Recent evolutions of French Design and Construction Rules

R. LAMBS, J.M. GRANDEMANGE (FRAMATOME-ANP)
D. PARIS, C. FAIDY (EDF)

KEY WORDS
Codes, Standards, Construction.

ABSTRACT.
This paper summarises the studies and evaluations made in order to support the recent evolutions of the French Design and Construction Rules, with the objective to improve the competitiveness of nuclear power plants.

To this aim, an inquiry was conducted with Suppliers, in order to identify the topics corresponding to cost reduction potentials. Following this inquiry, the RCC-M construction code provisions which may be improved in order to reduce the cost were identified and highlighted compared to the others cost-intensive requirements falling outside the code scope.

In parallel, other non-nuclear codes, such as CODAP and CODETI in France for Vessels, heat exchangers and piping, and ASME VIII were analysed in order to evaluate the possibility to refer to more standard alternatives for safety related mechanical components. In such a case, eventual complementary requirements should be specified, and some exercises of application were conducted with the suppliers on typical examples.

In order to finalise the overview, return of operating experience was addressed and discussed with the Safety Authority, leading to complementary precautions, in particular on fatigue and fast fracture prevention.

The corresponding revisions have been included in the 2000 edition of the RCC-M construction code.

INTRODUCTION
In order to improve the competitiveness of nuclear power compared to other sources for production of electricity, it is necessary to optimise the construction costs and the construction schedules. Consequently, EDF and FRAMATOME decided to work in a common project with the aim of reducing the cost of components of the Nuclear Island of Pressurised Water Reactors. This has been associated with the continuous integration of manufacturing and operation experience relating to the improvement of safety and reliability of the plants.

In a similar way, the Basic Design Optimisation phase of the European Pressurised Reactor (EPR) project was dedicated to the research of cost reduction without decrease of the safety of the plant.
The continuous introduction of new requirements in the nuclear practices for manufacturing both mechanical and electrical equipment for more than 20 years without periodic and systematic "winnowing out " has led to high acquisition costs. The reduction of the market leads additionally to the disappearance of specific nuclear suppliers.

Two possible fields of action have been identified on:

- technical requirements (design, materials, manufacturing, examination, ...),
- agreement and surveillance of suppliers (Quality Assurance, Inspection, ordering documents, required documents).

The main orientation retained for preparing the necessary changes was to avoid codifying " in camera ", but instead to acquire a better knowledge of industrial practices outside the nuclear field by means of field inquiries and targeted exercises, in order to define:

- the appropriate modifications of present RCC-M construction code [1] and specifications,
- the conventional codes and standards and the type of engineering requirements that could constitute an alternative satisfactory working basis.

For mechanical equipment, the following approach was retained:

- for class 1 equipment, maintain specific requirements where necessary in relation with the applicable regulation while aiming to take current industrial practices into account, wherever possible,
- for the other nuclear island equipment (class 2 and 3), modify the current requirements in order to avoid specificities, by following current industrial practices, while maintaining equivalent quality.

Investigations on best practices have been performed in cooperation with 20 selected suppliers of: exchangers and tanks, valves and fitting, pumps, pipes, forged parts, castings and tubes. The analysis of comments from suppliers was performed by the end of 1997. Results having an impact on Design and Construction Rules are detailed in the following chapter.

In parallel, several updating of the construction code were prepared, including precautions issued from the return of operating experience, as well as updating taking into account recent justification studies established for the construction of the last N4 series.

ECONOMICAL OVERVIEW.

FEED BACK OF INQUIRIES

Comments received from suppliers can be summarised as follows:

General QA approach and inspection.

The important number of documents referenced in the specifications complicates price evaluation. A need for harmonisation with ISO 9000 standards and certification was suggested, and a duplication of QA audits by the Utilities and the Contractor was considered as a loss of time for the manufacturer, without obvious quality benefit.
Constraints on the fluidity of the manufacturing process are due to actions of inspectors, which leads to the necessity for a better coordination of the Utilities and Contractor's inspectors.

**Ordering documents package and required documentation.**

Too many documents are sometimes referenced when self supported technical specifications could help. It is then difficult and costly for the supplier to identify the real requirements applying to its furniture.

