

Short Trainings on Quality Assurance



**Work sheet for implementing short trainings on
quality assurance for craftsmen and skilled workers in the field of
energy recovering building refurbishment**



Promoted by the European Commission



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1. Introduction – Why short trainings?

Links / further information on the project in German:

www.hannover.de/de/umwelt_bauen/energie/leitstelle_energie_klimaschutz/concerto/index.html

In English:

www.concerto-act2.eu

Since January 2006, the cities of Malmö (Sweden), Nantes (France), Koszalin (Poland), Newcastle (England) and Hanover (Germany) work together within the European “act 2” Concerto programme. The aim of „act 2“ is to promote energy efficiency and renewable energies in five participating European municipalities up to the year 2010. Nantes und Hannover are implementing some model projects, while the other three cities benefit as kind of observers from such gained experiences.

Within the „act 2“ programme, concomitant trainings for parties and people involved in the model projects are being carried out. This work sheet depicts short trainings on quality assurance and is set up in a way that it is possible to transfer idea, concept, design, as well as issues and content of the trainings into different local conditions and refurbishment projects within Germany and possible other European contexts.

This work sheet is aiming at architects, engineers and planners of energy recovering refurbishment. The focus is on residential buildings and the trainings address mainly involved craftsmen and skilled workers. Essential contents of the trainings are:

- ▶ Dissemination of quality assurance objectives
- ▶ Exposition of the specific refurbishment goals
- ▶ Revision of airtightness' basic principles
- ▶ Means of quality assurance (airtightness/ blower-door-tests, thermography)
- ▶ Exposing most common mistakes

Quality assurance for energy recovering refurbishment basically consists of six individual steps (STEPs):

- ▶ STEP A: Trainings
- ▶ STEP B: Energy certificate according to the German Energy Conservation Regulation (abbr. EnEV-certificate)
- ▶ STEP C: Checking construction details for thermal bridging
- ▶ STEP D: Hydraulic balancing of heating and, if existing, venting appliances
- ▶ STEP E: Blower-Door-Test
- ▶ STEP F: Thermographic characteristics of the building

Short trainings on quality assurance for craftsmen and skilled workers, which are described in the following, are part of “Step A” being the first step on the way to quality assurance. Next to the training course description given here, you can find ample information and different materials such as correspondence, minutes, list of participants and much more on the accompanying CD (in German Language)

As this work sheet focuses on elaborating concomitant trainings, instruments and methods of quality assurance are not depicted in detail. Still, references and publications for further information are given in the left margin.

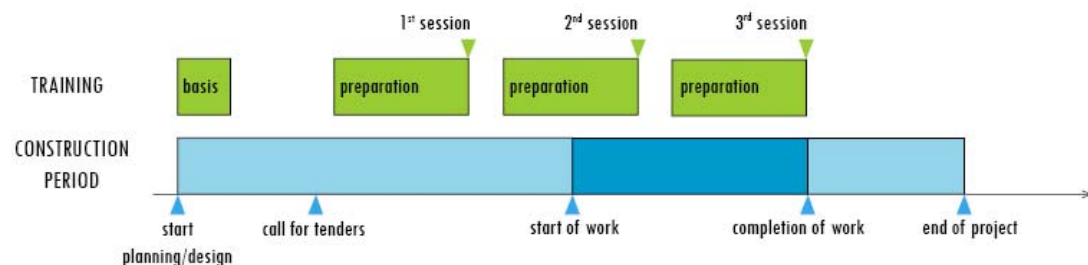
2. Overview / training procedure

Short trainings for craftsmen (act2-QA-trainings) can be a constant element of energy recovering building refurbishment. Predominant target groups for such trainings are involved companies of the respective building project. It is wise to let all involved trades participate in the trainings, though the number of participants should be restricted to the people in charge of the actual job. In addition, participation of the different parties involved in the planning as well as a direct representative of the building owner/client is most desirable.

The training course's outline comprises three sessions of 2-3 hours each but can be extended according to the participant's wishes and needs:

- 1. Session** theory briefing: prior to start of construction
(general introduction to quality assurance)
- 2. Session** practice briefing: during construction period
(on-site training on airtightness, thermal bridges and hydraulic balance)
- 3. Session** practice briefing: success control
(final session including project evaluation)

a. Time Schedule of the Trainings



The diagram above depicts the general construction timeline of energy recovering building refurbishment (blue line). On top of the construction timeline, the different sessions and preparation phases of the training course are displayed (green line). It becomes apparent that for implementing such trainings a common ground has to be agreed upon first of all with building owner and decision makers.

