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FEUP FACULDADE DE ENGENHARIA
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PROFESSIONAL ACTIVITY REPORT

A standardization approach for the design enhancement

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To my family

A wise and frugal government, which shall restrain men from injuring one another, shall leave them otherwise free to regulate their own pursuits of industry and improvement, and shall not take from the mouth of labor the bread it has earned.

in Thomas Jefferson First Inaugural Address on March 4th, 1801

ACKNOWLEDGMENTS

I would like to thank António Barroso, who was my first employer back in 2003, for his friendship and for teaching me the tricks and hints of the engineering design. Fate would bring us together once again in 2008 at *Engicraft*, which ended up being the last engineering company I worked for in Portugal. I also place on record his patience to dig up all the information regarding the projects referenced in this report.

Secondly, I take this opportunity to express my gratitude to *CEN/CENELEC Management Centre* that gave me opportunity to embrace this new exciting challenge called standardization in a city where I was most welcomed. In particular, I am grateful by the support shown by Geert and Jean-Paul.

Finally, I bring a word of thanks to my dissertation advisor, Professor Hipólito Sousa, for his availability and for the follow up of this report development.

RESUMO

Este relatório descreve as principais atividades profissionais desenvolvidas por Alexandre Beltrão, a quem foi concedido o grau de licenciado em engenharia civil, no ramo de estruturas, pelo Instituto Superior Técnico de Lisboa. Durante o seu percurso profissional, o autor também acumulou experiência em projetos de hidráulica e tornou-se Projetista de Redes de Gás, nível IV, reconhecido pelo Instituto Tecnológico do Gás. Isto permitiu-lhe ao autor desenvolver os projetos descritos neste relatório, projetando as diferentes especialidades como o abastecimento de água e combate ao incêndio, drenagem de águas resíduas, abastecimento de gás e sistemas automáticos de sprinklers.

Entre 2003 e 2005, trabalhou para a NMAB, uma pequena companhia de engenharia desenvolvendo não só cálculo estrutural mas também projetos de abastecimento de água e de drenagem de águas residuais.

Em 2005, ingressou na DIMECONSULT, especialistas em projetar pontes, viadutos e passagens, de forma a estar mais envolvido no cálculo estrutural.

A experiência adquirida em projetos de hidráulica e o conhecimento do funcionamento do mercado de engenharia em Lisboa levaram a um convite para dirigir o departamento de hidráulica da delegação de Lisboa da AFAConsult, uma empresa de engenharia sediada em Vila Nova de Gaia.

Entretanto, NMAB foi transformada em Engicraft, uma companhia do Grupo Focus, que cobre todas as especialidades de projeto numa solução de "chave na mão" (One Stop Solution). Em 2008, o autor recebeu um convite pessoal de um dos seus donos para fazer parte da equipa, onde ficou até 2012.

Em Março de 2013, Alexandre mudou-se para Bruxelas para ingressar no Centro de Gestão do CEN e CENELEC (CEN/CENELEC Management Centre) como "Programme Manager" na unidade para a Indústria, Tecnologia e Infraestrutura, lidando maioritariamente com a normalização do sector da construção. Neste relatório, é feita uma breve descrição do funcionamento e objetivos da normalização. De forma a fazer a ligação entre estas duas experiências profissionais aparentemente tão distintas (projeto e normalização), o autor identifica, para cada projeto listado, uma norma que o poderia ter ajudado a melhorar na direção da solução ótima, considerando os aspetos técnicos e/ou o contexto legal aplicável.

Tendo em conta os treze projetos listados neste relatório de atividade profissional, é evidente que o autor adquiriu ao longo dos anos o conhecimento técnico necessário para lhe permitir adotar soluções não convencionais ("out of the box") que vão além das exigências mínimas impostas por lei e além das soluções tradicionais aceites pela prática corrente. Com isto, é possível alcançar melhores soluções do ponto de vista técnico a/ou económico. Para alcançar este objetivo, o autor desenvolveu ferramentas informáticas para auxiliar o cálculo e para gerar automaticamente mapas de quantidades e condições técnicas. A descrição destas ferramentas é parte integrante deste relatório.

Este relatório demonstra que as normas podem ser usadas como documento técnico com o consenso Europeu nos últimos desenvolvimentos em determinado assunto ou como auxilio para o cumprimento da legislação Europeia.

Sem intenção de ser um documento exclusivamente em matérias legais, este relatório faz referência a algumas Diretivas e Regulamentos Europeus que seguem os princípios legislativos da "New Approach". O Regulamento para os Produtos de Construção também é mencionado, embora não fazendo parte deste grupo de documentos legislativos.

PALAVRAS-CHAVE: Normalização, Legislação, Europeu, Projeto, Construção

ABSTRACT

This report describes the main professional activities developed by Alexandre Beltrão, who was granted the degree of licentiate in civil engineering, specialized in structural design, by the "Instituto Superior Técnico" in Lisbon. During his professional life, the author accumulated experience also in designing hydraulics projects and became a Gas Networks Designer, education level IV, recognized by the "Instituto Tecnológico do Gás". This allowed him to develop the projects described in this report, designing different disciplines such as water supply and firefighting, wastewater drainage, gas supply and automatic sprinkler systems.

From 2003 to 2005, he worked for NMAB, a small engineering company developing not only structural design but also water supply and wastewater drainage projects.

In 2005, he joined DIMECONSULT, specialists in designing bridges, viaducts and passages, in order to be more involved in the structural design.

The accumulated experience in hydraulics projects and the awareness of the functioning of the engineering market in Lisbon led to an invitation to run the hydraulics department of the Lisbon branch of AFAConsult, an engineering company based in Vila Nova de Gaia.

Meanwhile, NMAB had been transformed into Engicraft, a company of the Focus Group, which covers all the project disciples in a One Stop Solution. In 2008, the author accepted a personal invitation from one of its owners to join the team, where he stayed until 2012.

In March 2013, Alexandre moved to Brussels to join CEN/CENELEC Management Centre as Programme Manager in the "Industry, Technology and Infrastructure" unit, dealing mainly with the construction sector standardization. In this new function, the author allied his technical background and management skills with the organization strategy and legal framework. In this report, a brief description on the standardization functioning and objectives is done. To make the link between these two apparently disconnected professional experiences (design and standardization), the author identifies, for each listed project, a standard that could have improved it in the direction of the optimal solution, taking into consideration technical aspects and/or the applicable legal context.

Going through the thirteen projects listed in this professional activity report, it is clear that the author has gained the needed technical knowledge throughout the years to allow him to adopt "out of the box" solutions that go beyond the minimum requirements imposed by the regulations in place or beyond the conventional solutions accepted by the implemented practice. This allows the achievement of better solutions, from the technical or/and economical point(s) of view. To support this goal, the author developed IT tools to support the calculation or to generate bills of quantities or automatic technical conditions. The description of these tools is also included in the remit of this report.

Moreover, this report shows that standards can be used as technical design document bringing the consensual European state of the art and/or giving guidance in a particular subject or to support the fulfilment of European Union Law.

Without intending to be strictly a document on legal matters, this report makes reference to some European Directives and Regulations that follow the New Approach legislative principles. The Construction Products Regulation is also mentioned, although not being part of this group of legislative pieces.

KEYWORDS: Standardization, Legislation, European, Design, Construction

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SYMBOLS, ACRONYMS AND ABBREVIATIONS

ANEC - European consumer voice in standardisation

AVCP - Attestation and Verification of Conformity of Performance

BIM – Buiding Information Modelling

BT – Technical Board

CCMC – CEN/CENELEC Management Centre

CEN – European Committee for Standardization

CENELEC – European Committee for Electrotechnical Standardization

COBie - Construction Operations Building Information Exchange

COCOR - Coordinating Commission for the Nomenclature of Iron and Steel Products

CPD – Construction Products Directive

CPR – Construction Products Regulation

CRUP – Conselho de Reitores das Universidades Portuguesas

CWA – CEN Workshop Agreement

DG GROW - Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs

DG ENER - Directorate-General for Energy

DGEMN - Direcção Geral dos Edifícios e Monumentos Nacionais

DoP – Declaration of performance

EAD – European Assessment Document

EC – European Commission

ECISS - European Committee for Iron and Steel Standardization

ECOS - European Environmental Citizens' Organisation for Standardisation

ECSC - European Coal and Steel Community

EDP – Energias de Portugal

EFTA – European Free Trade Association

EN – European Standard

EOTA – European Organisation for Technical Assessments

EPAL – Empresa Portuguesa das Águas Livres, SA

EPUL – Empresa Pública de Urbanização de Lisboa

ESO – European Standardization Organization

ETA – European Technical Assessment

ETSI - European Telecommunications Standards Institute

ETUI - European Trade Union Institute

EP - Estradas de Portugal

EPB – Energy Performance of Buildings

FEUP – Faculdade de Engenharia da Universidade do Porto

HVAC – Heating Ventilation and Air Conditioning

IC FEUP – Instituto da Construção

INESC Porto - Instituto de Engenharia de Sistemas e Computadores do Porto

INH - Instituto Nacional da Habitação

IST – Instituto Superior Técnico

IPQ – Instituto Português da Qualidade

IT – Information Technology

ITG – Instituto Tecnológico do Gás

IT&T – Industry, Technology and Infrastructure

LNEC – Laboratório Nacional de Engenharia Civil

LPG - Liquefied Petroleum Gas

MEP - Mechanical, electrical, and plumbing

NFPA - National Fire Protection Association

NSB – National Standardization Body

OJEU – Official Journal of the European Union

PC – Project Committee

PM – Programme Manager

ProNIC - Protocolo para a Normalização da Informação Técnica na Construção

REH - Regulamento de Desempenho Energético dos Edifícios de Habitação

RCCTE - Regulamento das Características de Comportamento Térmico dos Edifícios

SBS - Small Business Standards

TC – Technical Committee

TR – Technical Report

TRIS - Technical Regulation Information Systems

TS – Technical Specification

WG – Working Group

1
INTRODUCTION

1.1. FOREWORD

In 1999, the higher education qualifications were aligned throughout Europe, during the Bologna Process, in order to make them comparable. The Bologna declaration was signed by the Education Ministers from 29 European countries, Portugal being among them.

This led to a reorganization of the qualifications: bachelor´s degrees with the duration of three years were upgraded to full degrees, while 5-year degrees were given the master´s degree qualification. This update was not done for the students "caught" in the transition period. As consequence, those who studied for five years did not automatically achieve the qualification of Master.

To correct this situation *CRUP* made a communication on January 8th 2011. Its recommendations were followed by *FEUP* that issue a regulation [1] with the conditions to grant the qualification of Master to these students.

This report was developed in this context as, according to article 3º of this regulation, a report on the professional activity of the last 5 years needs to be elaborated.

1.2. PROFESSIONAL BACKGROUND OF THE AUTHOR

The author finished the civil engineering 5-year degree at *IST* in 2003, being the last 2 years a specialization in structural design.

From 2003 to 2005, he worked in NMAB, a small engineering company developing not only structural design but also water supply and drainage projects.

In 2005, he joined DIMECONSULT, specialists in designing bridges, viaducts and passages, in order to work more in structural design. This did not entirely happened as he still continued involved in water supply and drainage projects, in particular, designing the systems inside residential buildings and the exterior water supply and sewage networks.

The accumulated experience in hydraulics projects and the awareness of the functioning of the engineering market in Lisbon led to an invitation to run the hydraulics department of the Lisbon branch of AFAConsult, an engineering company based in Vila Nova de Gaia. To fulfil the requirements of the position, the author developed his competences in the design of firefighting systems, in particular automatic sprinkler systems, and got the *ITG* degree to be recognized as Gas Networks Designer, education level IV.

Meanwhile, NMAB had been transformed into Engicraft, a company of the Focus Group, which covered all the project disciples in a One Stop Solution. In 2008, the author accepted a personal invitation from its owner to join the team, where he stayed until 2012. At the time, the economic crisis installed in Portugal forced Engicraft to make a drastic staff reduction.

In March 2013, the author moved to Brussels to join *CCMC* as Programme Manager for the *IT&T* unit dealing mainly with the construction sector standardization.

1.3. REPORT OBJECTIVE

The objective of this report is to demonstrate the main competences and skills acquired by the author in the development of his professional activity for the last 5 years, first as design engineer (focusing in the hydraulics) and as *CCMC* Programme Manager afterwards.

This 5-year period covers the work developed at Engicraft after 2010. Nevertheless, it was decided, for consistency reasons, to report the entire period in which the author worked for that company, including the first two years back in 2003, when it was still called NMAB. This part of the report intents to highlight the author´s technical skills in the development of the several listed projects. This includes not only the execution of the project as such, but also the conception phase where the author tries to find the most adequate solutions.

The last two standardization related years are also in the scope of this report. In this new function of Programme Manager, the author allied his technical background and management skills with the organization strategy and legal framework. The objective of this part is to show how the behavioural competences, fundamental to the fulfilment of these new tasks, were acquired or further developed. Among them, the most important are:

- Achievement – To meet targets in compliance with quality and time;
- Analytical thinking – To analyse the environment and make decisions;
- Entrepreneurship – To spot opportunities that add value to the organization;
- Customer service orientation – To meet costumers´ needs;
- Flexibility – To adapt one´s approach within the agreed framework;
- Team working – To work with others to achieve positive outcomes;
- Communicating – To express information in clearly and coherently;
- Influencing and negotiating – To present a professional image of the organisation and self.

To make the link between these two apparently disconnected professional experiences (design and standardization), the author identifies, for each listed project, a standard that could have improved it in the direction of the optimal solution. This should be considered as an example, to prove that a project always has room to be further enhanced through the utilization of standardization deliverables. It should not be considered as neither an exercise to list all the deliverables applicable to that project in an exhaustive way nor a technical study on how the deliverable could have changed particular parts of the design.

1.4. REPORT STRUCTURE

As stated previously, for each listed project, a related standard is identified. Therefore, to make this approach more comprehensible, this report will address the standardization first and the design related matters afterwards. As a consequence, this activity report is presented in a chronologically reversed order, starting by the most recent professional experience.

The following chapters are:

- Chapter 2 – Professional activity at CEN/CENELEC Management Centre between 2013 and 2015;
- Chapter 3 – Professional activity at Engicraft/NMAB in the 2003 to 2005 and 2008 to 2012 periods,
- Chapter 4 – Closing notes and conclusions

2

CEN/CENELEC MANAGEMENT CENTRE (2013 - 2015)

2.1. ORGANIZATION DESCRIPTION

The European Committee for Standardization (*CEN*) and the European Committee for Electrotechnical Standardization (*CENELEC*) are two independent associations with 33 members each, which are National Standardization Bodies (*NSB*) from the 28 countries of the European Union together with three countries from European Free Trade Association (Iceland, Norway and Switzerland) and two others in the process of joining the Union (Turkey and Former Yugoslavia Republic of Macedonia). In the majority of the countries, the *CEN* and *CENELEC* member is the same national body.

Fig.1 – CEN and CENELEC members (NSB)

In general, each country has a National Standardization Body (*NSB*), which is responsible for the development of national standards to fulfil the national market needs. In Portugal, the *NSB* is the 'Instituto Português da Qualidade´ (*IPQ*), which is member of both *CEN* and *CENELEC*. The Portuguese standards have the reference NP (Norma Portuguesa), as it is the case of NP 1037-1 [10]. When the standard is the national adoption of an European Standard (EN), the reference will be NP EN. The Portuguese version is only the national adoption of the European one. This means that its technical content cannot be changed. The NP EN will have a new cover and can be (normally is) translated. Informative annexes and notes are allowed to be added in order to give further information to the user on the national specificities and/or conditions or guidance on the standard application.

The structure of both organizations is the same (see Figure 2). At the top, the General Assembly (where all the members are represented) is responsible for taking all statutory and general policy decisions.

The Administrative Board supports the General Assembly by ensuring the correct execution of its decisions. Moreover, it is responsible for the external policy and financial affairs.

The Technical Board is the body, under which, all the technical standardization work is developed. Each Technical Committee has a specific scope for the development of standardization deliverables. The decisions are taken by several delegations representing the national members (national standardization bodies). Usually, working groups are created and assigned with tasks, in particular the drafting of the deliverables. Experts in the working groups are nominated by the members but they don´t represent them. They are selected by their personal technical expertise in a specific field.

A Project Committee is created to address a short standardization need. In these cases, it is not worthwhile to begin a *TC* and the *PC* is disbanded as soon the work is done. Being a small body, working groups are not allowed.

Working Groups can also be directly under the Technical Board. In this case, they are not responsible for the drafting of deliverables but for technically supporting it, developing a given task. As any other working group, the developments should be reported to the parent body.

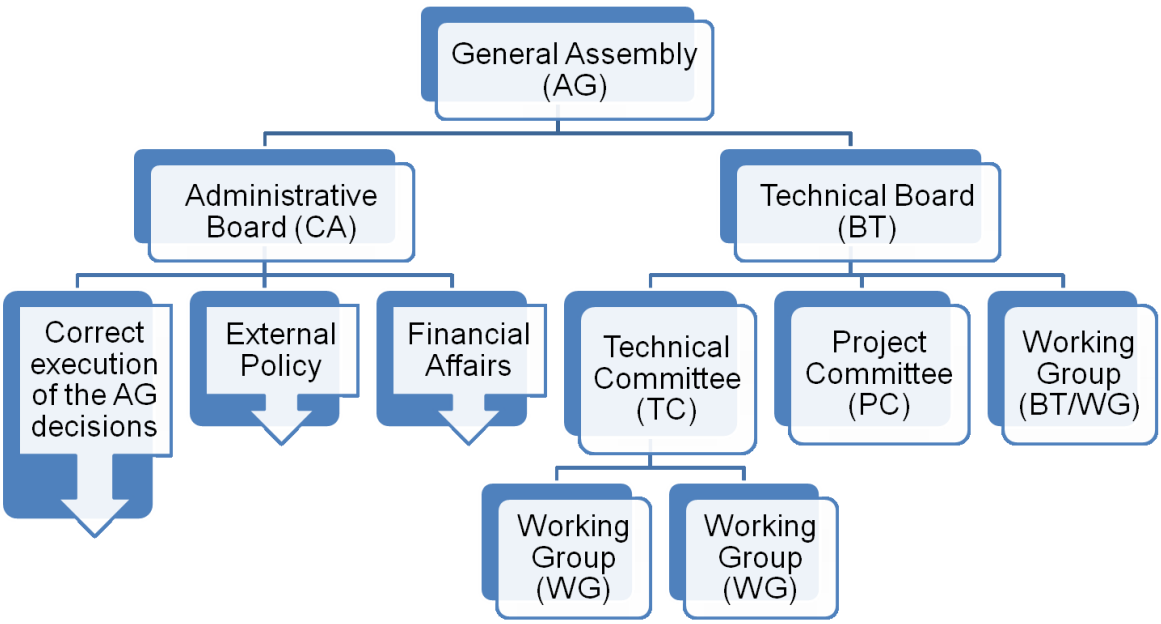


Fig.2 – CEN and CENELEC structure

Within a Technical Committee, the *CEN*/*CENELEC* members are each one represented by a delegation composed by a maximum of three people. These delegations from the several countries bring the expertise from the national mirror committees, which have the same scope as the European equivalent body. Here, the national expertise in determined subject is brought by experts representing the industry, professional associations, government, consumers, patients, etc.

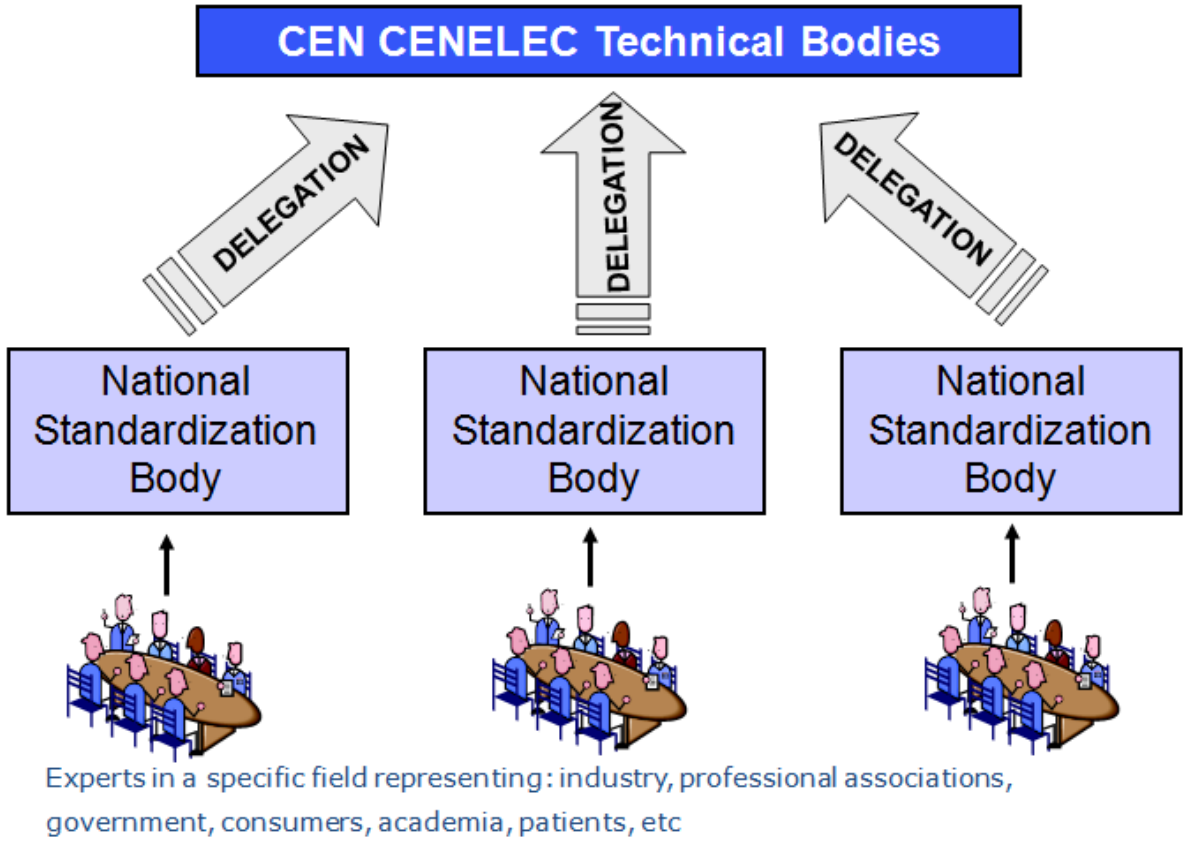


Fig.3 – The national delegation principle

2.2. Deliverables Development Process

The regulation (EU) No 1025/2012 [3] on European standardization, recognizes three *ESO* (European Standardization Organizations): *CEN*, *CENELEC* and *ETSI*. These organizations develop European standardization deliverables in a consensual, transparent and open way. For *CEN* and *CENELEC* several types of deliverables can be achieved depending on the content, on the level of agreement and on the participants drafting the document. The mains differences between them are summarized in Table 1: the European Standard (EN); the Technical Specification (TS), the Technical Report (TR) and the CEN Workshop Agreement (CWA).

Table 1 – Types of standardization deliverables

EN	CEN-CLC/TS	CEN-CLC/TR	CWA
Standstill	No Standstill	No Standstill	No Standstill
3 languages	1 language	1 language	1 language
Enquiry Mandatory	No enquiry	No enquiry	Enquiry optional
Approval by *NSB´*s	Approval by *NSB´*s	Approval by *NSB´*s	Approval by participants
Weighted vote	Weighted vote (TCA)	Simple majority (TCA)	Consensus
Mandatory publication	Announcement	Announcement	Announcement
Competing / conflicting standards are withdrawn	Competing / conflicting standards may continue to exist	Competing / conflicting standards may continue to exist	Competing / conflicting standards may continue to exist
Possibility to support European legislation	Not normally	Not normally	Not normally

The most important deliverable is the European Standard (*EN*), for its implications. To start with, there is a standstill obligation as soon the development of the EN starts. This means that the members cannot develop national standards on the same scope. This would be useless because, when the EN is published, all members have the obligation of adopting it as national standard, removing the ones conflicting with it. Moreover, it can be used to support European legislation (this will be further elaborated under 2.3). Given its importance, it is approved when the weighted votes of the members reach at least 71% after it has passes a public enquiry phase.

Following the usual EN development process (see figure 4):

- An assigned working group of experts develops a draft;
- The *TC* sends the draft for public comment at national level,
- The *WG* integrates the comments considered valid in an improved draft;
- The *TC* agrees to send the draft for voting;
- If approved by weighted vote, the standard is published.

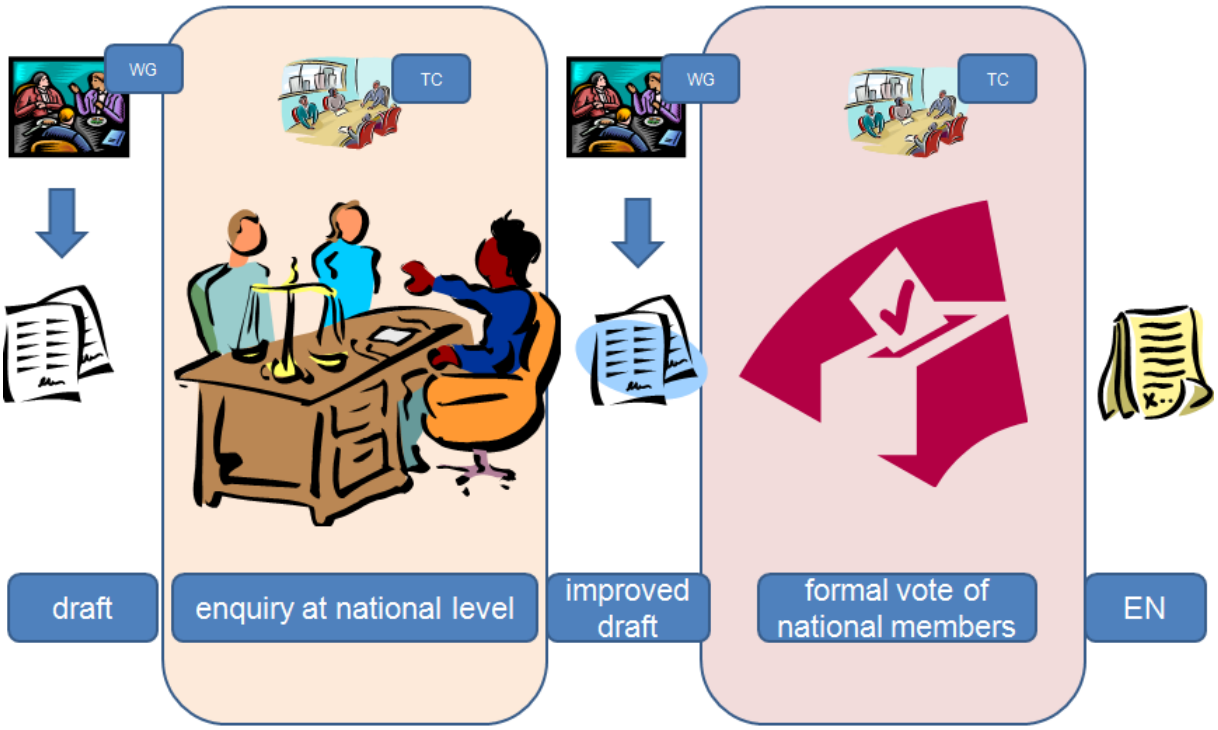


Fig.4 – EN development process

The technical specification (*TS*) has the same editorial structure as the EN, but it is less consensual. Usually, members follow this process when they are not ready to have the obligation to adopt the document as national standard, meaning than conflicting national standards can still exist. The development time is also shorter, as the translation in three languages and the public enquiry are not necessary. The *TS* is usually seen as the first step towards a future *EN*.

The technical specification (*TR*) is a strictly informative document with no requirements, having a different editorial structure from the EN and TS. No requirements whatsoever should be found in these documents. For example, they can give guidance, list data or present a study. For its approval simple majority (more than 50%) is enough.

The workshop agreement (CWA) is a document with a concept completely different. The document is not approved by the *NSB* but by privates or companies that need a document achieved by consensus. The secretariat is held by one of CEN or CENELEC members but the way of work is completely flexible and fast. At the end, the list of the involved parties will appear in the foreword of the document.

2.3. Standardization and Legislation

2.3.1. European Design Standards in National Regulations – Portuguese Case

European Standards are not pieces of legislation but can be explicitly referenced in them.

A good example of this relationship are the EN Eurocodes. The European Commission view towards these standards is that they 'are expected to contribute to the establishment and functioning of the internal market for construction products and engineering services by eliminating the disparities that hinder their free circulation within the Community. Further, they are meant to lead to more uniform levels of safety in construction in Europe. The EN Eurocodes are the reference design codes. After

publication of the National Standard transposing the Eurocodes and the National Annexes, all conflicting standards shall be withdrawn. It is mandatory that the Member States accept designs to the EN Eurocodes. They are currently at the stage of maintenance and evolution in order to address the variety of new methods, new materials, new regulatory requirements and new societal needs developing and to extend harmonisation. The EN Eurocodes apply to structural design of buildings and other civil engineering works including geotechnical aspects and structural fire design.´

The question on whether the Eurocodes are mandatory or not is not of easy answer, although the *EC* would like this to be a reality. For public contracts, a contract authority ´may not reject a tender for works, products or services which comply with a national standard transposing a European standard´. This is stated in the Directive for Public Procurement [20].

Nevertheless, some countries, as it is the case of Portugal, do not have the Eurocodes referenced as being the national structural code and still keep the old regulations like *REBAP* [30] for the structural design of reinforced concrete. This of course creates confusion among design engineers and can increase the costs associated to the design because it may have to comply with both national regulation and Eurocodes.

The reference to the Eurocodes in the national regulation was already on the Portuguese political agenda but it was dropped. Chances are that it may happen again in the future.

When the time comes, a discussion can be started regarding the Energy Performance of Buildings (*EPB*) as well. Currently the *EPB* Directive [4] is transposed to the Portuguese law through the Regulation for the Energy Performance of Residential Buildings (‘Regulamento de Desempenho Energético dos Edifícios de Habitação´ - *REH*) [31]. This will support the 2020 Member States ambitions to reduce the energy consumption and to promote the nearly zero energy buildings.

This will only be possible if there is an alignment at European level on how the Energy Performance can be technically calculated. For that reason, the European Commission issued in December 2010 a Standardization Mandate M/480 [32] to CEN, CENELEC and ETSI for the elaboration and adoption of standards for a methodology calculating the integrated energy performance of buildings and promoting the energy efficiency of buildings. The improved set of *EPB* standards shall become a systematic, clear and comprehensive package for the benefit of professionals, Member States and relations with third countries. In order to ensure user-friendliness, a continuous but modular overall structure is needed, covering all standards related to the energy performance of buildings, providing the overall framework which will enable a step-by-step implementation by the EU Member States. The mandated works will include guidance on the rationalization of different options given in the standards, providing a balance between the accuracy and level of detail, on one hand, and the simplicity and availability of input data, on the other. Hidden complexities will also be taken into account, such as the impact of differences in the overall legal frameworks on the national choices and national input data.

The horizontal coordination of the work under M/480 has been allocated to:

- CEN/TC 371 - Project Committee - Energy Performance of Building project group.

Five CEN technical committees have been assigned the task of developing the required standards:

- CEN/TC 89 - Thermal performance of buildings and building components;
- CEN/TC 156 - Ventilation for buildings;
- CEN/TC 169 - Light and lighting;
- CEN/TC 228 - Heating systems in buildings;
- CEN/TC 247 - Building automation, controls and building management.

The full set of standards (around forty), is expected to be published in mid 2016. Each of these EPB standards will be accompanied by a Technical Report ´according to a common structure, comprising at least the results of internal validation tests (such as spreadsheet calculations for testing and demonstrating the procedures), examples and background information. If possible all informative parts which are currently part of the standards will be moved to these technical reports. This will significantly reduce the length of the standards and strengthen their focus, thus facilitating the adoption (including translation) in national/regional regulations´ - from mandate M/480 text.

Therefore, it is expectable that Member States may include these standards in national regulations, in a similar way to what has been already done with the Eurocodes in some countries.

The Portuguese Government may then have a regulatory conflict to solve, in particular in what regards the thermal performance and heating systems of buildings, where two national regulations are currently in place:

- Regulation for the Thermal Performance of Buildings (*RCCTE*) [34];
- Regulation for the Energy Heating and Cooling Systems (*RSECE*) [35].

2.3.2. The New Approach – Standards in European Regulation

Standards can also support European legislation. Regulation (EU) No 1025/2012 [2] recognizes three European Standardization Organizations (*ESO*) capable of producing such documents: *CEN*, *CENELEC* and *ETSI*. ´With great power comes great responsibility´. These organizations have to periodically report their work to the European Commission and to follow strict rules to guarantee transparency and openness to all stakeholders and, in particular, to the organizations listed in the Annex III of the regulation:

- European consumer voice in standardisation (*ANEC*);
- European Environmental Citizens' Organisation for Standardisation (*ECOS*);
- European Trade Union Institute (*ETUI*);
- Small Business Standards (*SBS*).

This system, where a technical way to fulfil the general legal requirements is defined through a harmonized standard (cited in the *OJEU*) is called ´New Approach´. An example of the citation of the EN references on the Official journal can be found in Figure 5.

This comes in opposition to the ´Old Approach´ where specific technical requirements or documents were directly defined in regulation. Being a very rigid system, the ´Old Approach´ was a barrier to innovation and competiveness.

The European Commission, being the guardian of the European Law and responsible for its implementation, can, at any time, issue a standardization request to the ESO. The ESO will the reply to this request, accepting it and providing the EC with a work programme (list of standards to be developed and respective time frame).

An easy to understand example of the ´New Approach´ are the harmonize standards under the Directive on the safety of toys [7], as it a familiar matter to everyone.

The Directive sets general requirements for the safety of toys. Some of them are related, for instance, to the physical and mechanical properties of the toys:

´1. Physical and Mechanical Properties

1. Toys and their parts and, in the case of fixed toys, their anchorages, must have the requisite mechanical strength and, where appropriate, stability to withstand the stress to which they are subjected during use without breaking or becoming liable to distortion at the risk of causing physical injury.
2. Accessible edges, protrusions, cords and fastenings on toys must be designed and manufactured un such a way that the risks of physical injury from contact with them are reduced as far as possible.´

These requirements set what has to be achieved by the manufacturers without defining how. As there are several ways of doing it, it wouldn´t be possible to write in the law the best way of technically do it. This is the responsibility of each manufacturer.

Moreover, this could be seen as a huge burden to industry that may not have the technical expertise and financial availability to develop its toys to fulfil the requirements of the Directive. That´s were standards step in!

The European industry, using the standardization system, develops a standard defining a possible way of achieving the requirements of the Directive, based on the latest state of the art. After cited on the *OJEU*, these standards confer presumption of conformity to the Directive. This means that the manufacturer, when fulfilling the requirements of the standard, is automatically fulfilling the requirements of the Directive and can affix the CE marking on its products.

Commission communication in the framework of the implementation of Directive 2009/48/EC of the European Parliament and of the Council of 18 June 2009 on the safety of toys

(Publication of titles and references of harmonised standards under Union harmonisation legislation)

(Text with EEA relevance)

(2014/C 181/01)

ESO ([1])	Reference and title of the harmonised standard (and reference document)	First publication OJ	Reference of superseded standard	Date of cessation of presumption of conformity of superseded standard Note 1
(1)	(2)	(3)	(4)	(5)
CEN	EN 71-1:2011+A3:2014 Safety of toys — Part 1: Mechanical and physical properties	This is the first publication	EN 71-1:2011 +A2:2013 Note 2.1	30.9.2014
CEN	EN 71-2:2011+A1:2014 Safety of toys — Part 2: Flammability	This is the first publication	EN 71-2:2011 Note 2.1	30.9.2014
CEN	EN 71-3:2013 Safety of toys — Part 3: Migration of certain elements	29.6.2013		
CEN	EN 71-4:2013 Safety of toys — Part 4: Experimental sets for chemistry and related activities	28.5.2013		
CEN	EN 71-5:2013 Safety of toys — Part 5: Chemical toys (sets) other than experimental sets	29.6.2013		

Fig.5 – Example of standards cited under a ´New Approach Directive´ (*OJEU*)

European Standards are, by definition, voluntary and, even harmonized standards, can include strictly voluntary clauses not giving presumption of conformity to any Directive requirement. So, the question would be: which are the clauses of the standard related to which legal essential requirements? The answer to this question can be found at the end of each harmonized standard, in an informed Annex ZA. In this annex, a table connects the dots, indicating the relationship between the European Standard clauses and the essential requirements of the Directive (see Figure 6).

Annex ZA
(informative)

Relationship between this European Standard and the Essential Requirements of EU Directive 2009/48/EC

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association to provide a means of conforming to Essential Requirements of the New Approach Directive 2009/48/EC.

Once this standard is cited in the Official Journal of the European Union under that Directive and has been implemented as a national standard in at least one Member State, compliance with the clauses of this standard given in Table ZA.1 confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding Essential Requirements of that Directive and associated EFTA regulations.

Table ZA.1 — Correspondence between this European Standard and Directive 2009/48/EC

Clause(s)/sub-clause(s) of this EN	Essential Requirements (ERs) of Directive 2009/48/EC	Qualifying remarks/Notes
4.2 Specific requirements	Annex II, III point 13	The limits for cadmium were amended by Commission Directive 2012/7/EU

WARNING — Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard.

Fig.6 – Example of the Annex ZA

2.4. THE CONSTRUCTION PRODUCTS REGULATION

The Construction Products Regulation [2] is not a New Approach Directive. Its predecessor, the Construction Products Directive was not either. In this case, the standard does not give the presumption of conformity to the construction production towards the requirements of the Regulation. In fact, the *CPR* does not have any requirements for the construction products as such but for their marking. This is clear even in the regulation title ´Regulation (EU) No 305/2011 [...] laying down harmonised conditions for the marketing of construction products [...]´. For that reason, the table ZA.1 of a harmonized standard under the CPR, when compared to a table in a standard under a new approach Directive, does not have the column making the link to the Essential Requirements of the Directive (see Figure 7).

