Ductwork airtightness requirements in Portugal

Portugal introduced, for the first time, in the 2006 Building Regulations, a requirement on the airtightness of the ductwork in new HVAC installations. A test is required during commissioning. Data on compliance is however still quite scarce to conclude how effective this requirement is in practice.

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EPBD context and CEN standards

The EU Directive 2002/91/EC and its recast published in 2010 (Directive 2010/31/EU) on the Energy performance of Buildings (EPBD) only include requirements for regular inspection of air-conditioning systems of an effective rated output of more than 12 kW (article 15), as well as heating systems including a boiler with nominal power above 20 kW (article 14). Inspections should identify opportunities for removing inefficiencies in the whole systems in a cost-effective way. There is no specific requirement for ductwork air-tightness, but this is certainly one issue that inspectors should analyse because leaking ducts have an important role in increasing energy consumption in air-based heating and cooling systems.

EN 15240 describes the methodology to perform inspections for air conditionning systems. However, given the large share of ventilation systems in the energy use in buildings, CEN also developed EN 15239 for the inspection of ventilation systems, even when they are not included in the strict scope of article 15 of the EPBD. Together with EN 15378, concerning the inspection of heating systems, these standards cover the inspection of HVAC installations.

Test procedures and measurement methods for air conditionning and ventilation installations are described in EN 12599. They include checks, for instance, of the accessibility and cleanliness of the system according to EN 12097 and EN 15780, as well as measurements, e.g., of airflow rates or ductwork leakage (with reference to EN 12237 and EN 1507).

Commissioning requirements in Portugal

As part of the transposition of the 2002 version of the EPBD, new regulations were adopted in Portugal and came into force in 2006. Requirements for new HVAC systems included for the first time a set of mandatory tests that must be carried out during commissioning, before the building receives its use permit.

Although there is no specific requirement on duct airtightness for new HVAC systems in both versions of the EPBD, its relevance can be argued on the basis of the following arguments:

- The overall goal of the EPBD is to obtain energy-efficient buildings. When a new building is completed, all its components, both fabric and technical systems, should be energy-efficient. Although the Directive 2002/91/EC only required MS to put in place minimum requirements for the building envelope, the recast EPBD corrected that oversight and it now foresees minimum requirements for both envelope and technical systems components. It thus seemed logical, even back in 2006, under the umbrella of the first EPBD, to impose a minimum performance requirement on ductwork airtightness as part of the overall energy-efficiency requirements in the Portuguese building regulations.
- If a new ductwork system is not airtight from the start, it will be a lot more difficult and costly to make it airtight later, after an inspection report identifies this opportunity for improvement. Recommenda-

tions for improvements must be cost-effective and it is often too costly to replace or to improve the performance of an inneficient ductwork system. Therefore, it also seemed logical that, in new buildings, ductwork had to be airtight when it was first installed.

Therefore, the 2006 Portuguese building regulations focussed on ductwork airtightness for new systems being installed, rather than just considering improving ductwork performance in the context of the regular inspections required by the EPBD.

The aim of the tests is to demonstrate that the installation is functioning as designed, in operational terms, but also meeting the minimum energy efficiency and indoor air quality (IAQ) targets set in the legislation.

Proof of the results of these tests, consisting of a detailed report, must be handed to the Qualified Expert (QE) who will issue the Energy Performance Certificate (EPC) for the building, who may ask for further tests if he/she is not satisfied with the report or just for confirmation (random check). Often, the QE is present while the commissioning tests take place. The EPC is required by the local authorities before issuing the building's use permit.

Tests on the ventilation system include:

- Airflow delivered to each room in accordance with design parameters;
- Overall cleanliness of the whole ductwork and other components, such as air handling units and fans;
- Airtightness of the ductwork.

The regulations do not require a specific testing methodology, but tests must follow recognised procedures, such as described in EN 12599.

Ductwork airtightness test

Ductwork air-tightness is often considered to be an issue in cold climates only. There has however been a significant amount of work in hot and mild climates, in particular in the US, that demonstrates the important energy savings potential that can be achieved by reducing duct leakage.

In Portugal, up until 2006, there was no check on the quality of the ductwork (most often, building owners did not require the check simply to avoid its cost), and its performance was in general quite poor (high leakage, cheap materials used), resulting in significant losses, with important negative consequences in terms of the energy efficiency of the whole installation (more air had to be circulated and treated to compensate for the leakage). Moreover, it was often impossible to meet the minimum fresh air rates in many spaces, resulting in degraded IAQ levels. The new regulation aims at ensuring minimum levels of IAQ and improved energy efficiency during operation of the building, by adopting a life-cycle perspective and moving away from the up-to-then prevailing strategy of lowest possible first cost.

To comply with the Portuguese regulation, ductwork leakage of air conditioning installations of buildings larger than 1000 m² may not exceed 1.5 l/s.m² under a static pressure of 400 Pa (Class A limit according to EN 12237 is 1.32 l/s.m² at 400 Pa). Air-tightness tests should be carried out using the following procedure (**Figure 1**):

- A 10% random sample of the ductwork is selected and tested by the inspector. If the measured leakage is below 1.5 l/s.m², no further testing is required;
- If the first test is not satisfactory, a second test is performed, after the contractor takes corrective measures, again on the initially tested ducts plus an additional randomly selected 20% of the ductwork. If these tests are satisfactory, no further testing is required.
- If the previous test is still unsuccessful, the contractor must take additional corrective measures and the final test(s) must cover the whole ductwork until the required airtightness is met.

