SQUARE - A System for Quality Assurance when Retrofitting Existing Buildings to Energy Efficient Buildings

Survey of National Conditions

WP 2.1
An overview on existing QA systems for energy efficient renovation with improved environment

Supported by

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SQUARE

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Internal report

Work Package 2 Survey of National Conditions

Deliverable D2:1 An overview on existing QA systems for energy efficient renovation with improved environment

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Preface

This internal report is part of the work carried out within the SQUARE project (EIE/07/093/SI2.466701), which stands for A System for Quality Assurance when Retrofitting Existing Buildings to Energy Efficient Buildings. The project is co-funded by the European Commission, supported by its Programme Intelligent Energy Europe (IEE). The SQUARE project aims to assure energy efficient retrofitting of social housing with good indoor environment, in a systematic and controlled way.

The partners of the SQUARE project are:

- AEE Institute for Sustainable Technologies, Austria
- EAP Energy Agency of Plovdiv, Bulgaria
- TKK Helsinki University of Technology, Finland
- Trecodome, Netherlands
- TTA Trama Tecno Ambiental S.L, Spain
- Poma Arquitectura S.L., Spain
- SP Technical Research Institute of Sweden, Sweden
- AB Alingsåshem, Sweden

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Summary

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The survey includes an overview of promising existing measures and QA systems for energy efficiency and good indoor environments in Europe.

Quality assurance methods for new buildings and/or renovation have been developed in Austria and Sweden. The Swedish one is available also in English. Both ones also have target values for different indoor air parameters.

In Finland target values for indoor climate have been presented. It is possible to select target values from three different indoor air quality classes. In Finland it have been developed testing methods for building materials and ventilation system components. More than one thousands products available in Finland have been classified as low emitting. Those materials helps when planning healthy low energy renovation of social apartment buildings. Most of those emission tested building materials are available only in Finland.

In Finland there are no special QA systems for renovation. In Finland there are several guidelines and official methods for building and energy inspections, selection of target values, guidebook for healthy apartment building and mandatory service manual for apartment buildings.

The Swedish QA system can be adapted but adjusted according to local official methods for energy inspections, indoor air quality inspections and target values for indoor air quality and energy efficiencies.

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1 Introduction

The work package 2 consist a survey of current conditions for continuing work. The survey includes an estimation of the energy savings potential of retrofitting social housing in different countries together with an overview of promising existing measures and QA systems for energy efficiency and good indoor environments in Europe.

1.1 Description of task

The task 2.1 consist of literature review of alternative QA systems for energy use and indoor environment.

1.2 Objectives and target groups

The objective is information transfer to Work Package 4, where the QA systems will be further developed and adopted, and to Work Package 5, where energy improvement measures will be evaluated.

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2 Existing QA systems in the participating countries

Austria

Energy Quality through Retrofit

The aim of the Quality assurance tool **EQ^S** ("Energy Quality through Retrofit") is to achieve energy savings, comfort and to avoid structural damages by assuring energetic as well as structural quality during the retrofit process.

The EQ^S system involves the building owner, the contractor, construction companies and an EQ^S consultant. The contractor advances the investment costs for the building owner and acts as retrofit manager as well. The contractor guarantees towards the building owner a certain amount of energy savings through the improved energy performance of the building. The advanced investment is then refinanced by the gains through energy savings within an agreed on contract duration.

SAQ - Sanieren mit Qualität (Retrofit with quality)

SAQ is a tool for the assessment and comparison of different retrofit alternatives for public buildings. Energetic as well as ecological quality criteria are defined within an excel-tool. The compliances of each criteria and each alternative can be evaluated and assessed according to a weighted point scale.

Total Quality System – TQS

The aim of the Total Quality System (TQS) is to support real estate developers, housing companies, planners, tenants and owners to create a sustainable building quality by defining specific planning targets at the beginning of the planning phase (of new buildings or retrofitted buildings) and to perform a compliance check afterwards.

By means of several criteria and target values, which are defined in a guidebook, the building quality is evaluated. According these criteria "planning targets" are defined independently from each other.

Bulgaria

No QA systems for energy and indoor environment have been detected.

Finland

In Finland there are no special QA systems for renovation. In Finland there are several guidelines and official methods for building and energy inspections, selection of target values, guidebook for healthy apartment building and mandatory service manual for apartment buildings.

