



**SLOVENSKÉ
ELEKTRÁRNE**

NUSIM Conference 2006

**Operational Safety
Performance of Slovak NPPs
in 2005**

Levice, 27 – 28th April 2006

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Presentation Structure

- ◆ Operational safety performance monitoring system
- ◆ Performance of Slovak NPPs in 2005
- ◆ Conclusions



Three factors of high level of safety

- ◆ good design
- ◆ operational safety →
- ◆ human performance

**MUST BE IN A COMPLEX
INTERACTION!!!**



Safety performance indicator system

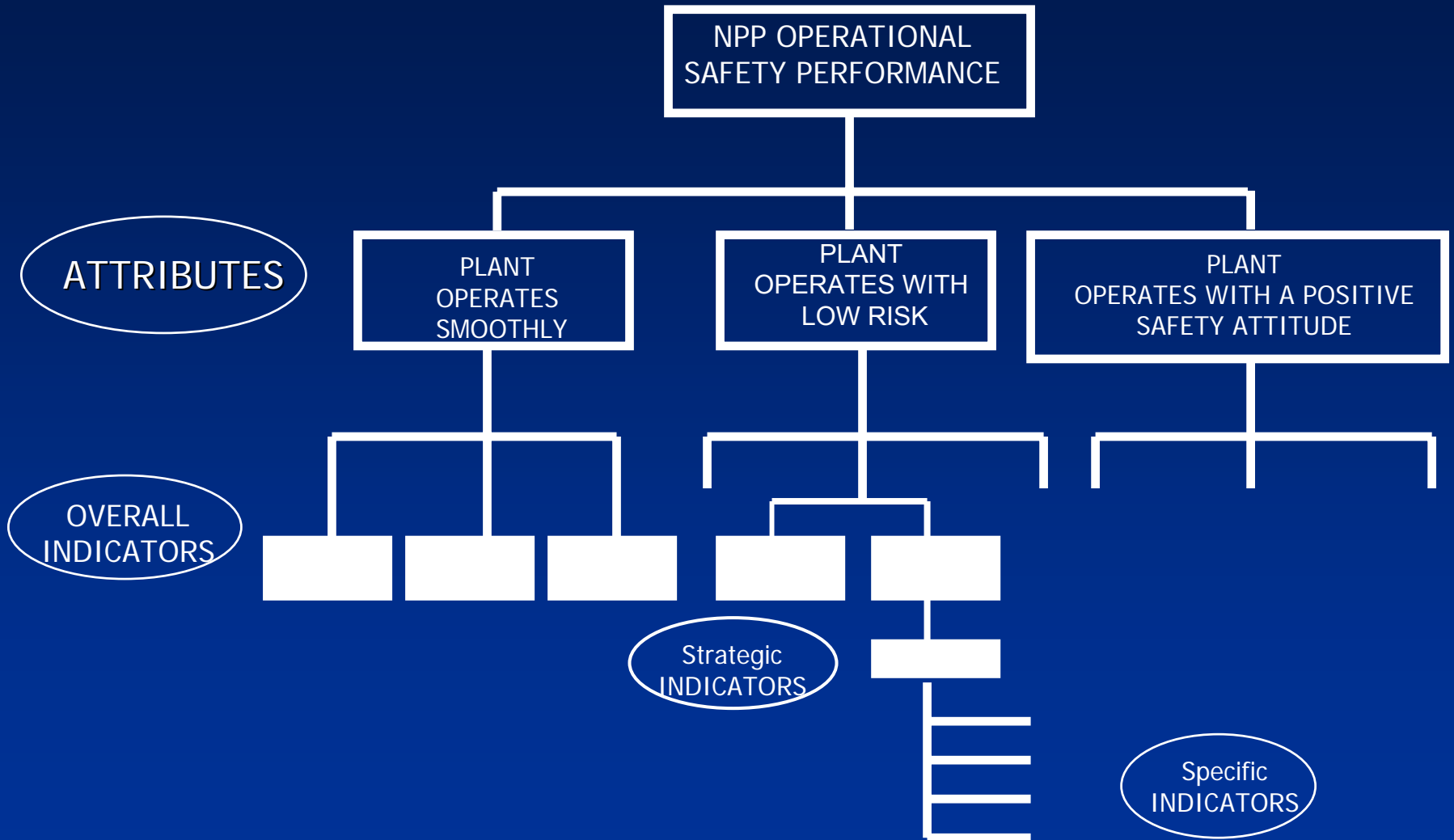
- ◆ Operational safety level cannot be measured directly \Rightarrow but by means of monitoring and measuring of parameters we can inferring it
- ◆ neither one SPI nor actual time snapshot data can measure overall level of NS
- ◆ but well established and complex system, monitoring of trends of SPIs and well justified and understood data (compared against targets) can serve as a good tool for management of OS
- ◆ SE system is based on IAEA-TECDOC-1141 „Operational safety PI for NPPs“
- ◆ structured system – specific numerical indicators gathered to non quantitative strategic and overall indicators



