Passive SYS TH.

BEPU Integration with: 3D NK, Structural Mechanics, CFD.

THE (NEW) VISION: THE I-FSAR

THE CURRENT SAFETY APPROACH & THE PROPOSAL – PART 1
>>>> THE TIME FRAME LANDMARKS <<<<



THE (NEW) VISION: THE I-FSAR

THE CURRENT SAFETY APPROACH & THE PROPOSAL – PART 1
>>>> STRENGTHS & WEAKNESSES OF FSAR <<<<

FSAR
=
THE COMPENDIUM OF NRST FOR INDIVIDUAL NPP

STRENGTHS

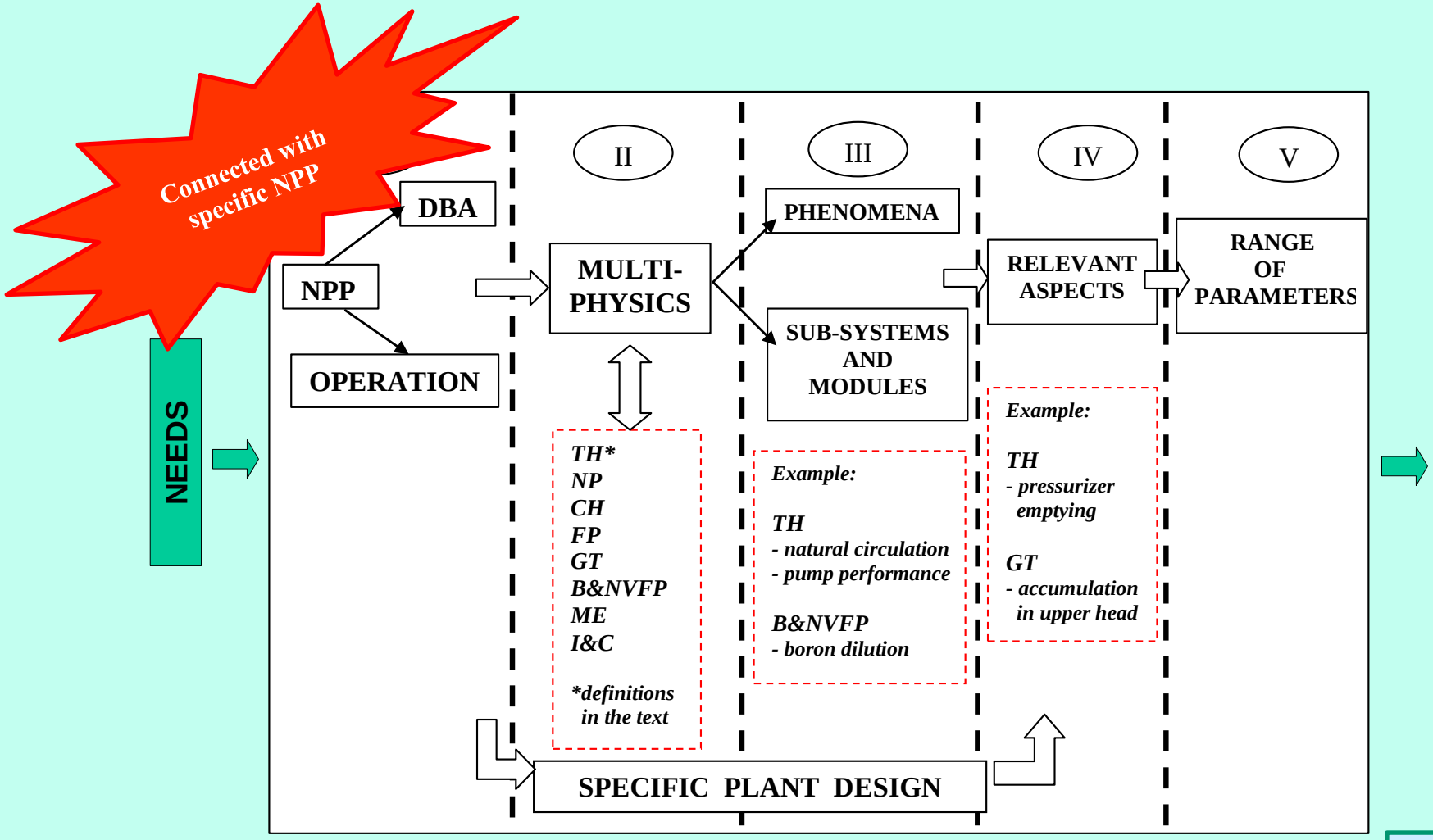
Structure & List of Content
Requirements & Acceptance Criteria

