Government of Italy

ITALIAN NATIONAL REPORT
FOR THE CONVENTION ON NUCLEAR SAFETY

NPP

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PREFACE

This National Report, pursuant to Article 5 of the Convention on Nuclear Safety co-ordinated by the International Atomic Energy Agency, which entered into force on 24 October 1996, describes the official actions that the Government of the Republic of Italy, as a Contracting Party to the Convention since 15 April 1998, has taken in order to fulfil its obligations prescribed in the Convention text as specified in Articles 6 through 19 of the Convention.

This National Report was prepared in accordance with the “Guidelines Regarding National Reports under the Convention on Nuclear Safety”.

Nuclear installations covered in this National Report are land based civil nuclear power plants under the jurisdiction of the Republic of Italy complying with the definition given under the Article 2, comma (i).

This National Report was drafted by the Italian Nuclear Regulatory Authority, that is ANPA, as co-ordinating organisation of the “Working Group for the Implementation of the Convention on Nuclear Safety” established by the Ministry of Foreign Affairs. This Report was reviewed by relevant governmental and industrial organisations, and released by ANPA.

Major contributors to the preparation of this National Report, besides ANPA were ENEL, that is the National Electricity Company, the Department of Civil Protection, the Ministry for Health, the National Institute of Health and ENEA.

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LIST OF ACRONYMS

AFR	Away From Reactor
ALARA	As Low As Reasonably Achievable
ANPA	National Environmental Protection Agency
ATWS	Anticipated Transient Without Scram
BWR	Boiling Water Reactor
CEVaD	Centre for Data Elaboration and Evaluation
CIPE	Interministerial Committee for Economic Planning
DISP	Nuclear Safety and Health Protection Directorate
ECCS	Emergency Core Cooling System
ENEA	Agency for New Technologies, Energy and Environment
ENEL	National Electricity Company
ESF	Engineering Safety Features
EU NRWG	European Union Nuclear Regulators Working Group
FSAR	Final Safety Analysis Report
GCR	Gas Cooled Reactor
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiological Protection
IFEC	Fuel Elements Fabrication Facility
INPO	Institute of Nuclear Power Operations
IRS	Incident Reporting System
ISPESL	National Prevention and Workers Safety Institute
ISS	Italian National Institute of Health
LOCA	Loss Of Coolant Accident
LWR	Light Water Reactor
NEA	Nuclear Energy Agency
NRWG	Nuclear Regulatory Working Group
OECD	Organisation for Economic Co-operation and Development
OECD CNRA	Committee on Nuclear Regulatory Activity
OECD CSNI	Committee on Safety of Nuclear Installations
OECD INEX	International Nuclear Exercise
OSART	Operating Safety Assessment Review Team
PARM	Post Accident Radioactive Monitoring
PASS	Post Accident Sampling System

PSA	Probabilistic Safety Analysis
PSAR	Preliminary Safety Analysis Report
PUN	Italian Nuclear Unified Project
PWR	Pressurised Water Reactor
QA	Quality Assurance
RCPB	Reactor Coolant Pressure Boundary
RESN	Radiological Environmental Surveillance Network
SGTR	Steam Generator Tube Rupture
TC	Technical Commission for Nuclear Safety and Health Protection
TMI	Three Mile Island NPP
TS	Technical Specification
US NRC	United States Nuclear Regulatory Commission
WANO	World Association of Nuclear Operators

1. Introduction

1.(a) Italy's Nuclear Policy and Related Government Structure

1.(a)1. Italy's Nuclear Policy

In Italy the pacific use of nuclear fission for energy supply started in the early sixties.

Three nuclear power plants, 160 MWe GCR at Latina, 270 MWe PWR at Trino and 160 MWe BWR at Garigliano, were in operation since the year 1964.

The Garigliano power plant was shut down in the year 1978 in order to undergo major modifications, but since then it never restarted.

In the year 1981, a fourth unit, 882 MWe BWR at Caorso started its commercial operation, and in the following years begun the construction of two 1000 MWe BWR units at Montalto (Alto Lazio NPPs).

The nuclear programme, in the middle of the eighties, foresaw the further realisation of at least 4 1000 MWe PWR units, according to the new national project named PUN (Nuclear Unified Project).

In addition, two experimental reactors were developed since the early seventies: the CIRENE reactor (natural uranium, heavy water, 60 MWe) and the prototype fast reactor named PEC (Fuel Elements Testing Reactor).

At the same time, fuel cycle activities were developed in industrial and/or experimental-pilot scale, such as uranium fuel fabrication (FN, at Boscomarengo, for BWR and PWR assemblies; IFEC, at Saluggia, for MTR and CIRENE fuels); fuel reprocessing (EUREX, at Saluggia, for MTR, CANDU and LWR fuels; ITREC, at Trisaia, for uranium-thorium fuel cycle); plutonium fuel fabrication (Plutonium Plant at Casaccia).

After the Chernobyl accident, a general public debate took place in Italy on the implications of the use of nuclear energy.

In November 1987, a referendum was passed: this vote was formally limited to specific aspects of nuclear legislation in force at that time, but it was anyhow interpreted as negative for existing nuclear technology.

As a consequence, the new National Energy Plan called for the abandonment of nuclear power, and legislation was passed to close the Latina, Trino and Caorso power plants, as well as the CIRENE and PEC experimental reactors, and to halt construction of the two 1000 MWe BWR units at Montalto (which were 70 percent complete).

At the same time, according to a resolution of the Interministerial Committee for the Economical Planning (CIPE), the National Electricity Company ENEL, that is the National Utility, was charged to start the actions for the decommissioning of all its own nuclear power stations.

From then on, no significant change of policy has occurred on this matter, and therefore no new order for nuclear installations is, at the present, foreseen in Italy.

On the other hand, specific policies were issued by the Government addressing to keep up-to-date the competencies and capabilities on nuclear installations technologies of National State R&D Organisations, as well as of the National Regulatory Body and selected Industries.

1.(a)2. Italy's Government Structure related to nuclear policy.

With specific reference to the application of nuclear fission as national energy source, the main national instrument is the "National Energy Plan" presented by the Ministry of Industry, endorsed by the Council of Ministries, and approved by the Parliament.

The Interministerial Committee for the Economical Planning (CIPE) issues, on behalf of the Government, and taking into account the directives of the Parliament, resolutions concerning specific aspects of the national nuclear policy related to the nuclear installations.

1.(b) National Nuclear Programmes Pertaining to Nuclear Installations - Main Themes and Main Safety Issues

All the Italian NPPs are at present shut down and, at different levels, under decommissioning.

The Garigliano power station, a BWR unit (160 Mwe), started its commercial operations in the year 1964, and was permanently shut down in the year 1978.

The present status is the following.

- all spent fuel removed from the site (mostly sent to reprocessing at foreign plants; 322 elements stored AFR (Away From Reactor) at Saluggia-Avogadro storage pool);
- radwaste treatment and conditioning under completion;
- mapping of contamination fully carried out;
- "easy" decontamination performed;
- first phase of decommissioning programme ("safe storage") under way.

The Latina power station, a MAGNOX type unit (210 MWe initially, then reduced to 160 Mwe), started its commercial operations in the year 1964, and was permanently shut down in the year 1986. Such a decision was later on definitively confirmed by a resolution of CIPE.

The present status is the following.

- all spent fuel removed from the site (all reprocessed at foreign plants)
- radwastes treatment and conditioning underway;
- mapping of contamination fully carried out;
- "easy" decontamination performed;
- first phase of decommissioning programme ("safe storage") under way.

The Trino power station, a PWR unit (270 Mwe) started its commercial operations in the year 1965 and was permanently shut down in the year 1987, just after the 9th refuelling

(just before starting the 10th cycle). Such a decision was later on definitively confirmed by a resolution of CIPE.

The present status is the following:

- all the fuel permanently removed from the core (mostly sent to reprocessing at foreign plants; 96 elements stored AFR, of which 47 in the storage pool at the same Trino site, and the remaining 49 at Saluggia-Avogadro storage pool);
- radwastes treatment and conditioning under way;
- first phase of decommissioning programme ("safe storage") is under way as a licence modification.

The Caorso power station, a BWR unit (882 Mwe), started its commercial operations in the year 1981 and was permanently shut down in the year 1986, just after the 4th refuelling (before the 5th cycle starting). Such a decision was later on definitively confirmed by a resolution of CIPE.

The present status is the following:

- all the fuel still stored in the reactor building: 560 elements in the reactor vessel (160 of which as fresh elements) and 632 in the storage pools; the operation for removal of the fuel from the core to the storage pools is going to start and its completion is foreseen for the end of this year (1998),
- radwastes treatment and conditioning under way;
- decommissioning programme under evaluation by the Regulatory Authority.

All the radioactive wastes produced by these power stations during their operations are still held at these plant sites, waiting for a national low and intermediate level waste repository. Within this frame ANPA has set up a task force for the definition of the fundamental safety objectives for such a facility.

The intermediate storage of spent fuel outside the reactor building (on site AFR) is an essential step in order to reach the "safe storage" condition for the Trino and Caorso plants (and also for the nuclear storage facility at Saluggia). The national Italian Utility (ENEL), owner of the nuclear power plants, has chosen dry storage in metallic casks as the preferred option, and an international bid is underway for the supply of dual-purpose casks (storage and transport) for this purpose. The casks, according to the Utility proposal, will be properly stored at the Trino and Caorso sites, until they can be transferred to a national storage facility (for which discussions are on-going at the political and technical level). ANPA has set up a task force for the definition of the safety criteria both for the metallic casks and the associated intermediate storage facilities.

The transfer of spent fuel from the reactor pools to the dual-purpose metallic casks will assure that the fuel is kept in a safe condition at least for the next 50 years (the current conservative operating life requested for the dual purpose dry storage casks), while waiting for the availability of the national final disposal facility for such a type of radioactive material.

It is to be noted that the fuel pools of the Caorso plant, where are currently contained 632 fuel elements, will soon contain 1192 fuel elements, against a capacity of 2000, in spent fuel storage racks containing Boraflex as neutron absorber. The fuel elements will remain in the pools for the time necessary (about 5 years) for the procurement and licensing of the dual-purpose metallic casks, where they will be dry-stored.

Known issues on Boraflex stability prompted an ad-hoc surveillance program to be set in place. In the Caorso case, however, the effect of gamma radiation is limited, since the "freshest" fuel in the pool was irradiated at least ten years ago. Silica concentration measurements in the pool have also not shown unusual levels or trends. In any case, ANPA has requested that, given the existing space margin in the racks, the fuel shall be stored in such a configuration that no credit for the Boraflex is needed to assure subcriticality of the overall assembly.

In this situation, the national nuclear programmes pertaining to nuclear installations (as within the scope of the subject Convention) may be summarised as the following:

- the definition, through a reconsideration of the SAFSTOR ("safe storage and delayed dismantling") technique until now implemented , of a unitary and coherent strategy for the decommissioning of all dismissed nuclear installation, with particular reference to:
  - the selection of the proper strategy [DECON ("immediate dismantling") or SAFSTOR, as well as a proper combination of those ones];
  - the selection, characterisation and operation of the centralised national site for the disposal of low and intermediate level waste and for the temporary (long term) storage of spent fuel;
  - the provisions, currently underway, for the institution of a National Agency for the operational management of radioactive wastes and for the operational decommissioning of nuclear installations;
- the keeping up-to-date the national competencies and capabilities in the safety and in the technology of nuclear installations, also through international corporations (in terms of bi and multi-lateral contexts) in particular by participating in international programmes of assistance to the eastern European Countries, by co-operating in international research projects, as well as by participating in the initiatives of the major International Organisations (e.g. IAEA, OECD-NEA);
- the participation of the national nuclear industry both in realisation activities already in progress and in international tenders for the realisation of new nuclear installations (e.g.: ANSALDO for Rumanian Cernavoda units) and of the National Utility in NPPs on-site assistance programs (e.g.: Armenia - Medzamor, Mexico - Laguna Verde);
- the promotion of the maintenance and the improvement of the updating of the nuclear safety culture at national level.

1.(c) List of Nuclear Installations

See annexes 5.(a) and 5.(b).

2. Article-by-Article Review

2.(a) General Provisions

2.(a)1. Art. 4 Implementing Measures

The Italian Legislative and Regulatory framework has been long in force (since the early 60 ties), as it will be better outlined in the annexes and in other sections.

This framework is quite complete and does not require any modifications and/or improvements because of the Convention; it must be emphasised that Italy is a member of the European Union, where policies pertaining to Radiation Protection share a common philosophy of strong regulatory control. To a certain extent, this also holds as regards nuclear safety, where national peculiarities are more enhanced, due to the fact that Nuclear Programs had a different development history and that no EURATOM directives in that field have been issued. Nevertheless, a strong effort to harmonise the approach has been in place for a long time and considerable progress has been made.

2.(a)2. Art. 5 Reporting

Not applicable.

2.(a)3. Art. 6 Existing Nuclear Installations

Reference is made to the annexes 5(a) and 5(b), where the list and the main features of NPPs are outlined. Considering their present status, no specific safety assessment for the purposes of this Convention had to be performed. Nevertheless, a general outline of the safety assessments performed during licensing phase or during periodic reviews is given in the appropriate sections.

2.(b) Legislation and Regulation

The present Italian Regulatory System related to nuclear installations is the result of an evolution of rules and standards that begun in the early 60^{ties} and that took into account the experience of licensing and operation of NPPs of different types and generation.

2.(b)1. Art. 7 Legislative and regulatory framework

A more comprehensive description of the Italian Legislative and regulatory framework is given in Annex 5(c). In the following the main outlines are presented.

2.(b)1.1. Overview

The Italian regulatory system is made up of three types of rules of different legal force depending on their origin:

- legislation proper and governmental or ministerial decrees;
- technical guides;
- technical standards.

a) Legislation and ministerial decrees.

In the Italian system the source, however indirect, of legally binding rules must be either an act of Parliament (statute) or a Legislative Decree; the Government can issue governmental or ministerial decrees binding in law. The practice of laying down numerical limits and minute regulations in decrees issued by the Executive is very frequent. An important feature of legally binding rules concerning Safety and Radiation Protection in Italy is that contravention to obligations by operators and/or users constitutes a misdemeanour and entails a penal

sanction; compliance can be enforced by means of criminal proceedings after due process of law.

The main corpus making up, inter alia, the Italian system are itemised below, as regards Statutes and Legislative acts:

Act no. 1860 of 31 December 1962 published in the Italian Republic's Official Journal no. 27 of 30 January 1963, as amended by the President's Decree no. 1704 of 30 December 1965 (Italian Republic's Official Journal no. 112 of 9 May 1966) and by the President's Decree no. 519 of 10 May 1975 (Italian Republic's Official Journal no. 294 of 6 November 1975).

Presidential Decree no. 185 of 1964: "Safety of plants and protection of workers and general public against the risk of ionising radiation associated to the peaceful use of Nuclear Energy replaced in 1996 by the Legislative Decree no. 230/1995, described below.

Legislative Decree no. 230 of 17 March 1995 published in the Supplement to Italian Republic's Official Journal no. 136 of 13 June 1995, implementing six EURATOM Directives on radiation protection (EURATOM 80/836, 84/467, 84/466, 89/618, 90/641 and 92/3).

The Legislative Decree no. 230, promulgated in 1995, which has been in force in Italy since January 1st 1996, replaces the previous radiation protection act, the Presidential Decree no. 185/1964. The Presidential Decree no. 185/1964 is still in force, temporarily, in some parts; for the implementation of these parts, Legislative Decree no. 230 needs a series of Government and Ministerial Decrees, which have not been all issued yet.

Act no. 393 (1975) Administrative rules on the selection of the site for NPPs

Presidential Decree no. 1450 Requirements and procedure for the acquisition of the operational personnel licences (1971)

Presidential Decree no. 519/1975 "Civil responsibilities in the field of nuclear safety"

The Acts of legislative force on the institution and subsequent re-organisations of the Regulatory Body are listed below:

- Act no. 933 (1960) On Establishment of the National Committee for Nuclear Energy (CNEN)
- Act no. 84 (1982) Establishment of the State Agency for new technologies, energy and environment (ENEA)
- Act no. 61 (1994) Establishment of the National Agency for the Environmental Protection (ANPA).