Product: Drainage channel Type M and Type I as covered under the scope of this standard.

Intended use: Collection and conveyance of surface water from areas subject to pedestrian and/or vehicular traffic.

Essential Characteristics	Requirement clauses in this and other European Standard(s)	Levels and/or classes	Notes
Water-tightness — jointing of drainage channels	7.5.1	None	no leakage
Load bearing capacity, deflection under load			Results shall be expressed according to clause 4.
— maximum load	7.15	None	
— Permanent set	7.16	None	Shall be in accordance with Table 11.
Durability	6	None	For weathering resistance of precast concrete units the results shall be expressed according to Table 1.

Fig.7 – Content of the table ZA.1 in a cited standard under the CPR – Relevant clauses for product Type M and Type I

Basically, the *CPR* has provisions on how to mark the construction products, by affixing the CE marking and by drawing up the Declaration of Performance, according to the following articles;

- ´Article 4 (1) When a construction product is covered by a harmonised standard or conforms to a European Technical Assessment which has been issued for it, the manufacturer shall draw up a declaration of performance when such a product is placed on the market.´;
- ´Article 9 (1). The CE marking shall be affixed visibly, legibly and indelibly to the construction product or to a label attached to it. Where this is not possible or not warranted on account of the nature of the product, it shall be affixed to the packaging or to the accompanying documents.´

In the case of the *CPR*, the table ZA.1 indicates where in the standard the provisions to test and declare each Essential Characteristic can be found (e.g. to test and declare the water-tightness in jointing of drainage channels provisions indicated in clause 7.5.1 of the standard have to followed – see figure 7).

Following these provisions, the manufacturer will declare de performance of the chosen Essential Characteristics in the CE marking and in the Declaration of Performance.

The testing of the product as such (assessment of the performance) is only one of the *AVCP* (Attestation and Verification of Constancy of Performance) system tasks. These tasks can be performed either by the manufacturer himself or by a notified body (laboratory/testing house). The choice of the *AVCP* system is done by a European Commission legal decision for each family of products with a certain use. Usually, the greater the safety risk on the utilization of the product, the higher the AVCP system (being the 1+ the highest, meaning more demanding since it has more intervention of the notified body).

Therefore, the attribution of these tasks either to the manufacturer or to the notified body are not set in the body of the standard as they are already legally defined in the Annex V of the CPR. In a simplified way, its content is presented in the Figure 8.

Nonetheless, the technical description of these tasks is done in clauses listed in table ZA.3 (the same way is done in ZA.1 for the ´Assessment of performance´).

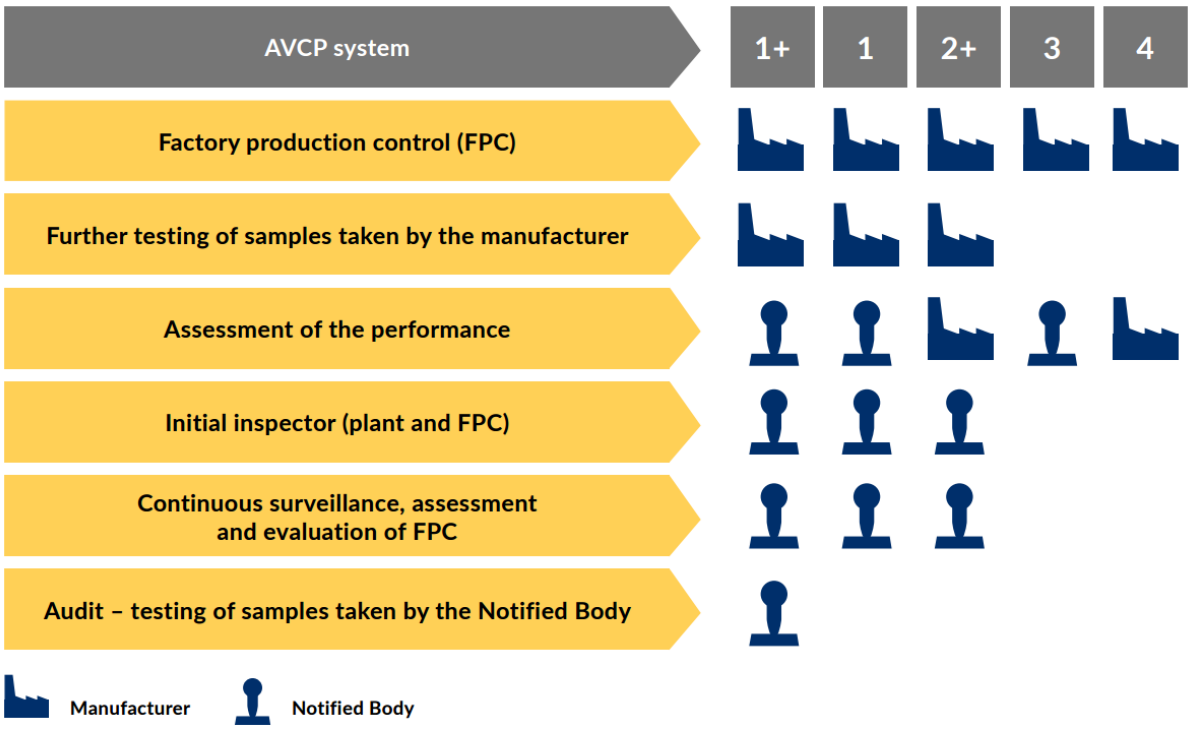


Fig.8 – AVCP systems [35]

These Essential Characteristics are the ones regulated at least in one European Member State and notified in the Technical Regulation Information Systems (*TRIS*). The Commission analyses these legislative projects in the light of EU legislation, avoiding the creation of barriers to trade.

Although, this database is publically available for consultation, it would be extremely burdensome to the manufactures to go through it in order which are the national regulations concerning his product, in particular in relation to which essential characteristics and to what the performance levels to be reached.

The CPR gives the solution to this problem in article 10 (1): ´Member States shall designate Product Contact Points for Construction pursuant to Article 9 of Regulation (EC) No 764/2008´. The preceding recitals give its background, justification and objective:

- ´(42) It is important to ensure the accessibility of national technical rules so that enterprises, and in particular SMEs, can gather reliable and precise information about the law in force in the Member State where they intend to place or make available on the market their products. Member States should therefore designate Product Contact Points for Construction for this purpose. In addition to the tasks defined in Article 10(1) of Regulation (EC) No 764/2008 of the European Parliament and of the Council of 9 July 2008 laying down procedures relating to the application of certain national technical rules to products lawfully marketed in another Member State (1), Product Contact Points for Construction should also provide information on rules applicable to the incorporation, assembling or installation of a specific type of construction product.´
- ´(43) In order to facilitate the free movement of goods, Product Contact Points for Construction should provide, free of charge, information about provisions aimed at fulfilling basic requirements for construction works applicable to the intended use of each construction

product in the territory of each Member State. Product Contact Points for Construction may also provide economic operators with additional information or observations. For additional information, Product Contact Points for Construction should be allowed to charge fees that are proportionate to the costs of providing such information or observations. Member States should furthermore ensure that sufficient resources are allocated to the Product Contact Points for Construction.´

In the Portuguese case, the Product Contact Point for Construction is the following:

- Instituto Português da Qualidade, IPQ, I.P. Departamento de Assuntos Europeus e Sistema Português da Qualidade (DAESPQ)
  Rua António Girão, 2 – 2829-513 Caparica
  +351 212 948 100
  ipq@ipq.pt

This does not mean that the manufacturers will only declare the characteristics for which the relevant Member States have requirements, only reaching the minimum required performance level. They can declare as many as they find necessary, not to fulfil the legal provisions, but to satisfy the buyers/designers demands for products with higher quality (higher declared performances).

2.5. PROGRAMME MANAGER FOR IT&T (INDUSTRY, TECHNOLOGY AND INFRASTRUCTURE)

Programme Managers (*PM*) are responsible for the efficient, timely and cost effective coordination of activities concerned with the development of standards for the construction sector. Programme Managers are a vital link between the Technical Bodies, sector organizations, the European Commission and the European Free Trade Association and other external stakeholders with responsibility for advising upon and coordinating the information flow between these parties, and for facilitating standards development work.

The author, being *PM* for the *IT&T* unit, is responsible for the Construction (partially), Personal Protective Equipment and Materials sectors. Within the Construction sector, he exclusively follows the following sub-sectors:

- Energy performance of buildings (*EPB*);
- Heating, Ventilation and Air Conditioning (*HVAC*).

The communication with the European Commission (in particular with *DG GROW* and *DG ENER*) is also an important task for a *PM*. Besides all the exchange of information needed for the acceptance and fulfilment of an standardization request, the *PM* represents *CEN* or *CENELEC* in the relevant *EC* bodies:

- Advisory Group on Construction Products – It has the task to assist the Commission in issues related to the Construction Products Regulation, including for the preparation of Delegated Acts. All member EU countries are members of this group. CEN and CENELEC participate as observers;
- Standing Committee on Construction – This Committee was created by Article 19 of the Construction Production Directive (*CPD*) [8]. It is made up of representatives appointed by the Member States and chaired by the Commission. Its main task was to examine any question posed by the implementation and the practical implementation of the Directive. This Committee continued to exist even when the *CPR* entered into force on the 1st of July 2013, replacing the *CPD*. Although, its role has changed, it supports the

implementation of this new piece of legislation. CEN and CENELEC participate as observers;

- *CEN*/*BT*/*WG* 102 – *EC*/*CEN* Task Force on Construction – This group was created to speed up the standardization work in the construction. The secretary is held by *CCMC* and the chairman is the sector Rapporteur. The members are the most relevant CEN members (those with holding the secretariats of the Construction *TC*s) and the European Commission (*DG GROW*). This group can advise *CEN* Technical Board on the decisions to be taken.
- Personal Protective Equipment Expert Group - This group is composed by the European Commission (now DG Grow), the Member States and the European stakeholders (being CEN among them). It deals with general policy issues, discusses the practical application of the PPE Directive and advises the Commission on measures to ensure the correct application of the PPE Directive, in particular in what regards Formal Objections. All Members States have the right to challenge the citation of a harmonized standard, if not entirely fulfilling the Directive requirements (usually safety related). This group decides to support or not this objection when it sent to Committee on Standards for final decision.

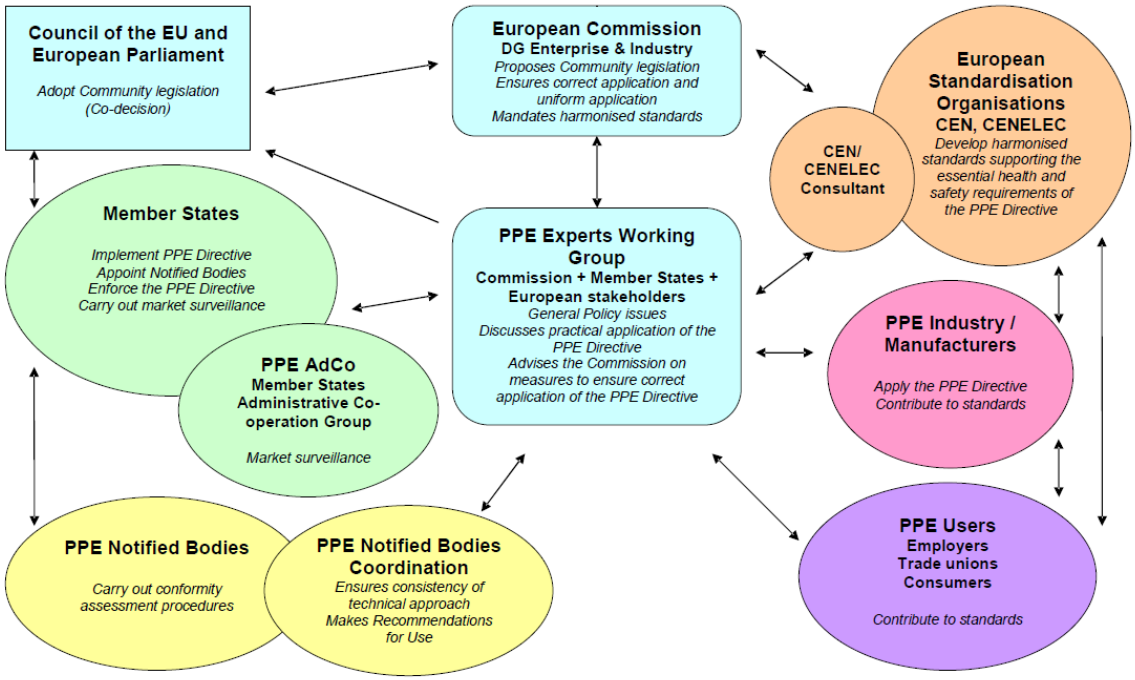


Fig.9 – Organisational scheme for the PPE 89/686/EEC Directive

Consequently, the author has acquired the legal knowledge of the regulations supported by the standardization work:

- Regulation (EU) No 1025/2012 (among other things, establishes rules with regard to the cooperation between European standardization organizations, national standardization bodies, Member States and the Commission) [3];
- Regulation (EU) No 305/2011 – Construction Products Regulation [2];
- Directive 2010/31/EU (recast) – Energy Performance of Buildings [4];
- Directive 2009/125/EC (recast) – Ecodesign requirements for energy-related products [5];

- Directive 89/686/EEC - Personal protective equipment [6].

Moreover, the author gained the understanding of the European Union organization and of the management of funding contracts under the Framework Partnership Agreement signed between the European Commission and CEN.

On top of the general following-up of the standardization programme of the technical committees under the assigned sectors and dealing with their specificities, the author has also taken the secretary role of:

- CEN/CENELEC Coordination Group Light – This Coordination Group was created by a decision taken at both CEN and CENELEC Technical Boards to manage the work and assign tasks under the already accepted standardization requests (mandates):
  - M/485 - Mandate to CEN, CENELEC and ETSI for standardisation in the field of fluorescent lamps, high-intensity discharge lamps, ballasts and luminaires able to operate such lamps;
  - M/495 - Standardisation mandate to CEN, CENELEC et ETSI under Directive 2009/125/EC relating to harmonised standards in the field of Ecodesign;
  - M/519 – Mandate addressed to CEN, CENELEC and ETSI to develop standardisation in the field of light emitting diodes (LEDs).

The members of this group are the secretaries and chairpersons of the Technical Committees involved in the work. The European Commission, Ecofys and *ECOS* participate as observers. The *TC´*s identified on the Terms of Reference are.

- CENELEC/TC 23BX ´Switches, boxes and enclosures for household and similar purposes, plugs and socket outlets for d.c. and for the charging of electrical vehicles including their connectors´;
- CENELEC/TC 34A ´Lamps´;
- CENELEC/TC 34Z ´Luminaires and associated equipment´;
- CEN/TC 169 ´Light and lighting´;
- CEN/TC 247 ´Building Automation, Controls and Building Management´.

- *COCOR* - In the history of European construction, *ECSC* (the European Coal and Steel Community) was the first cornerstone - predating the treaty of Rome. In 1953, Coordinating Commission for the Nomenclature of Iron and Steel Products (*COCOR*) was established and created between its creation and 1986 about 200 reference documents, called Euronorms, most of which served as a basis for the preparation of the existing European Standards in this sector. Since 1986, the standardization of iron and steels products in Europe has been conducted by the European Committee for Iron and Steel Standardization (*ECISS*).
  ECISS is an independent body and an Associated Standards Body of *CEN*. It is linked to *CEN* for administrative and legal purposes. *ECISS* operates according to its own Internal Regulations. It is managed by a Coordinating Commission (*COCOR*) and is serviced by a central secretariat employed by *CEN*, but reporting directly to *COCOR*.
  ECISS aims at producing standards on the definition, classification, testing, analysis and technical delivery requirements of the products of the iron and steel industry. *ECISS* aims to have these standards implemented as national standards by the members.
  ECISS Members come from the national standards bodies of the *EC* and *EFTA* countries, which are also *CEN* members and want to collaborate to *ECISS*. Each *ECISS* member may be represented in *COCOR* by a delegation comprising a maximum of three

delegates: representing their national standards body, their producers and their users. Work items to be included in the work programme may be proposed by *ECISS* and *CEN* members, the *EC*, *EFTA* and other European organizations.

3

ENGICRAFT (2003 – 2005 / 2008 – 2012)

3.1. COMPANY DESCRIPTION

Engicraft is the engineering branch of Focus Group, which has a multidisciplinary team composed by architects, engineers, urban planners and landscapers and a wide experience in health, education, justice, sports, tourism, housing, offices and spatial planning projects (see figure 10). Engicraft, which was initially NMAB, is currently dealing only with the hydraulics discipline, although it also developed structural design projects in a more consistent way for a short period mainly in 2012 and 2013.

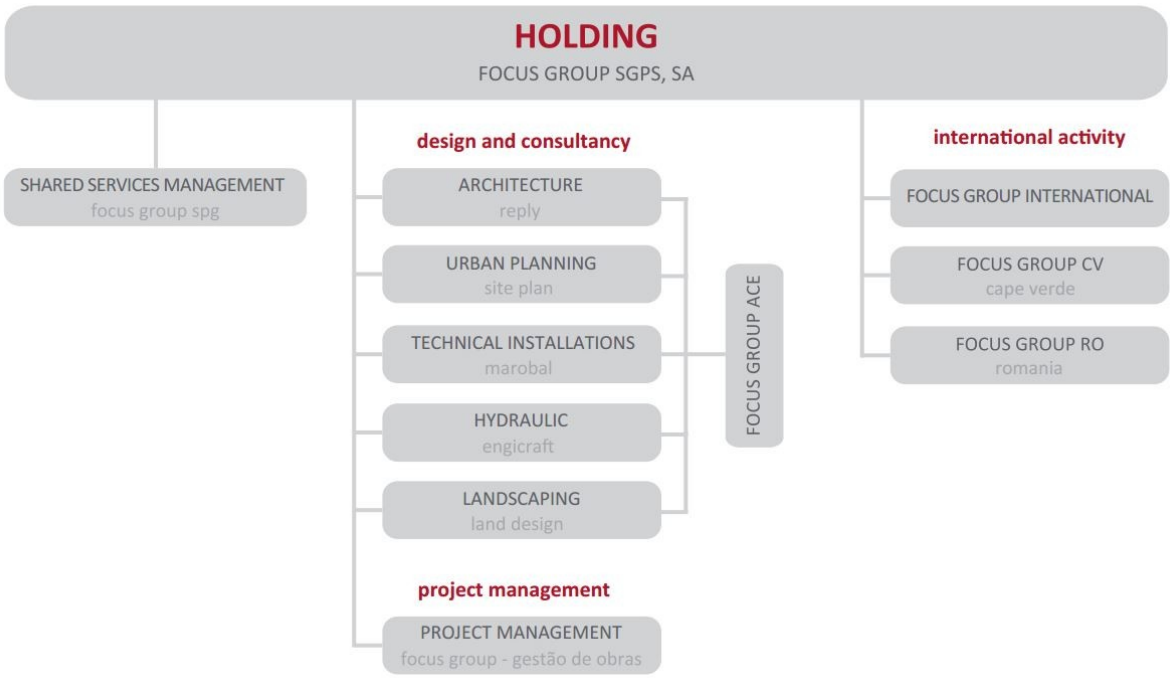


Fig.10 – "Focus Group SGPS, SA" structure

3.2. DESIGN ENGINEER

3.2.1. ROLE DESCRIPTION

In Engicraft, the author worked as Design Engineer, mainly in hydraulics and gas supply projects. Being a chartered engineer recognized by the national engineers association (Ordem dos Engenheiros) and a certified design engineer by *ITG*, he assumed the technical responsibility of some of the projects he collaborated in.

His task did not end in the fulfilment of the technical tasks, such as the technical conception, the calculation or the drafting of building documents such as plants and details. Due to the fact that Engicraft is fully integrated in a wider enterprise (Focus Group) developing several disciplines in a "one stop solution", he took for himself the management and coordination of some projects. In order to assist not only the management but also the design, he developed computer tools in Microsoft Excel and Visual Basic (described under 3.2.2). In particular, these tools were the basis for the calculation done in most of projects referenced in this professional activity report.

The role of a Design Engineer goes beyond the office door. During the development phase, it is necessary to deal with bureaucratic burden that is to achieve project approval and permits emissions in the public, sectorial or regional authorities such as *EPAL*, *ITG* and municipal technical services. Most of these approvals override the national regulations in place like the one setting the rules for the water supply and drainage [9]. This forces the designer to be aware of these specificities to include them. Some examples of these additional provisions can be found in the following documents:

- "Regulamento para o Serviço de Abastecimento de Água pela EPAL - Empresa Portuguesa das Águas Livres, S.A.e Legislação Diversa" – *EPAL* regulation for the approval of water supply systems in Lisbon;
- "Regulamento Geral das Canalizações de Esgoto da Cidade de Lisboa - Edital n. 145/60" – Wastewater Drainage Pipework Regulation of the city of Lisbon;
- "Manual de Especificações Técnicas da *EDP* - gás distribuição" – Technical specifications applications to all gas networks to be supplied by "Energias de Portugal" (*EDP*).

Other provisions are not clearer defined as it is in the case of the fixed firefighting systems approval by the firefighting unit in Lisbon. For more sensitive situations, the approval the project is discussed during a meeting. Several matters are discussed, in particular the suitability of the solutions (e.g. solution by wet or dry systems), the accesses to the building by the fire-fighters and to the equipments and the appropriateness of the fire-fighters resources to equipment foreseen (e.g. types and dimensions of the hoses).

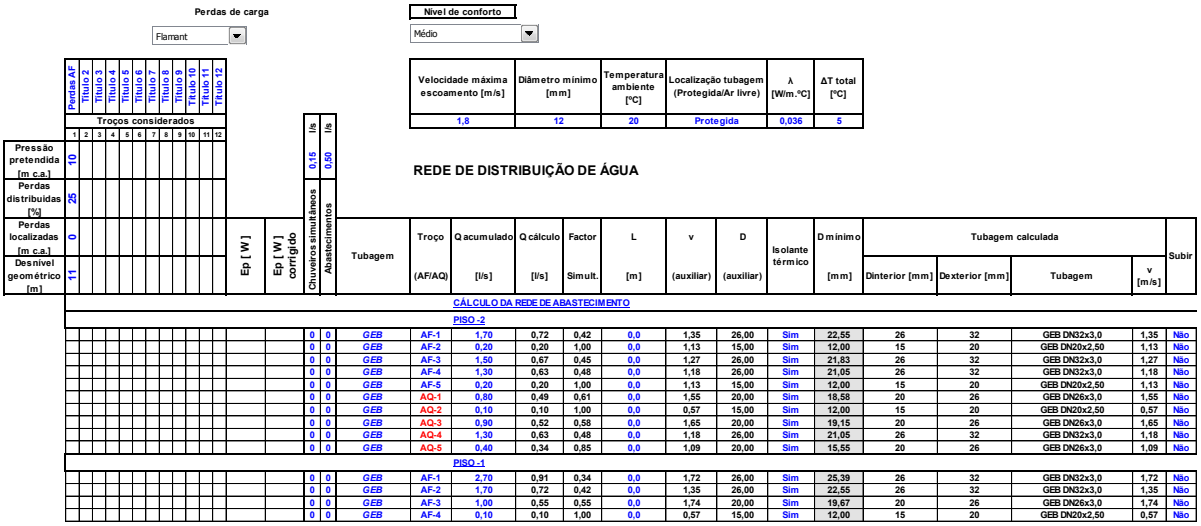
After all disciplines approved, the engineer journey tasks are not yet concluded as the monitoring of construction works is needed, not only the clarify design doubts but also to guarantee its correct execution.

3.2.2. CALCULATION TOOLS

As pointed out previously, the development of the projects referenced in this report were supported by IT tools developed by the author. This goes beyond the conventional spread sheet as it required programming skills. The most relevant ones are described in the following points.

- **Water Supply calculation for buildings**

In order to optimize the water supply calculation for buildings, the author developed an excel tool. The data introduction sheet can be found below (figure 11). This tool was revised and improved for years in order to accommodate all the needs that did come up during the development of the projects.



Perdas de carga: Flamant

Nível de conforto: Médio

Velocidade máxima escoamento [m/s]	Diâmetro mínimo [mm]	Temperatura ambiente [ºC]	Localização tubagem (Protegida/Ar livre)	λ [W/m.ºC]	ΔT total [ºC]
1,8	12	20	Protegida	0,036	5

REDE DE DISTRIBUIÇÃO DE ÁGUA

Pressão pretendida [m c.a.]	10
Perdas distribuidas [%]	25
Perdas localizadas [m c.a.]	0
Desnível geométrico [m]	11

Troços considerados: 1 2 3 4 5 6 7 8 9 10 11 12

Perdas AF | Título 2 | Título 3 | Título 4 | Título 5 | Título 6 | Título 7 | Título 8 | Título 9 | Título 10 | Título 11 | Título 12

Ep [W]	Ep [W] corrigido	l/s Chuveiros simultâneos	l/s Abastecimentos	Tubagem	Troço (AF/AQ)	Q acumulado [l/s]	Q cálculo [l/s]	Factor Simult.	L [m]	v (auxiliar)	D (auxiliar)	Isolante térmico	D mínimo [mm]	Tubagem calculada: Dinterior [mm]	Dexterior [mm]	Tubagem	v [m/s]	Subir
CÁLCULO DA REDE DE ABASTECIMENTO																		
PISO -2																		
		0	0	GEB	AF-1	1,70	0,72	0,42	0,0	1,35	26,00	Sim	22,55	26	32	GEB DN32x3,0	1,35	Não
		0	0	GEB	AF-2	0,20	0,20	1,00	0,0	1,13	15,00	Sim	12,00	15	20	GEB DN20x2,50	1,13	Não
		0	0	GEB	AF-3	1,50	0,67	0,45	0,0	1,27	26,00	Sim	21,83	26	32	GEB DN32x3,0	1,27	Não
		0	0	GEB	AF-4	1,30	0,63	0,48	0,0	1,18	26,00	Sim	21,05	26	32	GEB DN32x3,0	1,18	Não
		0	0	GEB	AF-5	0,20	0,20	1,00	0,0	1,13	15,00	Sim	12,00	15	20	GEB DN20x2,50	1,13	Não
		0	0	GEB	AQ-1	0,80	0,49	0,61	0,0	1,55	20,00	Sim	18,58	20	26	GEB DN26x3,0	1,55	Não
		0	0	GEB	AQ-2	0,10	0,10	1,00	0,0	0,57	15,00	Sim	12,00	15	20	GEB DN20x2,50	0,57	Não
		0	0	GEB	AQ-3	0,90	0,52	0,58	0,0	1,65	20,00	Sim	19,15	20	26	GEB DN26x3,0	1,65	Não
		0	0	GEB	AQ-4	1,30	0,63	0,48	0,0	1,18	26,00	Sim	21,05	26	32	GEB DN32x3,0	1,18	Não
		0	0	GEB	AQ-5	0,40	0,34	0,85	0,0	1,09	20,00	Sim	15,55	20	26	GEB DN26x3,0	1,09	Não
PISO -1																		
		0	0	GEB	AF-1	2,70	0,91	0,34	0,0	1,72	26,00	Sim	25,39	26	32	GEB DN32x3,0	1,72	Não
		0	0	GEB	AF-2	1,70	0,72	0,42	0,0	1,35	26,00	Sim	22,55	26	32	GEB DN32x3,0	1,35	Não
		0	0	GEB	AF-3	1,00	0,55	0,55	0,0	1,74	20,00	Sim	19,67	20	26	GEB DN26x3,0	1,74	Não
		0	0	GEB	AF-4	0,10	0,10	1,00	0,0	0,57	15,00	Sim	12,00	15	20	GEB DN20x2,50	0,57	Não

Fig.11 – Data introduction spreadsheet (Water Supply)

In this spreadsheet, all the necessary information is introduced by the user in the blues cells (or red, if the considered section belongs to the hot water network). The user can also introduce information using the dropdown buttons available. The complete list of inputs that have to be introduced is:

- The formula to be used in the pressure loss, where two options are given: Flamant or Colebrook-White. Although the first one is usually the most used and widely accepted in Portugal, the second one is more precise and can be useful in some particular cases. This possibility allows the comparison both methods by simply changing the formula in a dropdown button. Usually the Colebrook-White calculation leads to bigger head losses.
- The selection of the comfort level according to the Portuguese Regulation [9], which affects the simultaneity factor. Usually the curve for medium utilization is used but exceptions are possible. In particular the curve for high utilization is used in the calculation of hotels (high probability of simultaneous utilizations of the pumbling fixtures) and the curve for low utilization is used when the economic factor is one of the priorities (e.g. low cost housing).
- The threshold value for the maximum speed [m/s] allowed in the entire system. According to the regulation, it should not exceed 2 m/s. Nevertheless, this design criterion can be changed. A reduction in the speed will surely increase the pipework diameters, but also extend the durability of the network and prevent vibration noises (mainly in metallic pipes).
- The minimum pipework diameter to be used in the calculation. The reduction of the section in the end part of the pipe is not always the most economic solution because this will need the utilization of a reduction fixture (which is usually more expensive than the pipe as such) and extra work that otherwise would not be needed.
- The constants to be used in the temperature loss calculation: the design exterior temperature [ºC]; the pipework installation (inside/outside the wall); the thermal conductivity [W/m.ºC] of the insulation material (if any) and maximum temperature loss allowed in the entire network

[ºC]. With this information, it is possible to approximately foresee the energy loss in the system and calculate the flow rate in the recirculation system to compensate it.

- Definition of the several routes for the head loss calculation through the following data: final pressure; percentage to be considered for pressure loss in fixtures; singular pressure losses to be considered (e.g. in the water meter); maximum height variation and the identification of all design branchs.
- The definition of type of pipe to be used in each of the design branchs (from a dropdown button). This includes the most used systems and brands of pipework used in the market. Based on the selection made, the values used in the calculation (diameters, roughness factor, the coefficient of thermal expansion, etc) will be the ones listed in the database (see figure 12).

	Dimensões (mm)			Diâmetro Nominal (mm)	Designação	Factor rugosidade b (Fórmula de Flamant)	Coeficiente "C"	Coeficiente de dilatação linear x 10^-5[m/m.ºC]	K (Rugosidade absoluta) [m]
	Exterior	Espessura	Interior						
GEB Geberit Mepla (Tubagem Tricomposta)	16	2,25	11,5	12	GEB DN16x2,25	0,000134	33	2,6	0,000003
	20	2,5	15	15	GEB DN20x2,50	0,000134	33	2,6	0,000003
	26	3	20	20	GEB DN26x3,0	0,000134	33	2,6	0,000003
	32	3	26	25	GEB DN32x3,0	0,000134	33	2,6	0,000003
	40	3,5	33	32	GEB DN40x3,5	0,000134	33	2,6	0,000003
	50	4	42	40	GEB DN50x4,0	0,000134	33	2,6	0,000003
	63	4,5	54	50	GEB DN63x4,5	0,000134	33	2,6	0,000003
	75	4,7	65,6	65	GEB DN75x4,7	0,000134	33	2,6	0,000003
UNIPIPE UNIPIPE da Uponor (Tubagem Tricomposta)	16	2	12	12	UNIPIPE DN16x2,0	0,000134	33	2,5	0,000003
	18	2	14	15	UNIPIPE DN18x2,0	0,000134	33	2,5	0,000003
	20	2,25	15,5	15	UNIPIPE DN20x2,25	0,000134	33	2,5	0,000003
	25	2,5	20	20	UNIPIPE DN25x2,50	0,000134	33	2,5	0,000003
	32	3	26	25	UNIPIPE DN32x3,0	0,000134	33	2,5	0,000003
	40	4	32	32	UNIPIPE DN40x4,0	0,000134	33	2,5	0,000003
	50	4,5	41	40	UNIPIPE DN50x4,5	0,000134	33	2,5	0,000003
	63	6	51	50	UNIPIPE DN63x6,0	0,000134	33	2,5	0,000003
	75	7,5	60	60	UNIPIPE DN75x7,5	0,000134	33	2,5	0,000003
	90	8,5	73	75	UNIPIPE DN90x8,5	0,000134	33	2,5	0,000003
	110	10	90	90	UNIPIPE DN110x10	0,000134	33	2,5	0,000003
PEX Polietileno Reticulado da Wirsbo-PEX da UPONOR	12	1,7	8,6	8	PEX DN 12x1,7	0,000134	12	20	0,000003
	16	1,8	12,4	12	PEX DN 16x1,8	0,000134	12	20	0,000003
	20	1,9	16,2	15	PEX DN 20x1,9	0,000134	12	20	0,000003
	25	2,3	20,4	20	PEX DN 25x2,3	0,000134	12	20	0,000003
	32	2,9	26,2	25	PEX DN 32x2,9	0,000134	12	20	0,000003
	40	3,7	32,6	32	PEX DN 40x3,7	0,000134	12	20	0,000003
	50	4,6	40,8	40	PEX DN 50x4,6	0,000134	12	20	0,000003
	63	5,8	51,4	50	PEX DN 63x5,8	0,000134	12	20	0,000003
	75	6,8	61,4	65	PEX DN 75x6,8	0,000134	12	20	0,000003
	90	8,2	73,6	75	PEX DN 90x8,2	0,000134	12	20	0,000003
	110	10	90	90	PEX DN 110x10	0,000134	12	20	0,000003

Fig.12 – Water Supply pipework database (small extract)

- The accumulated rate flow of each design branch, which is the sum of all the individual plumbing fixtures flow rates supplied by that specific pipe.
- The length of each design branch. This will be used for head loss and recirculation network calculation. On top of that, the total lengths of the pipes (for each diameter) can be extracted automatically to be included in the bill of quantities
- The existence or not of thermal insulation (fundamental for the energy loss calculation).

Then, the tool either automatically calculates the other cells (as any other "normal" spreadsheet) or generates a table or file (programming using macros needed). The most important automatically outputs given by the tool are presented below:

- The Water Supply network calculation output, which puts together in a table all the information needed to be presented (see figure 13). The information on the flow speed, although is not necessary for the installer, is checked by the authorities responsible for the

project approval and therefore needs to be listed. This table is usually added to the project as an annex.

DIMENSIONAMENTO DA REDE DE DISTRIBUIÇÃO DE ÁGUA

Troço	Q acumulado [l/s]	Q cálculo [l/s]	Factor Simultaneidade	Tubagem calculada	Velocidade [m/s]
CÁLCULO DA REDE DE ABASTECIMENTO					
PISO -2					
AF-1	1,70	0,72	0,42	GEB DN32x3,0	1,35
AF-2	0,20	0,20	1,00	GEB DN20x2,50	1,13
AF-3	1,50	0,67	0,45	GEB DN32x3,0	1,27
AF-4	1,30	0,63	0,48	GEB DN32x3,0	1,18
AF-5	0,20	0,20	1,00	GEB DN20x2,50	1,13
AQ-1	0,80	0,49	0,61	GEB DN26x3,0	1,55
AQ-2	0,10	0,10	1,00	GEB DN20x2,50	0,57
AQ-3	0,90	0,52	0,58	GEB DN26x3,0	1,65
AQ-4	1,30	0,63	0,48	GEB DN32x3,0	1,18
AQ-5	0,40	0,34	0,85	GEB DN26x3,0	1,09
PISO -1					
AF-1	2,70	0,91	0,34	GEB DN32x3,0	1,72
AF-2	1,70	0,72	0,42	GEB DN32x3,0	1,35
AF-3	1,00	0,55	0,55	GEB DN26x3,0	1,74
AF-4	0,10	0,10	1,00	GEB DN20x2,50	0,57
AF-5	0,45	0,36	0,81	GEB DN26x3,0	1,16
AF-6	0,45	0,36	0,81	GEB DN26x3,0	1,16
AQ-2	0,80	0,49	0,61	GEB DN26x3,0	1,55
AQ-3	0,80	0,49	0,61	GEB DN26x3,0	1,55
AQ-4	0,10	0,10	1,00	GEB DN20x2,50	0,57
AQ-5	0,35	0,32	0,91	GEB DN26x3,0	1,02
AQ-6	0,35	0,32	0,91	GEB DN26x3,0	1,02

Fig.13 – Water Supply network calculation output

- As written previously, as soon as the design data is inserted, it is possible to extract all the total lengths of the different types of pipes used (see figure 14). This information is then used in the drafting of the bill of quantities.

MEDIÇÃO DAS TUBAGENS CALCULADAS

Tubagem	L [m]
ÁGUA FRIA	
COPRAX PN20 DN40	78,00
COPRAX PN20 DN32	71,50
COPRAX PN20 DN25	48,50
COPRAX PN20 DN50	7,50
COPRAX PN20 DN63	15,50
ÁGUA QUENTE	
COPRAX PN20 DN40	53,00
COPRAX PN20 DN32	99,50
COPRAX PN20 DN25	48,50
COPRAX PN20 DN50	4,50
COPRAX PN20 DN63	15,50
ÁGUA QUENTE DE RETORNO	
COPRAX PN20 DN25	138,50

Fig.14 – Pipework total length output

- This tool does not automatically identify the route with the biggest head loss. The user has to define several hypothesis (usually less than three is enough) of route configuration and test them. It is possible to run the tool for each one of these and the outputs will have the configuration presented in Figure 15. It is then possible to know whether the pressure given by the public network is enough. If not, it will have to be guaranteed by a pumping system.