WEAKNESSES

Cross-connections among Subjects
Vendor/Owner produced

THE (NEW) VISION: THE I-FSAR

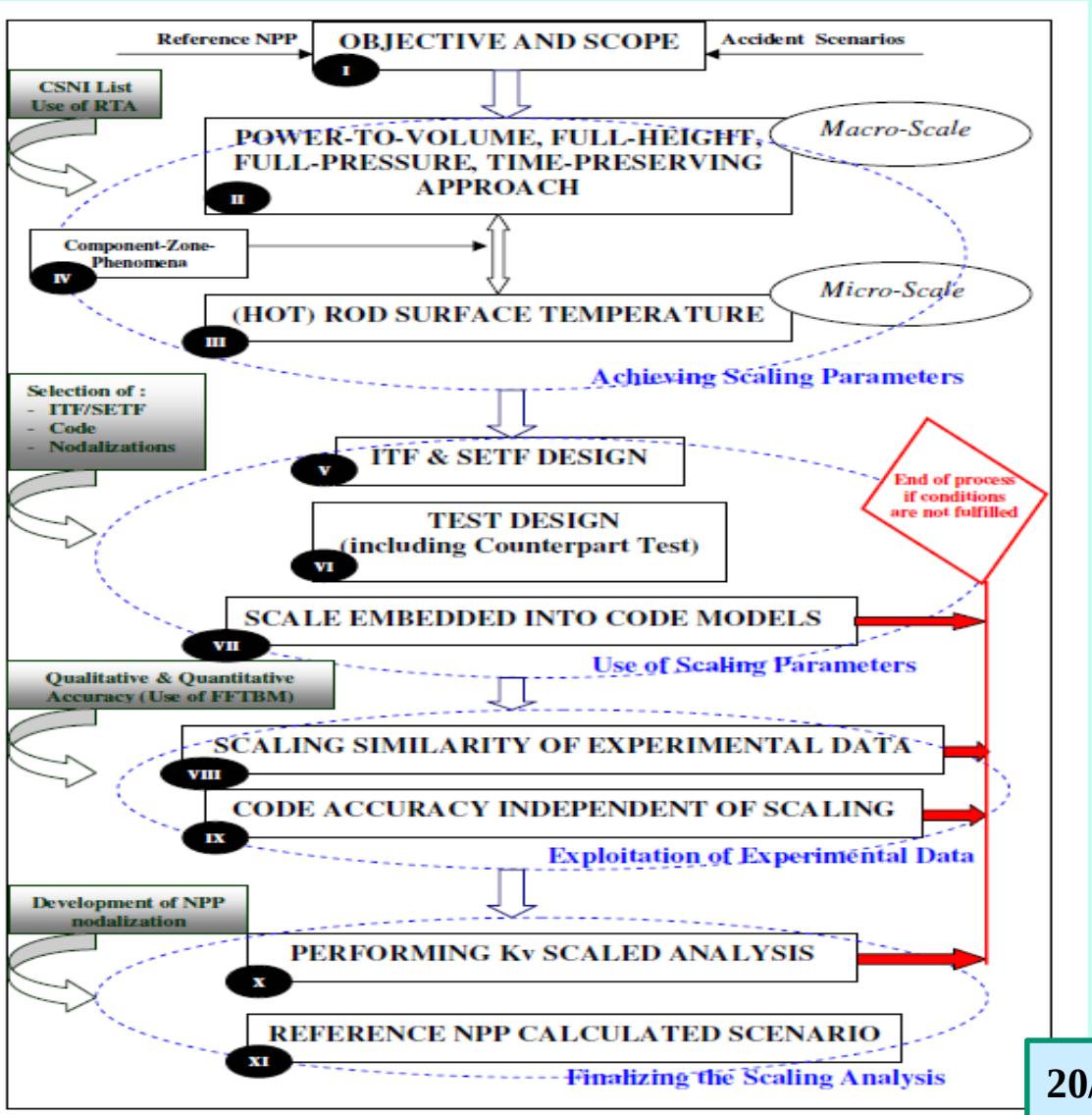
THE CURRENT SAFETY APPROACH & THE PROPOSAL – PART 1
>>>> BEPU & VALIDATION <<<<



THE (NEW) VISION: THE I-FSAR

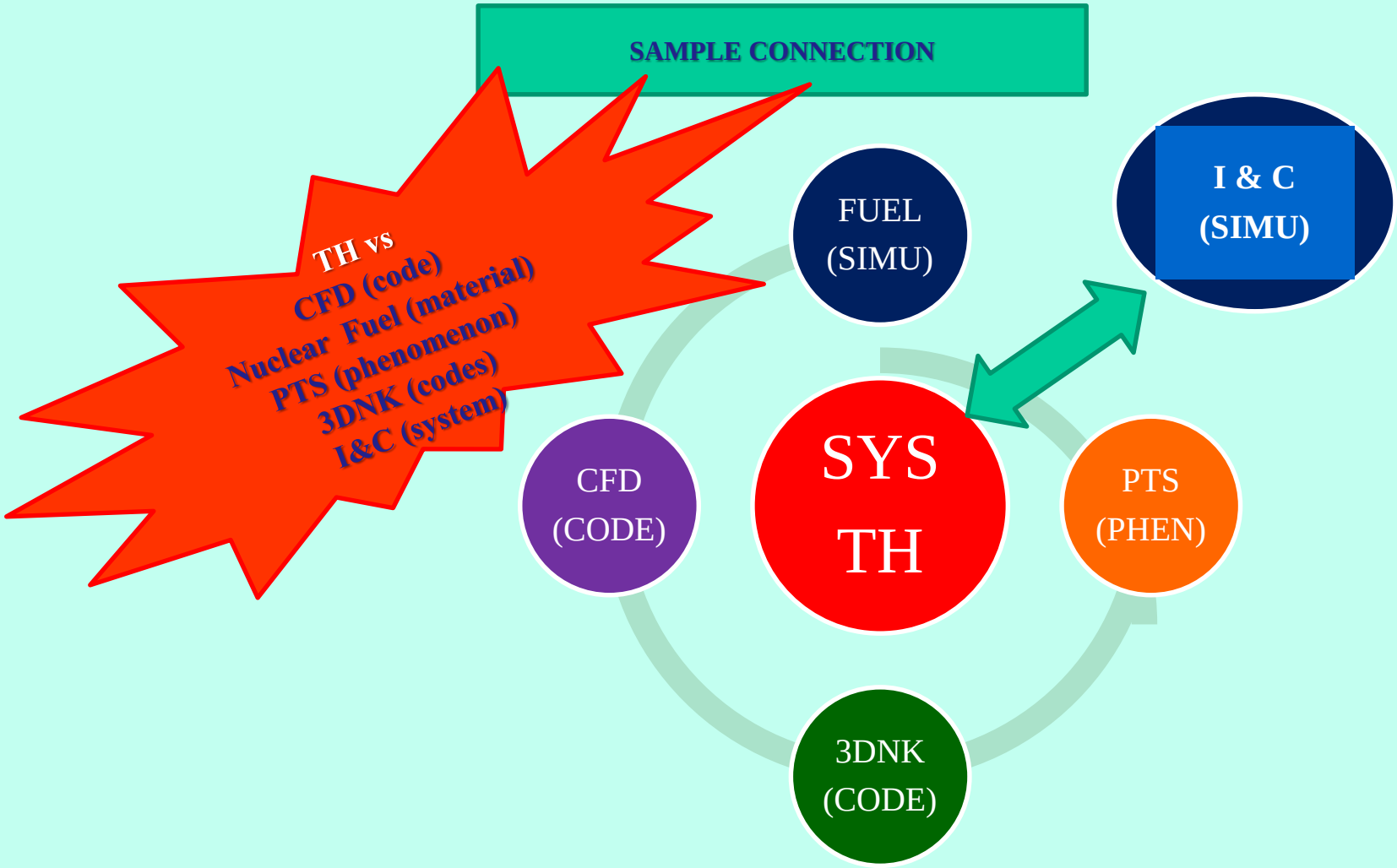
THE CURRENT SAFETY APPROACH & THE PROPOSAL – PART 1
>>>> BEPU & SCALING ISSUE <<<<