An Approach to Monitoring NPP Operational Safety Performance

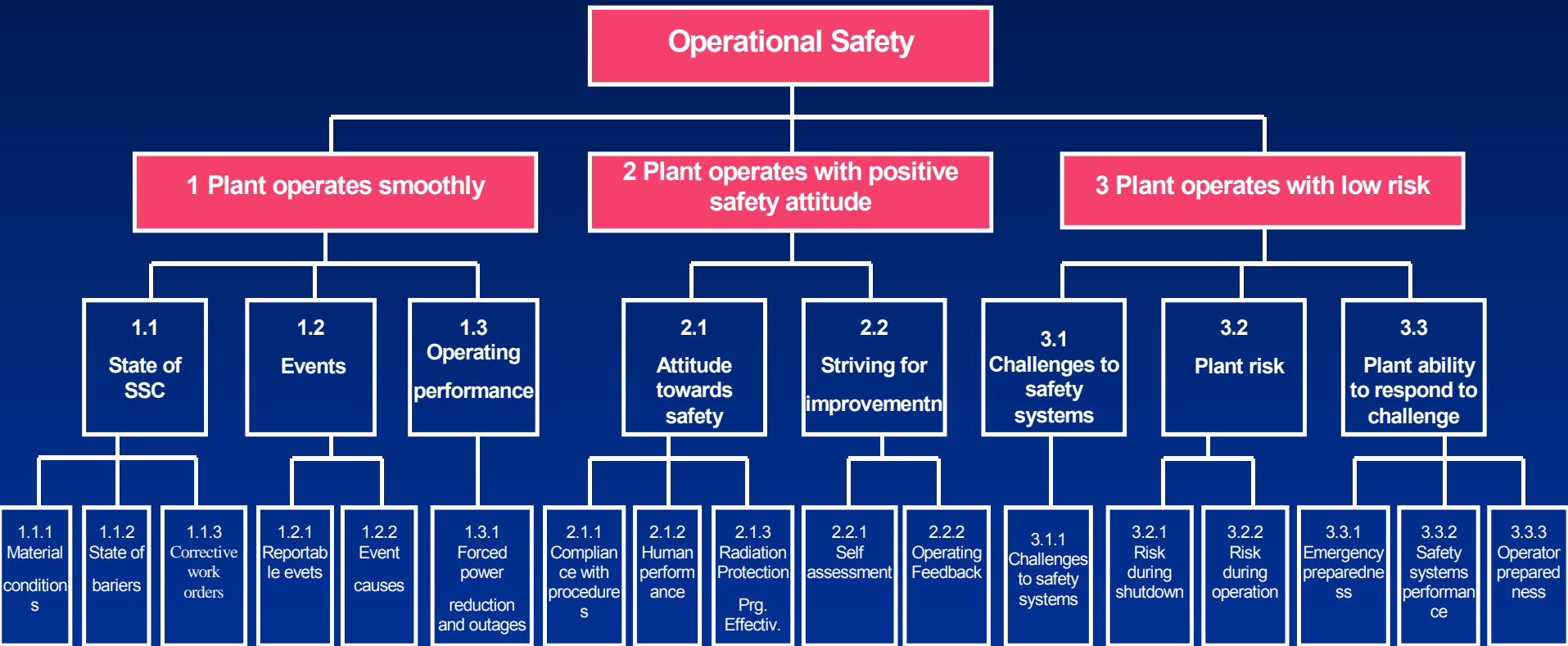


The hierarchical structure of PI



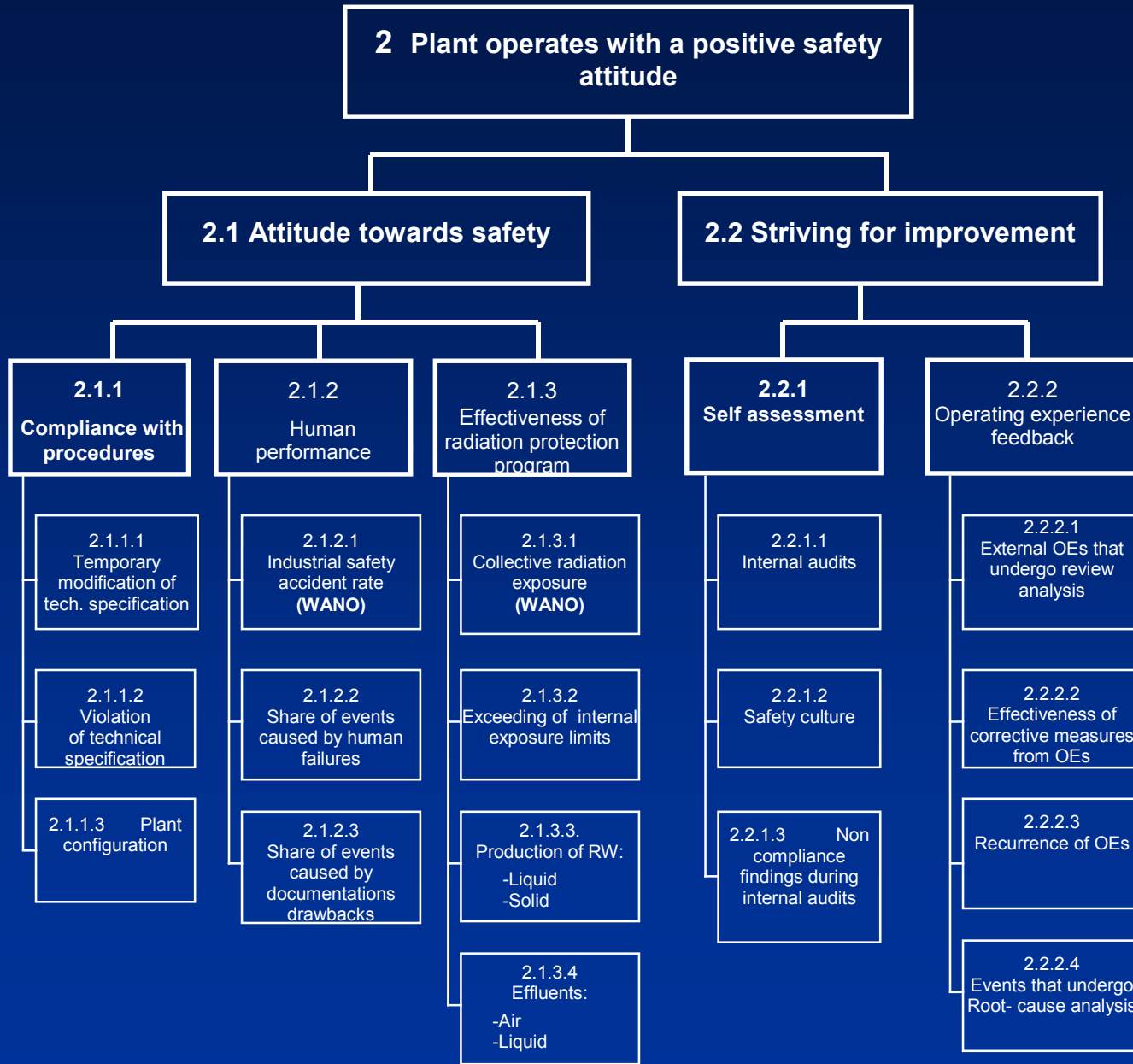


SE structure of SPI system





Example of an Attribute Structure





Criteria, Bands and Colour Codes





SW for SE SPI system - PPRC (example of a hierarchical tree)

PPRC - [EMO_WANO]

Súbor Ukazovatele Správy Zobrazit' Nastavenie Okno Nápvoda

Štruktúra: EMO_WANO
Periód: Ročná
Obdobie: Rok: 2004 A
 Zobrazit' hodnoty ukazovateľov

Legenda:
Rok 2001 Rok 2002 Rok 2003 Rok 2004
■ Neprijateľné pásmo ■ Nezadaná hodnota
■ Varovné pásmo ■ Nedefinovaná
■ Štandardné pásmo
■ Extra pásmo

Aktualizovať Nastavenie Tlač detailu

EMO_WANO

- 1EMO_WANO
- 2EMO_WANO
- EMO-ISAR (WANO)

1EMO_WANO

- 1EMO-AO-1JUA7 (WANO) 0 0 1,863 0
- 1EMO-SSP (WANO)
- 1EMO-CRE (WANO) 651,16 299,97 322,57 316,988
- 1EMO-FRI (WANO) 0,11 0,091 0,0675 0,058
- 1EMO-CHI (WANO) 1,13 1,01 1 1
- 75 86,33 82,95