Indoor climate classification

As a result of many extensive research projects on indoor climate and clean ventilation, Classification of Indoor Climate, Construction and Finishing Materials was published in 1995. This classification changed the installation work in construction sites (clean

ventilation) as well as building material market (low emission building material labeling) and has systematized the design.

The classification was updated in 2001, Classification of Indoor Climate 2000, Target Values, Design Guidance and Product Requirements and next proposal for update is published and would be completed during 2008. Versions 1995 and 2001 are available also in English.

First part of the Classification deals with indoor climate target values. The Classification has three categories: category S1, S2 and S3. Category S1 corresponds to the best quality, meaning higher satisfaction with the indoor climate and smaller health risks. Category S3 is in line with the official quality set by building codes. Target values are not given separately for different building types, but this will be possibly implemented in the 2008 version. Due to this reason the Classification is most suitable for office and public buildings and less suitable for dwellings.

The second part of the Classification, Guidance for design and construction, deals with the construction and ventilation system cleanliness issues and moisture control issues. It introduces P1 class for ventilation system cleanliness and another P1 class for construction work cleanliness. Ventilation system P1 is verified with visual inspection method of ducts and air handling units. Inspected components are compared to visual scale.

In 2007, more than 1100 building material products by over 115 producers and more than 100 clean ventilation products by 8 producers have passed the Classification criteria and granted with M1 label. The largest product groups are plaster, rendering, putties, fillers, flooring, paints and varnishes, building boards and mineral wool. These figures simply mean that high majority of building materials in Finnish market are M1 labelled today.

Criteria for healthy (apartment) building

This construction process based criteria is being tested and developed further by four construction companies in four different pilot building under construction, there the research team has been involved from the conceptual design phase continuing to the completion of buildings.

The contents of the criteria are divided to follow the construction process:
1. Design specification
2. Conceptual design
3. Design
4. Construction
5. Balancing and tuning HVAC systems and commissioning
6. Operation and maintenance

This guidebook was developed mainly for new buildings but there are several parts which can be used during renovation of existing apartment buildings. Such areas are how to keep ventilation system clean during construction, moisture control plan during construction and cleaning of building before occupancy. This guidebook is available only in Finnish.

Control of room temperature in block of flats
The better insulation and use of preheated supply air can cause too high temperature levels inside single apartment in block of flats. This short guideline shows the effects of window ventilation, window type and solar shades on room temperature levels. When mechanical cooling is need guidelines for design are given. This guide is available only in Finnish.

Guidelines for conditions surveys

Guidelines for inspections of apartment buildings. Structures, windows, heating and ventilation systems and other building services can be inspected. Apartment building is inspected mainly visually only. In every 10th year the Finnish State pays half of total inspections costs.

Guidelines for energy inspections

The energy use of apartment building can be evaluated by method developed Finnish MOTIVA-energy audit company. It is also possible to get State subvention for energy inspection.

Spain

No QA systems for energy and indoor environment have been detected.

Sweden

P-marking of indoor environment and energy use
SP Technical Research Institute of Sweden's P-marking quality assurance scheme for buildings, products, services etc., now includes P-marking of the indoor environment and energy use performance of buildings. The rules for the system, which cover new buildings, renovation and existing buildings, are set out in SP's Certification Rules no. SPCR 114E, specifying requirements in respect of both energy use and indoor environment management.

This quality assurance system has been successfully applied to schools, offices and dwellings. The performance of a building is determined not only by a good indoor environment, but also by low impact on the external environment as a result of energy use in the building.

3 Comparison of IAQ related target values in Austria, Finland and Sweden.

Values from Austria have been taken from Total Quality System. Values from Finland have been taken from Indoor Climate Classification 2000. All values represent class S2.

In table 1 are shown values for thermal environment, in table 2 values for ventilation and ventilation system and in table 3 values for IAQ.

Table 1. Target values for thermal environment.