CÁLCULO DAS PERDAS DE CARGA

Pressão pretendida [m c.a.]	10
Factor para perdas localizadas [%]	25
Desnível geométrico [m]	11

Altura manométrica necessária [m c.a.]:
26,26

Percurso mais desfavorável	1			
Troço	Tubagem calculada	J [m/m]	L [m]	ΔH [m]
AF-0	PEAD PN10 DN63	0,059	5,0	0,29
AF-1	GEB DN32x3,0	0,083	19,5	1,61
AF-1	GEB DN32x3,0	0,083	4,8	0,40
AF-4	GEB DN32x3,0	0,061	4,2	0,26
AF-5	GEB DN26x3,0	0,145	4,2	0,61
AQ-2	GEB DN26x3,0	0,073	4,5	0,33
AQ-4	GEB DN26x3,0	0,073	3,7	0,27
AQ-5	GEB DN26x3,0	0,110	4,0	0,44
			TOTAL [m]	4,20

Fig.15 – Pressure losses output

The design of a pumping system is done using a different excel spreadsheet, specific for that purpose, although it uses the same database for the several types of pipes (see figure 16).

The particularity of this sheet is not in the calculation of the pumping system as such but in the functionality to generate the list the respective list of fixtures (curves, reductions, valves, etc) needed for the installation based on the pipework diameters calculated. This is then included in the bill of contents.

Gerar medições

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CÁLCULO DAS CENTRAIS DE BOMBAGEM

			Célula [m]																			
Designação	Q [l/s]	Tubagem	a	b	h	Descarga	$Q_{adução}$ [l/s]	$Q_{descarga}$ [l/s]	Adução	Células	Acessórios	Aspiração	Acessórios	Colectores	Acessórios	Compressão	Acessórios	Camião	Tropiein (10 cm)	Caleira (20 cm
Água consumo	27	AI (F)	3,00	15,00	2,50	FF DN40	7,81	14,07	AI DN80 (F)	AI DN50 (F)	FF DN65	AI DN200 (F)	FF DN200	AÇO DN300	FF DN300	AI DN150 (F)	FF DN200	FF DN100	AI DN100 (F)	FF DN125

Medição dos acessórios e equipamentos

1) Abastecimento às células

2 x Válvula de flutuador FF DN65

2 x Válvula de retenção FF DN65

2 x Válvula de seccionamento FF DN65

2 x Passa-muros AI DN50 (F)

2 x Protecção à valvula de flutuador em PVC DN315

2) Abastecimento às células por camião (opcional)

2 x Válvula de seccionamento FF DN100

2 x Passa-muros AI DN100 (F)

2 x Curva de 90º AI DN100 (F)

3) Aspiração do reservatório

2 x Válvula de aspiração FF DN200

Fig.16 – Water Supply pump calculation (including pipework and fittings)

- **Wastewater and rainwater drainage calculation**

The tool for the wastewater and rainwater calculations follows a similar approach to the one used for the water supply tools. This means all the calculation are based in a database with all the important characteristics for the most used drainage pipes in the market (see figure 17). The new pipework types have been added every time its need came up during the development of a project.

		Dimensões (mm)			Diâmetro Nominal	Designação	K $[m^{1/3}s^{-1}]$
		Exterior	Espessura	Interior			
PP SN8	Popipropileno corrugado SN8 da Gama AMBIDUR da POLITEJO	125	8,2	108,6	125	PP SN8 DN125	120
		160	10,2	139,6	160	PP SN8 DN160	120
		200	12,8	174,4	200	PP SN8 DN200	120
		250	15,8	218,4	250	PP SN8 DN250	120
		315	20,1	274,8	315	PP SN8 DN315	120
		400	25,7	348,6	400	PP SN8 DN400	120
		500	31,4	437,2	500	PP SN8 DN500	120
		630	40,3	549,4	630	PP SN8 DN630	120
		800	53,7	692,6	800	PP SN8 DN800	120
BETÃO	Manilhas em Betão com união elástica da Borondo (2,4 m de comprimento)	396	48	300	300	BETÃO DN300	90
		510	55	400	400	BETÃO DN400	90
		650	75	500	500	BETÃO DN500	90
		760	80	600	600	BETÃO DN600	90
		990	95	800	800	BETÃO DN800	90
		1220	110	1000	1000	BETÃO DN1000	90
		1450	125	1200	1200	BETÃO DN1200	90
		1720	160	1400	1400	BETÃO DN1400	90
		1800	150	1500	1500	BETÃO DN1500	90
		2160	180	1800	1800	BETÃO DN1800	90
		2300	150	2000	2000	BETÃO DN2000	90
		2860	180	2500	2500	BETÃO DN2500	90
		3600	300	3000	3000	BETÃO DN3000	90
PVC SN4	PVC SN4 da gama POLIDOM da POLITEJO	-	-	0	-	-	-
		32	1,8	28,4	32	PVC SN4 DN32	120
		40	1,8	36,4	40	PVC SN4 DN40	120
		50	1,8	46,4	50	PVC SN4 DN50	120
		63	1,8	59,4	63	PVC SN4 DN63	120
		75	1,8	71,4	75	PVC SN4 DN75	120
		90	1,8	86,4	90	PVC SN4 DN90	120
		110	2,2	105,6	110	PVC SN4 DN110	120
		125	2,5	120	125	PVC SN4 DN125	120

Fig.17 – Drainage pipework database (small extract)

Another similarity with the water supply tool is the existence of the functionally to export the calculated data in already formatted tables that can be directly added to the project as annexes. The Figure 18 shows an example of one outputs generated. In this case, it gives the necessary information on the domestic wastewater drainage collectors.

DRENAGEM DAS ÁGUAS RESIDUAIS DOMÉSTICAS

COLECTORES													
Tipo de esgoto	Troço	Qacumulado [l/min]	Coef. Simult.	$Q_{cálculo}$ [l/min]	K [$m^{1/3}s^{-1}$]	i [m/m]	Tubagem	$D_{interior}$ [m]	v [m/s]	θ [rad]	h útil [m]	Raio hidr. [m]	$\tau=\gamma Ri$ [N/m^2]
PISO													
Doméstico	1	510	0,40	206	120	0,020	PP SN8 DN125	0,109	1,23	2,47	0,036	0,020	4,2
Doméstico	2	510	0,40	206	120	0,020	PP SN8 DN125	0,109	1,23	2,47	0,036	0,020	4,2
Doméstico	3	210	0,61	129	120	0,020	PP SN8 DN125	0,109	1,13	2,15	0,029	0,017	3,4
Doméstico	4	120	0,80	96	120	0,020	PVC SN4 DN75	0,071	1,14	2,76	0,029	0,015	3,2
Doméstico	5	90	0,91	82	120	0,020	PVC SN4 DN75	0,071	1,11	2,63	0,027	0,014	3,0
CAVE													
Doméstico	1	1110	0,28	312	120	0,020	PP SN8 DN125	0,109	1,32	2,81	0,045	0,024	4,9
Doméstico	2	1110	0,28	312	120	0,020	PP SN8 DN125	0,109	1,32	2,81	0,045	0,024	4,9
Doméstico	3	510	0,40	206	120	0,020	PP SN8 DN125	0,109	1,23	2,47	0,036	0,020	4,2
Doméstico	4	600	0,37	225	120	0,020	PP SN8 DN125	0,109	1,25	2,54	0,038	0,021	4,3
Doméstico	5	600	0,37	225	120	0,015	PVC SN6 DN110	0,104	1,12	2,76	0,042	0,022	3,5
Doméstico	6	120	0,80	96	120	0,015	PVC SN4 DN75	0,071	1,01	2,89	0,031	0,016	2,5
Doméstico	7	480	0,42	200	120	0,015	PVC SN6 DN110	0,104	1,10	2,66	0,039	0,021	3,3
Doméstico	8	360	0,48	172	120	0,015	PVC SN6 DN110	0,104	1,07	2,53	0,036	0,020	3,1

Fig.18 – Drainage network calculation output

The calculation is different for stacks and collectors and for wastewater and rainwater drainage, due of technical and legal requirements. Therefore, there are several spreadsheets for the introduction of data. The input is different in the four possible combinations as it is described below.

The inputs for the Domestic Wastewater collectors and branches calculation are (see figure 19):

- The pipe filling rate. The Portuguese Regulation [9] defines that the wastewater shall only occupy half of the pipe (3/4 if the diameter is higher than 200 mm).
- The units for the accumulated flow rate. For calculation of internal networks the unit is used is litres per minute [l/min] as it is the sum of the individual plumbing fixtures flow rate. When the calculation is done for a system exterior to the building (usually public), the flow rate is calculated on a basis of a prevision of the habitants to be served. The tools automatically adapts the calculation when this option is changed.
- The selection of the simultaneity curve. The tool foresees a especial profile to be used in hotels.
- The selection on the type of effluent (domestic or greasy). This will not affect the density (though grease is less dense than the average wastewater) but will change the minimum design shear stress to be considered in the calculation. Usually, sewer pipes can be considered self-cleansing if a shear stress value of 2 N/m^2 is attained when the pipe is flowing half full. For pipes transporting wastewater with a great content of grease, this value has to be increased because the risk of deposition is higher.
- The selection of the pipework material and system according to the database (Figure 17).
- The accumulated rate flow of each design branch, which is the sum of all the individual plumbing fixtures flow rates supplied by that specific pipe.
- The pipe slope.

DIMENSIONAMENTO DOS COLECTORES DE ÁGUAS RESIDUAIS DOMÉSTICAS

Entrada de dados: Caudal acumulado

Tipo de escoamento: 1/2 ou 3/4 Secção — Formatação: Activa

Curva: Normal

Tipo de esgoto	Material da tubagem	Troço	Qacumulado [l/min]	Qcálculo [l/min]	Caudal [m³/s]	Coef. Simult.	K [m^1/3 s^-1]	i [m/m]	Tubagem	D interior [m]	v [m/s]	θ [rad]	h útil [m]	Raio hidráulico [m]	τ=γRi [N/m²]	Tubagem (Vent.)	Secção usada no cálculo	D mínimo [m]
PISO																		
Doméstico	PP SN8	1	510	206	0,00344	0,4	120	0,020	PP SN8 DN125	0,109	1,23	2,47	0,036	0,020	4,2	PP SN8 DN125	1/2 Secção	0,083
Doméstico	PP SN8	2	510	206	0,00344	0,40	120	0,020	PP SN8 DN125	0,109	1,23	2,47	0,036	0,020	4,2	PP SN8 DN125	1/2 Secção	0,083
Doméstico	PP SN8	3	210	129	0,00215	0,61	120	0,020	PP SN8 DN125	0,109	1,13	2,15	0,029	0,017	3,4	PP SN8 DN125	1/2 Secção	0,069
Doméstico	PVC SN4	4	120	96	0,00160	0,80	120	0,020	PVC SN4 DN75	0,071	1,14	2,76	0,029	0,015	3,2	PVC SN4 DN50	1/2 Secção	0,062
Doméstico	PVC SN4	5	90	82	0,00137	0,91	120	0,020	PVC SN4 DN75	0,071	1,11	2,63	0,027	0,014	3,0	PVC SN4 DN50	-	0,062
CAVE																		
Doméstico	PP SN8	1	1110	312	0,00520	0,3	120	0,020	PP SN8 DN125	0,109	1,32	2,81	0,045	0,024	4,9	PP SN8 DN125	1/2 Secção	0,097
Doméstico	PP SN8	2	1110	312	0,00520	0,28	120	0,020	PP SN8 DN125	0,109	1,32	2,81	0,045	0,024	4,9	PP SN8 DN125	1/2 Secção	0,097
Doméstico	PP SN8	3	510	206	0,00344	0,40	120	0,020	PP SN8 DN125	0,109	1,23	2,47	0,036	0,020	4,2	PP SN8 DN125	1/2 Secção	0,083
Doméstico	PP SN8	4	600	225	0,00375	0,37	120	0,020	PP SN8 DN125	0,109	1,25	2,54	0,038	0,021	4,3	PP SN8 DN125	1/2 Secção	0,085
Doméstico	PVC SN6	5	600	225	0,00375	0,37	120	0,015	PVC SN6 DN110	0,104	1,12	2,76	0,042	0,022	3,5	PVC SN6 DN75	1/2 Secção	0,090
Doméstico	PVC SN4	6	120	96	0,00160	0,80	120	0,015	PVC SN4 DN75	0,071	1,01	2,89	0,031	0,016	2,5	PVC SN4 DN50	1/2 Secção	0,066
Doméstico	PVC SN6	7	480	200	0,00333	0,42	120	0,015	PVC SN6 DN110	0,104	1,10	2,66	0,039	0,021	3,3	PVC SN6 DN63	1/2 Secção	0,086
Doméstico	PVC SN6	8	360	172	0,00286	0,48	120	0,015	PVC SN6 DN110	0,104	1,07	2,53	0,036	0,020	3,1	PVC SN6 DN63	-	0,086

Fig.19 – Data introduction spreadsheet (Domestic Wastewater collectors and branches)

The inputs for the Domestic Wastewater and Ventilation stacks calculation (see figure 20) do not differ much from those used for the collectors and branches. Obviously, the following calculation process is different, even more because of the possible use of ventilation stacks. The consideration secondary ventilation reduces significantly the diameters of the main discharge stacks.

DIMENSIONAMENTO DOS TUBOS DE QUEDA DOMÉSTICOS

Nº pisos: 8
Pé direito: 3
Formatação: Activa

Ventilação - Qar [l/min]

Prumada	Material	Qacumulado [l/min]	Coef. Simult.	Qcálculo [l/min]	Tubagem s/ ventilação secundária	Taxa de ocupação	Tubagem c/ ventilação secundária	Ventilação secundária	Considerar ventilação?	Tubagem s/ ventilação Dmin[mm]	Tubagem c/ ventilação Dmin[mm]	Nº pisos	L [m]	Q total	Q para ventilação secundária
EDIFÍCIO DE ESCRITÓRIOS															
D1	PP GEB	2240	0,2	452	-	0,143	PP DN110	PP DN75	Sim	148	87	8	24	4071	2714
D2	PP GEB	2960	0,2	524	-	0,143	PP DN110	PP DN90	Sim	156	92	8	24	4720	3147
D3	PP GEB	1440	0,2	358	-	0,167	PP DN90	PP DN75	Sim	123	80	8	24	2684	1789
D4	PP GEB	1530	0,2	370	-	0,167	PP DN90	PP DN75	Sim	124	81	8	24	2772	1848

DIMENSIONAMENTO DE COLUNAS DE VENTILAÇÃO

Coluna	Material	Qcálculo [l/min]	Tubagem	Nº pisos	L [m]	Dmínimo[mm]
V1	PP GEB	4071	PP DN90	2	6	83
PISO 3						
V2	PP GEB	4720	-	8	24	114
V3	PP GEB	8791	-	2	6	111

Fig.20 – Data introduction spreadsheet (Domestic Wastewater and Ventilation stacks)

The spreadsheet for the rainwater collectors (see figure 21), in terms of inputs, only differs from its equivalent for domestic wastewater because there is no column for accumulated from rate [l/m]. Instead, the total area to be drained is inserted. Considering the design rain intensity, the tool automatically calculates the flow rate.

DIMENSIONAMENTO DE COLECTORES PLUVIAIS

Material	Troço	Área [m²]	Qcálculo [l/min]	i [m/m]	Tubagem	D interior [m]	K [m^1/3 s^-1]	v [m/s]	θ [rad]		h útil [m]	R hidráulico [m]	τ=γRi [N/m²]
PVC SN6	POÇO	6453	13551	0,010	PVC SN6 DN400	0,376	120	1,53	3,91	1	0,259	0,111	10,9
PVC SN6	POÇO / 2	3226	6775	0,010	PVC SN6 DN315	0,297	120	1,42	3,79	1	0,196	0,086	8,4
PVC SN6	POÇO / 4	1613	3388	0,010	PVC SN6 DN250	0,235	120	1,31	3,65	1	0,147	0,067	6,5
PVC SN6	POÇO / 8	807	1694	0,010	PVC SN6 DN200	0,188	120	1,21	3,49	1	0,110	0,052	5,1
PVC SN6	POÇO / 16	403	847	0,010	PVC SN6 DN140	0,132	120	1,08	3,97	1	0,092	0,039	3,8

Fig.21 – Data introduction spreadsheet (Rainwater collectors)

Finally, the data introduction spreadsheet for rainwater stacks (see figure 22) also needs the data regarding the total area to be drained by each one of them. The particularity here is that, since the calculation is made considering that the system behaves as a discharge from an orifice, it important to consider the effect of the pressure (or head). This means that the bigger the width of water above the stack, the bigger the discharge flow will be. Of course that, for structural safety reasons and to avoid infiltrations, a big volume of water should not be allowed on the roof. On the other hand, rainwater stacks should never have a diameter inferior to 50 mm because it would then be easily clogged by leaves or dirt. Usually, a reasonable design water width varies between 30 and 40 mm.

This spreadsheet also allows open-channel flow calculation (in opposition to the previous pipe flow). This is useful as the there is the interaction between the channels and the stacks (the rainwater flow is transported by the channels and discharged into the stacks). The tool gives the possibility to select the geometry of the channel (half circular, rectangular, etc).

DIMENSIONAMENTO DE TUBOS DE QUEDA PLUVIAIS

Caleira rectangular				
Inc. [%]	Largura [m]	Altura caleira[m]	Altura lâmina líquida [m]	Q [l/min]
0,5	0,16	0,16	0,112	1183

Caleira meia cana		
Inc. [%]	Ø [m]	Q [l/min]
0,5	0,10	244

Caleira considerada: Caleira meia cana

Intensidade de precipitação
2,10
K [$m^{1/3}/s$]
120

Saída Lateral			
l [m]	Dinterior [m]	Altura [m]	Q [l/min]
0,15	0,05	0,03	65,97

Material	Nº Tubos	Área [m^2]	Altura lâmina líquida [m]	Qcálculo [l/s]	Tubagem	$D_{mínimo}$[mm]
EDIFÍCIO DE ESCRITÓRIOS						
FF	P1	55	0,035	1,93	FF DN70	50
FF	P2	55	0,035	1,93	FF DN70	50
EDIFÍCIO DE HABITAÇÃO						
FF	P1	190	0,035	6,65	FF DN150	134
FF	P2	35	0,035	1,23	FF DN70	50
FF	P3	240	0,035	8,40	FF DN200	177
FF	P4	110	0,035	3,85	FF DN70	66
FF	P5	88	0,035	3,08	FF DN70	50
FF	P1 A P5	637	0,035	22,30	FF DN600	513
FF	P6	62	0,035	2,17	FF DN70	50

Fig.22 – Data introduction spreadsheet (Rainwater stacks)

- **Automatic generator of bill of quantities and technical conditions**

In general, small engineering enterprises do not have a consolidated and updated database with materials and works (and respective unitary costs) that can be used as basis for the drafting of the bill of quantities, necessary in all execution projects. The procedure used usually consists in copying and pasting the parts already used in a previous project. This, besides being very burdensome, does not guarantee any consistence of the final result as the information can be vary in the different sources (previous projects).

To simplify the process and to improve the consistency of the bills of quantities of the company, the author started to collect in a single and consolidate excel database all the items that were being used,

classifying them by type, intended use (discipline: drainage, water supply, etc), material and brand. An extract of this database can be found in Figure 23.

DESCRIÇÃO	CT DO ITEM	PREÇO	UN.	PRINCIPAL	SECUNDÁRIO	MATERIAL	MARCA
Fornecimento e montagem de válvulas de retenção, do tipo SOCLA, incluindo fixação e todos os trabalhos complementares, com:	Válvulas de retenção			REDE DE COMBATE A INCÊNDIO	VÁLVULAS	DIVERSOS	DANFOSS SOCLA
DN 15 - modelo 601 - Refª149B2504		7,07 €	un				
DN 20 - modelo 601 - Refª149B2505		8,59 €	un				
DN 25 - modelo 601 - Refª149B2506		10,81 €	un				
DN 32 - modelo 601 - Refª149B2507		15,76 €	un				
DN 40 - modelo 601 - Refª149B2508		21,06 €	un				
DN 50 - modelo 601 - Refª149B2509		32,31 €	un				
DN 65 - modelo 635E - Refª149G3552		105,14 €	un				
DN 80 - modelo 635E - Refª149F021283		116,44 €	un				
DN 100 - modelo 635E - Refª149F021284		124,62 €	un				
DN 125 - modelo 635E - Refª149F021285		144,07 €	un				
DN 150 - modelo 635E - Refª149F021286		186,63 €	un				
DN 200 - modelo 635E - Refª149F021287		275,26 €	un				
DN 250 - modelo 635E - Refª149F021288		388,07 €	un				
DN 300 - modelo 635E - Refª149F021289		601,58 €	un				
Tubagem em aço inox AISI 316, com acessórios tipo press-fitting, em rede de distribuição de água, incluindo abertura e tapamento de roços e todos os trabalhos complementares , com:	Tubagem em aço inox com acessórios press-fitting			REDE INTERIOR DE DISTRIBUIÇÃO DE ÁGUA	TUBAGEM	AÇO INOX	GEBERIT
DN 15 em rede de água fria		21,55 €	ml				
DN 18 em rede de água fria		22,02 €	ml				
DN 22 em rede de água fria		23,02 €	ml				
DN 28 em rede de água fria		25,21 €	ml				
DN 35 em rede de água fria		28,80 €	ml				
DN 42 em rede de água fria		34,99 €	ml				
Fornecimento e montagem de torneira de lavagem com rosca, tipo «VABS» modelo V2500, incluindo todos os acessórios, ligações e trabalhos complementares, com:	Torneiras de lavagem			REDE INTERIOR DE DISTRIBUIÇÃO DE ÁGUA	VÁLVULAS	LATÃO	DANFOSS SOCLA
DN 15 - Refª 149B5325		6,63 €	un				
DN 20 - Refª 149B5326		9,30 €	un				
DN 25 - Refª 149B5327		14,16 €	un				

Fig.23 – Materials and works database (including cost)

Nevertheless, the existence of a database can solve the consistency of the result but still some copy and pasting would have to be needed. To avoid that, the author created a macro to generate automatically bills of quantities with the company format based on the database and on the quantities inserted by the user (figure 24).

ESTIMATIVA ORÇAMENTAL					
	António Fernandes				
	ALOJAMENTO LOCAL				
		Revisão			
		00		2012-10-09	
	DESIGNAÇÃO	QTD.	UN.	PREÇOS (€)	
				UNITÁRIOS	TOTAIS
I	REDE INTERIOR DE DISTRIBUIÇÃO DE ÁGUA				
1	VÁLVULAS				
1. 1	Fornecimento e montagem de torneira de lavagem com rosca, tipo «VABS» modelo V2500, incluindo todos os acessórios, ligações e trabalhos complementares, com:				
1. 1.1	DN 20 - Refª 149B5326	1,00	un	9,30 €	9,30 €
1. 2	Fornecimento e montagem de torneira de esquadria, de 1/4 volta, para seccionamento de aparelho sanitário, do tipo Sanindusa Aveiro, ou equivalente, incluindo todos os acessórios, ligações e trabalhos complementares, com:				
1. 2.1	1/2" x 1/2" (ref.5030561)	1,00	un	11,41 €	11,41 €
1. 3	Fornecimento e montagem de válvulas de retenção, do tipo SOCLA, incluindo fixação e todos os trabalhos complementares, com:				
1. 4	Fornecimento e montagem de válvulas de seccionamento do tipo esfera "VABS", incluindo ligações e todos os trabalhos complementares:				
1. 4.1	DN 25 - modelo V665 - Refª149B5050	1,00	un	8,21 €	8,21 €
1. 5	Fornecimento e montagem de válvulas de corte embutida com botão de acesso do tipo Geberit, incluindo ligações e todos os trabalhos complementares:				

Fig.24 – Bill of quantities (output)

This tool simplified and improved the process in what concerns the bill of quantities development.

Based on this document, the following task would be to gather the technical information concerning the materials and works foreseen in the project and compile then in a unique document – the technical conditions.

As these conditions are independent from each other, the process is again the same; going back to old projects where the same solution may have been used and use some of the information.

The solution found by the author to improve the process was to create independent technical conditions files for each of the materials and works (or at least for the most relevant) as the example presented in figure 25 for washing taps.

The tool (excel macro) is able to recognize automatically which materials used and works are foreseen in the project (quantity in the bill of quantities different from zero) and compile the respective technical condition in a single file to be part of the project.

TORNEIRAS DE LAVAGEM

1. APLICAÇÃO

As torneiras de lavagem a instalar terão o calibre da tubagem onde estão inseridas.

2. CARACTERÍSTICAS

As torneiras a aplicar serão em latão cromado e deverão satisfazer as seguintes características:

- O revestimento do crómio terá a espessura média de 0,18 a obter pelo método de "SPOT Test Method for Chromium";

- Terão dureza e textura reconhecidas como aceitáveis pelo LNEC.

3. ENSAIO HIDRÁULICO

As torneiras poderão ser submetidas aos ensaios que o LNEC recomenda para tais componentes, devendo ser nomeadamente ensaiadas à pressão de 21 kg/cm^2 durante quinze minutos sem rotura do material.

Serão dispensados os ensaios dos protótipos que sejam acompanhados de um boletim de ensaios do LNEC, comprovativo de resultado satisfatório.

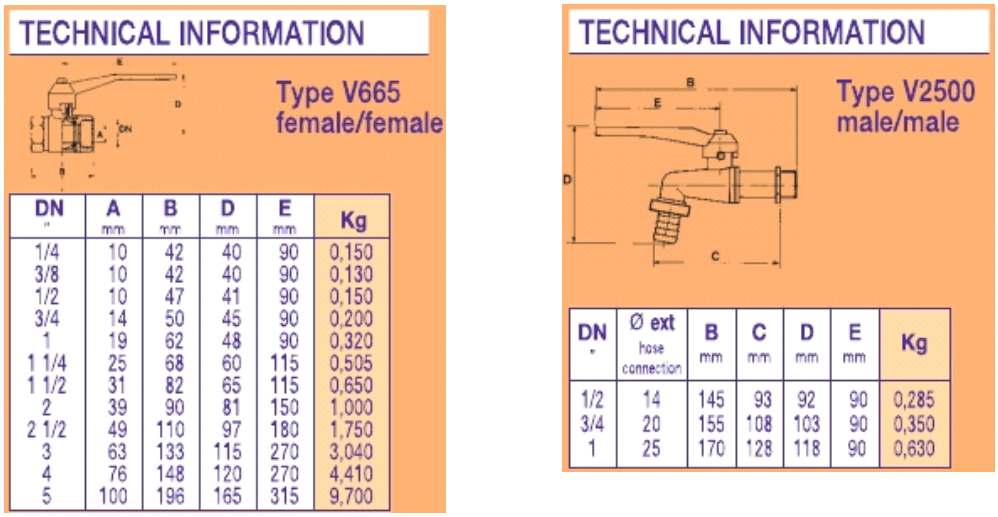


Fig.25 – Example of a Technical Conditions file (for washing taps)

3.3. BUILDING MARTIM MONIZ EPUL – LISBON (MARCH 2012)

Fig.26 – Building Martim Moniz EPUL

3.3.1. DESCRIPTION

This project was promoted by *EPUL*, former company responsible for supporting the town Council of Lisbon in the urban planning in big areas of the city and real estate.

The enterprise foresees the creation of new 130 apartments in Martim Moniz Square, in the heart of the city. The sizes vary from one to three bed apartments. The six buildings have mainly housing purposes but commercial areas are also foreseen at the ground levels. In average, each building has seven floors above the surface and two or three under it for parking and storage.

The total construction area is 36.000 m^2, costing around 7.5M € to build, of which 615k € are imputed to the three disciplines developed (water and gas supply and drainage).

The disciplines developed by the author were:

- Water Supply and Firefighting
- Drainage
- Gas Supply

3.3.2. GAS SUPPLY

Since the construction works were stopped for months before this project was attributed to Engicraft, the first task was to collect the information in situ on the equipments already in place in order to design the remaining network parts. To better understand the project, the existing network was represented in black and the foreseen on in red (see figure 27).

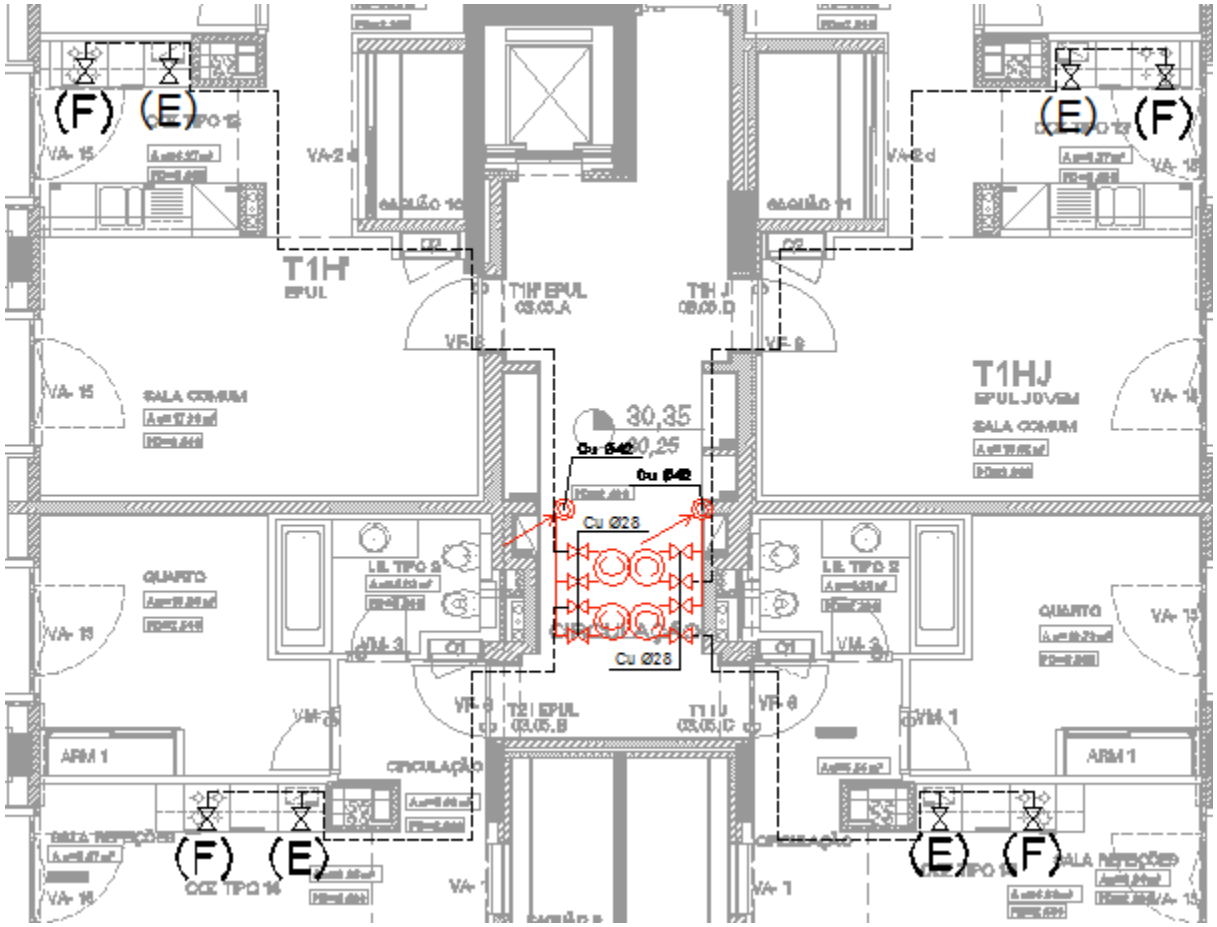


Fig.27 – Existing and foreseen gas networks

In general, all the interior copper piping was already installed. The big the supply pipes (in steel), the connections to the public network, the meters and valves were still missing. Since most of the structure was already built, it was not possible to foresee ditches to install the pipes to connect the internal network with the public one. The only option was to insert them in the concrete stairs with an adequate protection (see figure 28).

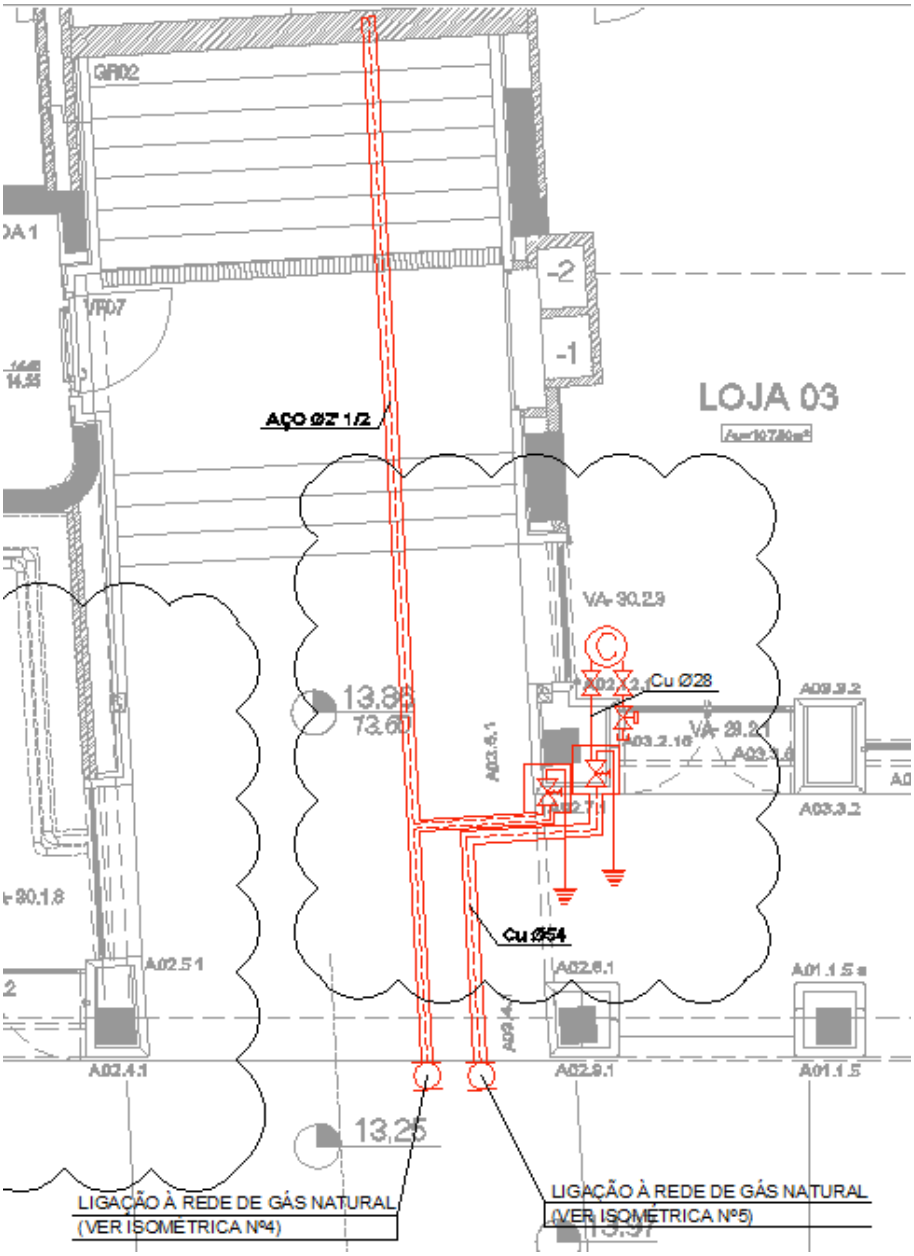


Fig.28 – Connection to the public network

The gas supply system was also presented in a tri-dimensional representation, giving an overall view (see figure 29).

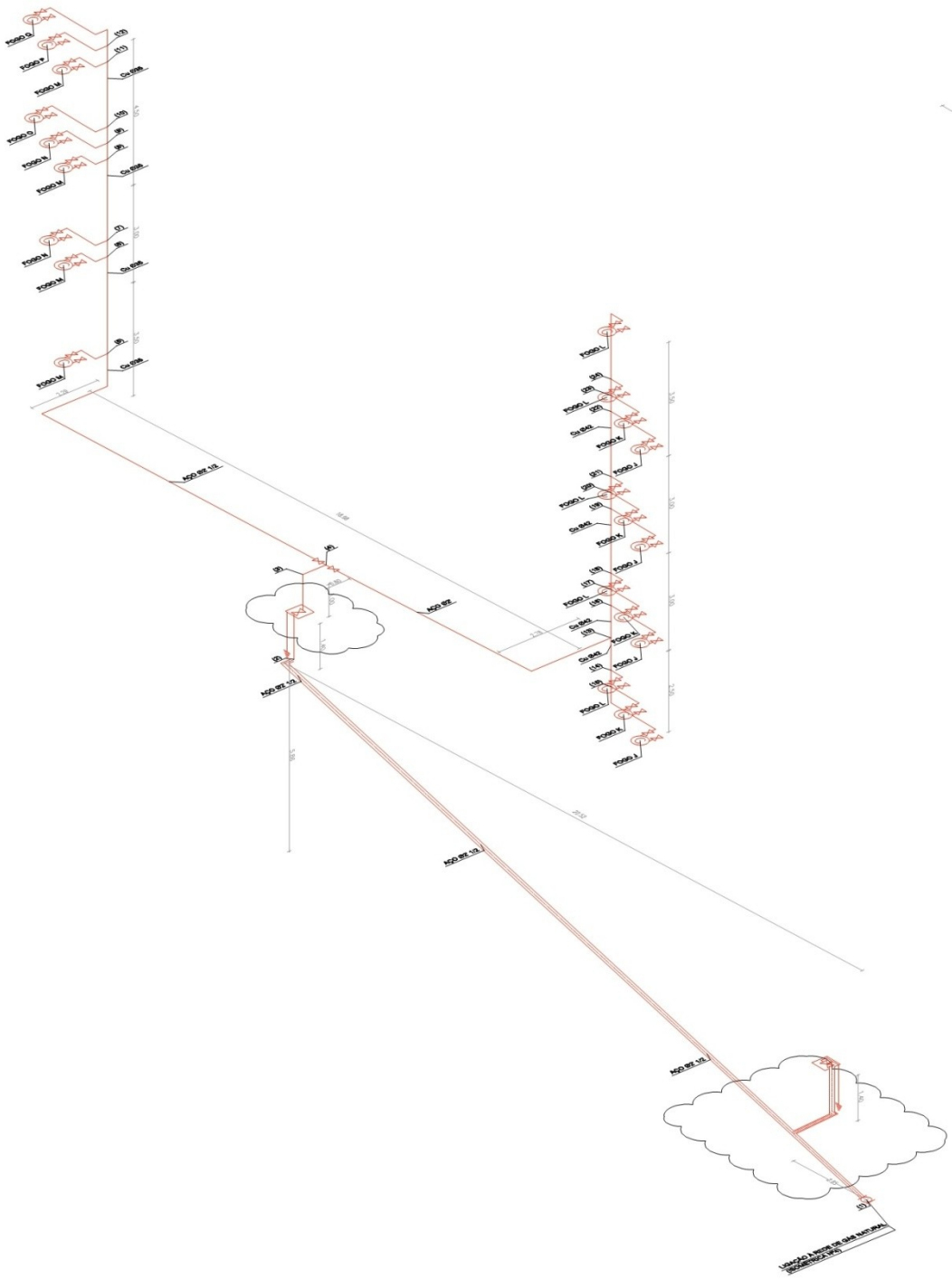


Fig.29 – Overall tri-dimensional representation

The ventilation was calculated according the Portuguese standard NP 1037-1 [10], which defines the requirements for the natural ventilation systems to fulfil its tasks when gas-burning appliances are working or just to guarantee the indoor air quality (see figure 30). The conformity to this standard is necessary approve the project with the local authorities, usually the gas supply company. Therefore, this standard is “de facto” mandatory in Portugal.