**Design.**

A strong recommendation to refer to non-nuclear codes practices (CODAP [2], CODETI [3], ASME VIII [4]...) for heat exchangers, tanks and pipes, came from most of the suppliers. They also noticed that the requirements for pipe supports lead to procure and manufacture an important amount of supports. In the same way they asked for the reason to have specific technological requirements for pumps and valves.

**Materials and construction.**

The complexity of part procurement qualification required in RCC-M paragraph M140 and M 160 was identified and it was suggested to limit this application to specific needs.

The specific requirements applying to welding (duration and conditions of weld metal acceptance, duration of welding procedure qualifications and additional welder qualifications ) were questioned as far as they differ sometimes from the European Standards and from ASME requirements (even for nuclear field).

Expensive requirements on cleanliness and packaging of equipment are sometimes applied without necessity to semi-finished products.

Following the analysis of these various comments, specific EDF / FRAMATOME working groups were installed with the objectives to propose modifications of the current requirements.

**WORKING METHODOLOGY**

To this aim, 14 working groups have been set up on the following scopes: general requirements, ordering document package, required documentation, Quality Assurance and suppliers inspection, mechanical equipment, review of RCC-M, materials and construction, design and technological requirement for pumps and valves, comparison of conventional codes with RCCM, design of pipe supports, electrical equipment and functional qualification of equipment.

The proposals of the various working groups may be summarised as follows.

**General requirements.**

Concerning ordering document package, recommendations have been prepared on the harmonisation of ordering document structure, the content of each document, the way to specify, and the use of referenced codes and standards, Reference lists for required documentation have been prepared on mechanical equipment and accessories, on electrical equipment, on control equipment, and on site activities, with recommendation for preparation of the specific lists for each order.
An updating of the RCC-M Quality Assurance chapter A5000 has been prepared, which is based on the ISO 9001 and 9002 standards and complemented to comply with the 50 C/SG-Q AIEA standard.

A common set of Suppliers inspection rules have been prepared, defining the inspection policy in conformity with the requirements of the French Regulation and the general organisation of the surveillance, leading to common practices.

**Mechanical equipment.**

Modifications of RCC-M have been proposed, which are presented in the following chapter. Design and technological standard requirements have also been prepared for pumps and valves.

A general report on the comparison of Conventional Rules with RCC-M has been issued, covering tanks, heat exchangers and pipes, in co-operation with six selected suppliers.

New concepts for design of pipe supports have been examined with a particular consideration of the specified seismic loading, using reduced rigidity of supports.

**CONVENTIONAL RULES EVALUATION**

In the field of the conventional construction codes for pressure vessels, the ASME VIII division 1 (Boiler & Pressure Vessel Code) [4] is often referred to by the other codes (ANSI, API, ...) for some requirements in the field of minimal thickness and admissible properties of materials. In the same way for piping system the American reference is either ASME B31.1 or ASME B31.3.

The French conventional codes CODAP [2] and CODETI [3] describe the good industrial practice in France for design and construction of pressure equipment and piping system respectively using the reference to French AFNOR standards. The equipment covered by these codes belong to more various industrial fields (chemical plants, refinery, ...) than the RCC-M code which is applicable only to mechanical components of PWR nuclear islands.

Nevertheless, all these codes have to solve the same technical problems and may only differ in the way to solve them, according to the importance of the behaviour of the components covered and according to the manufacturing technologies currently applied.

**Structure of the codes.**

The general structures of all codes are similar: they all include chapters respectively devoted to general provisions, materials and procurement, design, construction examination and inspection.

There are nevertheless some differences on technical aspects. In the French conventional codes CODAP and CODETI, as well as in ASME VIII division 1 (B&PVC), the structure seems more adapted to the organisation of industrial companies: drawing and industrial-offices are in closer relation with the workshops.

This is why some design provisions concerning directly fabrication are included in Part F "Fabrication" (or subsection B part UW for ASME) rather than in Part C "Design", as in the RCC-M. This is specially the case for the description of the allowable welded joints according to the category of the component.
The RCC-M describes the components as they have to be build, therefore connections (between two components) are the responsibility of the designer rather than of the manufacturer.

**Classification of the components.**

In ASME VIII division 1 (B&PVC), there is no classification of components needing specific design analysis, but the code defines "weld categories" depending on the location of the weld in a vessel, which are related to the stress loading. A limitation of the "types of weld" and of weld efficiency factors are defined and the non destructive examinations required are specified.

