SAFETY IN THE NUCLEAR INDUSTRY

CONTENTS (1)

- Nuclear safety definition
- Nuclear safety as control of "states"
- Limits of nuclear safety definition
- Nuclear safety as control of risk
- Nuclear safety, historical perspective
- Safety culture definition
- Safety culture for EDF

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NUCLEAR SAFETY DEFINITION (1)

Nuclear safety is "the actions taken to protect man and the environment against the dispersal of radioactive substances"

NUCLEAR SAFETY DEFINITION (2)

- **It depends on the various provisions made at all stages in the design, construction, operation and decommissionning of nuclear facilities**

- **It depends on reliability of equipment, actions of people and efficiency of organizations**

NUCLEAR SAFETY AS CONTROL OF "STATES"

- **The acceptable level of risk is defined by Safety Authority and translated into safety requirements**

- **Operator main responsability : compliance with requirements**

This nuclear safety concept has produced good results

but ...

LIMITS OF NUCLEAR SAFETY DEFINITION

- **The definition of nuclear safety is a designer perception : safety is "what we do" to guarantee safety**
- **It is viewed through compliance to regulatory body requirements**
- **The definition only allows a negative assessment by counting up incidents and descrepancies**
- **For plants staff and first line management, safety often appears in opposition with availability or cost control**

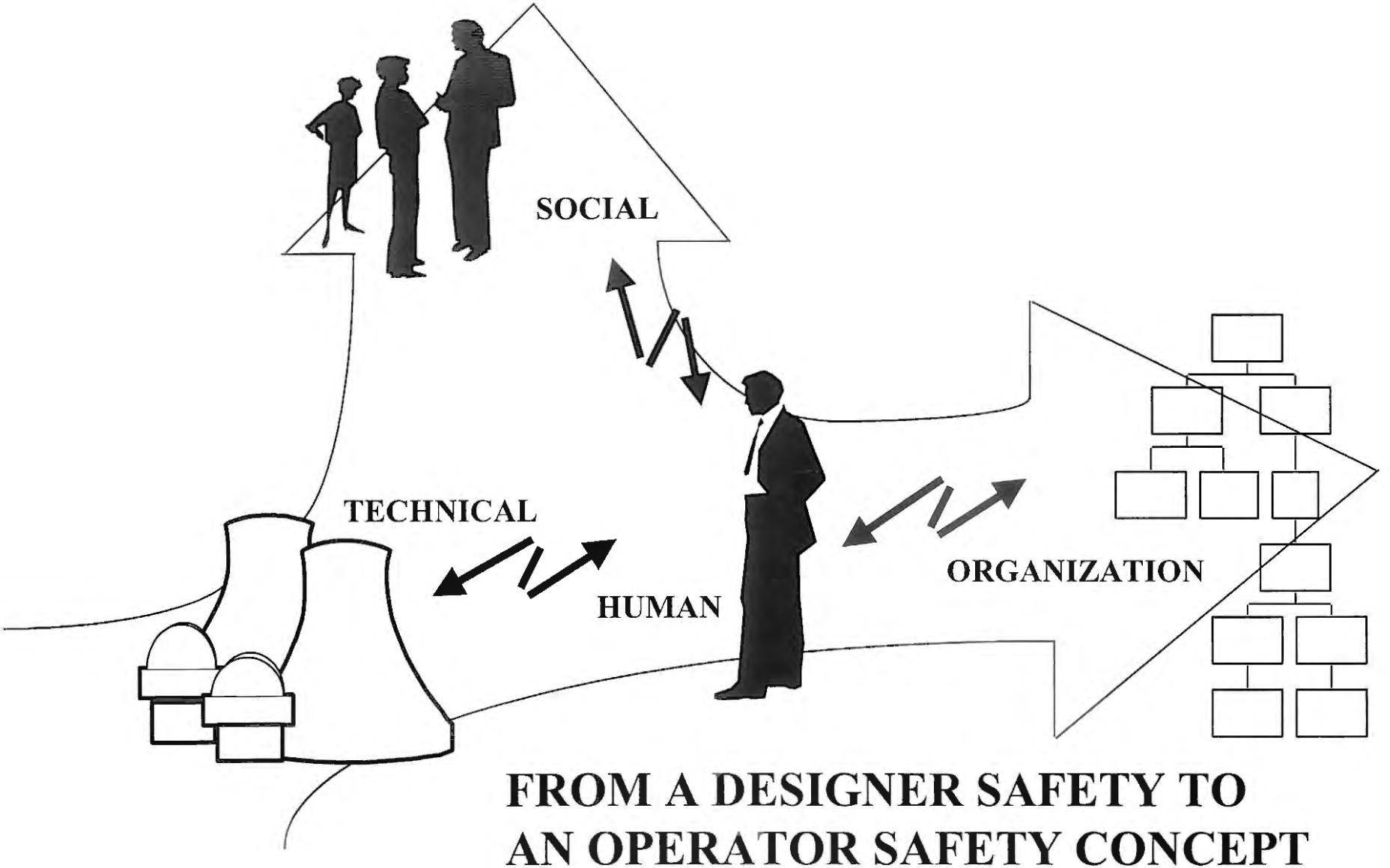
- **For further progresses we need liberating people strengths while recognizing their weaknesses :**