	Austria	Finland	Sweden
Winter			
Satisfaction			80 %
Air temperature		20-22 °C	20-24 °C
Vertical temperature gradient		3 °C/m	2,5 °C/m
Operative temperature	18-22 °C	20-22 °C	20-24 °C winter
Radiation asymmetry			<10 K
Floor temperature		19-29 °C	19-26 °C (new buildings) >16 °C (existing buildings)
$T_{surface}$ – Air	1		
T_{window} – Air	4		
Mean velocity		0,16-0,17 m/s	0,18 m/s
Relative humidity	45%		
Summer			
Satisfaction			80 %
Operative temperature		23-26 °C	20-26 °C
Mean velocity		0,25 m/s	0,22 m/s
Relative humidity	55%		

Table 2. Target values for ventilation

	Austria	Finland	Sweden
Ventilation rates		8 l/s, person 0.2 ach (without occupancy)	4 l/s, person (bedrooms) 7 l/s, person (living rooms) 0.35 ach
Ventilation efficiency			>40%
Supply air filter		F7	F7
Air tightness		1.0 1/h	0.8 l/s, m2 (2.2 1/h)

Table 3. Air quality

	Austria	Finland	Sweden
Satisfaction			80 %
CO_2 (ppm)	800	900	1000
CO mg/m^3	1.5	3	*
Radon Bq/m^3	------	100	200
NO_2 µg/m^3	*	------	*
Particles µg/m^3	*	40	*
TVOC µg/m^3		300	
Formaldehyde µg/m^3		50	50
Ozon µg/m^3		50	-----

*Values exceeding the limit values for outdoor air cannot be accepted

In Finland and Sweden there are also target values for noise levels caused by HVAC-system. In Sweden there are target values also for lighting.

4 Conclusions and discussion

Quality assurance methods for new buildings and/or renovation have been developed in Austria and Sweden. The Swedish one is available also in English. Both ones also have target values for different indoor air parameters.

In Finland target values for indoor climate have been presented. It is possible to select target values from three different indoor air quality classes. In Finland it have been developed testing methods for building materials and ventilation system components. More than one thousands products available in Finland have been classified as low emitting. Those materials helps when planning healthy low energy renovation of social apartment buildings. Most of those emission tested building materials are available only in Finland.

In Finland there are no special QA systems for renovation. In Finland there are several guidelines and official methods for building and energy inspections, selection of target values, guidebook for healthy apartment building and mandatory service manual for apartment buildings.

Appendix A - An overview on existing QA systems in AUSTRIA for energy efficient renovation with improved environment

A) Q uality assurance tool EQS ("Energy Quality through Retrofit")

The aim of EQS is to achieve energy savings, comfort and to avoid structural damages by assuring energetic as well as structural quality during the retrofit process.

The EQS system involves the building owner, the contractor, construction companies and an EQS consultant.

The contractor advances the investment costs for the building owner and acts as retrofit manager as well. The contractor guarantees towards the building owner a certain amount of energy savings through the improved energy performance of the building. The advanced investment is then refinanced by the gains through energy savings within an agreed contract duration.

In order to improve the communication and documentation procedures between the concerned parties an EQ^S handbook is developed for each retrofit project.

EQ^S retrofit procedure

An EQ^S retrofit procedure passes four main phases:

I. Structural survey and retrofit concept
II. Planning and tendering
III. Implementation
IV. Award

Within each retrofit phase the concerned parties have different tasks:

Retrofit phase	Retrofit task	Building owner	Contractor	EQ^S consultant	Construction companies
I.	**Structural survey**		Contact with building owner	Giving basic information concerning retrofit process	
		Giving information on site	Structural survey		
	Retrofit concept		Retrofit concept	Checking retrofit concept	
		Policy decision Retrofit targets after presentation of retrofit concept			
		Signing of contract EQ^S attendance			
II.	**Planning**		1. Planning meeting	Planning criteria Examples for tendering List of documents	
		Giving information	Exact structural survey		
			Planning according to the retrofit concept	Planning supervision	
		Giving agreement	Planning approval	Giving agreement	
	Tendering and procurement		Tender documents according to the retrofit concept	Tender supervision	
			Announcement of the tender	Giving agreement	
			Validation of offers		Preparation of an offer
				Procurement meeting	
			Procurement		
III.	**Implementation**		Construction schedule	Adoption of list of documents	
				2. Construction meeting	
			Construction management	List of documents	
					Visual documentation of construction site
			EQ^S relevant information, pictures	Construction site visits, obligatory meetings	
			Instructions for correction of defects	Construction site protocole	
					Correction of defects
IV.	**Award**			Final quality check	
				Energy certificate	

B) SAQ (Sanieren mit Qualität – Retrofit with quality)

SAQ is a tool for the assessment and comparison of different retrofit alternatives for public buildings.