The most important stages are finding common ground and preparing and implementing the trainings. These three stages are explained in more detail in the following paragraph.



b. Different Stages of QA-Trainings

- ▶ **Basis:**
 - inform the building owner
 - fix refurbishment goals and elements of quality assurance
 - master plan
 - embedding of quality assurance in tendering and award procedures
- ▶ **Preparation:**
 - specify participants (target group)
 - generate programme, determine location and date
 - additional speakers, experts, participants and material necessary?
 - Send out invitations
 - prepare slides, contents/ if necessary prepare handouts for the participants
 - minutes
- ▶ **Implementation:**
 - lecture on training contents
 - round-table/open discussion

3. Basis



picture 3.1 – current facade;
Source: architectural office pk nord



picture 3.2 – current facade;
Source: architectural office pk nord

Tip:
There is often some confusion about the actual u-values of windows. Therefore, make sure you ask for the precise u-values of frame and glazing already in your call for tenders and ask for verification before installing.

Tip:
With front-wall installations it is often forgotten to plaster the exterior wall in this part after tile interruption. Such a leakage is often only discovered by means of a blower door test.

Right at the start of the planning process refurbishment goals are agreed upon with the building owner. There may be very different initial conditions and motives for the refurbishment of a building. Reasons behind energy recovering refurbishment range from high energy costs to little comfort, humidity and mould problems due to draughty flats. In many cases, one motive is to achieve sustainable building improvements and meet today's expectations.

It is the planner's task to develop an optimum master plan that combines matters of design, function and energy efficiency. For energy recovering refurbishment, building shell insulation and measures in the field of building services engineering such as heat supply and possible ventilation systems need to be attuned to one another.

What combination of measures is most effective and suitable for the house? What means are needed to achieve the most?

Refurbishing the building envelope may for example be used to improve the window design and the overall facade in a formerly badly proportioned building.

In a different situation, buildings may have elaborate ornaments in the facade that do not allow covering by thermal insulation. In these cases other measures like improved supply engineering and insulation of roof and basement can achieve notable energy savings.

For the refurbishment as an investment into future, careful planning and diligent construction is needed. Whoever invests large amounts of money needs to be sure that desired benefits such as reduced energy consumption and increased comfort do become reality.

It is therefore needed in the planning to especially pay attention to building physics and make sure that no thermal bridges occur and all connections are airtight.

After the planning stage, it is important to ensure that all planning details are implemented in the right and appropriate way.

At this point QA-trainings, as described in this work sheet, step in.

In the call for tenders possible installing companies should get information about planned quality assurance measurements and need to be bound to participate in the according trainings.

It is also important to explicitly express the aimed at insulation standard of construction elements if this standard is higher than what is asked for in the official building code (Energy Conservation Regulation, abbr.: EnEV). In the tendering procedure, insulating materials and sealing compounds need to be defined according to their thermal conductivity.

Once the installing companies have been selected, the implementation of act2-QA-trainings can start.

These trainings have not only positive effects on the quality of workmanship but also on the installing companies as such whose employees are receiving further education. Installers get a general introduction to quality control for airtightness (blower door test), thermal bridging (thermography) and hydraulic balancing of heating and venting appliances. They are thereby further educated and more attentive and diligent in their work.

To the benefit of all, deficiencies and damages are thus prevented.



The following trades need to be involved in the trainings:

- ▶ window construction and implementation
- ▶ companies and trades who deal with insulation such as painters, roofers, dry construction workers, possibly carpenters and joiners
- ▶ companies that install front doors and doors in the staircase such as metal workers, locksmiths and construction workers
- ▶ companies that deal with balconies such as locksmiths, plumbers and concrete workers
- ▶ companies for sanitary technology
- ▶ companies for heating and ventilation technology

To ensure successful implementation, it has to be pointed out to all companies that possible subcontractors need to take part in the trainings as well.

With diligent construction supervision and the described measures of quality assurance, winter can be awaited in a comfortable new home.



picture 3.3 – refurbishment;
Source: architectural office pk nord

links / further information (in German):
www.kompetenzzentrum-iemb.de

4. Preparation

For implementing act2-QA-trainings successfully some preparing measures are necessary. The measures differ, with the first session providing theoretical background information whereas the two following sessions take place on-site and are therefore more hands- on providing the participants with helpful practical experience.