The main functions of the Regulatory Body in Italy were entrusted to the Directorate for Nuclear Safety and Health Protection (DISP) of CNEN, then ENEA. Act no. 61, which established ANPA by transferring to it functions, staff, technical structures, equipment and financial resources, of the former ENEA-DISP, assigned consequently the main functions of National Regulatory Body to the above mentioned Agency, among its many duties concerning the Environment Protection field.

b) Technical guides

This issuing of technical guides, previously carried out by the Directorate for Nuclear Safety and Health Protection (ENEA-DISP), is now assigned in Law to the National Agency for the Protection of the Environment (ANPA) by article 153 of the Legislative Decree no. 230/1995.

Technical guides contain recommendations and are a tool to implement rules of good practice. 28 technical guides have been issued on Safety and Radiation Protection matters ranging from procedural to detailed technical guidance.

In addition, the existing wealth of international recommendations, such as IAEA (International Atomic Energy Agency) and ICRP (international Committee on Radiological Protection) publications, has been largely made use of in the Italian system.

Selected ANPA (former ENEA-DISP) Technical Guides addressed to Nuclear Installations' licensing:

-- Doc. DISP (87) 10 "General Design Criteria for PWR NPPs"

-- Doc. DISP (87) 11 "Design Requirements for the limitation of the worker exposure for the PWR NPPs"

-- T.G. no.1 "Content of the Preliminary Safety Analysis Report for NPPs, pursuant to article no.36 of the Legislative Decree no. 2301995 "

-- T.G. no.2 "Procedure for the Authorisation of Changes in NPPs"

-- T.G. no.4 "Implementation of the article no.41 of the Legislative Decree no.230/1995 --Detailed Construction Designs"

-- T.G. no.8 "Quality Assurance Criteria for NPPs"

-- T.G. no.9 "Quality Assurance Description of the documentation required for design and construction phases prior to carry out nuclear tests"

-- T.G. no.11 "Criteria for the compilation of information reports on the operation of NPPs to be sent to DISP"

-- T.G. no.20 "Quality Assurance Description of the documentation required for operation phase of NPPs"

-- T.G. no.21 "Content of Operating Rules"

-- T.G. no.22 "Quality Assurance. Guide for collection, storage, preservation, and safekeeping of quality assurance records for NPPs"

-- T.G. no.23 "Quality Assurance. Guide for procurement of Items and Services for NPPs"

-- T.G. no.24 "Quality Assurance. Guide for Auditing on QA Programmes for NPPs"

-- T. G. no.25 "Quality Assurance. Guide for Applying on design activities for NPPs"

-- T.G. no.26 "Radioactive Waste Management"

c) Technical standards

These standards are mainly published by UNI (Ente Nazionale Italiano di Unificazione) the Italian National Standards Body.

Other Standards often used were those published by CEI (Comitato Elettrotecnico Italiano) and by ISO (International Standards Organisation).

Standards documents are developed within an Expert Group and approved by the Technical Committees.

Such standards developed within the above mentioned Bodies represent a broad consensus of the experts (industry, research, and sometimes regulatory Agencies) in the field who were involved in the development of the standard itself: thus, they are thought to stand for good practice.

Moreover, in the design, construction and operation of NPPs, other rules such as the ones concerning fire fighting, pressure components integrity, labour and health apply.

Among the other foreign technical standards often adopted and endorsed, on a case by case basis, it is worth to mention :

- the American Nuclear Society (ANS), the American National Institute (ANSI)

  concerning specific requirements of safety systems

- the American Society of Mechanical Engineers (ASME)

  concerning the design of mechanical structures

- the Institute of Electric and Electronics Engineers (IEEE)

  concerning electric systems plus Instrumentation and Control

- the American Concrete Institute (ACI)

  concerning the civil structures

2.(b)1.2. General features of the main Italian Rules concerning Safety and Radiation Protection

The main body of the applicable Italian rules is contained in:

Nuclear Act 31.12.1962, no. 1860, and Legislative Decree no. 230/1995.

Both the statute and the decree provide for the most important aspects concerning both safety and radiation protection, as regards not only nuclear installations but also other aspects of the uses of radiation, so as to make up a comprehensive corpus of rules at the highest level.

The legislative provisions apply to every aspect of activities relevant to radiation protection, such as:

- Construction, operation, decommissioning of nuclear installations; provisions for decommissioning are a new feature of this Legislative Decree that were not included in the previous rules.
- Production, importation, export, handling, holding, processing, use, marketing, storage, transport, termination of holding, collection and disposal of nuclear radioactive substances.
- Work with radiation generating devices.

- Mining activities.

- Exposure to natural sources of radiation as well as any other activity or situation involving a significant risk, such types of exposures are to be laid down by governmental decrees.

Administrative tools used to keep under control the field are listed below.

Notification of holding of radioactive substances must take place within 5 days to the Ministry of Industry and ANPA if certain levels of radioactivity are exceeded, such as:

1st Group of Radiotoxicity ≥ 370 MBq

2nd Group of Radiotoxicity ≥ 3700 MBq.

Radiotoxicity Groups are determined according to the directive 84/467/EURATOM.

For lesser amounts of radioactivity, starting from 3.7 kBq (1st Radiotoxicity Group), notification of holding must also be made to local Health Bodies and Labour inspectorates.

Authorisation for trading in radioactive substances, ores and source materials is issued by the Ministry of Industry and is deemed as issued after 30 days. Ores and source materials are defined as in EURATOM Treaty article 197 and Eur Regulation no. 9, together with natural U, natural Th, depleted U (less than 0,72% U235).

Transport of radioactive substances must be entrusted to carriers authorised by the Ministry of Industry and Ministry of Transportation, except for small amounts of radioactive isotopes. Special kinds of transportation, e.g. spent fuel, need a special authorisation.

Authorisation is provided for the use of radioactive substances (medical, industrial and research) from amounts starting from 11,100 GBq for sealed sources classified in the 1st Radiotoxicity Group and from 3.7 GBq for unsealed sources in the 1st Group etc.

The provisions for licensing of nuclear installations are treated elsewhere.

It must be recalled here that the Countries members of the European Union share common directives and regulations that have been inspiring more and more many relevant aspects of the national regulatory system, above all in the field of radiation protection. Even in the Rome Treaty, signed in 1957, directives were included regarding radiation safety fundamental rules; procurement, treatment, controls and property of special fissile material. The quoted Treaty requires (art. 37) also the notification to the member States about the construction of any kind of plant that may discharge radioactive wastes. The aim of the notification is to give the possibility to verify whether any possible discharge can lead to contamination of water, ground or air of any member state.

Here the list of main directives/regulations of interest follows:

- directive of the EC Council on fundamental safety rules on the protection of the workers and the public against ionising radiation (first issue 1959, subsequent revisions 1962, 1966, 1976, 1979, 1980, 1984, last issue 96/29 on 13 May 1996). In particular, according to the original treaty, the fundamental rules on this matter concern:

  1. the maximum permissible doses, including adequate margins,
  2. the maximum permissible exposures and contamination levels,
  3. the fundamental principles on workers' health surveillance.

  Furthermore, this directive lists the practices for which notifications and authorisations are required, address to the general safety objective of justifying the practices against

  benefits, to the ALARA principle application taking into account economical and social costs, to the need of identifying limits for professionally exposed workers (divided into two

categories), apprentices and students. Information on the risks, individual monitoring and medical surveillance, recommendations applicable to interventions in case of emergency are considered too. The radiological protection of workers coming from external Organisations is specified in the Council Directive 90/641/EURATOM.

- regulation on the maximum radioactivity activity level of food stuffs and fodders (EURATOM Council regg. 3954/87, 944/89 and 770/90), and on export of food stuffs and of fodders after nuclear accidents or radiological emergencies (Council reg. no. 2219/89)
- Fast information exchange among member states in case of radiological emergencies (Council decision 87/600 EURATOM), which unifies and details the procedures, taking into account the Paris Convention (see below)
- Information of the public about the countermeasures to be implemented and about the behaviour in case of radiological emergencies (89/618 EURATOM and subsequent communication 91/C/103/03). Specific types of information is directed to the:

    a) public potentially affected by a radiological emergency (preliminary information), regularly updated and provided without the need of request

    b) public actually affected by a radiological emergency

    c) rescue teams.

OECD member states have also the Paris and Brussels Conventions (issued in 1960 and 1963 respectively), which constitutes the first tool to internationally deal with the nuclear liability maters. This convention assigns to the Plants' Operating Organisations the responsibilities for any damage caused by nuclear accidents. The compensation measures are exclusively in charge on the mentioned Organisation. Further updating to those conventions is still in progress. Furthermore, Italy is also a contracting party to the Vienna Convention on nuclear liability. Italy also became on 26th January 1998 a signatory to the Vienna Convention on the safety of spent fuel management and the safety of radioactive waste management.

2.(b)1.3. General content of the most relevant Acts and Laws.

Legislative Decree no. 230/1995 is made up of 12 titles and 5 annexes:

Title 1 defines the Fields of Application of the law and establishes the general principles of radiation protection.

Title 2 defines radiological terms and units.

Title 3 identifies involved governmental bodies.

The following four sections define the rules regulating the following nuclear activities:

Title 4 - Mining activities

Title 5 - Import, production, trade, transport and detention

Title 6 - Use of radioactive materials and waste management

Title 7 - Nuclear plants

Title 8 defines requirements for licensees and workers concerning radiation protection.

Title 9 defines general requirements for the protection of population and patients receiving radiological treatment.

Title 10 establishes requirements for Nuclear Emergencies plans and information to the public in case of emergency.

Title 11 covers sanctions rules in case of behaviours offending law requirements, according to the different Titles of the law.

Title 12 regulates interimistic provisions.

The Law has 5 appendices which report details on quantitative reference values, exemptions, fields and conditions of application etc. In particular Appendix IV defines dose limits for workers and general public.

In particular, for the construction, operation and decommissioning of nuclear facilities the Legislative Decree no 230/1995 establishes:

- responsibility of licensee and authorities involved in the regulatory process

- licensing process procedures

- content of the documents and of the analyses to be submitted by the applicant.

The regulatory tool commonly used in order to meet the problem of installation backfitting is the modification of the operating licence, in cases where this is warranted by the entity of the modifications required. Usually, in the licence, there are in built instruments that permit minor modifications on the strength of ANPA acts. Needs for modifications may come from periodical safety assessments that are provided for in the licence document.

The main Rule that is related to the duties and responsibilities of the Regulatory Body is the Act no. 61 (1994).

The quoted Act replaces earlier legislation on matters related to the institution of the Regulatory Body, establishes duties and responsibilities of ANPA (National Agency for Environmental Protection) and Regional Agencies with regard to environmental protection in Italy.

According to the Act, ANPA has the following main duties :

- main functions of Regulatory Body, such as the legal authority for conducting the licensing process, for elaborating and providing the final advice for the Licences and, thereby, for regulating NPPs siting, design, construction, commissioning, operation and decommissioning, as specified under the section 1-bis., comma 5 of the quoted Act
- control of the remaining activities related to the pacific use of nuclear energy and radiations
- promotion of research on the physical environment, pollution, industrial risks and ecosystem protection and conservation
- systematic collection, storage and publication of environmental data
- public information and training programmes on environmental protection issues
- technical advice to public authorities on different matters related to environmental protection, such as:

  - pollutants acceptability levels,

  - air, water and soil quality standards,

  - waste management strategies and technologies.

Duties and responsibilities of ANPA as Nuclear Regulatory Authority are better detailed in the Legislative Decree no. 230/1995.

The technical guidance and standards that at the early 60^{ties} were initially assumed as reference for the design, construction and operation of NPPs were essentially the ones developed in the Country where the specific technology was originated. The reasons for that are easily understandable if one thinks that NPPs had a US and UK origin.

A long process of assimilation into the main stream of the industrial and regulatory practices has been taking place since the inception of the Italian nuclear program. The results of that assimilation process developed into an indigenous conception of the safety and radiation protection criteria. In this context it must be remarked that radiation protection concepts such as justification and optimisation were long in use even before the formal introduction into the legislative corpus of rules. Moreover, in the 80^{ties}, some specific Italian requirements were introduced into a new homogeneous corpus establishing general criteria and requirements applicable to pressurised light water reactors. That process lead to an approach that resulted in establishing integration between safety and radiation protection requirements. Full use of probabilistic assessments was required by applicants for demonstration of having met the radioprotection objectives in terms of doses to members of the public for the entire spectrum of operational scenarios (including transients and accidents).

A reflection of the adoption of nuclear US technologies has been the intensive use of some parts of 10 CFR (U.S. Code of Federal Regulations), and of other US industrial standards, as it is better described under Article 10, section 2(c)1.

2.(b)2.Art. 8 Regulatory Body

In accordance with Law no. 1860 and Legislative Decree no. 230/1995, the authority responsible for licensing is the Minister for Industry, Commerce and Crafts.

In particular for the NPPs the construction permit and the operating licence are granted by a Decree of the Minister after the presentation by the applicant of the application documents requested by the Legislative Decree no. 230 and the positive advice of ANPA.

ANPA is, in fact, inter alia, the technical body responsible for regulatory procedures.

The main tasks of ANPA to fulfil the obligations of the Legislative Decree no. 230/1995 are:

-controls and surveillance on existing nuclear installations,

-licensing on new nuclear installations,

-controls and surveillance on possession, commerce, transportation, utilisation, release of radioactive material,

-controls and surveillance on radioactive waste management,

-radioprotection of workers, public, environment,

-nuclear emergency preparedness,

-fulfilment of International Agreements on control and surveillance of nuclear materials (e.g.:NPT, Additional Protocol),

-promotion of international co-operation in the field of nuclear safety and radiation protection,

-promotion of actions aimed at maintaining and improving the national know-how and the national safety culture in the field of nuclear safety and radiation protection.

In addition to these duties, ANPA has also to:

-support the State Administrations to issue specific decrees for the implementation of the fundamental nuclear laws,

-to issue specific technical guides,

-to realise a National Database on all nuclear applications.

ANPA responsibilities for the licensing process of NPPs include:

-assessment of the safety analysis carried out by the operating organisation

-inspection of equipment and materials during the design, construction and operational phases for the systematic verification of plant operation safety

-enforcement action to remedy any failure to meet both the licensing conditions and any safety operation criteria

The Legislative Decree no. 230/1995 foresees, in agreement with IAEA guide no. 50-C-G "Code on the Safety of NPPs: Governmental Organisations", a Technical Commission for Nuclear Safety and Health Protection established at ANPA. Its role is to give ANPA an independent advice on safety and health protection issues in relation to the main stages in the licensing procedure and to emergency plans.

Members of this Commission are appointed by the Ministries of Environment, Industry, Employment, Health, Interior, Public Works, ENEA and ANPA. When necessary other specialists are appointed by the Chairman of the Commission. For matters under the competence of other Public Scientific Organisations and Administrations (e.g. Italian National Institute of Health, National Research Council), in compliance with Section 9 of the Legislative Decree 230/1995, those Organisation and Administrations are invited to sit in the Commission through a designated representative.

During the licensing process ANPA performs its independent assessment on the basis of documentation presented by the licensee and involving the above mentioned Commission.

ANPA transmits its assessment report to the Minister of Industry who involves other Ministries. Any comment by other Ministries is returned to ANPA to be incorporated in the final report for the Ministry of Industry. A simplified scheme of the relationship between Authorities having responsibility on nuclear safety and operators is shown on the enclosed figure no.1

Within ANPA, while the overall responsibility rests to the Chairman and to the General Director, the duties of Regulatory Body are carried out by the Department of Nuclear Safety and Radiation Protection.

At present, about 60 specialists (of which 26 acting also as inspectors) belong to the Department, which is subdivided in the following Sectors:

- co-ordination of inspection and regulations
- emergency preparedness
- reactor safety
- nuclear technologies
- nuclear facilities, radwaste, decommissioning

- radioisotopes and sources
- radiation protection in nuclear installations
- radioactive and fissile materials.

In addition, to the Department of Nuclear Safety and Radiation Protection are assigned the following inter-sectors co-ordination functions:

- assistance to the Eastern Europe Countries on nuclear safety and radiation protection;
- promotion and management of international cooperations (IAEA, OECD-NEA, EU, multilateral, bilateral).

The activity of ANPA, which covers the protection of the environment in general (and not only the “nuclear” field), is mainly financed by the central budget approved by the Italian Parliament each year.