2EMO_WANO

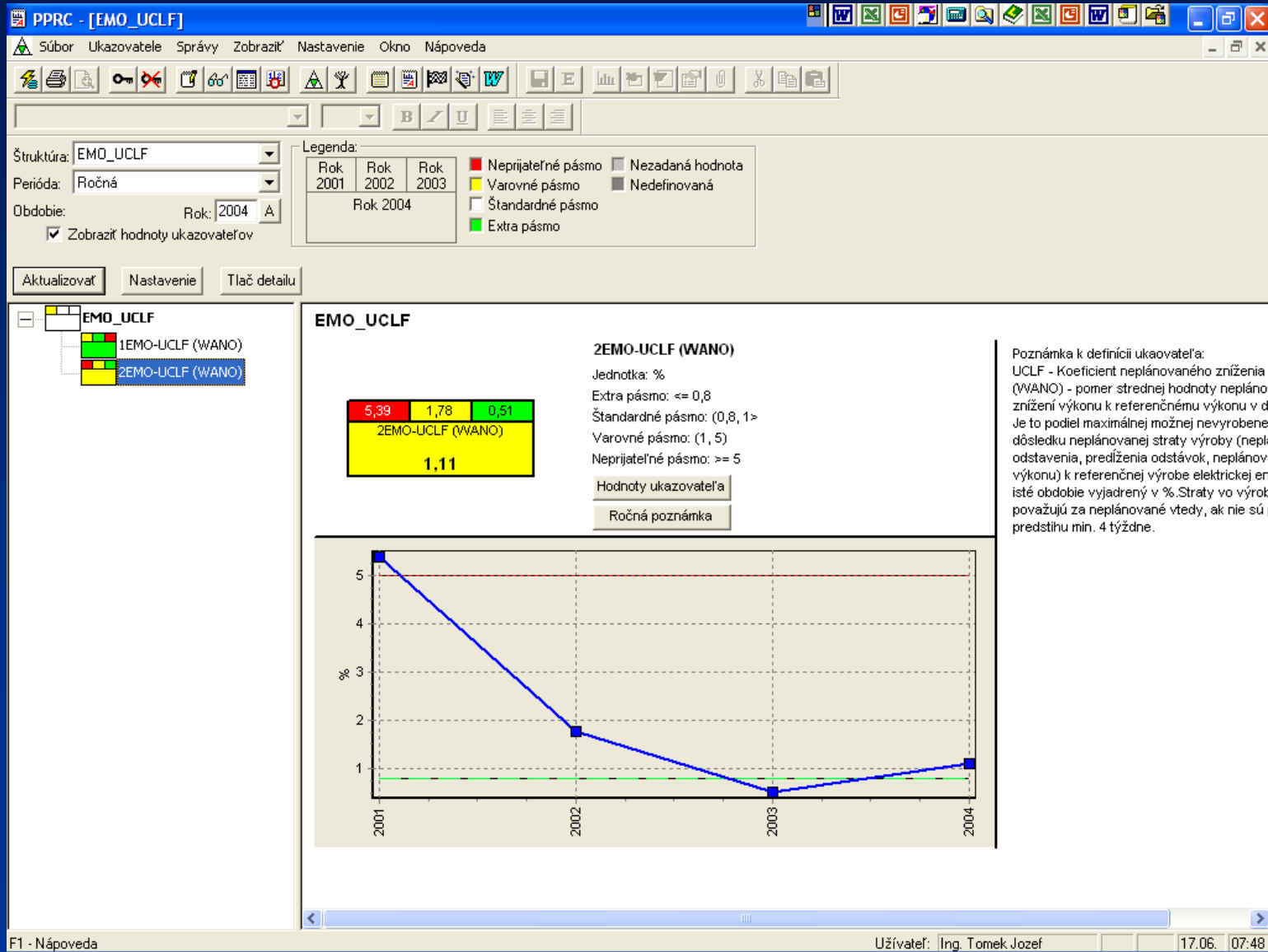
- 2EMO-AO-1JUA7 (WANO) 0 1,01 0,891 0,954
- 2EMO-SSP (WANO)
- 2EMO-CRE (WANO) 46,04 107,56 114,36 134,673
- 2EMO-FRI (WANO) 25,14 11,365 3,932 0,257
- 2EMO-CHI (WANO) 1,25 1,05 1,02 1
- 77,71 76,01 87,75

EMO-ISAR (WANO) 0,28 1,4673628 0,749 0,198

F1 - Nápvoda Užívateľ: Ing. Tomek Jozef 17.06. 07:59



SW for SE SPI system (example of trend monitoring)