PEOPLE AT THE HEART OF SAFETY

PREVENT AND CONTROL RISK

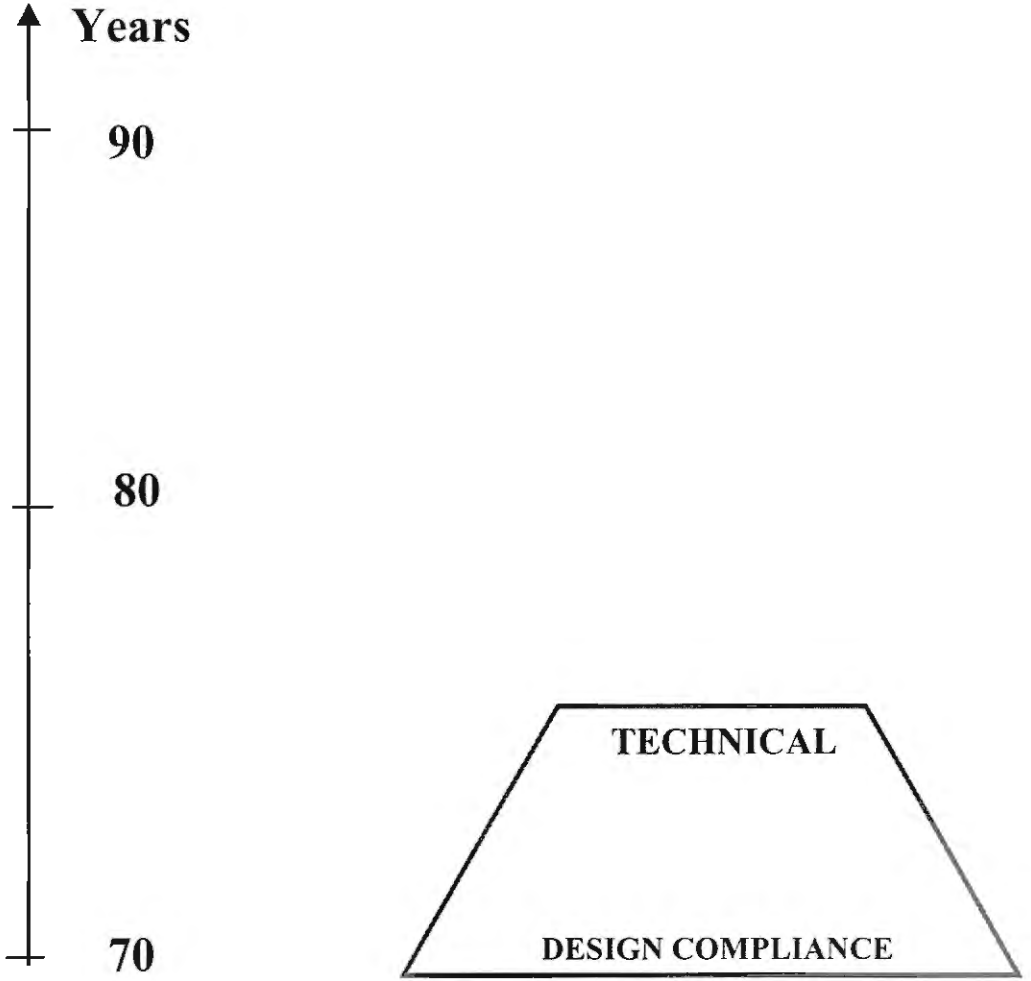
SAFETY AS CONTROL OF RISK

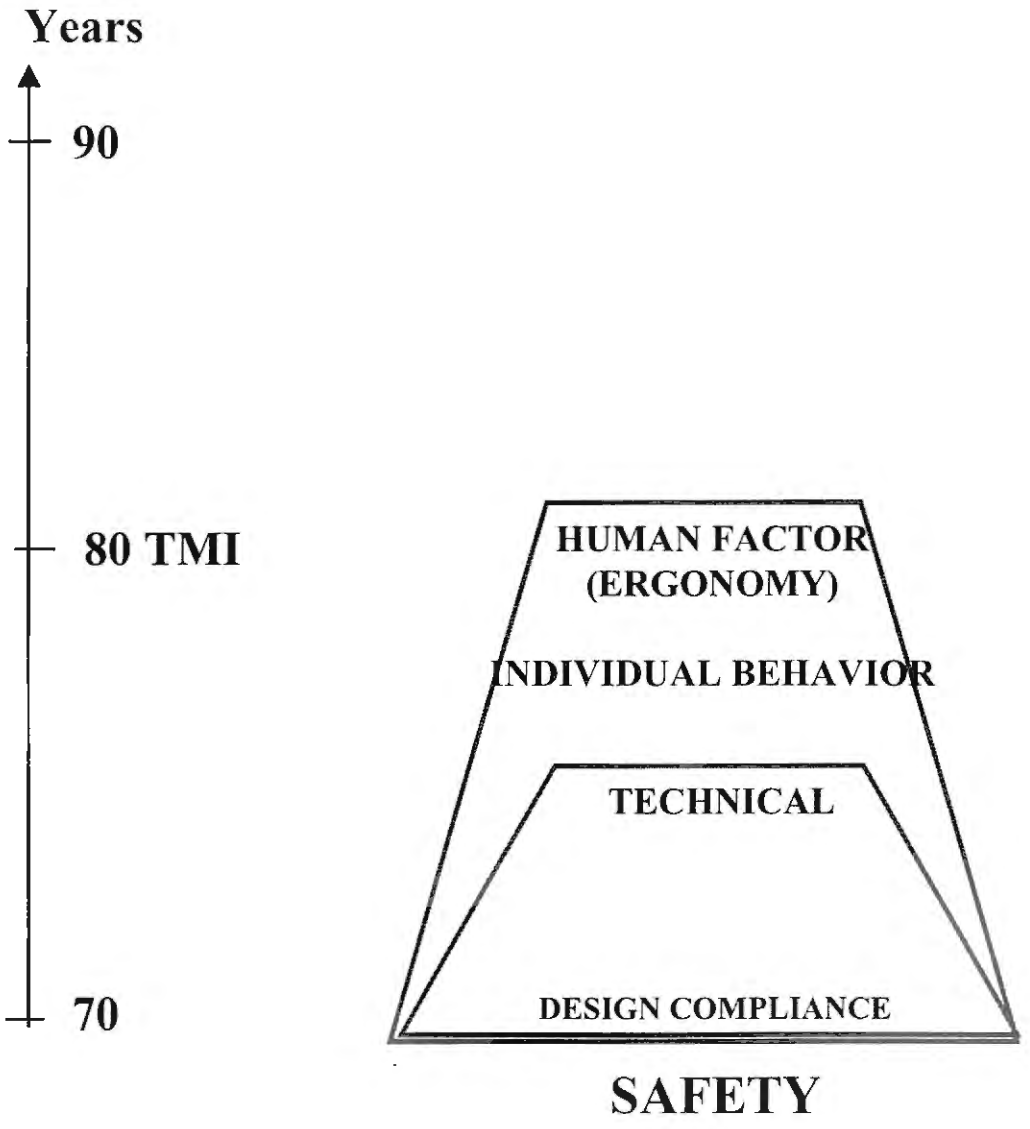
- **The risk is the objective side of safety**
- **An operator can identify risk and work to reduce it**
- **Identifying risk provides a concrete objective for moral responsability**
- **Safety defined as the fight against risk ; dynamic value**
- **Safety thus defined, takes on a more positive, value-enhancing role for the operator**