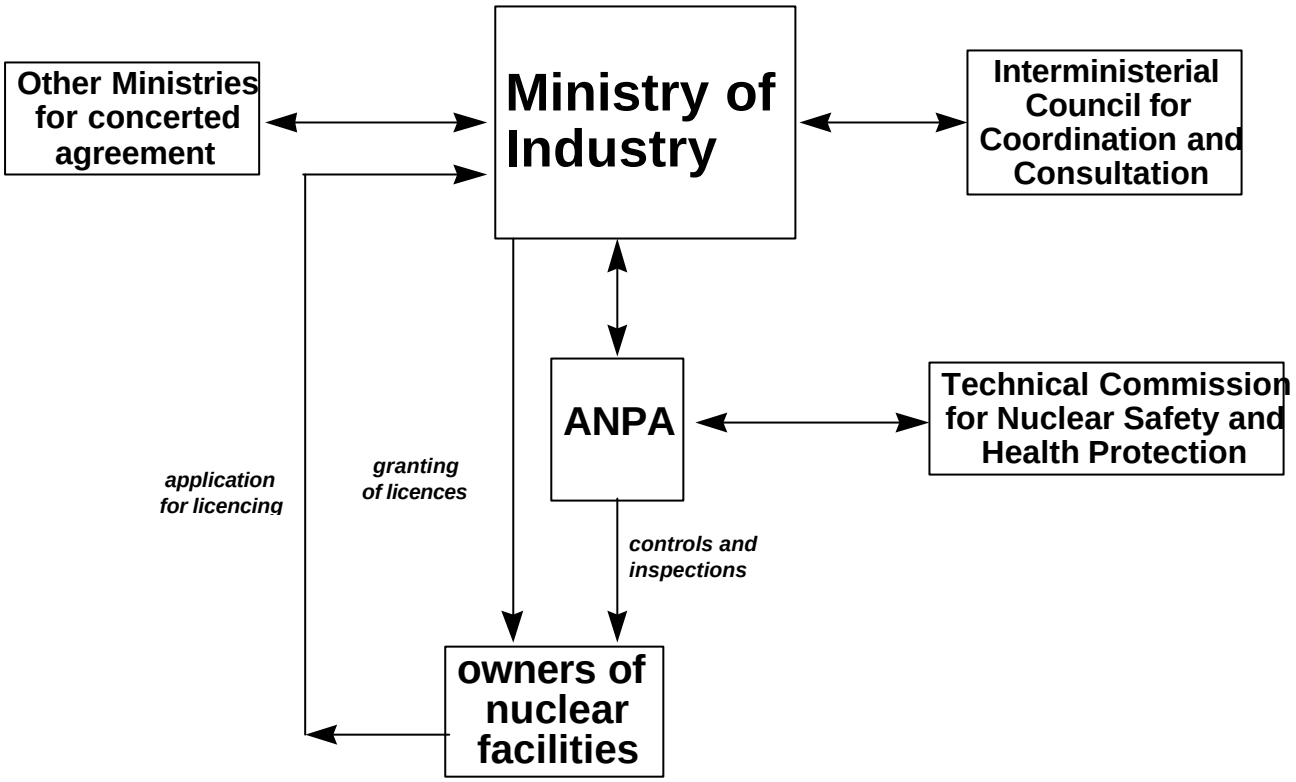
Within the nuclear field, funds are also collected from :

- Charging the operators, at approved rates, for regulatory activities (at present mainly in the areas of transport, medical applications, and industrial use of radioactive sources)
- Participating in the RAM and TSO (ANPA is also the Italian TSO) activities within the framework of the EU programs.
- Fines to operators for violations (mainly in the area of health protection)

All incoming funds are approved by the ANPA Board and added to the annual financial plan, which is subject to strict Government control.

At present, the state funding covers all personnel and operating costs. Part of the collected funds are also dedicated to R&D activities in the nuclear safety area and to the co-operation with a number of international organisations (mainly IAEA, OECD/NEA, CCE). Membership fees for these organisations are paid by the Ministry of Foreign Affairs.

**Fig. 1 Licensing of nuclear installations in Italy.
Relationship between responsible Authorities and operators.**



2.(b)3.Art. 9 Responsibility of the licence holder

According to the Act no. 1860 and the Presidential Decree no. 519/1975, the primary responsibility for safety is assigned to the operating organisation.

Therefore the operating organisation is responsible of all the activities performed during design, construction, commissioning and operation having direct influence on safety.

The system of controls provided for in the Italian rules uses three tools essentially:

1. the analysis of the safety reports and other relevant documents, the analysis on the results of tests and measurements, the performance of additional or repeated tests,
2. the inspection system, in order to verify compliance with applicable rules and constraints at all stages from design to operation,
3. the sanctions in case of non compliance either with provisions in Law or prescriptions in the licensing acts range from penal to administrative measures. The former can entail deprivation of freedom and fines, the latter consist in suspensions or revocation of the licences in worst cases. The penal sanctions are applied by Courts following reports from Inspectors that have Police power in the Italian system. The administrative measures are

applied by the Ministry of Industry. Before applying the administrative measures, the Ministry can issue an injunction to comply with applicable regulations and prescriptions.

2.(c) General Safety Considerations

2.(c)1. Art. 10 Priority to safety

The legislative framework and the Italian regulatory practice that have been long in use even before the publication of IAEA Safety Fundamentals (SS 110), have stimulated the Safety Authorities, the Utility, the Suppliers and Contractors to be committed to reaching and maintaining the highest priority in safety matters. In fact, there is a wealth of regulatory tools that enjoin a humus of safety culture, tools such as:

- Legislative Corpus itself, which imposes a multi-step licensing process (e.g.: Siting, Construction, Operation)
- General design criteria, requiring inter alia the application of the defence in depth principle, which for instance in the design phase requires the implementation of multiple barriers and of prevention and mitigation measures.
- Regulatory guides,
- Preliminary, Intermediate and Final Safety Reports,
- Detailed designs,
- Quality Assurance Programmes,
- Safety relevant works Operational Rules (Operation Regulations, on-site Organisation Chart, Roles and Responsibilities),
- Technical Specifications,
- Operating Manual (e.g.: Procedures for normal and emergency condition),
- State exams for Operator Licences and State Certification for Plant Managers,
- Periodic assessment and reporting of performances,
- Inspections.

Since the start of the Nuclear Programmes, all the involved Organisations, each in its own fields, have been involved in International fora dealing with Nuclear Safety. Consequently, the latest international achievements have been implemented in Italian applications.

Considerable efforts have been spent in Italian research in the field of thermal hydraulics, severe accidents, mechanical aspects, methods for probabilistic analysis; on the same themes, there have been joint efforts with foreign and international Organisations.

Particular emphasis has been given, since the inception of the Italian Nuclear Programme, to the Optimisation principle as stated in the ICRP publications no. 9, 22, 27, 60, even before the basic principle was laid down, significantly in art. 2 of Legislative Decree no. 230/1995:

"*All exposures to ionising radiations shall be kept as low as reasonably achievable, economic and social considerations being taken into account".*

Moreover, various Organisations, dealing with nuclear legislation and/or regulations, , such as Ministries, the Technical Commission for Nuclear Safety and Health Protection, , besides ANPA itself, each give close, independent scrutiny to the documentation submitted by the applicant and to ANPA Safety Evaluations. On the operation side, the Utility is required by Law to set up a special Safety Evaluation Group, which has the responsibility to examine all the relevant decisions (e.g.: plant hardware or procedures modifications), in order to identify their safety relevance.

In order to specify in a better way the previous item, the various aspects of the nuclear safety can be summarized as follows.

Safety Policies

The license holder shall operate,maintain and modify the systems of the nuclear power station by assigning the highest priority to the nuclear safety and so keeping the consequential risk to the public acceptably low.

Safety Procedures at the Designer

The designer must take into account at the highest level the health, the safety and the protection of the environment. The nuclear safety must be implemented using the following principles:

- to meet the safety, health and environmental laws, regulations and international standards,
- to maintain emissions from the nuclear power plant below the limits defined by the Authority of Control and to strive to reduce them,
- to apply the ALARA principle.

Safety Procedures at the Utilities

The utility must operate the NPP in compliance with the approved Operating Manual which must contain data and meet the following principles:

- the specific numerical limits for operating parameters which must be complied with to operate the plant in a safe state,

- the principles to be applied to operate the plant's systems in a safe state.

Such principles cover mainly:

- control of reactor power continuously,
- fuel cooling in at all time,
- containment of fission products in every condition,
- maintaining the operating limits which can affect public safety,
- maintaining defence in depth,
- establishing feed back actions and countermeasures (i.e. corrective actions).

Design Safety Principles

The design of Caorso NPP is based on the principles of multiple barriers to radioactive releases and redundancy for safety functions. Such principles comply with:

- accident prevention measures,
- redundancy in equipment and procedures,
- diversity in performing safety functions,
- physical and functional separation of the safety systems.

Some of the original systems were modified to update them to the new safety regulations issued both at international and national level.

2.(c)2. Art. 11 Financial and human resources

Financial Situation

The licensee holder in Italy has the responsibility to provide both adequate financial and human resources to support the safety of each nuclear power plant throughout its life.

He is also responsible of the dismantling of the same NPP at the end of its technical life.

To support the cost of the dismantling, the licensee holder appoint a financial fund on the basis of the energy produced by the nuclear power plant.

Human Resources

The licensee holder must provide human resources throughout the entire life of the plant to operate in a safe state. Italian Laws state that the operating personnel for the NPPs must attend an appropriate training and must be certificate their capacity to operate in a NPP.

So, many qualified positions in the staff of the NPPs are foreseen and such staff must be approved by the Authority of Control together with the Operational Regulation.

To certificate the operator qualification, many examination must be get through by the single person.

The responsible of health physic must be member of the “health physic association” at level 3 (the highest one).

The operating staff in the control room cannot leave his work without substitution.

2.(c)3. Art. 12 Human factors

2.(c)3.1. Methods to Prevent, detect and correct Human Errors

The important role of the human performance in design and operation of a nuclear plant has been focused to be a safety concern after TMI accident.

Italian organisations have revised and improved, from the human factors point of view, a variety of aspects of the design and operation of a nuclear power plant.

These aspects include :

- **Safety relevant Work Organisation Rules** (Operation Regulations, on-site Organisation Chart, Roles and Responsibilities)

(see point 2.(c)3.2. Managerial and organisational Issues)

- **Procedures development**

The procedures development, in particular for the emergency procedures, has followed a definite process with requirements for the main phases :

1. analysis,
2. writing,
3. verification,
4. validation.

The human factors scope was to assure procedures with : technical accuracy, written correctness, usability, operational correctness.

- **Operator Training**

Most of the ENEL training activities for personnel assigned to nuclear power plants were performed at the training centre located near Piacenza.

In order to cope with the requests of the Regulatory Body, ENEL has set up internal guidelines for the qualification of the personnel of Caorso. The first series of guidelines was limited to working positions with major responsibility. For each working position the guidelines state the content of the job, the school degree level, the experience necessary to cover that position, the training curricula and the retraining criteria. The training curricula are divided in three parts: basic training courses, specific training courses, training on the job.

For each course a specific plan is established which includes the objectives, the technical contents, the time length, the detailed program, the practical exercise, the list of teaching

aids, the certification criteria and finally the instructor qualification. The average training time is two years.

Simulators were used for licensed supervisors and operators, initially provided by other Constructor facilities, then by the Piacenza training school (Owned and managed by ENEL), where a BWR Plant training simulator has entered in operation from 1984.

- **Good understanding and clarity of Technical Specifications (TS)**

  The TS are operator oriented, the Base section of the TS has been carefully written and a great emphasis has been given to human factors principle in order to add clarity and understanding to TS requirements.

  From the human factors point of view two aspects have been considered as relevant:

  1. No conflicting interpretation of TS requirements have to be possible.

  2. The existence of the bases and their clarity and wording.

  It must be underlined that in this respect, the experience of the revision made on the Caorso NPP Technical Specifications, written on the basis of the US format for those kind of plants, required very limited modifications due to the good initial quality.

- **Control Room Review**

After TMI the control room design criteria had a considerable evolution. The existing Caorso NPP control room panels were partially redesigned and extensively modified according to the criteria of NUREG-0700, primarily with regard to general environment, panels, alarm system and Process computer man-machine interfaces.

Modification of the I&C system related to Reactor Protection System and ECCS initiation was implemented, by the installation of an Analog Trip System (ATS), which simplified the test and maintenance procedures. This activity was completed in 1986.

- **Event Reports System and Operating Experience**

  After TMI, requirements were issued and led to the definition and implementation of an integrated program, which included national and foreign experience, for the systematic collection, review, analysis and feedback of operating experience to the plant staff and its incorporation into training and retraining programs. Both the on-site and Headquarters Utility Organisations were involved in implementing such an integrated program.

  International operating experience was circulated among operating, maintenance and engineering supports personnel, according to a general ENEL procedure and a specific Caorso procedure, to assure a wide and timely spread of information and support analysis and evaluations.

  An event reporting system was set-up on a data bank support, for Events Recording and for Component failures, capable of connection and interchange with other national and international Data Banks.

  In addition the Caorso Plant modifications (e.g. Primary Containment inerting, ATWS installation, PASS and PARM introduction, etc.) that ENEL intended to perform from 1989, contained many items related to improvement having also significant influence on Human Factors. These modifications where presented by ENEL to Minister of Industry and Regulatory Body in years 1987/1988 to obtain approval, but they have not been implemented due to Government decision to interrupt NPP operation.

2.(c)3.2. Managerial and organisational Issues

According to the Italian law, the licensee, before carrying out fuel loading and commissioning tests, must provide to the Regulatory Body the **Safety relevant Work Organisation Rules.**

The Safety relevant Work Organisation Rules is a document which specifies the organisation and functions, under both normal and abnormal conditions, of the staff responsible for the direction, operation and maintenance of a nuclear power plant, including the physical and medical surveillance of radiation protection at all modes of operation.

The document has to be approved by the Regulatory Body after consultation with the Technical Commission for Nuclear Safety and Health Protection.

The Italian Regulatory Body has defined a Technical Guide on the contents of the Safety relevant Work Organisation Rules with many specific criteria for the approval of the utility's document.

The safety in a complex reality, such as a nuclear power plant, requires, from the human factors point of view, the maximum order in the methods of operation, This in order to avoid a state, also partial , of "organisational confusion", due to significant lacks in the design of the human system or in the supervisory system, that are the frequent root cause of many accidents.

The Italian Body Regulator's criteria require that the activities, relevant for the safety, be clearly defined, properly assigned, executed according to predetermined and written procedures, carefully recorded, regularly supervised, and the whole system readily corrected when necessary.

The whole operating organisation is seen as a great and diffused intelligence that only through the good organisation can be maintained in the condition to understand the operation of the whole plant and to carry out all the functions requested or necessary to its safety.

For a more reliable functioning of the organisational structure, the Italian Regulatory Body has generate specific criteria on the following general aspects of a NPP:

- translation from the enunciation of the Safety Report into concrete terms and precise tasks of the safety;
- organisation of the safety work;
- dimensions of the operating organisational structure;
- assignment of the responsibility for the safety tasks;
- definition of all the tasks, technical and/or organisational, assigned to the various individual working positions of the structure;
- organisational procedures

2.(c)3.3. Role of the Regulatory Body and the Operator regarding Human Performances issues

The Italian Regulatory Body is responsible of the controls on the training system and to conduct the examinations for licensing power plant operators.

But, also the best of the operators might err, like the best of the operating organisation may malfunction. A corrective system is always necessary.

According to the Italian Regulatory Body, only inside the various units of the plant operating organisation , there is all the information on the work and it is possible to reveal lacks of human system and operator's errors in the initial phase of accidents development.

ANPA has fixed criteria for an autocorrective system, that must function at various levels along the vertical axis of the operating organisation: unit level, department level, plant level.

ANPA has stressed the importance that "a human error", when committed the first time, has to be seen not only as a matter of concern, but also as a source of experience from which benefit can be derived, rather than a matter of concern. It is essential that individual is encouraged to identify, report and correct imperfections in their own work in order to help others as themselves to avert future problems.

Disciplinary measures have to be taken only for repeated deficiency or gross negligence. Nevertheless sanctions have not be applied in such a way as to encourage the concealment of errors.

- **Lower Unit Level**

  On each specialist unit of the departments, **the Unit Supervisor** has the responsibility to evaluate the collected data, to control both the good qualification and the behaviour of his technicians, to assure the correct implementation of the procedures. He has to suggest an eventual need of personnel training, or immediate modifications of components of the plant and of operating procedures for a safe operation.

- **Department Level**

  On each department **the Assistant manager** has to analyse the results of tests and inspections made by the personnel of the department and to observe the trend of the collected data with the scope to suggest possible modifications of components of the plant, of operating procedures or of administrative procedures for a better operation.

