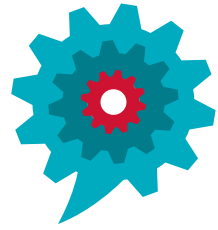
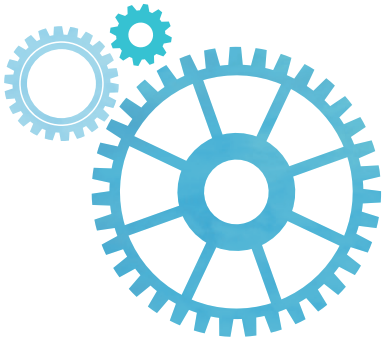


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(Legal) Maintenance Plan for building's energy performance

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Abstract: The EU Directive 2002/91/CE, regarding building's energy performance was transposed into national law in 2006, recently updated by Legislative Decree 118/2013 which substantiates: Energy Certification System of Buildings (SCE), Regulation of Energy Performance of Residential Buildings (SHR) and Regulation of Energy Performance of Commerce and Services Buildings (RECS).

This points to an evaluation of energy performance of buildings based on the thermal behavior and efficiency of the systems, and in the installation, operation and maintenance of technical systems. The TIM (Installation and Maintenance Technician) must perform several maintenance activities related to buildings and technical systems, including: maintenance management; planning; recording occurrences; details of tasks and operations; and other actions and documentation necessary for that purpose.

The RECS establishes rules to be observed in building's maintenance, to promote energy efficiency and indoor air quality. A maintenance plan must: be initiated at the design stage; be put in practice after the completion of the installation of building systems; and to be accomplished during the building's lifetime.

This paper proposes to present a working methodology, to be undertaken by TIM, leading to compliance with legal requirements for maintenance of Commerce and Services Buildings in assessment of the energy performance.

Keywords: Maintenance, Energy, Performance, Building, Technician

I. INTRODUCTION

The Directive No. 2002/91/EC [3] of the European Parliament and of the Council from 16 December 2002 regarding the energy performance of buildings, was transposed into Portuguese law by Decree No. 78/2006 [4] of April 4, which approved the National energy Certification System and Indoor Air Quality in buildings, Decree No. 79/2006 [5] of 4 April, which approved the Regulation of Energy in buildings and HVAC systems, and Decree No.

80/2006 [6] of 4 April, which approved the Regulation of characteristics of Thermal Behavior of Buildings.

More recently Directive No. 2010/31/EU [1] of the European Parliament and of the Council from 19 May 2010 regarding the energy performance of buildings, overhauled the system established by Directive No. 2002/91/EC [3], and clarified some principles of the original text and insert new provisions aimed at strengthening the framework of promotion of energy performance in buildings, aiming the goals and challenges agreed by the Member States for 2020.

Thus, the Member States of the EU, are doing the transposition of Directive No. 2010/31/EU [1] to the legal regime in each country. In the case of Portugal, was transposed into Portuguese law through Decree No. 118/2013 [2] of August 20, where it regulates:

- SCE - Energy Certification of Buildings;
- REH - Regulation of Energy Performance of Residential Buildings; and
- RECS - Regulation of Energy Performance of Buildings for Commerce and Services.

The requirements definition and assessment of energy performance of buildings shall be based on the following pillars:

- in the case of residential buildings a prominent position is assumed about:
 - thermal behavior; and
 - efficiency of the systems;
- to which are added, in the case of buildings of commerce and services:
 - Installation, handling and maintaining technical systems.

For each of these pillars are still defined general principles, embodied in specific requirements for:

- new buildings;
- buildings undergoing major intervention, and;

- existing buildings.

The Directive No. 2010/31/EU [1] points to the main types of technical building systems:

- thermal quality requirements;
- energy efficiency requirements for various systems, including:
 - air conditioning systems;
 - preparation systems for domestic hot water;
 - lighting systems;
 - systems for using renewable energies, and;
 - energy management systems.

To put these requirements into practice, rules for installation, handling and maintenance of HVAC systems in buildings of commerce and services are defined, in order to promote optimal functioning in energy terms.

II. TECHNICIANS OF THE ENERGY CERTIFICATION SYSTEM FOR BUILDINGS

The energy performance of buildings is ensured by the intervention of two types of technicians:

- Qualified Experts (QE), and;
- Technicians for Installation and Maintenance (TIM).