The French conventional codes make a classification of the components in order to adapt the requirements concerning design, material procurements, fabrication and examinations to the potential risk of failure and to the consequences of an eventual failure. This analysis takes place in a safety approach, quite similar to the nuclear safety approach.

The potential risk of failure is analysed for each equipment, leading to a classification of the risk as "high", "average" or "low". In the same way, the potential consequences of a possible failure are evaluated as "important", "average" or "low": see Table 1.

<table>
<thead>
<tr>
<th>Potential risk of failure</th>
<th>Potential consequences of a possible failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1: Cyclic loading</td>
<td>H1: Risk for the population</td>
</tr>
<tr>
<td>S2: Number of start-up and shut-down</td>
<td>H2: People in proximity</td>
</tr>
<tr>
<td>U1: Operating conditions:</td>
<td>T1: Toxicity of the Product</td>
</tr>
<tr>
<td>U2: In-Service Monitoring</td>
<td>F1: Releasable energy</td>
</tr>
<tr>
<td>D1: Geometry</td>
<td>F2: Explosion of the product in case of leak</td>
</tr>
<tr>
<td>D2: Lifetime.</td>
<td>F3: Inflammability</td>
</tr>
<tr>
<td></td>
<td>F4: Risk due to the temperature</td>
</tr>
<tr>
<td></td>
<td>M1: Economical incidence of a failure</td>
</tr>
<tr>
<td></td>
<td>M2: Consequences of the failure of neighbour structures</td>
</tr>
</tbody>
</table>

**Table 1. Evaluation of failure risks and consequences for the classification in Construction categories, according to the CODAP Code**

Finally, on the basis of the criteria on potential risks and consequences of possible failure, a given construction category is chosen (Ex, A, B, or C). When these rules are applied to most of the nuclear components of Class 2 or 3 the resulting classification should be "AVERAGE potential risks" and "AVERAGE Consequences of possible failure". It should be noticed that an "AVERAGE" classification may result even if some criteria of potential risks are considered "IMPORTANT", provided these risks are compensated by in-service arrangements or inspections reducing the risk of failure. That leads generally to an AVERAGE value of the overall evaluation of the potential risk. In the case of important consequences of failure and high risk of failure, the resulting category can as a minimum be "A" or shall be increased to "Ex" by the purchaser in the order.

These criteria for "potential risks/consequences of failure" proposed in the conventional French codes lead to identify mechanical components of nuclear islands for which "category B" would be the result and which could be designed and manufactured according to conventional rules.
Materials procurements

The aim of the "procurement" provisions of the codes is to require properties consistent with construction needs and design hypothesis.

Owing to the gradation of the requirements in the CODAP for materials procurement according to the classification in categories, the Manufacturer may retain practices in accordance with his more usual fabrications.

Globally, for categories A and B, especially when the weld efficiency factor $z = 1$, the requirements of the CODAP are comparable to those of the RCC-M, with some differences concerning essentially formal aspects. This situation is similar for the materials procured in accordance with ASME II part D, except that acceptance test at elevated temperature are not defined in the ASME code.

The additional verifications required by the RCC-M increase the detailed knowledge of the materials properties (impact test or tensile test at elevated temperature), but should be limited to components for which these guaranties are important. For most equipment, a more pragmatic approach (based on standards) should be sufficient.

The material requirements of the CODETI are established on the basis of those of the CODAP in more condensed terms. Some of them are less stringent than those of the CODAP, but these differences are justified considering the potential application.

Design conditions.

The mechanical principles on which the rules are based are similar in all codes. But there are some differences in their formulations.

The RCC-M limits the dimensioning rules to simple geometry, because it is generally possible to carry out detailed analysis if needed, especially if the mechanical loading is significantly higher than the pressure.

The CODAP includes rules for analysing the combination of pressure and mechanical loads, but application are less detailed than required by the RCC-M. Recent specific rules for detailed analysis have been included in chapter C 10.1 of the CODAP. Simplified rules (C 10.2), and detailed fatigue analysis provisions (C 10.3) are under preparation.

Consequently, the number of basic geometries for which analytical formulas exist is greater in CODAP than in the RCC-M and might be used for nuclear components in order to help the designers. Nevertheless, additional calculations will remain necessary in order to combine mechanical loads and pressure.