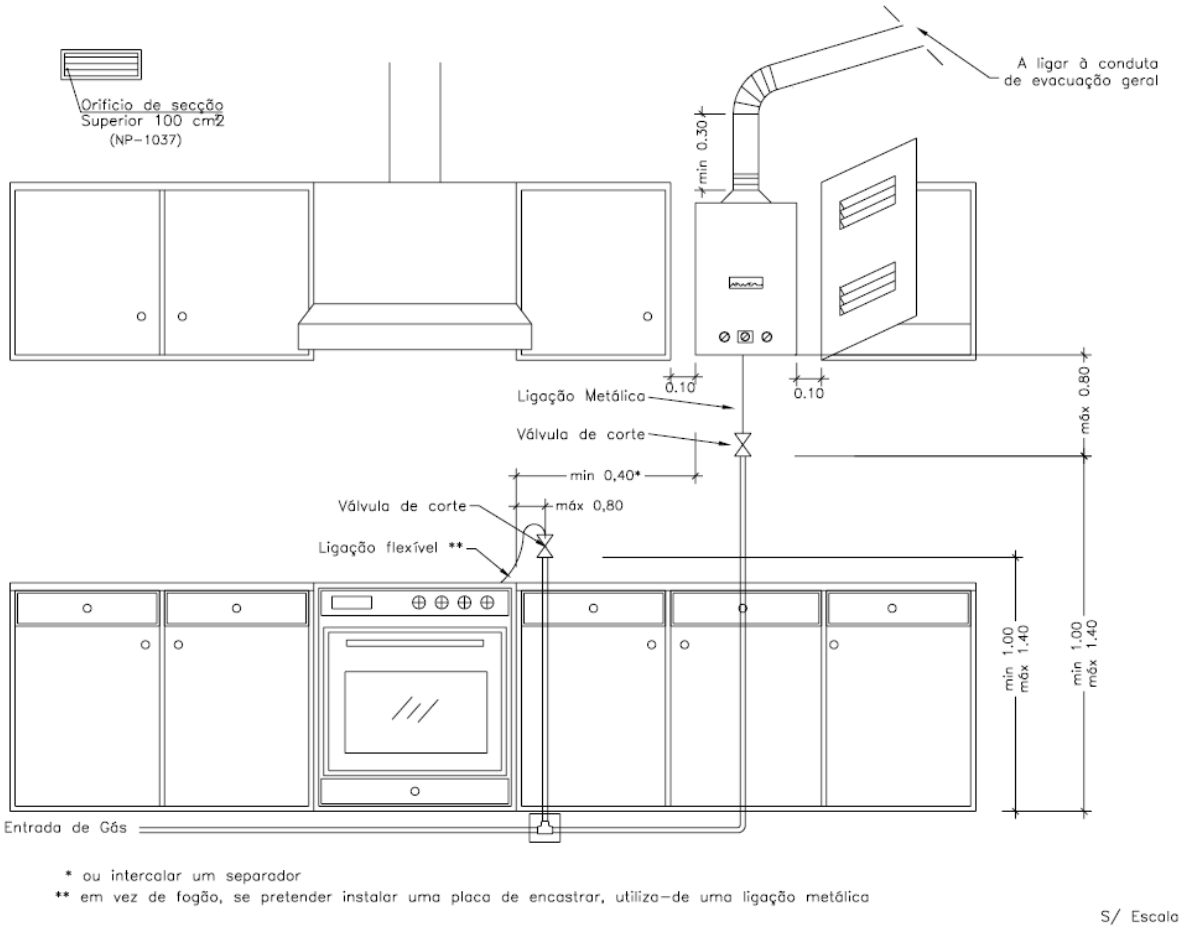


Fig.30 – Gas-burning appliances with installation scheme according NP 1037-1

This standard (NP 1037) provides the necessary calculation method to achieve the safety and indoor quality requirements needed in order to approve the project. It is not a technical document to help the designer improving the overall ventilation solution. The further developing of the solution can assume an important role when no "typical" configuration is possible. In this particular case, the ventilation grids are not installed on the facade as usual. Instead, the air circulation is made through an interior open space, foreseen for lighting purposes (see figure 31).

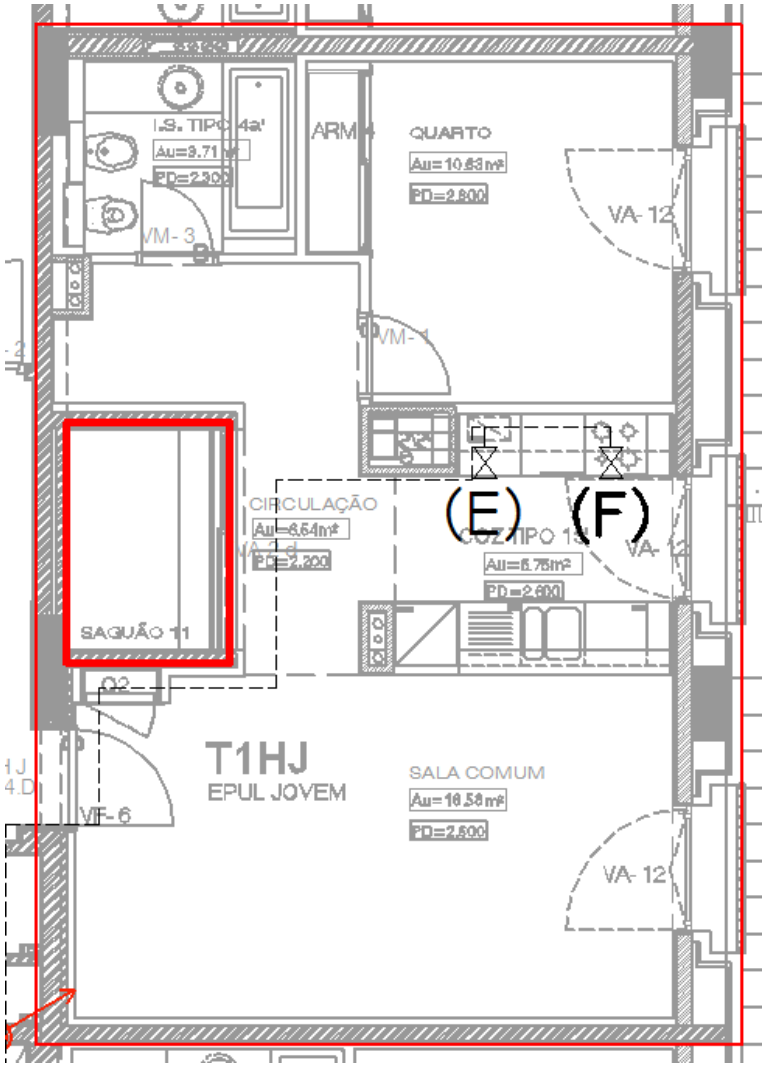


Fig.31 – Interior ventilation/lighting column

3.3.3. CEN/TR 14788:2006 - VENTILATION FOR BUILDINGS - DESIGN AND DIMENSIONING OF RESIDENTIAL VENTILATION SYSTEMS [11]

This technical report was drawn up by the Technical Committee CEN/TC 156 "Ventilation of buildings". It "specifies recommendations for the performance and design of ventilation systems which serve single family, multi family and apartment type dwellings during both summer and winter. It is of particular interest to architects, designers, builders and those involved with implementing national, regional and local regulations and standards". The scope of this *TR* is wider than the scope of NP 1037-1 as it adds three strategies to the natural ventilation:

- fan assisted supply air ventilation;
- fan assisted exhaust air ventilation;
- fan assisted balanced air ventilation.

Moreover, ventilation aspects of combined systems (ventilation with heating and/or cooling) are covered.

In what regards the natural ventilation, point 8.3.3 of the technical report clarifies the distinction between this document and national regulations or standards:

"Design and dimensioning of natural ventilation systems requires design tools (e.g. computer models) which are too complex for inclusion in this Technical Report, particularly for tall buildings with common duct systems. Therefore, natural ventilation systems should be designed and dimensioned in accordance with national regulations or standards, or according to a system covered by a European Technical Approval. However, the following guidance and general rules may be useful."

It is not the intention of this deliverable to override national standards, in particular NP 1037-1, but to give further guidance and general rules to designers. In fact, that is why this deliverable is a *TR* and not an *EN*. A European Standard has to be adopted by the CEN members and all the national standards have to be withdrawn. If 14788:2006 was an *EN* instead of a *TR*, the Portuguese National Standardization Body (*IPQ*) would have to implementing it as national standard (NP EN 14788:2006) and all conflicting national standards would have to be withdrawn (including NP 1037-1).

This technical report, besides giving the steps for the calculation of residential systems (in chapter 8), gives important additional information in the final annexes, which can used to complement the design:

- Annex A - Residential pollutant production rates;
- Annex B - The relationship between humidity and temperature and use of the psychrometric chart;
- Annex C - Method of calculating water vapour absorption effect;
- Annex D - Residential ventilation systems and their interaction with the dwelling;
- Annex E - Calculation methods for ventilation requirements;
- Annex F - Examples of assumptions and resulting calculated values for ventilation air flow rates;
- Annex G – Noise;
- Annex H - Nomograph for calculating air flow rate to reduce the risk of surface condensation occurring on the inner wall surface for various wall U-values and ambient air conditions.

3.4. ECO-TRACKS – ALONG DÃO AND VOUGA RIVERS (JANUARY 2012)

Fig.32 – Eco-tracks

3.4.1. DESCRIPTION

The old decommissioned railroad line of the Dão wine region was converted into this new cycle path, which also involved the refurbishment of the stations and other support buildings along its 45km of length which connect the municipalities of Viseu, Tondela and Santa Comba Dão.

The project includes the complete design of this new eco-trail, its infrastructures, buildings, landscaping and signage.

The disciplines developed by the author were:

- Water Supply
- Drainage

3.4.2. DRAINAGE

This project covered not only the drainage of the rainwater on the eco-tracks as such, but also the wastewater drainage of the old train stations, now transformed into assistance facilities. These tracks, being away from the residential clusters, do not have the public sewage network accessible. Therefore, it was necessary to create solutions either to transport the rainwater or wastewater flow to the river or to allow this volume to be infiltrated in the soil.

In the case of the facilities, a small wastewater treatment system is foreseen to ensure the flow quality before it could be infiltrated into the soil through a bottomless manhole with a generous area (see figure 33).

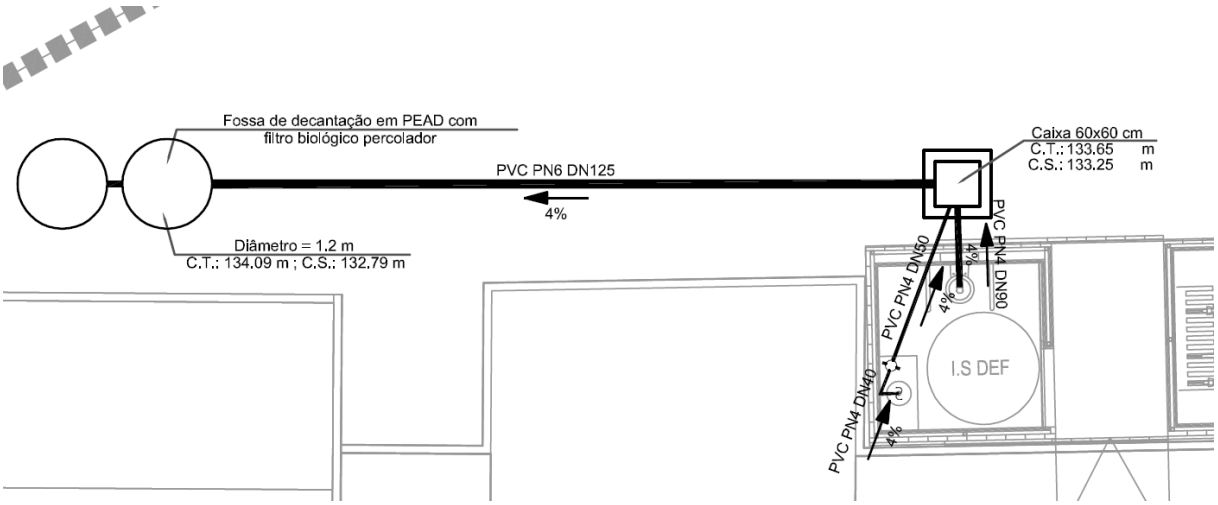


Fig.33 – Supporting facility wastewater drainage

For the rainwater drainage of the tracks, lateral concrete half pipe channels will be used to collect the superficial water. Perforated PCV pipes enclosed by gravel will be installed beneath it to accumulate the underground water (see figure 34).

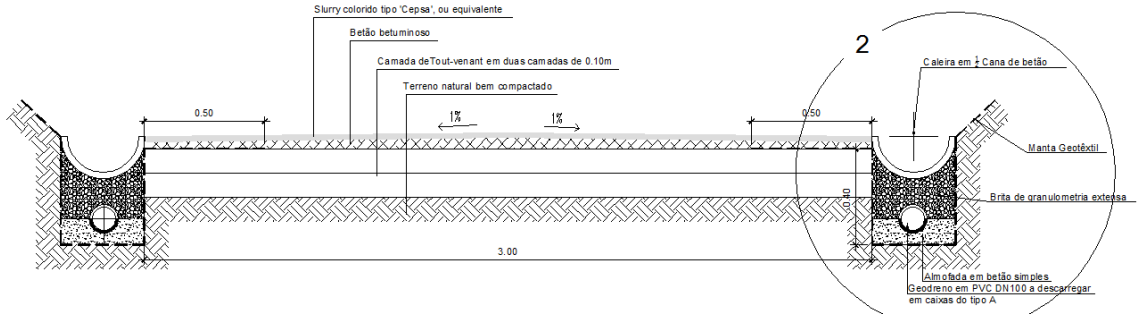


Fig.34 – Eco-track drainage

All this water will then be brought together at the gullies and then discharged at the river through the buried PVC SN8 DN315 pipes (see figure 35).

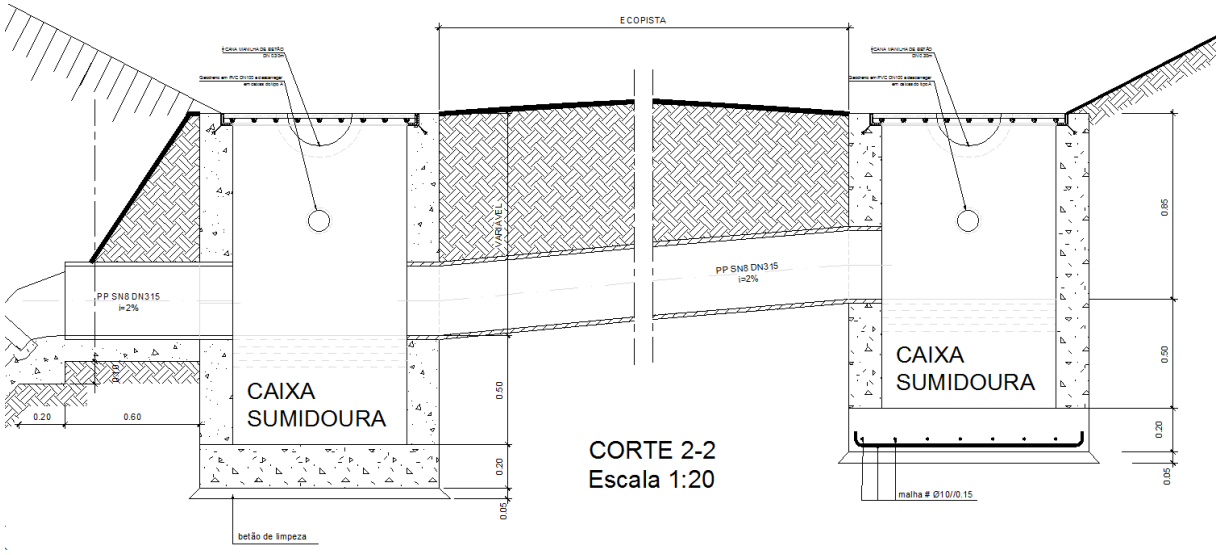


Fig.35 – Eco-track drainage (gullies)

In this particular case, due its proximity, the infrastructure needed to transport the collected rain water to the rivers is not significant. Nevertheless, the infiltration (if the necessary infiltration area is available) is usually a more economical solution. On the other hand, the design can be more onerous as you need to identify the conditions, in particular the soil characteristics. Moreover, a deficient evaluation of these conditions can increase the risk of flooding, for which the designer will be ultimately responsible.

3.4.3. CEN/TR 12566-2:2005 - SMALL WASTEWATER TREATMENT SYSTEMS FOR UP TO ≤50 PT - PART 2: SOIL INFILTRATION SYSTEMS [12]

This technical report was drawn up by the Technical Committee CEN/TC 165 "Wastewater engineering". It is one of deliverables of a package dealing with all the aspects related to small wastewater treatment systems. This part 2 gives guidance for infiltration systems which can be used in places of use where legally provisions for soil infiltration systems do not exist. In Portugal, the treatment of the effluents and its discharges has to respect environmental regulation but there no specific legal provision for the infiltration systems used.

These treatment systems are installed when no public sewage network is available and therefore how to deal with the outflow is a relevant issue to be addressed by the designer. In this report, solutions to infiltrate small wastewater volumes originated by the maximum of 50 people. The different possible systems are presented in a preferential order:

- Infiltration trench;
- Shallow infiltration bed;
- Vertical infiltration bed:
- Infiltration mound.

The document takes the designer through the design process starting with the site considerations. At this phase, some of the informative annexes can be of great utility. Annex A refers to the preliminary site consideration and it includes a surprising clause about how plants can be used as drainage indicators. "Due to the habitats that are required by various plant species, the presence of a particular

plant can indicate the drainage properties of a site". Annex B presents a scheme for the preliminary determination of soil parameters in situ. These two Annexes can be used together to easily evaluate the feasibility of the foreseen solutions.

The dimensioning described in the technical report leads not only to the general design of the infiltration systems but also to the selection of its several components. The construction requirements and maintenance issues are equally addressed.

3.5. CONVENT OF JESUS – LISBON (DECEMBER 2010)

Fig.36 – Convent of Jesus

3.5.1. DESCRIPTION

This refurbishment of an old building mainly covers the application of rendering and plastering and the substitution of internal networks of water supply and drainage.

The disciplines developed by the author were:

- Water Supply
- Drainage

3.5.2. THE REFURBISHMENT

The objective of this small refurbishment was to recover this old Convent, trying to keep, as far as possible its original architectonical characteristics and, at the same time, to provide it with the infrastructures in line with the requirements of nowadays.

Fig.37 – Convent of Jesus stairs

In particular, special care was taken to preserve the walls, as some of them have old tiles that cannot be replaced. The execution of openings to install the pipes in these masonry walls would be a very sensitive work as they do not give guarantees of steadiness. On the other hand, as these are structural elements, its solidity should not be compromised because it could originate deformations and cracks.

One of the solutions was to create a technical area to install the piping between the original wall and a "fake" one made of gypsum boards (see figure 38).

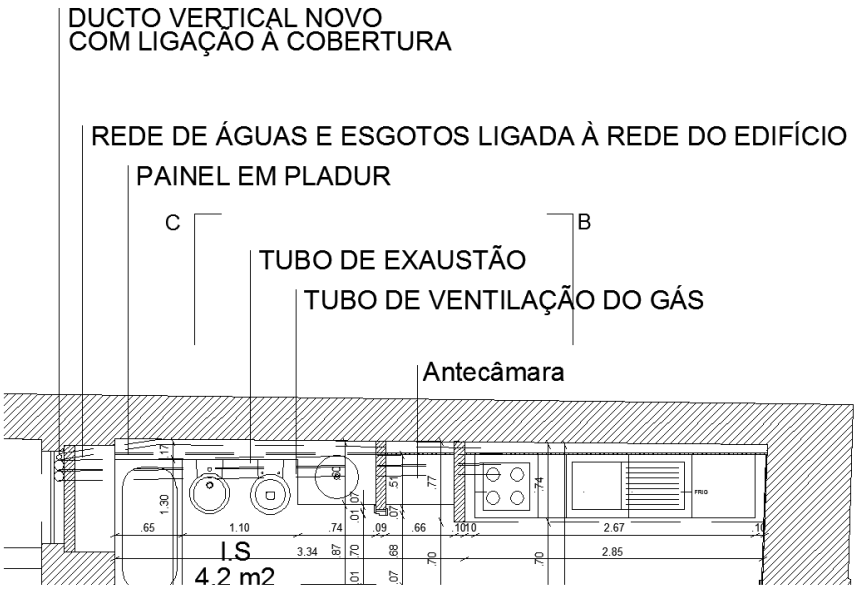


Fig.38 – Piping installation behind gypsum board walls

Nevertheless, other cases still existed where the piping had to be installed in the wall (see figure 39).

Fig.39 – New water meter

As pointed out previously, designers often avoid to foresee construction work that will affect the existing masonry walls. Rather than include technical requirements for the maintenance and repair renders, they decide to use alternative solutions like the gypsum boards. This is a quick solution, which carries little responsibility to the designer and gives guarantees of nice wall finishing.

Nevertheless, this does not fully fulfils the objectives of the refurbishment as the walls will still keep its deficiencies such as cracks, geometrical irregularities or dampness. In some cases, the areas to be recovered can have such an extension that there is no solution rather than foresee its recovery (see figure 40).

Fig.40 – Area needing recovery

A good and detailed project execution plan should contain the site instructions for the construction works and the procedures for its approval. This would also give a huge guidance to the site engineer on how to monitor the work development. Some of this technical information can be found in standards.

3.5.3. EN 13914-1:2005 - DESIGN, PREPARATION AND APPLICATION OF EXTERNAL RENDERING AND INTERNAL PLASTERING - EXTERNAL RENDERING [13]

This European standard was drawn up by the Technical Committee CEN/TC 125 “Masonry”. It gives requirements and recommendations not only for the design but also for the preparation and application of renders and plasters on all types of backgrounds.

One of the chapters (chapter 8) is dedicated to the recommendations for the maintenance and repair, which covers, among other things, the repair of cracks and hollow or detached areas. This chapter is complemented by an informative annex (Annex B), which gives recommendations for the renovation and repair of defective renders on old or historic buildings where the types of materials and techniques used are often different from those in current usage. Following this annex, the designer should be able to engage preliminary investigations to reach the diagnosis of the cause of need of restoration (dampness, soluble salts in the background, cracking, etc.). Secondly, he should be able to decide on the restoration systems and measures and include them into his design. Finally, the recommendations

of the last chapter of the annex (B.6) dealing with the application should also be included in the project.

3.6. HIGH SCHOOL – SILVES (SEPTEMBER 2010)

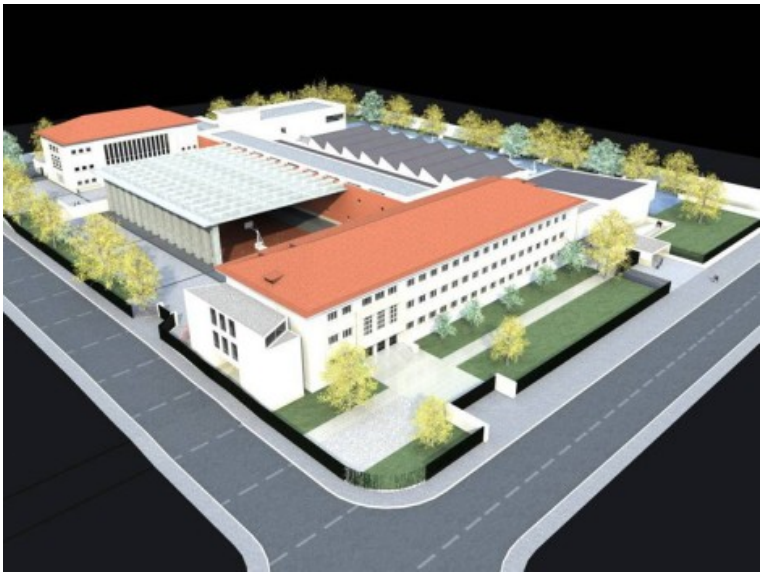


Fig.41 – High-school – Silves

3.6.1. DESCRIPTION

This extension and renovation of the Silves high-school, a facility built in the technical schools' layout of the late 50's, involved the addition of four new buildings and the structural reinforcement of the existing ones, as well as the complete renovation of the mechanical, electrical, and plumbing (*MEP*) services.

The total area of intervention was 16.500 m^2.

The disciplines developed by the author were:

- Water Supply and Firefighting
- Drainage
- Gas Supply

3.6.2. GAS SUPPLY

Since there is no public gas supply infrastructure available, a LPG (propane) tank with a capacity of 7,48 m^3 (3 ton) was foreseen. The distribution is made through buried HDPE (high-density polyethylene) until the safety valve on the limit of the buildings. The piping in the interior will be executed in copper. A general scheme is presented in figure 42.

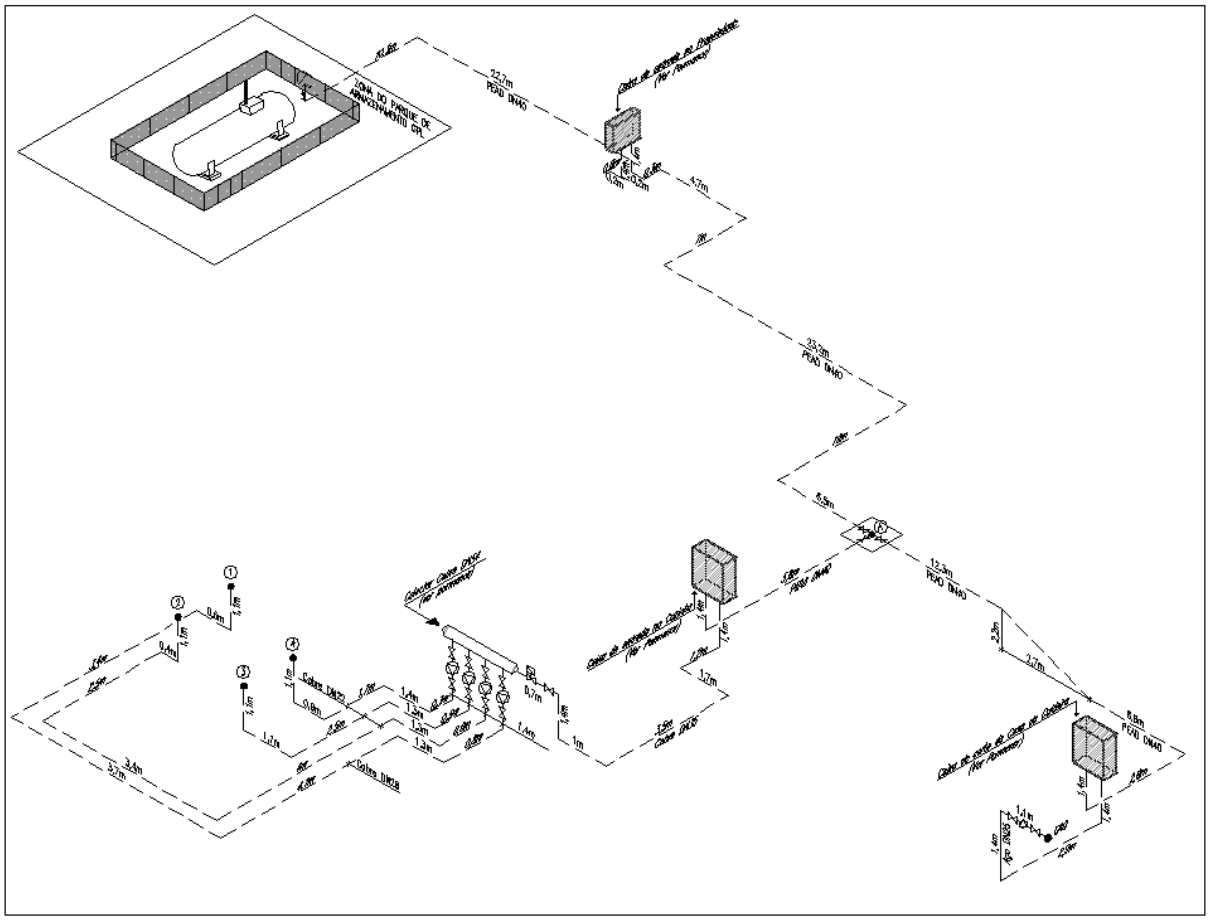


Fig.42 – Gas supply infrastructure

The design and installation of gas systems is heavily regulated at national level. The project makes reference to the several Portuguese pieces of legislation.

The design of the tank as such is not part of the project, only its capacity and the reference to the standards to be followed during its design and manufacture is included. Then will be up to the supplier of the equipment to fulfil the legal requirements, in particular those ser by the Pressure Equipment Directive [14].

3.6.3. EN 12542:2010 - LPG EQUIPMENT AND ACCESSORIES - STATIC WELDED STEEL CYLINDRICAL TANKS, SERIALLY PRODUCED FOR THE STORAGE OF LIQUEFIED PETROLEUM GAS (LPG) HAVING A VOLUME NOT GREATER THAN 13 M³ - DESIGN AND MANUFACTURE [15]

In order to have presumption of conformity with the Pressure Equipment Directive, the harmonized EN13445 series (cited on the *OJEU* - *see figure* 43) can be followed for the unfired pressure vessels, in which LPG tanks are included.

ESO (1)	Reference and title of the harmonised standard (and reference document)	Reference of superseded standard	Date of cessation of presumption of conformity of superseded standard Note 1
CEN	EN 13445-1:2009 Unfired pressure vessels - Part 1: General	EN 13445-1:2002 Note 2.1	Date expired (31/12/2009)
CEN	EN 13445-2:2009 Unfired pressure vessels - Part 2: Materials	EN 13445-2:2002 Note 2.1	Date expired (31/12/2009)
CEN	EN 13445-3:2009 Unfired pressure vessels - Part 3: Design	EN 13445-3:2002 Note 2.1	Date expired (31/12/2009)
CEN	EN 13445-4:2009 Unfired pressure vessels - Part 4: Fabrication	EN 13445-4:2002 Note 2.1	Date expired (31/12/2009)
CEN	EN 13445-5:2009 Unfired pressure vessels - Part 5: Inspection and testing	EN 13445-5:2002 Note 2.1	Date expired (31/12/2009)
CEN	EN 13445-6:2009 Unfired pressure vessels - Part 6: Requirements for the design and fabrication of pressure vessels and pressure parts constructed from spheroidal graphite cast iron	EN 13445-6:2002 Note 2.1	Date expired (31/12/2009)
CEN	EN 13445-8:2009 Unfired pressure vessels - Part 8: Additional requirements for pressure vessels of aluminium and aluminium alloys	EN 13445-8:2006 Note 2.1	Date expired (31/12/2009)

Fig.43 – Part of the summary list of titles and references harmonised standards under Directive 97/23/EC for Pressure equipment

The third part of the standard (EN 13445-3) relates to the design of the pressure vessel and it is one of the biggest standards of the CEN catalogue (865 pages!). One may think that not all clauses are necessary to be followed to achieve the presumption of conformity but table ZA.1 of the Annex ZA leaves no doubt (see figure 44).

Table ZA.1 — Correspondence between this European Standard and Pressure Equipment Directive 97/23/EC

Clause(s)/subclause(s) of this EN	Essential Requirements (ERs) of Pressure Equipment Directive 97/23/EC	Qualifying remarks/Notes
All clauses	2.2	Design for adequate strength

Fig.44 – Part of the table ZA.1

In order to fulfil all the essential requirements of the Pressure Equipment Directive regarding the design for adequate strength, all the clauses of the standard have to be followed. This can be very burdensome for the manufacturer of the tank and for the designer, in the case where he needs to check the design.

The European standard EN 12542, drawn up by the Technical Committee CEN/TC 286 "Liquefied petroleum gas equipment and accessories", comes as a solution. This voluntary standard (not cited on the *OJEU*) specifies requirements for the design and manufacture of a reduced range of products usually used in domestic gas systems: static welded steel cylindrical tanks, serially produced for the storage of liquefied petroleum gas (LPG) with a volume not greater than 13 m3 and for installation above or below ground.

This standard makes normative references to the EN13445 series, meaning that that both are aligned. As a general rule, any standards in the CEN catalogue are neither overlapping nor contradicting each other.

3.6.4. RAINWATER DRAINAGE

As it was done for the domestic water drainage, also the rainwater drainage system was totally refurbished in this school.

With the ecological water saving objective in mind, a system to collect and store rainwater was originally foreseen. Four reservoirs, with a 50.000 litres capacity each, would feed the internal irrigation system (see figure 45). Moreover, could reduce the peak discharge to the public system, which often does not have the capacity to accommodate it, originating floods. This problematic has gained relevance with the downstream surfaces becoming more and more impermeable.

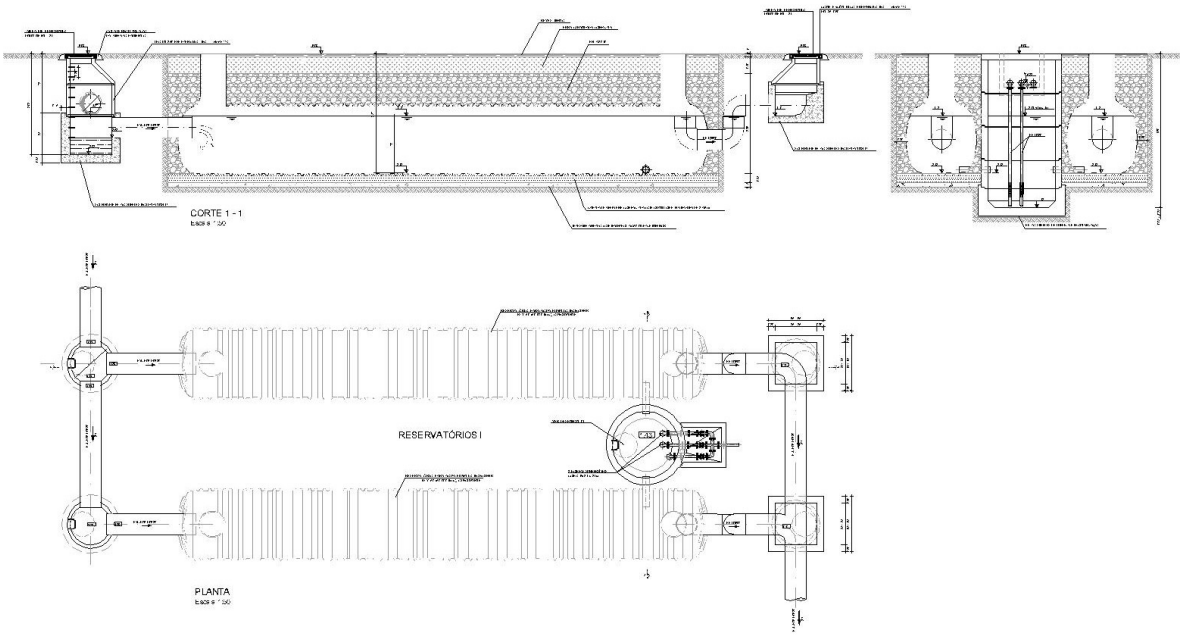


Fig.45 – Rainwater reservoirs with 50.000 litres capacity

This system for the re-use of the rainwater was abandoned in one of the following phases and removed from the project for financial reasons. At certain point, it was necessary to reduce the overall cost of the construction and the conclusion was reached that the investment necessary would not easily be paid by the water savings.

Nevertheless, this came to be a good exercise to conceive the system, mainly based on the personal professional experiences since few technical documents are available.

Some details were considered important and taken into account in the project:

- Sand trap manholes installed upstream the storage tanks;
- Superficial discharge in the tanks to remove the superficial residues such as leaves;
- Tanks filling controlled by an electrovalve to maximize the collected rainwater volume;
- Safety discharge in overflow case;
- Water extraction done by the irrigation pumps at a below the surface level using a buoy.

3.6.5. prEN 00165232-1:2014 - Systems for the on-site reuse of water — Part 1: Rainwater [16]

This draft standard, still in development by CEN/TC 165 (under public enquiry) and not yet published, will put together all the European expertise in a single technical document about the on-site reuse of rainwater. Being an European Standard (*EN*), all *CEN* members will have to adopt it as their national standard, withdrawing the conflicting ones.