Connected with specific CODE



THE (NEW) VISION: THE I-FSAR

THE CURRENT SAFETY APPROACH & THE PROPOSAL – PART 1
>>>> BEPU & NON-TH CODES <<<<

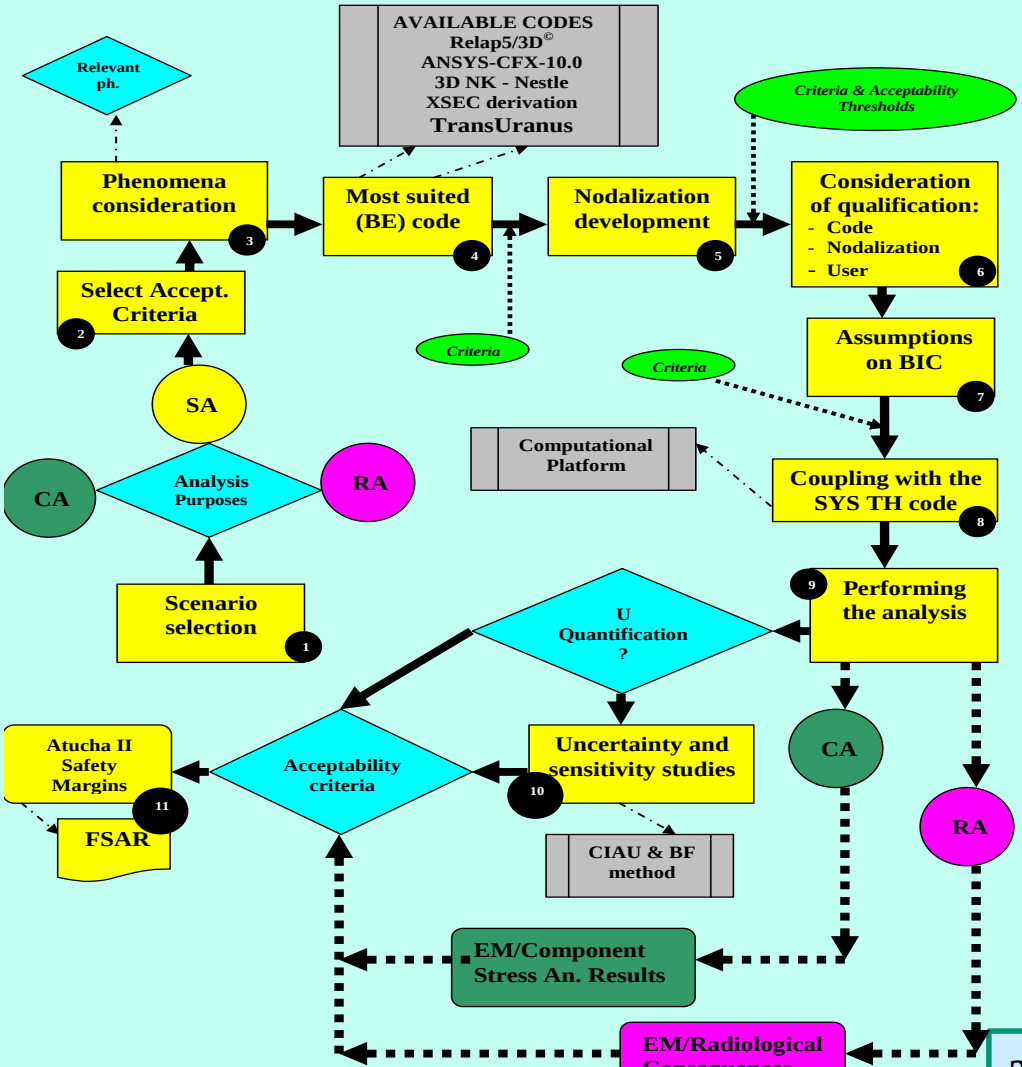


THE (NEW) VISION: THE I-FSAR

THE CURRENT SAFETY APPROACH & THE PROPOSAL – PART 1
>>>> BEPU MOTIVATIONS & FEATURES <<<<

The Road-Map for BEPU

Impractical to summarize BEPU in a few slides



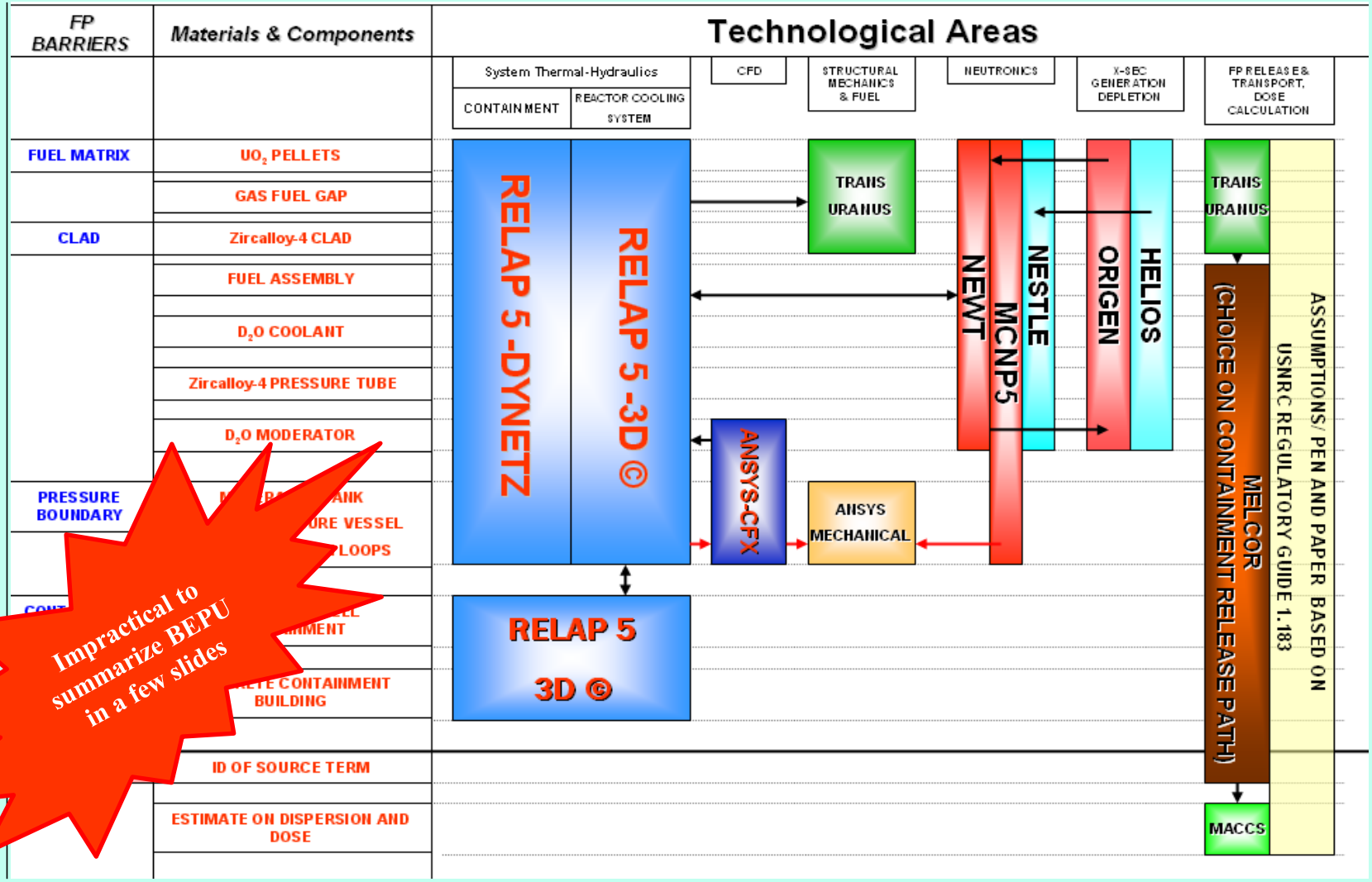
SYSTEM ANALYSIS

COMPONENT ANALYSIS

RADIOLOGICAL CONSEQUENCES ANALYSIS

THE (NEW) VISION: THE I-FSAR

THE CURRENT SAFETY APPROACH & THE PROPOSAL – PART 1
>>>> BEPU MOTIVATIONS & FEATURES <<<<



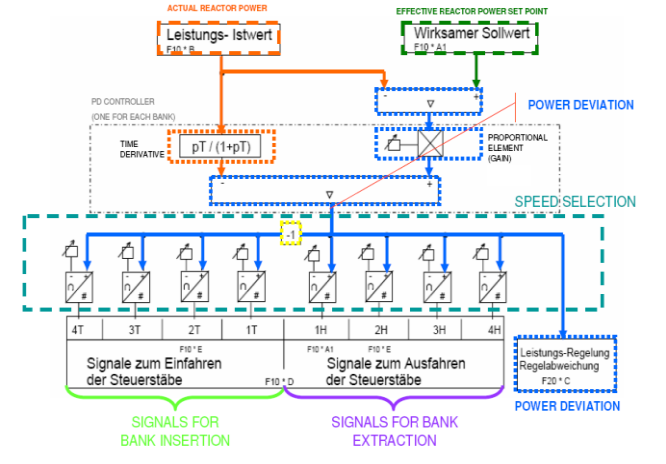
THE (NEW) VISION: THE I-FSAR

THE CURRENT SAFETY APPROACH & THE PROPOSAL – PART 1
>>>> BEPU and I & C MODELING <<<<

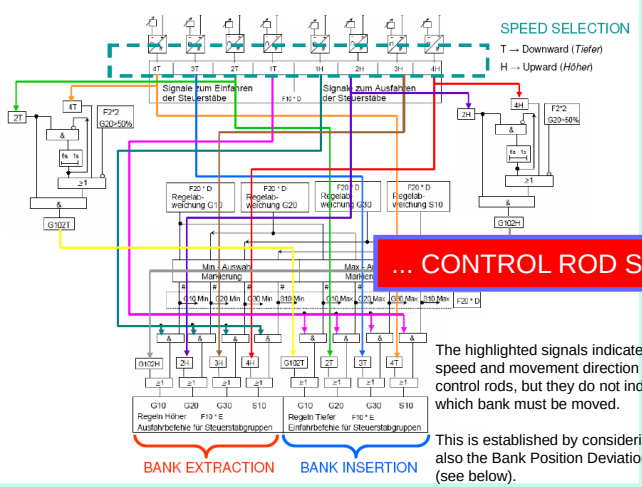
Computational Tools & Qualification
I & C

.... REACTOR POWER DEVIATION

- The Power Deviation for the control system is produced by a PD controller and it is used to select speed and movement direction for the bank movement.
- The bank that must be moved is selected in a different logic (showed in the following)



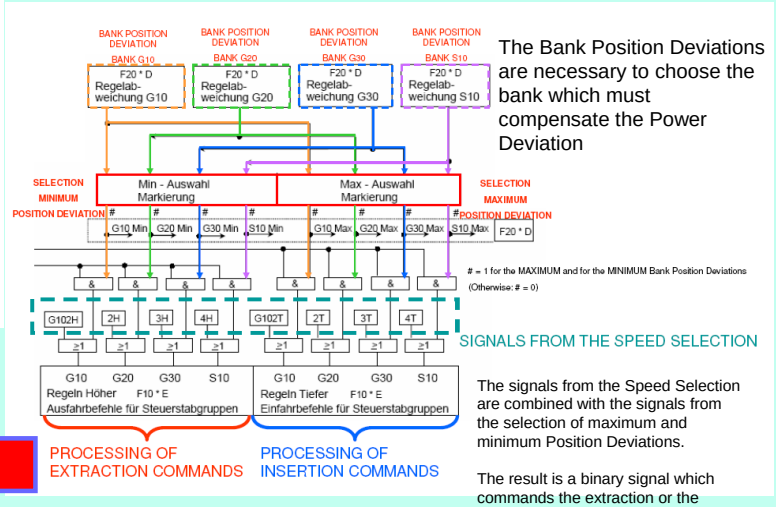
... CONTROL ROD SPEED



The highlighted signals indicate only speed and movement direction of the control rods, but they do not indicate which bank must be moved.

This is established by considering also the Bank Position Deviations (see below).

... BANK POSITION DEVIATION



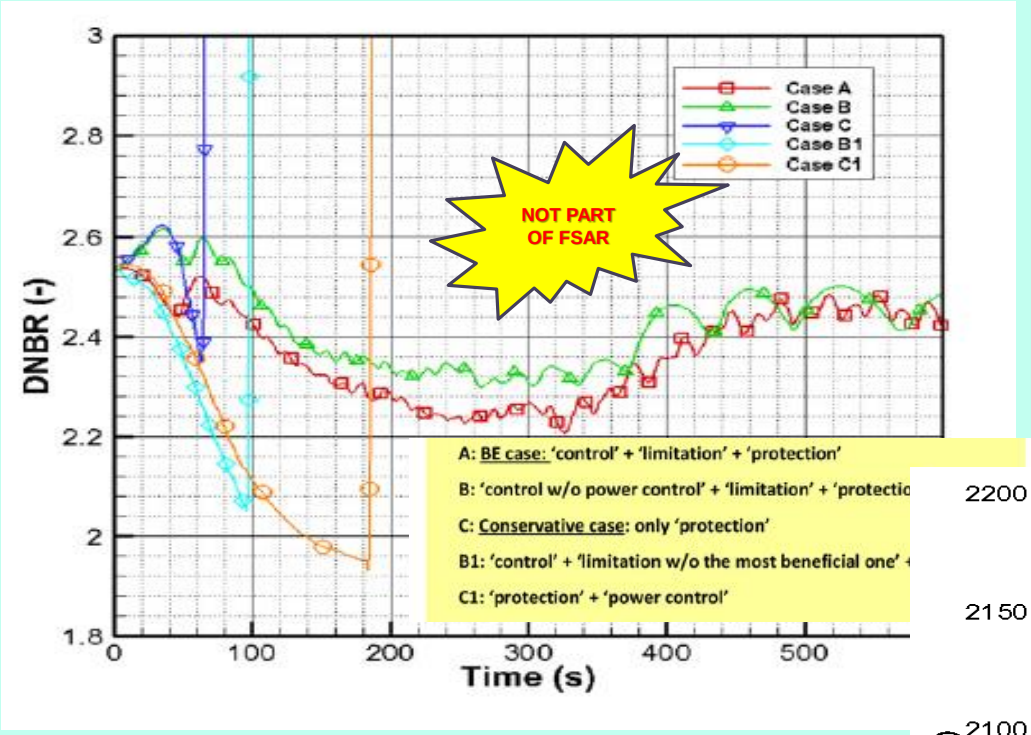
The Bank Position Deviations are necessary to choose the bank which must compensate the Power Deviation

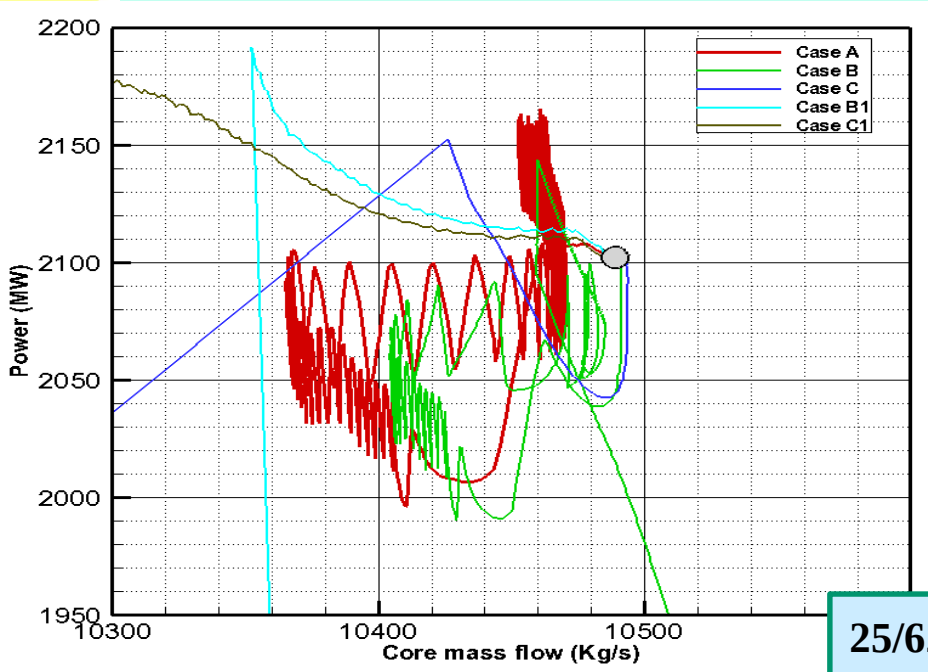
The signals from the Speed Selection are combined with the signals from the selection of maximum and minimum Position Deviations.

The result is a binary signal which commands the extraction or the insertion of a particular bank.