- **Plant Management Level**

  On each plant is required the institution of an **Advisory Council on Safety (also called "Plant Council of Delegates"),** formed by plant technicians supervising the most relevant activities (e.g.: operation, maintenance, radiation protection) supporting the Plant Superintendent with the following consultative functions, according to the Italian Law:

a) to review any proposed modification to the plant or to part of it and to express evaluations and advice on safety matters;

b) to review any proposed modification to the operating procedures of the plant and to express evaluations and advice on safety matters;

c) to review programmes of trials, tests, and other special activities to be carried out on the plant and to express evaluations and advice on safety matters;

d) to review periodically the overall operation of the plant, and to express opinion and possible recommendations regarding safety and protection;

e) to lay down the internal emergency drill for the plant and arrange for any necessary modification in consultation with the Provincial Fire Service Headquarters;

f) to assist the emergency director (person qualified by state examination to the "Direction" of nuclear plant in normal and emergency conditions, in "on call availability shift") or the plant superintendent in the adoption of the measures which may be necessary to deal with any unusual or abnormal condition which may constitute a danger for persons or things.

2.(c)4. Art. 13 Quality Assurance

At the Legislative level, the main reference is represented by the Legislative Decree no. 230/1995; in fact, the Safety Criteria and Requirements are dictated through the art. 36 of such a Decree, to the Safety Reports whose content is defined by appropriate ANPA Technical Guides.

Also for the establishment and the implementation of Q.A. safety criteria and requirements, the process put in place in Italy is a development process similar to the other safety requirements mainly described under sections 2.(b)1.3 and 2(c)1. Art. 10. In particular, Caorso NPP was licensed by adopting technical guidances and standards at that time in force in the Country of origin of the relevant used technology, the USA. 10-CFR-50, Regulatory Guides and Standards Review Plans developed by NRC, the U.S. Regulatory Body represented some of the major tools used. In particular, in the Q.A. field, the main references used were:

- 10-CFR-50, Appendix B "Quality Assurance Criteria for Nuclear Power Plants"

- ANSI no. 45 part 2 together with relevant daughter Standards

Then, since the beginning of 70^{ties}, a process of issuing of national technical guidances, standards and practices has been developed, both at the industrial and at the regulatory level, mainly in connection with the nuclear programme which was going to be established. In the Q.A. specific field, the Italian Regulatory Body started to issue a series of Technical Guides as recommendations to the Applicant as well as to the Licensee, covering all the phases of the Italian licensing process. The implementation of the above mentioned Guides started with Caorso NPP construction and commissioning phases.

Hereinbelow, a list of the major Technical Guides developed by the Italian Regulatory Body in matter of Quality Assurance is reported.

T.G. no.8 "Quality Assurance Criteria for NNPs", corresponding to the Appendix B of 10-CFR-50

T.G. no.9 "Quality Assurance Description of the documentation required for design and construction phases prior to carry out nuclear tests".

T.G. no.20 “Quality Assurance Description of the documentation required for operation phase of NPPs“, implemented for Caorso since 1981.

By making reference to the IAEA Safety Guides on the Q.A. matter released in the middle of 70^{ies}, the Italian Regulatory Body developed and issued at the beginning of the 80ties the following additional Technical Guides.

T.G. no.22 “Quality Assurance. Guide for collection, storage, preservation, and safekeeping of quality assurance records for NPPs“

T.G. no.23 “Quality Assurance. Guide for procurement of Items and Services for NPPs“

T.G. no.24 “Quality Assurance. Guide for Auditing on QA Programmes for NPPs“

T.G. no.25 “Quality Assurance. Guide for Applying on design activities for NPPs“

T.G. no.27 “Tests for the NPPs Operation” (1985)

T.G. no.28 “Surveillance for Internal Contamination”.

The requirements related to Quality Assurance where included in the Technical Guide no. 1 (1975) with the commitments to the Applicant for the licensing process, according to former DPR no. 185/64 and actual Legislative Decree no. 230/1995, to include in the documentation for obtaining the NPP construction permit (see 2.(c) 5.2) the description of the QA Programme related to the design, procurement, manufacturing, construction and installation, including the non nuclear tests phase. In this Guide is also specified that the QA Programmes related to the nuclear tests and Plant operation phases shall be presented by the Applicant in the Final Safety Analysis Report.

In the late 70^{ies},as domestic Technical Standards, it was issued the Standard UNI 8450, addressed to Construction, Tests, Operation and Decommissioning of NPPs, which has been used by ENEL for Caorso Operation phase, as an integration to the Technical Guides n°8 and 20, particularly for procurement of safety related services and components.

Regulatory control

In addition to the issuing of the above listed Technical Guides, the regulatory control during the licensing process was based on the analysis and review of QA Programmes for Construction, Tests, and NPP Operation submitted by the Applicant including the QA Programmes of Architect Engineer, Vendor and Manufacturers of Safety related components.

In accordance with the recommendations of the Regulatory Authority, ENEL in 1981 provided to re-organise its quality system and to define and implement a QA Program which, after a consistent remaking work of the existing Operating Procedures in order to cope with the

requirements of the T.G. no. 8 and no. 20 and to cover all aspects and criteria there expressed, essentially encompassed all activities relevant to the safety and physical protection for the Caorso NPP operation phase.

The Caorso QA Program included activities and responsibilities distribution/interfaces of the entire ENEL organization (Central and On-site) involved in the nuclear field, taking into account the relevant State Laws, Decrees and related documents governing the NPP operation.

The QA Program presented finally to the Regulatory Authority for approval, was accompanied by a formal Declaration of the ENEL General Director where it was stated the ENEL commitment for its implementation and the attainment of safe NPP operation.

In course of the QA Program implementation, ENEL made a big effort in the Personnel instruction and training, having as main objective the diffusion of a safety culture in order to give an essential contribution to attain a Defence in depth framework for the NPP operation.

In Attachment 5(h) the complex of fundamental documents governing the NPP operation and the role of the QA Program is summarised.

In Attachment 5(i) the effort of ENEL in maintaining safety and quality objectives in course of the long period of Caorso NPP Lay-up is summarised.

Audits

An additional primary tool of Regulatory Control is the performance of periodic Audits

to the Applicant and to the Licensee for a direct control on these Organisations.

Periodic Audits to Architect Engineers, Vendors, Manufacturers, and Suppliers in general were also conceived as an indirect tool of control of the Applicant and of the Licensee.

2.(c)5. Art. 14 Assessment and verification of safety

The licensing procedures to be implemented in Italy for the different stages are described in detail in the Law no. 393, and in the Legislative Decree no. 230 and foresee the following stages of authorisation:

-site approval

-construction permit

-approval of safety systems construction

-commissioning tests

-operating licence

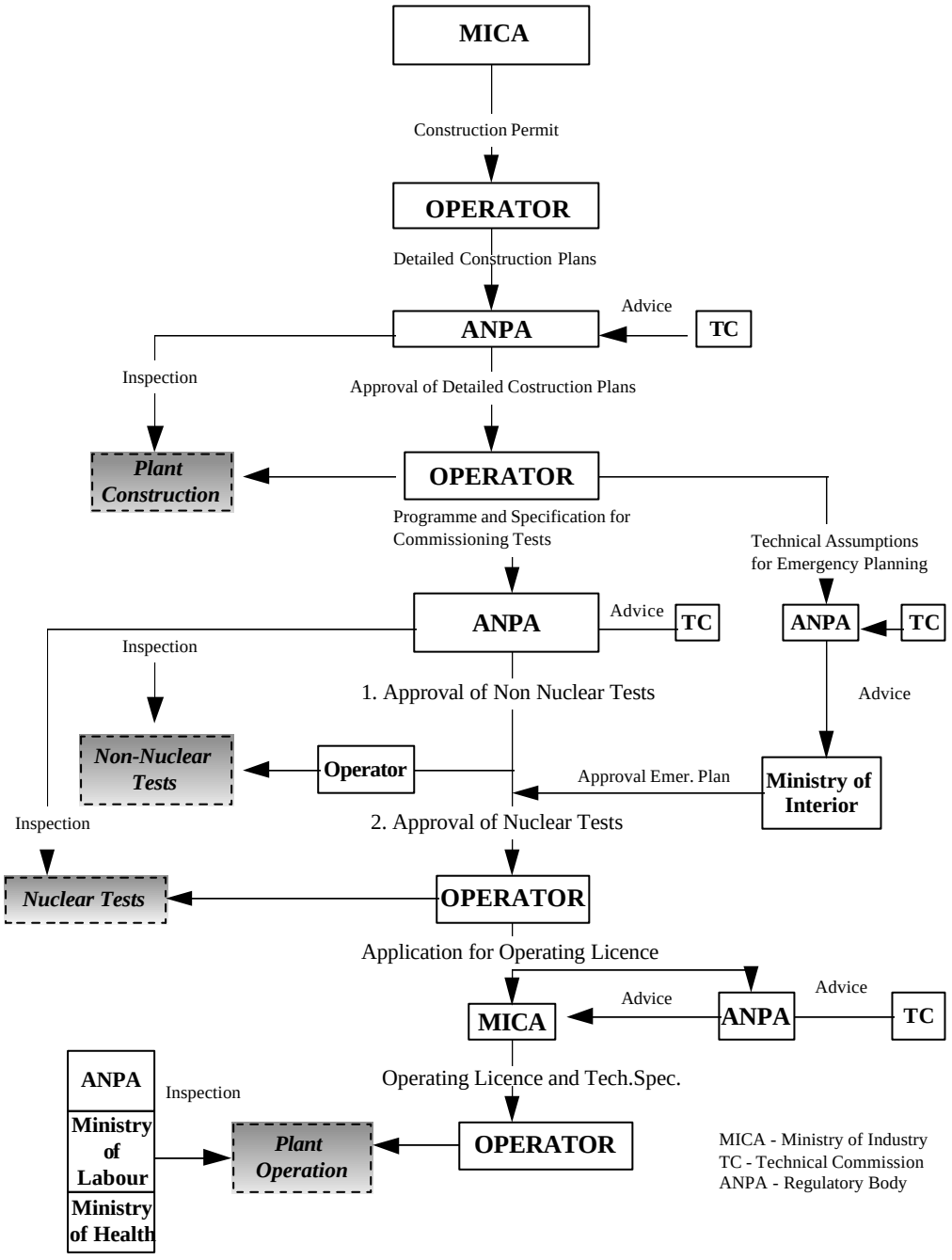


Figure 2. Simplified flow chart of the licensing process in Italy

2.(c)5.1. Site approval

Siting is regulated by the Act no. 393/1975, which defines a site selection procedure consisting of two stages.

In the first phase a few potentially suitable, wide areas, are identified by regional authorities, technically supported by the Regulatory Body, trough a preliminary screening where only general parameters are considered.

In order to facilitate this phase, the Italian Regulatory Body drew up a "National Sites Map", where the areas liable to be selected for the installation of a NPP are pointed out. The main aspects considered for the site selection application are the following:

Demography (for precaution and practicability of the sites, areas with low population density were privileged, in view of minimising the burden of possible accidental situation).

Seismology (historical seismology and the most relevant tectonic structures).

Technical suitability in relation to relevant parameters such as water availability, slopes.

In the second phase a specific site is identified and qualified inside each area. To this end, in depth survey and detailed analysis are performed, taking into account items such as: meteorology and climatology, hydrology, geology, seismology and geotechnics, ecology, land and water uses.

In the Italian experience, survey and analysis are carried out by the applicant, under the technical surveillance of the Italian Regulatory Body. The final choice among the sites approved by the Italian Regulatory Body is made by the regional authorities.

Site characteristics are widely discussed also in the Preliminary and Final Safety Analysis Reports and they must be periodically reviewed and, as necessary, updated during the operation of the nuclear power plant, to ensure the continued safety acceptability of site related factors.

2.(c)5.2. Construction Permit

The applicant asking for the authorisation has to submit to the Ministry of Industry and to Regulatory Body the following documents:

- Preliminary General Design of the plant, reporting a description of the plant itself and a preliminary study of the waste management alternatives.

- Preliminary Safety Analysis Report

The Regulatory Body, on the basis of the transmitted documentation and of additional documents considered important and asked to the applicant, performs a preliminary safety assessment of the design, including an evaluation of the adequacy of the site characteristics and a preliminary study on waste management.

The results of evaluations by the Regulatory Body are summarised in a specific evaluation report that is transmitted to the Ministry of Industry that, subsequently, transmits it to other

interested Ministries (e.g. of Interior, of Work, of Health) asking them to formulate their advice on the general design of the plant.

Comments formulated by these administrations and by the Technical Commission for Nuclear Safety and Health Protection are taken into account in the subsequent final evaluation report issued by the Regulatory Body.

This final report represents the main reference for the Ministry of Industry to grant the construction permit. A set of prescriptions related to the most significant aspects of nuclear safety and health protection is normally attached to the construction permit. These prescriptions more specifically attain:

- detailed aspects of the design,
- site specific requirements,
- organisational framework and quality assurance programme,
- radiological commitment,
- probabilistic goals.

As an example, in the list of prescriptions, it is normally included the identification of plant systems "relevant to safety", whose detailed design, according to the Italian licensing practice, will be submitted to the Regulatory Body for approval before the on-site construction. Furthermore the set up of a Quality Assurance programme, to be as well submitted to the Regulatory Body, is prescribed.

The level of compliance with the prescriptions attached to the construction permit is normally verified throughout the subsequent phases of the licensing process, that is in the phase of approval of the detailed design of safety related systems and during the supervision activity on their construction.

2.(c)5.3. Approval for Safety Systems Construction (Detailed Designs)

As mentioned before, the Italian licensing procedure envisages that the on-site construction of safety related systems should be preceded by the approval of their detailed design. This is a step typical of the Italian Safety Regulations.

Therefore, the applicant that has obtained the NPP construction permit has to submit to the Regulatory Body the detailed design of those plant systems declared as relevant to safety.

Construction of systems relevant to safety cannot be started before the approval by the regulatory body of these reports.

As a follow up action of the design approval, during construction and installation, the regulatory body performs several inspections to supervise that the construction of each system proceeds accordingly to the approved design.

The Italian Legislative Decree no. 230/1995 (such as the previous DPR 185/64) identifies two major significant phases for the commissioning of a NPP.

Non nuclear Tests

Nuclear tests

2.(c)5.4. Non-Nuclear tests

The “non-nuclear test phase” comprises the so called pre-operational tests that must be performed at component, system level and at integrated level. These tests must be performed before fuel loading and are aimed at demonstrating that the structures, systems, and components will operate in accordance with design in all operating modes and throughout the full design operating range.

The test programme has to be approved by the Regulatory Body. For specific tests judged by the Regulator relevant to safety also the test specifications have to be approved before their execution. For each test, a report has to be produced and given to the Regulator.

The tests are performed under the responsibility of the licensee and the Regulator can decide, on a case by case basis, to supervise the tests with its inspectors.

2.(c)5.5. Nuclear tests

According to the Nuclear Law, the Applicant can proceed with the fuel loading and the nuclear tests after having received an approval by the Regulator.

In order to receive this approval, an application has to be presented containing the following documentation:

Final Safety Analysis Report

Safety relevant works Operational Rules

Operation Manual including emergency procedures

General nuclear tests programme

Results of pre-operational tests (non nuclear tests)

Proposal of technical specifications

QA programme

Emergency plans

As a condition to accept the application, non nuclear tests have to be successfully performed.

In addition to that, the approval of the test programme is strictly depending on the approval of the emergency plans (on-site and off-site).

For each relevant test, the Applicant has to present to the Regulatory Body the test specification and is allowed to perform the test only after the approval of the Regulatory Body.

The Regulatory Body has also the possibility to request specific tests that are considered relevant and important for the nuclear safety.

The execution of the tests is performed under the responsibility of the Applicant.

When the tests are completed, the Applicant must submit to the Regulator the tests reports containing the main data collected during the execution of the tests and an evaluation of the tests results.

Tests at different power levels are performed and approval is needed to proceed to high power.

These reports will represent one of documental basis for the operating licence, that is granted by the Ministry of Industry.

2.(c)5.6. Operating licence

The request must be addressed to the Ministry of Industry and to the Regulatory Body. The operating licence is granted by the Ministry of Industry.

It is released to the operating organisation on the basis of the positive judgement expressed by the Regulatory Body as a result of the evaluation of the final version of the application documents for the commissioning tests and of the satisfactory results of the commissioning tests programme. Certificates stating the satisfactory results of the commissioning tests should be attached by the applicant to demonstrate that the plant features will ensure an adequate level of operational safety.

The Ministry releases the operating licence and, according to the law, states conditions related to:

compliance with technical specifications

organisational structure of the operating organisation

emergency procedures and emergency plan

role and requirements of plant personnel responsible for safety

establishment of Plant Council of Delegates for safety matters.