Preparation of 1st Session

Point of Time: prior to construction work

Content: general introduction to quality assurance in theory

Aim: A general introduction to quality assurance is meant to supply all participants with an overview of planned energy recovering measures (see also „implementation“).

Date: The first session ought to take place just after contracting the different installing companies by the client/building owner. Architects, engineers and planners who are in charge of quality assurance do well to send out written invitations to the first session.

Training Location: For a first general and theoretical introduction to quality assurance, seminar or briefing rooms (if available) are sufficient as well as suitable containers on the building site.

Equipment: flip chart, PC, beamer, screen and overhead projector are minimum requirements. In general, the necessary equipment depends on how the planner, architect or engineer passes down his information. Additional required materials are part of the „implementation“ section.

Length of Training: The first session takes approximately 90 to 120 minutes. This should already be announced in the call for tenders and a subsequently send out written invitation.

Documentation, Post-Processing: A list of attendance needs to exist. Moreover, short minutes reflecting main training contents ought to be generated and disseminated.



picture 4.1: training location 1
Source: GMW, architectural office

Preparation of 2nd Session

Point of Time: during construction period

Content: on-site instruction concerning airtightness, thermal bridging and hydraulic balancing

Date: Alongside to implementing construction measures, the second training needs to take place on site. It is necessary for building shell measures to have already been implemented but still be modifiable (named: qualified construction works). For the hydraulic balancing some regulators need to be installed already so that adjustments can be carried out and exemplified. The same applies for hydraulic balancing of possible ventilation systems. It is for the second training again a good idea to send out written invitations.

Training Location: An empty flat would be most applicable for the training but an already inhabited one may work as well. In this case a suitable tenant needs to be found in consultation with the client/building owner. After oral consultation, client and tenant need to be informed in written form.

Equipment: It is important to provide all necessary quality assurance measuring instruments. Such instruments may be:

- ▶ airtightness testing equipment / Blower-Door including hot ball anemometer
- ▶ thermographic camera
- ▶ equipment for testing ventilation system settings such as volumetric flow meter, fan-wheel anemometer, thermal hygrometer, hot ball sensor and acoustic pressure measuring devices.

In addition, for the hydraulic balancing of heating and ventilation systems calculation bases ought to be available as well.

Length of Training: approximately 90 to 120 minutes are sufficient for the second training. Though It depends on the participant's number of questions in the "learning-by-doing" process.

Documentation, Post-Processing: A list of attendance is needed again. Minutes reflecting main issues ought to be generated and disseminated.



picture 4.2 — on-site session, here: Blower door test; Source: GMW engineering office GmbH

Preparation 3rd Session

Point of time: success control

Content: final training including evaluation of results

Date: The third training is part of the success control after refurbishment measures have been completed. Again, written invitations to the final training should be sent out. Please find model invitations (in German) on the attached CD (see below).

Training Location: An empty flat is again most applicable for the final training but an already inhabited one may work as well. In this case, a suitable tenant needs to be found in consultation with the client/building owner. Client and tenant need to be informed in written form. Moreover, remaining tenants need to be informed about training procedures and inspections.

Equipment: As with the previous on-site training, all necessary measuring devices for the aimed at quality assurance are to be at hand. Such devices may be:

- ▶ airtightness testing equipment / Blower-Door including hot ball anemometer
- ▶ thermographic camera
- ▶ equipment for testing ventilation system settings such as volumetric flow meter, fan-wheel anemometer, thermal hygrometer, hot ball sensor and acoustic pressure measuring devices.

Once again, calculation bases for the hydraulic balancing of heating and ventilation systems ought to be available as well.

Length of training: The estimated length of training is again 90 to 120 minutes but depends mainly on the number of revealed defects and shortcomings.

Documentation, post-processing: A list of attendance is needed once again. Minutes reflecting main issues and results ought to be generated and disseminated.

Supportive Preparation Resources on CD (German Language)

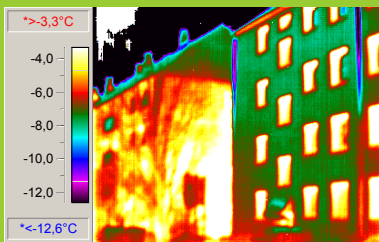
Please find on the attached CD the following draft versions which may help organise trainings in the future.