THE (NEW) VISION: THE I-FSAR

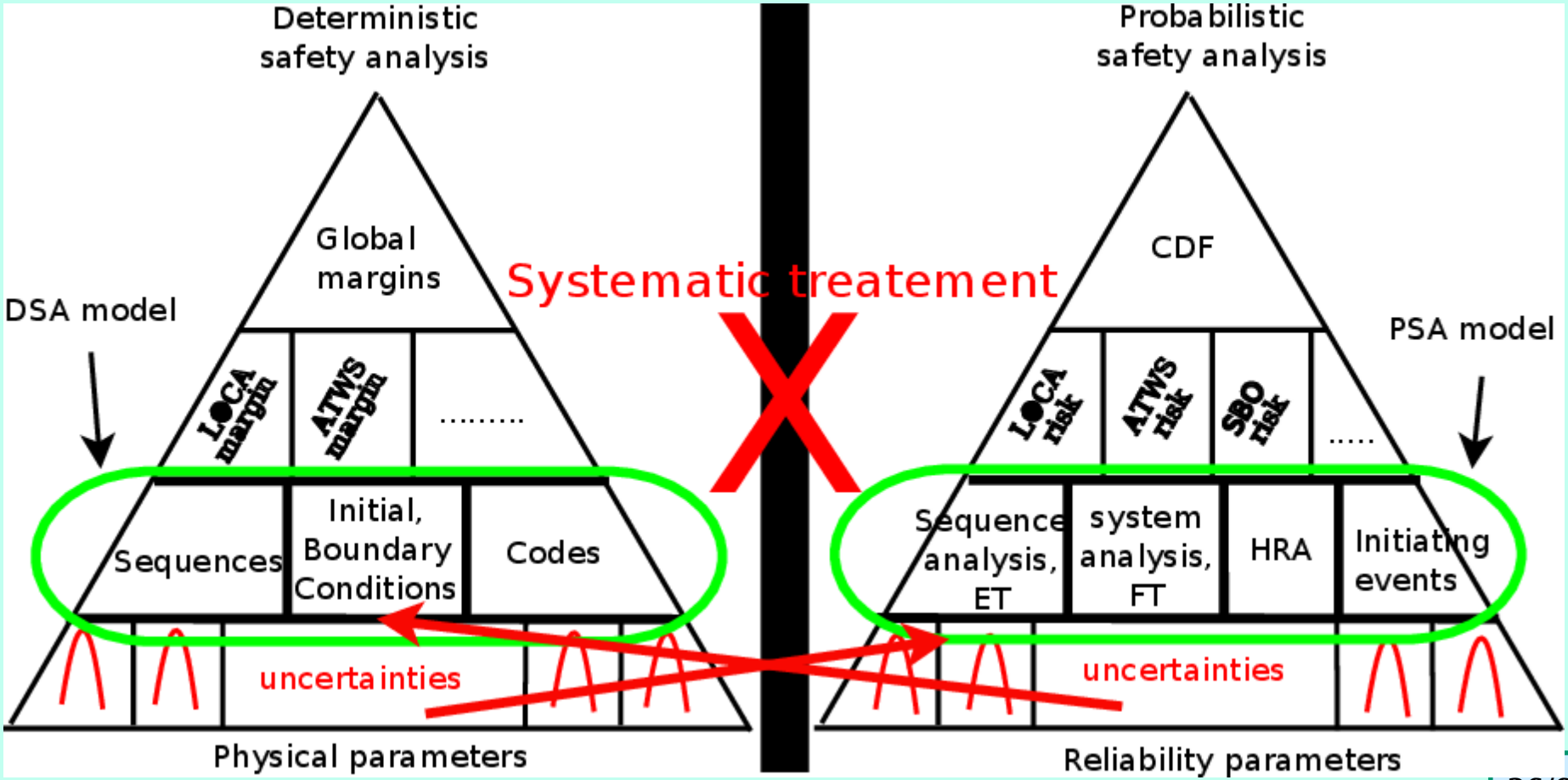
THE CURRENT SAFETY APPROACH & THE PROPOSAL – PART 1
>>>> BEPU and I & C MODELING <<<<





THE (NEW) VISION: THE I-FSAR

THE CURRENT SAFETY APPROACH & THE PROPOSAL – PART 1
>>>> INTEGRATION DSA-PSA <<<<



THE (NEW) VISION: THE I-FSAR

THE CURRENT SAFETY APPROACH & THE PROPOSAL – PART 1
>>>> ANOTHER VISION FOR BEPU <<<<

THE PROCESS

We are here!

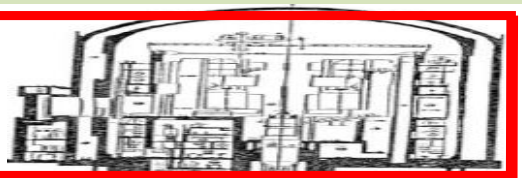
ACCIDENT ANALYSIS / FSAR – CHAPT. 15

LICENSING ← → BEPU ← Other Disciplines + PSA

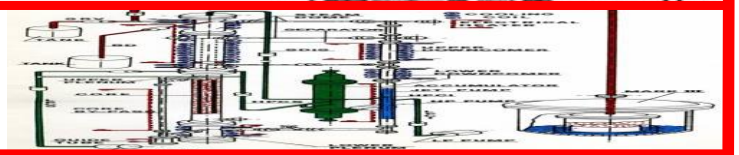
UNCERTAINTY

DATA

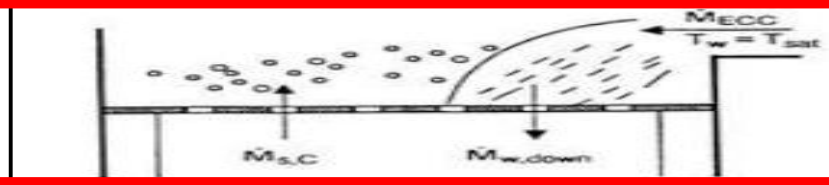
NPP



ITF



SETF



BASIC

SYS TH CODE DEVELOPMENT

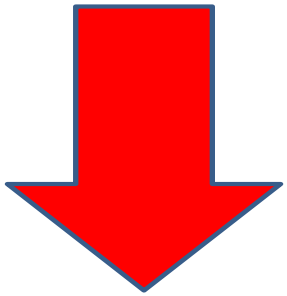
V & V - SCALING

THE (NEW) VISION: THE I-FSAR

THE CURRENT SAFETY APPROACH & THE PROPOSAL – PART 1
>>>> ANOTHER VISION FOR BEPU <<<<

… BEYOND (current) BEPU

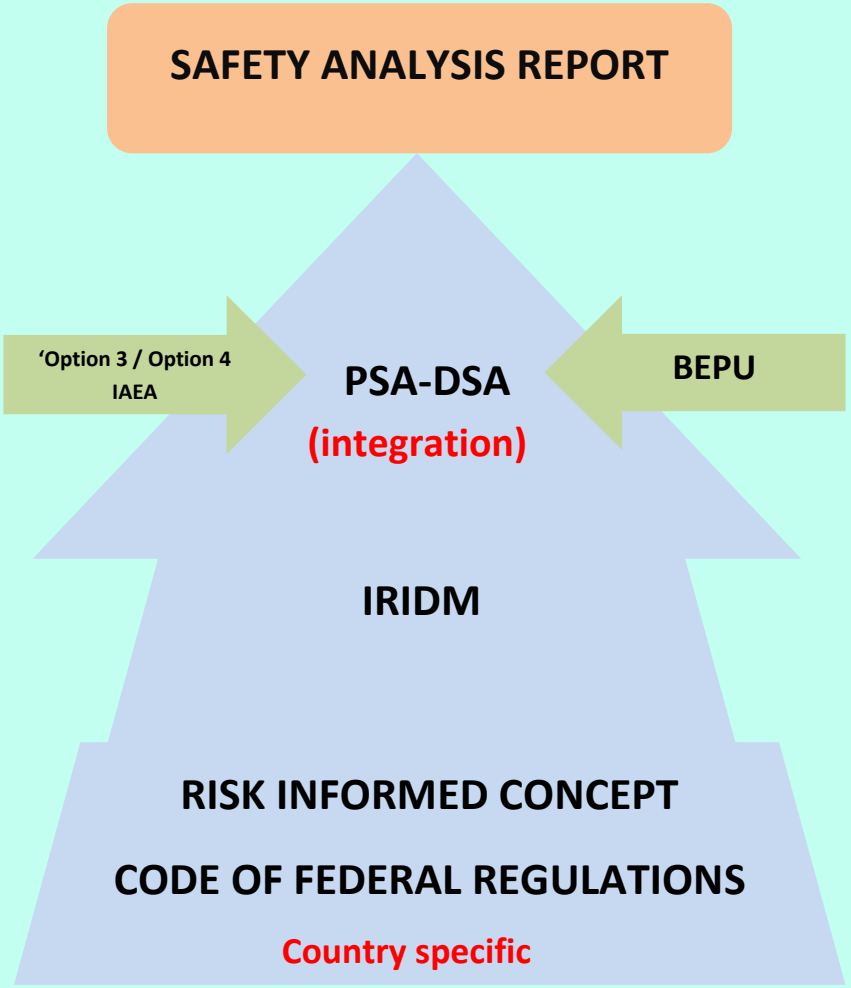
TO APPLY THE [TH] BEPU TECHNOLOGY
(V & V – SCALING – UNCERTAINTY – CODE COUPLING – PSA …)
TO ANY ANALYSIS NEEDED FOR NPP SAFETY



BEPU – (I) FSAR

THE (NEW) VISION: THE I-FSAR

THE CURRENT SAFETY APPROACH & THE PROPOSAL – PART 1
>>>> SUMMING-UP BEPU BASED I-FSAR <<<<



THE (NEW) VISION: THE I-FSAR

THE CURRENT SAFETY APPROACH & THE PROPOSAL – PART 1
>>>> INNOVATION OF BEPU BASED I-FSAR <<<<

The **first key innovation** is that the Safety analysis shall be carried out by **experts independent** of the Owner, of the Vendor or the Designer for the concerned NPP.