FROM A DESIGNER SAFETY TO AN OPERATOR SAFETY CONCEPT

NUCLEAR SAFETY, HISTORICAL PERSPECTIVE



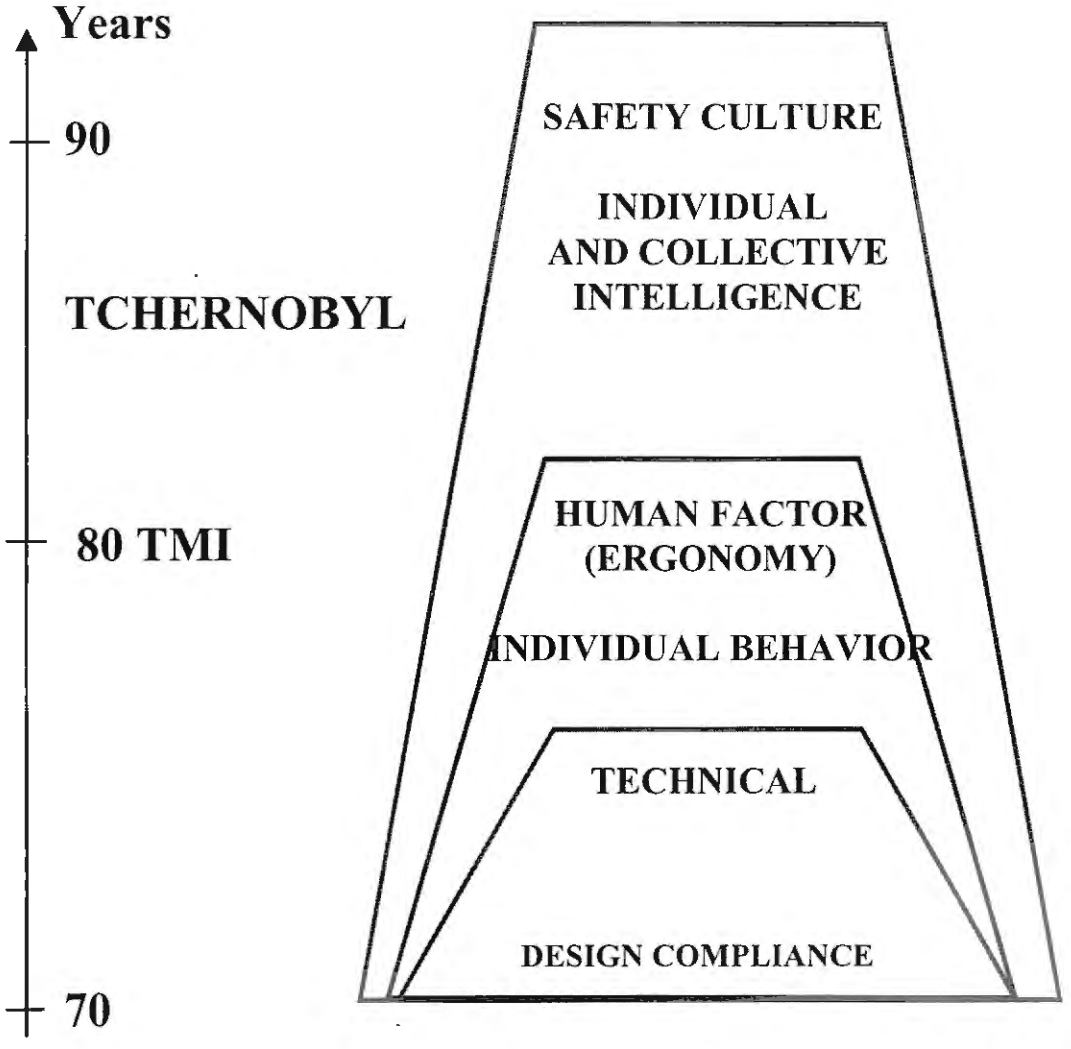


OBJECT

Source of Errors

?

HUMAN ROLE



SUBJECT

Source of Performances
Actor Involvment

OBJECT

Source of Errors

?

HUMAN ROLE

SAFETY CULTURE DEFINITION (IAEA)

Safety culture is "the combination of properties and attitudes which, in organizations and individuals, cause issues relating to the safety of nuclear power plants to receive proper attention in due time!"

SAFETY CULTURE FOR EDF

As a nuclear power plants operator, EDF's safety culture can therefore be defined on two levels :

- **Awareness of our moral responsibility as a nuclear operator with regard to the risk that this industry presents**
- **Integration of essential attitudes :**

  - Controlling technological risks,

  - Preventing risks inherent to human and organizational factors ,

  - Preventing risks of internal and external disunity

IDENTIFYING RISK FACTORS

- **Technological risk controled by compliance with basic safety and policy requirements**
- **Risks inherent to human an socio-organizational factors prevented by quality of actions, organizations and decision making processes**
- **Risk of internal and external disunity (social aspect) prevented by maintaining a climate of trust, cooperative social relations and quality of managemnet**

These three kinds of risks are of equal importance and the

link between them should be considered

NUCLEAR SAFETY MANAGEMENT
(1)

- **CLARIFY RESPONSABILITIES**
- **CHECK**
- **DEBATE ABOUT SAFETY**
- **MAKE DISTINCTION BETWEEN AMBITIONS AND REQUIREMI**

NUCLEAR SAFETY MANAGEMENT (2)

1) REQUIREMENTS

- TO MASTER TECHNOLOGICAL RISKS AND SOME ORGANIZATIONAL
  ONES
- COMPULSORY COMPLIANCE
- CLARIFICATION AND SIMPLIFICATION
- PLANT CONDITION INDICATORS

2) AMBITIONS FOR PERMANENT IMPROVEMENTS

- POLICIES, STRATEGIC INITIATIVES, OBJECTIVES
- ACTORS INVOLVMENT TO CHOOSE THE BEST WAY
- RISK ANALYSIS, SELF ASSESSMENT, SELF DIAGNOSIS...
- MANAGEMENT INDICATORS

NUCLEAR SAFETY IMPROVEMENT

1) ESSENTIAL TO KEEP THE CONFIDENCE OF THE GENERAL PUBLIC IN USE OF NUCLEAR ENERGY
ESSENTIAL TO BENEFIT FROM THE CONSIDERABLE INVESTMENT THAT THE 58 NUCLEAR POWER PLANTS REPRESENT