Drafts to work with:

- ▶ written invitations for all three sessions
- ▶ correspondence with client/building owner
- ▶ correspondence with possible tenants who place their flat at disposal for on-site trainings
- ▶ list of attendance

Minutes-draft version:

- ▶ Exemplary minutes for each training session. Named issues and results in the minutes may complement possible training procedures.



pictures 4.3 and 4.4 – on-site session, here: thermo graphic portrayal after refurbishment;
Source: GMW – engineering office GmbH



5. Implementation

After formalities and preparation means for QA-trainings have already been described in detail it is now important to focus on issues and elaborate helpful information and advice.

Implementation of 1st Session: General Introduction to Quality Assurance

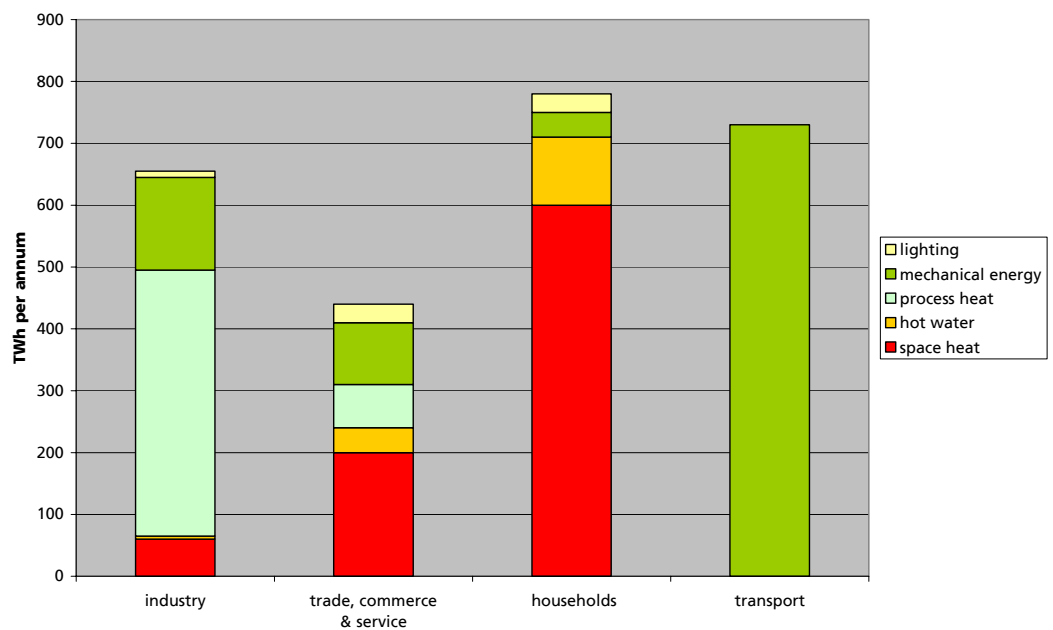
Point of Time: prior to construction work

Content: general introduction to quality assurance in theory

Background Information / Goals and Objectives

Energy Saving in Buildings

40 % of the overall energy demand in Germany is consumed in buildings by private households, as well as trade, service and industrial companies. Hot water generation and space heating require the biggest share of energy, in private households even up to 90%. In this context, energy recovering refurbishment plays a decisive role and quality assurance measures are to guarantee successful and sustainable energy savings.



graph 5.1 – training contents, share of different types of energy demand, Source: GMW – engineering office GmbH



Aims and Objectives of planned Energy Saving Refurbishment Measures

Calculation bases of the building to be refurbished are energy balances according to the national building code (Energy Conservation Regulation, abbr.: EnEV- certificate) or respectively the Passive House Planning Packet (abbr.: PHPP) for the existing building stock. Physical features of building shell surfaces as well as appliances for hot water generation and space heating are taken into account in the EnEV-certificate and PHPP.

Essential objectives in the energy balance are the expected end energy demand, annual heat requirement, annual primary heat demand and CO₂-emissions.

Based on agreed aims and objectives, which may be specified by promotional programmes, different measures are elaborated to achieve energy savings in compliance with the overall objectives. Such measures tackle insulation characteristics of the building shell as well as the prospective type of heat supply.