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Plant operates smoothly

State of SSC

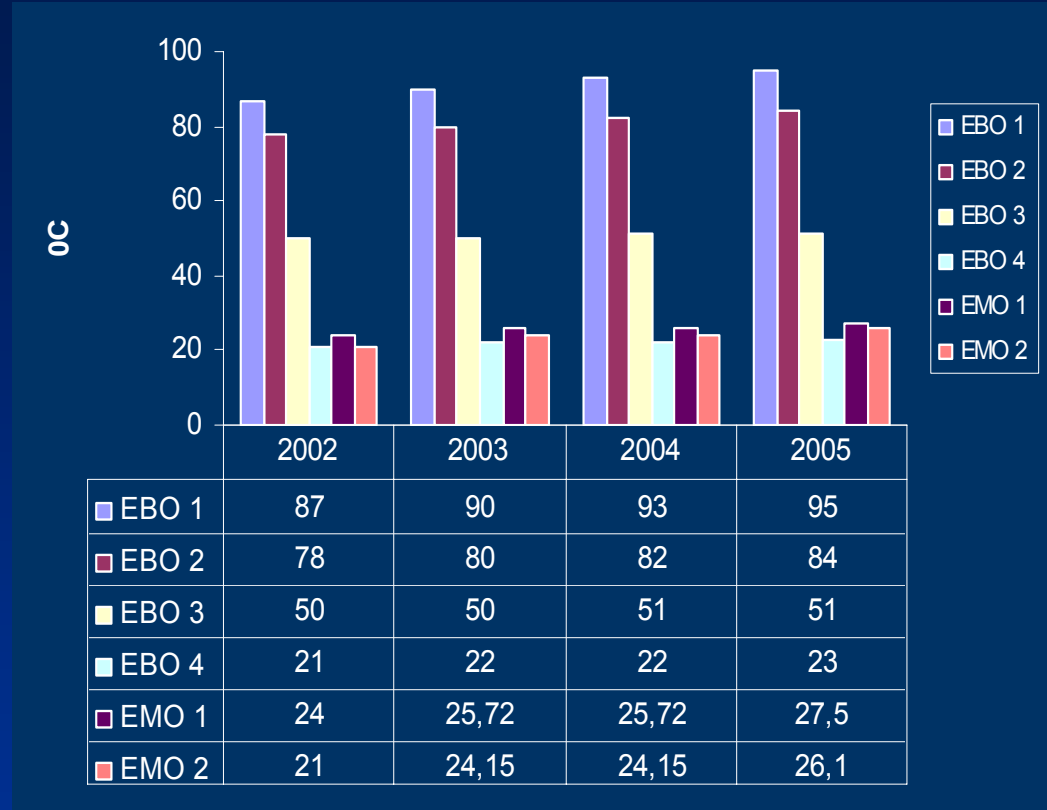
RPV - Brittle fracture temperature

Limiting values

•V-1: 142 °C

•V-2: 135 °C

•EMO: 135 °C



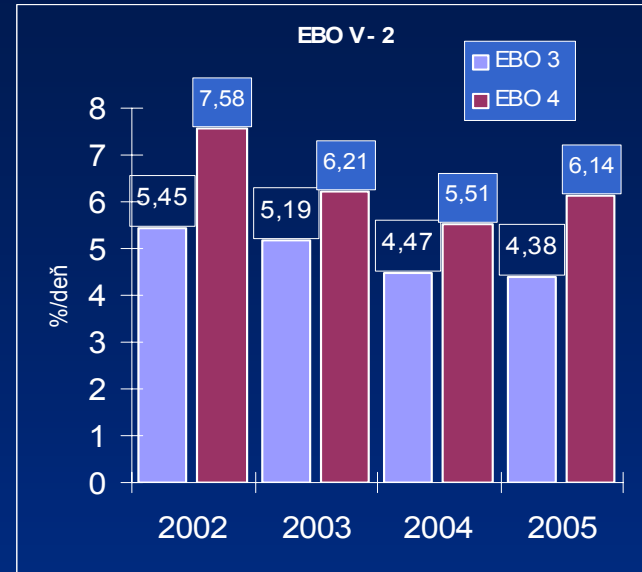
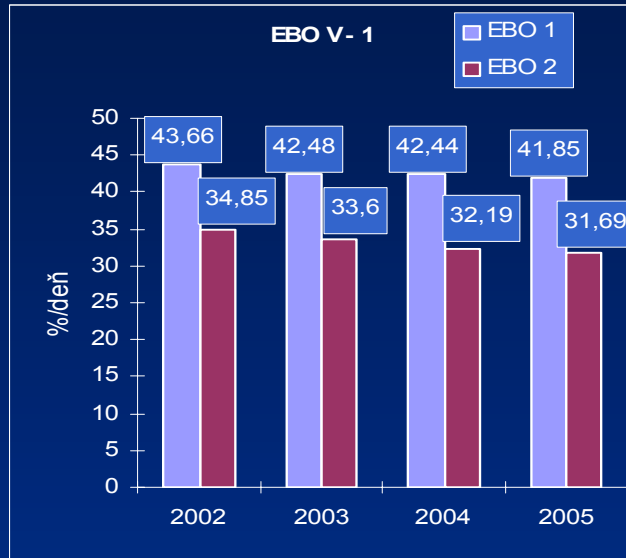
Fuel reliability factor [kBq/l]

	EBO 1 V-1 FRI	EBO 2 V-1 FRI	EBO 3 V-2 FRI	EBO 4 V-2 FRI	EMO 1 FRI	EMO 2 FRI
I / 2005	5,86	64,92	0,12	0,86	0,082	0,434
II / 2005	2,61	142,46	0,16	0,74	0,049	0,584
III / 2005	3,35	229,05	0,04	0,66	0,067	3,854
IV / 2005	3,29	0,05	0,11	0,91	0,053	1,443