In particular, the seismic loading is considered as an emergency condition when applying the CODAP. The usual practice in the nuclear industry is to consider an Operating Basic Earthquake in Design or Upset condition and a Safe Shutdown Earthquake in faulted condition. Therefore the criteria of the CODAP rules should be adapted. The following table 2 shows an example of criteria which may be combined with CODAP in order to meet nuclear safety needs.

For the CODETI (applicable to piping system), the design rules are based on ANSI B31.3, when those of the RCC-M, class 2 and 3 are comparable to ANSI B31.1. A specific appendix is devoted to the seismic analysis, which is consistent with the nuclear practice, but anchor displacements are not included in the equations. It shall be noticed that no seismic analysis is prescribed for piping system in ASME / ANSI.
OPERATING CONDITIONS | CRITERIA TO BE VERIFIED
--- | ---
Present RCC-M practice | RCC-M Level | CODAP/CODETI Category
DESIGN | 0 | 
NORMAL | A | NORMAL CONDITION \( f_N \)
UPSET + \( \frac{1}{2} \) SMS | B | NORMAL CONDITION \( f_N \)
EMERGENCY | C | EMERGENCY CONDITION \( f_E \) \( (= 1.425 f_N) \)
FAULTED + SMS INTEGRITY | D | \( F_{ACC} = 2 \times f_N \) or earthquake = 0.71 SMS
 FAULTED + SMS: FUNCTIONALITY | C | EMERGENCY CONDITION \( f_E \)
FAULTED + SMS OPERABILITY | 0 | NORMAL CONDITION \( f_N \)

Table 2: Example of possible correspondence between RCC-M and CODAP

The dimensioning rules of the CODAP and the CODETI lead to lower wall thickness than those of the RCC-M or ASME VIII division 1 owing to higher nominal design stresses: Table 3.

<table>
<thead>
<tr>
<th>Construction Code</th>
<th>Design stresses applicable to stainless steel</th>
</tr>
</thead>
<tbody>
<tr>
<td>CODAP</td>
<td>( \frac{R_m}{3.5} ) \text{ or } \frac{R_{p_{1.0}}}{1.66} \</td>
</tr>
<tr>
<td>CODETI</td>
<td>( \frac{R_m}{3.5} ) \</td>
</tr>
<tr>
<td>ASME II RCC-M Class 2</td>
<td>( \min (S_T/4; 1.1 S_T R_T/4; S_y \times 2/3; 0.9 S_y R_y) ) \</td>
</tr>
</tbody>
</table>

\( S_T \) and \( S_y \): Specified minimum values at room temperature of tensile strength or yield strength respectively.
\( R_T \) or \( R_y \): Ratios values of tensile strength or yield strength respectively, given by average temperature dependant trend curve.
\( R^{'}_m \) and \( R^{'}_p \): Specified minimum values at elevated temperature of tensile strength or yield strength respectively.

Table 3: Comparison of design stresses

However, the choice of the actual wall thickness is also linked to additional parameters (standard thickness) or availability of the basic products and fabrication consideration (overall reinforcement of the shell in order to avoid local reinforcement). In some cases, the stability under external pressure will be the more significant loading condition.

Manufacturing, welding and examination.

The same aspects are covered in all codes: forming and cutting processes, misalignment and fabrication tolerances. The requirements are quite similar and if the
requirements of the RCC-M are more explicit, there are no technical difficulties to fulfil them. The quality of the welded joints is an important point for all codes.

The provisions of the CODAP are based on the current practices of fabrication of pressure vessels and are independent of the category of construction.

The essential specific RCC-M requirements are related to the proof of the equipment quality whatever the method used by the manufacturer. On the contrary, if the manufacturing process presents a risk, it will be forbidden.

The CODETI rules were adapted from the CODAP to the particular case of piping. Piping systems being essentially constituted by straight pipes and standardised components, the number of manufacturing processes is lower than for pressure vessels.

The requirements of the RCC-M for Non-Destructive Examination methodologies are based on the standards applied in the industrial field. The practices are written in more details, concerning the stage at which the examination shall be performed during manufacturing, the extend of the examination and the criteria to be met.

Besides, the requirements of the RCC-M are also more precise for fabrication processes (machining, bending, blasting and passivation), cleanliness examination, surface roughness, surface treatment, storage, handling and protection before packing.

The requirements in ASME follow the same approach except that the referred standard are ASTM and not ISO or EN standards.