Energetic as well as ecological quality criteria are defined within an excel-tool. The compliances of each criteria respectively each alternative can be evaluated and assessed according a weighted point scale.

SAQ criteria:

The SAQ criteria include the following aspects:

Criteria	Point scale
Energy performance	
Building envelope	-10 … +10
Energy carrier	0 … +3
Solar energy, heat recovery	0 … +3
Environmental performance	
Architecture	-2 … +8
Infrastructure	-5 … +5
Dangers	-5 … +5
Water	-1 … +5
Biodiversity	-1 … +5
Recyclable material	-1 … +5
Health performance	
Warmth in winter	0 … +5
Coolness in summer	0 … +5
Ventilation	0 … +5
Solar exposure	0 … +5
Light exposure	0 … +5
Sound proofing	-3 … +5
Accessibility	0 … +5
Moisture protection	-3 … +5
Ecological performance	
Energy accountancy	0 … +4
Building materials	0 … +10
Water balance	0 … +6
District heating	0 … +10

C) Total Quality System

The aim of the Total Quality System is to support real estate developers, housing companies, planners, tenants and owners to create a sustainable building quality by defining specific planning targets at the beginning of the planning phase (of new buildings or retrofitted buildings) and to perform a compliance check afterwards.

By means of several criteria and target values, which are defined in a guidebook, the building quality is evaluated.

According these criteria "planning targets" are defined independently from each other. Because of this method planning and target conflicts can and shall be identified by the planning team in order to optimize the building as a complex system.

The TQ system can be applied to single- and multi-family-houses as well as to office buildings. In the case of retrofitting it can be used for the assessment of an existing building stock and for the planning of retrofit measures.

The construction and the planning teams have to optimize the technical conditions and to lay the foundation for an energy-efficient operation of the building.

Criteria, which are influenced by the building user, are part of the monitoring during the operation of the building.

TQ - evaluation criteria – overview:

0 Project description
1 Conservation of resources

1.1 Energy demand of the building
1.2 Soil protection
1.3 Conservation of drinking water
1.4 Efficient usage of building materials

4.1.1.1 2 Reduction of the pollution of environment and population

2.1 Atmospheric emissions
2.2 Waste avoidance
2.3 Sewage
2.4 Reduction of motorized individual traffic
2.5 Avoidance of pollution through building materials
2.6 Avoidance of radon
2.7 Electro-biological building services (optional)
2.8 Avoidance of mould

4.1.1.2 3 Comfort for users

3.1 Indoor air quality (natural ventilation and ventilation systems)
3.2 Indoor climate (temperature, humidity, ...)
3.3 Daylight
3.4 Sun in December
3.5 Sound proofing on top floor
3.6 User-friendly building management systems

4.1.1.3 4 Durability

4.1 Flexibility of the construction at change of usage
4.2 Basics for building operation and maintenance

5 Security

5.1 Break-in protection (optional)
5.2 Fire protection
5.3 Accessibility (optional)
5.4 Environmental risks(not evaluated)

4.1.1.4 6 Planning quality

4.1.1.5 7 Quality assurance during construction

4.1.1.6 7.1 Building supervision

4.1.1.7 7.2 Final inspection

8 Infrastructure and equipment

8.1 Connection to infrastructure
8.2 Equipment characteristics of flats and their surroundings

4.1.1.8 9 Costs

4.1.1.9 9.1 Prime (purchase) costs (optional)

4.1.1.10 9.2 Follow-up costs (not evaluated)

4.1.1.11 9.3 Life-cycle-costs (not evaluated)

In connection with the SQUARE project following criteria are to be pointed out:

Criteria 1: Conservation of resources

Energy demand of the building

Planning targets concerning the energy demand of a building have to be defined for

- the primary energy demand of a building during its construction (building materials, transports, building services), referring to the lifetime of a building [kWh/a]
- the total energy demand (delivered electrical power, district heating energy, fuels per year) and the primary energy demand of a building during its operation

The aim of this criteria is to reduce the primary energy demand referring to the lifetime of a building as well as the primary energy demand for the operation of a building as far as possible.