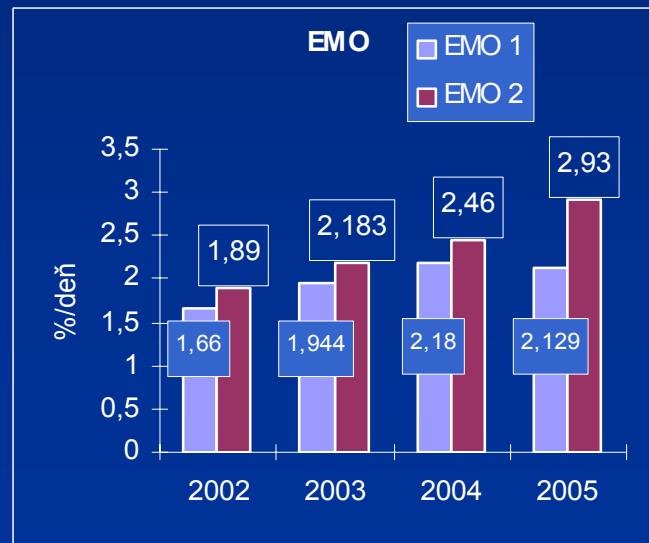


Plant operates smoothly

Containment leaktightnes



Limit 13%

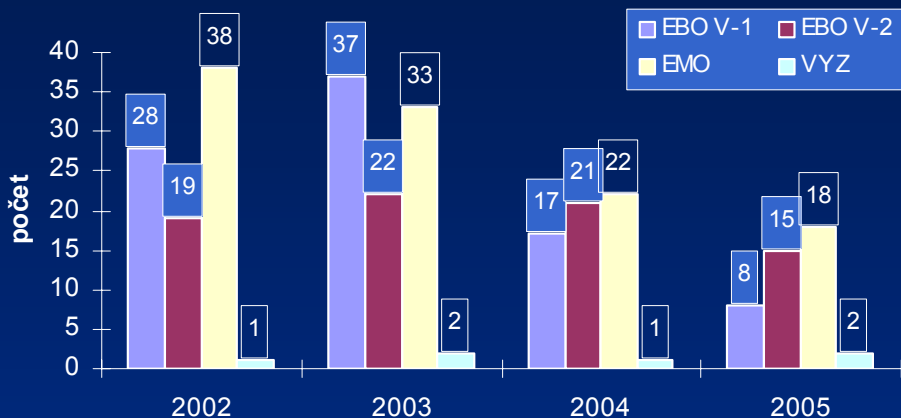


Limit 5%

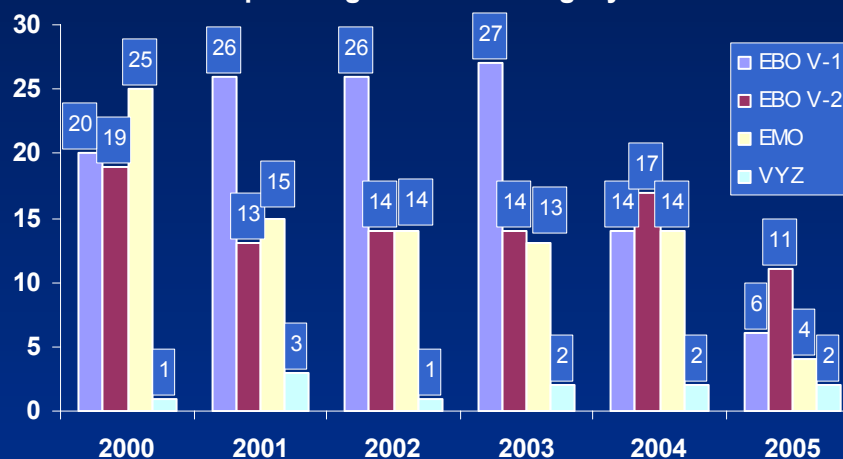


Plant operates smoothly Operating Events

Deviations – reportable to UJD



Operating Events - Category INES 0



INES 1	2000	2001	2002	2003	2004	2005
EBO V-1	0	0	0	0	0	0
EBO V-2	1	0	0	0	1	0
EMO	1	2	1	1	1	1
VYZ	0	0	0	0	0	0



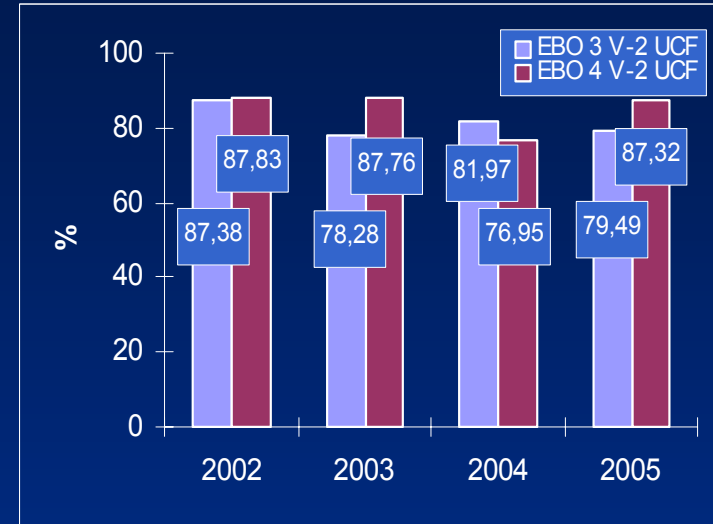
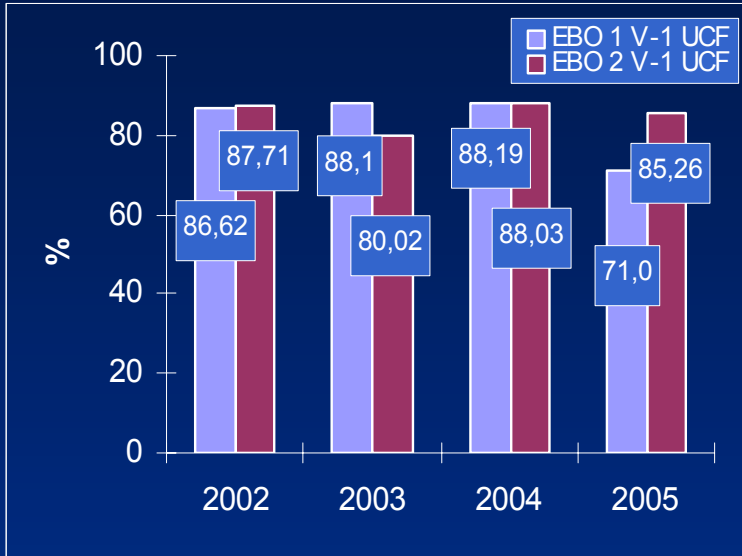
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Plant operates smoothly ATTRIBUTE

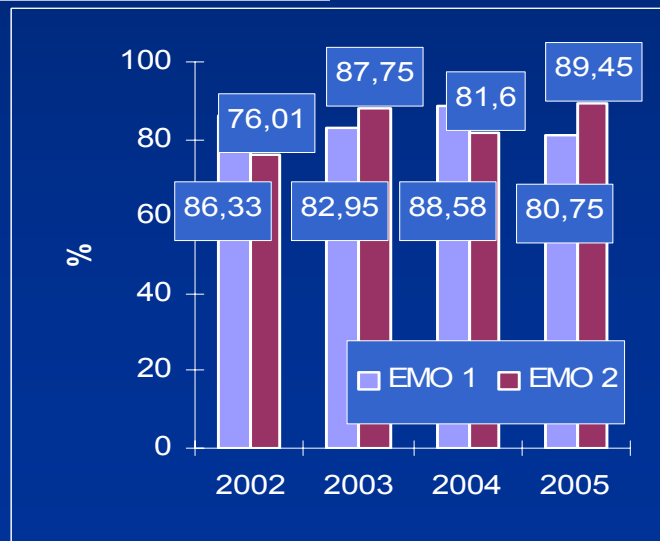
Operating performance

1

Unit Capability Factor (UCF)



WANO PWR 2005
AVERAGE: 83,03 %
MEDIAN: 86,74 %





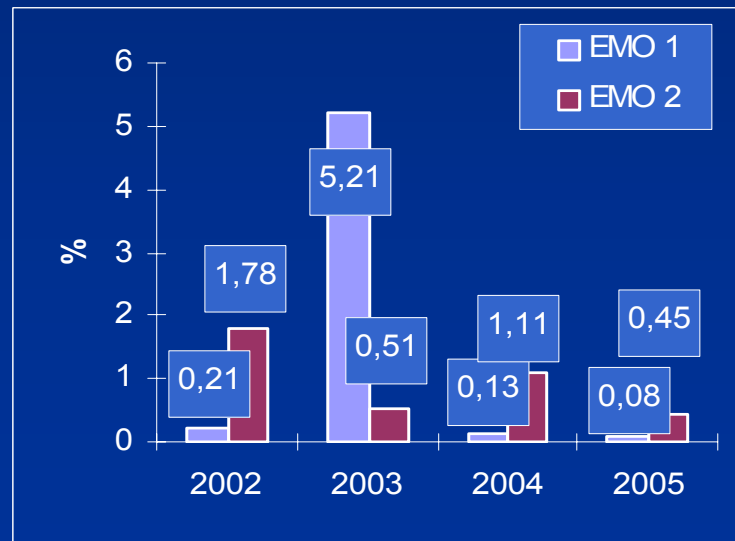
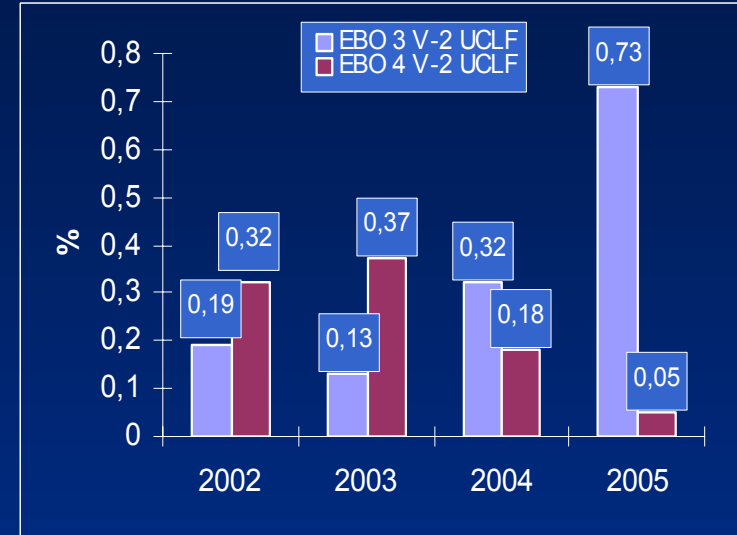
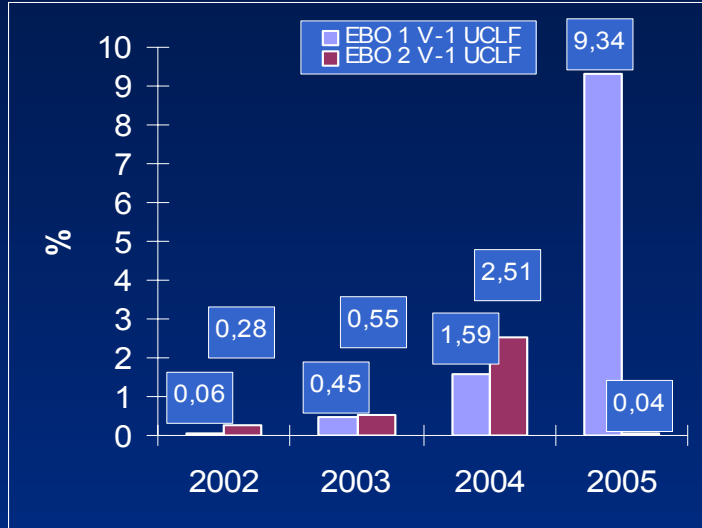
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Plant operates smoothly ATTRIBUTE