Furthermore the Ministry states in the licence that the plant configuration and the document basis for the licence cannot be modified without approval and that, after 10 years (e.g. for Caorso plant), a periodic safety review should be performed.

Finally, according to the law, the licencee has to satisfy the requirements related to nuclear liability.

Additional requirements for operation were also defined at level of technical guides issued by the Regulator (e.g. regulatory treatment of plant modifications, periodic reporting on plant performance and event reporting system).

2.(c)5.7. Regulatory inspection, assessment and enforcement

The purpose of the regulatory vigilance during the NPPs operation is to verify the fulfilment of the rules coming from Legislative Decree no. 230/1995 and of the prescriptions which are part of the licence conditions for the specific plant. During all the phases of the life of any NPP, from the construction to the decommissioning, inspections and walk-downs are performed, considering also the issues related to the storage and the use of radioactive sources, and to the transport of radioactive materials.

According to Art. 10 of the Legislative Decree no. 230/1995, the inspections are performed by ANPA personnel, which has been specifically selected and licensed and acts with a Police role. The purpose of such inspections is to verify the fulfilment of binding rules having legal relevance. Plant walk-down are also frequently performed by other ANPA technicians with the purpose of acquiring data, information and other technically relevant elements to be evaluated with respect to technical regulations.

The vigilance activities may be either:

- ordinary (planned in advance for each technical area) or
- extraordinary.

2.(c)6. Art. 15 Radiation protection

The main Law that regulates radiation protection matters is the Legislative Decree no. 230/1995. Before the promulgation of this Decree the main source of provisions regarding radiation protection was the Presidential Decree no. 185 of 1964; the latter's provisions were also completed by decrees of the Ministers of Labour and of Health.

As was the case with the Presidential Decree of 1964, Legislative Decree no. 230 of 1995 contains the main body of provisions regulating every aspect of radiation protection, which hold for every kind of installation, i.e. for accelerators, irradiators, hospitals and other medical uses of radiation, as well as for NPP's.

The provisions of the new Legislative Decree no. 230 were written in order to enact the transposition of six EURATOM directives previously issued by the European Union, of which Italy is a member, and to profit from the wealth of past operational experience in radiation protection. In the course of the preparation of Legislative Decree no. 230 the International Commission for Radiological Protection (ICRP) issued its new recommendations in Publication no. 60 of 1991, of which one of the most important features are new, lower dose limits for workers and public: the latter aspect is due to the reappraisal of radiation risk and radiation risk projection models. The Italian Regulatory Authorities decided to enact the new dose limits recommended by ICRP Publication no. 60 even though the European Union had not yet issued at the time a directive to that effect. One of the objectives of Legislative Decree no. 230 was to ensure stability in respect of previous radiation protection legislation (Presidential Decree no. 185 of 1964) and in respect of common radiation protection practice in Italy. That is the reason why present Italian radiation protection legislation still makes use of, e.g., the dose equivalent concept, the weighting factors and the Annual Limits on Intakes, the latter as a means of controlling internal exposure, that were recommended in previous ICRP Publications and EURATOM Directives. Another important change in the corpus of Italian radiation protection legislation will be forthcoming owing to the fact that the European Union issued in 1996 a new directive embodying new radiation protection rules, notably as regards, inter alia, exposure to natural sources of radiation.

2.(c)6.1. Dose limits

A) WORKERS

The following limits shall not be exceeded for exposed workers:

- an effective dose equivalent of 100 mSv in five consecutive years;
- an effective dose equivalent of 50 mSv in any single (calendar) year;
- a dose equivalent of 150 mSv per year to the lenses of the eyes;
- a dose equivalent of 500 mSv per year to skin, forearms etc.

However, during normal operations, recourse can be made to specially authorised exposures for medically fit category A workers (as hereinbelow defined) if exceeding dose limits cannot be avoided; such exposures can be incurred only by voluntary workers and must not exceed twice the yearly limits laid down for exposed workers. In particular, no women of reproductive capacity can undergo such exposures; the same rule applies to male workers having exceeded dose limits in the twelve months before.

Special provisions ensure that workers having exceeded the effective dose equivalent limit of 50 mSv for any reason whatever must not be exposed in excess of 20 mSv per calendar year as long as their yearly averaged exposures are more than 20 mSv.

WORKER CLASSIFICATION CRITERIA

An individual, in relation to his work activity, can be classified:

a) non-exposed worker, if he is not likely to receive, because of his work, doses exceeding the following limits in a (calendar) year:

- an effective dose equivalent of 1 mSv, or

- a dose equivalent of 15 mSv to the lenses of the eye, or

- a dose equivalent of 50 mSv to skin, arms, hands and feet;

(the above limits are numerically equal to those laid down for members of the public).

b) exposed worker, if in relation to his work activity he has a likelihood to receive doses exceeding the limits indicated in a).

Exposed workers can be classified in two categories for monitoring and surveillance purposes:

Category A workers

Category B workers

Category A workers: Exposed workers are classified as Category A when they have a likelihood to receive in a calendar year doses exceeding:

- an effective dose equivalent of 6 mSv, or

- a dose equivalent to the lenses of the eye of 45 mSv, or

- a dose equivalent to skin, arms, hands and feet of 150 mSv.

Category A workers must be individually monitored, both for external and internal exposures while for category B workers area monitoring is used, as a rule, in order to assess doses and to verify compliance with ALARA constraints and, of course, with dose limits.

Category B workers: occupational exposure of any worker shall be so controlled through area monitoring that the previous dose levels for purposes of classification are not exceeded.

For apprentices and students of age ≥18 years, who are training for employment involving exposure to radiation, the worker classification criteria shall be applied; other special provisions are laid down with a view to protecting apprentices and students of age between 16 and 18 years, women of reproductive capacity. For the latter, moreover, the dose equivalent to the abdomen must not exceed 13 mSv in a quarter; other provisions with a view to limiting internal exposure by inhalation apply.

In case of Internal Exposure of Exposed Workers the dose limits are considered as respected if intakes do not exceed the prescribed annual limits of intake (ALI) by inhalation in one calendar year and twice the ALI values in five consecutive years. If the exposure can be considered as uniform and does not exceed 2000 h per year demonstration of compliance can be made with the appropriate derived limits of radionuclide concentration in air.

Moreover, delineation of work areas based upon an analogous regime of dose levels is used, thus distinguishing work areas at risk in controlled and surveyed areas.

According to EURATOM directive no. 90/641, special provisions were established in the Legislative Decree no. 230 for outside workers and in particular the use of a radiation "passport", logging doses incurred during their working activities.

B) MEMBERS OF THE PUBLIC

The following limits shall not be exceeded for members of the public:

- an effective dose equivalent of 1 mSv per year,

- a dose equivalent to the lenses of the eye of 15 mSv per year

- a dose equivalent to skin, arms, hands and feet of 50 mSv per year.

In case of Internal Exposure of members of the public the dose limits are considered as respected if the intakes do not exceed the prescribed relevant annual limits of intake (ALI) by inhalation or ingestion in one calendar year.

Exclusions from the dose limits

For the reasons stated above as regards the new EURATOM directive to be transposed into legislation by the year 2000 some practices and situations are at present excluded from the system of dose limitation, i.e. dose limits do not apply. Instances are:

- exposures incurred at work to Rn-222 and Rn-220 and their decay products as well as to other natural radiation sources (ores) not exceeding a 1% content in weight of Uranium and Thorium;

- exposure of individuals as part of their own medical diagnosis or treatment and as comforters of patients

- accidental or emergency exposures

- volunteers in clinical research programs.

C) DESIGN CRITERIA AND AUTHORISED LIMITS

The Italian Regulatory Practice has always made intensive use of Design Criteria (Radiological Safety Objectives) and authorised limits for ensuring that, during normal operating conditions, dose commitments to workers and reference groups of the population are well below primary dose limits.

As regards transient and accident conditions, the Italian Regulatory Body, in accordance with Western Regulatory thinking, has laid down design criteria applicable to each kind of installation, seeking to differentiate between various types of transient and accidental conditions in terms of maximum dose levels not to be exceeded to the relevant reference groups of the populations.

D) SURVEILLANCE

For the implementation of provisions regarding radiation protection of workers and public both at the design stage and at the operational level there exist in the Italian system qualified experts, whose technical qualification is recognised through State examinations. Those professionals have been playing an advisory role and bearing technical responsibility, as far as radiation protection is concerned, since the promulgation of Presidential Decree no. 185 of 1964; their role, which has been confirmed and emphasised by Legislative Decree no. 230 of 1995, consists in carrying out both preventive and periodical radiation protection evaluations and measurements, in particular regarding dose assessments both for workers and members of the public. Moreover qualified experts bear technical responsibility in that they must give operators all technical advice relevant to ensuring effective radiation protection of workers and public both at the design stage and at the operational level.

An important instrument for the radiation protection of exposed workers is medical surveillance carried out by specialised physicians whose capacity to act as approved medical practitioners is recognised by means of State examinations. Every member of the work force must be recognised as fit prior to being exposed to radiation as a category A or B worker and is also subject to periodic reviews of health.

All considerations, evaluations, measurements and technical advice by qualified experts must be recorded, in particular as regards dose assessment records for which a strict regime of filing is provided for; the same requirement for filing holds for records concerning medical surveillance of exposed workers.

E) RADIATION PROTECTION INSPECTIONS AND ENFORCEMENT

Verification of compliance with radiation protection requirements laid down in law and in licensing prescriptions is the responsibility of various independent bodies. ANPA inspectors are vested with authority over the whole domain of radiation protection requirements as both workers and public are concerned, Labour Inspectorates are concerned with requirements pertaining to workers' protection while Inspectors with regional bodies are mainly concerned with radiation protection requirements for the public. It must be remembered that Inspectors are vested with police powers in the Italian system.

2.(c)6.2. The ALARA Principle

The principle that doses incurred in relevant exposures are to be kept as low as reasonably achievable, social and economic considerations being kept into account, is laid down in article 2 of Legislative Decree no. 230 of 1995, together with the principles of justification and of dose limitation. It must be remembered that the optimisation principle, together with the justification principle, had been implemented in Italian regulatory philosophy and practices long before it was legislated into the new Legislative Decree no. 230.

The implementation of the ALARA principle in the Italian system of regulatory control is ensured by means of two regulatory tools:

- provisions in the Legislative Decree no. 230;

- administrative prescriptions.

The decree has distinct provisions for doses to workers and public to be kept ALARA by operators: the provisions state, essentially, that rules of good practice are to be obeyed at every stage. Rules of good practice are not an exclusive means to ensure optimisation as ALARA is also called: other means may be used to that end provided that results are the same.

The second regulatory tool, largely employed in the Italian system for the purpose of implementing ALARA, is the use of administrative prescriptions at every stage of the licensing process. That practice has had a deep reaching influence even in design choices. It must be pointed out that such prescriptions are enforceable by means of criminal penalties.

From an operational viewpoint the whole of the regulatory instruments available, that is:

- the careful planning at the design stage, through the laying down of the Design criteria as specified under sections 2(c)6.1 sub-part C),

- the consequent safety assessment and all ensuing reviews,

- the safety and radiation protection culture fostered among all Italian organisations involved,

- the good independent prevention role played by qualified experts.

- the support role by the NPP Council of Delegates,

- the system for verification of compliance,

all have conspired so that a more than satisfactory radiation protection level from the ALARA viewpoint was ensured for all stages of the plant life.

2.(c)6.3. Environmental Radiological Surveillance

In the Italian system there is a general provision for any installation subject to radiation protection requirements, i.e. to the provisions of Legislative Decree no. 230, to set up and operate environmental radiological surveillance in the context of radiation protection of the public and of the environment. For nuclear installations there are moreover special requirements to that effect.

Surveillance on radioactivity in the environment is also made both at the national and the regional level (as required by Sect. 104 of the quoted Legislative Decree) by measuring networks concerning the environment proper, for the co-ordination of which the Ministry of the Environment is responsible, and on foodstuffs and drink, for the co-ordination of which the Ministry of Health is responsible. Co-ordination from the technical viewpoint is the responsibility of the National Agency for the Protection of the Environment (ANPA), that is the Regulatory Body.

This system implies large efforts in the field of quality control and quality assurance: intercalibration and intercomparison exercises are therefore planned out on a two years basis.

A completely automatic and centralised network has been planned and is, at present, under realisation to detect and control levels in air of artificial radioactivity; such an alarm system has mainly to control, with adequate detection capability, the atmospheric particulate collected on filters and the gamma dose rate in air. Moreover, the system must work in continuous and transmit all information on real time basis, covering, as far as possible, all the access routes of radioactivity. A set of seven automatic stations, with alpha and beta detectors as well as Germanium detectors for gamma spectrometry, and a network of 50 gamma dose rate detectors is being installed all over the Italian territory. The first set of three automatic stations, with a control centre, is now fully operating while the installation of the 50 gamma dose rate detectors has at present already begun.

A separate alarm network of the Ministry of the Interior is also concurrent with the national network for the attainment of the objectives of surveillance.

Radioactive Material Release

In the context of present legislation all radioactive material releases from authorised installations are subject to radiation protection requirements and no general limits for the release of radioactive materials are laid down, that is, there are no general unconditional clearance levels. Consequently, specific provisions for radioactive material releases are contained in the nuclear installation licence and procedures for radiometric control of

materials to be released must be approved by the Regulatory Body; records of radioactivity released and the destination of solid materials must be kept.

The main purpose of the surveillance around nuclear installations is the protection of public and environment.

The principal aim of the operational surveillance programme is the verification of the environmental radiological impact estimated before the licensing, in order to assess a population dose according to regulatory requirements.

The environmental surveillance programme is carried out by the nuclear installation Licensee and by the National Regulatory Authority, ANPA.

The Licensee Programme is based on " a priori" and on "a posteriori" controls as follows:

a) "a priori" controls, consisting of the management of the radioactive effluents in order to assess the compliance with the authorised discharge limits, through the radiological monitoring at discharge points, data recording, etc.;

b) "a posteriori" controls, consisting of the management of a "radiological environmental surveillance network" (RESN).

The ANPA Programme is implemented through the following controls:

a) control of the monitoring systems at the discharge points;

b) control on the RESN to verify the highest degree of the Licensee's Organisation, the reliability of the measurement laboratories and the Quality Assurance of the analytical procedures, in order to guarantee the compliance with the regulatory requirements and mostly the legal liability claims;

c) performing an independent environmental survey.

The Radiological Environmental Surveillance Network (RESN)

The RESN was developed on the basis of pre-operational environmental studies which led to the identification of:

a) the exposure pathways,

b) the critical population groups,

c) background radioactivity.

On this basis, environmental matrices, sampling locations, sampling and measurement frequency were defined.

This network provides the guarantee that the radiological discharges from nuclear installations will not exceed the prescribed limits.

This network represents also a check tool on the facility operations and continuous adaptations (modifications) throughout the operating lifetime of the facility are expected to take into account changes occurred in the operations.

The hereinbelow table provides a reference for the implementation of Caorso RESN. Such a program has been revised and approved by the Regulatory Body.