Primary energy demand of a building during its construction

Usage of durable building materials with low primary energy demands

Aim	Verification
Reduction of the primary energy demand of the building during its construction referring to its expected lifetime Primary energy demand of durable building components ≤ 23 kWh/m²a (m² living space)	Mass abstract Calculation of the primary energy demand of the building materials or product specific life cycle assessments (ISO 14040 ff)

Primary energy demand of a building during its operation

Reduction of the energy demand for heating
Reduction of the total energy demand
Reduction of the primary energy demand

Aim	Verification
Low energy demand for heating	According ÖN 832 or PHPP
Low total energy demand	According PHPP or other
Low primary energy demand	According PHPP or other
Reduction of transmission losses through improved insulation	Specifications, calculation of U-values
Reduction of transmission losses through compactness (V/A)	According ON B 8110-1
Heat bridges free construction	According EN ISO 10211-1
Reduction of ventilation losses through air tight building envelope and ventilation systems with heat recovery	Blower-door-tests, thermographic analysis, according ISO 9972, DIN V4108-7
High annual use efficiency of the heating system	Measurements, ON H 5056

Energy demand for heating and domestic hot water conditioning and system losses

Maximization of the annual use efficiency of the heating system through minimization of system losses

Aim	Verification
High efficiency, high coefficient of performance for heat energy production	Information of the manufacturers
High efficiency, high coefficient of performance for domestic hot water conditioning	Information of the manufacturers
Enforced usage of renewable energy sources	Verification by designs, drawings, plans

This criteria is part of the monitoring system during the building operation.

Energy demand for heating and domestic hot water conditioning

Out of the reason that the domestic hot water demand entirely depends from the user behavior, only the energy demand for heating is considered in this point.

Aim	Verification
Energy demand for heating ≤ 15 kWh/m²a (m² net floor area) or ≤ 12,75 kWh/m²a (m² gross floor area)	According ÖN EN 832

This criteria is part of the monitoring system during the building operation.

LEK – value

The LEK-value describes the insulation quality of the building envelope as a function of its geometry.

Share of renewable energy sources

Renewable energy sources can be recovered by thermic solar collectors, heat pumps, wood, and biogas.

Aim	Verification
Enforced usage of renewable energy sources	Verification by designs, drawings, plans

Criteria 3: Comfort for users

Indoor air quality (natural ventilation and ventilation systems)

A CO_2 concentration of the indoor air of 0,8 Vol% has to be targeted.

In residential buildings this requirement is easily achieved, therefore no separate verification has to be carried out. Some target values for several air pollutants are given as reference values including target values in the case of a retrofit action:

Compound	Target value
Toluol	0,3 mg/m³
Carbon monoxid	1,5 mg/m³ (8h)
Pentachlophenol (PCP)	0,1 µg/m³
Dichloromethane	0,2 mg/m³
Styrene	0,03 mg/m³
Mercury	0,0,35 µg/m³

Indoor air quality with ventilation systems

Aim	Verification
Securing the air quality through: Checking risk factors with checklists Development of a ventilation concept Development of a concept to avoid air pollutants	 Documentation of risk factors Ventilation concept Concept to avoid air pollutants

This criteria is part of the monitoring system during the building operation.

Indoor air quality with natural ventilation

Aim	Verification
Securing the air quality through: Development of a concept to avoid air pollutants	 Designs, specifications, simulation Concept to avoid air pollutants

Indoor climate (temperature, humidity, ...)

Aim	Verification
Summer operation: Planning target air temperature ≤ 26°C Planning target relative humidity ≤ 55%	ÖN B 8110-3 or simulation
Winter operation: Planning target air temperature 18 –22 °C Planning target relative humidity ≥ 45% Air velocity ≤ 0,15 m/s Temperature difference of interior surfaces at design conditions Δ t between wall and air < 1 K Δ t between glass and air < 4 K	Specifications Building physics - verification

Criteria 6: Planning quality

Aim	Verification
Development of a clear usage concept Definition of requirements concerning - energy, - conservation of resources, - environment pollution, - comfort, - flexibility Investigation of follow-up costs Calculation of life-cycle-costs Optimization through assessment of different alternatives Data pooling within a building information system Development of a building management concept	Usage concept Planning task book

Criteria 7: Quality assurance during construction

Building supervision

Aim	Verification
Inspection of the thermic and sound proofing quality of the building, air tightness of the building envelope, thermographic analysis, blower door test Documented interim approvals	Interim approvals, thermographic analysis, blower door test, sound proofing measurements