Operating performance

1

Unplanned Capability Loss Factor (UCLF)



WANO PWR 2005

AVERAGE: 4,15 %

MEDIAN: 1,61 %

BEST QUARTILE: 0,33 %



Positive safety attitude

Adherence to procedures

Violation of limits & conditions

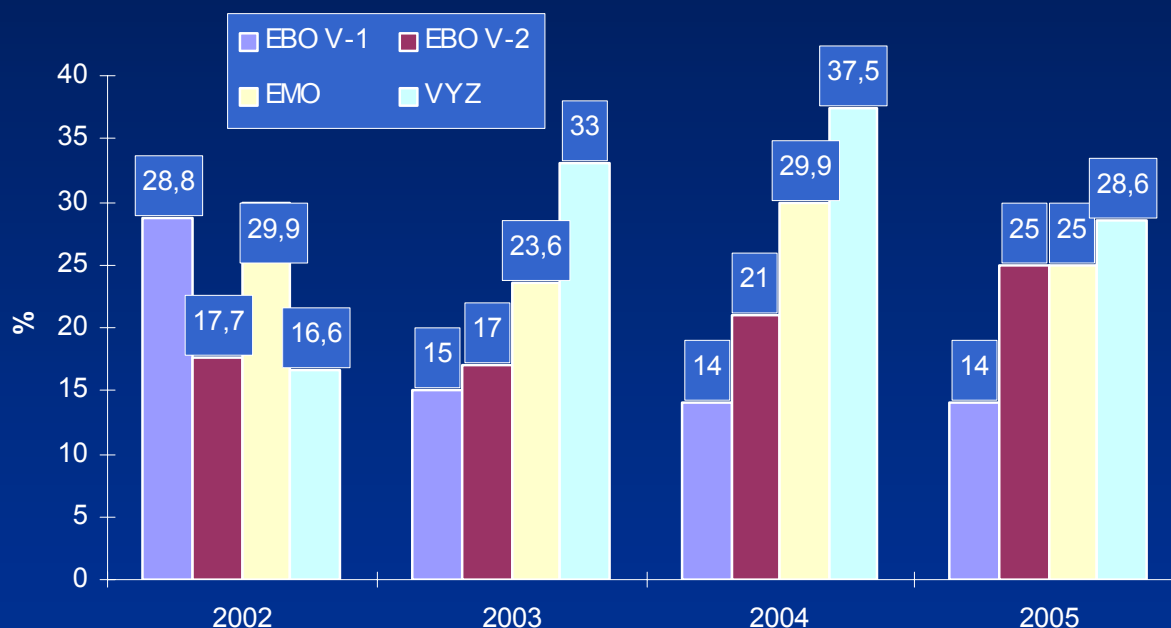
EMO – subpressure in MCP compartment not met – revealed last year, but non-conformity goes to the plant commissioning

	EBO 1	EBO 2	EBO 3	EBO 4	EMO 1	EMO 2	VYZ
2002	0	0	0	0	0	0	0
2003	0	0	0	0	1	0	0
2004	0	0	1	0	1	0	0
2005	0	0	0	0	1	1	0



Positive safety attitude Human Factor

OE caused by human failures [%]



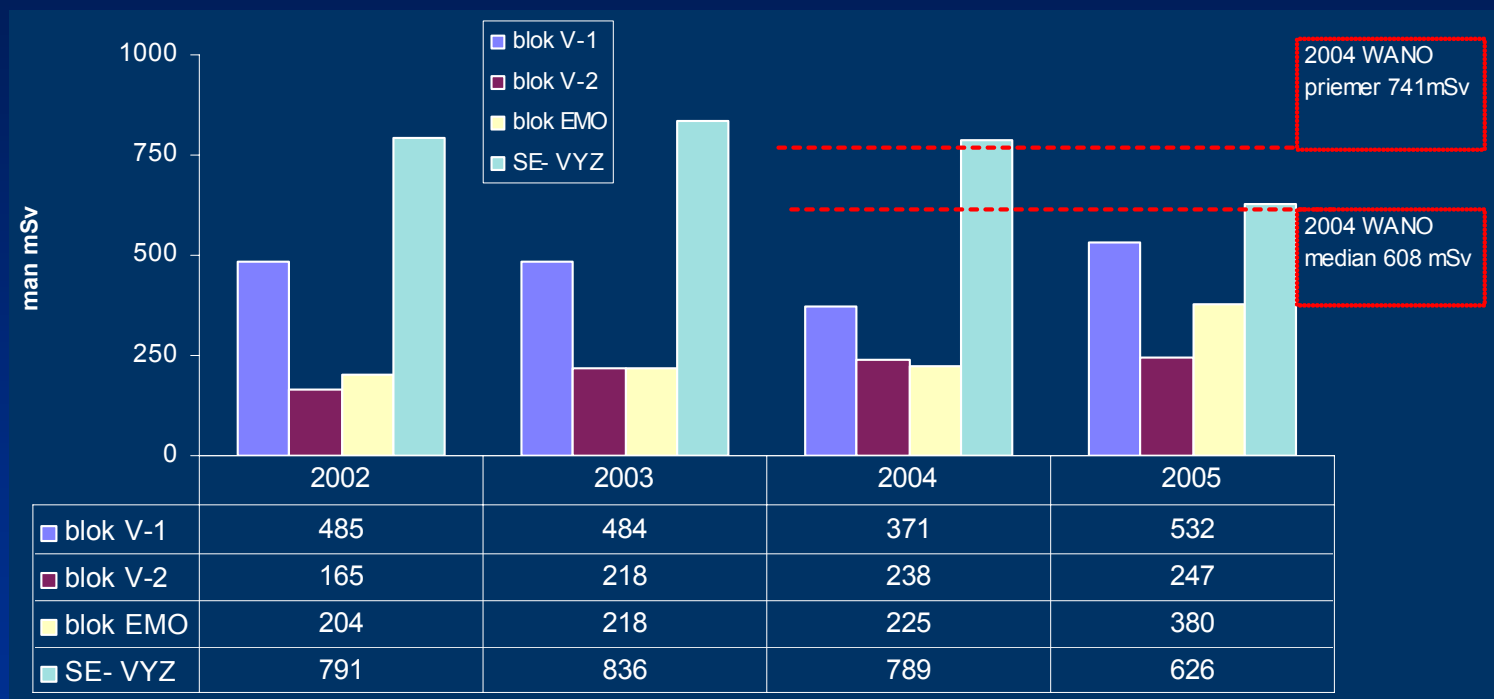
Increasing value at V-2 also caused by failures of contractors
personnel (MOD programme) – 2003/2004/2005 – 3OE/ 6OE/ 8OE



Positive safety attitude

Efficiency of radiation protection system

Collective radiation exposure per unit



- No radiation incident experienced at any nuclear facility!
- Individual doses within authorized limits!