To achieve the agreed on aims and objectives of energy recovering refurbishment, it has proven necessary to install quality assurance in the field of building physics and plant engineering. As already described in chapter 2 (overview), quality assurance in this case is organised in the following individual steps or stages:

- ▶ STEP A: Trainings
- ▶ STEP B: Energy certificate according to the German Energy Conservation Regulation (abbr. EnEV-certificate)
- ▶ STEP C: Checking construction details for thermal bridging
- ▶ STEP D: Hydraulic balancing of heating and if existing venting appliances
- ▶ STEP E: Blower-Door-Test
- ▶ STEP F: Thermographic characteristics of the building

Step A -trainings are described in this work sheet. They are meant to enable everyone involved in the construction process to avoid mistakes but to achieve the quality standard already specified in the call for tenders. In the end, all different steps of quality assurance including measuring methods and verification procedures serve to guarantee a refurbishment free of defects.

Step B and C exclusively address people and companies involved in the planning process. There are no connections to the installing companies at these stages. Still, in the following a brief overview is given about principles for planning airtight and thermal bridge-free as these principles need to be implemented later on in the building project.

Tip:

At this point in time it is reasonable to actually name and formulate objectives and planned measures for the building project.

Tip:
Some slides as well as a model example of quality assurance are part of the attached CD (German language)

Training Contents

Overview

Main issues are:

- ▶ Introduction to heat and energy saving
- ▶ Objectives and aimed at characteristics for the building project and possible effects and requirements on execution of construction works
- ▶ Display of different kinds of thermal bridges and how they occur
- ▶ Principles of airtight construction
- ▶ Information on quality assurance measuring instruments: blower door test and thermographic pictures
- ▶ Construction details and suggestions to avoid common defects and mistakes
- ▶ Hydraulic balancing
- ▶ Open discussion

Airtightness

Depending on the building's geometry, flow directions and wind speed create areas of higher and lower pressure on the building surface compared to indoor pressure. This wind pressure causes exterior air to infiltrate the building on the wind-facing side and indoor air to escape on the other side of the building. Given high wind speed, wind pressure is the main cause for air change rates in buildings and thus leads to high energy demands. Above that, moist and uncontrolled escaping indoor air may lead to construction damages.

To restrict air infiltration, heat loss limits of air permeability in buildings are specified in a DIN-standard (DIN 4108-7). Disregard or poorly conducted airtightness is a hidden defect of construction works.

Depending on the different equipment in buildings, different airtightness requirements have been set up:

- | | |
|--------------------------------------|--------------------------------|
| ▶ Buildings with window ventilation: | $n_{50} \leq 3,00 \text{ 1/h}$ |
| ▶ Buildings with ventilation system | $n_{50} \leq 1,50 \text{ 1/h}$ |
| ▶ Passive Houses: | $n_{50} \leq 0,60 \text{ 1/h}$ |

Another request is to avoid leakages in the building shell that allow indoor air to enter the construction part.

Additional reasons for good airtightness are:

- ▶ maintaining thermal comfort
- ▶ avoiding cold air patches
- ▶ securing low-emission indoor air
- ▶ working ventilation systems
- ▶ avoiding humidity
- ▶ securing of positive thermal features
- ▶ minimising energy losses

As verification procedures for airtightness the blower door tests is being used (also named airtightness-test or pressure-difference-test; see implementation of 2nd session, page 16).



picture 5.1 — installing a Blower-Door;
Source: BlowerDoor GmbH

Links / further information:
www.blowerdoor.de
www.flib.de



Links / further information:
www.buildingphysics.de (HEAT)
www.bauphysik-software.de

Thermal Bridges

Reducing thermal bridges is mainly a planner's task. For the later implementation construction details need to be passed on. Plans need to comprise all necessary data concerning insulation material, insulation thickness, anchoring depth and many more. From a building physical point of view, the influence of thermal bridges gets higher the better the insulation standard of a building is.

Next to reducing transmission heat losses, the most important effect is to avoid mould and moisture problems. With strong heat drains, the danger of condensation arises in areas of thermal bridges where construction elements cool down to an extent that condensing water may create perfect conditions for mould to grow. For the estimation of thermal bridges different calculation methods exist (such as software HEAT 2.0) which simulate temperature developments on the building element. With respect to expected surrounding temperatures and relative air humidity on the one hand and planned measures on the other hand, parts of building construction may be tested and judged according to feasibility and usefulness. For the implementation in buildings, thermographic cameras are used as verification devices.