2) BASED ON OPERATING EXPERIENCE FEEDBACK ON SYSTEMS AND EQUIPMENT, ORGANIZATION, PROCEDURES AND TRAINING

- DESIGN AND OPERATING PROCEDURES MODIFICATIONS
- MAINTENANCE PROGRAMS : PREVENTIVE, CORRECTIVE AND RELIABILITY CENTERED MAINTENANCE
- ADDITIONAL TRAINING AND AUTHORISATIONS
- ORGANIZATION, MANAGEMENT METHODS
- QUALITY MANAGEMENT

APPENDIX 1

NUCLEAR SAFETY BASIC PRINCIPLES

NUCLEAR SAFETY BASIC PRINCIPLES (1)

- **Defense in depth**

  prevention to stop a failure from occuring

  monitoring or detection to anticipate a failure or to detect it as soon as possible

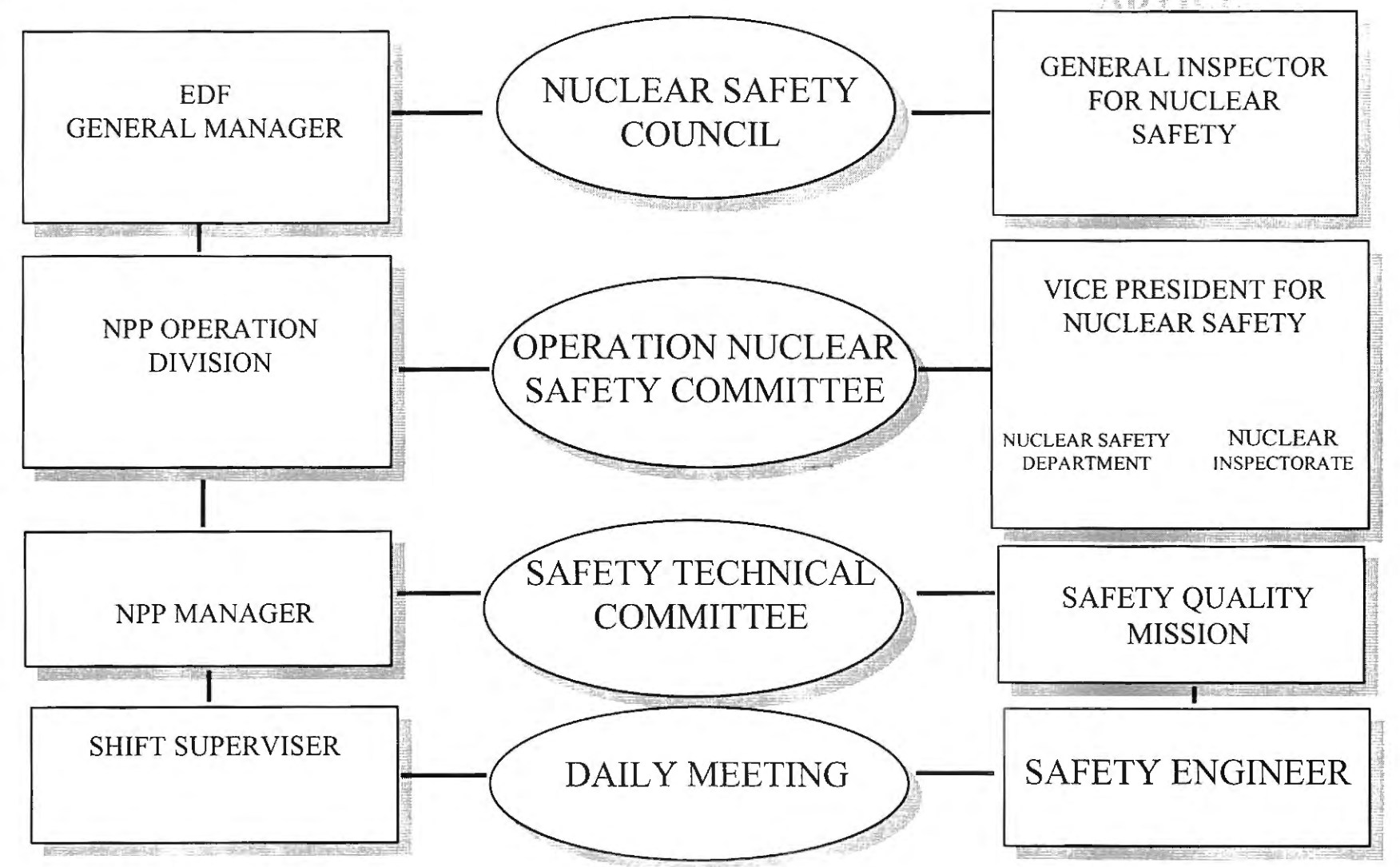
  means of action to mitigate the consequences of failures

NUCLEAR SAFETY BASIC PRINCIPLES (2)

- **Barriers**
  - **fuel cladding**
  - **reactor coolant system**
  - **containment**
- **Safety functions**
  - **reactivity control**
  - **fuel cooling control**
  - **radioactive material containment control**