This standard will give the general specifications on design, sizing, installation, identification, commissioning and maintenance of systems for the reuse of rainwater on site. All the steps of this cycle are to be considered:

- Rainwater collection at the roof level;

- Pipework system;
- Pre-treatment (when necessary);
- Additional treatment (e.g. metal roofs);
- Distribution;
- Use (e.g. toilet, laundry, cleaning, garden, industrial, fire fighting).

3.7. HIGH SCHOOL OF VERGÍLIO FERREIRA – LISBON (JUNE 2010)

Fig.46 – High-school of Vergílio Ferreira

3.7.1. DESCRIPTION

The high-school of Vergílio Ferreira was covered by the "Parque Escolar" national initiative to refurbish and modernize old schools.

The main objective of this project was to refurbish and reorganize the existing buildings, including the construction of a new entrance one, which will comprise the administrative services and will have the function to people access to the library and to the spaces destiny to workers and parents.

In this project, more than adapt the old networks and structures to the current requirements, a special attention is given to the environmental quality and energy performance of the buildings.

The total area of intervention was 11.000 m^2.

The disciplines developed by the author were:

- Water Supply and Firefighting
- Drainage

3.7.2. THE PRONIC TOOL

This project was one of the projects launched by "Parque Escolar, E.P.E.", which was a public enterprise created to plan, manage, develop and execute the public schools infrastructure modernization programme approved by the Ministers Council in late 2006.

This programme had three main objectives:

- Refurbish and modernize the high-schools buildings, adapting them physically and functionally to the new teaching requirements, in particular to the new Information Technology (*IT*) needs;
- Transform the high-schools into a space open to the surrounding community, in order to facilitate access to its equipments;
- Create a new management model of the infrastructures, optimizing the resources during the posterior maintenance phase.

In order to support these objectives, and to create more fairness and transparency in the launched public calls for tender for the execution of the several high-schools projects, "Parque Escolar" imposed to all candidates the utilization of *ProNIC* – Protocol for the Technical Information Standardization in Construction. This covered not only a systematic and integrated technical content database, but also an *IT* tool, which was expected to be a reference to the Portuguese construction sector. It was developed by:

- the Construction Institute of the Faculty of Engineering of the University of Porto (*IC-FEUP*);
- the National Laboratory of Civil Engineering (*LNEC*);
- and the Systems and Computers Engineering Institute of Porto (*INESC-Porto*),

with the support of several national public procurers:

- the Directorate General for the National Monuments and Buildings (*DGEMN*);
- the Roads of Portugal (*EP*);
- the former National Institute for Housing (*INH*).

This *IT* tool could generate automatically bills of quantities with the associated files for the works, materials, performances and costs.

With the European crisis settling in, Portuguese engineering enterprises tried to rotate their sails towards the international market, where *ProNIC* is of little use. In the European context, other countries adopted other data formats for the publication of subsets of building model information as it the *COBie* (Construction Operations Building Information Exchange) case in the UK.

Anyhow, all these systems are neither harmonized nor correlated, which makes the transmission of information between then impossible.

3.7.3. CEN/TC 442 ON BUILDING INFORMATION MODELLING (BIM)

Recognizing the harmonization need on the field of Building Information Modelling (*BIM*) in Europe, the Norwegian member of CEN (Standards Norway) proposed to CEN/BT the creation of a working group to study the possibility of having a new technical committee.

During a year, the European experts from almost all CEN members discussed in the CEN/BT WG 215 meetings the Scope, a Business Plan and an initial Work Program for a future new technical committee on BIM in CEN. This was agreed on unanimous consent on 2014-12-10.

With the support of all CEN members, Standards Norway formally proposed the creation of the *TC* and assumed its secretariat in April 2015.

The new CEN/TC 442 on Building Information Modelling (BIM) will develop European deliverables within the following scope:

"Standardization in the field of structured semantic life-cycle information for the built environment.

The committee will develop a structured set of standards, specifications and reports which specify methodologies to define, describe, exchange, monitor, record and securely handle asset data, semantics and processes with links to geospatial and other external data."

CEN members are now setting the national mirror committees and registering the experts to integrate the national delegations. In Portugal, the *IPQ* already has a mirror committee in place (Comissão Técnica 197), chaired by the António Aguiar Costa, who was the Portuguese expert in the CEN/BT WG 215 and will be the Portuguese head of the Portuguese delegation in the CEN/TC 442.

The kick-off meeting of this new *TC* is scheduled for the September 2015 in Brussels, where important decisions need to be taken, such as:

- the approval of the *TC* chairperson;
- the approval of the business plan;
- the approval of the requested liaisons with European organizations;
- the decision on which ISO standards to adopt using the Vienna Agreement signed between CEN and ISO (mainly from ISO/TC 59/SC 13 "Organization of information about construction works");
- the decision on the work items (deliverables) to be developed at European level;
- the creation of working groups to develop the work.

It is expected a big participation of all the interested European Stakeholders representing architects, engineers and users. Moreover, *SBS*, *ANEC* and the European Commission already expressed their interest on participate. Member States have a big interest in BIM in their quality of public procurers.

3.8. STADIUM CASTELÃO – FORTALEZA, CEARÁ - BRAZIL (MARCH 2010)

Fig.47 – Stadium Castelão

3.8.1. DESCRIPTION

The Castelão stadium, dating from 1973, needed a profound renovation in view of the 2014 FIFA World Cup, increasing its capacity to 67.000 spectators and updating its technical facilities to the demanding current FIFA standards in a enterprise of 180M € worth.

In a partnership with the architects Vigliecca and Associates, of São Paulo, the project objective was to prepare the design of all engineering services up to a pre-detail design stage, on which the design/build competition was launched.

The disciplines developed by the author were:

- Water Supply and Firefighting
- Automatic Sprinkler Systems
- Drainage

3.8.2. AUTOMATIC SPRINKLER SYSTEMS

The objective pre-detail design stage was to develop the design to a stage where a bill of quantities could be foreseen with some accuracy. This would be part of the elements to be included in the final proposal to the design/build competition. Not having guarantees on the attribution of the project, it was fundamental not to develop the design in excessive detail.

Part of this project was developed by a Brazilian party, which defined the standards and national regulations to be followed. In what concerns the automatic sprinkler systems, the following National Fire Protection Association (*NFPA*) standards were chosen:

1) NFPA 13: Standard for the installation of sprinkler systems [17];
2) NFPA 20: Standard for the installation of stationary pumps for the fire protection [18].

The foreseen sprinkler network covered not only the parking lot, but also the offices on top of the stadium and the area for the installation of the pump for fire protection.

Given the specificities of the building and its use, it was classified as being under OH1 risk (Ordinary Hazard – Group 1) according to NFPA 13 [17] criteria. As consequence, among other implications, the maximum distance between sprinklers has to be 4,6 m and a water reserve has to be available to guarantee the continuous flow in a area of 186 m^2 for one hour.

The standard foresees a simplified design of the piping network based on the building risk adopted, taking into account the number of sprinklers to be supplied (see table 2).

Table 2 – Steel pipe diameters for OH1 risk

DN [mm]	DN [in]	Number of sprinklers
25	1	1 - 2
32	1 1/4	3
40	1 1/2	4 - 5
50	2	6 - 10
65	2 1/2	11 - 20
80	3	21 - 40
90	3 1/2	41 - 65
100	4	66 - 100
125	5	101 - 160
150	6	161 - 275
200	8	See area limit

At certain point, the number of sprinklers is limited by the maximum area that can be controlled by a single deluge system (4.831 m^2 for OH1 risk) – see figure 48.

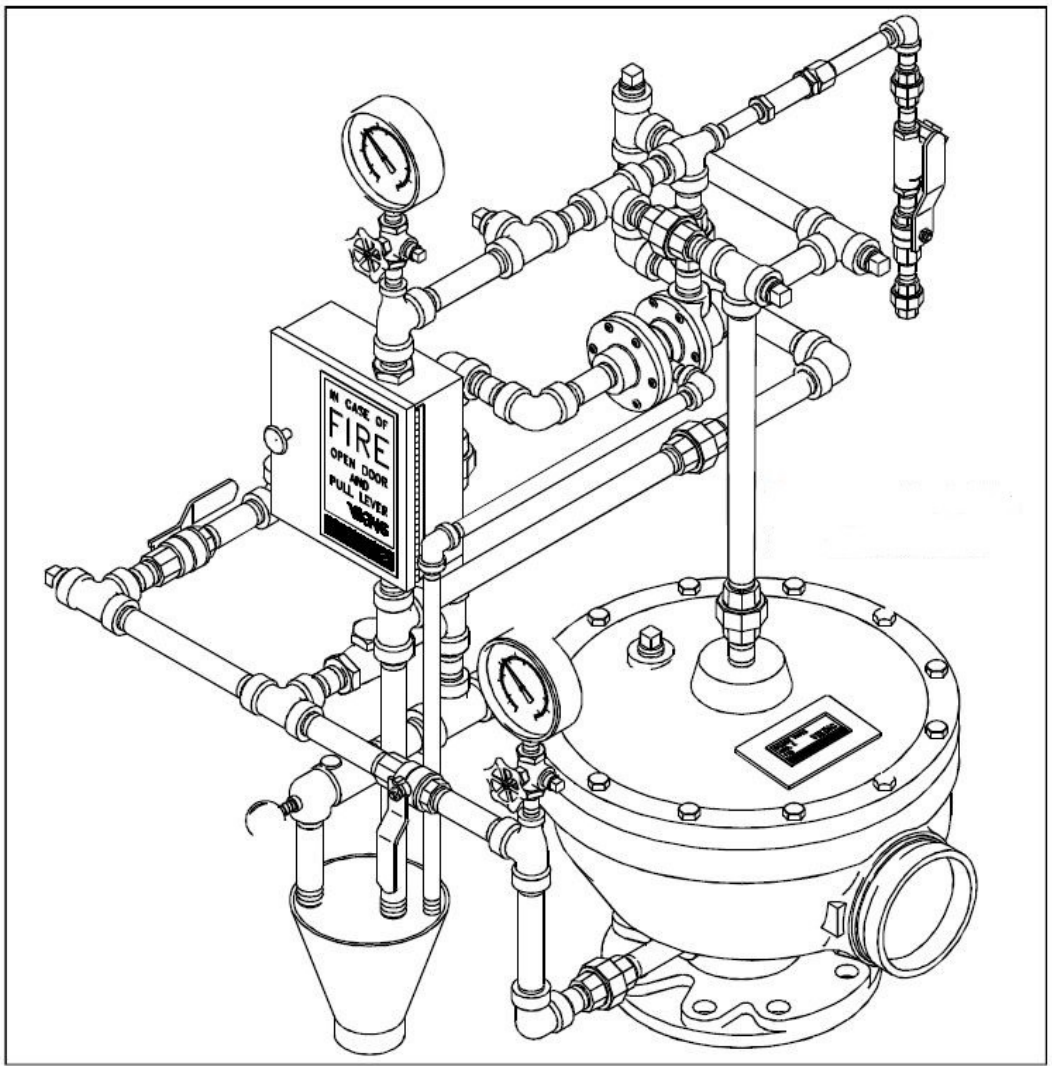


Fig.48 – Conventional deluge system

Based on these criteria, it was possible to design the automatic sprinkler systems of the stadium (see figure 49).

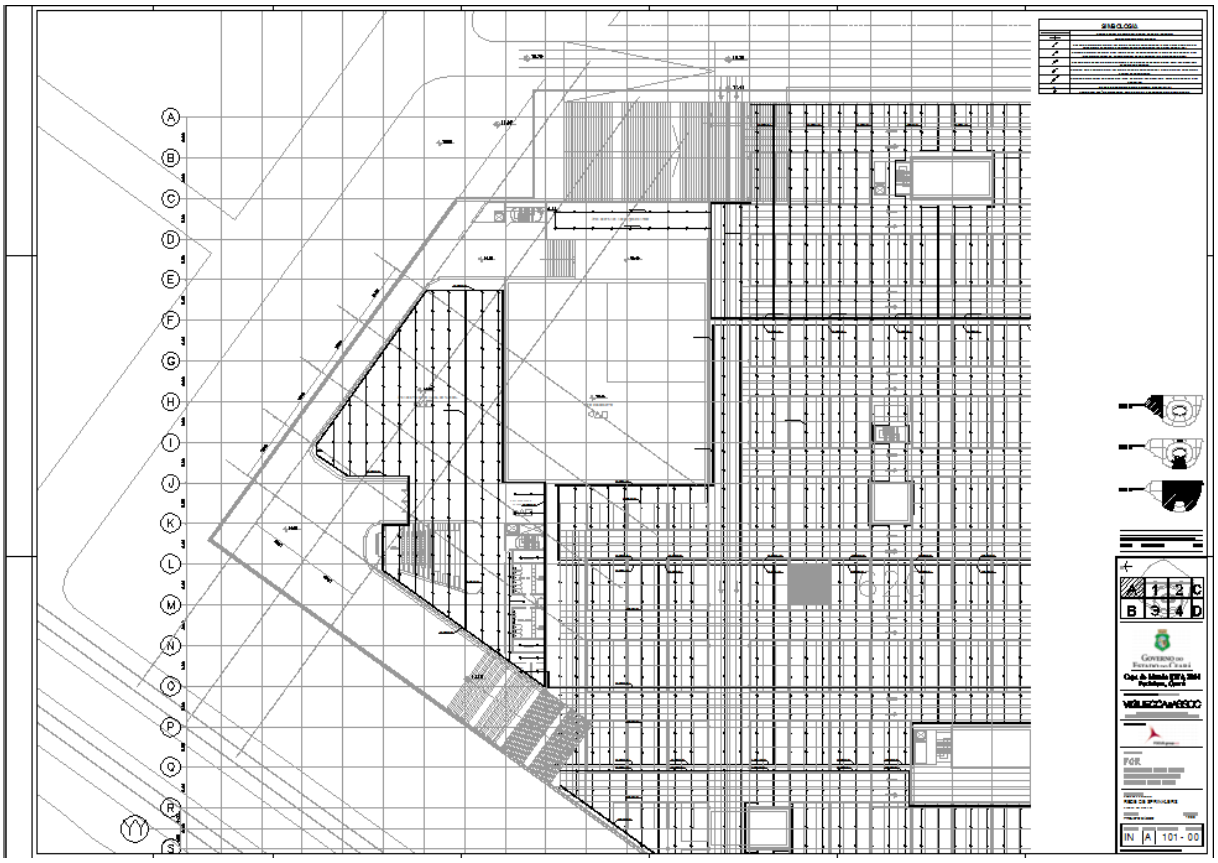


Fig.49 – Part of the automatic sprinkler system piping installation

The main group of pumps guarantees a flow of 140 m^3 per hour with a pressure of 7 bar. The fire reservoir has therefore a total capacity of 140 m^3.

3.8.3. FprEN 12845:2014 - Fixed firefighting systems - Automatic sprinkler systems - Design, installation and maintenance [19] - the latest version is still under Formal Vote (FprEN)

In this particular project, the *NFPA* standards were an imposition and not a technical decision taken by the designer. In some cases these, due to the geographical location or to influence of the United States, these standards are followed. This happens even in Europe, by the imposition of insurance companies and enterprises. This should not happen, as there are equivalent European Standards in place, and most definitely not for public procurement. The Directive 2014/24/EU on public procurement [20], clearly states in article 3(b) that, without prejudice to mandatory national technical rules, to the extent that they are compatible with Union Law, the technical specifications shall be formulated by reference to the following sources (in order or preference):

1) National standards transposing European standards;
2) European Technical Assessments;

3) Common technical specifications;
4) International standards;
5) Other technical reference systems established by the European standardisation bodies;
6) National standards, national technical approvals or national technical specifications relating to the design, calculation and execution of the works and use of the supplies; each reference shall be accompanied by the words ‘or equivalent’.

Having said that, the technical specification to be used in Europe for the design and installation of automatic sprinkler systems should be the EN 12845 [19] and not the NFPA 13 [17].

This European Standard was drawn up by Technical Committee CEN/TC 191 “Fixed firefighting systems”. It also foresees a simplified design for piping systems based on the building risk, number of sprinklers fed and type of range pipe arrays called “pre-calculated pipework” (see figure 50 for the simplified scheme used by the author).

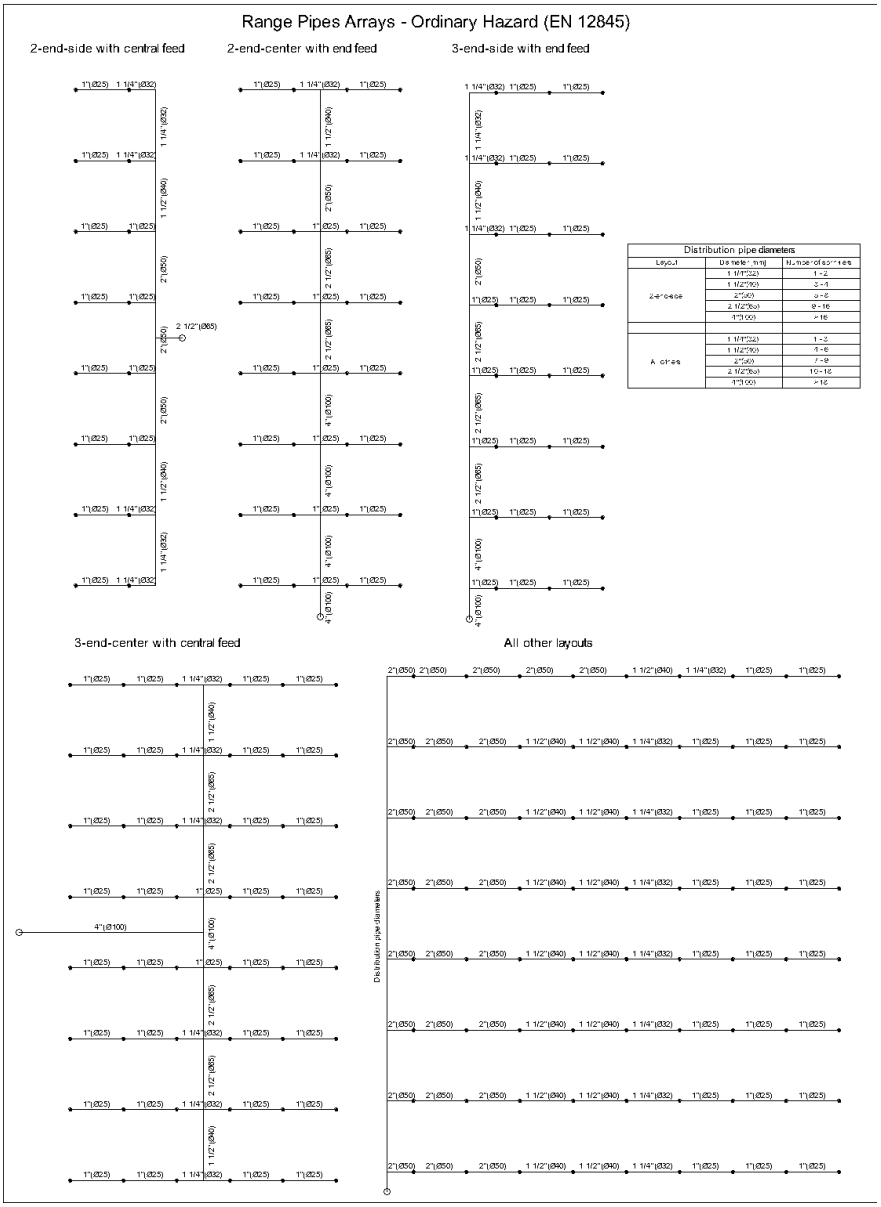


Fig.50 – Simplified design scheme used by the author following EN 12845 (Ordinary Hazard)

Of course that the fully calculated pipework is possible and the necessary elements are listed in clause 4.4.3.3., included the detailed calculations on purpose designed work-sheets or as computer printout.

3.9. HOTEL PORTO MÓS – LAGOS, ALGARVE (JANUARY 2009)

Fig.51 – Hotel Porto Mós

3.9.1. DESCRIPTION

"Hotel Porto de Mós" was a project of a four star hotel with 296 rooms, to be built in Lagos, near the Porto de Mós beach.

The disciplines developed by the author were:

- Water Supply
- Drainage

3.9.2. SWIMMING POOL

The design of a swimming pool is often undervalued in the overall project. A specific project for the swimming pool equipment (such as pumps, filters and piping) may exist but the more detailed requirements are left open for the construction phase. In most cases, the manufacturer/installer responsible for supplying the equipment will present a proposal adapted to his equipment and solutions.

Nevertheless, the connections with the other building systems have to be foreseen, in particular with the water supply and drainage. The architecture has to assign the suitable area to the installation of the equipment.

The swimming pool as such, when it is not a pre-fabricated one, is included in Structural Design project. Usually, the design engineer does not follow any other provisions than those foreseen in the National Regulations and/or in the Eurocodes.

The geometry of the swimming pool as such is usually decided by the architect, usually not based in any technical requirements rather than the client expectation or his own esthetical/artistic concept. In this particular case, the main pool was designed with a two-circle shape, united by a channel (see figures 52 and 53). Some equipment was foreseen such as a wooden bridge and a water fall to a smaller contiguous pool.

Fig.52 – Main swimming pool integrated in the drainage project

Fig.53 – Main swimming pool 3D preview

3.9.3. EN 13451-1:2011 - SWIMMING POOL EQUIPMENT - PART 1: GENERAL SAFETY REQUIREMENTS AND TEST METHODS [21]

This European Standard was prepared by Technical Committee CEN/TC 136 "Sports, playground and other recreational facilities and equipment". It specifies general safety requirements and test methods for equipment used in recreational pools. These safety requirements cover important aspects, such as:

- General structural integrity – Achieved by calculation and/or testing. Annexes A and B give the method of calculation and the loads to be assumed by the structural engineer;
- Materials – For the selection of the suitable materials. In the particular case of stainless steel, the Annex G gives requirements for its use in the swimming pool atmosphere;
- Minimum space - The manufacturer/supplier shall indicate the minimum space needed for the installation, operation and use of their equipment;
- Protrusions - Protrusions are a hazard of impact or entrapment especially where water movement can cause involuntary movement of users;
- Edges and corners;
- Entrapment, crushing and shearing points;
- Slip resistance.

Usually, none of these aspects are covered by the project.

3.10. HOTEL SANA LUANDA ROYAL – LUANDA - ANGOLA (JUNE 2008)

Fig.54 – Hotel Sana Luanda Royal

3.10.1. DESCRIPTION

This hotel is becoming a reference in the Angolan capital hospitality scene. With its 219 rooms, 16 master suites and 3 presidential suites, this hotel is suited not only for business users, but also welcomes extended stays in its 50 SANA Residence apartments. The facilities include five restaurants,

two bars, a disco and an extensive wellness club and spa. The hotel's conference centre has nine conference rooms, the largest of which has 680 seats.

The total construction area reaches the 45.000 m^2.

The disciplines developed by the author were:

- Water Supply
- Drainage

3.10.2. WATER SUPPLY

Being a five-star hotel, this project covers not only the water supply to the rooms and suites as such (see figure 55), but also to the various services such as the hotel kitchen, four restaurants, a bar, a lounge VIP area, several swimming pools, toilets (see figure 56), changing rooms and irrigation systems.

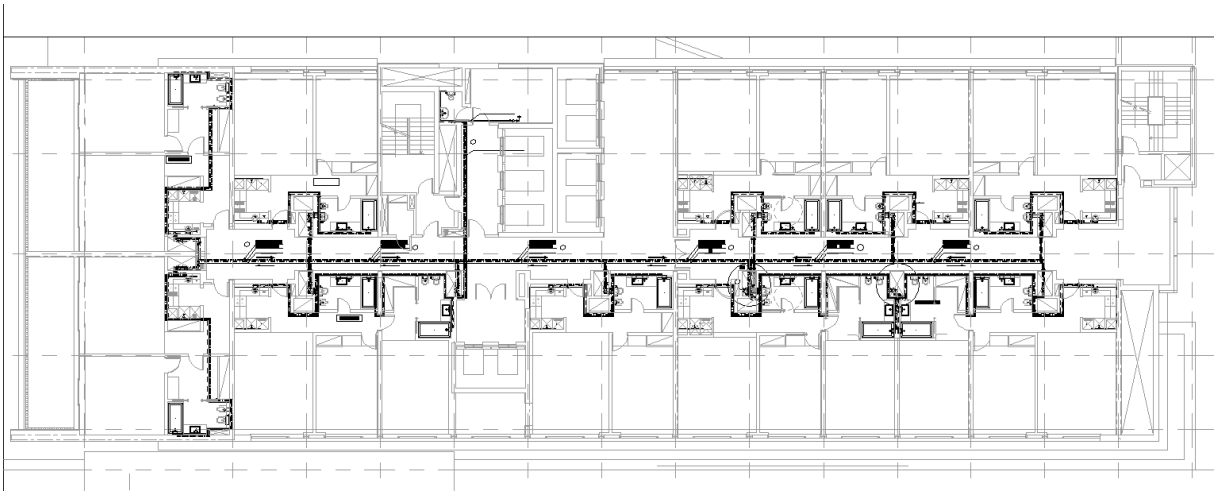


Fig.55 – Distribution scheme on the rooms floors

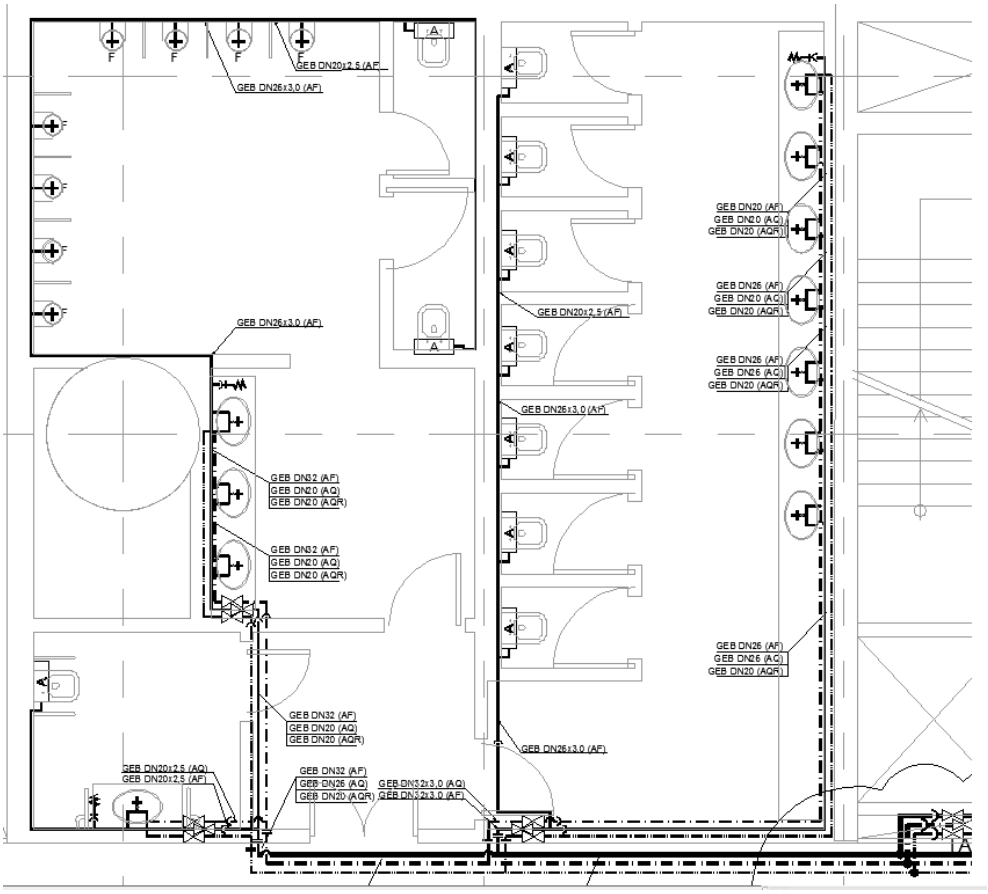


Fig.56 – Public toilets on ground floor

In some of these services, as it is the case of the restaurant on the first floor (see figure 57), meters were installed to allow its exploration by an independent party. Since the recirculation of hot water was foreseen, a meter is necessary in both hot water supply and recirculation pipes. This system makes the hot water available almost instantly avoiding its waiting and the consequent water waste.

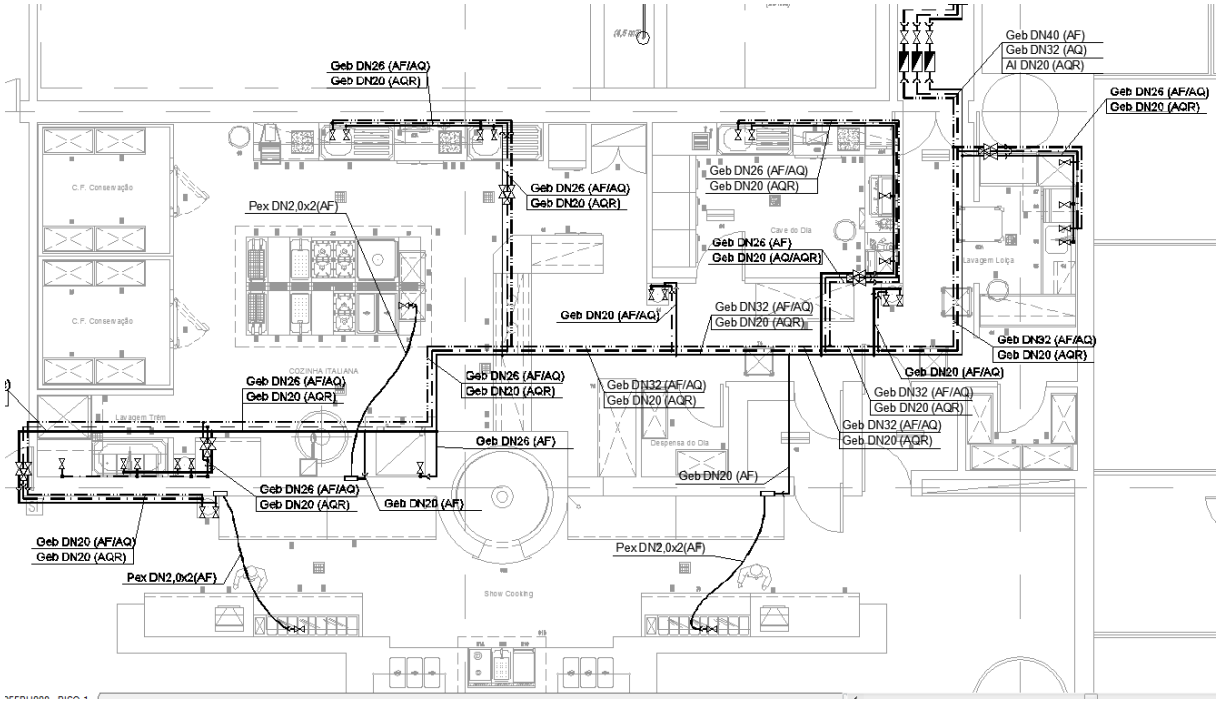


Fig.57 – Restaurant on first floor

The installation of the recirculation piping was done even inside the rooms and suites, until the last hot water plumbing fixture (see figure 58). These are mandatory requirements in a five-star hotel to guarantee the adequate comfort levels to the guests.

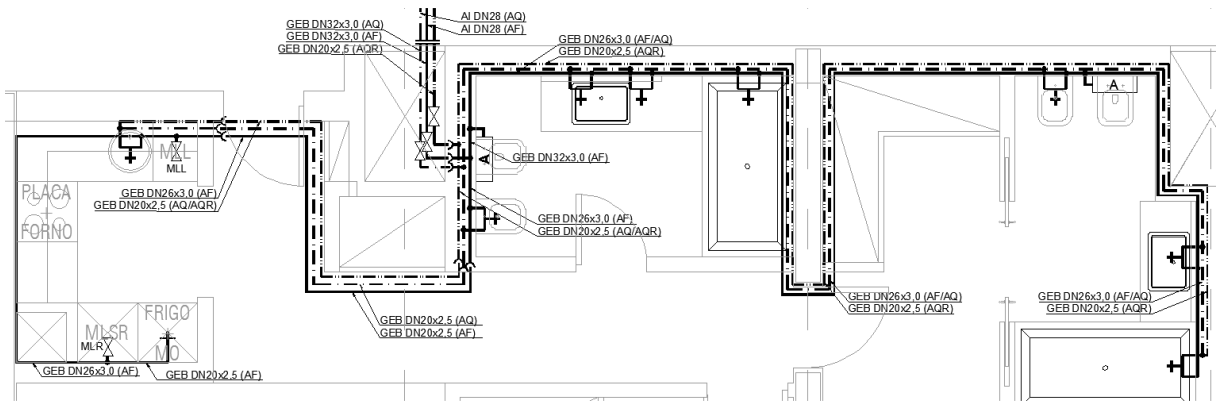


Fig.58 – Detailed distribution scheme of a T2 type suite

Considering that the water supply in Luanda is not reliable (in terms of flow and quality), a reservoir with potable water guarantees the supply for 1,3 days considering the hotel in its full occupancy. This corresponds to a total volume of almost 250 m^3, which was not easy to accommodate in the building. Since the parking lot access ramps go around an empty circular nucleus, the solution found was to use it to store the potable water, although its untypical form (see figure 59).

Before being stored as potable water, suitable to supply the hotel, the water from the public network has to pass through the installed treatment process, as it doesn"t offer quality reliability. Initially, it is stored in two huge reservoirs, located in the exterior of the circular access ramps with capacities for 383 m^3 and 455m^3 respectively. This water cannot be used before passing by the three membrane filtration systems, which will guarantee the low allowable levels for turbidity and microbiology (see figure 59). These systems are even able to remove viruses and chlorine resistant organisms, such as cryptosporidium oocysts and Giardia cysts. Conventional treatment systems are either unable to meet these quality standards or multiple barriers are required which need a large footprint and investment. Moreover, these systems are not dependent on the availability of consumables such as chorine, which can also be a problem in Angola.

The drinkable water is then stored in the potable water reservoir, mentioned before. Its volume should be enough to fulfil the hotel needs for a little more than a day, being afterwards fully refilled during the night with the treated water coming from the bigger tanks.

Taking into account the building height, it was necessary to implement three independent pressure levels guaranteed by three pressuring units (each one of them with four pumps):

- first pressure level from the underground floors to the 5th;
- second pressure level from the 6th to the 16th floor;
- third pressure for the remaining upper levels from the 17th to the 22nd floor.

Reduction valves assure that the pressure in the piping does not exceed 6 bar, which would decrease the durability of the system and increase the risk of leaking.

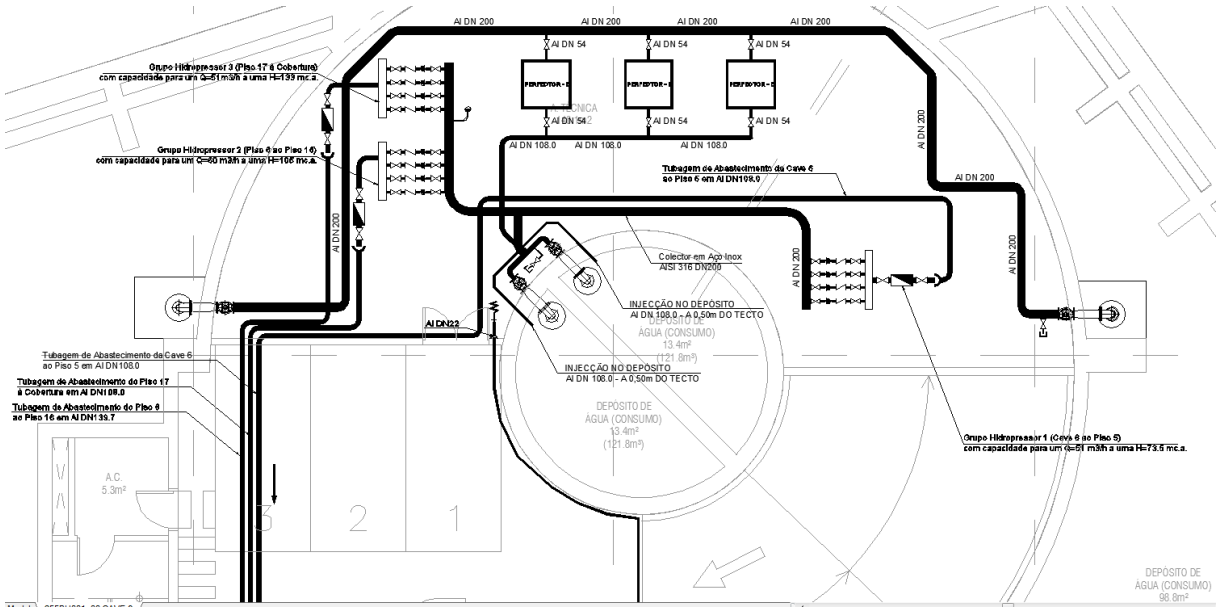


Fig.59 – Pumping and treatment technical area on floor -6

The hot water network starts on the six water deposits located on the third floor. Their heating is done by two big gas boilers (see figure 60).

In what concerns the pressure levels for the hot water, they are the same as the ones for the cold water network. By balancing the pressures, the migration between both networks is avoided.

The temperature control is done by the thermostatic mixing valves installed on the hot water deposits exit.

The expansion vases have 80 litres of capacity to accommodate the volume increase in the low hot water consumption periods.

Circulation pumps in the lowest and water purgers on the highest point of the hot water system ensure an adequate recirculation.