A. Duties of QE

- making energy assessment of buildings to be certified under the SCE, not compromising indoor air quality;
- identify and evaluate the buildings subject to certification, opportunities and recommendations for improvement of energy performance, registering them in pre-certificate or certificate and other accompanying documentation;
- send pre-certified and certified SCE;
- collaborate in the process of checking quality of SCE;
- check and submit to SCE's plan for energy rationalization.

B. Duties of TIM

The rules proposed for the installation, handling and maintenance of HVAC systems in buildings of commerce and services should be conducted by people with appropriate expertise designated by Technician for Installation and Maintenance (TIM).

Incumbent upon TIM coordinate or perform activities of planning, verification, management of energy use, installation and maintenance for buildings and technical systems and, in the case of large buildings of commerce and services (GES), the TIM shall develop and fulfill respective maintenance plan.

More specifically, in compliance with the provisions of paragraph 4 of article 13 of Decree No. 118/2013, of August

20 and without prejudice to the specific provision in the Rules of the Energy Performance of Buildings Trade and Services (RECS), the building's TIM, should:

- ensure proactive management building energy which includes:
 - promote the installation of energy metering systems, which allow a more detailed assessment of consumption whenever possible;
 - make the annual energy performance record, based on the best available information and according to the proposal of the managing body of the SCE for this purpose in buildings with a rated thermal input exceeding 250 kW for climate model;
 - use the computing platform provided by the managing entity, proceeding to fill the necessary information, as well as the submission of a report mentioned ahead.
- develop and/or maintain an updated Plan for Maintenance (PM) of the building and its technical systems;
- ensure compliance with the PM checking its proper implementation;
- inform the owner of the need for the energy certification of buildings;
- maintain the project and other technical documentation about the building and its technical systems upgraded, and advise the owner in the selection of new technical systems, exclusively with regard to compliance with the SCE, REH and RECS and other applicable laws;
- keep up to date register of occurrences;
- as it relates to the installation of new systems within their technical skills:
 - integrating the team of system installation, directly and actively participating in the tasks;
 - monitor assays receipt of installations.
- as regards the maintenance of technical systems within its jurisdiction:
 - integrating the maintenance team of systems, participating directly and actively in the tasks;
 - ensuring the implementation of the actions envisaged in the PM, according to the procedures described therein;
 - highlighting the execution of maintenance tasks.

III. BUILDINGS WITH ALMOST ZERO ENERGY NEEDS

The Directive No. 2010/31/EU [1] cited above, indicates that buildings should progressively show almost zero energy needs. The buildings nearly zero energy needs are those that have a high energy performance and that meet the energy needs due in large measure of energy from renewable sources including that produced on site or nearby.

In terms of temporal gap it points that almost zero needs of energy for buildings should be obtained to license new buildings after December 31, 2020, or after December 31, 2018 in the case of new buildings on the property of a public entity and held by an entity public.

Buildings with almost zero energy must be provided with:

- efficient component compliant with the most demanding threshold levels of economic viability that may be obtained from the application of the methodology with cost, differentiated for new and existing buildings and different types; and
- forms of local capturing renewable energy covering much of the remaining energy needs planned, according to the REH models and RECS, according to the following forms of abstraction:
 - preferably, the building itself or the plot of land where it is built;
 - in addition to the in common use infrastructure as close as possible to the place where it is not possible to meet the needs of renewable energy with recourse to local funding provided specifically for this purpose.

IV. REH – REGULATION OF ENERGY PERFORMANCE OF HOUSING BUILDINGS

The REH establishes requirements for residential buildings, new or subject to interventions, as well as the parameters and methodologies for characterizing the energy performance, in nominal terms, of all residential buildings and their technical systems in order to:

- to promote the improvement of the respective thermal behavior;
- the efficiency of their technical systems; and
- minimising the risk of surface condensation in the

V. RECS – REGULATION OF ENERGY PERFORMANCE OF BUILDINGS OF COMMERCE AND SERVICES

The RECS establishes rules to be observed in the design, construction, alteration, operation and maintenance of buildings of commerce and services and their technical systems, as well as requirements for the characterization of their performance in order to promote energy efficiency and the quality of indoor air.