APPENDIX 2

NUCLEAR SAFETY ORGANIZATION


EDF
GENERAL MANAGER
NUCLEAR SAFETY
COUNCIL
GENERAL INSPECTOR
FOR NUCLEAR
SAFETY
NPP OPERATION
DIVISION
OPERATION NUCLEAR
SAFETY COMMITTEE
VICE PRESIDENT FOR
NUCLEAR SAFETY
NUCLEAR SAFETY
DEPARTMENT
NUCLEAR
INSPECTORATE
NPP MANAGER
SAFETY TECHNICAL
COMMITTEE
SAFETY QUALITY
MISSION
SHIFT SUPERVISER
DAILY MEETING
SAFETY ENGINEER

SAFETY INDICATORS

MEASURING SAFETY IS NOT SIMPLE

WE NEED A SET OF INDICATORS

EDF PROPOSES 3 CATEGORIES

⇨ **SAFETY CONDITION INDICATORS**

⇨ **SAFETY MANAGEMENT INDICATORS**

⇨ **POTENTIAL RISK INDEX**

SAFETY CONDITION INDICATORS

PHYSICAL PARAMETERS WITH LIMITS SET IN SR OR TS

MEASURES COMPLIANCE WITH SAFETY REQUIREMENTS

SAFETY MANAGEMENT INDICATORS

OBJECTIVE SET BY MANAGEMENT

MEASURES SAFETY IMPROVEMENTS

POTENTIAL RISK INDEX (PRI)

CONDITIONAL PROBABILITY OF FUEL DEGRADATION

MEASURES POTENTIAL CONSEQUENCES OF INCIDENTS

SAFETY CONDITION INDICATORS

I- CONDITION OF SAFETY BARRIERS

1st Barrier Cladding conditions (primary coolant contamination) : WANO indicator

2nd barrier RCS Global leak rate (l/h)

SG leak rate (l/h)

usage factor on 2 RCS zones

3rd barrier Containment leak rate in normal operation : Nm3/h with ΔP 60 mb

Number of activity peaks to the stack > 4 10^5 Bq/m^3

SAFETY CONDITION INDICATORS

II - AVAILABILITY OF SAFETY FUNCTION

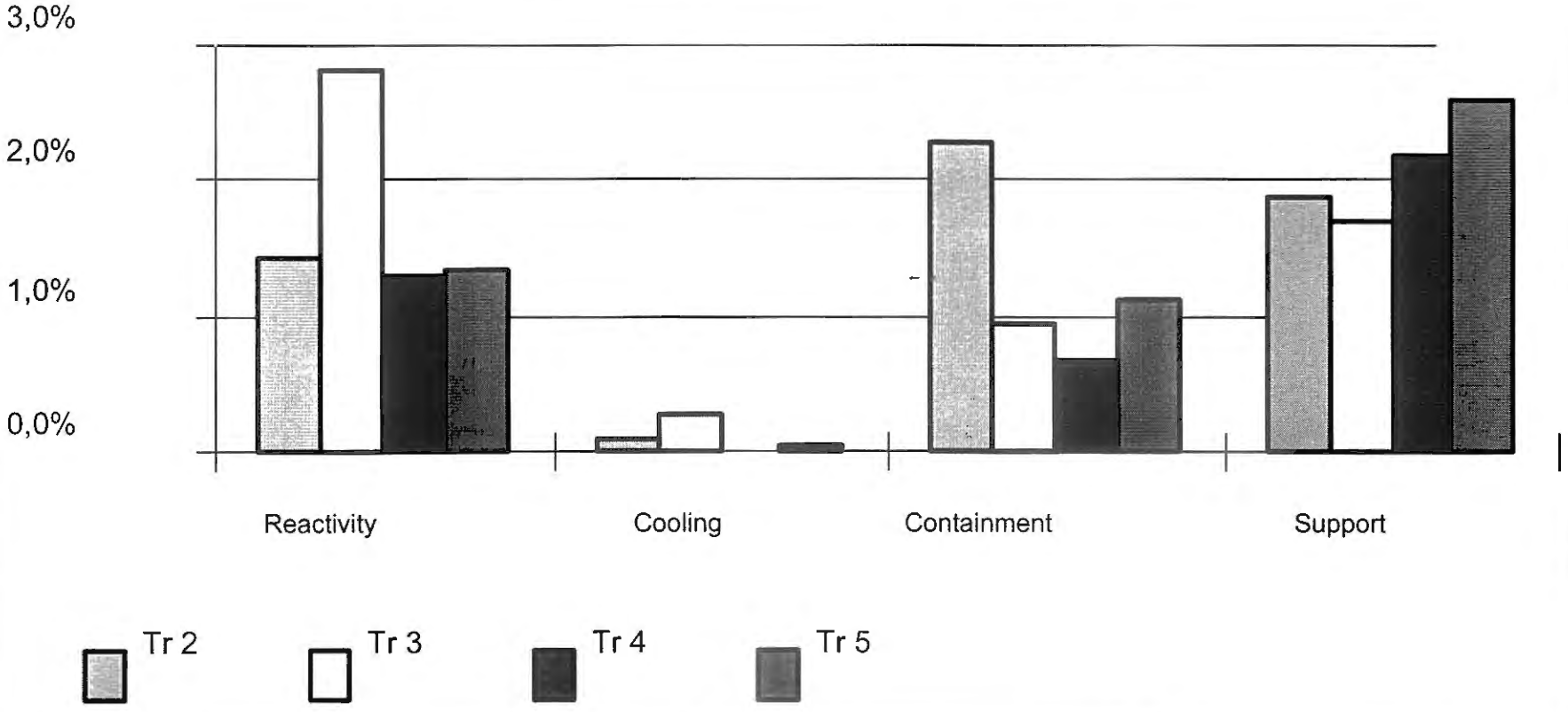
- → **reactivity control**
- → **cooling control**
- → **containment control**
- → **plant support control**