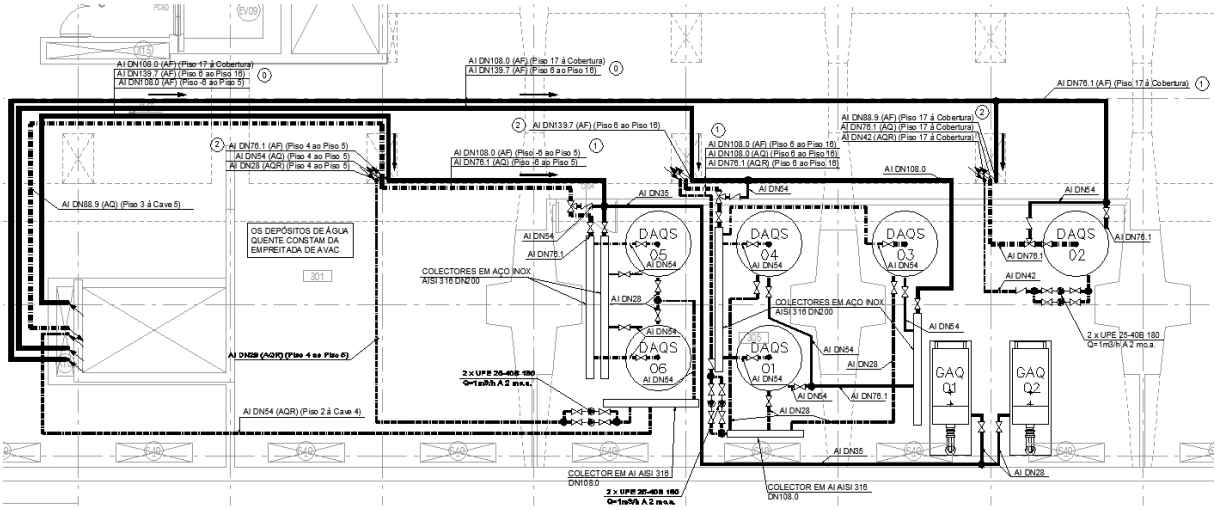


Fig.60 – Heating technical area on third floor

3.10.3. EN 1508:1998 - WATER SUPPLY - REQUIREMENTS FOR SYSTEMS AND COMPONENTS FOR THE STORAGE OF WATER [22]

This European standard was prepared by the Technical Committee CEN/TC 164 "Water Supply". It can give some requirements for the design of a reservoir, especially in this case where its geometry does not follow the usual one.

In particular, stagnant zones should be avoided and access and security should be assured.

Bringing no surprising technical content to a engineer used to design reservoirs, it is a good check list to verify all the technical aspects that should be taken into account.

When using the usual configurations and geometry, all these requirements all fulfilled by definition and have no relevance. Nevertheless, when adopting different solutions, these have to be checked thoroughly.

3.11. HYPERMARKET FEIRA NOVA – MALVEIRA (APRIL 2008)

Fig.61 – Hypermarket Feira Nova

3.11.1. DESCRIPTION

This project for a new hypermarket from the "Feira Nova" group followed most of the technical solutions already adopted and implemented in other locations. In the conception of this new one in Malveira, the project covered not only the internal systems but also the exterior networks such as the drainage of the parking lot and the adaptation of water distribution and sewage systems to the new needs.

The disciplines developed by the author were:

- Water Supply and Firefighting
- Drainage

3.11.2. DRAINAGE

This project covers the overall drainage of the hypermarket, including the rainwater, wastewater and the greasy sewage coming from the fresh produce zones of fish and meat. The installation and collocation of channels, drains and equipment was thought having into account the users (hypermarket employees) needs (see figure 62). Other hypermarkets from the same chain were visited to identify the foreseen use, to identify the solutions used and, when possible, to improve them.

The wastewater, containing a high percentage of grease, has to be treated in a grease separator. The resulting water can be merged downstream with the remaining flow.

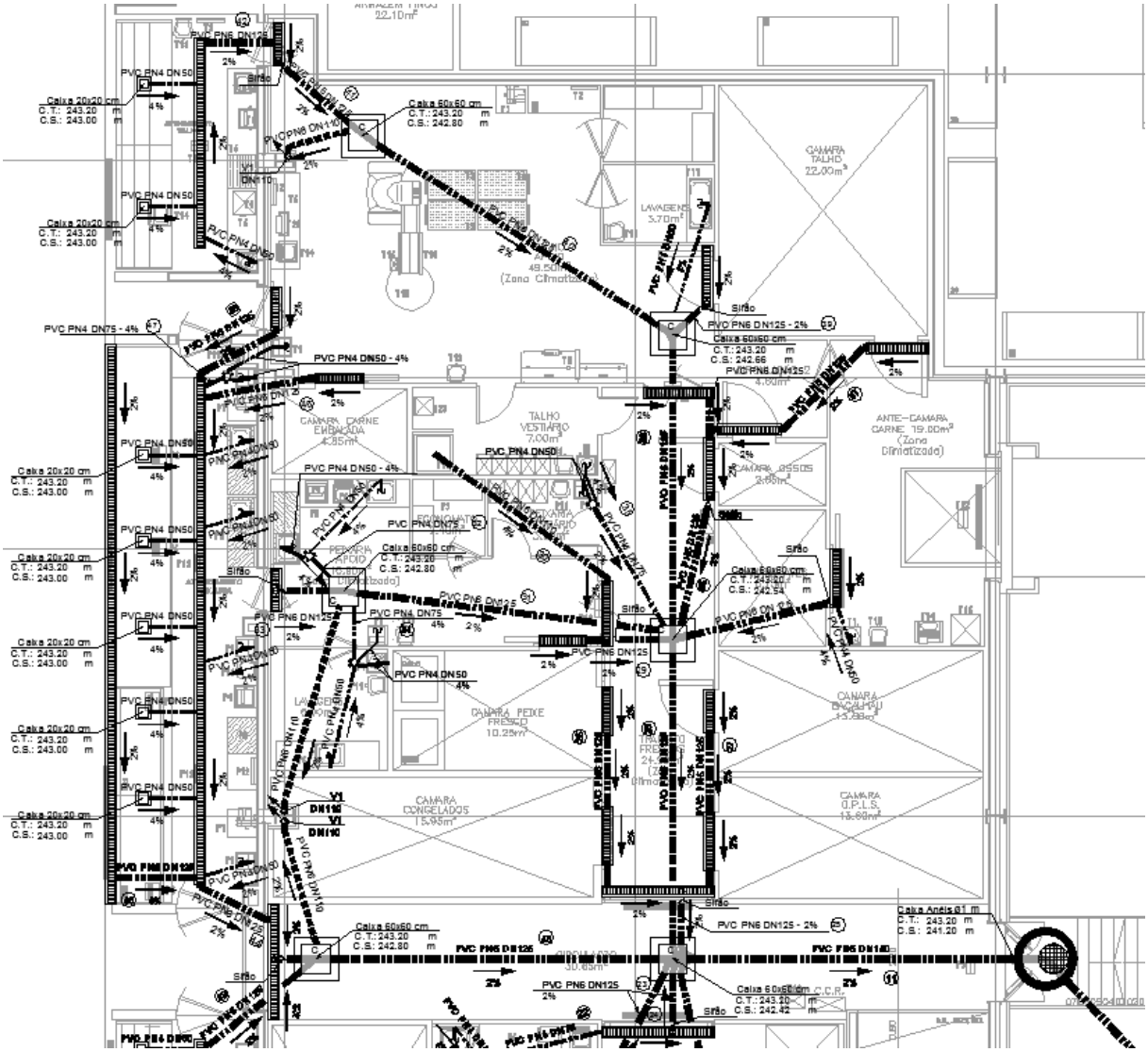


Fig.62 – Greasy wastewater drainage network

The rainwater collection is also an important part of this project as there is a big exterior parking lot to be drained, in addition to the roof (see figure 63). This is done through cast iron drains connected to piping system installed in the ceiling of the level beneath. In some areas, where there is risk they may be damaged by the circulation of the vehicles, the plastic pipes have mechanical protection.

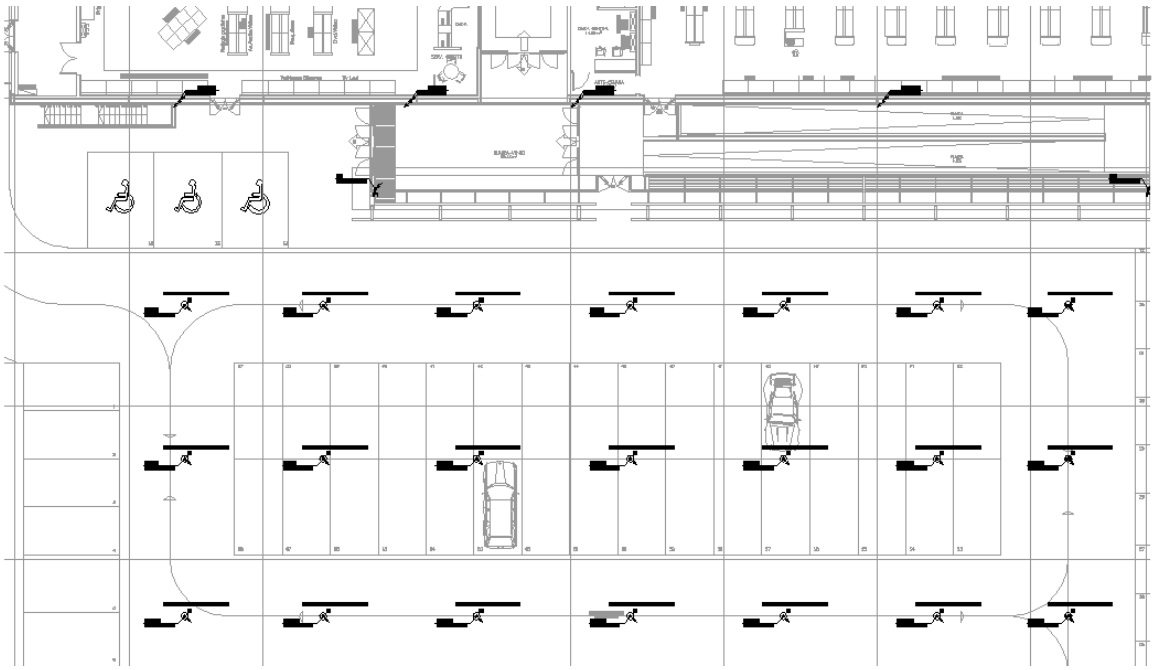


Fig.63 – Parking lot rainwater drainage

One of the initial conditions imposed by the municipal services for the issuing of the construction permit was that the exterior infrastructures for the connection to the public sewerage system would have to been include in the construction works to be done. Therefore, these infrastructures were foreseen (figure 64).

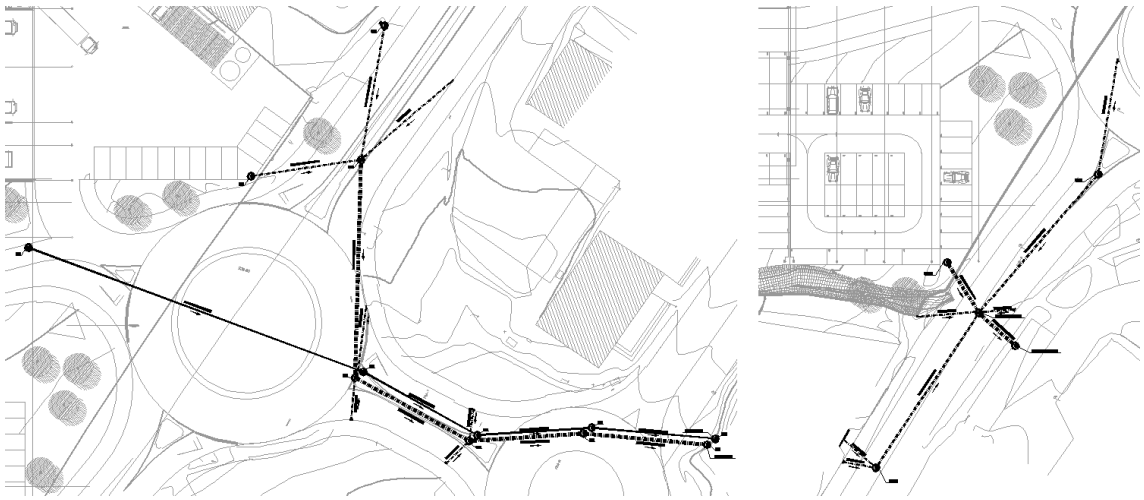


Fig.64 – Exterior infrastructures for the connection to the public sewerage system

The longitudinal profiles are important to complement the information given by the exterior infrastructures plant (see figure 65). They include the terrain morphology, the manholes and the pipes with the necessary inclination to guarantee the flow and tractive tension, which prevents or reduce excessive deposition of solid material in the sewers. The design is done avoiding burying too much the pipes. This will reduce the excavation volume. Of course that a minimum depth (usually 1 meter) has

to exist for protection and too allow to other more superficial infrastructures to be installed, such as the piping for gas and water supply and the communication cables.

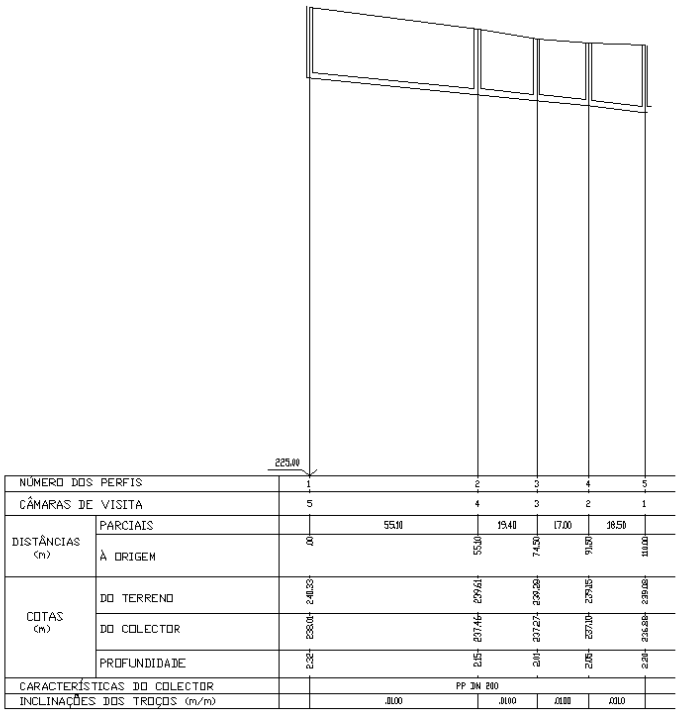


Fig.65 – Longitudinal profile

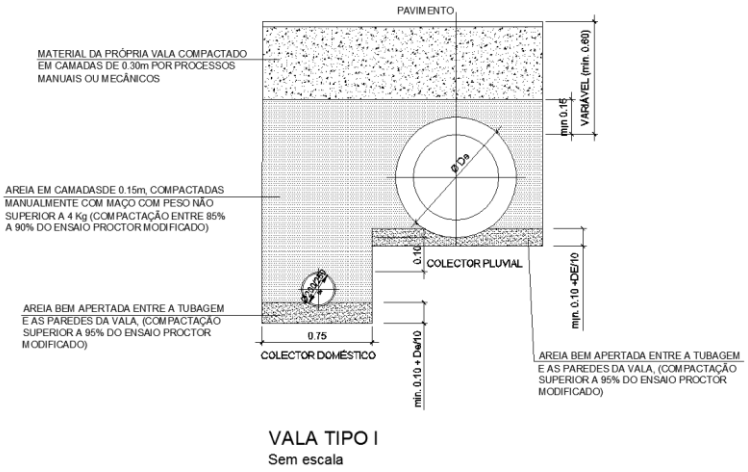


Fig.66 – Typical buried pipe installation

3.11.3. CEN/TS 15223:2008 - PLASTICS PIPING SYSTEMS - VALIDATED DESIGN PARAMETERS OF BURIED THERMOPLASTICS PIPING SYSTEMS [23]

The structural stability of buried pipes is usually not a concern for the designer. It is assumed that, if the pipe is properly installed and the soil duly compacted, they will not suffer deflection.

This is not entirely true as the conditions such as type of soil and depth do change along the network and, what can work in one situation, can be shown inadequate in another.

In Europe several design methods exist and some are still under development. The plastics pipes industry has carried out a lot of research with full-scale trials. From these research graphs have been made that shows the deflection in the pipes immediately after installation. Also the so-called settlement period is measured. This settlement will always take place. In case that heavy traffic is present, the final deflection will be reached faster.

This technical specification (CEN/TS 15233), drawn up by CEN/TC 155 "Plastics piping systems and ducting systems" brings all this European expertise together. Since some of the methods are still under development, the document does not yet have the status of European Standard (*EN*). This means that conflicting national standards may continue to exist. The document includes thermoplastics pipe material related properties and design topics to be taken into account when carrying out any static pipe calculation.

This *TS* can be used to give guidance to applying structural design of thermoplastics piping systems applications. Furthermore, since this method is based in long term experience, the technical specification can be also used to justify and/or verify of any structural design method.

3.12. RESIDENTIAL CONDOMINIUM – TALATONA - ANGOLA (FEVEREIRO 2008)

Fig.67 – Residential Condominium

3.12.1. DESCRIPTION

The Talatona Plaza Residence is a private condominium in South Luanda, Angola. It is composed not only by apartments but also by commercial areas.

The building, with four independent blocks, accommodates 128 apartments, from two to four bedrooms each, and 19 commercial stores. On top of that, there are several services such as a private pool, a kindergarten and service locker rooms.

The disciplines developed by the author were:

- Water Supply
- Drainage

3.12.2. DRAINAGE

This project covers the drainage of the domestic waste and rainwater through traditional gravity systems using thermoplastic plastic, elevated or buried. The above-ground floors of the building follow a similar organization. As far as possible, the location of the technical areas is kept from floor to floor, allowing the verticality of the discharge stacks.

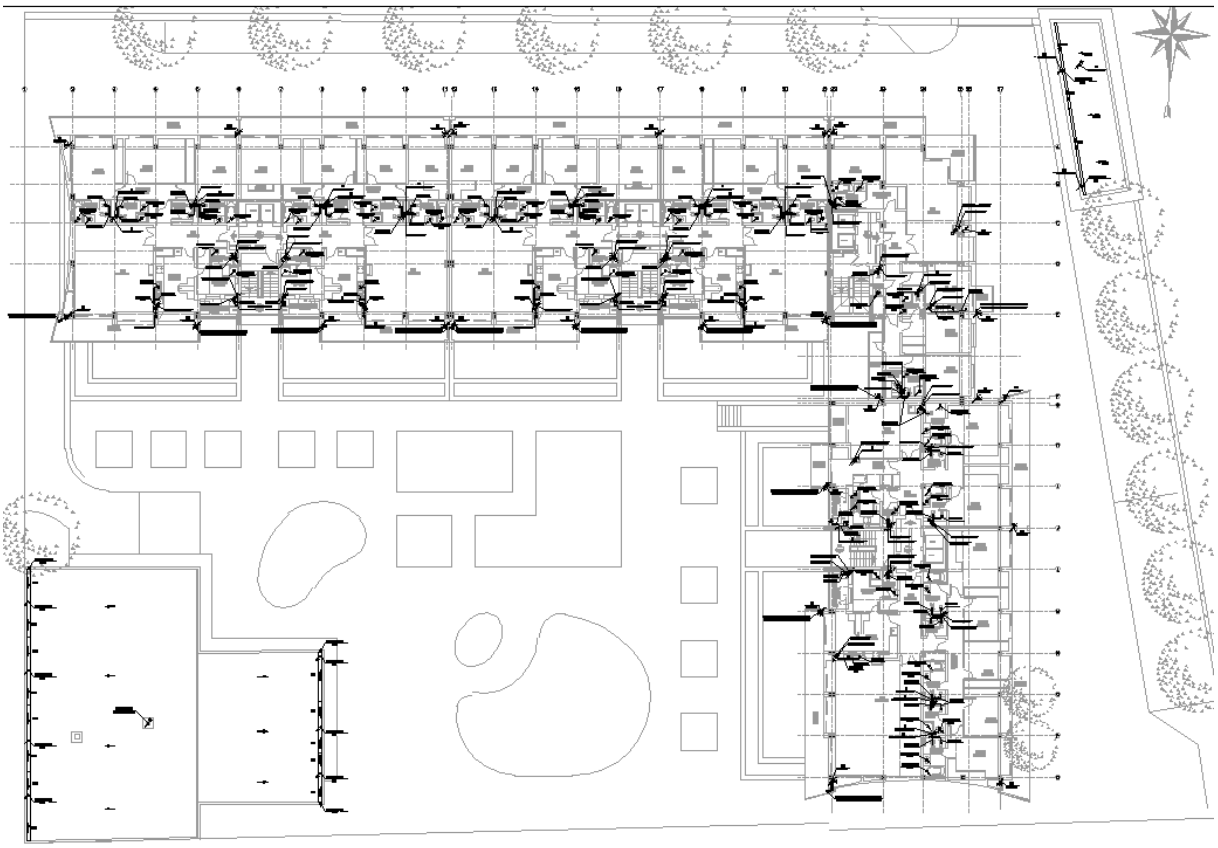


Fig.68 – Drainage of the above ground floors

In order to improve the performance of domestic waste water drainage system, the primary discharge stacks are ventilated by secondary ventilation stacks. The installation follows the traditional configuration (figure 69).

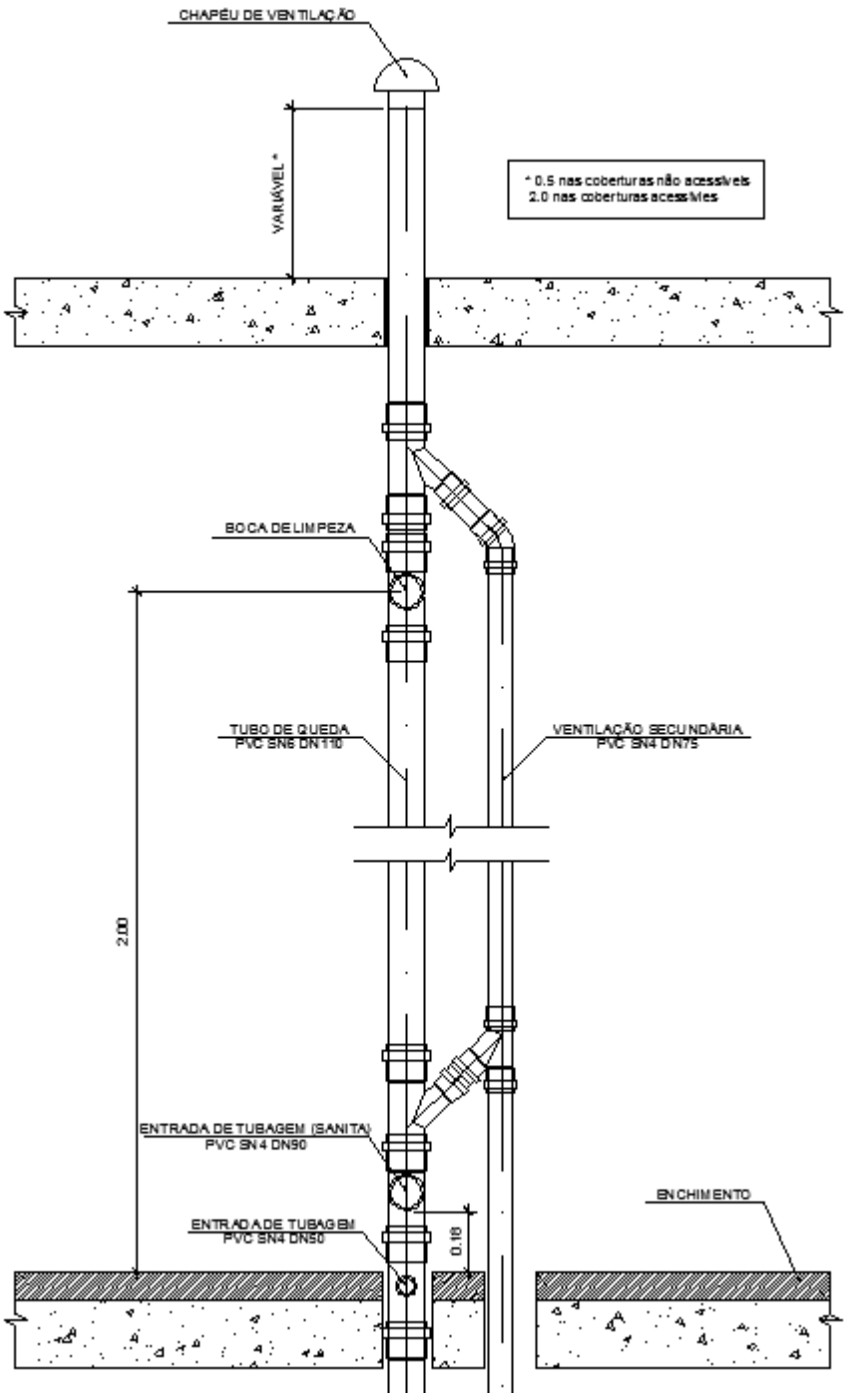


Fig.69 – Ventilation with secondary stack

This project covers not only the "L" shaped building as such but also its exterior and the below ground parking lot.

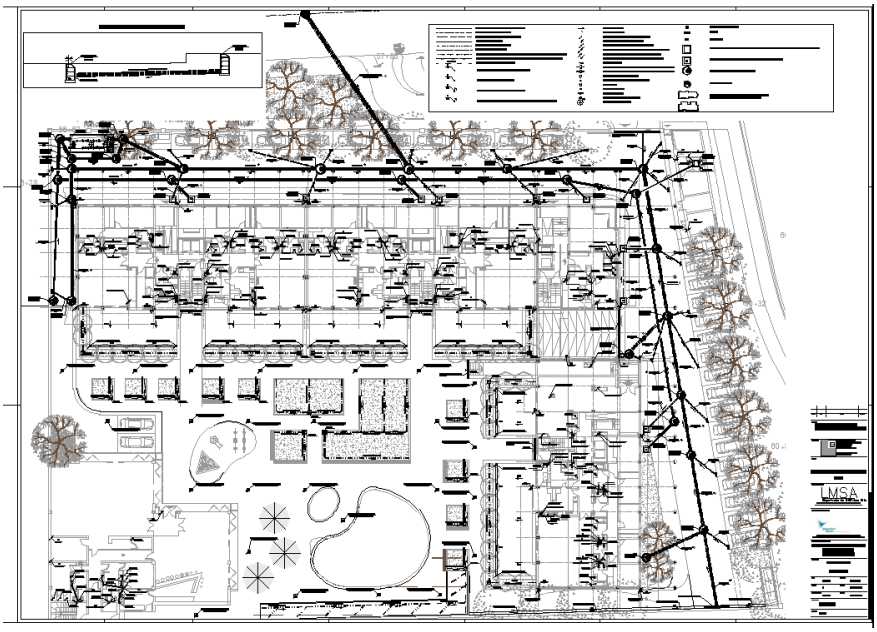


Fig.70 – Drainage at the ground floor level

The drainage of the parking lot, located in the below-ground floor (figure 71), is done at two levels:

- Above the concrete slab, to collect the washing water through the cast iron drains;
- Under the concrete slab, to collect the soil water throughout the perforated plastic drains installed in gravel and wrapped up in geo-textile membrane to avoid the small soil particles to get in. This underneath drainage will avoid infiltration problem and reduce the hydrostatic pressure in the structure.

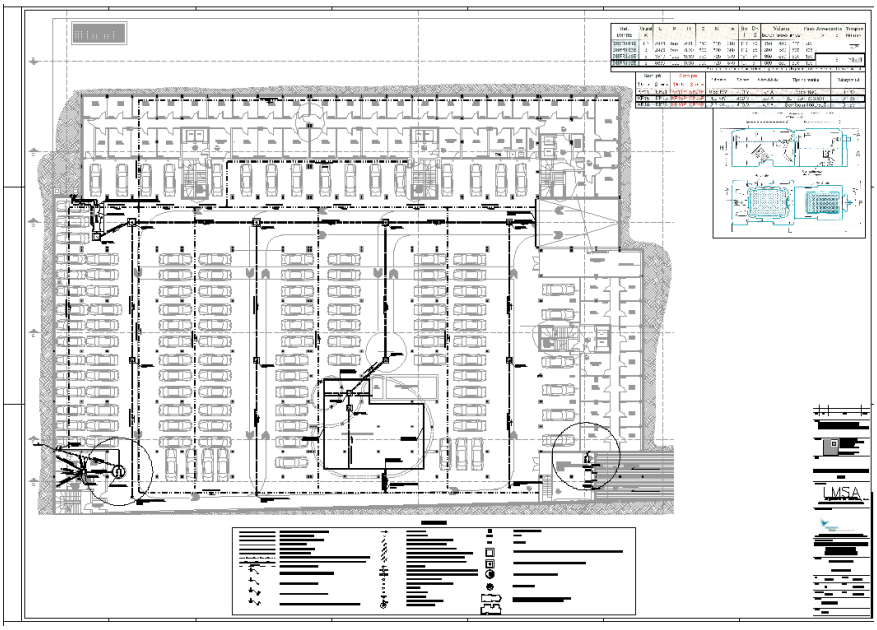


Fig.71 – Drainage at the under-ground level

The water volume collected by the by the parking lot drainage system will be treated by the buried hydrocarbon separator, which will remove light liquids such oil and petrol (figure 72). The decontaminated effluent will pumped into de rainwater drainage gravity network above.

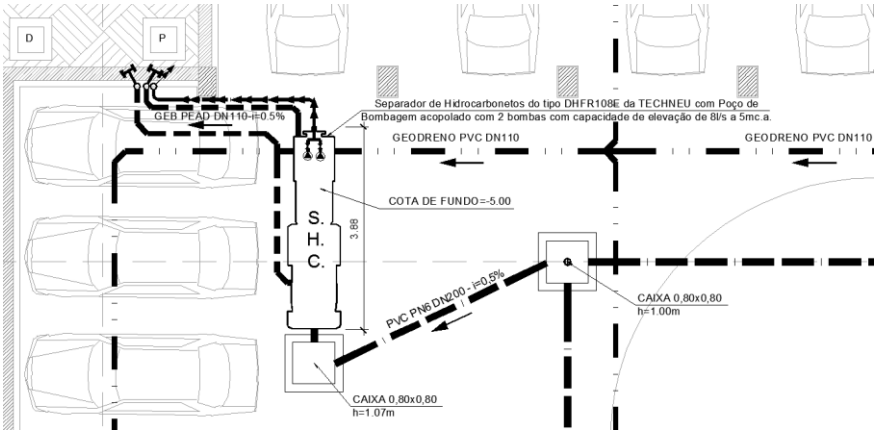


Fig.72 – Hydrocarbon separator installation

The selection of the adequate separation equipment was done going through a technical catalogue of a manufacturer and selecting the model with required characteristics for this situation, in particular:

- the flow treatment capacity;
- the pump capacity (pressure and flow);
- the physical dimensions;
- miscellaneous (alarm system, cover extension, structural resistance, etc).

Ref. DHFRE	Caudal l/s	L	P	H	E	S	Fe	Dn 1	Dn 2	Volume Decantador	Volume Separador	Volume Bombagem	Peso	Acrescentos A	Acrescentos B	Tampas Número
DHFR101E	1,5	2420	980	830	540	530	300	110	50	150	440	350	85	1	1	
DHFR103E	3	2420	980	1090	800	790	300	110	65	300	530	500	105			
DHFR106E	6	3510	1000	1090	730	720	370	160	65	600	850	800	180		3	
DHFR108E	8	3880	1000	1090	730	720	370	180	80	800	850	800	195			

As dimensões são em milímetros, os pesos em quilogramas, os volumes em litros (volume útil).

Sem pé		Com pé		Potência	Tensão	Intensidade	Tipo de bomba	Tubagem (s)
1 bomba	2 bombas	1 bomba	2 bombas					
KP11	KP21	KP11P	KP21P	0,55 kW	230 V	3,9 A	Nova 600	Dn 40
KP15	KP25	KP15P	KP25P	1,5 kW	400 V	3,3 A	Semisom 800/50T	Dn 65
KP18	KP28	KP18P	KP28P	2,2 kW	400 V	4,9 A	Semisom 1000/50T	Dn 80

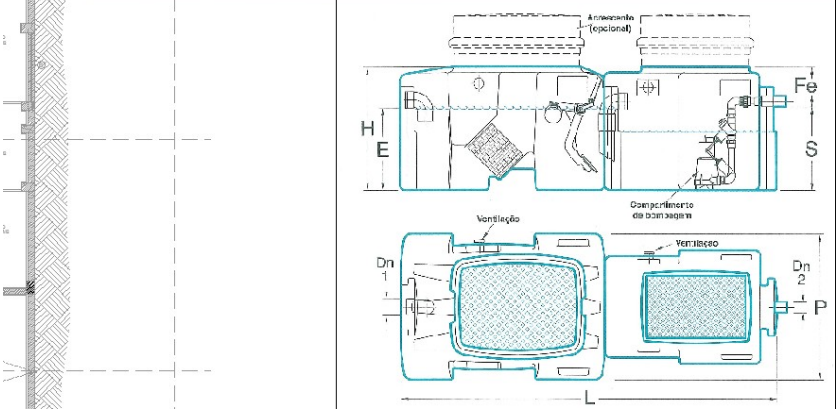


Fig.73 – Hydrocarbon separator selection

3.12.3. EN 858-2:2003 - SEPARATOR SYSTEMS FOR LIGHT LIQUIDS (E.G. OIL AND PETROL) - PART 2: SELECTION OF NOMINAL SIZE, INSTALLATION, OPERATION AND MAINTENANCE [24]

As referenced before, usually the separator system for light liquids is selected from a manufacturer´s technical catalogue taking into consideration the relevant characteristics. This could be justifiable by the civil engineer designers´ lack of knowledge on this type of equipments. Therefore, its selection is often done with the support of the manufacturer. This will guarantee that the selected equipment will, in fact perform adequately when installed. On the other hand, the project stays bound to a specific range/brand of equipments. Moreover, because the selection criteria and requirements are not set in the project, it is not possible for the contractor to make a different selection from the one imposed in the project. This can lead for to an exclusion of the project in a public contest.

Separator systems are used in a wide variety of situations to fulfil a number of different requirements. The European Standard on this matter (EN 858-2), prepared by Technical Committee CEN/TC 165 "Wastewater engineering", can help designers to establish why a separator system is needed and what specific function it is expected to fulfil before selecting the appropriate size and type of installation.

An adequate selection of the separator should not only take into consideration its size but also other characteristics such as:

- Configuration to meet effluent quality requirements (sludge trap, bypass, sampling shaft, etc);
- Automatic warning devices and electrical devices;
- Pipes and connections;
- Place of installation;
- Protection against escape of light liquids;
- Connection to the drainage system.

3.12.4. EN 12056-2:2000 - GRAVITY DRAINAGE SYSTEMS INSIDE BUILDINGS - PART 2: SANITARY PIPEWORK, LAYOUT AND CALCULATION [25]

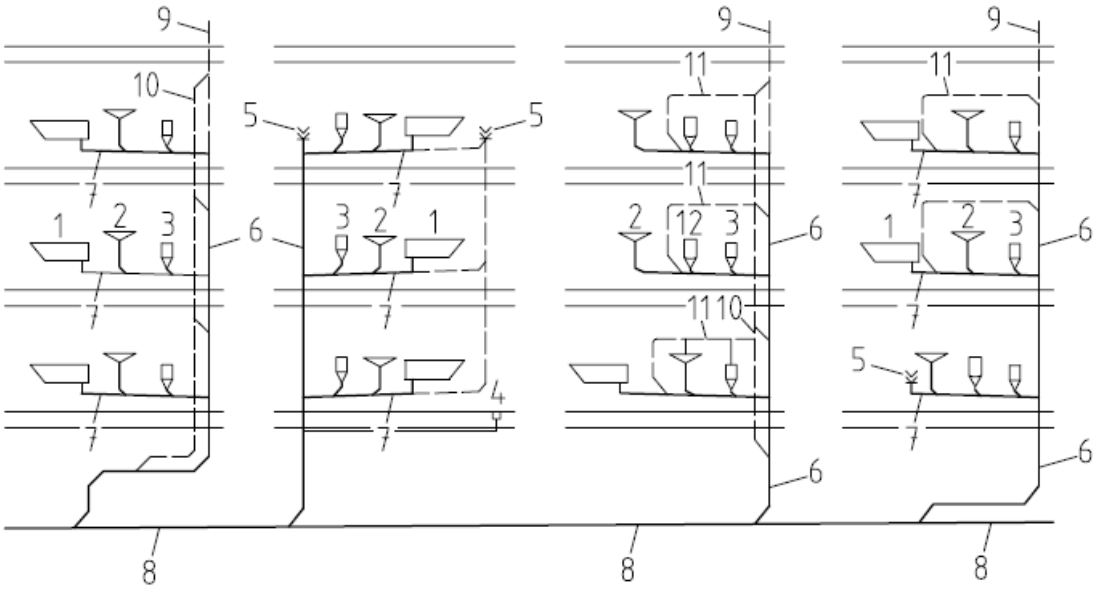
This European Standard, also draw up by CEN/TC 165, is of difficult application as almost all countries have contradicting nationals and local regulations and practices in what regards the design of sanitary pipework. The list of these documents is presented in the informative Annex A. This inventory is not exhaustive and only ten countries figurate in it (Austria, Belgium, Denmark, France, Germany, Ireland, Italy, Netherlands, Sweden, Switzerland and United Kingdom).

Portugal also has a regulation in place for gravity drainage systems [9], although it is not listed in Annex ZA. The regulation conflicts with the standard in several aspects, in particular:

- the standard design uses discharge units (DU) instead of discharge flows (l/s);
- the values as such are different (e.g. 1,5 l/s for toilet in regulation against 2 or 2,5 in standard – depending on the system);
- different factors (frequency factor in the standard against the simultaneity factor in the regulations);
- different minimum pipe diameters.

As consequence, it is impossible to approve a project developed following EN 12056 with the Portuguese authorities. Of course, designers could still use it in project such as this one, in Angola, where usually there is no authority checking the drainage project. This would mean to readapt their tools and design procedure to the standard. As this would be a burden, the Portuguese regulation [9] is usually the one used in Angola.