The **second key innovation** is that the latest qualified analysis techniques shall be adopted as well as the latest qualified findings from technology research. This includes the **BEPU & DSA-PSA integration**.

The **third key innovation** is the objective of homogeneity in the NRST matters: analyses including calculation processes shall not be limited to the accident analysis, but encompass any **FSAR (analysis based) topic**.

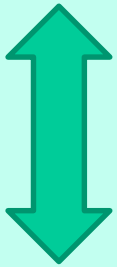
The **fourth key innovation**, see Part 2, consists in creating a connection (systems and/or controls) between **safety analysis and the hardware** of the NPP.

THE (NEW) VISION: THE SM-DC

THE CURRENT SAFETY APPROACH & THE PROPOSAL – PART 2
THE TARGET & MOTIVATION

TO STRENGHTEN THE CONNECTION

FSAR / SAFETY ANALYSIS



NPP HARDWARE / OPERATION

THE (NEW) VISION: THE SM-DC

THE CURRENT SAFETY APPROACH & THE PROPOSAL – PART 2
THE LIST OF CONTENT

1) THE DEFINITION OF SM

- The Standard Definition
- The Extended Definition
- The Connection with I-FSAR

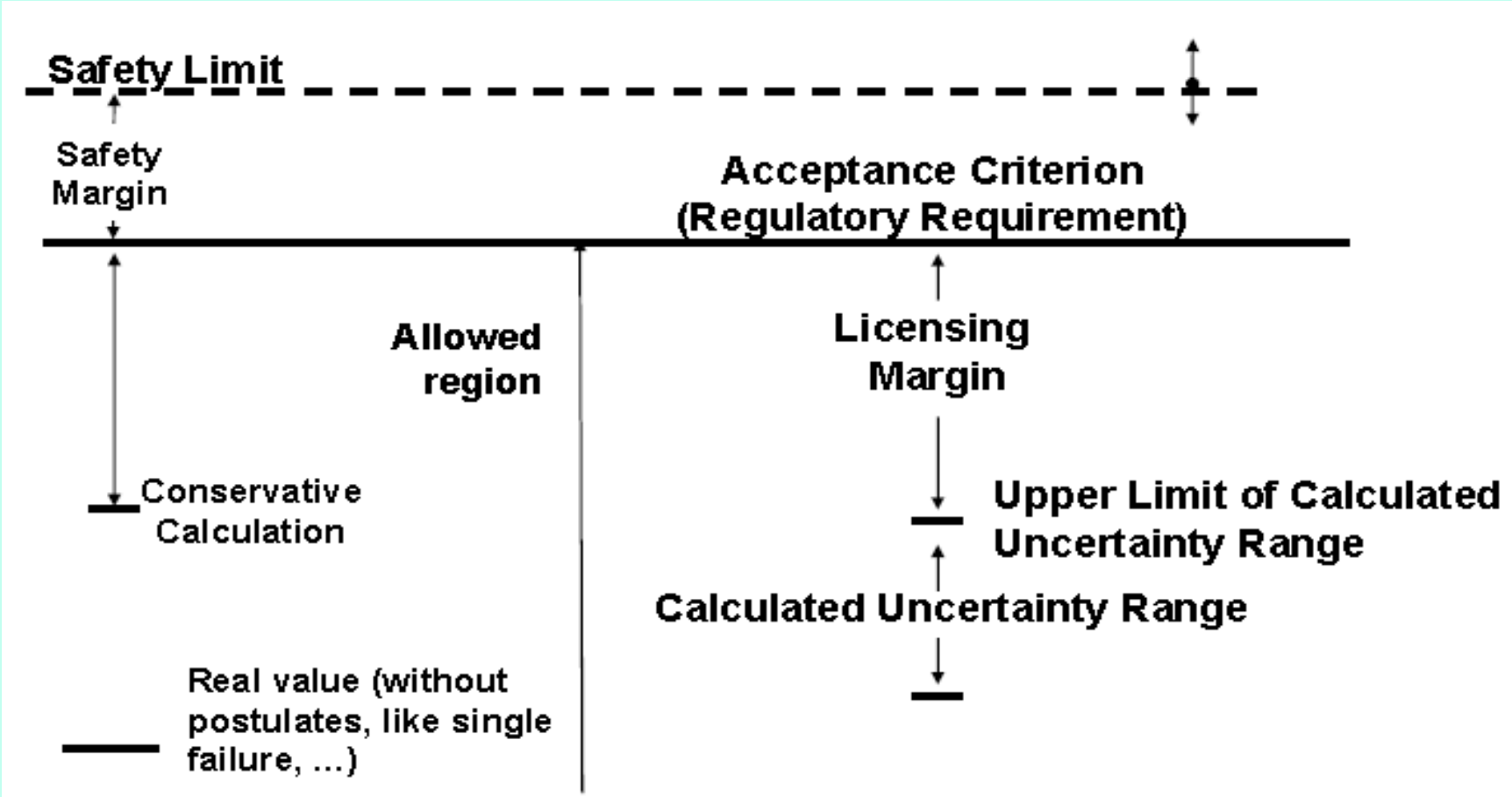
2) IMPLEMENTATION & WORKING MODALITIES

- The SM Matrix
- The Application of Extended SM Concept

THE (NEW) VISION: THE SM-DC

THE CURRENT SAFETY APPROACH & THE PROPOSAL – PART 2
>>>> THE STANDARD DEFINITION OF SM <<<<

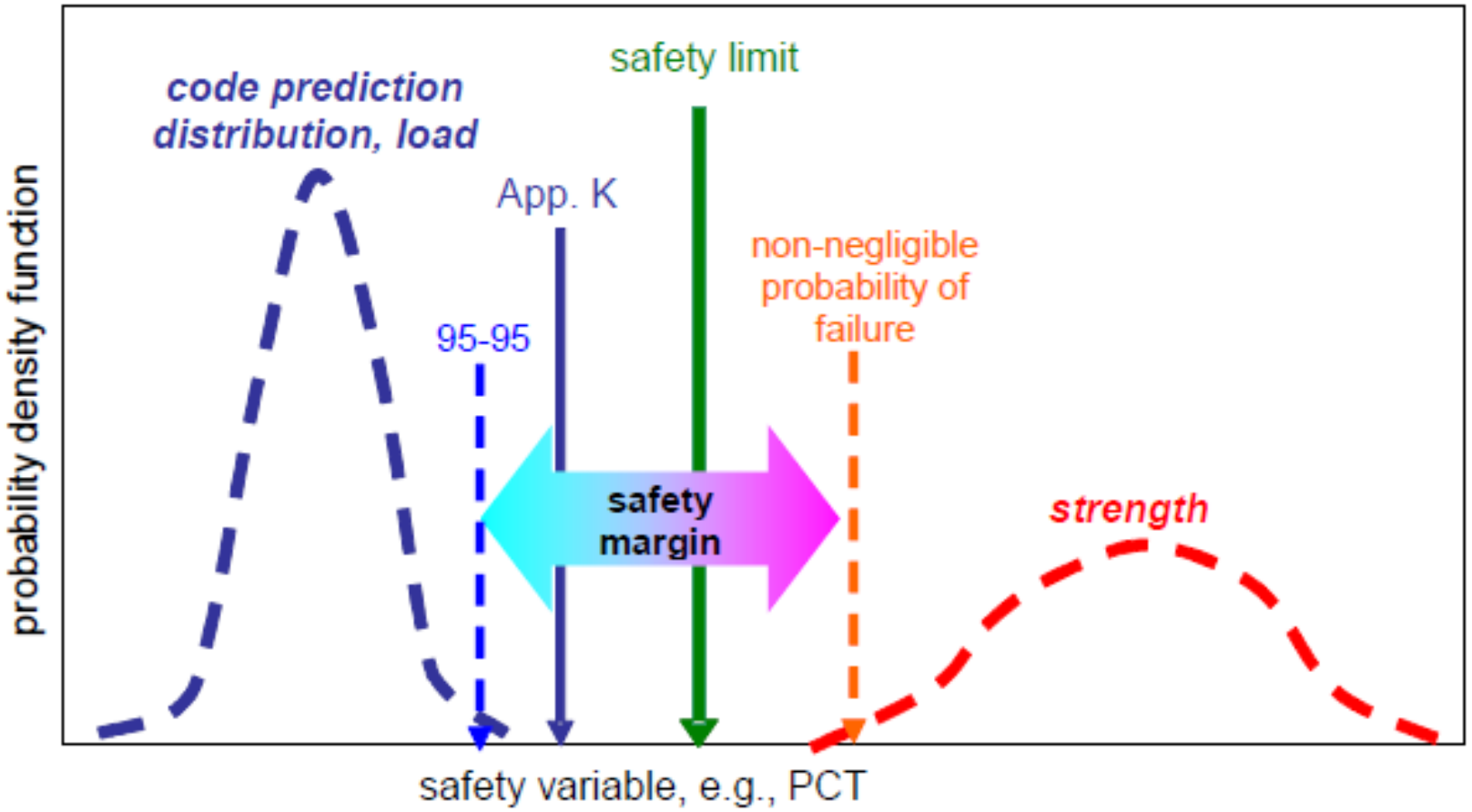
THE ORIGINAL



THE (NEW) VISION: THE SM-DC

THE CURRENT SAFETY APPROACH & THE PROPOSAL – PART 2
>>>> THE STANDARD DEFINITION OF SM <<<<

THE CONSIDERATION OF THE STOCHASTIC NATURE OF THE PROCESSES …



THE (NEW) VISION: THE SM-DC

THE CURRENT SAFETY APPROACH & THE PROPOSAL – PART 2
>>>> FROM STANDARD TO EXTENDED DEFINITION OF SM <<<<

THE STARTING POINT

- 1 (one) Safety Objective
- 10 (ten) Safety Principles
- 5 (five) levels of Defense in Depth
- 6 (six) 'generalized' Safety Barriers
- 19 (nineteen) Safety Functions
- ~ 20 (about-twenty) standard-accepted definitions for SM
- > 100 (more-than-one-hundred) concepts-statements connected with SM
- Safety Analysis and connected DSA and PSA.