Positive safety attitude

Efficiency of radiation protection system

2

Zariadenie	Druh výpuste	Aktivita	Jednotka	Podiel z limitu [%]
EBO V-1	Vzácne plyny	8,35	TBq	0,209
EBO V-1	Aerosóly	194,27	MBq	0,121
EBO V-1	Jód 131	347,45	MBq	0,267
EBO V-2	Vzácne plyny	9,75	TBq	0,244
EBO V-2	Aerosóly	17,17	MBq	0,011
EBO V-2	Jód 131	0,76	MBq	0,001
EMO	Vzácne plyny	4,57	TBq	0,011
EMO	Aerosóly	20,53	MBq	0,012
EMO	Jód 131	0,38	MBq	0,0005
VYZ A-1	aerosoly alfa	0,02	MBq	0,2
VYZ A-1	aerosoly beta, gama	21,63	MBq	2,3
VYZ MSVP	aerosoly beta, gama	3,59	MBq	1,2

← Airborne RA releases

Zariadenie	Druh výpuste	Aktivita	Jednotka	Podiel z limitu [%]
EBO V-1	Koróz. a štiepne produkty	51,65	MBq	0,137
EBO V-1	Trícium	7,21	TBq	16,49
EBO V-2	Koróz. a štiepne produkty	39,40	MBq	0,106
EBO V-2	Trícium	6,30	TBq	14,41
EMO	Koróz. a štiepne produkty	59,36	MBq	5,4
EMO	Trícium	8,96	TBq	74,66
VYZ	Koróz. a štiepne produkty	70,50	MBq	0,6
VYZ	Trícium	2141,60	GBq	58

