Technical guides for owner/manager of an air conditioning system: volume 9

How to integrate Energy Efficiency and AC inspection with full benefit in the structures in place

Supported by

Intelligent Energy Europe
Authors of this volume
Jerôme Adnot (ARMINES, France)
Daniela Bory (ARMINES, France)
Roger Hotchin (BRE, UK)

The sole responsibility for the content of this publication lies with the authors. It does not represent the opinion of the European Communities. The European Commission is not responsible for any use that may be made of the information contained therein.
All actors of the AC market are responsible of efficiency: how make their interests converge?

There are always several actors on customer side in the way to Energy Efficiency (EE), even if they belong to the same company: the owner (and usually investor, except in case of Third Part Financing (TPF)), the operator (making short term decisions on functioning), the maintainers, the occupant, etc. None of these has the same information and interest.

There are also various actors on the professional side, installers (contractors, fitters), designers, maintainers, manufacturers, with zones where they are in competition, and others not. We can provide some “modeling” of the objective for each actor: comfort at lowest immediate cost for occupant, low investment and high asset value for owner, contract renewal for maintainer (without energy consideration), some kind of total cost for integrated operators, etc. We will discuss the objectives not in general, but as far as they can be used to reach the positive goal we have: integration of EE and inspection in the current life.

On total we have a chain with stronger and weaker links, not the same in each country. Each of the professionals in the following chain can make more or less what its immediate neighbours are supposed to do.

Let’s now describe some structures through which the professionals react to new legislations and think about global issues. The manager should think in Euros per unit of function (comfortable square meter of office) but he cannot usually reconstitute the cost and make improvement decisions. He may contract an operator or have the operational work done locally by somebody not technically qualified. Professional operation may be more expensive but may provide efficiency indicators. Maintenance takes place on a regular basis or after a breakdown, and aims at availability, not usually thermodynamic performance. The operator can be a maintainer or not. Now the legislation has brought the inspector into the system, but this periodic inspection is subject to cost constraints and may become more a supervision of maintenance than an energy and cost audit. So a real audit remains necessary, and has to be performed by a real HVAC consultant, in conjunction with inspection or not. The difference between Inspection and Audit remains precisely in the commercial action: an audit is offered by somebody wanting to “sell” something: an improvement in equipment, an improvement in design, an improvement in control. An inspection is supposed to be a legal obligation performed by non-profit people. We would like to suggest that the best way to perform it is by people “already paid” (and in this sense not profit oriented) but that best knows the plant, like the maintainers.
New air conditioning inspection aspects and impact on the market

The relationship between professions in AC will change with the new measures.

Article 9

Inspection of air-conditioning systems

With regard to reducing energy consumption and limiting carbon dioxide emissions, Member States shall lay down the necessary measures to establish a regular inspection of air-conditioning systems of an effective rated output of more than 12 kW. This inspection shall include an assessment of the air-conditioning efficiency and the sizing compared to the cooling requirements of the building. Appropriate advice shall be provided to the users on possible improvement or replacement of the air-conditioning system and on alternative solutions.

Inspection could help in some way to ensure that existing maintenance and operation contracts are appropriate and are properly observed. However there is no contradiction between the development of independent inspections and the development of paid Energy services in private premises. One barrier for more energy services is the lack of visibility of the services and the lack of third part certification. It is important that Member States (MS) implement the “inspection” measure in such a way that a review of operation and maintenance contracts are encompassed within inspections and audits not only a review of aspect of plant. In parallel it would be very useful that efforts be made to define best practice in operation and maintenance so that best practice guidelines can be issued against which existing contracts would be compared at the time of inspection and/or audits.

There is still much uncertainty about the effects expected from the implementation of Article 9, and the Member States are exploring the weight to give to the various aspects:

- technical awakening of the owner and diagnosis of asset situation?
- how is the installation maintained?
- what does really Air Conditioning costs to the owner? Could that be changed?
- comparison with State of the Art installations?
- do we have a scenario of changes needed in the event of refurbishment for some other reason?

Things seem so simple for the heating side!

Article 8

Inspection of boilers

With regard to reducing energy consumption and limiting carbon dioxide emissions, Member States shall either:

(a) lay down the necessary measures to establish a regular inspection of boilers fired by non-renewable liquid or solid fuel of an effective rated output of 20 kW to 100 kW. Such inspection may also be applied to boilers using other fuels. Boilers of an effective rated output of more than 100 kW shall be inspected at least every two years. For gas boilers, this period may be extended to four years. For heating installations with boilers of an effective rated output of more than 20 kW which are older than 15 years, Member States shall lay down the necessary measures to establish a one-off inspection of the whole heating installation. On the basis of this inspection, which shall include an assessment of the boiler efficiency and the boiler sizing compared to the heating requirements of the building, the experts shall provide advice to the users on the replacement of the boilers, other modifications to the heating system and on alternative solutions; or
(b) take steps to ensure the provision of advice to the users on the replacement of boilers, other modifications to the heating system and on alternative solutions which may include inspections to assess the efficiency and appropriate size of the boiler. The overall impact of this approach should be broadly equivalent to that arising from the provisions set out in (a). Member States that choose this option shall submit a report on the equivalence of their approach to the Commission every two years.