Hydraulic Balancing

a) Heating System

Different distances from heat supplier to heat consumer (radiator, floor heating and air heater) different pressure relations arise in the heating system. Consuming elements that are located close to the heat pump get higher plant pressure than other located in greater distance. In a non-balanced heating system a great share of the heat may already be consumed by the nearest consumer so that others may not get enough and vice versa. While more remote consuming elements get the needed amount of heat, other nearby elements in the heating system are overfed with heat, leading to increased energy demands. With hydraulic balancing, each consuming element in the heating chain gets the appropriate heat load by means of hot water circulation. This kind of adjusting the settings in a heating system reduces the energy demand, energy costs, and improves cost effectiveness and environmental record. Possible savings in existing appliances may be up to 30 %, ensuring improved thermal comfort at the same time.

In VOB part C (federal construction works standard) hydraulic balancing is required. Elements of heating and hot water appliances need to be attuned to one another. Operational reliability and sufficient but economical and efficient operation needs to be achieved. Pipes and fittings need to be suitable for changing service conditions. Part load conditions leading to higher operational pressure have to be avoided. One possibility is to install regulator valves or pressure difference regulators.

Energy recovering refurbishment usually integrates already existing heat distribution systems and centralised systems are not changed completely. Still, hydraulic balancing then requires the installing of new regulating thermostatic valves and return fittings in the existing consuming elements.

A base for quality assurance and thus professional hydraulic balancing is the calculation of the heating tube system including all specifications and calculations for valve settings. Quality assurance has to check, adjust, verify and finally certify these pre-settings.

b) Ventilation System

As already described for heating systems, basic conditions are alike for different pressure conditions in ventilation systems. If ventilation systems are planned within energy recovering refurbishment measures, lacking fine tuning in ventilation systems leads to even higher energy losses. Apart from that, such non-adjusted ventilation systems achieve less heat recovery (if equipped as such) and inappropriate hygienic air change including humidity removal. High energy consumption, bad air quality, humidity damages up to mould formation and high environmental impact in general would be the consequences.

In order to avoid such negative side effects, hydraulic balancing for ventilation systems is necessary. As with the heat supply, hydraulic balancing is the installer's task, in Germany part of the federal installation specification VOB part C.

It has proven appropriate to adjust and regulate ventilation systems in compliance with the German federal engineering standard „VDI 2079“. Measurement basis for quality assurance and adjustments in these cases is yet again DIN 1946 part 6 (German Industry Standard) which needs to be part of the planning as well.

Quality assurance following VDI 2079 (engineering standard):

- ▶ Check for completeness
- ▶ Operational test
- ▶ Operational measurement

In the first step, the scope of delivery is checked. The second, operational test contains verification of accurate installation of important components. In the third step, operational measurements check the predetermined desired values with different measuring methods. Quality assurance means to test and adjust specifications and finally certify the building and its technical components.



Open Discussion

In the first session different comments and questions arise according to the participant's state of knowledge. Many questions may only be answered after displaying and experiencing a complete cycle of quality assurance including the different measuring methods. Still, as a supplement to the training contents of the first session an open discussion is important to have.

Implementation of 2nd Session: On-Site

Point of time: während der Bauphase

Content: on-site training tackling issues of airtightness, thermal bridges and hydraulic balancing

Initial Situation

As described in the „Preparation“ chapter, the second session takes place on-site the building project. Concerning thermography it is sufficient to meet outside the building. For blower door tests and hydraulic balancing an empty or chosen occupied single flat is needed.

Training Contents

Implementation of Blower Door Test

To check the airtightness, a so called blower door test (pressure difference test) is carried out. In this test, a fan creates constant overpressure and low pressure is in the building.

The fan and corresponding measuring unit is installed in a window or exterior door. Starting with low pressure measurements, pressure differences of 50 Pascal between outside air and indoor air are created. Through leakages in the building shell outside air is now streaming into the building. There are different possibilities to locate such leakages:

- ▶ Sensing by hand
- ▶ Measuring air velocity with an anemometer at the leakage.
- ▶ using a fog machine in over pressure tests; the artificial fog leaves the building on the outside and leakages can be located. This is also suitable for locating leakage paths in the building, i.e. in shafts and hollow spaces.
- ▶ Additional thermography of inner building surfaces; building components cool down due to outside air streaming in. This air inflow is then detectable.