So now one may ask what is the added value of using this standard? As seen previously, the design method foreseen in the standard is so different that no correlation is possible with the regulation in place. Still, this standard brings very interesting schematics for ventilation solutions that deviate from the typical main stack with a secondary ventilation, some of them using air admittance valves (figure 74).



Legend:

1	Bath
2	Wash Basin
3	WC
4	Floor Gully
5	Air Admittance Valve
6	Stack
7	Branch Discharge Pipe
8	Drain
9	Stack Vent
10	Ventilating Stack
11	Branch Ventilating Pipe
12	Urinal

Fig.74 – Secondary ventilated system configurations

Although, not yet very known in Portugal, this type of equipment is widely commercialized by big manufactures like "Geberit" (see figure 75).

Fig.75 – Air admittance valve "Geberit Bon Air"

The admittance valves can improve the overall as it provides air to the system at the end of very long branches or in the case where the access to exterior is not accessible to make the primary ventilation.

These solutions are usually accepted by the authorities as they only complement and improve the ventilation requirements defined in the regulation.

3.13. HOTEL WESTIN CAMPO REAL – TORRES VEDRAS (JULY 2005)

Fig.76 – Hotel Westin Campo Real

3.13.1. DESCRIPTION

Situated on the Portugal coast, around 45 km north from Lisbon, this resort includes a hotel with 151 rooms, including 10 suites and a Royal Suite. The hotel has 3 restaurants and 2 bars.

The construction area totals 11.000 m^2 with a value of 7.5M €.

The disciplines developed by the author were:

- Water Supply
- Drainage
- Gas Supply

3.13.2. DRAINAGE

Being a hotel, the main domestic waste water drainage pipework can be found in the bedrooms. Therefore, it was important to find and optimized installation scheme for each room that then would be replicated in the 151 rooms (see figures 77 and 78). For this task, several factors had to be taken into account:

- the use of the suitable pipework diameters;
- the coordination with the architect. In this case, no layer was foreseen in the floor as all pipework will be installed in the walls. Their thickness was adjusted accordingly;

- the coordination with the other disciplines to assign the locations of the networks in the common technical spaces (e.g. for the location of the room drainage and ventilation stack).

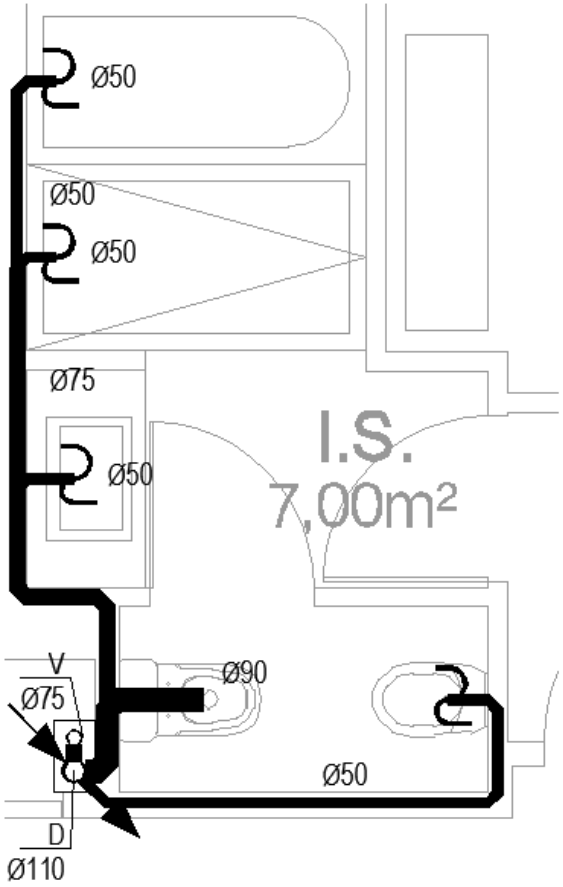


Fig.77 – Domestic waste water drainage pipework in the rooms

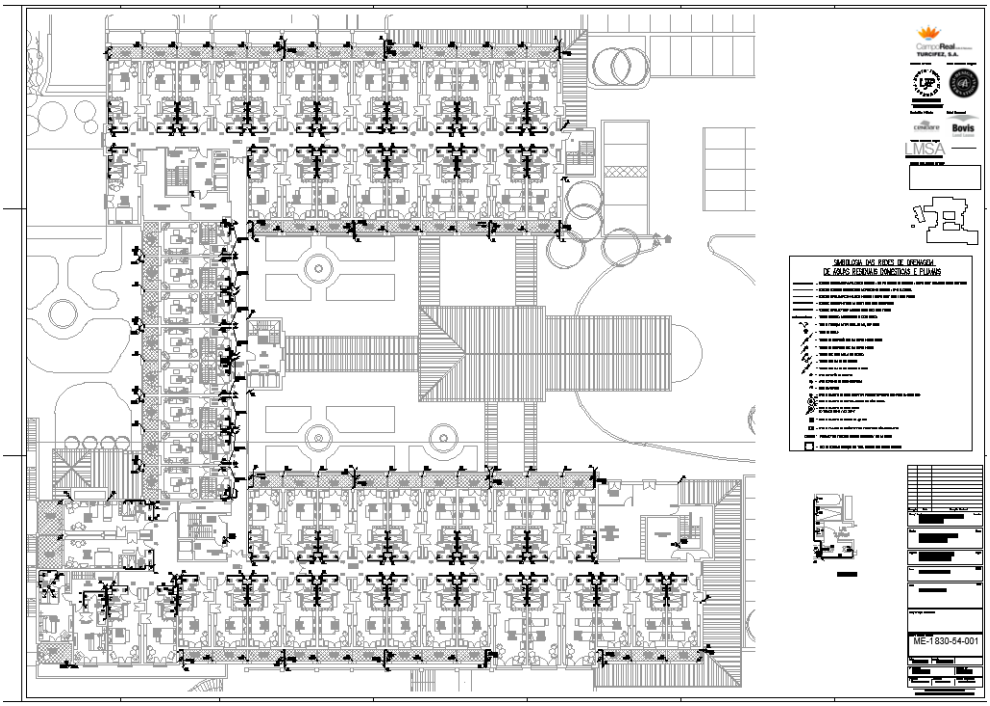


Fig.78 – Replication of the room drainage scheme

The exterior infrastructures are also included in this project, making the connection to the public wastewater and rainwater drainage systems (figure 79).

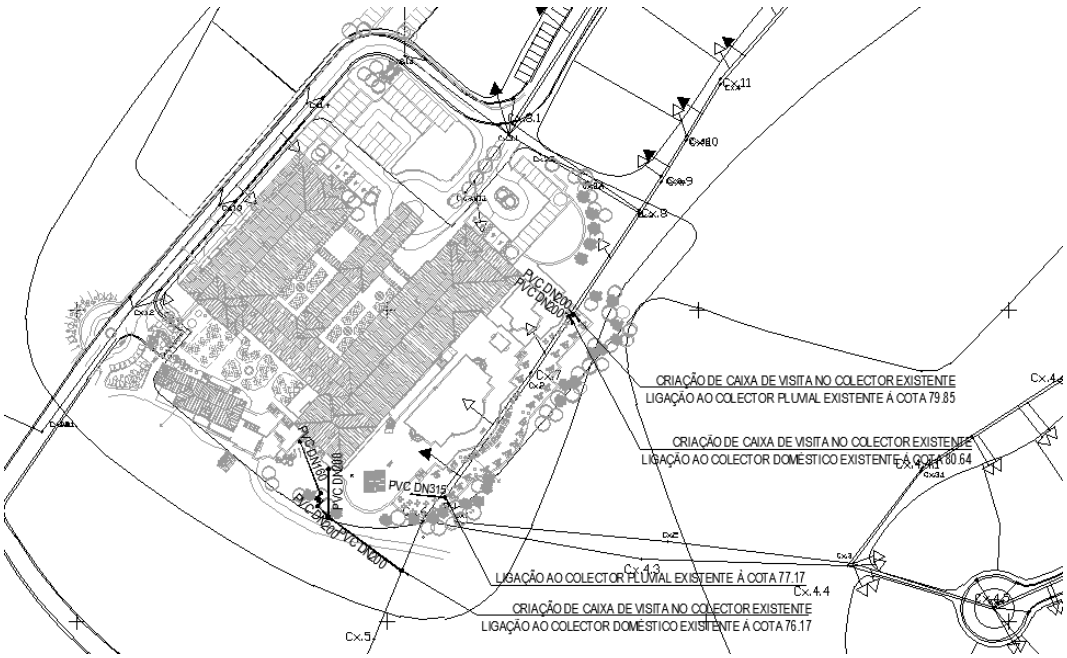


Fig.79 – Connections to the public drainage systems

In particular, one of these is the connection of the independent drainage network that collects the greasy wastewater coming from the hotel kitchen. Very greasy wastewater puts the pipe systems and drainage equipment at risk. Grease and oils are deposited with other wastewater components on the walls of the pipes and can lead to corrosion, blockages and noisome smells.

For that reason, this waste wastewater passes through a grease separator, buried in the exterior of the hotel (see figures 80 and 81). The separation is done by gravity, as grease has a lower density than water.

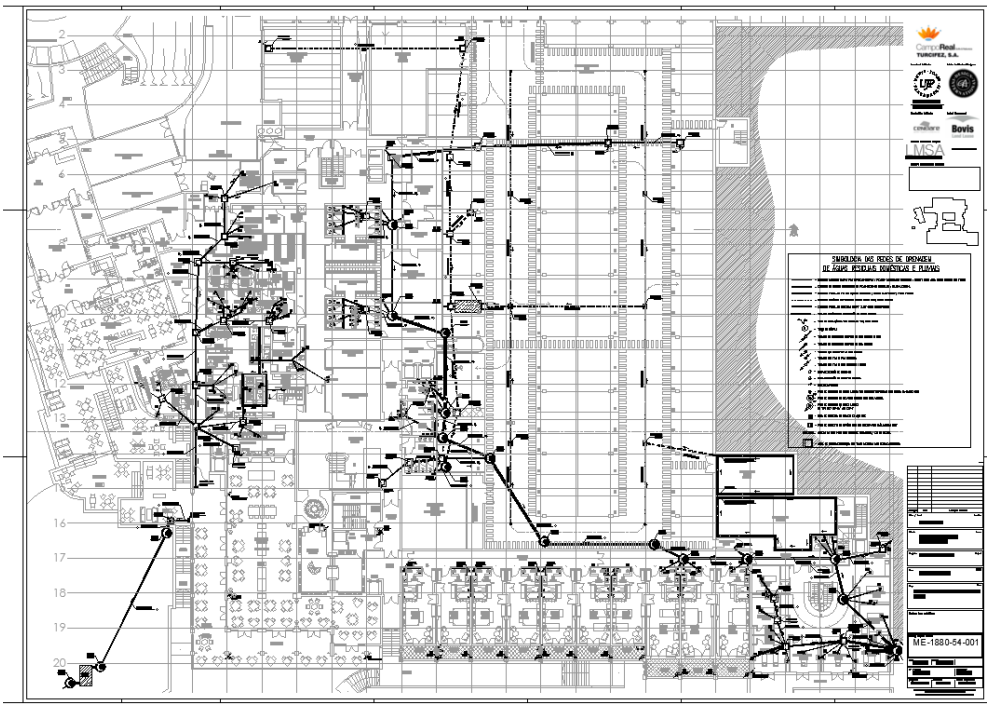


Fig.80 – Hotel drainage at the ground level

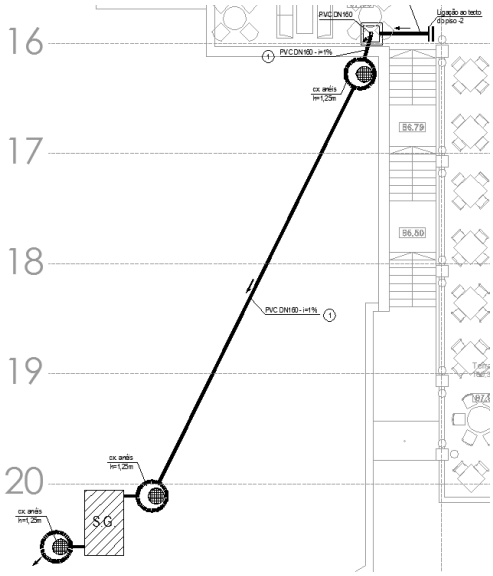


Fig.81 – Grease separator installation in the exterior

The situation previously described, concerning the separator systems for light liquids, is also applicable to the grease separators. The selection of the equipment was done with the assistance of the manufacturer, who even provided the technical drawings to be include in the project.

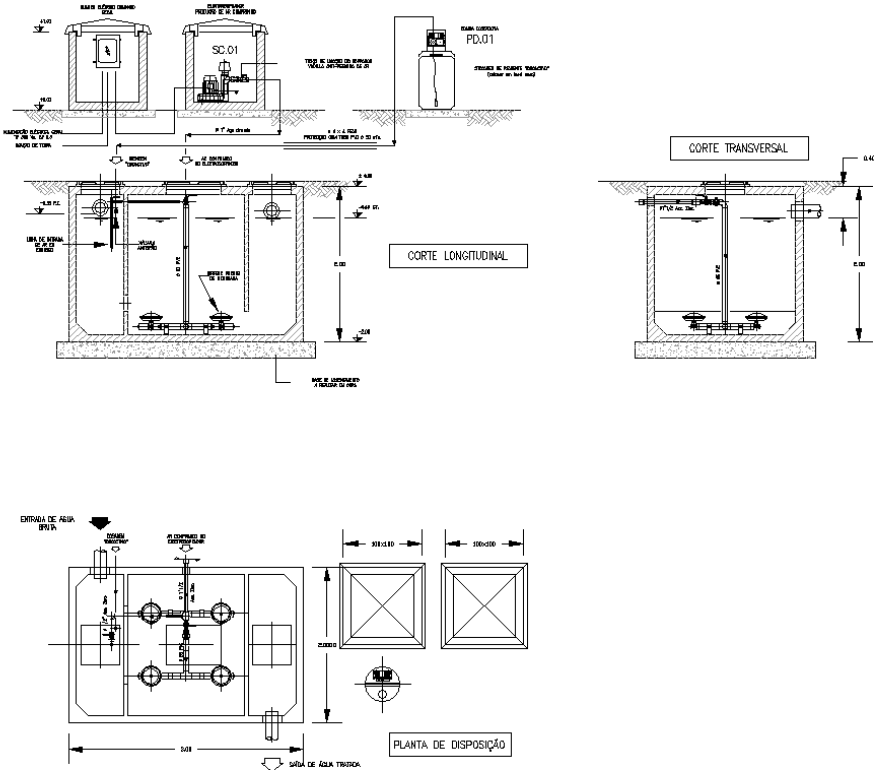


Fig.82 – Grease separator technical drawings

3.13.3. EN 1825-2:2002 - GREASE SEPARATORS - PART 2: SELECTION OF NOMINAL SIZE, INSTALLATION, OPERATION AND MAINTENANCE [26]

The same way EN 858-2 [24] can help designers to establish why a separator system for light liquids is needed and what specific function it is expected to fulfil before selecting the appropriate size and type of installation, EN 1825-2 performs the same objective regarding the grease separators.

However, the selection of the equipment size can be more complicated as aspects have to be taken account, other than the maximum flow rate of wastewater. The characteristics of the flow are important as well:

- maximum temperature of the wastewater;
- density of grease/oils to be separated;
- influence of cleansing and rinsing agents.

The standards also gives important guidance on the place of installation and ventilation of the equipment.

3.14. MUNICIPAL STADIUM – OEIRAS (FEBRUARY 2004)

Fig.83 – Municipal Stadium

3.14.1. DESCRIPTION

In this project, the construction of the West stand was foreseen. It not only extended the seating capacity by 4.300 but also improved the supporting facilities.

During its development, its integration in the surrounding environment was taken into account as it located inside of a municipal park called “Parque dos Poetas”.

The disciplines developed by the author were:

- Water Supply
- Drainage

3.14.2. DRAINAGE

This projects covers, not only the new West stand, but also the the full refurbishment of the sanitary installations in the rest of the stadium. This includes the interior pipework installation and also a new exterior network.

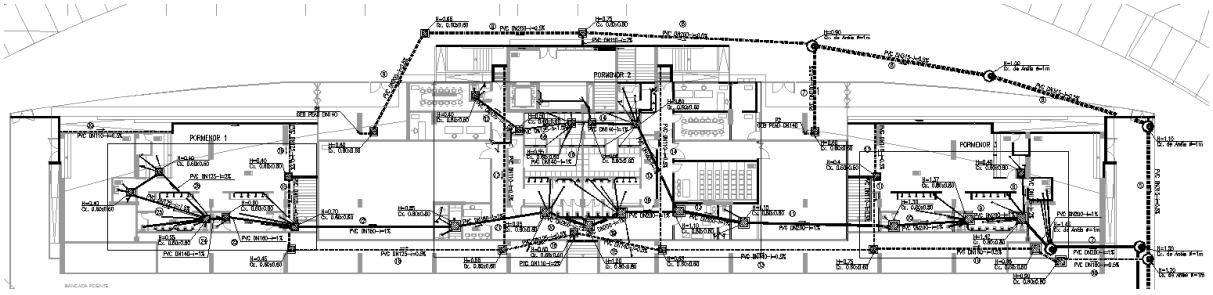


Fig.84 – West stand drainage systems

The rainwater system was also changed. New channels were foreseen to improve the water collection in the exterior areas and in the lower areas near the stairs. The adoption of the drainage channels was chosen as preferable solution. As described in the drawings, the channel to be installed outside the building will be the "ACO DRAIN S1000K" or equivalent, made of polymer concrete with an F class grate in cast iron.

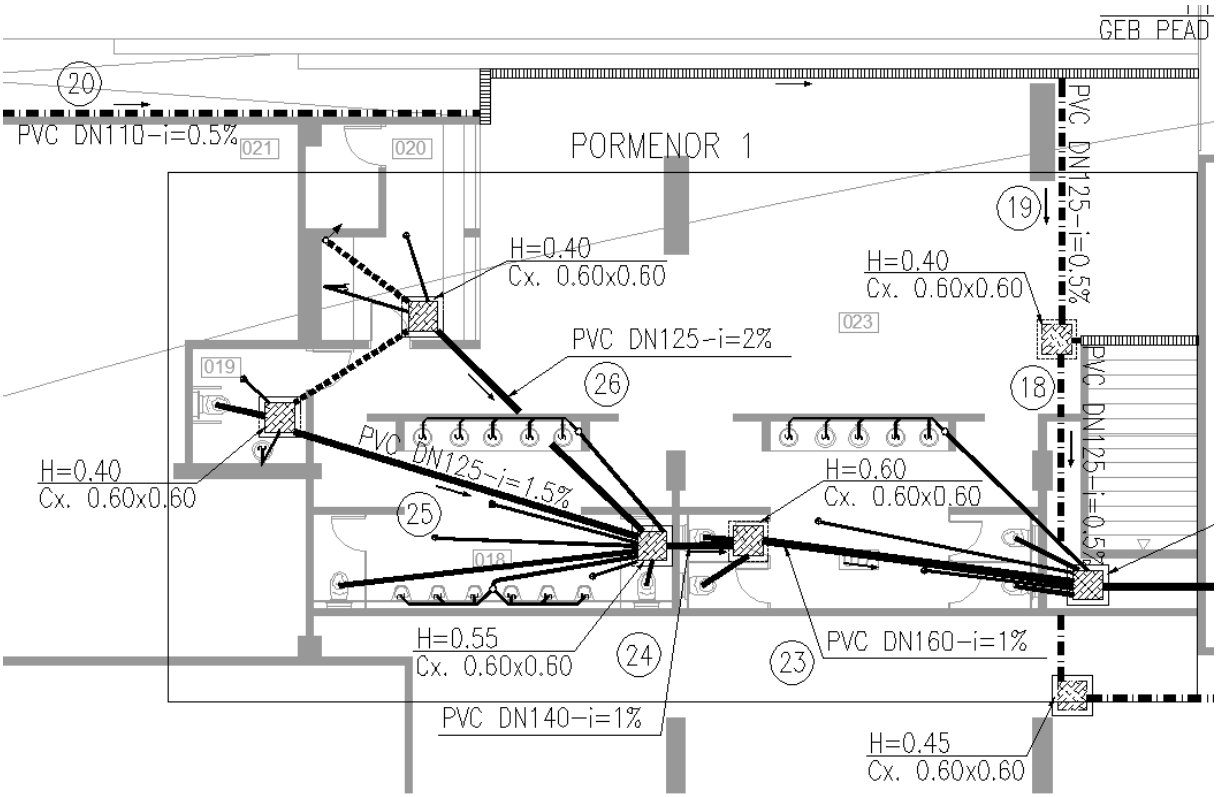


Fig.85 – Toilet drainage and rainwater drainage using channels

The roofing rainwater drainage could not be done using the traditional system. Usually a drain can cover an area from 40 to 60 m^2, depending on the water layer thickness. This would imply a huge number of those. Moreover, the drainage pipework network beneath the roofing would need to have big diameters. This could be solved by dividing it in several independent systems but that would imply to have a bigger pipework length and more discharge stacks.

The solution was to use a syphonic rainwater drainage system that allows to increase the amount of rainwater discharge and coverage area by drain. This can go from 200 to 400 m^2, depending on whether the roof outlets being used are the ones with 12.5 l/s or 25 l/s capacity.

The pipe diameters can also be reduced by half, in general. This is achievable because this system works with no air in it, which provokes a negative pressure. The negative pressure in the pipe withdraws the rainwater by suction, instead of merely allowing it to drain away, and also ensures and improved self-cleaning function.

The conditions to make the system work are basically the following:

- A correct pipeline system dimensioning,
- An arrangement of the roof outlets to balance its pressure. If this is not done properly, one of drains will "suck" the water faster than the other to the point when the water layer above it

will be reduced below the minimum to work properly (usually 40 mm). At the point, air will get into the system making it work as a conventional one;

- The roof outlets technology as such, which allows only water getting in the system until it is completely full. In a way, the outlet has a air purging capacity.

The design and installation of these systems is so sensitive that usually the manufacturers not only install them but also have design services. This can assure reliability on one hand but, on the other hand, it creates a dependency on the manufacturer. In some situations where changes are needed or when the project delivery deadline is too tight, it can be a problem.

For this project, the system selected was the "Geberit Pluvia". Although there as other syphonic systems available in the market, Geberit it is still most know one, with decades of experience and many syphonic roof drainage systems in place. Despite the fact that its calculation software is available ("GeberitProPlanner") the design of this system was done the support of its design services.

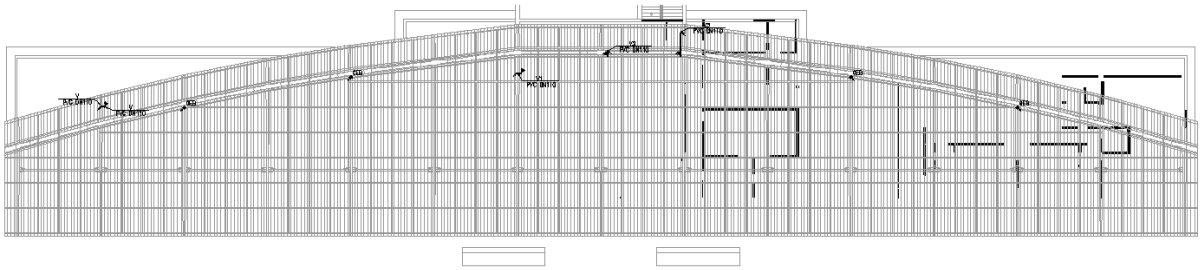


Fig.86 – West stand with syphonic rainwater outlets

3.14.3. EN 1433:2002 - DRAINAGE CHANNELS FOR VEHICULAR AND PEDESTRIAN AREAS - CLASSIFICATION, DESIGN AND TESTING REQUIREMENTS, MARKING AND EVALUATION OF CONFORMITY [27]

In resemblance to what happens in Architecture projects, some of the materials foreseen in the engineering are described by making reference to a specific model or brand instead of requesting for specific characteristics, which could allow all the suitable manufacturer to supply. This can only be achieved if designers include in the project which are the essential characteristics that the manufacturer should list in CE marking and which are their acceptable performances. Then it would be easy for the buyer (contractor) to ask to make a product selection by comparing the CE marking of products proposed by manufactures or distributers.

The involvement of all economic operators to the successful implementation of the Construction Products Regulation (*CPR*) is clearly stated in whereas (41):

"All economic operators intervening in the supply and distribution chain should take appropriate measures to ensure that they place or make available on the market only construction products which are in compliance with the requirements of this Regulation, which aim to ensure the performance of construction products and fulfil basic requirements for construction works. In particular, importers and distributors of construction products should be aware of the essential characteristics for which there are provisions on the Union market, and of the specific requirements in Member States in relation to the basic requirements for construction works, and should use this knowledge in their commercial transactions."

It should be reminded that, if a standard is published on the Official Journal of the European Union (*OJEU*) under the Construction Products Regulation (*CPR*), then the fixing of the CE marking and the

drawing up of the declaration of performance (*DoP*) is mandatory of all the construction products covered by its scope and identified as being part of the product families list table ZA.1, according to the following articles:

- "Article 4 (1) When a construction product is covered by a harmonised standard or conforms to a European Technical Assessment which has been issued for it, the manufacturer shall draw up a declaration of performance when such a product is placed on the market.";
- "Article 9 (1). The CE marking shall be affixed visibly, legibly and indelibly to the construction product or to a label attached to it. Where this is not possible or not warranted on account of the nature of the product, it shall be affixed to the packaging or to the accompanying documents."

The scope of the standard can be wider that the products listed in Annex ZA, as some parts of the standard may be only voluntary without addressing any legal requirements

For the specific case of drainage channels, there a harmonized standard cited on the *OJEU*: EN 1433. Therefore, drainage channels of Type M and Type I, for the collection and conveyance for surface water from areas subject to pedestrian and/or vehicular traffic, are covered by the *CPR* provisions (a type M drainage channel requires additional support to accommodate the vertical and horizontal loads in services while a type I channel does not).

The definition of the product families, the intended uses, the essential characteristics and the *AVCP* systems (Attestation and Verification of Conformity of Performance) are decided by Commission Decisions. Then, all this information is compiled in a mandate (now standardization request under Regulation 1025/2012 [2]) and sent to the concerned *ESO*(s) for acceptance. The mandates are publicly available on the European Commission website [28].

EN 1433 was developed by CEN/TC 165 under the mandate M/118 "Mandate to CEN/CENELEC concerning the execution of standardisation work for harmonized standards on waste water engineering products related to the following end uses:

- 18/33: Drainage (inc. Highways) and proposal of other liquids and gaseous waste;
- 32/33: Sanitary and cleaning fixtures."

If one compares the request made by mandate with the result delivered (candidate harmonized standard), probably will find that are not perfectly in line. This happens because, at the mandate acceptance or during the standard development, the concerned technical committee may suggest changes to the content of the mandate. These proposals are the "answers to the mandate" and have to be approved by European Commission. In this process, the European Commission has the support of the so called "CEN Consultants", which are external and independent. Regardless of this designation, these consultants work for the *EC*, although maintaining a close collaboration with the CEN and CENELEC work. Their main tasks are:

- To give guidance to the technical committees on the relevant piece of legislation (Directive or Regulations);
- Make a formal assessment on possible "answers to mandate" assuring that the provisions stated in the piece of legislation are being fulfilled;
- Guarantee that the candidate harmonized are in line with the mandate and latest answer through a formal assessment. Without his formal approval, the standard reference will not be sent to the *EC* to be cited on the Official Journal.

Coming back to EN 1433 and to the drainage channels, table ZA.1 lists the Essential Characteristics for this specific product (for a specific intended use).

Table 3 – Content of the table ZA.1 – Relevant clauses for product Type M and Type I

Product: Drainage channel Type M and Type I as covered under the scope of this standard. **Intended use:** Collection and conveyance of surface water from areas subject to pedestrian and/or vehicular traffic.			
Essential Characteristics	**Requirement clauses in this and other European Standard(s)**	**Levels and/or classes**	**Notes**
Water-tightness — jointing of drainage channels	7.5.1	None	no leakage
Load bearing capacity, deflection under load — maximum load — Permanent set	 7.15 7.16	 None None	Results shall be expressed according to clause 4. Shall be in accordance with Table 11.
Durability	6	None	For weathering resistance of precast concrete units the results shall be expressed according to Table 1.

The designers, rather than selecting a drainage channel by its brand or model, should indicate what the performance levels necessary for the relevant characteristics (being these essential characteristics among them). The requested performance levels can be the minimum required by law or another one, higher that the designer decides to be necessary for technical or quality reasons. This will allow, to the buyer/contractor to compare the characteristics of several products in the market and select the most advantageous. The CE marking guarantees that all the Essential Characteristics were tested under the same conditions and that therefore the declared performances are comparable. In the end, this is the big objective behind the *CPR*, to promote the competitiveness and innovation in the construction sector.

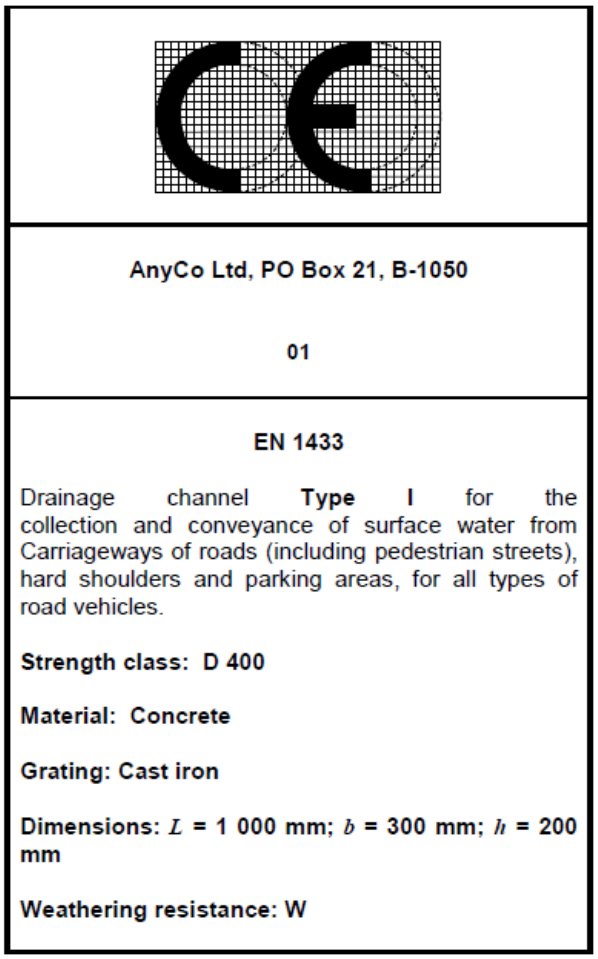


Fig.87 – CE marking example following EN 1433

EN 1433 is a harmonized standard, cited on the *OJEU* under the *CPR*. This does not mean that all its clauses support this Regulation. In fact, only those referenced in the Annex ZA do so. The remaining part of the standard is strictly voluntary giving guidance to the designer in several aspects, among others:

- the selection of the correct load class for the a specific installation;
- the selection of the suitable material for the channel and grating/cover.

Supplementary requirements for concrete products submitted to very severe freeze-thaw conditions with standing water containing de-icing salts can be found in the normative Annex B.

3.15. HOTEL OLISSIPO – LISBON (JANUARY 2004)

Fig.88 – Hotel Olissipo

3.15.1. DESCRIPTION

The Hotel Olissipo project includes not only the hotel building as such but also two contiguous office buildings, each of these with 10 elevated floors and 4 below the surface, in a total construction area of 57.700 m^2. Olissipo Orient is a four star rated hotel, with 182 rooms, among them 14 suites.

The disciplines developed by the author were:

- Water Supply and Firefighting
- Automatic Sprinkler Systems
- Drainage

3.15.2. DRAINAGE

The Hotel Olissipo project was the author"s first project with some complexity. As an exercise to better conceive and understand the general solution, a cross section was drawn including all the elements from the domestic wastewater and rainwater drainage networks including all the elements such as drains, pipework, stacks and lifting plants (figure 89).

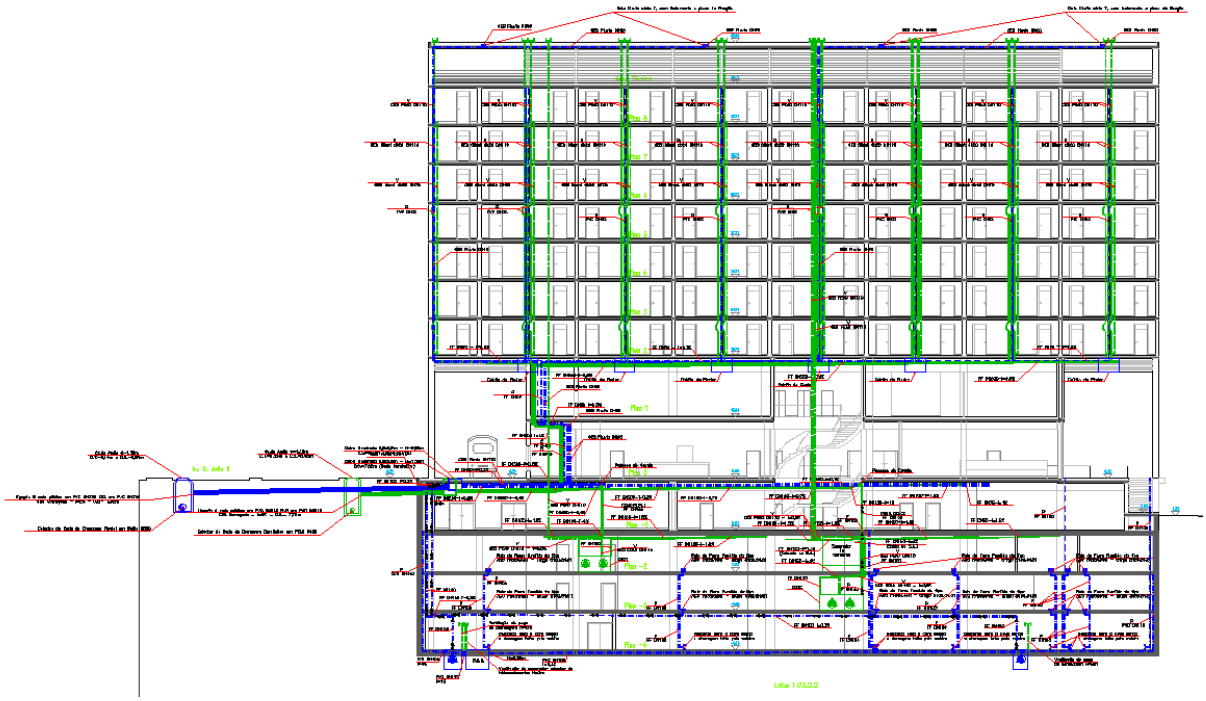


Fig.89 – Hotel Olissipo cross section

The drainage of the domestic wastewater of rooms is done by twenty-eight stacks made of polyethylene with high thickness walls, to reduce the noise of the flow discharges. Several suppliers/manufacturers have this option in their catalogues, as it is the case of Geberit with the systems "Geberit Silent". This can be complemented by wrapping up the stacks (an more important the junctions and direction changes) with rock wool. Also another way of reducing the noise problem is to make the stacks slightly deviate every two or three floor to avoid the flow speed increase.

The ventilation of the domestic wastewater stacks in done primarily at the roof level through ventilation hats (natural ventilation). The performance of the ventilation system is improved by the existence of a smaller, parallel ventilation stack. Moreover, the secondary ventilation reduces the diameter of the main stack. From the economical point of view, there also benefits. As the price of the pipes generally does increase linearly with the increase of the diameter, two smaller pipes is usually a better solution than a big one.

The network installed at the first floor ceiling gathers the wastewater flow of these main stacks into two bigger pipes. A collector installed at the floor -1 ceiling will ultimately make the connection with the public network.

All the discharge branches are in ("normal") polyethylene as the these usually do not contribute significantly for the noise increase. The adopted inclination is 4% rather than the minimum 2% required by the regulation [9].

For the toilets and services installed in the floors underground, the gravity drainage is not possible. Therefore, two lifting plants are located in two intermediate levels (floors -2 and -3). These are prefabricated systems with a small deposit incorporated. Their pressure pipes will make discharge on the upper part of the collector installed in floor -1. This will avoid a backflow.