The basic difference between heating and air-conditioning is the following: in heating it is enough to check frequently the state of the main equipment (the boiler for heating, in our case the compressor) and to think about the system only at the end of its lifetime. For air-conditioning, the system is the problem! We could even say that the compressor is the less sensitive part of the system.

Let’s incorporate Inspection in the life cycle of an HVAC plant!

![Diagram of Inspection Integration](image)

Integration of inspection

We see on figure that there is some kind of contradiction or interaction between the periodic inspection and the periodic maintenance.

Certifiers, Operators, Maintainers, Inspectors, many people on the same field!

For instance there are potential benefits from sharing the information collected in fulfilment of the Directives inspection and certification requirements, and reducing the total workload. A good logbook would be also useful for both measures. It seems reasonable to require building owners create, use and update a logbook in order to facilitate the application of any existing or future building and energy related regulations. (In the UK, for example, Building Regulations compliance already requires the provision of a building logbook).

Who is expecting inspection results? One of the most cost effective outputs of the inspection is to question (thanks to an outside view) the way the AC system is managed and operated. On the one hand nobody knows the plant better than the operator (notably determining controls, modes and set points) or the maintainer (increasing reliability). On the other hand nobody is less interested in energy performance, reducing capacity, limiting equipment operation, etc. (except when an Energy Performance Contract has been signed, with profit sharing or fixed price arrangements).

So part of (all?) the inspection recommendations are to be transmitted by the owner to the operator, and a direct dialogue between the operator and the independent inspector is an opportunity for real world follow up. It is therefore very desirable for this direct dialogue to take place.
Collaboration between the inspector and operators/maintainers is essential for another reason. Should inspection certificates be issued for installations that we have not seen operating - and maybe cannot operate? No! So there is a need to put the plant ON even for a short time. If we want to inspect in winter, the operator has to be present and generate an artificial cooling demand, (something that is not possible with all systems). Some systems cannot be technically inspected outside of the cooling season, but most can.

One of the outputs of the inspection, maybe the only one that the owner will always understand, is the implicit or explicit judgement on the O&M in place. As we have already discussed, there should be an obligation to maintain the “as-built” documentation and the log-book to avoid extra costs in the inspection process. The inspection report should say whether the maintenance regime in place appears to correspond to the contract or not. A good Inspection report will say where the contract can be improved. It could be important to adjust Inspection time step to maximise this benefit (for instance one year after the start of a new O&M contract, one year before its end).

A number of technical actions (benchmarking, checking of equipment references, checking of maintenance contracts, etc) could well be made at distance, via phone and fax. Inspection infers presence and visualisation, but the degree should be commensurate with the potential for savings, and it may not be cost effective to visually inspect all equipment.

- Visible O & M errors, certainly. A 5-10% potential is quoted by « experts » for such errors, easy to correct if the diagnosis is expressed in the terms of the operator and takes into account the real operational constraints that the operator withstands.

- Invisible O & M errors, difficult without short-term monitoring or use of BEMS data, and without some kind of modelling of the ideal behaviour of the plant to be compared with the real one. A 10-40% potential is quoted by « experts » for such errors, but the effort to (possibly) achieve this is clearly beyond that envisaged by compulsory inspection.

- Benchmarking with other plants of the same type and age. This is certainly information that the owner would appreciate, and that only an independent inspector can bring. The knowledge is dramatically missing.

- Improvements that can be made to the hardware. This needs a lot of expertise and engineering even to produce raw estimates. The (probably conservative) estimate of the potential for savings made in EECCAC is 50% of present energy consumption.

The only direct and certain benefits of implementation of article 9 are the discovery of visible operational errors (under 10%). Beyond this, compulsory inspection can provide indirect help to the next stages towards achieving savings, by systematically documenting what has been inspected. It would be valuable for national implementations to require standardised documentation.

According to savings potential it may be cost effective to visually inspect all equipment, or not. However there is an opportunity missed when corrections are not made immediately. This should be allowed, or even promoted, the “inspector” coming very frequently to the plant could be the maintainer.

**Scenarios for successful implementation**

Four scenarios have been imagined for national transposition:

- Implicit scenario 1 : to generate continuous awareness of owner of more or less complex and correct AC plants. Evidence of degraded performance : a dysfunction, a lack of operation or maintenance, poor control. It’s the most common scenario, because most people see the problem of air conditioning as a problem of maintenance + over sizing, by analogy with heating.
Scenario 2: inspection targeted at expenditure; the regular inspection could create the economics of renovation of the air-conditioning installation or the change of mode of operation. Energy Certification is unlikely to bring a good breakdown of energy consumption by service. To be benchmarked with “service” contracts by outside operators (or intractors).