Final inspection

Aim	Verification
Approval checks of the constructions and building services	Documentation, approval report

Appendix B - An overview on existing QA systems for energy efficient renovation with improved environment - Finland

In Finland there are no separate quality assurance guides for new or renovated buildings. The main guidelines are:

- Indoor climate classification
- Criteria for healthy building
- Installation Guide for Clean Ventilation
- Control of room temperature in block of flats
- Energy labelling
- Guidelines for indoor climate investigation in residential buildings
- Energy inspections

Indoor climate classification

The significance of indoor climate for health, comfort and productivity has been well recognized in Finland over last decades. As a result of many extensive research projects on indoor climate and clean ventilation, *Classification of Indoor Climate, Construction and Finishing Materials* was published in 1995 [1]. This classification changed the installation work in construction sites (clean ventilation) as well as building material market (low emission building material labeling) and has systematized the design.

During first five years the Classification was taken into general use and it received satisfaction by construction clients and building owners, designers, manufacturers of building materials as well as the contractors were pushed to accept new measures needed.

The classification was updated in 2001, *Classification of Indoor Climate 2000, Target Values, Design Guidance and Product Requirements* [2] and next update was published in the end of 2008.

The classification has three important parts aiming at good indoor climate, marked with S, P and M in Figure 1.

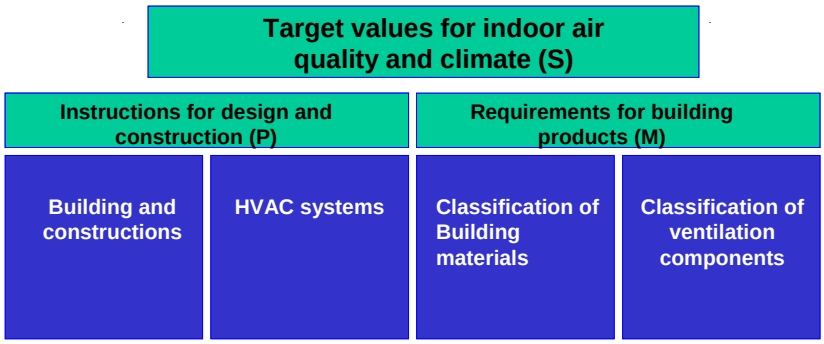

Figure 1. The structure of the Classification of Indoor Climate 2000.

Indoor climate target and design values

First part of the Classification deals with indoor climate target values. The Classification has three categories: category S1, S2 and S3. Category S1 corresponds to the best quality, meaning higher satisfaction with the indoor climate and smaller health risks. Category S3 is in line with the official quality set by building codes. Target values are not given separately for different building types, but this will be possibly implemented in the 2008 version. Due to this reason the Classification is most suitable for office and public buildings and less suitable for dwellings.

In addition to the target values, the Classification gives the most important design values for heating, ventilation and air conditioning equipment and systems. Design values regarding thermal comfort are shown in Table 1. In similar fashion, airflow rate, noise level, filter class and air tightness values are given.

Table 1. Design values for the heating and cooling system.

Factor	Unit	**S1**	**S2**	**S3**
Room temperature, summer	°C	24	26	27
Room temperature, winter	°C	21	21	20
Individual control of temp., winter	°C	±2	±2	--
Individual control of temp., summer	°C	±2	--	--
Air velocity, winter (21°C)	m/s	<0,14	<0,17	<0,20
Air velocity, summer (24°C)	m/s	<0,20	<0,25	<0,30
Relative humidity, winter	%	25	--	--

The use of the Classification in the building design has been studied in 2003 [3] mainly with questionnaires and interviews for construction clients consultants and building owners. The survey shows that the Classification has been widely used for the determination of the indoor climate targets in office and public buildings. Construction client consultants reported in the survey that target and design values of classification are used in 50 to 90% of construction projects of office and public buildings. The also reported that design and target values of the Classification have established a common design standard followed as default by HVAC-consultants. By follow-up studies it is also demonstrated that S1 targets have been met in some building projects showing that these targets are realistic. In most of cases S2 targets have been followed. Thus, Category S2 has been well accepted as default target level in office and public buildings.