Type of sampling	Frequency of sampling	Amount of sampling	Frequency of measurement	Type of measurement	Minimum detectable Level
Air	continuous	350/500m^3	weekly	β tot.	0.18 mBq/m^3
			monthly	γ Spectrometry	Cs^{137} 0.11 mBq/ m^3
Milk	monthly	15 litres	4/year	Sr^{90}	30 mBq/l
	4/year		4/year	γ Spectrometry	Cs^{137} 20 mBq/l
					Co^{60} 30 mBq/l
Fodder	2/year	4 kg	2/year	γ Spectrometry	Cs^{137} 150mBq/kg dry
				γ Spectrometry	Co^{60} 300 mBq/kg dry
Vegetables	2/year	5 kg	2//year	Sr^{90}	100 mBq/kg
				γ Spectrometry	Cs^{137} 200mBq/kg
				γ Spectrometry	Co^{60} 200 mBq/kg
Maize	yearly	5 kg	yearly	γ Spectrometry	Cs^{137} 100mBq/kg
				γ Spectrometry	Co^{60} 100 mBq/kg
Tomatoes	yearly	30 kg	yearly	γ Spectrometry	Cs^{137} 10 mBq/kg
				γ Spectrometry	Co^{60} 10 mBq/kg
Pork Meat	yearly	5 kg	yearly	γ Spectrometry	Cs^{137} 100mBq/kg
				γ Spectrometry	Co^{60} 100 mBq/kg
Beef Meat	yearly	5 kg	yearly	γ Spectrometry	Cs^{137} 100mBq/kg
				γ Spectrometry	Co^{60} 100 mBq/kg
Fish	4/year	5 kg	4/year	γ Spectrometry	Cs^{137} 100mBq/kg
	2/year		2/year	γ Spectrometry	Co^{60} 100 mBq/kg
Fish to be fried	2/year	5 kg	2/year	Sr^{90}	100 mBq/kg
				γ Spectrometry	Cs^{137} 100mBq/kg
				γ Spectrometry	Co^{60} 100 mBq/kg
Po river water	continuous	4050 litres	monthly	γ Spectrometry	Co^{60} 0.3 mBq/l
				Cs^{137}	Cs^{137} 1.5 mBq/l
Drinkable	4/year	100 litres	4/year	γ Spectrometry	Co^{60} 0.3 mBq/l
water	2/year		2/year	Cs^{137}	Cs^{137} 1.5 mBq/l
Sediments	2/year	6 kg	2/year	γ Spectrometry	Cs^{137} 500mBq/kg
				γ Spectrometry	Co^{60} 400 mBq/kg
Soil	2/year	5 kg	2/year	γ Spectrometry	Cs^{137} 500mBq/kg
				γ Spectrometry	Co^{60} 400 mBq/kg
Eggs	4/year	40	4/year	γ Spectrometry	Cs^{137} 100mBq/kg
	2/year		2/year	Cs^{137}	Co^{60} 100 mBq/kg
TLD	6/year		6/year	Exposure rate	30 μGy/2 months
Fall-out	continuous		monthly	γ Spectrometry	
				β tot.	

Independent Environmental Survey by the Regulatory Authority

The main objectives of this survey are:

a) to compare the Licensee's RESN data,

b) to identify possible new exposure pathways.

These environmental campaigns are carried out on three main steps:

a) environmental characterisation in order to identify the investigation area and the sampling stations,

b) samples collection and physical chemical and biological analyses,

c) impact assessment.

The Regulatory Body performs surveys around installations with a frequency dependent on installation operational state, occurrence of extraordinary events, also with a view to independently verifying compliance with authorised limits.

2.(c)7. Art. 16 Emergency preparedness

2.(c)7.1. A General Description of Laws, Regulations and Requirements for on-site and off-site emergency preparedness

In Article 7 of this report the legislative and regulatory framework governing nuclear activities in Italy has been given in detail; Articles 115 to 135 of **Legislative Decree no. 230/95** lay down specific advice and provisions on Emergency Preparedness.

In case of Emergency Preparedness however this framework must be enlarged with the general legislation governing all cases of accidental events and disasters: particularly the role of **Law no. 225/92** should be emphasised where it prescribes that, on the basis of *"the guiding rules approved by Government and in accordance with general criteria established by the National Council of Civil Protection"*, programs and plans, for every specific risk typology, shall be prepared and applied, both at national and local level.

The law makes a preliminary distinction between programming and planning activities: programming activity relates to event prevision and risk knowledge on the territory as well as to prevention and mitigation of risk itself, while planning activity concerns operational and co-ordinated elaboration of the necessary procedures in case of an event occurred in the frame of a specific programmed scenario. In this sense, programming activity is preliminary to emergency planning and preparedness; so far local and national plans shall be related and shall abide by, as strictly as possible, the Prevision and Prevention Programmes prepared by local and governmental authorities on a three years basis.

As far as the nuclear risk is concerned, due to the fact that nuclear power plants are not operating on the Italian territory, the national programme has addressed some specific aspects of prevision and prevention. Different scenarios have been analysed, referring to

non-Italian nuclear power plants, with automated data acquisition and their use for diffusion and deposition calculations. Prevention has been focused on “non-structural” aspects such as information of the particular critical group of people concerned or general public and through the on-going installation of alarm networks for early-warning in case of nuclear accidents. The typical reference scenario is a beyond Design Basis accidents with extended core damage and with relevant loss of radioactive contaminants, in a Light Water Reactor of 1000 MWe power, located at 150 km from the Italian boundary; the occurrence has been worsened with meteorological conditions so as to determine contamination of wide areas of the Italian territory during the 24 hours following the accident.

Further scenarios and risk sources have been analysed, both on a national and local scales - municipal, provincial and regional - : accidents at Italian nuclear power plants (in spite of the non operating situation), accidents during transport of radioactive sources and fissile materials, accidents due to nuclear powered satellites or ships.

Following the specific indications of both Laws No 230/95 (Article 121) and No 225/92 (Article 4), a **GENERAL NATIONAL PLAN OF PROTECTIVE MEASURES FOR RADIOLOGICAL EMERGENCIES** has been prepared and officially approved. Its main aim is to give operational directives in case of accident situations where national resources are needed (Department of Civil Protection as Competent Authority) or to provide general guidelines for emergency planning and preparedness in case of local situations where the primary responsibility is at local level (Prefect). These distinctions apply both for general cases (Law no. 225/92) and for nuclear plants (Legislative Decree no. 230/95, art.116).

The General National Plan is divided in two parts:

1. General Part
2. Operational Part

2.(c)7.2. General Part of the National Plan

Different risk sources on Italian territory are presented and for each of them the territorial competence is determined, for planning purposes. For each accidental scenario, emergency provisions and measures are given.

In case of transboundary severe accident, the radiometric control of the environment and foodstuffs, and the evaluation of future levels of contamination and subsequent dose levels will play a relevant part in the decision-taking process of specific countermeasures, such as iodine-prophylaxis, population sheltering or food ban.

In case of nuclear powered satellites fall, the dispersion and diffusion of radioactive fragments - with different sizes - on the national territory will be the relevant fact, requiring the immediate evaluation of the interested geographical area and the prompt recovery of the most dangerous fragments. Early notification of such events, with all technical information about the satellite itself, is part of the “Convention on Early Notification” subscribed as Member State of the IAEA.

All other accidental scenarios (e.g.: transportation of radioactive materials, accidents in Italian nuclear plants) will outline local scenarios; for them the “Provincial emergency plans”, prepared in the framework of the former Presidential Decree No 185/64 and under updating

procedure as stated in the above-mentioned Legislative Decree no. 230/95, are feasible and adequate tools.

2.(c)7.3. Operative Part of the National Plan

On the basis of the identified accidental scenarios and the territorial competence, the National Plan determines the ruling structures (Competent authorities) the technical and the operative bodies, both at national and at local levels.

The ruling structure is the **Prime Minister** (or a delegate) with the support of the Operative Committee of Civil Protection, with representatives of all the related national administrative bodies (Department of Civil Protection, Ministry of Interior, Ministry of Health, Ministry of Defense, others), in case of national emergency or the provincial **Prefect**, in case of local emergency.

Again, in case of national emergency, the technical structure is the Center for Data Elaboration and Evaluation (**CEVaD**), as stated at art. 123 of Law no. 230/95 which includes representatives of ANPA (as coordinator), National Institute of Health (ISS), National Prevention and Workers Safety Institute (ISPESL), National Fire Brigades Department (VV.F.), National Meteorological Service (ITAV) and representatives of Regional Laboratories.

ANPA will provide also technical and logistic support for CEVaD.

2.(c)7.4. Training and Exercises

In the framework of the EU Council Decision (see subsequent section) regular exercises are organised:

I. every 6-7 weeks, alternately

   A. level 1: test of communication system

   B. level 2: transmission of a message to a Competent radiation protection Authority

II. Once a year:

   A. level 3 exercise with simulation of an accident scenario, initiated by the Commission

   B. level 3 exercise in the framework of OECD-INEX exercise

As far as local and regional accident scenarios are concerned, regular exercises, both on-plant and off-plant, are organised on a once-a-year basis

2.(c)7.5. International Arrangements

- IAEA Convention on Early Notification of a nuclear accident (Vienna, September 1986)
- EU Council Decision 87/600/EURATOM on Community arrangements for the early exchange of information in the event of a radiological emergency (December 1987).

2.(c)7.6. On-call availability shifts

In order to fulfil to emergency coordination requests, coming from local and central Authorities, as well as from public opinion concerns, ANPA has established and operates a continuous service of “on-call availability shifts”.

Professional experts and specialists from ANPA are organised in several groups and give support and intervention expertise on a 24-hours basis among periodical turns for whatever type of emergency call, from loss of radioactive sources during transportation up to a nuclear accident occurring in another country with transboundary consequences that might affect the italian territory.

Experts will provide also ANPA response during the first phase of periodical and non-periodical runs of national and international drills, such as ECURIE level 1, 2 and 3 practices.

2.(d) Safety of Installations

The licensing process that was implemented since 60^{ties} (i.e. since the issue of DPR no. 185) is described in section 2(b) and 2.(c)5, where the applicable Laws are also outlined. The main feature of this process is that it is made of several steps, the three main ones being: the construction permit, the approval of detailed designs and the operation license. Licensing and technical surveillance covers the whole life cycle of a nuclear power plant and consists in a series of measures upon siting to decommissioning. In this section, the applicable regulations and practices are delineated in their operative features, together with specific application experiences.

2.(d)1.Art. 17 Siting

An important planning stage of the legal process for siting was the preparation by the Regulatory Body (former ENEA DISP), in agreement with ENEL (the national electricity generating board) and the regional authorities, of a national map of sites liable to be selected for nuclear power plants. Siting of NPPs is governed as to procedural aspects by Act no. 393 of August 2, 1975 and no. 8 of January 10, 1983.

Act no. 393 entrusts the Regulatory Body (ANPA) with supplying, for each nuclear station, technical assistance to the Region in selecting at least two areas suitable for siting from among those areas consistent with the indications on the “site map”. The interested Region is determined by CIPE (Interministerial Committee on Economic Planning) together with the Interregional Advisory Committee, according to ENEL multi-year programs, previously approved by CIPE itself. Choice of areas is followed by ENEL identifying, evaluating and qualifying a specific site, if any, inside each of the areas: the fulfilment of technical inquiry of the Regulatory Body on the proposed sites entailing the issuing of its advice to the Region: and finally the Region itself determining the final siting decision. The purpose of all this is to give an assessment on suitability of the specific sites. This involves also the detailed analysis of the possible impact of the station on the environment and vice versa. This analysis is performed on the basis of specific Reports, required by the Law, namely Progetto di Massima (Preliminary Design) and Rapporto Preliminare di Sicurezza (Preliminary Safety Analysis Report). The contents of the quoted reports and the technical aspects to be considered in site analysis are covered by specific

technical guides issued by the Regulatory Body. In the course of the inquiry for obtaining the construction permit, the plant preliminary design and the relevant preliminary safety reports are analysed jointly with due consideration of site dependent conditions. It is during this stage that the main package of standards to be applied for the specific plant are identified and reviewed and the set of plant's systems and components related to safety and health protection is determined.

Once the site has been approved, a procedure starts leading to granting of a construction permit by the Ministry of Industry.

The site features are updated and reviewed in the context of:

- the periodical plant safety reviews (usually every ten years) that are requested as conditions of Licence,
- the periodical reviews of the technical bases of Emergency Plans, as requested by the Legislative Decree no. 230/1995 under art. 120; those last reviews are made any time some relevant changes have been singled out but at least every three years.

According to art. 37 of the Treaty constituting EURATOM, every Installation which could produce radioactive effluents has to notify relevant plant and safety analyses data to all member states that might be interested by possible contamination either during normal operation and during accidents (implementing recommendation - 1960). This procedure has been strictly followed in Italy.

2.(d)2. Art. 18 Design and construction

2.(d)2.1. Design

Once the construction permit has been issued, the approval of the Regulatory Body (ANPA) is required for the "detailed designs" of the systems and components identified as to be related to safety and health protection. That approval is required before starting on-site constructions involving the above parts. This intermediate step consists of a multi stage procedure, such that at the various phases of design development, the proper requirements are incorporated in a controlled manner; the procedure is concluded by the issue of the Final Safety Report, which is required before starting of nuclear tests and sums up and update the main safety related aspects that came out from the previous activities.

The content of the documents to be provided by the Applicant for detailed designs approval is shown in Annex 5(d).

The amount of systems, structures and components usually identified as safety related is quite high, hence a large number of "detailed design" reports, specifications and drawings are requested for review and approval; typical examples of the involved plant features follow:

- Buildings where the Nuclear Island, the engineering safeguards and their auxiliaries are located,
- Buildings relevant for plant personnel radiation protection, for emergency response, for plant control, for gaseous, liquid and solid wastes treatment,

- Buildings or constructions for the normal and ultimate heat sink,
- Emergency core cooling systems,
- Electrical systems,
- Instrumentation and controls,
- Heat removal systems,
- Auxiliary water and air systems,
- Pressure boundary and Containment isolation systems,
- Fire protection systems,
- Balance of Plant systems,
- Waste treatment systems,
- Radiation Protection Systems.

This system by system approach requires, in early phases of the review process, the issue of more general documents pertaining aspects which are applicable to many systems, such as methods for seismic design and for accidents and transient analysis, separation criteria, fire protection strategy. Moreover, for any structure or system, the "detailed design" documentation consists of an overall report issued by the applicant, which documents of the designer are attached to (i.e. system and main components specifications, process and instrumentation diagrams, process diagrams, drawings, composites, flow control diagrams, transient and accident analysis results).

On the basis of the documents provided by the applicant, containing the safety justification of the plant, the Regulatory Body performs its own review, which goes into details of the safety systems design, of the transients and accidents analyses, of the impact of the operation and accidents on the site, on the population and on the workers.

Independent analyses are performed on some relevant items. Evaluation reports are produced on system by system basis and are reviewed by the Technical Commission for Nuclear Safety and Health Protection. An overall final evaluation report is also produced at the end of the licensing process, which outlines also the technical and administrative constraints required for the operation.

This procedure, which is imposed by the Law, gives a relevant burden to the Regulatory Body, that must have the capabilities for performing reviews and independent assessments on several matters.

The "detailed designs" approvals are followed by surveillance of the Regulatory Body during the subsequent design and construction stages, aiming to verify the compliance of as-built systems with requirements and targets planned at the approval stage.

The Italian Practices on Design Criteria and Requirements, that evolved since the first Licensing activities under the main Laws issued in the 60^{ties}, found the final form in the document stating design criteria for Pressurised Water Reactors (i.e. PUN). It represents the most systematic effort undertaken by the Italian regulatory body along its process of defining an autonomous position with respect to the criteria developed in the country of origin of the technology. The list of the parts of this document are shown in Annex 5(f).

Three main guide principles have been established:

1. *dose limitation to workers and general public, which has been implemented by fixing radiological protection objectives. For general public, the objectives are defined with reference to normal, transient and accident conditions, up to design basis accidents. The radiological protection objectives for PWRs are shown in Annex 5(g).*

2. *safety and health protection approach mainly based on prevention in order to devote the maximum resources in avoiding the occurrence of accidents, more than in mitigating their consequences; this has been implemented by fixing probability limit targets for the occurrence of accidents exceeding design basis and entailing core degradation;*

a wide use of probabilistic techniques in performing safety analysis, to be used as an interactive design tool, together with deterministic criteria.

As far as the protection of general public is concerned, the plant shall be so designed that the radiological consequences for the defined plant conditions do not exceed pre determined values [see Annex 5(g)]. The relevant annual probability limits for each plant condition are referred to each single event, meant as an individual event or a discrete sequence of individual events. An in depth evaluation of occurrence probabilities is then requested for their proper assignment in different plant conditions; these must include design basis accidents (DBA) and beyond design basis accidents (BDBA) typical of the plant technology, as well as other significant occurrences whose probability is equal to or lower than 10^{-5} /yr. The radiological consequences are intended to refer to a site where a power station with 1000 MWe units is located. For the last plant condition (accidents), a lower limit design objective is defined for the effective dose equivalent. Any deviation found shall be justified for each individual case, in the light of design alternatives and/or other available solutions, also taking the collective dose into account.

As far as the protection of workers from exposures is concerned, the annual collective dose equivalent value for exposed workers in all normal and scheduled operations shall be aligned with the best international standards. In this regard, at the time of PUN design (late 80^{ties}), this value was set to be lower than 4 manSv for each 1000 MWe unit and every effort had to be made to reach the lowest numerical objectives characterising the most recent plant designs. Moreover, a limit for the annual man dose equivalent for the complex of exposed workers was set to be within 5 mSv, taking into account both internal and external radiation. Outside workers, self-employed workers or workers employed by third parties had to be considered among exposed workers along with those employed in the plant. Attainment of the objective above had to be demonstrated with reference to different design options such as: pressure boundary materials, primary coolant chemistry, component reliability and working life, location of components, plant layout. As regard to not exposed workers on the plant, an individual dose equivalent objective equal to 0.25 mSv/yr was established for normal

condition and frequent transients. For severe accidents safety objectives, in terms of maximum probability of occurrence, were also established.