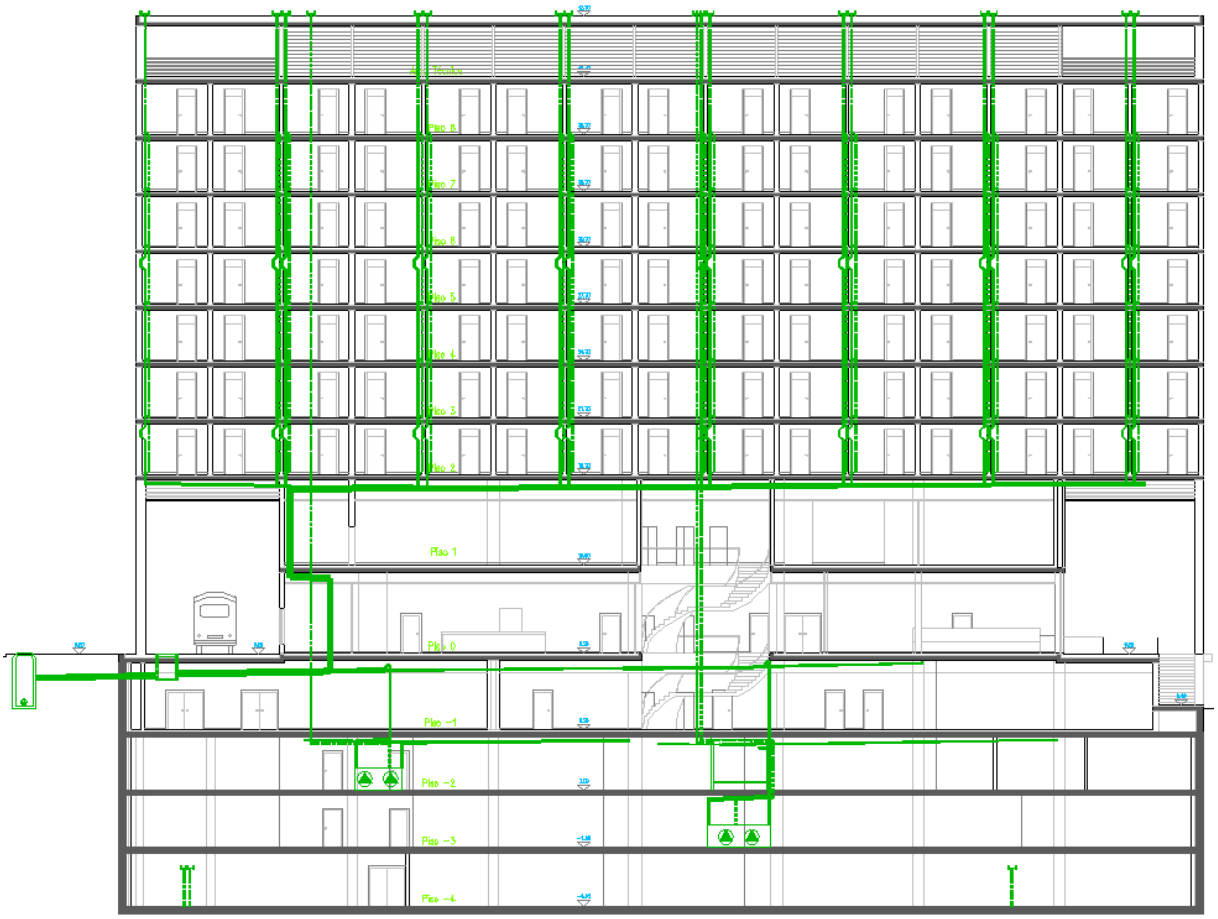


Fig.90 – Hotel Olissipo cross section (domestic wastewater drainage network)

In this hotel, the rainwater drainage covers three different systems (see figure 91).

The roof drainage will be done using a syphonic solution (the description of such systems was done previously under point 3.14.2 on the drainage of the Municipal Stadium of Oeiras). Therefore, in the room floors the polyethylene stacks will be part of that system.

The transition to a regular gravity system is done at the level of the first floor ceiling. Both systems cannot communicate directly as this would compromise the performance of the syphonic system by the introduction of air through the gravity system. The solution found was to install prefabricated concrete boxes where the system "Geberit Pluvia" can discharge. The drainage of this boxes is then done by gravity. The pipework downstream can then receive flow from several sources without any inconvenience. Among these sources, there are drainage or small surfaces (such as balconies or terraces) or the washing of the parking lot in the underground floors. In fact, being this building located right next to the Tagus River, the infiltration water is by far more significant. This water is brought together in two lifting station built on floor -4, through by perforated drains wrapped up by a geotextile membrane installed above the structural slab.

One of the lifting stations receives water exclusively from the parking lot and therefore a separator for light liquids is installed to treat the inflow.

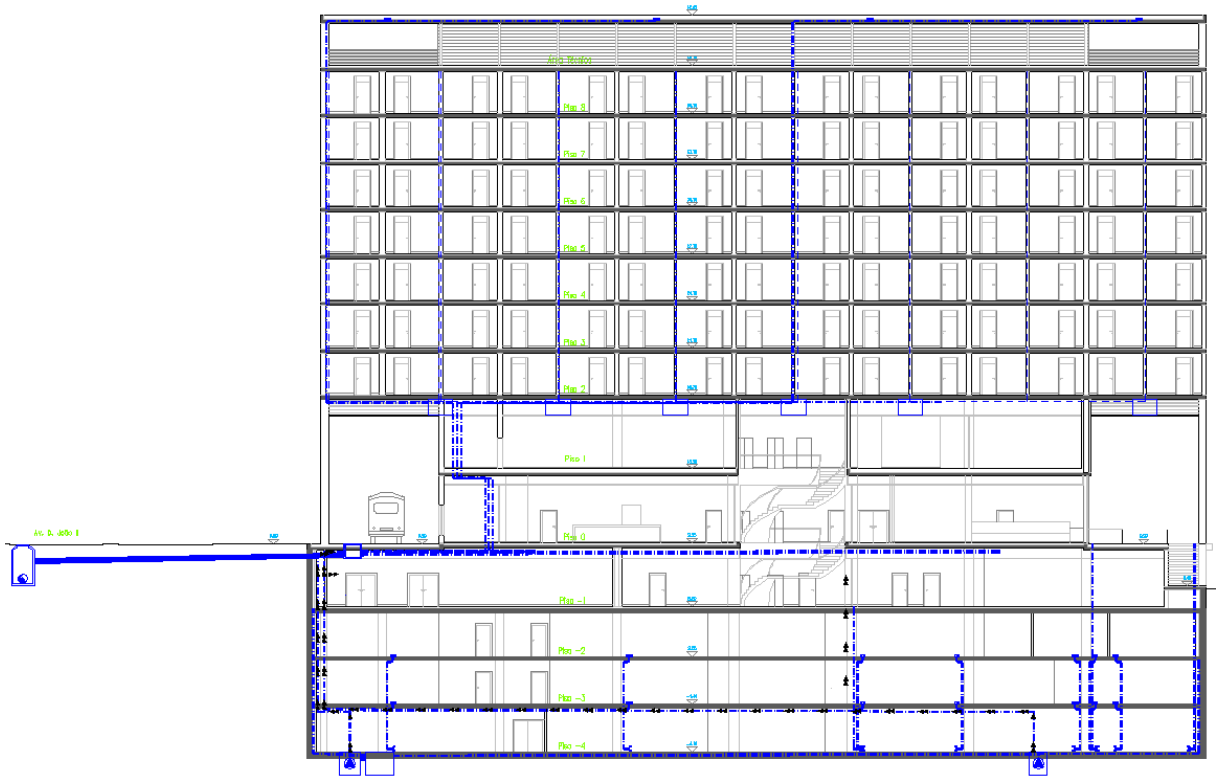


Fig.91 – Hotel Olissipo cross section (rainwater drainage network)

The drainage lifting stations were designed following the conventional details drawings for a submergible pump, with the technical space for equipment installation (valves and controls) – figure 92.

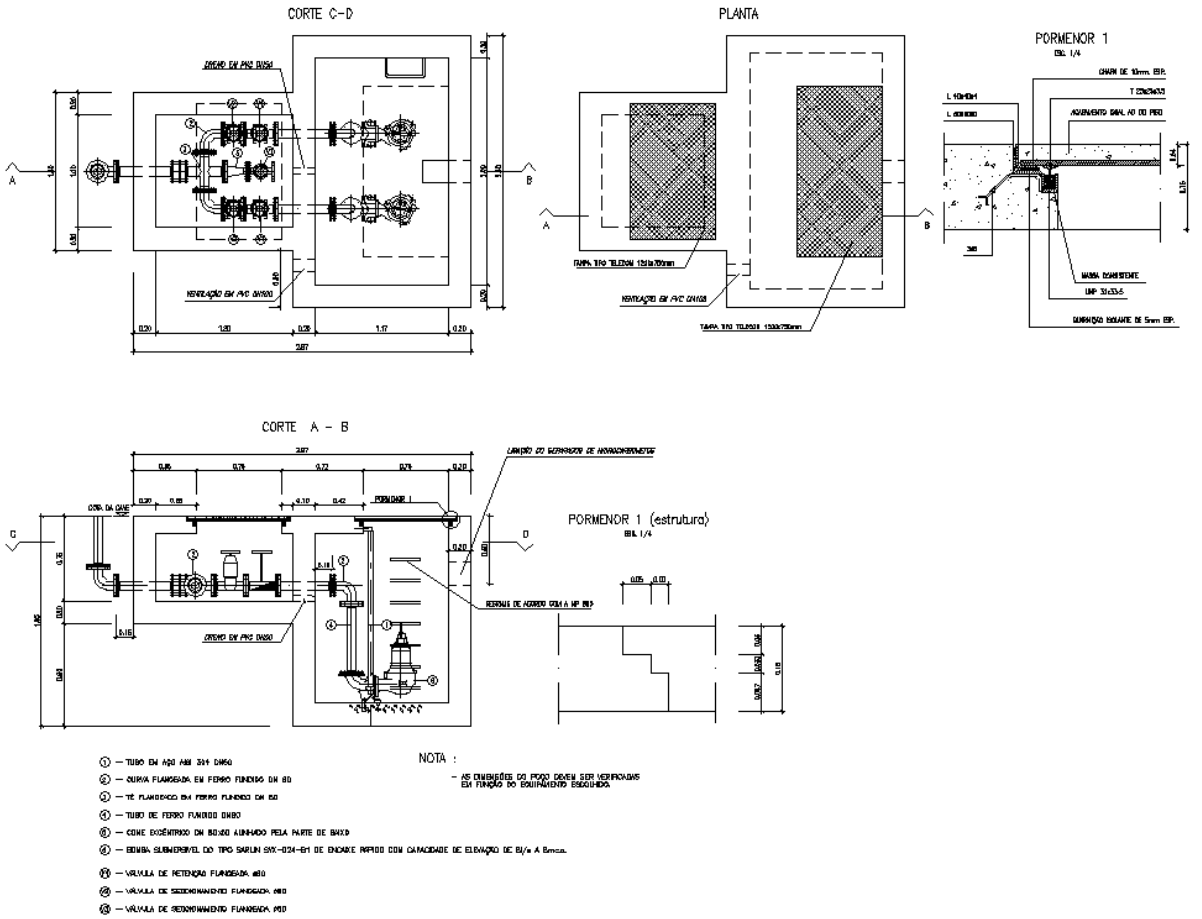


Fig.92 – Lifting station

3.15.3. EN 12056-4:2000 - GRAVITY DRAINAGE SYSTEMS INSIDE BUILDINGS - PART 4: WASTEWATER LIFTING PLANTS - LAYOUT AND CALCULATION [29]

This standard is the fourth part of a series of five developed by CEN/TC 165 "Wastewater engineering":

- Part 1: General and performance requirements;
- Part 2: Sanitary pipework - Layout and calculation;
- Part 3: Roof drainage - Layout and calculation;
- Part 4: Wastewater lifting plants - Layout and calculation;
- Part 5: Installation and testing, instructions for operation, maintenance and use.

They are cross referenced, working as a whole. In the chapter 2 "Normative references" of each standard (part) all the remaining four parts are listed. This means that, if one follows one of these parts to design a gravity drainage system inside a building, it may happens that he will end up using all of them. Standards are mainly split for the following reasons:

- there can be different expertise for the several parts. The drafts can be developed by several working groups with different sets of experts;
- it becomes more manageable when a part needs to be revised or amended;
- it is easier for the user as he can buy only a part he needs.

Part 2, for the sanitary pipework was previously referenced under point 3.12.4 as tool to, among other things, improve the ventilation pipework.

Part 4, focus on both wastewater and rainwater lifting plants as it is stated on its scope:

"This part gives layout, operation and maintenance requirements for lifting plants for wastewater containing faecal matter, faecal-free wastewater and rainwater within buildings and sites, together with their discharge pipework and connection to drain. It also covers faecal wastewater lifting plants for limited applications."

As written previously, when describing the domestic wastewater drainage, design provisions were taken to avoid the backflow effect. Nevertheless, this standard (part 4) can give further requirements for the protection against it (under chapter 4) like as the use of an anti-flooding valve in certain conditions.

Important information is also given regarding the installation on the following matters:

- Pipework;
- Ventilation;
- Drains;
- Electrical connections.

This can help the designer to improve/check his installation drawings of the lifting stations as well as complement the general technical conditions of the project.

One of the chapters of the standard is dedicated to selection of the lifting plants based on the flow (Q_p) vs. Head (H_p) curves. This is usually well known to all the engineers making this kind of selection.

This standard even gives requirements beyond the project phase.

During the construction phase, the contractor can use the chapter seven regarding the commissioning. This gives the contractor (buyer) a checklist of items that the supplier has to fulfil before, during and after testing in order to have his product accepted.

The final chapter of the standard is about maintenance and can give guidance to the owner on the time between maintenance checks and on what should be the tasks to be included in the maintenance contract.

4
FINAL NOTES

4.1. THE DESIGN ENHANCEMENT

As initially proposed, the objective of this report was to demonstrate the main competences and skills acquired by the author in the development of his professional activity for the last 5 years, first as design engineer (focusing in the hydraulics) and as *CCMC* Programme Manager afterwards.

Going through the thirteen projects listed in this professional activity report, it is clear that the author has gained the needed technical knowledge throughout the years to allow him to adopt "out of the box" solutions that go beyond the minimum requirements imposed either by the regulations in place or by the implemented practice. This allows the achievement of better solutions, from the technical or/and economical point(s) of view. A summary is presented in table 4.

The author developed, throughout the years, several IT tools to support the calculation of the several disciplines. These were continuously adapted to the new state of the art and to the needs of the projects under development.

Moreover, more than improve the technical content of the project, he also improved the designing process as such. Using his programming and analysis skills, the author was also able to identify the repetitive tasks that could be easily automated and to create the necessary tools to execute them (see 3.2.2). As consequence, the designing development time was reduced and the consistency and accuracy of the elements delivery was improved.

Table 4 – Conventional / usual solutions vs. Innovative / alternative solutions

Project	Discipline	Conventional / usual solution	Solution adopted (innovative / alternative)
3.3. Building Martim Moniz	Gas supply	- Exterior supply pipe installed in ditch	- Exterior supply pipe installed integrated in structural concrete stairs with mechanical protection
		- Ventilation grid installed in the facade	- Installation made through an interior open space

3.4 Eco-tracks	Drainage	- Wastewater system connected to the public network	- Installation of treatment system
		- Rainwater / treated wastewater discharged into a water stream	- Rainwater / treated wastewater infiltrated in the soil
3.5 Convent of Jesus	Refurbishment	- Pipework inside the walls	-Pipework in technical areas
3.6 High School - Silves	Gas Supply	- Gas supply system connected to the public network of natural gas	- Installation of propane reservoir
3.7 High School of Vergílio Ferreira	Preparation of bills of quantities	- Consideration of own database (based on own projects)	- Utilization of PRONIC. Consideration of public database also including materials, performances and costs
3.8 Stadium Castelão	Automatic sprinkler systems pre-detail design	- Full design	- Simplified design
3.10 Hotel Sana Luanda Royal	Water supply	- Cold water and hot water networks only	- Hot water recirculation network also considered
		- One water storage reservoir with chorine treatment	- Two water storage reservoirs (non-drinkable and drinkable water). Treatment by membrane filtration systems
		- One pressure level	- Three pressure levels
3.11 Hypermarket Feira Nova	Drainage	- Equipment installation based on designer's experience	- Equipment installation based on users' experience
3.14 Municipal Stadium -Oeiras	Drainage	- Gravity rainwater drainage system	- Syphonic rainwater drainage system

As *CCMC* programme manager, the author gained new skills and new expertise on legal and political issues that came to complement (and not the replace) the technical experience knowledge acquired previously. To prove that there is the link between the design process and standardization done along this professional activity report. The author was able to, for each developed project listed; identify one deliverable that could have been used to further enhance it (see table 5). This was also done having into account the legislative framework in place either Portugal and/or in Europe, whenever applicable.

Table 5 – Design enhancement achievable with standards

Project	Standard	Design difficulty	Solution provided by the standard
3.3. Building Martim Moniz	CEN/TR 14788	- Ventilation design in non-conventional situations	- Recommendations for the performance and design of ventilation systems - Additional design methods and data given in the annexes
3.4 Eco-tracks	CEN/TR 12566-2	- Selection of the infiltration system - In-situ assessment of the soil permeability	- Criteria for the selection of the preferential method - Methods for the preliminary site consideration
3.5 Convent of Jesus	EN 13914-1	- Pipework installation in old buildings walls	- Recommendations for the renovation and repair of defective renders on old or historic buildings
3.6 High School - Silves	EN 12542	- Verification of the design under the Pressure Equipment Directive using the harmonized standard (865 pages)	- Utilization of a smaller standard dedicated to tanks smaller than 13 m^3
	prEN 00165232-1	- Design of systems for the on-site reuse of water based on the designer´s expertise and experience	- Design of systems for the on-site reuse of water based on the consensual European technical expertise
3.7 High School of Vergílio Ferreira	CEN/TC 442 EN's	- Consideration of national public database also considering materials, performances and costs. - No correlation with international data systems	- European BIM system using the same libraries
3.8 Stadium Castelão	EN 12845	- Utilization of an American standard (NFPA 13)	- Utilization of an European standard (as foreseen in the Public Procurement Directive)
3.9 Hotel Porto Mós	EN 13451-1	- Definition of requirements for recreational swimming pools	- General safety requirements and test methods for swimming pool equipment

3.10 Hotel Sana Luanda Royal	EN 1508	- Definition of requirements for water reservoirs with non-conventional configurations and geometry	- Requirements for systems and components for the storage of water (to be used as a design check list)
3.11 Hypermarket Feira Nova	CEN/TS 15223	- Structural design of buried piping systems is taken into account	- Guidance to applying structural design to buried thermoplastics piping system applications
3.12 Residential Condominium - Talatona	EN 858-2	- Little knowledge on the selection of separator systems for light liquids. Reliance on a supplier	- Requirements for the selection of separator systems for light liquids
	EN 12056-2	- Utilization of the same ventilation scheme for all situations	- Schematics for ventilation solutions that deviate from the typical main stack with a secondary ventilation
3.13 Hotel Westin Campo Real	EN 1825-2	- Little knowledge on the selection of grease separators. Reliance on a supplier	- Requirements for the selection of grease separators
3.14 Municipal Stadium -Oeiras	EN 1433	- No reference to the essential characteristics (included in the CE marking under the *CPR*) when selecting construction products	- Harmonized standard (cited on the *OJEU* under de *CPR*) for drainage channels for vehicular and pedestrian areas
3.15 Hotel Olissipo	EN 12056-4	- No guidance given in the project for maintenance and commissioning of the lifting stations	- Chapters for commissioning and maintenance requirements

As cleared wrapped up in the previous table, standards can improve the engineering design process.

In particular, standards can be used for the following purposes:

1) As technical design document bringing the consensual European state of the art (e.g. EN 12845 for the design of fixed firefighting systems);
2) As technical design document giving guidance on the products and systems selection (e.g. EN 1825-2 for the selection of grease separators);
3) As a technical document bringing guidance on the maintenance and commissioning of equipments an systems (e.g. EN 12056-4 for the maintenance and commissioning of lifting stations);

4) As a technical document to define the rules for the data and information systems and exchange (e.g. the future standards developed by CEN/TC 442 on Building Information Modelling);
5) As harmonized standard under a New Approach Directive giving presumption of conformity with the directive requirements (e.g. EN 13445-3 for the design of unfired pressure vessels under the Pressure Equipment Directive and the non harmonized EN 12542 that gives requirements for a more reduced range of products – static welded steel cylindrical tanks, serially produced for the storage of liquefied petroleum gas (*LPG*) having a volume not greater than 13 m^3);
6) As harmonized standard under the Construction Products Regulation identifying the essential characteristics for a specific product family under an intended use and the way declaring their performance (e.g. EN 143 for drainage channels for vehicular and pedestrian areas).

4.2. THE FUTURE OF THE CONSTRUCTION SECTOR STANDARDIZATION

4.2.1. THE CPR ERA

The Construction Products Regulation (*CPR*) [2] was published in 2011 to replace the previous Construction Products Directive (*CPD*) [8] in what was seen only as strengthening up of a piece of legislation as some countries (as it is the case of Portugal or the UK) were not entirely transposing it to national legislations.
In the *CPD*, it was not clear whether the CE marking was mandatory. Nevertheless, the construction products that did have the CE marking were accepted as satisfying the essential requirements according to article 4(2) of the directive: "*Member States shall presume that the products are fit for their intended use if they enable works in which they employed, provided that latter are properly designed and built, to satisfy the essential requirements referred to in Article 3, and those products bear the EC mark*". At that time, the CE marking was seen as a voluntary mark that would allow the free movement of the construction products through Europe as stated in Article 6(1): "*Member States shall not impede the free movement, placing on the market or use in their territory of products which satisfy the provisions of this Directive*".
After the entrance of the CPR into force on the 1st of July 2013, the market and, in particular, the manufacturers of construction products soon realized its implications. The CE marking had just become clearly mandatory (article 9(1) reads "*The CE marking shall be affixed visibly, legibly and indelibly to the construction product or to a label attached to it. Where this is not possible or not warranted on account of the nature of the product, it shall be affixed to the packaging or to the accompanying documents*").
Moreover, the declaration of performance (DoP) becomes obligatory as well by application of the article 4(1) of the regulation: "*When a construction product is covered by a harmonised standard or conforms to a European Technical Assessment which has been issued for it, the manufacturer shall draw up a declaration of performance when such a product is placed on the market."* In this article, it is made clear that this obligatoriness is only valid when a harmonised standard (developed by *CEN* or *CENELEC)* or an *EAD´*s (developed by *EOTA*) do exist and are cited on the Official Journal of the European Commission (*OJEU*). The European Assessment Document (*EAD*) is the document on which the European Technical Assessment (*ETA*) drafting is based. The content of and EAD is described in article 24(1) of the regulation: "*A European Assessment Document shall contain, at least, a general description of the construction product, the list of essential characteristics, relevant for the intended use of the product as foreseen by the manufacturer and agreed between the manufacturer and the organisation of TABs, as well as the methods and criteria for assessing the performance of the product in relation to those essential characteristics.*"
A manufacturer has the right to pursue the CE marking through an *ETA*, requesting it to *EOTA*, when no *CEN*/*CENELEC* harmonized standard is cited on the OJEU for his product. This will then be a voluntary CE marking trigged by the manufacturer as such, usually to be able to compete with other

products of the same segment already CE marked. For that reason, this usually happens to innovative products that do not raise enough technical agreement yet to have a dedicated European Standard (*EN*).

The addition of the Declaration of Performance to the CE marking obligation generated one of the first critics to the new regulation. The information to be included in the DoP (described in article 6 of the *CPR*) is basically the same as the one listed in the article 9 (2) for the CE marking: "*The CE marking shall be followed by the two last digits of the year in which it was first affixed, the name and the registered address of the manufacturer, or the identifying mark allowing identification of the name and address of the manufacturer easily and without any ambiguity, the unique identification code of the product-type, the reference number of the declaration of performance, the level or class of the performance declared, the reference to the harmonised technical specification applied, the identification number of the notified body, if applicable, and the intended use as laid down in the harmonised technical specification applied*". This was seen as an unnecessary bureaucratic burden to the manufactures as they have to produce a paper document (DoP) to accompany each product placed on the market. Although article 7 foresees the supply of the DoP by electronic means, some small manufacturers do not have yet the resources to do it and still, the paper copy can always be requested by the recipient: *"7(1). A copy of the declaration of performance of each product which is made available on the market shall be supplied either in paper form or by electronic means. However, where a batch of the same product is supplied to a single user, it may be accompanied by a single copy of the declaration of performance either in paper form or by electronic means.*

7(2). A paper copy of the declaration of performance shall be supplied if the recipient requests it."

Moreover, with the CPR entrance into force in 2013, the CE marking is no longer a voluntary mark only used for those manufacturers that want to place their products in other European Union countries. The CE marking is mandatory for all manufacturers and therefore "*the EU begins on the other side of the street*". As consequence, the national voluntary marks, more than becoming useless, they became illegal as the CE marking is now by law the only way to declare the performance of the construction products essential characteristics as set in article 8(3):

"For any construction product covered by a harmonised standard, or for which a European Technical Assessment has been issued, the CE marking shall be the only marking which attests conformity of the construction product with the declared performance in relation to the essential characteristics, covered by that harmonised standard or by the European Technical Assessment.

In this respect, Member States shall not introduce any references or shall withdraw any references in national measures to a marking attesting conformity with the declared performance in relation to the essential characteristics covered by a harmonised standard other than the CE marking."

Article 67(2) of the CPR foresees a report on its own implementation to be submitted by the European Commission to the European Parliament and to the Council:

"By 25 April 2016, the Commission shall submit to the European Parliament and to the Council a report on the implementation of this Regulation, including on Articles 19, 20, 21, 23, 24 and 37 on the basis of reports provided by Member States, as well as by other relevant stakeholders, accompanied, where relevant, by appropriate proposals."

As part of this exercise, the EC (DG Grow) requested several intermediate reports to an independent consultant (RPA – Risk & Policy Analysts) on the topics related to the CPR implementation. The third report covers the national certifications/quality marks [37]. This document identifies three types of national certifications/quality marks that still exist and therefore work as barriers to trade and to the full implementation of the CE marking:

- Standards-related marks – "*Standards-related marks are used, in this context, to refer to national/quality marks which are directly or indirectly supported by, related to, linked to, or measured against standards which are of relevance to the CPR. The main problem with these marks is that it is not always clear to manufacturers whether or not they fulfil a different/complementary function to the CPR, safety assessments, CE marking (e.g. in terms of covering essential characteristics) and/or whether, overall, they potentially confuse third parties as to the meaning of the CE marking*.";

- De facto mandatory marks – "*De facto mandatory marks, are used in this context to refer to national marks which claim to be "voluntary"; however, they are effectively (de facto) mandatory for manufacturers as they will be unable to sell their products on certain markets, or in certain sectors, without them. These include cases where national/quality marks are (compulsory) requirements imposed under public procurement rules or by insurers (without which insurance cannot be obtained)*.";
- Market-driven marks – "*Market-driven quality marks, in this context, refer to those quality marks which are recognised and highly rated by customers and consumers. In many cases, they do not clash with the CE marking CPR Implementation - Topical Report RPA | 8 and, technically, do not impede the free movement of construction products.12 However, they occupy a very strong position in the market and, as such, effectively become barriers to trade – as manufacturers are unable to trade their products without these. Or put another way, customers (consumers) will not buy products which do not have these quality marks. For these marks, the main problem is that that there is no mutual recognition between these marks (or cross-border benefit) which reinforces their importance at the national level. Where this practice exists, it is SMEs who are hit hardest, as larger companies can rely on their good reputation and resources to gain more accreditation and sell more products*."

Therefore, it is clear that the CPR is not yet fully implemented and will be a goal to be reached in the future as the stakeholders involved, manufacturers, buyers, designers and users recognize the CE marking as the only legal mark with the essential characteristics performance information.

Since the declaration of these performances is done using the assessment methods described in the harmonized standards, they should not contain prescriptive requirements (such as defining minimum widths or suitable materials) as this would block innovation. Moreover, classes and thresholds intended to set a quality level should not be allowed either as this could block some products already placed on the market. The decision on the required performance(s) needed for a specific intended use of the product should be left to be taken by the buyer of the product or by the designer.

In fact, this notion that standards should be performance based is already set in the *CPD* as article 7(2) states that *"the resulting standards shall be expressed as far as practicable in product performance terms, having regard to the interpretative documents."* At that time, it was already not up to the experts developing the standards to set the minimum requirements for those performances (classes and thresholds) but rather the responsibility of the member states. In article 6(2) that is made clear by the following sentence "(...) *Member States may determine the performance levels also to be observed in their territory only within the classifications adopted at Community level and only subject to the use of all or some classes or one class.*".

Nevertheless, throughout the CPD years, the harmonized standards where developed to set quality levels to products according to what was considered suitable by the experts. The system pass/fail was very common where a certain level of performance had to be achieved for the product to be CE marked. This was possible, at that time, for two reasons. First, it had few legal implications as the CE marking was not considered obligatory and secondly there was no procedure foreseen in the CPD for the approval of these classes and thresholds by the member states.

That changed dramatically with the entrance into force of the *CPR* on the first of July 2013. Not only the CE marking become mandatory, with a reinforced legal value, but also a procedure (by a delegated act) is set for the member states approve the classes and thresholds:

- Article 6(3) – *"(...)Where appropriate, the Commission shall also determine, by means of delegated acts in accordance with Article 60, the threshold levels for the performance in relation to the essential characteristics to be declared."*;

- Article 27(1) – *"The Commission may adopt delegated acts in accordance with Article 60, to establish classes of performance in relation to the essential characteristics of construction products."*

The classes and thresholds for the standards already cited on the OJEU under the *CPD* can be considered valid under the *CPR* is we consider the article 66(1) applicable: "*Construction products*

which have been placed on the market in accordance with Directive 89/106/EEC before 1 July 2013 shall be deemed to comply with this Regulation."
Nevertheless, for the new standards to be cited on the *OJEU* or for the revision of the existing ones the CPR new approach applies. This will force, in the future, the standardization to work more in collaboration with the Commission in the preparation of these delegated acts, when needed be. This is still an ongoing exercise between CEN/CENELEC and the EC to build the necessary processes and timeframes needed allow an optimal standards development and information exchange.

4.2.2. THE CE MARKING AND THE SINGLE MARKET

One of the main objectives of the CPR is to create a truly single market with a CE market accepted everywhere in Europe. Other national and quality marks related to essential characteristics covered by the CE marking are to be considered illegal. Now longer the manufacturers have to comply with several national approvals and certifications schemes, which are a bureaucratic and financial burden. Although not fully implemented yet, in the future, the CE marking will mean a valid product passport valid in all EU countries. Nowadays, still some national approval schemes are in place. They have been in place and the transition to the new reality will take time. Slowly, the standardisers, the manufactures and the national authorities will adapt. The manufacturers will demand a truly free single market. The European Commission, responsible for the implementation and fulfilment of the European law, will take the legal measures against the infringing member states. This has already happened and its outcome should be seen an incentive to speed up the full CPR implementation among all the EU countries.

Moreover, the CE marking allows all manufacturers to place their products into the market declaring their performances in the relevant essential characteristics and leaves the option to the buyer that will select the product with the adequate performances for the intended use. This comes in opposition to the previous view under the *CPD* that the CE market was a quality mark approving the product through a defined pass/fail criterion. This was a barrier to innovation as manufacturers were stuck to the prescriptive requirements set in the standards developed under the *CPD*.

With this transition to the *CPR*, the harmonized standards will become more and more performance based and less prescriptive. They will only describe the methods on how to assess the performance. The manufacturer will then try the achieve the best results using the materials, technologies and concepts we may consider suitable and declare them in a form or a level (value), class or description according to article 2 (5): "*'performance of a construction product' means the performance related to the relevant essential characteristics, expressed by level or class, or in a description;*". This means more competitiveness and entrepreneurship, which is usually associated to small and medium enterprises.

4.2.3. THE FULL HARMONIZATION OF THE DESIGN

There is a thin line between the definition of construction product and the definition of construction work. If, for some cases, the distinction is clear, for others, it can raise discussion. It is obvious that a brick is a construction product and that a brick wall is a construction work. It is not so immediate when we consider other products bearing the CE marking such as complex metallic structures welded on site or in-situ road barriers.
Nevertheless, an assessment method for a product characteristic can also be used for construction works. The best example of this situation are the Eurocodes that set the requirements for the structural design of buildings, bridges and other construction works and that can also be used for assessment of construction products essential characteristics such as mechanical resistance or bending strength.
Therefore, the Eurocodes also assume an important role in the implementation of the CPR, provided that they guarantee the means to affix the CE marking that are the same in all the EU countries. The

CE marking of a given product has to be comparable regardless of the country in which it was produced. Hopefully, this will be achieved in the upcoming years with Commission standardization request M/515 addressed to *CEN* for amending existing Eurocodes and extending the scope of structural Eurocodes. New materials will be added, the standards will be more user-friendly and another step will be taken towards the full harmonization of the structural design in Europe. In the next generation of Eurocodes there will be a reduction of the national determined parameters in the national annexes, which list the design specificities in each country. The opening up of the Eurocodes to new materials and solutions such as structural glass, fibre-reinforced polymers and membrane structures will promote innovation in the construction sector. Furthermore, the foreseen simplification will allow small and medium companies to use them.

Moreover, the further alignment of the Eurocodes will, in the near future, remove trade barriers across Europe in what regards engineering services. More and more, it will be possible to design construction works regardless to where the design is developed or where they are to be built. Nowadays, it is already a reality in what regards public procurement as the Directive [20] sets the European Standards as the first technical documents to be used. In the private, business to business context, it is up to parties to set the conditions of the service contract under which the design is developed. The expectation is that in the future the Eurocodes may be unanimously recognized in Europe as the European structural codes.

Another example where the European is trying to achieve the full harmonization of the design is the Energy Performance of Buildings through the mandate M/480, as already mentioned before. This mandate, issued in 2010, will allow the elaboration and adoption of standards for a methodology calculating the integrated energy performance of buildings and promoting the energy efficiency of buildings. The improved set of *EPB* standards shall become a systematic, clear and comprehensive package for the benefit of professionals, member states and relations with third countries. In order to ensure user-friendliness, a continuous but modular overall structure is needed, covering all standards related to the energy performance of buildings, providing the overall framework which will enable a step-by-step implementation by the EU member states. This mandate is already the second for the Energy Performance of Buildings. The first one, mandate M/343 did not fully fulfil the expectations as a single European methodology is not easy to achieve. The work of mandate M/480 (still ongoing) is different of its predecessor (M/343) as it benefited from the lessons learned from previous experiences.

In comparison with M/343, the member states representatives were directly involved in the standardization work providing the information on their needs and expectations regarding the standards and informing the experts of the relevant national regulations in place.

The different national regulations in place across Europe are in fact the main difficulty and challenge when developing a common methodology. In certain cases, it is just not possible to accommodate all the national requirements and needs. Nevertheless, the general idea is that the member states may also change their regulations converging to the *EPB* standards as this is something that standardization cannot achieve on its own. The standardization system cannot change national regulations but can point out the differences on them, making them clear, so they can be aligned in the future in an iterative way. In order to achieve this, each *EPB* standard has an annex (normative) with a template to be filed out in all the countries with their national options. As there is a format for these national annexes, they become comparable and differences may be outcome in the future. This was the lesson learned from the Eurocodes where, because no template was previously set, the national annexes are not easily comparable. Moreover, each standard also contains an informative annex with the "desirable" options (commonly called CEN options). This works as a technical advice from experts involved in the work to the member states that have to legislate and may not have the technical expertise to do so. Hopefully, this will the annex to which all member states will converge to in the coming years.

4.2.4. BUILDING INFORMATION MODELING

The BIM (building information modelling) is a set of methodologies to define, describe, exchange, monitor, record and securely handle asset data, semantics and processes with links to geospatial and other external data. This is fundamentally different from the building information models that are currently already used, mainly in architectural and structural models, supported by computer programs well known in the market.

Nevertheless, the information in these models in not interchangeable among the stakeholders that participate in the process, starting with the designers at the conception phase until the final users at the maintenance phase, passing by the entire construction of the building.

In the future, the recently created CEN/TC 442 will try to create common methodology and libraries within Europe to be used by all parties. This will then have other applications that go beyond the architectural and structural information. Among the most expected ones, are the lifecycle cost estimation and assessment information to be developed with CEN/TC 350 for 'Sustainability of construction works' and an integrated calculation of the energy performance of buildings to be developed in collaboration with CEN/TC 371 'Energy Performance of Buildings".

Moreover, all product TC´s will be involved in this work as the construction products properties included in the data dictionaries will have to be agreed. In particular, the legal marking information (Declaration of Performance) according to the Construction Products Regulation may, in the future, be supplied by the manufacturers in a BIM compatible form so it can be directly included in the building model. This would ease the burden of having to produce these documents in the traditional way (usually a paper declaration) and would guarantee that the information related to the product used in the building it is not lost after its construction since it would be integrated in the model.

The information about the construction product would then a clear digital format used by everyone, helping, in particular, small and medium enterprises that usually are not so aware of the legal implication of placing a product on the market. Moreover, with the drafting of these declarations in a comparable digital format, designers and buyers will have to change to collect this information from manufacturers (e.g. from their website or from a database) and compare them, leading to selection of the best option. This will most surely boost the competitiveness.

Finally, if a common digital format is adopted across Europe, the national authorities will have their market surveillance tasks much facilitated. No longer would a verification of paper documents be needed.

4.2.5. WIDER PARTICIPATION

Regulation 1025/2012 [3] and the Construction Products Regulation [2] have given more relevance to the standards. As the *ESO´*s (European Standards Organisations) gain more importance, their responsibilities are also increased, in particular the obligation to have a transparent system to develop standards that gives the opportunity to all stakeholders to participate.

As a consequence, CEN and CENELEC will seek more and more for a wider participation and representation of all concerned groups. A more enlarged consensus will allow the standards to be more strongly implemented and recognized in the market. This participation goes beyond the national mirror committees that bring the experience from the *CEN* and *CENELEC* 33 members. Within the rules of Guide 25 [38], relevant European Associations are allowed to participate directly in the standardization work in addition to those already foreseen in regulation 1025/2012 (*ECOS, ANEC, SBS* and *ETUI*).

4.2.6. DELIVERABLES FOR ALL

Although standardization is becoming more and more linked to the implementation of specific legislation, it will always be room in standardization to fulfil the market needs of the *CEN* and *CENELEC* members or to support research and innovation. This was the original aim of standardization and it is still one of the main objectives. This can be achieved through the different types of deliverables available (as explained in 2.2).
In particular, technical specifications (*TS*) and technical reports (*TR*) can be used by the members that would like to have a document available at European level but that do not yet gather enough consensus. These are the most suitable documents to cover innovative products or to contain the information about research studies. Nonetheless, the possibility to further develop these documents towards a European Standard (*EN*) is always possible.
Private companies are not out of standardization either. They can participate directly through a *CWA* (CEN Workshop Agreement) and define their own way of working provided that a CEN member takes the secretariat of the group (Workshop). This is a fast way to achieve a European document that can afterwards be used as draft for the development of other deliverables types.

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