Scenario 3: if Inspection is the start of a real Audit it should start by comparing the specific plant with state-of-the-art plants. Requires real engineers.

Scenario 4: preparation of a refurbishment (scenario 4). The methods and staff should in that case be adequate.

In any case, due to requirement that inspection is independent of installers, operators, etc., the owners that have already optimised their HVAC with good energy service contracts will pay again for something already done.

The first benefit of the regular inspection for the building owner will be to generate a continuous awareness that there is one (or various) more or less complex AC plants, a source of some potential problems (scenario 1). Indeed, most of owners need evidence that the performance of their building is degraded before taking actions. The poor performance of an installation compared to its initial (or expected) efficiency can be due to:

- a dysfunction of air-conditioning induced by a fault on one piece of equipment
- a lack of operation or maintenance
- a control problem
- an improper action of the operating staff or occupants
- poor (obsolete) equipment compared with present standards

If we target the inspection at expenditure (scenario 2) the regular inspection could create the economics of the possible complete or partial renovation of the air-conditioning installation or the change of mode of operation. If this looks significant it would become relevant for the building owner to pay for an energy audit. But in order to enter into that circle the inspection report should identify the share of total costs (energy, O&M, investment) corresponding to the AC function. One could imagine that this is part of the Energy Certification of Buildings in the same EPBD, but it is unlikely to be (a breakdown of energy consumption by service is likely to be provided in some Member States, but is not a requirement). So only the inspection could start this financial approach. Any reference to costs will naturally increase the relevancy, the interest and the impact of inspection for building owners. The total cost can be benchmarked with “service” contracts proposed by outside operators (or intractors).

At the same time, the requirement that the inspection is independent of installers, operators, etc in the Directive is not helpful to the provision of “energy services” as it seems to require the (few) owners that have already optimised their HVAC with good energy service contracts to pay again for something already done. This would be addressed if the requirement can be satisfied by a system of independent auditing and checking of registered inspectors – who could be existing O&M or energy service contractors.

If Inspection is the real start of an equipment Audit (scenario 3) it should start by comparing the specific plant with state-of-the-art plants. An installation can work perfectly and be correctly operated and maintained without being energy-efficient. Actually, the term “energy-efficient” is absolutely relative and depends on comparison with a reference or level of performance.

The inspection will thus highlight potential savings and – where economically justified - accelerate the replacement of air-conditioning systems or components by more efficient new ones. The inspection may focus on sizing that has to be closer to cooling requirements, on the appropriate choice of equipment, based on life-cycle costs (purchase + operation), on
possible improvement of both process and building and finally on best available technologies on the market.

There is a fourth possible view on the benefits of a compulsory Inspection: preparation of a refurbishment (scenario 4). The methods should in that case also be adequate to the objective.

ANALYSIS OF SOME SUCCESS PATHWAYS

Success pathways based on better O&M as a source of Energy Efficiency

Maintenance maintains or restores the main function (cooling), not good control and efficiency (a secondary function). However maintenance people know very well the plant and their action has usually a positive effect on performance. In many cases it seems easy to ask them to do as well “operation” (decisions about set-points, tuning, etc). The nature of maintenance actions depends on the contractual terms chosen: no contract (correction only), contract of means (prevention only), contract of results (availability level for instance). Maintenance is usually paid by the occupant, while works are paid by the owner and increase asset value. The occupant will try to obtain a lower cost maintenance, and this can be seen as one root of the necessity of outside inspection, requested to the owner in the directive: the owner is the only part thinking about future costs and asset value.

The existing standards about maintenance do not cover specifically Air Conditioning. EN 13 306, the closest to the subject is a terminology standard for maintaining anything (but software). The profession of maintenance is split and not unified, either nationally or at EU level. Installers capture part of the maintenance market (which part??). Manufacturers capture another part (which part??).

A corrective maintenance (after a fault or failure) will just re-launch operation. A preventive maintenance will avoid lack of main function. However the presence of professionals leads to stricter comfort definitions: they may be motivated to adjust comfort levels to meet more strictly the demand. The obligation of maintenance, cleaning, balancing and control of the equipment is a factor of better output of the installations and a guarantee of better energy efficiency. Further to this, the contracting party wants to preserve his market, by offering a range of improvement proposals and measurements intended for the satisfaction of the customer and also proposing attached work, all of those being able to have energy efficiency contents and to contribute to ‘continuous progress’. One way of action would be thus to establish a standard of energy efficient maintenance.

We foresee that the “minimum” inspection that most MS will undertake will be a subset of the CEN standard. We are not interested in the frame of this work in insisting on the inclusion of many maintenance checks, very often, and with a large cost. We are interested in the introduction of a few key checks (may be some temperatures, interpretation of meters readings) with a significant energy efficiency content.