Construction and ventilation system cleanliness

The second part of the Classification, Guidance for design and construction, deals with the construction and ventilation system cleanliness issues and moisture control issues. It introduces P1 class for ventilation system cleanliness and another P1 class for construction work cleanliness. To achieve P1, possible measures are:

- cleanliness of construction work (site planning, storage, schedules etc.)
- protection of building materials and HVAC components
- protection of open ducts ends on construction site and during transportation
- AH-units are not used before the P1 construction cleanliness stage

Ventilation system P1 is verified with visual inspection method of ducts and air handling units. Inspected components are compared to visual scale, an example is shown in Figure 2.

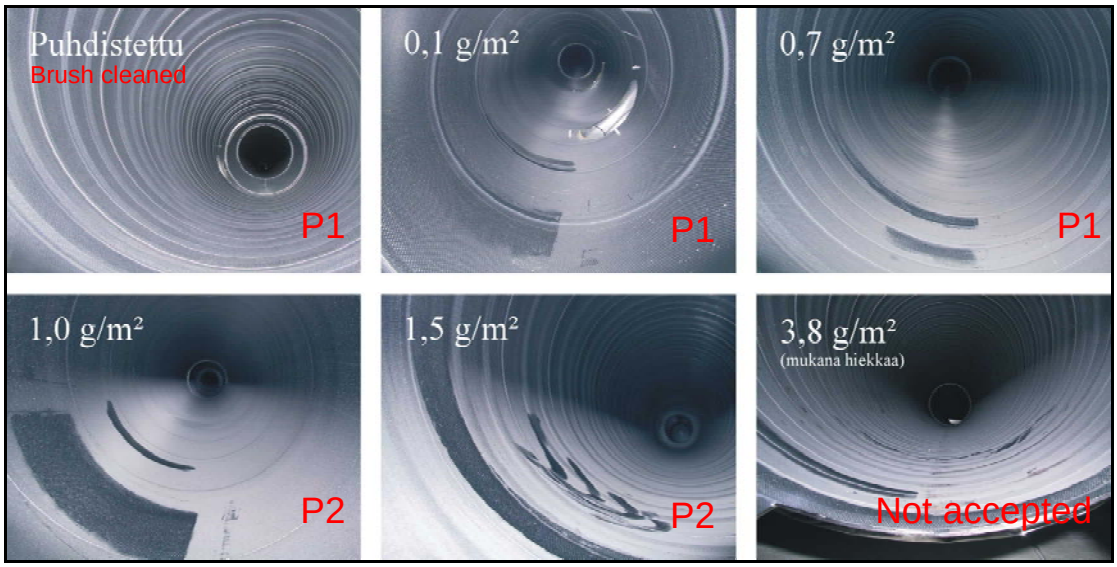

Figure 2. Visual inspection scale for ventilation components [6]

P1 caused a highly visible changed in construction sites. Since P1 was specified, it was a contractor's duty to deliver a ventilation ductwork/air handling units meeting the specification. The measures listed above were generally implemented. Building sites with non-protected ducts have not been the case after P1 specification. The system is also a win-win system for the client and contractor, as clean ventilation system delivered does not need brush cleaning. If P1 criterion is not met, then it is a contractor's duty to clean the systems so that it will meet the criteria.

Product labelling

Finland has taken a significant step towards healthier indoor climate by creating emission tests for building materials and launching the labeling system operated by Finnish Building Information Foundation RTS (www.rts.fi). This has lead to remarkable decrease in material emissions and may also have significant consequences to airflow rates and ventilation design, not yet fully implemented practice, but addressed in the Classification 2008 and discussed later in this Chapter.

After launching the Classification in 1995 it took some years before the wide scale labeling of building materials started. By December 2000 the Finnish Building Information Foundation RTS has granted an M1 label in accordance with the Classification criteria for over 400 building materials.

Requirements for emission class M1 are following:

- TVOC < 0,2 mg/m²h
  (70 % of VOCs have to be identified)
- Formaldehyde < 0,05 mg/m²h
- Ammonium < 0,03 mg/m²h
- Carcinogenic compounds < 0,005 mg/m²h
- Dissatisfaction with odour < 15 %
  (0.1 ≤ acceptability vote)

- Plasters and tiling products, levelling agents, putty, mastics, fillers, screeds and renders shall not contain casein.