The requirements concerning manufacturing, welding and examination follow a similar approach in the three conventional codes (extend, type of criteria, methods). It may consequently be possible to refer to these codes for some class 2 or 3 components, with complementary requirements being included in the equipment specification.

SYNTHESIS OF RCC-M CODE EVOLUTIONS

Updating of RCC-M construction provisions applicable to mechanical components were prepared on the basis of the above inquiries and the integration of operating feedback completed by specific safety precautions in order to prevent damage occurrence either due to operation or to specific manufacturing conditions.

INTEGRATION OF INQUIRIES.

Updating of the reference to industrial standards.

The evolutions of the industrial standards referred to in the RCC-M have been evaluated leading to the following evolutions:

- Replacement of French standards by European standards, for semi-finished products, for stainless steel plates and rods, for destructive tests on longitudinal welds of tubes, for Rockwell hardness test machine calibration, for non-destructive examination conditions of tubes, etc.

- Introduction of EN 26520 (identical to ISO 6520) standard relative to the classification of defects in fusion welds.

- Introduction of the new European standard, NF EN 10002-4, for extensometers calibration (elongation measurement). The possibility of using the existing practice (ASTM E83 standard) is kept.
Technical provisions identified during the inquiries.

These evolutions correspond to points which were specific to the French nuclear practice, and which have been corrected for a better harmonisation with the industrial practices:

- Harmonisation of the Molybdenum content of stainless steels with the international standards,
- Replacement of the tensile test with 5 minutes loading at minimum guaranteed yield strength, by a standard tensile test. The harmonisation of tests conditions at design temperature is also applicable for welds,
- Inter-granular corrosion test only requested when given criteria on Carbon content of materials are exceeded,
- Harmonisation of methodologies for impact tests conducted on stainless steels and nickel-base base materials (including welds) with the standardised practices used for procurement of materials and definition of associated criteria (replacement of KU impact tests by KV impact tests), and acceptance of qualifications obtained according to previous code editions,
- Replacement of validity duration limits for welding procedure qualifications, by a factory competence report., and extension of the validity duration from 2 to 5 years for filler materials procurements,
- Qualification of welders, according to European EN 287-1 standard, completed by a specific test coupons for complex shape configurations,
- Harmonisation of the validity domain (range of approval) for welding procedure qualifications (thickness of joint and number of cladding layers) with the current industrial practice (EN 288-1, ASME IX, KTA [5]),
- Reference to industrial standard for lots definition, for procurement of filler materials used for class 2 and 3 components (outside Main Secondary System),
- Redefinition of criteria for the selection of parts (devoted to heavy components) needing before procurement a specific RCC-M M140 qualification.

Some other proposals prepared following the inquiries, were not retained by the RCC-M Subcommittee, such as the suppression of simulated stress relieve heat treatments requested in the context of the procurement of base materials, which was kept for consistency with international rules applying for nuclear applications (ASME III subsection NB and KTA). The replacement of the hydraulic test on tubes by Eddy current non-destructive examinations, could only be accepted if a justification file is available.

Conditions for equivalence of procurement based on different code editions.

The request of manufacturers was to have the right to use components in excess from previous orders, where no technical drawbacks were identified. This was accepted subjected to the verification that procurement specifications published in different editions of the code were equivalent. This verification, done by the Afcen working groups, did lead to the preparation of a table of equivalence included in a new A.1500 chapter, now included in the Code. This equivalence covers all the procurements performed on the basis of a procurement specification from the 1988 edition to a more recent edition.
Qualification of heat exchangers tubes.

The initial RCC-M code rules were prepared for significant series of products. Prototype-series were requested before the complete series were started. In the context of the decrease of the amount of products ordered, the prototype-series were in some case larger than the ordered series, leading to the necessity for an adaptation of the code. No M140 qualification is now necessary, only a prototype-series of tubes exchanger for class 2 and 3 components is requested.

Procurement in small quantities.

A simplification was requested by suppliers about rules for the procurement of products in small quantities. This was accepted by a Modification Sheet, including equivalent possibilities and procedure simplifications.

INTEGRATION OF OPERATING AND STUDIES FEED BACK.

Design improvements

Since the previous edition of the RCC-M construction code, there have been several evolutions included, following R&D results and experience feedback integration. These updating are summarised below.

Precision have been included concerning the dimensions to be considered in the stress reports and the need for re-evaluation of such reports in case of deviations in actual component dimensions. Harmonisation with KTA provisions on this topic was also considered.