The maintenance on one site may be split between various firms or concentrated on a single one, depending on complexity and cost. Who maintains what (which systems, which parts of systems)? Today the compressors have very tight tolerances, minimum of friction and high efficiency. Even if mechanical defects on the compressor itself (such as wearing of valves) are relatively frequent and costly, it is often the result of problems outside of the compressor, overloading, lack of balancing, contradictions in control, etc. Unlike other parts, maintenance of the compressor by the manufacturers is really essential.

Moving to a contract of operations gives more possibilities to the professional than maintenance only. More risks as well. Good operation is signalled by absence of complaints and a control of running costs. However routine installs itself. The professional has to
“materialise” the action in some way. One way is the decrease of consumption with a financial benefit (another one being a survey of comfort). Strong profit sharing can take the form of a target price for service and energy, or for energy alone. As soon as service and energy are integrated in the same bill (that we will call full cost), this gives origin to rationalisation, internal to the service provider: increasing investment in time (or small equipment) and saving on energy. A less risky contract will envisage the sharing of energy savings, or excesses of consumption, in relation to a previously defined basic consumption during one given whole season, adjusted according to the period and the climate during the given season.

We speak more and more about “Energy services” as in a recent EU directive. The terminology 'Energy Service' appeared relatively recently, as a generic name to designate a quite broad scope of activities in the energy sector. However, before this name was used, various services in the energy field had been already proposed for a long time by many companies, all more or less based on the concept of 'Energy Performance Contract'.

The operation activity in France is characterized by three significant criteria, which define the relations between the customer and the service company:

- The contracts define the results to be achieved;
- The contracting party operates diagnoses and carries out the improvements of which it guarantees the profitability;
- The contracts are drawn up for duration of several years, although the current trend is towards a shortening of this duration.

In the majority of the countries of Europe and in the USA, the relationship between customers and companies is defined by:

- Contracts (or practices) based on specified methods;
- Few engagements of quality in the operation;
- Annual engagements that can be terminated at any time.

It follows that there is a multiplicity of contracts or ‘relations’, which can be established, for each component of an installation, between customer and supplier (supplier of refrigerating machines, supplier of cooling tower, supplier of control devices, etc.). It is in this context that the Energy Service Companies (ESCOs) are seen as revolutionary in countries that do not have the French model of a service company.

This type of contract can be done, on one hand, with big companies operators such as Elyo, Veolia, Suez etc. capable of continuous commissioning, born from big energy companies as heating operators: they extended their competences for HVAC.

On the other side exist a large number of little consultancies and manufacturers, installers and operators of HVAC systems, using other contractual models.

The problem lies mainly with self standing air conditioners including small splits, which don’t deserve a maintenance contract (the only action being the cleaning or change of the filters) but that the owner does not maintain himself either.

**Success pathway based on renovation on the grounds of EE**

Since the owner/manager is the only part thinking about future costs and asset value, one success path starting from “inspection” is a clear understanding by the owner of the costs. One significant barrier is that the immediate benefits go to another part : the occupant. So a revision of rental or service agreements should be able in case of significant improvement of the equipment. Depending on legislation about such agreements in each country, there may be a need for a legislative measure.
Let's assume in the following there are no obstacles: the owner has a perfect information on costs, and there is a contract allowing cost recovery from the occupant.

There are several mechanisms by which the owner reaches the conclusion that a new equipment should be ordered and installed. It can be a complete failure (in that case we are close to the situation of first installation). It can be a replacement due to high maintenance costs of an ageing equipment, or lacking availability (which is a similar situation if we use the concept of failure cost). It can be also a replacement where the new investment will be repaid from the gains due to the existence of more efficient machines today. Also we have to consider "special opportunities" to change part of the equipment and to restore asset value: resizing one way or another, following an audit or a reduction/expansion of premises, renovation of the full building taking place and giving a chance to schedule sooner works which could have taken place later. Other people may want to obtain an A certificate or a Green Building label on a "special opportunity" like ISO14001 certification. We will assimilate these last situations of "opportunities" with the "complete failure" since the decision is not based on a trade off between continuing operation cost and investment but influenced by an outside factor.

This part is about one success pathways: EE investment repaid from running costs savings (less maintenance and energy costs). There is already a certain pressure from professionals on the owners to promote equipment replacement, not necessarily performance orientated. How can we introduce EE in there? Installers, designers and operators all have to adapt to the customer demands. They have to display a competitive initial cost, not over a life cycle, or be able to guarantee a high reliability (better servicing, better contracts) in order to compete. There is almost no freedom for installers and designers to be rewarded for the extra energy efficiency of the systems they may promote although some operators can be reimbursed through performance contracting. There is a lack of training of system designers and installers on the options regarding energy efficient CAC systems because it would be a useless know how on the market as it is.

In this case you have to decide that there are going to have works in the building because the total costs of the new situation will be lower that the total cost of an unchanged situation. We consider that the changes possible through a better control, at almost no investment cost, will be decided or included in the operation contract without further study. The changes considered here request engineering studies and investment. However the economics of replacement are not the same as the economics of a first installation (NPV instead of LCC). The range of possible changes are more limited but the cost of the parts to be changed is also limited. Opening some improvement works has a cost, while at erection time there are no occupants and the craftsmen are there. The payback can happen differently. The algebra behind is obviously the same.