Plant systems and components serve one or several safety function

T.S. define allowed available time limit for safety system or component

$$I = \sum \frac{\text{actual equipment unavailability duration}}{\text{time spent in the reactor mode of operation}}$$

Safety function down times from January to May 1998 (reactor in production)



SAFETY CONDITION INDICATORS

ADVANTAGE - **Objectivity**

- **Close to basic safety concepts**

INCONVENIENT - **Difficult to measure improvements**

- **Measure design, construction as well as operational aspects**

SAFETY MANAGEMENT INDICATORS

Example

→ **Number of reactor scram / 7000 h critical** **WANO indicator**

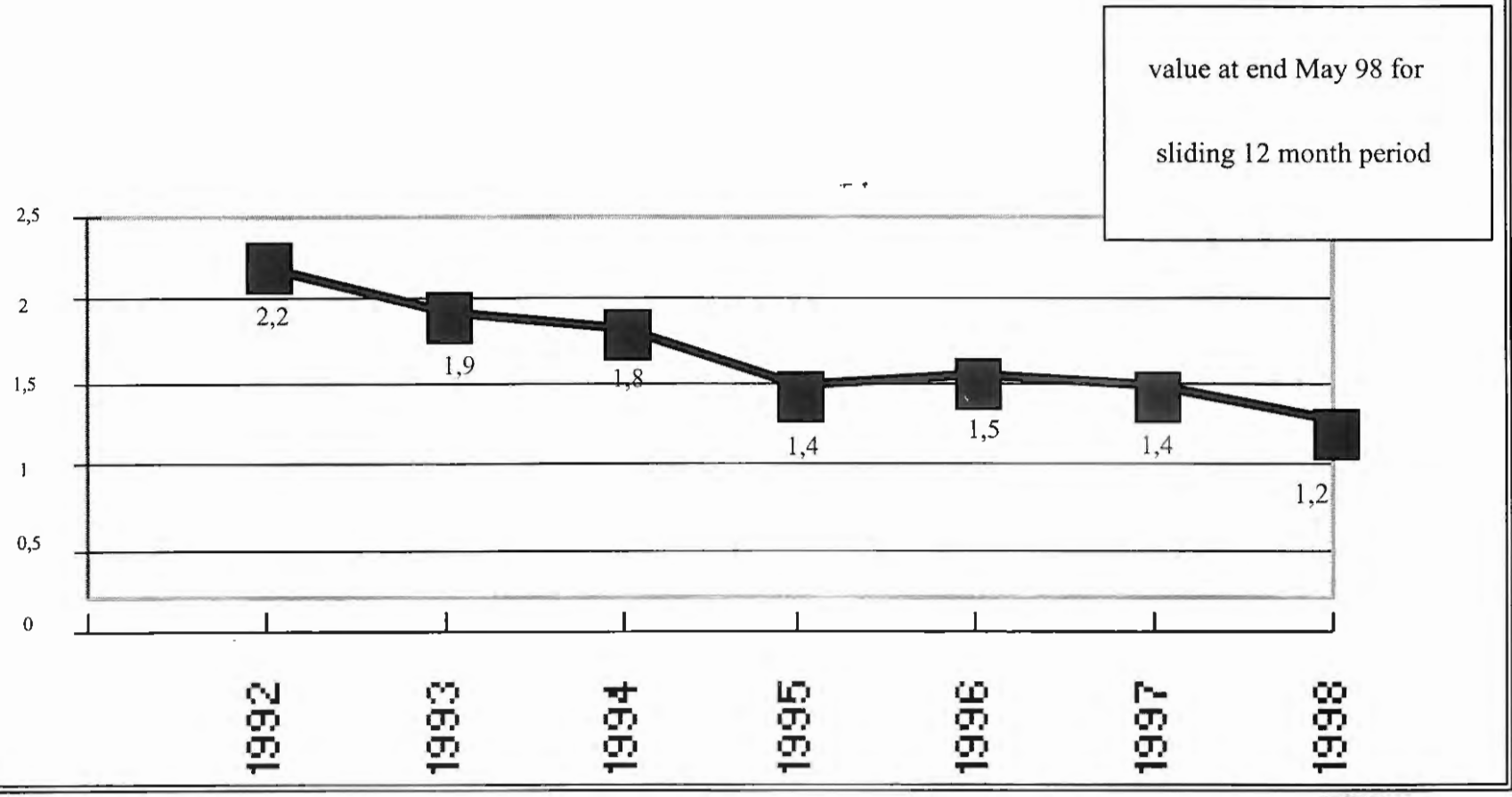
→ **Number of days without reactor scrams**