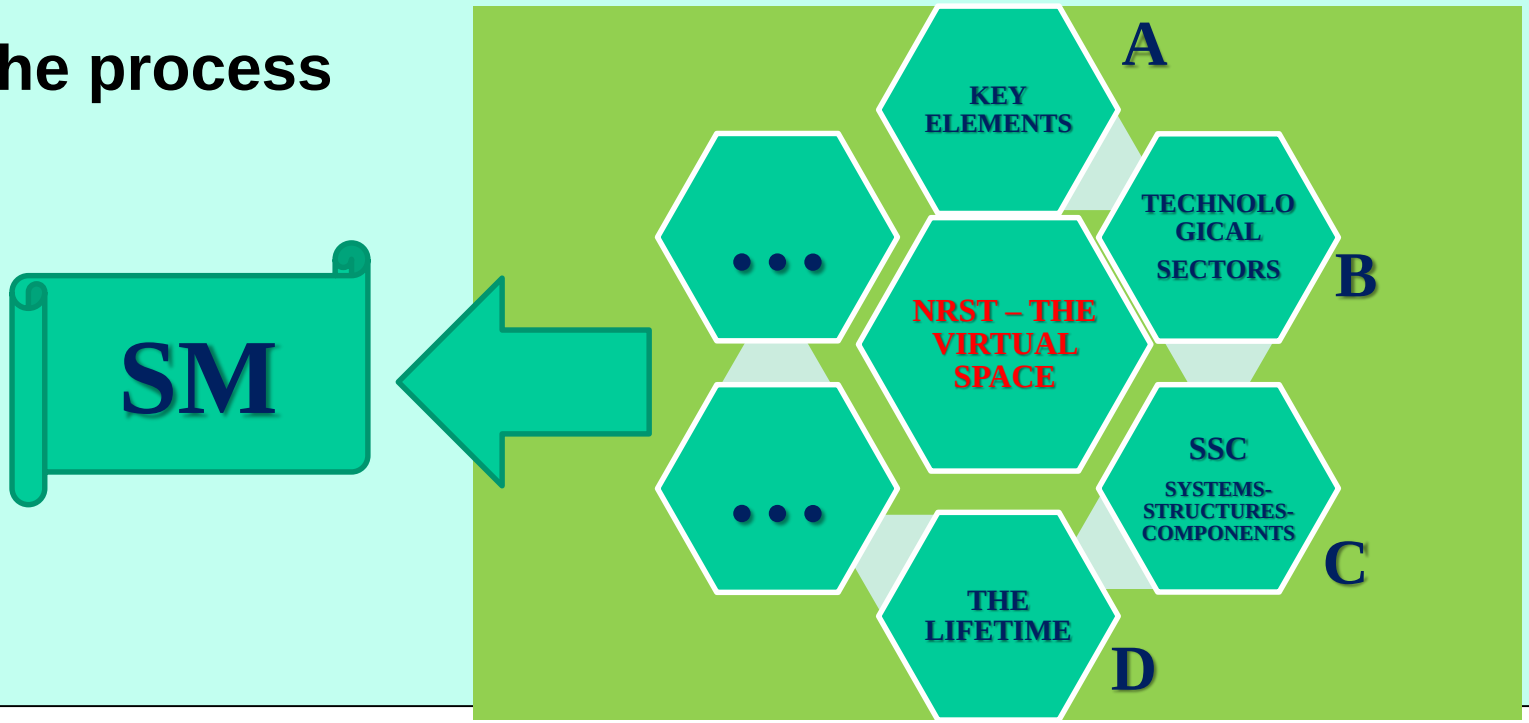
THE (NEW) VISION: THE SM-DC

THE CURRENT SAFETY APPROACH & THE PROPOSAL – PART 2
>>>> FROM STANDARD TO EXTENDED DEFINITION OF SM <<<<

IAEA ACTIVITY in progress:

… the words Safety Margins are used in combination with the words Design Margins.

The process



THE (NEW) VISION: THE SM-DC

THE CURRENT SAFETY APPROACH & THE PROPOSAL – PART 2
>>>> FROM STANDARD TO EXTENDED DEFINITION OF SM <<<<

NRST : THE KEY ELEMENTS
THE 'A' LIST – 6 topics –

KEY ELEMENTS

A1) Safety Principles, i.e. SP-1 to SP-10;

A2) DID Levels, i.e. DL-1 to DL-5;

A3) Safety Barriers, i.e. SB-1 to SB-6;

A4) Safety Functions, i.e.SF-1 to SF-19;

A5) PSA Elements, i.e. PE-1 to PE-n;

A6) DSA Elements, i.e. DE-1 to DE-m.

THE (NEW) VISION: THE SM-DC

THE CURRENT SAFETY APPROACH & THE PROPOSAL – PART 2
>>>> FROM STANDARD TO EXTENDED DEFINITION OF SM <<<<

NRST THE TECHNOLOGICAL SECTORS
THE 'B' LIST – 5 topics –

TECHNOLOGICAL SECTORS

B1) Radio-Protection

B2) Thermal-Hydraulics

B3) Structural Mechanics

B4) Neutron Physics

B5) Civil & Electrical Engineering

THE (NEW) VISION: THE SM-DC

THE CURRENT SAFETY APPROACH & THE PROPOSAL – PART 2
>>>> FROM STANDARD TO EXTENDED DEFINITION OF SM <<<<

NRST: THE SSC – SYSTEMS, STRUCTURES COMPONENTS
THE 'C' LIST – 19 topics –

SSC
SYSTEMS-STRUCTURES-COMPONENTS

C1) Reactor Pressure Vessel (RPV);

C2) Reactor Coolant System (RCS) piping;

C3) Balance of Plant (BOP) piping;

C4) Core - fuel;

C5) Core mechanical components;

C6) RPV components except core;

C7) RCS components;

C8) BOP components;

C9) Containment;

C10) Containment components;

C11) Core components;

C12) Reactor building;

C13) Auxiliary buildings;

C14) Reactor building and auxiliary building components;

C15) Site (parameters);

C16) Site structures and components;

C17) Off-site (NPP related relevant parameters);

C18) Off-site structures and components (NPP related);

C19) I & C .

THE (NEW) VISION: THE SM-DC

THE CURRENT SAFETY APPROACH & THE PROPOSAL – PART 2
>>>> FROM STANDARD TO EXTENDED DEFINITION OF SM <<<<

NRST: THE (NPP) LIFETIME
THE 'D' LIST – 7 topics –

THE LIFETIME

D1) Site selection;

D2) NPP design;

D3) NPP construction;

D4) NPP licensing;

D5) NPP operation;

D6) NPP maintenance;

D7) NPP decommissioning.

THE (NEW) VISION: THE SM-DC

THE CURRENT SAFETY APPROACH & THE PROPOSAL – PART 2
>>>> THE MULTI-D SM MATRIX <<<<

The NRST Space, multi-face and multi-field
←→
multi-dimensional SM Matrix

D_i & corresponding ID									
The ID of B_i									
No	Safety Margin / Design Margin	B_i	C	A1	A2	A3	A4	A5	A6
1	Xxxx xxxxx xxxx xxxx	1 to n	1-n to 19-m	SP-1 to SP-10	DL-1 to DL-5	SB-1 to SB-6	SF-1 to SF-19	PE-1 to PE-n	DE-1 to DE-m
2									
…									
N									

THE (NEW) VISION: THE SM-DC

THE CURRENT SAFETY APPROACH & THE PROPOSAL – PART 2
>>>> THE MULTI-D SM MATRIX <<<<

	B1) Radio-Protection	B2) Thermal-Hydraulics	B3) Structural Mechanics	B4) Neutron Physics	B5) Civil & Electrical Engineering
D1) Site selection	1	2	3	4	5
D2) NPP design	6	7	8	9	10
D3) NPP construction	11	12	13	14	15
D4) NPP licensing	16	17	18	19	20
D5) NPP operation	21	22	23	24	25
D6) NPP maintenance	26	27	28	29	30
D7) NPP decommissioning	31	32	33	34	35