The buildings covered by RECS should be evaluated and subject to requirements in order:

- promote the improvement of their thermal behavior;
- prevention of disease and the environment comfort focusing characteristics for this purpose in the glazed opaque envelope;
- promote efficiency and the rational use of energy, focusing, for this purpose, in components:
 - air conditioning;
 - preparation of hot water;
 - enlightenment;
 - power management systems, renewable energy, elevators and escalators.
- promote conditions of welfare and health of the occupants control of ventilation and indoor air quality;
- ensure that the technical building systems must be installed, maintained and conducted under conditions optimized for energy efficiency;

VI. INSTALLATION, HANDLING AND MAINTENANCE OF EQUIPMENT AND TECHNICAL SYSTEMS

In the implementation of energy performance regulations referred (REH and RECS), the operator TIM ensure the installation, handling and maintenance of equipment and technical systems appropriately.

In this task, the TIM should take into consideration:

- the requirements of the facility;
- the quality, organization and management of maintenance, including the respective planning, records of occurrences, the details of the tasks and operations and other actions and documentation necessary for that purpose;
- the operation of the facility through an optimized handling to ensure their operation in high energy efficiency schemes.

In new buildings the technical building systems must be designed, installed and maintained so as to be easily accessible for maintenance.

Manufacturers or installers of technical systems for new buildings of trade and services must:

- provide to the owner all technical documentation, including the make, model and features all the major constituents of technical systems installed in the building;
- ensure, where appropriate, that the equipment bearing installed in a clearly visible location after installation, the respective nameplate and technical characteristics.

VII. TESTING AND APPRAISAL OF INSTALLATIONS

The test and appraisal are made after the completion of the facility and prior to the service phase, to demonstrate to various stakeholders in the design and installation process

that the facilities meet the objectives for which they were designed and implemented. Testing should be performed working on the installation run, getting them registered in the implementation report.

A. Implementation Report

The implementation report should contain at least:

- date of completion and project managers of each test;
- identification of the entities or technicians present at the meeting;
- intended and achieved results;
- indication of possible follow-up measures in the event of the trial to be continued;
- indication of the need to make a new session and the term of start and finish must meet clearly defined.

B. Actions prior to testing

Prior to the completion of the tests or performance tests must:

- for each test must be specified in the design implementation of each specialty and be previously established procedures that includes:
 - methodologies for the implementation;
 - criteria for acceptance;
 - indication of the regulations to be observed;
 - local or form of testing (on site or in the laboratory, eg);
 - identifying the required stakeholders;
- the TIM of the building must get the proper training to testing;

C. Tests to perform

If they are installed, the respective components in building systems, the following tests shall be performed:

- testing the operational network condensate in order to verify the correct functioning and proper implementation of all siphoned areas;
- watertight to 100% of the pipe network, and the network must maintain a pressure of 1.5 times the rated working pressure for a period of twenty-four hours;
- sealing the ductwork, and the losses should be less than 1.5 l / s.m² area of conduct, when subjected to a pressure of 400 Pa. First test 10% of the network indicated by the designer (in case repeat testing the failure of the network 20% and in case of failure the new repeat test network 100%);
- measurement of the flow of water in each major system component, eg producers equipment and air handling units, so accessories should be provided

which enable their accurate measurement (indirect measurements will be accepted using differential pressure sensors in condition that they be calibrated by accredited bodies for this purpose);

- measurement of air flows in terminal units;
- measurement of temperature and relative humidity in the atmosphere in each independent functional area;
- measurement of electrical consumption in real working situations, all drivers of fluids, especially water and air, and refrigeration equipment including evaporators and condensing units;
- measurement of the combustion efficiency of all boilers or combustion and fuel consumption systems if they have their counters;
- check the electrical protections in situations of functioning of all thrusters fluids, specifically water and air, any existing boilers and refrigeration machines, with inclusion of evaporators and condensing units;
- checking the direction of rotation on all engines and propellers of fluids;
- verification of registration and respective good functioning of all monitoring points and control;
- confirmation of registration of cleaning of networks and components thereof, in compliance with the hygienic conditions of the facilities Heating, Ventilation and Air Conditioning (HVAC);
- test of light levels at sampling points representing the operation of the building;
- verification of the electricity consumption of lighting circuits, as follows:
 - the lighting apparatus operating at 100% light flux;
 - the lighting apparatus to function subject to the control functions.