→ **Number of TS non compliances**

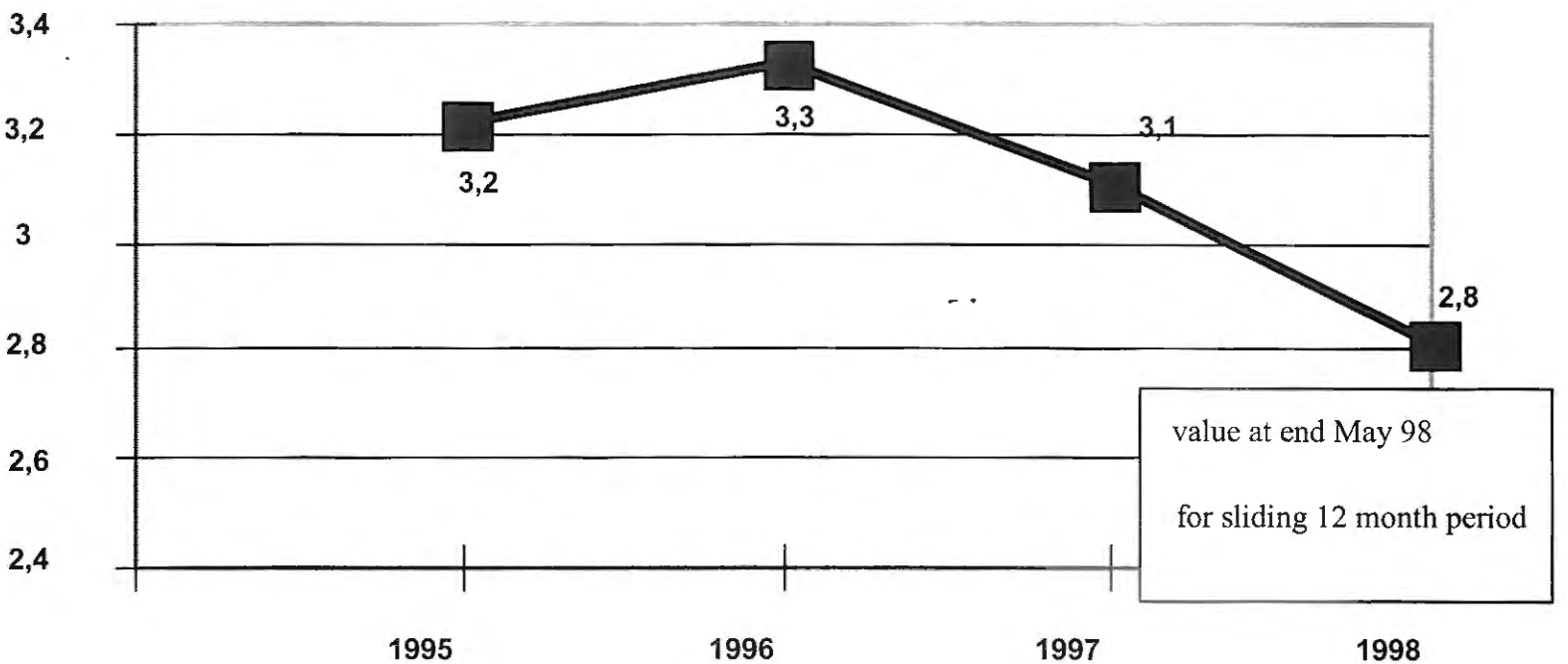
→ **Number of line up errors**

→ **Number of work order backlog**

Reactor scrams per 7000 hours' criticality per reactor-year



Number of non-compliances with operating specifications per reactor-year



SAFETY MANAGEMENT INDICATORS

ADVANTAGE - Challenge of plant personnal

- Measure improvement in quality of operation

SIDE EFFECT - might affect openness

POTENTIAL RISK INDEX

→ **Incident of the "initiator type"**

quantification of the remaining defense line

→ **Degradation of defense in depth**

quantification of the consequences if any one of the initiators had occurred