Criteria for valves were included in emergency and faulted conditions to cover cases where actual loads are considered for valve body analysis in such conditions. Also, stress criteria applying to class 1 bolting have been revised following French regulatory evolutions for a better consistency with ASME and KTA provisions.

Stress classification rules have been revised to accept, subject to justification, that a part of seismic loads be classified secondary. In parallel, the RCC-M recognises that a part of the thermal expansion loads may in some areas be classified primary.

Concerning fatigue prevention, fatigue plastic strain correction factors have been improved, taking into account the respective parts of the primary and secondary stresses in the stress cycles under consideration, leading to a more precise evaluation of the fatigue usage factor.

Following experience feedback, thresholds have been included in the class 2 piping design sections, above which precautions are recommended against thermal fatigue. When the thermal fluctuations of the fluid exceed 80°C for stainless steels and 50°C for carbon and low alloy steels, for a cumulated duration exceeding 30 hours, the following precautions are recommended:

- reduction of loads through improvement of layout design,
- determination of maximum use duration, based on analysis, test or industrial experience,
- grinding of welds, reduction of surface roughness, and limitation of residual stresses,
- recommendations for in-service surveillance by the Contractor.
Where components are subjected to severe cyclic loading, according to RCC-M A.4230 component classification criteria, the general "design by analysis" provisions are referred to for class 2 pumps, valves and piping. Such a possibility was only open for vessels and heat exchangers in ASME III Subsection NC and the previous RCC-M edition.

Fast fracture prevention was discussed in details in the context of the N4 construction and the discussion of the new French regulatory evolutions. An in-depth revision of the code is under preparation on this topic. Consequently, the 2000 Edition updating are limited to:

- material toughness properties to be considered as a function of residuals content,
- updating of influence functions for stress intensity factor determination.

**Procurement and manufacturing improvements.**

Several improvements, applicable to part procurement and to manufacturing precautions, have been integrated since the previous edition of the RCC-M. Some example of the most important requirements are reported below:

Sulfur and Phosphorus contents were reduced in order to improve the toughness properties and to be consistent with the required criteria for impact test for the procurement acceptance test. Some warning are also included for the contractor to require if necessary a special remelting of the ingot (under vacuum or slag) to reduce the impurities in the stainless steel base materials.

For the procurement of carbon steels used for class 1 pressure boundary the measurement of $RT_{NDT}$ is required for some components with the associated criteria to satisfy.

Volumetric examination (Radiographic testing) and surface examination (penetrant or magnetic particle testing) are systematically required on the final surface for castings in addition to a prototype piece qualification according to paragraph M 160.

The methodology to follow for flaws characterisation by U.T. technique has been improved in order to evaluate in a repetitive result whether the indications are planar or volumetric. This methodology experimented in an Afcen study, has also been submitted to European standardisation.

A specific warning has been introduced to ensure that stainless steel cladding by welding is performed with an improved implementation to avoid underclad defects due to reheat cracking.

**CONCLUSION**

The general conclusion of the studies made on cost reduction possibilities is that the technical requirements are not necessarily costly by themselves. They are only costly when they do not correspond to standard industrial practices.

Consequently, technical requirements shall not be established "in camera", but a technical evaluation of the existing industrial practices shall be done regularly in order to select those which may correspond to the actual needs. The additional requirements should, as far as possible, be limited to:

> the selection of the acceptable practices within the standard possibilities,
the choice of the options left open in the industrial standards,

the complementary provisions resulting from specific nuclear needs, such as faulted condition criteria, which shall be defined so as to remain compatible with the standardised industrial practices.

Industrial codes have been evaluated. The general conclusion is that, taking into account the above orientations, it should be possible to refer to these codes for class 3 and some class 2 components, the CODETI necessitating more additional provisions than the CODAP, and the ASME code needing different complementary provisions. The final decision can only be taken following discussions between Engineering and manufacturers under Safety Authority control, particularly in view of the evolutions of the French regulations.

The RCC-M code evolutions have been defined in order to take into account the results of inquiries made. These evolutions have been completed by additional precautions integrating the operating feedback of the 54 existing plants and the manufacturing experience. Provisions needed for the preparation of the justification studies were also updated, leading to a new 2000 edition of the RCC-M construction code.

REFERENCES