D. Information for conclusion of appraisal process

The process of provisional acceptance is complete when the following information is available:

- manuals for operating the installation;
- final design plots of all facilities, containing the final elements of all facilities, including architecture;
- report to perform the tests;
- catalogs and technical certificates of conformity of the equipment;
- sheets indicative of the procedure to adopt for the maintenance of each equipment or system in order to be integrated into the Maintenance Plan.

VIII. MAINTENANCE PLAN

The MP should focus on the technical building systems, in order to maintain them in proper operating condition and operation optimized to achieve the intended goals of thermal comfort and energy efficiency.

The MP should include at least the following information duly updated:

- full identification of the building and its location;
- Identification and contact details of the owner and, if applicable, the tenant, lessee or user;
- identification and contact the TIM of the building, if applicable;
- description and summary description of the building and the respective compartments or different areas, including:
 - the area(s) and activity type(s) usually developed;
 - the average number of users, distinguishing, if possible, permanent occasional;
 - the usual schedule of attendance of areas with permanent users.
- identification, location and brief characterization of the technical building systems, including HVAC, lighting, hot water preparation, renewable energy, technical management and elevator and escalator systems;
- detailed description of the procedures for preventive maintenance of technical systems, depending on the various types of equipment and the specific characteristics of its components and potential sources of indoor air pollutants;
- frequency of preventive maintenance and cleaning operations and the level of professional qualification of the technicians who must perform;
- register of preventive and corrective maintenance performed, with an indication of the technicians or technical performed, the results, and any other pertinent comments;
- definition of the quantities to be measured for subsequent formation of a history of facility operation.

The MP must include schematic diagrams of HVAC systems and other technical systems installed as well as a copy of the duly updated design and operation instructions and instructions about acting in case of an emergency.

The terminology used in the documentation and information that constitute the MP should be in accordance with the Standard EN 13306, as applicable to buildings.

IX. (LEGAL) MAINTENANCE PLAN FOR BUILDING'S ENERGY PERFORMANCE

Based on legal requirements set, the TIM can organize and implement a management system for building maintenance based on the following proposed work:

- characterization of building systems;
- counting energy systems;
- maintenance plan;
- other documentation.

In this paper it is proposed a set of items to be considered to accomplish with legal requirements concerning buildings maintenance.

By following the items proposed the TIM will fulfill all legal requirements pointed by Directive No. 2010/31/UE [1].

A. Characterization of building systems

Performance evaluation and maintenance of a building energy systems must be based on a thorough description of many existing systems. For this the following documentation must be available:

- ✓ Support: Data identification and location of the building, indicating:
 - the names and contact details of the owners or users, as well as the TIM;
 - the description of the building, referring areas, activities, number of users, schedules;
- ✓ Support: Listing or map of the installed technical systems indicating:
 - designation of equipment;
 - the make and model;
 - the main constituents;
- ✓ Supports: Picture of dog tags and specifications for each device;
- ✓ Support: Listing of the various monitoring points and control;
- ✓ Supports: operating and installation manuals;
- ✓ Supports: Final blueprints of all facilities;
- ✓ Supports: Catalogs and certificates of conformity of equipment;

The implementation report of the acceptance tests of the facilities that were conducted should be available. This report must be supported on the following media:

- ✓ Support: Procedures for conducting the approval tests;
- ✓ Supports: progress report for approval tests;

This report should include information on the following:

- ✓ Supports: Report of the tests of operating networks of condensates;
- ✓ Support: Report of the tightness of pipes and pipelines;

Diagrams should still be available with the schematic representation of technical systems and action in case of emergency, by which the following must be available:

- ✓ Supports: Schematics indicative of the operation of the facility;
- ✓ Supports: Schematics indicative of action in case of an emergency;

B. Counting Energy Systems

The metering of energy must be registered and energy consumption of the building must be accessed. Some documentation can be used for this:

- ✓ Support: Listing of energy metering systems;
- ✓ Support: Registers of counting electricity;
- ✓ Support: Registers of measuring water flow;
- ✓ Support: Registers of measuring air flow;
- ✓ Support: Registers of temperature and relative humidity;
- ✓ Support: Registers of measuring combustion efficiency;
- ✓ Support: Registers of the electricity consumption of lighting circuits;

Following this registration, energy metering should be performed to analyze the energy performance (annually).

