A Quality Assurance System for Improvement of Indoor Environment and Energy Use when Retrofitting Social Housing

Kristina Mjörnell and Peter Kovacs
SP Technical Research Institute of Sweden
The energy efficiency improvement potential...lies in the existing building stock, especially in the large areas of multifamily houses built in the 1970-ties.
Energy efficiency and good indoor environment

- Concentrating excessively on either energy efficiency or good indoor environment might cause mutual effects, and it is important to avoid this.
- To achieve the intended results of the retrofit requires knowledge, continuity and communication.
- This can be assured by a quality assurance system, describing a systematic and controlled way of working.
Successful energy improvement retrofit will be permanent only if the management is guided by effective routines.
Implementation of the QA System...

..in planning, design, construction, operation and maintenance

A ahead of retrofit
- Questionnaires to tenants
- Inspect and analyse building’s status and energy performance

Requirements
- Define requirements and targets
- Suggest measures

Design
- Choose building structures and installations
- Plan quality controls

Construction
- Verify requirements by inspections and measurements
- Commissioning

Commissioning
- Handing over
- Adjustments
- Establish operation and maintenance routines
- Educate operators and other professionals

Management
- Monitor energy use and indoor environment
- Questionnaires to tenants
- Review by the management

Governing and describing documents
- Procedures
- Records
- Templates
Implementation of the QA System...

..in planning, design, construction, operation and maintenance

Continual improvement

Governance and describing documents
- Procedures
- Records
- Templates
Ahead of Retrofit 1

Questionnaire

- Questionnaire to tenants identifying existing or potential problems

Thorough Primary Inspection (TPI)

- Inventory of construction status and damage, design concepts, materials
- Inspection and measurements (temperatures, air velocity, ventilation rates, light, noise, radon etc.) checking fulfilment of requirements
Ahead of Retrofit 2

First Energy analysis (FEA)

- Analysis of data of current (and past) energy use
- Inventory of design and standard of HVAC systems, lighting, monitoring system etc.
- Inventory of insulation standard, previous energy efficiency measures, adjustment records etc.
Definition of Requirements and Targets

The requirements and targets are based on legal requirements (binding), guidelines and recommendations (voluntary)

Requirements and targets concerning:

- Energy performance and energy use
- Indoor environment
- Quality requirements and targets for the construction process
- Performance requirements for critical components
Requirements and needed measures

- Results from the TPI and FEA (actual status) are compared with requirements and targets

- $\Sigma(\text{Requirements - Actual status}) = \text{Major retrofit or Limited action?}$

- Measures needed to reach the requirements and targets are suggested and planned
Design Stage

Designers:

- Work out solutions of the building structures and building services systems in accordance with chosen retrofitting measures
- Decide on methods for quality checks; e.g. sound or luminance levels, air-tightness, moisture content
- Do calculations or simulations showing that requirements concerning indoor environment and energy use are fulfilled
- Participate in construction meetings to follow up!
Construction Stage

Contractors:
- Carry out retrofit measures
- Make inspections and measurements to verify that requirements are fulfilled
- Supervise, collect verification reports and system documentation
- Continue the dialogue, visualise the property management stage, encourage knowledge sharing and feedback on upcoming challenges
Commissioning Stage

The QA system aims to bridge the gap between the renovation and the management stage

Important activities include:

- Handing over of the building to the management organization
- Consider outsourcing of e.g.
- Training of operators, caretakers, cleaners
- Documented plans for operation and maintenance
Property Management Stage

- Follow up of energy use
- Regular (e.g. monthly) checks during operation
- Questionnaire to tenants and continuous feedback
Pilot project Brogården

- Swedish multifamily housing area of 300 apartments
- The municipal housing association Alingsåshem AB intended to retrofit the houses to passive house standard
- Challenging targets on energy use and indoor environment
- Long time partnering contract with common targets and open cost accounting
Application of the QA system in Brogården

- Information meetings with all project participants
- Building contractor continually supplies information to employees on quality targets
- Keeps residents informed of the renovation process
- A display apartment providing occupants to examine the technical systems and practical arrangements in the new apartments.
- Job-planning before critical elements
- Verification with measurements and testing
Brogården, Alingsåshem before renovation

Central ventilation without heat exchange

15+15 isolation in the attic
U-value ca 0,20 W/m², K

10 cm isolation in walls
U = 0,4 W/m², K

3-pane windows
U= 2,0

Entrance doors
U = 2,5

No groundfloor isolation

Concrete balcony floor with thermal bridges to floor inside

Energy performance:
(kWh/m², year)
22 degrees indoor temperature

Space heating: 115
Domestic hot water: 42
Household electricity: 39
Common electricity: 20

Summary: 216

Air tightness 4ach at 50 Pa
Brogården after retrofit

Brogården, Alingsåshem after renovation

- 5 cm isolation on the existing roof
- 38 cm isolation in the attic
- U-value ca 0,20 W/m2, K

- 35 cm isolation in walls
  \[ U = 0,12 \text{ W/m2, K} \]

- 3-pane windows
  \[ U = 0,85 \]

- Entrance doors (porch)
  \[ U = 0,8 \]

- Decentral ventilation with heat exchanger
  Efficiency > 85%

- New exterior balconies without thermal bridges

- Air tightness
  \[ 0,4 ach at 50 \text{ Pa} \]

Energy performance:

- Space heating: 27 kWh/m2, year
- Domestic hot water: 25 kWh
- Household electricity: 27 kWh
- Common electricity: 13 kWh

22 degrees indoor temp

Summary: 92
Conclusions

A QA system for indoor environment and energy use has been adjusted to suit the retrofitting process.
The QA system is used to assure organization, routines, responsibility and resources to maintain a good indoor environment and energy use performance.
The QA system has been applied in a number of pilot project in Europe.
Experience from these project will be used to further improve the QA system.
The Pilot projects will serve as good examples inspiring other housing owner to carry out retrofitting projects.
Thank you for your kind attention.

www.iee-square.eu