It must be said that core degradation was conservatively assumed to occur when the core coolability conditions of US-NRC 10 CFR 50.46 are exceeded. Proven design alternatives had to be taken into consideration in developing the design so as to approach 10^{-7} and 10^{-6} per year respectively for any single sequence and for the overall probability of exceeding the coolability limits.

All these requirements imply that a Probabilistic Safety Assessment (PSA) of the plant is performed since the design stage. Guides were also provided on the methodology to be used in performing such studies; internal events such as area events had to be considered, while external events were excluded and dealt with only deterministic approach. Moreover, limits for failure frequencies to be assumed for individual systems and for sets of systems accounted for in each accident sequence were established. Among the objectives of the PSA there were also the following:

- evaluation of the balancing of the plant defence against core degraded accident sequences,
- identification of possible areas where it might be considered appropriate or necessary to introduce and improvement in systems and components

Some of the most significant general design criteria or requirements of PUN are listed below:

- the adoption of a double containment to enhance control of accidental releases[1]
- the reliability and the diversification of the reactor protection system,
- the protection against special natural and man-made events (e.g. sabotage, external missiles, tornadoes, flooding, etc.)[1]
- the protection against Anticipated Transients Without Scram[1],
- the prevention of interfacing systems LOCA[1],
- the minimisation of probability of RCPB loss of integrity[1],
- enhanced protection against SGTR events.

Note: 1 - this feature was already required for Caorso and Trino earlier NPPs, either by design or as backfitting measures, with an exception for the man-made events.

The licences issued in the years for the earlier NPPs were given on the basis of the criteria that were applied in those periods and that are easily recognised also in parts of the General Criteria and Regulations described above. Also backfitting of operating NPPs was made on the basis of this general approach, taking into account feasibility, operating experience and the evolution of the regulations in the Country where the technology was originally developed. A PSA was then performed for all the operating NPPs. In that case, the main goal was to compare the Core Damage Frequencies against similar estimations made for the plants of the same type and vintage around the world, to verify if appropriate balance was obtained for

different safety functions and to identify possible weak points. Further backfitting measures are more in detail described in section 2(d)3.

For instance, for Caorso NPP, during design and construction phases, particular emphasis was given to the following safety and radiation protection aspects:

- updated studies on the site environment in order to set up the most appropriate radioactive gases “discharge formula”, which identifies the maximum operating limits;
- appropriate monitoring of all the ventilations’ discharge points in order to detect any abnormal release to the environment;
- seismic behaviour of the buildings and components, by calculating in detail the specific response spectra for all the relevant buildings locations and by seismic qualification of the components; moreover, an extended seismic monitoring system was installed in plant buildings, having the capability to compare the possible real response spectra with the design one and to generate alarms;
- primary circuit integrity and in service inspection, with in depth independent analyses and pre-service investigations;
- primary containment integrity, with the performance of calculations and tests on the dynamic loads in the suppression pools following steam discharge, and by performing /analysing tests on the effectiveness of the Hydrogen protection systems (new H_2 recombiners and monitors were finally installed);
- secondary containment performance, with the verification of the capabilities of maintaining the required negative pressure under all accident and meteorological conditions and of maintaining the integrity and isolation capabilities even in case of earthquake;
- protection of control room operators by ensuring an appropriate leaktightness in the control room itself and by installing safety grade ventilation system with automatic switch to appropriate filtration stations;
- protection of the buildings against tornadoes pressure perturbations and associated missiles.

Other examples of further development of the Criteria and requirements in the subsequent years, before the issue of the General Criteria and Requirements, come from the Alto Lazio NPP licensing process. In particular, at that time, the following requirements were among the ones attached to the Construction Permit:

- a table assigned limiting radiological consequences to any of four event categories (in terms of frequency of occurrence);
- a Station Reliability Analysis was requested with the purpose of assessing the proper categories to the events in the light of the first item above,
- the seismic qualification of the structures had to be extended in the light of reducing the doses to the workers and to the public in case of earthquake and consequent recovery actions,
- carbon filters were required in the discharge side of all the ventilation systems that could possibly release radio Iodine,

- the lines passing through the primary containment had to be equipped with systems designed to avoid untreated leakages,

- no external consequences to the public had to be foreseen in case of:
    1. aircraft crash,
    2. pressure wave,
    3. unavailability of plant controls (automatic shutdown, isolation and cooldown for 10 hours).

  [as a consequence of this prescription, bunkered, additional ECCS were installed]
- the devices performing safety functions had to be protected against electromagnetic perturbations.

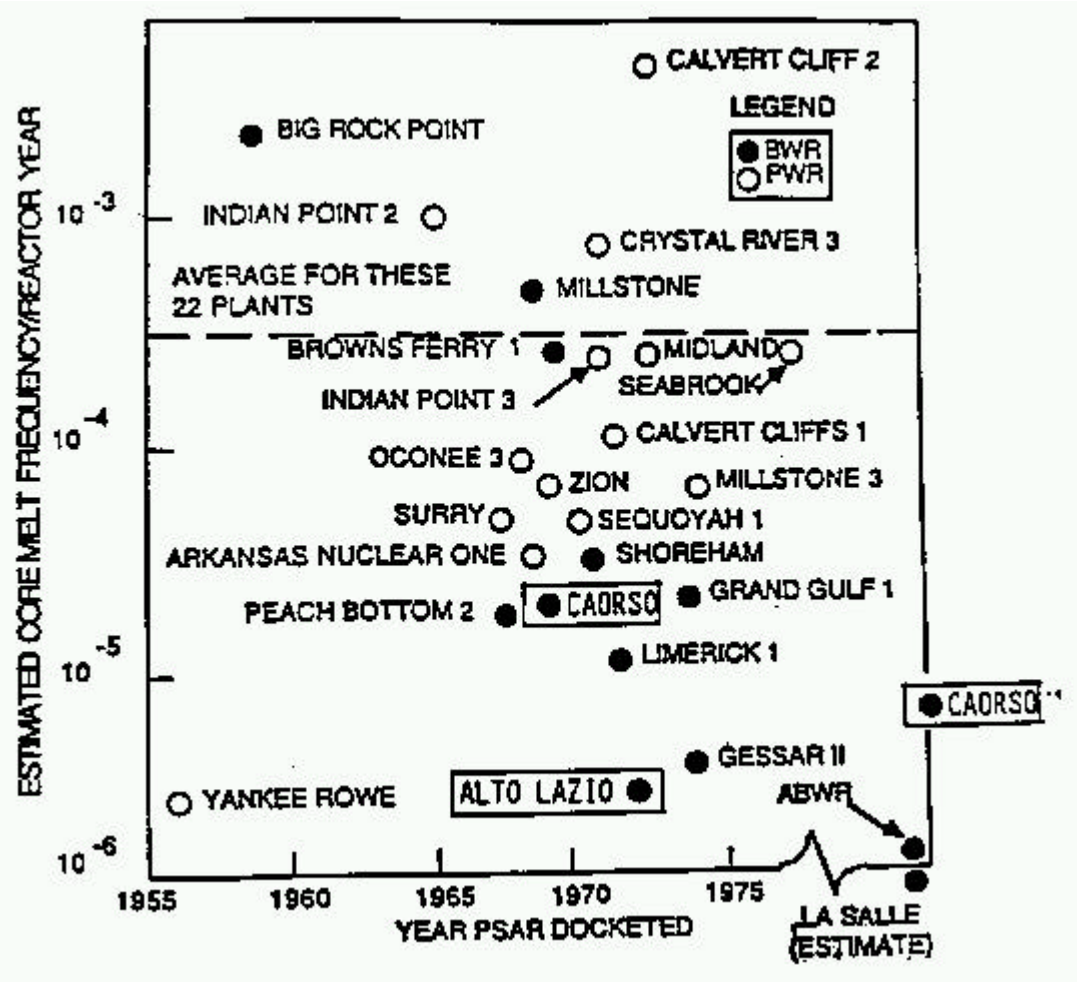


Figure 3 - Comparison of the core damage frequencies calculated for different BWR plants, which includes Caorso and Montalto NPPs. For Caorso two figures are presented considering both unmodified configuration and after implementation of post TMI requirements

2.(d)2.2. Construction

The plant construction activities have to proceed in a controlled way under the responsibility of the Applicant, with strict vigilance of the Regulatory Body, either at the components construction factories and at the site. Vigilance plans are formally notified to the Applicant on the basis of its own construction plans. Sometimes it happens that, in order to keep the construction period inside reasonable limits, the Applicant has to begin the construction of some components largely before the specific approval of their design (e.g. reactor vessel). In those cases, the Regulatory Body performs “Certification” activities, characterised by specific vigilance, certifying at the end that the component has been fabricated according to well identified specifications. Those specifications are subsequently reviewed in the proper context of licensing. If they are approved, the following phase of vigilance during the construction is substituted by the Certificate. If they are not approved, the Certified component cannot be installed in the plant.

The Application Documents for Approval of Nuclear Test Programme and Granting Operating License are shown in Annex 5(e).

The Regulations and the Practices related to the Commissioning activities are more in detail described below.

2.(d)2.2.1.Non-Nuclear tests

These tests must be performed before fuel loading and should be aimed at demonstrating that the structures, systems, and components will operate in accordance with design in all operating modes and throughout the full design operating range.

The licensee is requested by the law to perform tests both at system and integrated level.

The test programme has to be approved by the Regulatory Body. For specific tests judged by the Regulator relevant to safety also the technical specifications have to be approved before the execution of the test. For each test a report has to be produced and given to the Regulator.

The tests are performed under the responsibility of the licensee and the Regulator can decide, on a case by case, to supervise the tests with its inspectors.

2.(d)2.2.2.Nuclear tests

According to the nuclear law the Applicant can proceed with the fuel loading and the nuclear tests after having received an approval by the Regulator.

In order to receive this approval an application has to be presented containing the following documentation:

- Final Safety Analysis Report
- Safety relevant works Operational Rules
- Operation Manual
- General nuclear tests programme
- Results of non-nuclear tests (e.g. pre-operational)
- Proposal of technical specifications
- QA programme

- Emergency plans

As a condition to accept the application, non-nuclear tests have to be successfully performed.

In addition to that, the approval of the test programme is strictly depending on the approval of the emergency plans (on-site and off-site).

For each relevant test the Applicant has to present to the Regulator the test specification and is allowed to perform the test only after the Regulator approval.

The Regulator has also the possibility to request specific tests that are considered relevant and important for the nuclear safety.

The execution of the tests is performed under the responsibility of the Applicant.

When the tests are completed, the Applicant must submit to the Regulator the tests reports containing the main data collected during the execution of the tests and an evaluation of the tests results.

These reports will represent one of document basis for the operating license that is granted by the Ministry of Industry.

2.(d)2.2.3. Regulatory Inspection

The vigilance activities during the construction phase are aimed to verify that:

- the plant construction is carried out according to the Preliminary Safety Report and to the detailed designs which were approved,
- a proper sequence exists between the completion of analyses and the on-site activities.

Particular relevance is given to the vigilance performed before the application for licence, during construction phase; one of the main purposes of this vigilance is to verify that the documents, produced by the Construction Permit holder, by its supplier or sub-supplier firms, available on the site for construction and assembling purposes, are made in compliance with the requirements in the approved detailed systems' designs.

As soon as the plant construction is finished and before fuel loading, as already described above, the Construction Permit holder has to perform non-nuclear tests, conducted on the basis of test specifications approved by the Regulatory Body.

During the commissioning phase the Regulatory inspection activity is addressed to supervise on the correct execution of the tests included in the general test programme or requested by the Regulator itself.

In addition, all other areas pertaining plant operation and assessed in the frame of the approval process of the overall test programme should be addressed by the Regulator inspection activity.

In particular the following areas should be considered :

- applicant's organisation and responsibilities
- Technical specifications and surveillance procedures
- operating manual
- personnel training
- QA for test programme
- methods of notification to Regulator
- emergency plan
- health physics.

Tests

The activity of the Regulator on the site with regard to commissioning tests can be subdivided into:

- evaluation of tests procedures
- inspection during the execution of the tests
- evaluation of tests results.

General considerations on tests inspection programme

The following considerations, coming from the Italian experience can be outlined:

- at the turnover, that is the time when the construction group hands over the systems and components to the start up group, a large inspection had to be planned to check both the status of the plant in the as built configuration and of the related documentation. This phase included instrument and protection settings, wiring continuity checks, Hydraulic tests, first flushing etc.. In particular, complex components, such as motor operated valves, required a great care with regard to electrical and mechanical protection settings. This mainly because they are quite numerous and critical for the operability of the systems.
- Considering **systems pre-operational tests** it has to be stressed that, for some safety systems, this is the only phase in which a complete demonstration of their capability is possible. These systems are previously identified (e.g. low pressure coolant injection, etc.) and priority is given to their inspection.
- Inspection during **integrated tests** has to be carefully planned and implemented because such tests give the opportunity to see more than one system running together and, therefore, allow the identification of possible problems at the level of interfaces (e.g. electrical power and instrumentation air supply).
- For inspection during **start-up tests** some important elements to be considered in setting priorities were:

a) tests performed to adjust technical specification limits,

b) specials tests to investigate some plant and systems response with require departure from tech. Spec.,

c) tests that imply the verification of the overall plant behaviour during transients evaluated in the Safety Analysis Report

d) low power tests as they allow to identify infancy anomalies both at level of components and system management,

e) control system tests that are normally quite complex and require a specific training.

Other relevant aspects

Concerning other areas the following main aspects are identified as important to be addressed in the inspection programme:

Applicant's organisation and responsibilities

The inspection activity has to be addressed to verify if the actual organisation implemented at the plant is in agreement with the approved document on the organisational structure of the operating organisation.

As during the start up period the organisational document should also identify the contractors responsibilities and the interfaces among them and operating organisation staff, it is important that the organisation is carefully evaluated so that non compliances and inefficiencies are identified and resolved in view of the subsequent plant operation.

Technical specifications and surveillance tests

The main objectives of the Regulatory inspection in this area are addressed to:

- to verify that the plant operation in test conditions is performed according to technical specifications
- the correct interpretation and transcriptions of the relative technical specifications, in order to identify possible lacks or deficiencies

For surveillance tests, areas of inspection are usually:

- the adequacy of the step-by-step procedure (it is important with this regard to check the validity of test instrumentation calibration),
- the correct scheduling of surveillance tests. With this regard each surveillance test should be observed at least once,
- the clear identification of responsibility for test results approval

Operating manual

The following aspects are verified:

- completeness of covered topics
- adequacy and applicability of procedures

- up-dating process of procedures or instructions according to operating experience and tests results
- consistency of plant operation with operating manual

Personnel training

The surveillance performed by the Regulator inspectors during the commissioning programme is addressed to verify that the operating personnel is adequately involved since the system and preoperational tests and that a proper transfer of information is in place from the commissioning personnel to the plant operating personnel (if different).

QA for test programme

The Regulator performs audits on the correct implementation of a QA programme specific for the start up phase. The implementation of the programme takes into account some specific aspects, like:

- organisation at the moment of the tests, when many experts of different companies are present at the same time,
- activities are not of routine,
- the need for prompt corrective actions.

Controls are set in order to verify that the QA programme is really a simple and flexible tool covering in particular aspects like test procedures changes and tests management.

Emergency plan

The on-site inspection activity with regard to emergency plan are addressed to the adequacy of the procedures, equipment and training. It is important that a complete drill is performed before fuel loading.

Methods of notification to Regulator

One aspect to be carefully addressed pertains to the attitudes and capability of the plant to promptly inform the Regulator on the occurrence of particular malfunctions and events and to provide periodic information on the safety performance of the plant.

With this regard it is recommended that guidelines about this item are included in a technical guide issued by the Regulator.

Radiation Protection

The inspection activity with this regard are addressed to:

- verify the adequacy of procedures and equipment to limit dose to people both in and outside the plant
- verify that the workers are properly informed about the specific risks associated with the working place
- verify the adequacy of contamination control of workers at the exit of controlled areas

It is important that a first inspection is performed before fuel loading.

2.(d)2.2.4. Regulatory Assessment and Evaluation

Evaluation reports are also issued at significant milestones of commissioning tests. Those reports are based both on the report/s prepared by the Applicant and on the reports prepared as result of the on-site inspections. They provide the Regulator independent view of the tests results throughout a systematic analysis of most safety relevant tests, identifying all the problems that occurred during the test programme and the remedial measures.