Liquid RA releases →

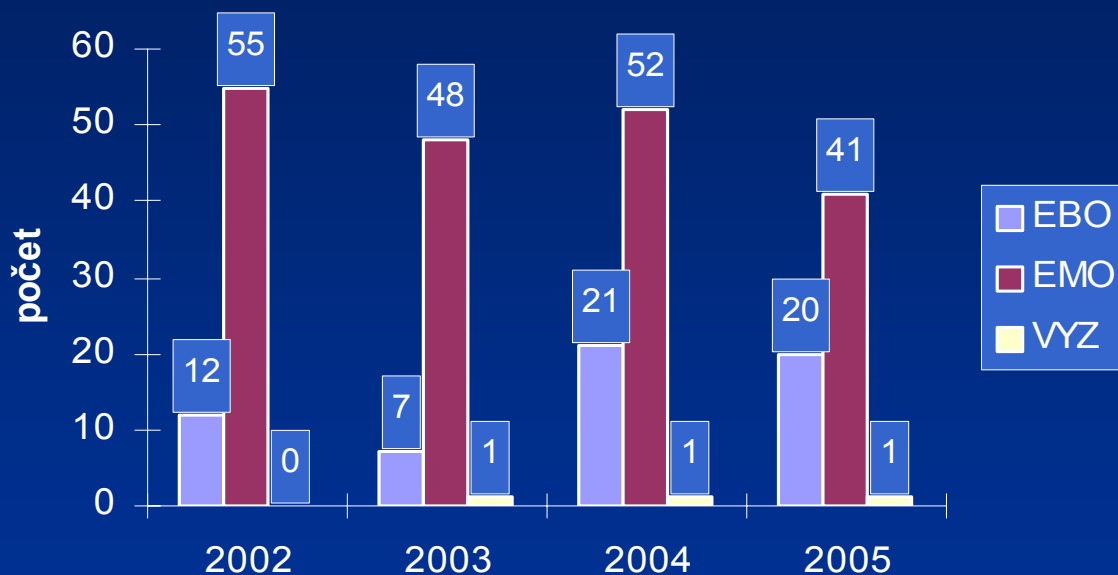


Positive safety attitude

Striving for improvement

Operating Experience Feedback

Number of analyzed external events

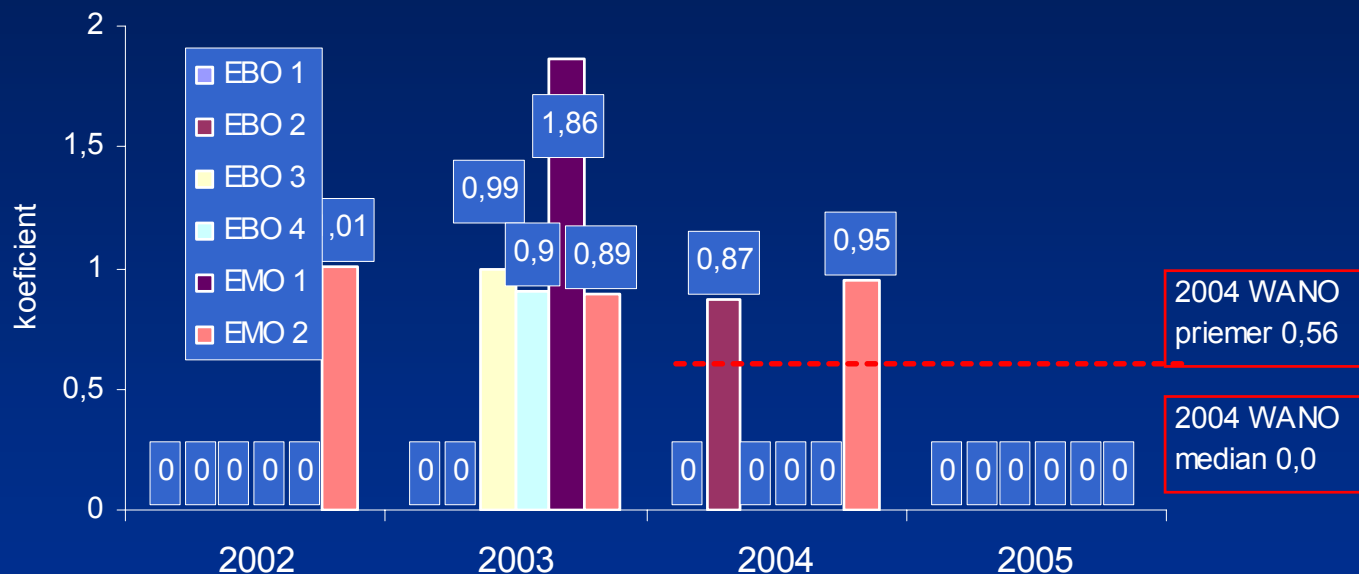


Operation with Low Risk

Actuation of Safety Systems

3

Reactor Scrams per 7000 Hours Critical

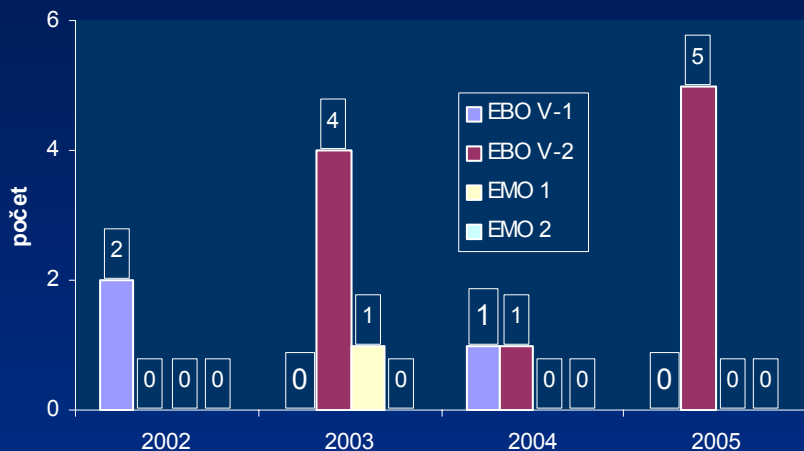




Operation with Low Risk

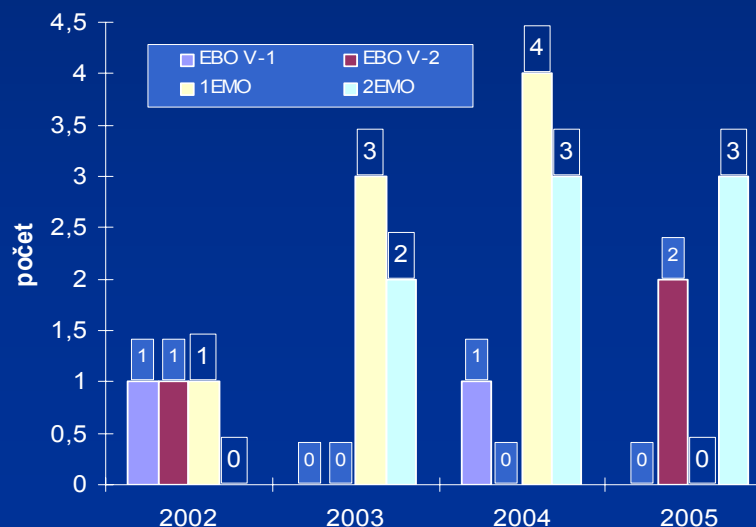
Actuation of Safety Systems

Spurious Actuation of SS



During outages - bound primarily with installation of new ESFAS system at V-2

Forced Actuation of SS

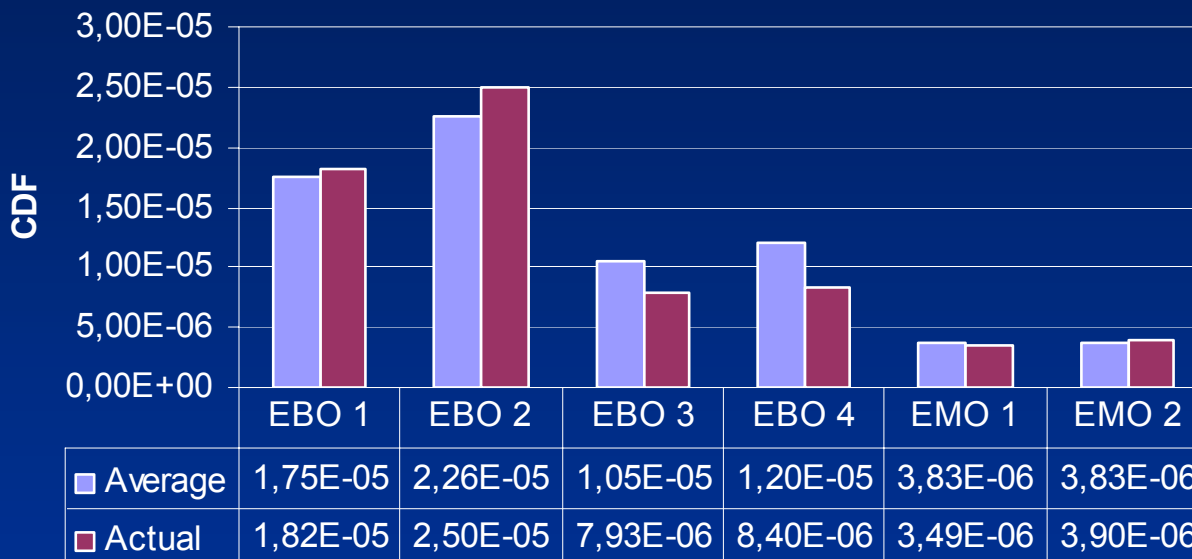




Operation with Low Risk

Actual Risk of Core Damage (Power Operation)

Actual Risk of Core Damage in 2005

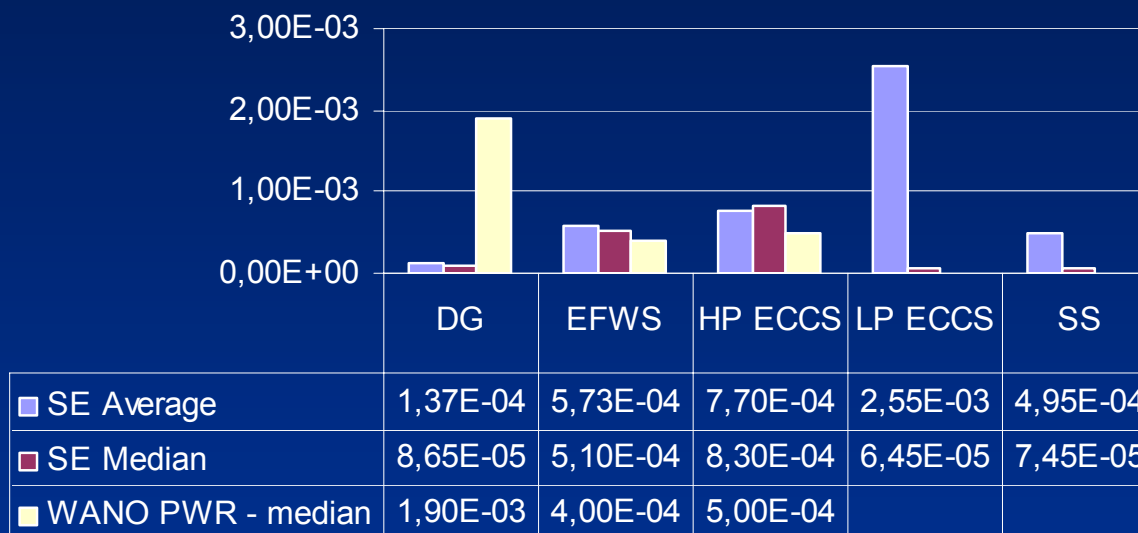


Operation with Low Risk

Availability of Safety Systems

3

Safety Systems Performance - 2005



Unavailability of SSs:

- low values, except of LP ECCS at EBO 2 – unavailability caused by planned maintenance of service water subsystem
- comparable with worldwide values



Conclusions

- ◆ **SE SPI system is a complex system for monitoring of NPP operational safety performance; good management tool.**
- ◆ **Operation of Slovak NPPs in 2005 was safe and reliable, with**
 - high level of performance
 - low risk
 - minimal impact on the personnel, environment and public
 - positive attitude to safety