- ✓ Support: Analysis of energy performance;

C. Maintenance Plan

The maintenance plan shall contain at least the following:

- ✓ Support: Maintenance procedures for each equipment, technical system and installation;
- ✓ Support: List and brief description of technical systems of the building grouped in:
 - air conditioning systems;
 - lighting systems;
 - systems of hot water preparation;
 - systems of renewable energies;
 - technical management systems;
 - elevators and escalators.
- ✓ Support: Maintenance schedule with indication of:
 - the frequency and / or expected dates of completion;

- the indication of the technicians and / or levels of competence required;

The various maintenance activities should include the following brackets:

- ✓ Support: Scan registry of installed electric protections;
- ✓ Support: Registration check of the direction of rotation of motors and propellers;
- ✓ Support: Scan registry of the various monitoring points and control;
- ✓ Support: Scan registry cleaning of HVAC components and networks;
- ✓ Support: Registration of testing the levels of lighting in the building;
- ✓ Supports: Records of maintenance performed indicating:
 - dates;
 - the technicians who performed the tasks;
 - results of operations;

D. Other documentation

Adequate support to the event log must exist:

- ✓ Support: Registration of occurrences;

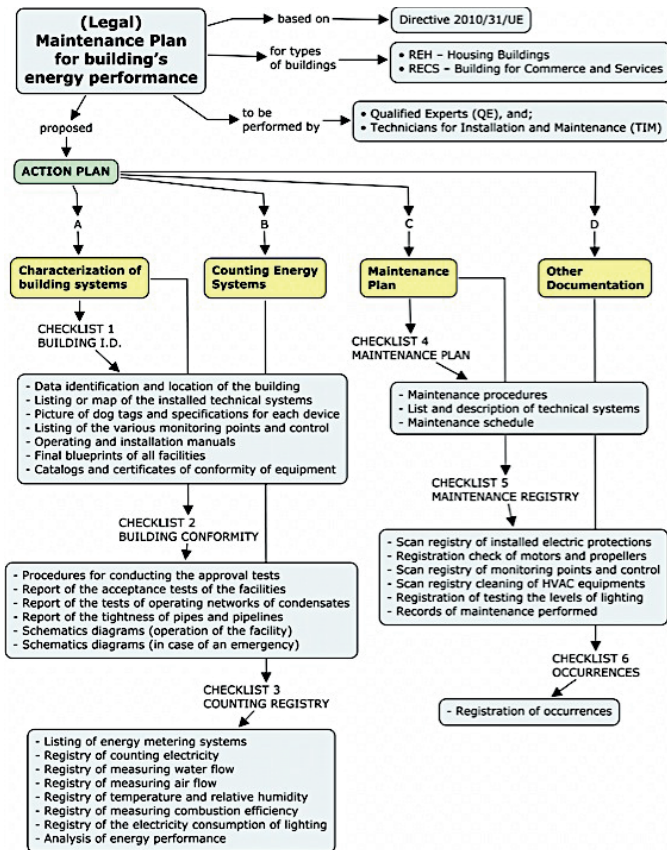


Fig. 1. Conceptual Map – (Legal) Maintenance Plan Content

ACKNOWLEDGMENT

The energy efficiency of buildings is close related with consumption reductions, replacement of existing equipment with others more efficient and by adopting appropriate

measures to management and maintenance equipment. The European Union has in place concrete measures translated in Directive 2010/31 / EU [1] for an approach to the concept of "building with nearly zero energy needs" by 2020.

To achieve this objective competes for skilled workers: the QE and the TIM, to develop correct design, installation, operation and proper maintenance.

The EU member states, to comply with the directive referred, issued legislation accordingly to introduce monitoring systems for energy performance.

Among the various activities of monitoring and evaluation of performance are included specific requirements for planning and execution of maintenance activities over the technical building systems.

With this paper is expected to have identified the main key requirements listed in various media and indicated in Fig.1 that must be produced to comply with the legal requirements and obtain the consequent improvement of the energy performance of buildings, including large office buildings.

REFERENCES

- [1] Directive No. 2010/31/UE, European Parliament and of the Council of May 19, 2010.
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- [6] Portuguese Decree No. 80/2006, of April 4.