Pictures with a Thermographic Camera

An infrared camera allows the documentation of the building's initial condition prior to energy recovering refurbishment and checks taken building physical measures as part of quality assurance. Thanks to „visualising“ heat flows, weak points in the building and its component joints can be detected. Detected areas can then be improved and kept in mind in the course of further implementation.



pictures 5.3 and 5.4 –
2nd meeting; Blower-Door is installed.
on the bottom: Anemometer in use
Source: GMW – engineering office GmbH



Hydraulic Balancing

a) Heating Systems

In a first step, crucial components for hydraulic balancing such as self regulating pumps, regulating valves or difference pressure regulators are closely looked at concerning their quality and tender specifications. It is necessary to once again point out the design data to all participants, usually in form of a wiring scheme. On this base, first settings are implemented. Afterwards, possible pre-settings of thermostatic valves and return pipe connections are explained and tested by the participants. To do this, a setting list (again a wiring scheme) needs to be there.

b) Ventilation Systems

Quality assurance in compliance with the federal engineering standard VDI 2079 as described in the first session now requires on-site training. It has proven beneficial to explain measuring instruments first before each participant has to do at least one measurement him- or herself..

Implementation 3rd Session: On-Site Success Control

Initial Situation

Like the second session, the third and final part of the training takes place on-site, simultaneous to the final inspection of the person in charge of quality assurance for the particular building project. Concerning thermography, it is sufficient to meet outside the building. For blower door tests and hydraulic balancing an empty or chosen occupied single flat is needed.

Performing the Blower Door Test

For success control and direct comparison, it is useful to take the same occupied single flat from the second session. The blower door test is set up and performed as described above. Current readings can now be compared to the test data and accomplished works may be judged and evaluated.

Typical weak points are:

- ▶ duct sealing
- ▶ junctions and joints in the roof
- ▶ door and window joints
- ▶ switches and power sockets in exterior walls
- ▶ the area of front-wall installations
- ▶ hatch to unheated annex



pictures 5.5 and 5.6 –
3rd meeting; thermographic pictures
Source: GMW – engineering office GmbH

Thermographic Pictures

Final pictures from a thermographic camera document that aimed at qualities of taken building physical measures have been achieved. As with the blower door test, direct comparison can be drawn between the building's initial condition prior refurbishment and after the overall implementation of refurbishment measures.

Typical weak points are:

- ▶ building junctions in the area exterior wall-cellar ceiling, exterior wall-window, exterior wall-roof
- ▶ projecting balcony slabs
- ▶ projecting roofs

Hydraulic Balancing

a) Heating Systems

According to compiled calculations, settings of regulating valves, thermostatic valves, return pipe connections, etc. are tested at random sample. It is beneficial once again to have the design data, usually in form of a wiring scheme at hand. The values and settings are being documented and a final certificate respectively final comment is given on behalf of the person in charge of quality assurance.

Typical weak points are:

- ▶ installation of new valves has been overlooked/forgotten
- ▶ setting adjustments did not take place; installation as delivered

b) Ventilation Systems

In co-operation with the participants, settings of the ventilation system are tested at random sample in compliance with the engineering standard VDI 2079. Values and settings are documented and a final report is given on behalf of the person in charge of quality assurance.

Typical weak points are:

- ▶ no device connection
- ▶ no condensate connection
- ▶ external-, exhaust air pipes are not insulated
- ▶ supply- and exhaust air sides have been interchanged
- ▶ supply - and exhaust air pipes are not secured against construction filth
- ▶ flexible aluminium tube, if applied, is dented
- ▶ valves not measured and adjusted, installation as delivered
- ▶ no user briefing
- ▶ no service notes exist

Supportive Resources for Implementation on CD (German Language)

Please find on the attached CD the following draft versions which may help implement trainings in the future.

Model Drafts:

- ▶ model presentation for communicating the basics in the 1st session
- ▶ examples for minutes and final reports for hydraulic balancing of the heating system and adjustment of ventilation system settings



- ▶ model Blower-Door certificate
- ▶ example for a list of radiator pre-settings within the hydraulic balancing

Extra:

A complete model version of quality assurance implemented in energy recovering refurbishment measures including all necessary steps.



6. Imprint

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