We consider there is an increase in maintenance costs when the installation becomes older (real costs not contractual values which are constant over a contract then rise suddenly )so there is a specific benefit in replacing old equipment that the new maintenance contract has to provide. The same for the electricity capacity subscription. But all this has to be negotiated again on the opportunity.

It is difficult for a plant owner to decide the substitution of an existing equipment on the grounds of potential savings, except if it is a large equipment and the owner has the know how. So the essential partner for such a change would be an operator having a full cost contract or an installer ready to guarantee savings.

The trade associations of manufacturers are strong enough, either nationally or at EU level Eurovent, to be partners in the process of improvement through renovation. They can analyse the renovation as a new market:

- For better equipment and more sales
- For a better satisfaction with their products and wellness of their installers
• For new types of products including features making checking and “inspection” easier.

The unions of installers are gathered in some European structures GCI, CEEBTP. For operators we have now EFIEES. There is an evolution among installers in the direction of more packaged contracts due to the competitive pressure of operators who have taken part of the installation market.

**Success pathways resulting from the combination of EE with reliability improvement or comfort improvement**

This is the case of a replacement due to unavailability or discomfort originated by an ageing equipment, two aspects that can be represented by the concept of failure cost.

There is the “simple” situation of equipment where some parts are no longer maintainable. The manufacturers have a limited compromise to run a stock of parts for maintenance. Among compressors, some are clearly outdated and parts and expertise are just completely missing: it’s the case of rotary vane compressors (palettes). The other pieces of equipment are just ageing and will experience more failures and generate more maintenance and unavailability costs, more discomfort and complaints.

There are classic ways to represent the actual problems of the specific equipment in discussion, when do they fail and why. Being electromechanical systems, we can expect individual parts to behave according to the “normal” law of R( Reliability):

\[
R = e^{-\lambda t}
\]

But by combination of failures and repairs, and new failures with larger costs of maintenance and unavailability, the final behaviour of a system is a question of Availability and follows a law like the following:

The best paper available on this subject seems to be “Survey of reliability and availability information” by Hale and Arno, ASHRAE Trans, 2001, v107, part 2, paper 4489. The data gathered are rather unique but don’t provide distinct values of mean time between failure (MTBF) and mean time to repair (MTTR) according to age. They allow however comparisons between types of equipment from previous generations (like the reciprocating piston compressors) and today dominant types (like the screw and scroll compressors).
quantity with the most significance for comparison seems to be the Operational Availability (OA). As opposed to Inherent Availability, operational availability takes into account all sources of stopping, maintenance or failure. The table gives the OA of various chillers types, according to the nature of the compressor.

<table>
<thead>
<tr>
<th>Type of compressor</th>
<th>Operational availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absorption</td>
<td>99.51%</td>
</tr>
<tr>
<td>Centrifugal</td>
<td>99.76%</td>
</tr>
<tr>
<td>Reciprocating</td>
<td>99.89%</td>
</tr>
<tr>
<td>Rotary</td>
<td>99.62%</td>
</tr>
<tr>
<td>Screw</td>
<td>99.66%</td>
</tr>
</tbody>
</table>

There is a reliability benefit in changing from one category to another. We estimate it per kWc as the loss of the value of one working hour (100 Euros invoicing) per failure hour (the total of working hours being 2000h/year). Moving from a rotary to a reciprocating would save 0.54 Euros per kW and per year, around 10 Euros/kW after actualisation, to be compared to 100 Euros/kW for the new reciprocating chiller (in fact the anticipation cost may be only 25 Euros/kW). Reliability by itself does not justify chiller renovation; there should be another source of savings: economies in refrigerant, energy savings. Note that ageing compressors do display a far larger loss of availability than assumed here, but we have no evidence.

The CAC system is not only a chiller. It may include one chiller and one AHU (if we see the world from the point of view of one customer). For an AHU the OA is 99.99%. No difference in unavailability!

The obsolescence of AC equipment has been accelerated by the change of refrigerants. When you know that the refrigerant you are using is no longer available in quantities, you take any opportunity to change your refrigerating equipment or to adapt it.

We can outline new approaches of success from this analysis:

- Auditing methods should include availability audit and inspection methods should include the treatment of existing failure data on site
- The establishment of a better data base of unavailability costs, namely with ageing would be useful to be used as default values in audit methods when the real parameters cannot be estimated
- the tool allowing the owner or manager to reconstruct bottom up the full cost of its AC should explicitly include unavailability costs.