The Regulator assessment activity with regard to the commissioning tests is normally addressed to the following major areas :

- assessment of the “construction verification programme”
- assessment of the “non nuclear tests programme” (preoperational tests) and major tests specifications
- assessment of the “nuclear tests programme” and major tests specification
- assessment of the “basic safety validation documents” requested to the Applicant as basis to approve the tests programme (see list of § 2.2).

The “construction verification programme” has to be completed prior to begin preoperational tests. In particular it consists of items, such as initial instrumentation calibration, flushing, cleaning, wiring continuity, hydrostatic pressure tests etc.

The Regulator addresses its assessment activity to the following aspects :

- completeness of the planned tests
- adequacy of the programme to ensure consistency of the “as built” systems, components and structures configuration with the design.
- adequacy of the organisation system in place at the plant to ensure an adequate and complete transfer of information from the construction group to the start up group.

After that, the construction verification tests have been satisfactorily completed the non nuclear test programme can proceed. This programme consists of the systems and integrated tests.

Systems tests include:

- manual operation
- automatic operation
- performance verification in different system operating modes
- operation and verification tests to demonstrate expected operation following loss of power sources
- proper functioning of I&C
- permissive and prohibit interlocks
- systems vibration and expansion.

According to the Italian law the performance of some specific integrated dynamic tests are required in order to evaluate, as a whole, the proper operation of ESF actuation system, the alignment and starting of ECCS, the emergency diesels loading sequence.

With regard to the systems test the Regulator assessment activity has to be based on the Applicant documents related to the tests general programme and to the tests specifications developed for each system. It was addressed to verify:

- the completeness of the programme and of the tests planned for each system, including specific test configuration aimed at verifying the existing margins provided by the system design in front of possible components malfunctions.
- the adequacy of the objectives of the tests for each system selected on the basis of its relevance for safety.
- the adequacy of acceptance criteria focusing, in particular, on the parameters related to the functional performance of the systems.
- the consistency with the design requirements and the assumptions of the safety analysis. In particular it should be evaluated that the system test configuration is representative of the actual expected plant operating conditions.

With regard to the integrated tests the Regulator has to evaluate:

- the completeness of the programme
- the adequacy to test interconnections and interfaces among systems (in particular front line and support systems)
- the correct time sequence

The nuclear testing phase includes the following steps :

- initial fuel load tests
- pre-criticality tests
- criticality tests
- low power testing
- power ascension testing.

Initial fuel load tests, pre-criticality tests and criticality tests commence with the placement of the first fuel assembly into the reactor vessel and end at the completion of the initial criticality tests. During this phase core physics tests are performed, core parameters and reactivity coefficients are measured and compared against design parameters.

The assessment activity of the Regulator with regard to the nuclear tests has to be performed in conjunction with the assessment of all the safety validation documents, in particular with reference to the positive results of pre-operational tests.

The assessment activity of the Regulator is based on the Applicant documentation describing the programme and the single tests specifications. Regarding to the programme, the assessment covers the following aspects:

- consistency with the assumed regulations (e.g. US NRC RG 1.68)
- completeness of the programme with respect to the reproduction of all the normal expected operating conditions and, to the extent practical, during and following anticipated transients.
- adequacy of the time sequence

- adequacy of the programme to validate the analytical models used for predicting plant responses to anticipated transients and accidents.

With regard to the specifications related to single tests or groups of tests the assessment is addressed to verify, in addition to the above assessment aspects, the following:

- the objectives of the tests
- the compliance of single tests or groups of tests with technical specifications
- the adequacy of acceptance criteria. They can be set at two different levels : **Level 1** is referred to the design values of the process variables. In the case the level 1 is exceeded the plant should be put into a standby condition (depending on violation in cold shutdown condition) until the problem is resolved. This standby condition should be specified in test specification. **Level 2** is referred to the expected values of single variables. If this value is exceeded this normally does not imply a condition to modify the test programme.
- the representativeness of the test with respect to the actual expected plant operating conditions
- general methodology to be followed for the performance of the test.

In the performance of these evaluations reference is made to the experience of similar plants.

The final achievement of this phase is the confirmation that the plant, as it has been built, has safety features which are adequate to proceed to fuel loading. In order to proceed to the subsequent phase of fuel loading and nuclear tests, the Construction Permit holder has to submit to the Regulator a General Plan (i.e General Nuclear Test Programme); the Regulator approval has to take into account the specific opinion of the Technical Commission for Nuclear Safety and Health Protection. Other documents are required in this step, besides the General Plan, as specified under the section 2.(c)5.5..

As result of the positive evaluation of the tests programmes the Regulator assessment activity should lead to identify aspects (e.g. concerning selection of relevant systems and components, operating conditions and related test phases) to be addressed during the on-site tests inspection programme with high priority.

In the following some typical problems occurred during the Caorso NPP start up are discussed:

- during the first phase of start up yelding of pipe snubbers occurred. This inconvenient was judged to be caused mainly by a not correct installation, water hammer in the pipe, loads larger than those specified by the supplier. After each of the identified event the Regulator asked to the Applicant to provide a clear identification of the causes and of the remedial measures adopted. In particular the Regulator formulated the requirement to adopt all the necessary measures to avoid water hammer loads (e.g. installation of adequate vents).
- Malfunctions of the level switches that caused the lack of actuation of ECCS.

  The Regulator prescribed to increase the frequency of surveillance and a systematic research of the causes. The study led to replace some water level instruments
- Some malfunctions of motor operated valves were revealed during the commissioning (e.g. no opening of the valve as result of the engine thermal

protection, not complete opening of the valves as result of torque limitation protection, impossibility to operate the valves from Main Control Room)

The Regulator identified some non compliances at the level of procedures adopted to report malfunctions that were not adequately put into evidence. In this frame it resulted difficult to perform a systematic analysis of the problem.

The Regulator therefore requested to improve administrative procedures to report malfunctions, to verify the completeness of suppliers documentation.

These improvements led to carefully identify the main causes of the malfunctions (e.g. inadequate calibrations, operating pressure beyond design value, etc.).

The Regulator requested to the Applicant to implement all the pertaining corrective actions.

- Defects in the control room switches were identified. This type of malfunction was associated to a bad lot of switches, that were replaced.
- Excessive vibration in the primary circuit at the level of the Residual Heat Removal (RHR) line connected to the primary circuit were revealed by the presence of noise. The Regulator requested to verify the status of the pipes snubbers and to design a specific test to identify unexpected loads.

  The performed test led to exclude the presence of dangerous vibrations. Corrective actions were also identified to optimise the regulation of the primary recirculation flow.
- Reactors Scrams

  During the commissioning tests the reactor had several scrams. The main causes can be classified as following:

  - scrams requested to perform the tests
  - operator errors during tests
  - errors during surveillance tests

  This lead the Regulator to force the Applicant to improve procedures and personnel training.

2.(d)3. Art. 19 Operation

2.(d)3.1. Main Operation Documents

Operation shall be conducted in accordance with the licensing documents and, in particular, according to the operational limits that were assumed in or resulted from the safety analysis. An important role, to that purpose, is played by the “Technical Specifications” (TS), which are bounding constraints that are conditions for the Licence. The content of this document is

strictly linked to the Safety Analysis performed for the plant, to the plant/site specific characteristics and to other considerations, including

probabilistic ones. Most of the bases of TS can be traced in the Final Safety Report, and more specifically where the plant responses to human errors, system and components failures, disturbances in the process are discussed. For Caorso NPP the standard format for TS of US NPPs of the same type was adopted. In order to modify the TS, the Operator has to apply for a Licence modification.

According to the Law, the licence holder has to operate the plant following the organisation and responsibilities which are outlined in the "Regolamento d'Esercizio" (Safety relevant works Operational Rules). This document has to be approved by the Regulatory Body, after having consulted the Technical Commission for Nuclear Safety and Health Protection. This document describes the organisation chart of the personnel responsible for operation, with specific regards to the role and responsibilities of those performing functions which are related with the safety of the plant and to the health protection of population and workers. The Licence specifies also which is the staff whose presence has to be ensured in any moment of plant operation.

Surveillance tests and inspections on systems, equipments and components have to be systematically performed by the Operator in order to verify their operability. Surveillance norms, which identify the systems to be tested and the test frequencies, are part of a specific document that can be modified with preventive approval of the Regulatory Body, according to a specific requirement in the Technical Specifications. Surveillance procedures can be modified by the Operator, but the modifications have to be notified to the Regulator. Moreover, a maintenance plan must be in place.

Also during operation, the fulfilment of Quality Assurance requirement is considered a relevant contribution to the overall safety of the plant, hence Technical Specifications require that all the provisions of the QA manual are always in place.

An Operating Manual is required to be presented to the Regulatory Body by the Legislative Decree no. 230/95 since the initial phase of nuclear tests planning. This manual contains procedures for responding to anticipated operational occurrences and accidents, and include also maintenance instructions.

A Health Protection Manual is also requested to be issued; this document contains procedures related to health protection interventions applicable to the workers for different conditions from routine to maintenance and emergency occurrences.

The main structure of the fundamental documents issued for Caorso NPP operation is shown in Annex 5(h).

Elements of the specific experience of Caorso NPP during the prolonged plant lay-up are described in Annex 5(i).

2.(d)3.2. Incident Reporting - Analysis of Operating Experience

In case of accidents, according to Art. 92 of the Legislative Decree no. 230/1995, the Licence holder is requested for notification as soon as possible, but not later than 3 days after, to the following Institutions:

- The Regulatory Body (ANPA)
- Local Labour Inspectorate (Province)

- Local Offices of the National Health Services.

In case of unexpected radioactive contamination inside the plant boundaries or an accidental occurrence implying a significant increase of the risk of exposure to the workers, the Operator has to implement all suitable measures aiming at avoiding any risk increase (art. 100 of the Legislative Decree no. 230/1995). Moreover, when significant contamination of air, water or land outside the plant boundary at the occurrence of accidental events, the operator is required to immediately notify to:

- Local Government Representative (Prefect),
- Local Fire Brigade,
- Local Offices of the National Health Services
- The Regulatory Body (ANPA)

The Prefect provides for immediate communication to the Presidency of the Ministries Council, that is to the Department for Civil Protection Co-ordination (art. 101 Legislative Decree no. 230/95).

Furthermore, the Operator has to take all the measures suitable to reduce the radioactive contamination in the areas outside the boundary of the plant, so to limit the risk to the public.

Programmes to collect and analyse operating experience data are in place in Operator premises; moreover, systematic notification to the Regulatory Body is made according to a specific Technical Guide. Special agreements are also in place with international Organisations both from Operator side (e.g.: WANO, INPO) and from Regulator Side (e.g.: OECD NEA - CNRA and CSNI, EU NRWG, or bilateral agreements as the one in place with the US NRC).

As already noted in section 2(d)1, the safety of operating plants is periodically verified against the evolution of the standards and against the results of the analysis of operating experience. That verification is aimed to identify possible suitable backfitting measures. Obviously it is not possible to apply completely the new requirements to plants that were already built and operating; nevertheless, several important modifications were implemented in older generations plants, mainly for systems and buildings essential to safety. For instance, for Caorso NPP several modification were made in order to improve the reliability of reactor trip system. Measures were implemented in order to seismically qualify Trino and Garigliano NPPs against the maximum historical earthquake in the specific area.

After TMI accident, several studies were performed in order to identify the implication of that accidents on the safety of operating plants in Italy. Several improvements were focused, taking strictly into account the results obtained in U.S.; part of those were implemented before the plant definitive shutdown, part were already licensed and were going to be implemented. The most important modifications/reviews that were identified for Caorso NPP were:

- re-analyses of several plant transients (e.g.: small LOCAs, safety valves spurious opening),
- improvements in man-machine interface that, for instance, lead to complete modification of Control Room and to the construction of a plant simulator with Control Room mock up,

- set up of new symptom oriented emergency procedures, associated with the performance of ad-hoc accident analyses.
- mitigation of large Hydrogen productions during degraded accidents (e.g.: containment inerting),
- protection against Anticipated Transients Without Scram (i.e..: improvement of the stand by liquid control system, installation of the Alternate Rod Injection System and improvement of the control rods drive system).

Moreover, a Probabilistic Safety Study (PSS) was performed (level 1 in 1986 and level 2 in 1987); among the main results of such study there are the following ones:

- the estimated core damage frequency was very low,
- the dominant contributor was the loss of offsite power,
- most of the core damage sequences resulted to be characterised by depressurised pressure boundary and intact containment,
- assuming the post TMI measures already in place, most of the sequences (93%) led to improvements of plant accident response, in particular to negligible releases (less than 0.1% volatiles),
- the success paths of the emergency core cooling systems were demonstrated to be much more favourable than the design one, even with conservative core damage criteria (e.g. for large LOCAs, 1 out of 6 available pumps were demonstrated to be sufficient for core cooling and 1 out of 4 diesel generators were demonstrated to be sufficient for all transients and accidents with loss of off site power).

The results of PSS demonstrated the effectiveness of some planned modifications (e.g. automation of Stand By Liquid Control Injection), moreover some Emergency Procedures changes were shown as very beneficial (e.g. removal of Automatic Depressurisation System inhibition in some sequences).

After Chernobyl accident, Italian Government asked IAEA for organising an OSART (Operational Safety Analysis Review Team) mission on Caorso NPP. This mission took place in 1987 and the main conclusions were:

- the operational story, in terms of number of abnormal events occurred, was inside the average behaviour of similar (i.e. age, supplier, power, ageing) NPPs,
- the plant personnel individual and collective exposures to radiations and the radioactive releases to the environment were maintained well below the averages for similar NPPs,
- the safety features of the plant were found effective for accidents prevention and mitigation,
- the house-keeping was judged good,

- the personnel attitude was found good,

- some suggestions for improvement s were issued in the areas of management and resources, of training and re-training, together with advise to delineate solutions for the final disposal of wastes.

2.(d)3.3. Waste Management

According the Italian Law (i.e. the Legislative Decree no. 230/95), any radioactive material, even if contained in devices or equipments, is defined to be a Radioactive Waste if no future use is foreseen.

The reference document concerning the Italian radioactive waste management is the Technical Guide no. 26, issued by the Italian Nuclear Regulatory Authority (ANPA - Agency for the Environmental Protection), which provides waste classification as well as the technical requirements for the waste forms and the waste packages.

According to the radioisotopes characteristics and concentrations, radioactive wastes are classified into three Categories:

Category I: Wastes which decay in a few months to radioactivity level below safety concerns (mainly hospital and research wastes with T1/2<1 year).

Category II: Wastes which decay to radioactivity level of about 370 Bq/g within few centuries. Activity of several radionuclides shall not exceed given values.

Category III: Long lived wastes not included in category I and II; high level wastes from reprocessing of spent fuel and alpha bearing wastes from the fuel cycle and R&D activities.

For the IInd Category wastes, the document lists conditioning requirements and specific acceptance criteria for shallow land disposal.

The waste producer is responsible for the waste treatment, conditioning and storage and, in compliance with the general requirements defined in the Technical Guide no. 8 "Quality Assurance Criteria", and with the "Qualification and Control Programme for the Conditioning of the IInd Category wastes" (Technical Position no. 1/26), must submit to the regulatory authority a complete documentation concerning:

- Quality Assurance Programme

- Adopted criteria for the waste conditioning facility design, operation and control

- Results of product characterisation.

The waste producer is also responsible for labelling, tracking and activity inventory of the radioactive wastes.

On Caorso site activities are currently in progress for the treatment and conditioning of the waste produced in normal operation, mainly resins and technological waste. As far as the spent fuel is concerned, realisation of an on site dry storage facility based on the use of dual purpose metal cask is foreseen.

Since there is not in Italy an operative site for the LLW disposal (IInd Category waste), all the radioactive waste produced in NPPs are stored on site.

Several institutional initiatives have been undertaken with the aim to start with a selection process of a national site for the near surface disposal of the IInd Category waste and for an interim storage facility for the IIIrd Category waste including the spent fuel.

3. Planned activities to improve safety

Given the extended cold shutdown state of the only Italian Nuclear Installation with fuel still partially inside the vessel and going to be unloaded to the pool, no actions on the basis of the Convention are neither necessary nor envisaged. The features of the Italian Regulatory framework, as made up by the highest level Legislation, is satisfactorily complete and advanced, moreover it combines strictness and flexibility.

4. References

References are exhaustively made in the text and in the annexes.

5. ANNEXES