This procedure was inspired by the AMA requirements in Sweden.

The new regulations in action

The new regulations apply to buildings larger than 1000 m² that begun their licensing procedure after 2006. Taking into account design and construction, this cycle usually takes, for large buildings, at least 3-4 years before completion. Therefore, there are not yet much data on the success of the new regulations. The first large buildings that had to comply with these new regulations only finished the construction phase late in 2009 and during 2010. New construction activity has also been quite low during the last few years due to the prevailing financial crisis and, therefore, the number of buildings affected by these new regulations is still rather small.

However, there is proof that the market adapted to the regulations. The share of pre-fabricated round ductwork with quality seals between ductwork components increased significantly (from <5% in 2006 to 30% in 2010). For rectangular ducts, the technology evolved to

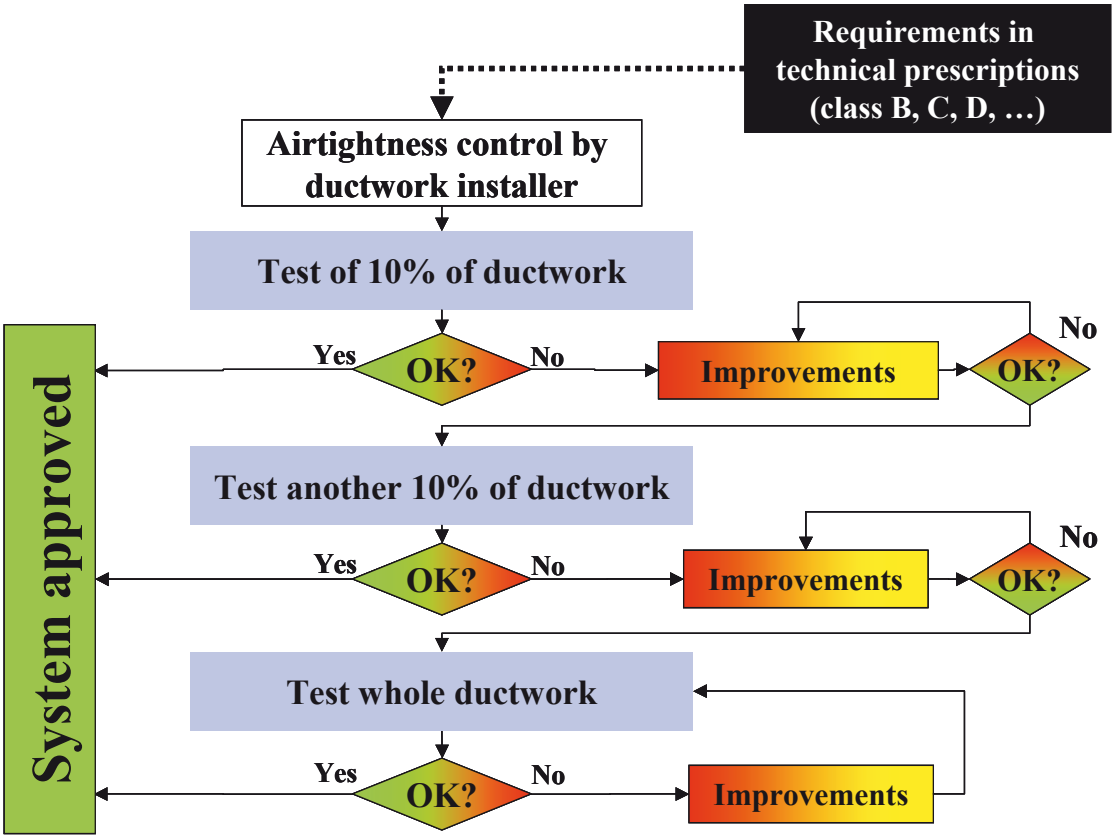

Figure 1. Swedish approach in framework of AMA procedures. The procedure now in use in Portugal is identical except for the initial requirement, which is defined in the regulation with a maximum leakage rate of 1.5 l/s.m^2 at 400 Pa (Class A limit according to EN 12237 is 1.32 l/s.m^2 at 400 Pa).

achieve better seals along duct sections and at unions between two consecutive sections, namely at the corners, representing now 20% of the market (extraction ducts carrying air that is not recirculated, e.g., from toilets and wet-zones, are still usually low-quality ducts). Welded and screwed joists disappeared since then. In parallel, a few specialized companies now offer duct leakage testing services in the market, while there were none in 2006.

Although only few EPCs have been issued for large new non-residential buildings so far, there is anecdotal evidence that the required commissioning tests (not just ductwork leakage) resulted, in most cases, in significant delays to the construction phase, with the corresponding negative backlash. Despite this, the new regulations that must be published to transpose the recast EPBD in Portugal, expected in 2013, are not expected to relax these air-tightness requirements for new ductwork to be installed.

Conclusion

It is too still early to say if the new regulations have been successful (the number of completed new HVAC installations falling under the new requirements is still rather small) and the data regarding the actual performance of few buildings constructed with the new requirements have not been fully analysed yet for lack of statistical significance. But ductwork technology evolved, and there is quantified proof that better quality components are now much more used, and ductwork leakage testing, as well as ductwork cleaning, are now new niche markets that appeared since the new regulations entered into force.

References

See the complete list of references of the article in the html-version at www.rehva.eu -> REHVA European HVAC Journal