Yet other success pathways resulting from the combination of EE with general retrofit

There are “special opportunities” to change part of the equipment and to restore asset value: resizing one way or another, following an audit or a reduction/expansion of premises, renovation of the full building taking place and giving a chance to schedule sooner works which could have taken place later. Other people may want to obtain an A certificate or a Green Building label on a “special opportunity” like ISO14001 certification. We will assimilate these last situations of “opportunities” with the “complete failure” since the decision is not based on a trade off between continuing operation cost and investment but influenced by an outside factor.
So we are in the following situation: at a certain time, there will be works in the building. The costs of replacement are lower because the occupants are not here, because the technicians are here with their equipment. The building owner has to decide on the adequate perimeter of changes. The decision will be to change every equipment with a limited reliability, including availability of parts, in the coming 10 years. The owner wants to reconstitute the asset value at a reasonable level. The partial replacement can include obsolescence reasoning: we want up-to-date equipment, even if we could run further the obsolete equipment.

The first existing approach is to take into account an expected life duration of the equipment, whatever the maintenance is. These could be:

<table>
<thead>
<tr>
<th>Type of equipment</th>
<th>Conventional life duration (in years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAC main equipment (not the weakest parts substituted in maintenance plans)</td>
<td>20</td>
</tr>
<tr>
<td>Roof tops and part of split systems exposed to outside</td>
<td>10</td>
</tr>
<tr>
<td>Other autonomous systems or system parts inside</td>
<td>15</td>
</tr>
</tbody>
</table>

With such an approach, when a refurbishment takes place for whichever reason, one is going to replace all equipment that have survived more than the conventional value, or (an alternative approach) that are going to reach their conventional value in the coming 5-10 years.

In some countries a renovated system has to reach the levels of a new equipment. At least the EPB directive requests MS to ensure that when buildings with a total useful floor area over 1 000 m\(^2\) undergo major renovation, their energy performance is upgraded in order to meet minimum requirements in so far as this is technically, functionally and economically feasible.

Member States shall derive these minimum energy performance requirements on the basis of the energy performance requirements set for new buildings. The requirements may be set either for the renovated building as a whole or for the renovated systems or components when these are part of a renovation to be carried out within a limited time period, with the abovementioned objective of improving the overall energy performance of the building (Article 6).

**Various links between EPBD and audits may provide success**

Other aspects of EPBD lead to Audits on top of Inspection. As we have seen the introduction of thermal regulation for any renovation will certainly generate more demands for Audit.

**Article 6 Existing buildings**

*Member States shall take the necessary measures to ensure that when buildings with a total useful floor area over 1 000 m\(^2\) undergo major renovation, their energy performance is upgraded in order to meet minimum requirements in so far as this is technically, functionally and economically feasible.*

But also Energy Performance Certification is a good frame for audit.

**Article 7 Item 2.**

*The energy performance certificate for buildings shall include reference values such as current legal standards and benchmarks in order to make it possible for consumers to*
compare and assess the energy performance of the building. The certificate shall be accompanied by recommendations for the cost-effective improvement of the energy performance.

If the certificates are based on actual building status, they will request some kind of Audit or Pre Audit. For the existing AC plants, it will be like the inspection (or less than the inspection). However there is a big stake in comfort auditing. The introduction of AC in existing and uncomfortable premises is a big motor of growth, and these plants are not the most efficient because of the constraints. One decision of importance is to enter the world of artificial air conditioning in existing buildings: did we try the various options to improve comfort by other means, in which zone AC is needed, which types etc.? This has an enormous energy impact (our estimate is that 40% of new equipment is in existing buildings).

Solutions allowing to come back to the comfortable situation before some usage change or passive solutions forgotten in design but still feasible may be less expensive than the introduction of AC in a building not designed for it.

QUALIFICATION AND ACCREDITATION ISSUES

Better definitions about qualification, certification, accreditation

For efficiency and customer confidence, all MS should try to make more homogeneous the definitions of “an independent manner” a “qualified and/or accredited expert, whether operating as sole trader or employed by a public or private enterprise” in the various countries. Some legislation can still be harmonised. We do not forget the link with Energy certification article 6.

Our proposed definitions. A certification institution must be accredited. The accredditor may be themselves accredited by a higher body or the State. An association, a person or a company may be certified for a certain activity. When an association or a company or scheme runs certification, they may license a company or a person to put it in practice, but bear the responsibility. Persons may have to prove their qualification (obtained from training) or competence (obtained from experience). One of the conditions of company certification may be the presence of staff with a certain qualification or certified competence.

One understands rapidly that the MS will try to use a system where their accreditation board accredits companies, far less costly than trying to certify individuals.

Eurovent-certification can certify components performance by being accredited to do so by the Belgian accredditor, BELCERT. They reach by the use of well calibrated laboratories (that they “certify” in some way), tolerances on certified performances of the order of 4-5% instead of 15%

Legal basis : « An independent body having a quality system for the specified type of equipment in conformity with the ISO-IEC / Guide 65:1996, General requirements for bodies operating product certification systems. »

There are standards about all this, unfortunately not so unified as the 9000 or 11000 series. Let’s mention other standards, not related with products but with “inspection”.