… ending-up (current version) with

- 35 SM definition tables
- A few-thousands SM definitions

THE (NEW) VISION: THE SM-DC

THE CURRENT SAFETY APPROACH & THE PROPOSAL – PART 2
>>>> THE IMPLEMENTATION OF THE IDEA <<<<

A FEW THOUSANDS SM DEFINITIONS *(ALSO FROM ALL AREAS OF THE BEPU BASED I-FSAR)*

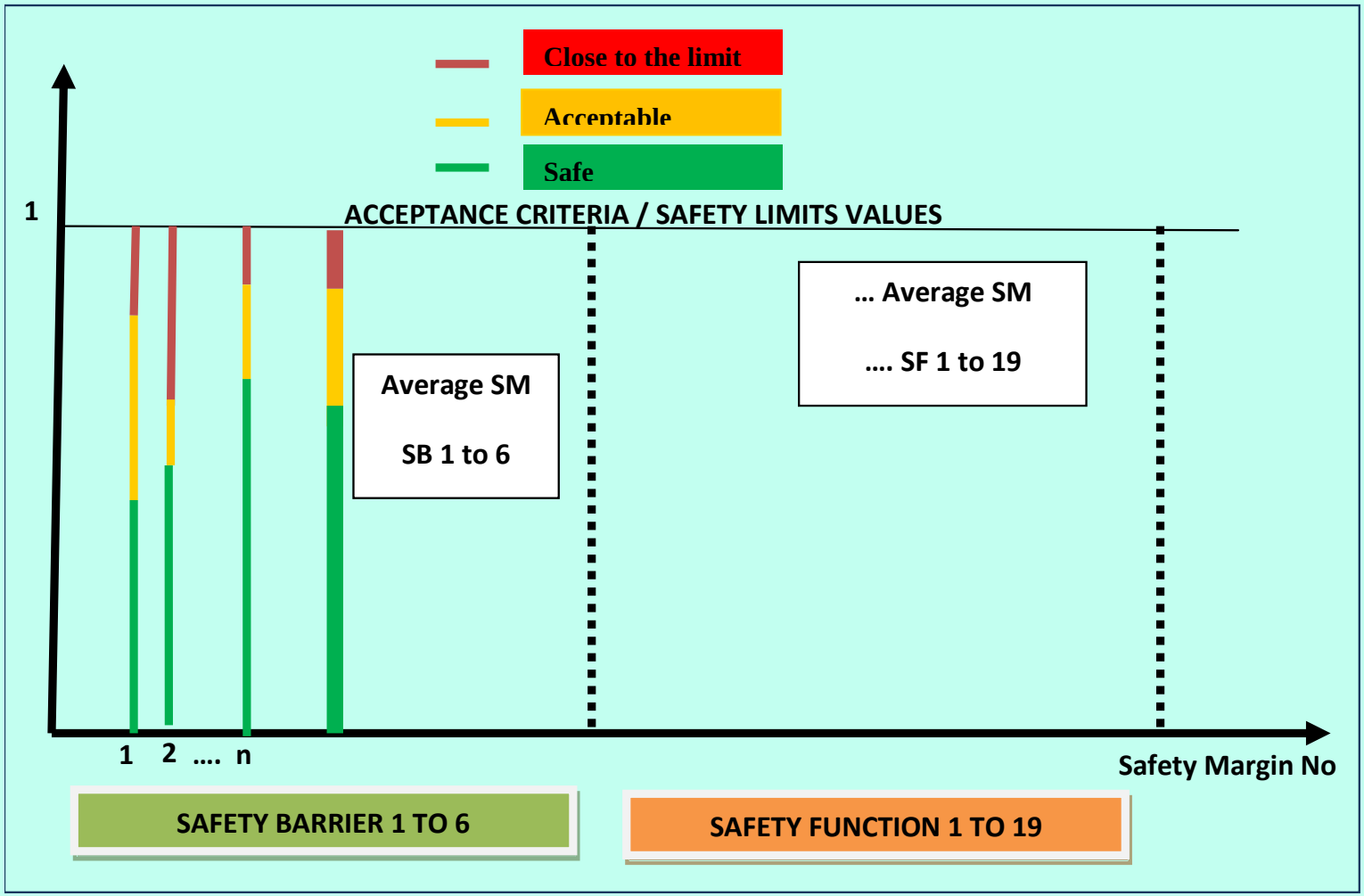
TRANSDUCERS DESIGNED-INSTALLED PER EACH SM

RANGE OF EACH SIGNAL

NEEDS DEFINITION-OF-ACCEPTANCE

THE (NEW) VISION: THE SM-DC

THE CURRENT SAFETY APPROACH & THE PROPOSAL – PART 2
>>>> THE APPLICATION OF THE SM-DC <<<<



THE (NEW) VISION: THE SM-DC

THE CURRENT SAFETY APPROACH & THE PROPOSAL – PART 2
>>>> INNOVATION OF SM-DC <<<<

The **first key innovation** is the homogeneous consideration of the **risk space**. (the acceptable SM for an airplane approaching the site added to a mistake of an employer…) including the combination of signals independent upon each other.

The **second key innovation** is the design of hardware corresponding to **risk indicators** derived from safety analysis. This, see Part 1, implies creating a connection between **safety analysis and the hardware** of the NPP.

SUMMARY – 1 OF 2

DUTY OF NUCLEAR SCIENTISTS AND TECHNOLOGISTS (RATHER THAN PROMOTING THE NUCLEAR ENERGY DEPLOYMENT) SHALL BE THE TECHNOLOGY IMPROVEMENT

IN THE CASE OF NRST

- The Emergency Rescue Team (ERT) as an additional safety barrier *(not discussed within the present vision)*

and

- The BEPU-based Independent FSAR (I-FSAR)

coupled with

- The Safety Margins Detection & Control

MAY CONSTITUTE IMPROVEMENTS TO RE-ESTABLISH THE PUBLIC TRUST TOWARD THE NUCLEAR ENERGY

SUMMARY – 2 OF 2

COST CONNECTION

FOR TYPICAL 1000 MWE PLANT

	ROUGH IN US $
NPP DESIGN-CONSTRUCTION	2 ÷ 5 E9
NPP LIFETIME PRODUCTION	< 6 E10
POTENTIAL ENVIRONMENT DAMAGE (following an un-controlled accident)	≈ E12
PROPOSED NRST IMPROVEMENTS	≈ E7*

** All together.*

CONCLUSIONS

SUBJECT HEREAFTER IS NPP TECHNOLOGY BASED ON WATER COOLED REACTORS

FOREWORD *(obvious)*

BACKGROUND *(un-necessary)*

THE (NEW) VISION *(ambitious)*

- **The Independent FSAR (I-FSAR)** PART 1
  - ✓ **The BEPU** *(established)*
- **Safety Margins – Detection & Control** PART 2

…NO CONCLUSION (Content: *Obvious, Un-necessary, and Ambitious or Established)*.

However, APPENDIX 1 (below):

Addressing Part 1 of the (New) Vision, the I-FSAR

APPENDIX 1

SUBJECT HEREAFTER IS NPP TECHNOLOGY BASED ON WATER COOLED REACTORS

Addressing Part 1 of the (New) Vision, the I-FSAR

COCONUT

COnsortium of COmpetence in NUclear Technology

THE INSTITUTION TO MANAGE THE

(NPP VENDOR/OWNER) INDEPENDENT FSAR

APPENDIX 1: COCONUT

COnsortium of COmpetence in NUclear Technology

THE FIELD OF COMPETENCE

THE TECHNOLOGY OF NUCLEAR SAFETY ANALYSIS

APPENDIX 1: COCONUT

COnsortium of COmpetence in NUclear Technology

THE TARGET

TO ISSUE THE I-FSAR

BEPU-BASED *INNOVATIVE* SAFETY ANALYSIS TECHNOLOGY

APPENDIX 1: COCONUT

COnsortium of COmpetence in NUclear Technology

THE MOTIVATIONS - 1 OF 2 (OTHER THAN I-FSAR)

NRST FULLY CONNECTED WITH COMPUTER SCIENCE. 1980 – 2010 IS THE DEVELOPMENT TIME FRAME.

SCIENTISTS / TECHNOLOGISTS SINCE 1980 COULD FOLLOW (CONTRIBUTE TO)THE DEVELOPMENT OF THE NRST AND HAVE «UNREPEATABLE» EXPERTISE.

THOSE SCIENTISTS CONSTITUTE THE OUTER LAYER OF COCONUT *(see below)*.

APPENDIX 1: COCONUT

COnsortium of COmpetence in NUclear Technology

THE MOTIVATIONS - 2 OF 2 (OTHER THAN I-FSAR)

THE COMPETENCE SPECTRUM IN NRST INCLUDES MORE THAN 100 SUBJECTS

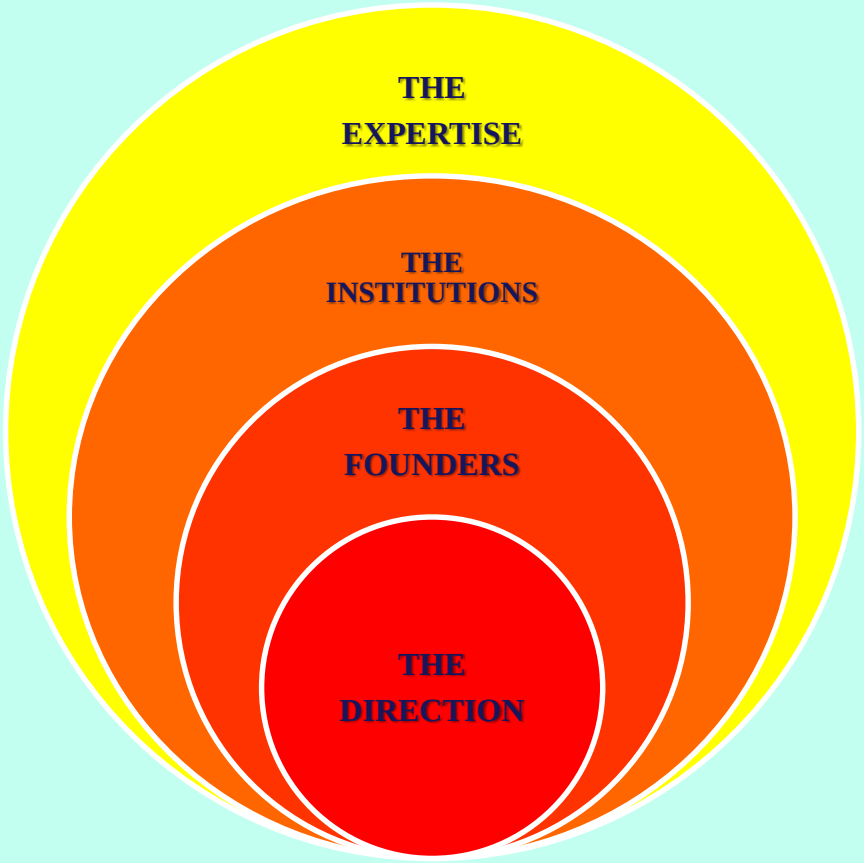
TOP LEVEL EXPERTISE EXPECTED PER EACH SUBJECT:

- ***SHORT & UNIQUE LICENSING TIME-FRAME (2-5 YEARS)***
- ***NOT AFFORDABLE BY ANY COMPANY***

APPENDIX 1: COCONUT

COnsortium of COmpetence in NUclear Technology

THE MACRO-STRUCTURE



APPENDIX 1: COCONUT

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THE STRUCTURE - 1 OF 2

THE INSTITUTIONS – 3RD LAYER

SENIOR/JUNIOR EXPERTS – 2ND LAYER

THE HEADQUARTERS

APPENDIX 1: COCONUT

COnsortium of COmpetence in NUclear Technology

THE STRUCTURE - 2 OF 2

THE SELECTED INSTITUTIONS (3 SO FAR) HAVING DECADES OF ENGAGEMENT IN NRST:

- PROVIDE POOL OF EXPERTISE & INFRASTRUCTURES
- DO NOT PREVENT MANAGEMENT FLEXIBILITY

THE COMBINATION OF SENIOR-JUNIOR EXPERTS:

- TO PROVIDE SUSTAINABILITY

DIFFERENT LEGAL AND OPERATING HEADQUARTERS

- SEPARATION OF MANAGEMENT-FINANCING-TECHNOLOGY

APPENDIX 1: COCONUT

COnsortium of COmpetence in NUclear Technology

THE KEY CHALLENGES

1) PROPRIETARY DATA ⟷ SECURITY OF INFORMATION
2) COMPETENCE AVAILABILITY & MANAGEMENT
3) DATA MANAGEMENT

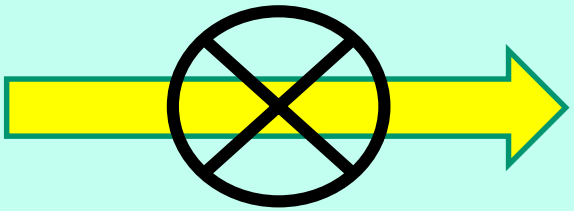
APPENDIX 1: COCONUT

COnsortium of COmpetence in NUclear Technology
The Challenges – 1 of 3

PROPRIETARY DATA & SECURITY OF INFORMATION

complex process

Pieces of the puzzle available



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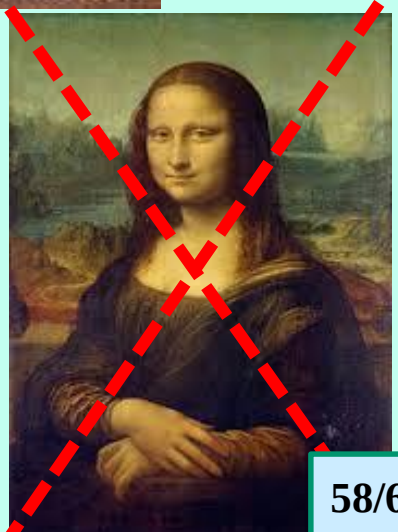
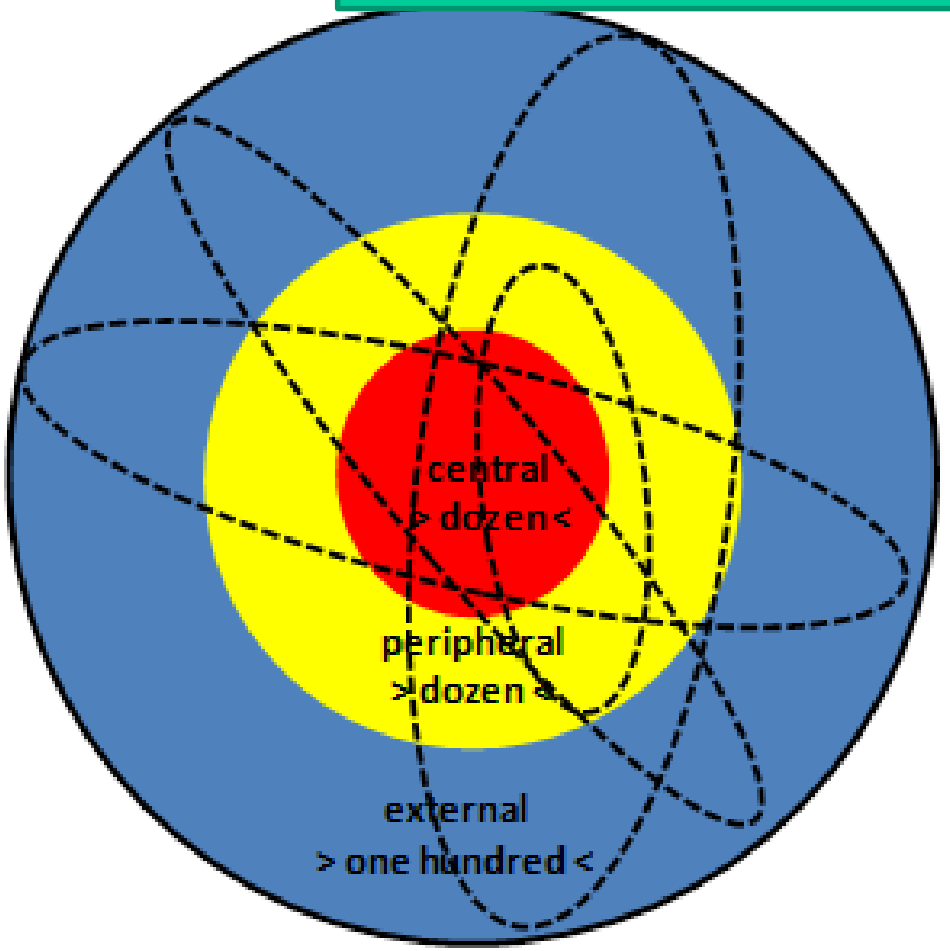


APPENDIX 1: COCONUT

COnsortium of COmpetence in NUclear Technology
The Challenges – 1 of 3

COCONUT: (Rough) Working Mode for security of information



NOMENCLATURE

central = expertise & management
(one dozen involved)

peripheral = expertise
(one dozen involved)

external = competence
(one hundred involved)

dotted lines = (time) period working group

full line = envelope of working modes

APPENDIX 1: COCONUT

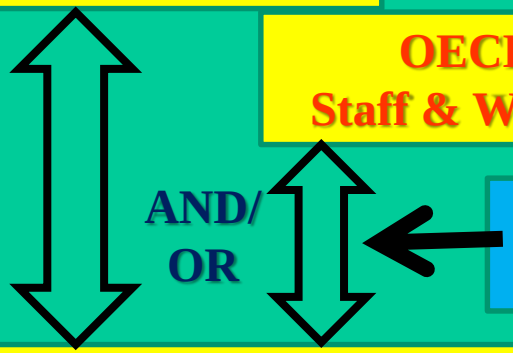
COnsortium of COmpetence in NUclear Technology
The Challenges – 2 of 3

AVAILABILITY & MANAGEMENT OF COMPETENCE

AVAILABILITY (OF EXPERTS)

IAEA
Staff & WG member

OECD/NEA
Staff & WG member



> 20 year expertise

Institution/Company

- R & D
- Consultancy
- Designer-Regulator
- University – Nat. Lab.

COMPETENCE MANAGEMENT

DIRECTORS EXPERTISE

Sample Expertise

- Project manager (> 10 E7 USD)
- Directing Expert Groups
- IAEA Senior Staff
- Conference Chair
- Project Direction

APPENDIX 1: COCONUT

COnsortium of COmpetence in NUclear Technology
The Challenges – 3 of 3

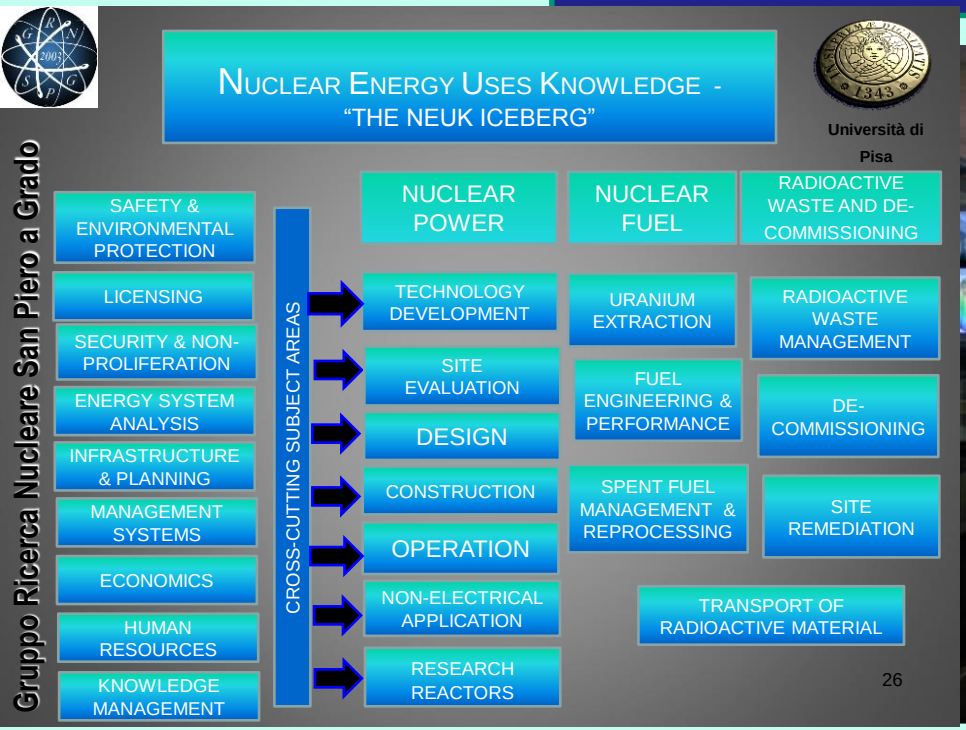
DATA MANAGEMENT

DESIGN-CONSTRUCTION-OPERATION OF NUTEMA

INSPIRED BY IAEA:

INSAG-19 – Design Authority (Concept)

INSAG-25 – IRIDM (Integrated Risk Informed Decision Making)




Exploiting the Iceberg
of Competence