Standard 17020:1998 is called: ”General criteria for the operation of various types of bodies performing inspection”, and seems applicable

ISO/IEC 17011:2004 specifies general requirements for accreditation bodies assessing and accrediting conformity assessment bodies (CABs). It is also appropriate as a requirements document for the peer evaluation process for mutual recognition arrangements between accreditation bodies.
Accreditation bodies operating in accordance with ISO/IEC 17011:2004 do not have to offer accreditation to all types of CABs.

For the purposes of ISO/IEC 17011:2004, CABs are organizations providing the following conformity assessment services: testing, inspection, management system certification, personnel certification, product certification and, in the context of this document, calibration. It seems to be applicable.

There is a CEN standard about maintenance, CEN 13313 "Refrigeration systems and heat pumps- Competence of staff, but we have found no reference to it, in terms of inspection being made by a competent staff, except the f-gas directive.

**Activation of bodies in charge of educational system and technical training**

Who trains whom? How? This depends largely on the type of work to be done. HVAC engineers capable of a real energy audit are trained with concepts.

If we promote a scheme similar in level with HVAC maintenance, technicians are trained by understanding examples and acquiring know how.

If we base inspection on chimney sweeps and the ventilation aspect, the cost will be lower, as the training and the results: only definition of dirty or corroded zones.

Note that with modern technology, audit or inspection can be a team work: inspectors can diagnose a number of things and transfer by video a number of images so as to receive orientation from a distant HVAC engineer.

In a survey reported by AREA in Europe, the people in charge of ODS or F gases have generally less than one year of training in air conditioning but most of them are "engineers" (50 to 80% except Germany and France, two countries having diplomas of “higher technician” comparable to some other countries “engineers”.

The training resources should be tailored according to the needs of the intermediate target groups who can lower the barriers to inspection, audits and actual improvement works.

**Federations of trade and Manufacturers** can provide training resources to their members. AREA has run a 3-year training project supported by the EC (Leonardo da Vinci programme - Vocational Training): The Refrigeration Craftsman; the aim was to establish an AREA industrial European standard for craftsmanship in the field of refrigeration with the objective of securing a uniform and proper level of education and training throughout Europe. The outcomes are unknown to us. There could be a link with our existing Training Package since they dealt with other subjects arising from ODS (Ozone Depleting Substances) like containment.

**Consultants, experts and national HVAC associations** are a special target. The educational committee of REHVA meets once a year at the General Assembly. The chairman of the committee is Prof. Dr.-Ing. Michael Schmidt. The educational committee of REHVA is involved in the following actions:

- Student Competitions at REHVA`s CLIMA-conferences
- Directory of Educational Institutions
- Directory of National Contact Persons

It could be the promoter of common educational materials.
Annex-Some national example

Some examples in France

Let's take the example of France. The most important organisation for accreditation in France is the COFRAC (Comité Français d'Accréditation). Qualibat is an organism for qualification for professionals of construction, and between the qualifications released, a qualification for management and maintenance of heating and A/C equipments exists. Qualiclima is an organism for qualification of installers of A/C equipments under the label Qualiclima and for chiller equipments under the label Qualifroid.

Let's see what each of them does.

COFRAC

In 1994, date of the creation of COFRAC, the authorities aimed the to create a system "euro-compatible", conformable with the European and international practices for accreditation of the operators on attestation of conformity, intended to support mutual recognition of the services carried out by accredited entities. COFRAC is thus located on the top of the structure for confidence that the public authorities have created.

The double mission of COFRAC, committee French for accreditation, is to attest that accredited organisms are qualified and impartial, to obtain international level of acceptation of their services and the recognition of the competences of the laboratories, organisms of inspection and the certification. COFRAC carries out its operating following the application of the national regulations and of the European directives.

Legal (to obtain a ministerial consent) or volunteer (to label an expertise) accreditation represents a competitive advantage and a project that will stir people into action offering a return on investment.

Major Actor for the evaluation of conformity, COFRAC benefits of the trust of the authorities, of its partners, of the organisms accredited and of the their customer. All adhere to accreditation, convinced on its plus value: legitimated competence, confidence of the economic actors, international recognition that can open doors to export. Four sections manage the accreditation:

1. Laboratories (mechanic, physique-electricity, biology-biochemistry, chemistry-environment)
2. Inspection
3. Certification of enterprises, staff and Environment
4. Certification of industrial products and services

Beyond the permanent structure, it has: a commission of internal audit, charged to regularly evaluate the correct operation of the accreditation and the respect by Cofrac of the requirements applicable to the organizations of accreditation and four committees of section, corresponding to the 4 sections of accreditation. Seven technical commissions of accreditation (CTA) are attached to the committee of Laboratories section: Health, Agro-alimentary, Chemistry-Environment, Comparisons intra-laboratory, Mechanics-Thermal, Building and Civil, Electricity-Radiation-Technologies of information.

COFRAC seems to request compliance with the two previously mentioned inspection standards to allow an institution to become a certifier of inspection.
Qualibat – for maintenance and many other things including HVAC installation

Qualibat is an organization for companies' qualification, its mission has been extended to certification. It’s an organization of private law, placed under the State Control (the Ministry in charge of housing), by two protocols in 1949 and 1988. They avoided COFRAC by being recognised directly by the State, but now it became impossible and they are requesting accreditation to COFRAC.

For some levels of qualification and certification, the staff has also to be qualified.

Between the activities of the organisation, the most interesting for our study, is the qualification in “Management and maintenance of heating and air-conditioning plants”, which definitions are described hereunder.

552 MAINTENANCE OF AIR-CONDITIONING PLANTS

The activity of maintenance of air-conditioning plants covers the execution of the preventive maintenance and corrective maintenance contracts on the air-conditioning plants according to the standard AFNOR X 60-010. It also covers additional work necessary to take into account of hygienic requirements (for example for cooling towers) and for the correct execution of the contracts (in particular: electric connection of the material, repairing of the heat insulators).

5522 Maintenance of autonomous air-conditioning plants (confirmed techniques)

The company may ensure preventive maintenance and corrective maintenance contracts on air-conditioning plants made of:

- room systems with cooling capacity lower than 12 kW,
- autonomous units with direct expansion with cooling capacity lower than 50 kW.

5523 Maintenance air-conditioning plants (expert techniques) – with a condition about supervision staff

The company may ensure the execution of preventive maintenance and corrective maintenance contracts on air-conditioning plants located inside all buildings, including the industrial buildings and set up all materials for the heating production, chilled water production and air-conditioning.

It also ensures the maintenance of the systems of remote alarm, remote monitoring, centralized energy management systems of air-conditioning plants.

Qualiclimafroid- installations

Qualiclimafroid is an association declared in Prefecture since 1973 under the name of Qualiclima. Then the name Qualiclima was modified thereafter, to become in 1995, Qualiclimafroid.

Qualiclimafroid association of qualification and of classification of the companies of installation of refrigerating materials, ventilation, treatment of the air and air conditioning delivers the following qualifications:

§ Qualiclima, air-conditioning plants
§ Qualifroid, chilling plants

These qualifications have been, on the request of the trade associations representing the refrigeration companies, of equipment of professional kitchens and of the air conditioning, integrated as a requirement for enabling to handle the fluids, by the Ministry of environment, agriculture, economy and industry and the Ministry for the equipment.
Qualiclimafroid is the only organization exclusively specialized in refrigeration and air-conditioning to deliver qualifications in conformity, according to the decree of February 10, 1993, to standards NF –EN 45012 (attestation of quality system and environmental management). Qualiclimafroid is the guarantee that all the fitters fill these three criteria:

§ To respect the legal constraints related to hygiene, safety and the environment
§ To be covered by contract of insurance Civil and Decennial
§ To be accredit by prefectural authorization to handle the refrigerants.

Like for Qualibat there are degrees depending on:

- Electric power absorbed
- Refrigerant (fluorinated or not),
- Target temperature (positive, negative or very low),
- Carrier (direct expansion or transfer fluid).

Some examples in Austria

In Austria the legislation about refrigerant and about working place are influencing a lot the structure of professions.

To operate a AC with more than 1,5 kg refrigerant, you need a permission according the refrigerant plant regulation (BGBl.Nr. 305/1969, Kaelteanlagenverordnung). This regulation is revised at present. The main focus of this regulation is the working safety (workplace regulations). Topics like dimensioning etc. are not a component of the investigation yet.

According the refrigerant regulation an annual inspection has to be done. This inspection has to be documented in an inspection book. There is no official guideline how this inspection should take place. Since 1992 there exist an advise (voluntary base) from the chamber of commerce, how to make an inspection.

There are regular inspections with prescribed exhaust measurement in Austria for many years for the heating systems. Primarily the exhaust gases are measured and from this the firing-technical efficiency is determined. A consultation, a prescribing or a recommendation are not however connected with it. However the case can be brought to the announcement, in consequence that the plant is not allowed to operate according the fact, that the emissions are higher than certain exhaust limit values. This activity can be prescribed for the installers or by the chimney cleaner.

The basic training toward installers is made by generally technical schools (Pinkafeld, Völkabruck, Jenbach. Mödling), which . Specialized education and training for cooling technician to takes place only in the context of the job. Further education are not prescribed however.

Further education are offered by the chamber of commerce (WIFI) and the Austrian Association of cooling and climatic technical. The OeKKV tries to offer together with the professional school Main (D) a mobile advanced training which visits the installers locally and offer them an advanced training in the region. Those is however only in preparation.

In Austria a division of the authority is present. Buildings are part of the legislation of the countries. Climatic and ventilation systems are components of the buildings, why the legal competence is by the countries.

At the same time air conditioning systems fall due to the work place regulation (working place security) under the federal legislation.