In the revision of 2008 these requirements will be slightly updated for the harmonisation of test methods with latest CEN/ISO standards. The revision will include renewed criteria for VOCs and new product groups such as furniture, cleaning and treatment products.

The Classification 2000 launched new product labelling system for clean ventilation products. This includes requirements for components odour (substituted by cleanliness criteria for oil and dust for ducts), requirements for cleanability and other hygienic requirements.
Cleanliness criteria for ventilation components is following:

- Oil concentration g/m^2 of
  - ducts <0.05
  - terminal units and dampers <0.05
  - pressed components <0.3
- Mineral fibres (MMVF), f/cm^3 <0.01
- Dust concentration, g/m^2 <0.5
- Odour
  - acceptability of air quality passing through the components >0.05

In 2007, more than 1100 building material products by over 115 producers and more than 100 clean ventilation products by 8 producers have passed the Classification criteria and granted with M1 label. The largest product groups are plaster, rendering, putties, fillers, flooring, paints and varnishes, building boards and mineral wool. See ref. [7] for complete listing [8] for testing protocol. These figures simply mean that high majority of building materials in Finnish market are M1 labelled today.

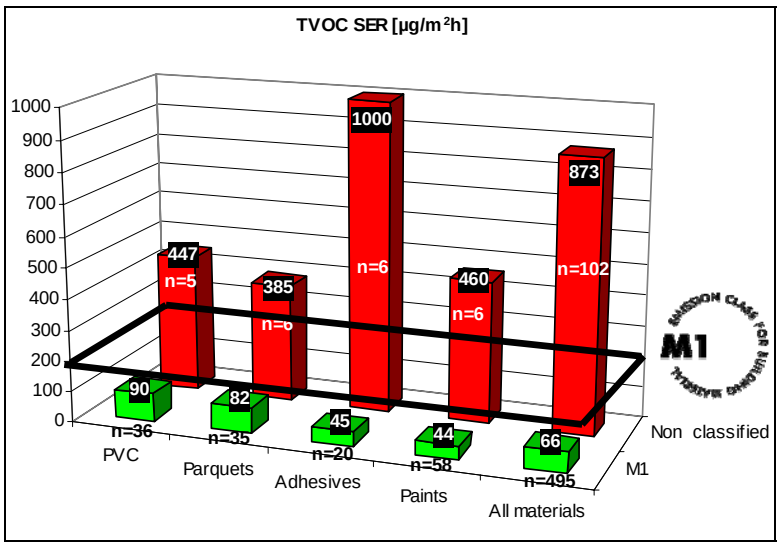

Figure 3. VOC emissions from M1-classified and non-classified products.

It should be noted that material emissions of finishing materials depend on the moisture content of the material below the finishing material (i.e. concrete or brick etc.). This issue is

addressed in the Classification through strict requirements for moisture control plans and measures in the building sites, which are carefully followed in practice also due to the risk of microbial growth in wet materials or surfaces.

Update 2008

New criteria have been included in to updated draft proposal for indoor climate classification. Values shown below are for class S2.

		normal	min/max
Operative temperature [°C]	$t_{out} \leq 0$ °C	21-22	20/23
	$0<t_{out}$ 15 °C	21-23	20/24
	t_{out} >15 °C	23-25	22/27
Mean velocity [m/s]	t_{air}=21 °C	<0,17	
	t_{air}=23 °C	<0,20	
	t_{air}=25 °C	<0,25	
Carbon dioxide level over background level [ppm]		<500	

Stability of thermal environment. At least 80% of time within ranges

Criteria for healthy building

Within the Finnish Healthy Buildings research programme a more detailed Criteria for Healthy Buildings has been outlined since 2001. This construction process based criteria is being tested and developed further by four construction companies in four different pilot building under construction, there the research team has been involved from the conceptual design phase continuing to the completion of buildings. Work comprises three office buildings and one apartment building. .

The contents of the criteria are divided to follow the construction process:

1. Design specification
2. Conceptual design
3. Design
4. Construction
5. Balancing and tuning HVAC systems and commissioning
6. Operation and maintenance

Thus, the criteria try to specify a construction process for a healthy building. In the design phases the duties of each stakeholder are specified and guidelines are given in form of checklists and model specifications how to include the criteria into agreements and specifications. The criteria is given for each design area stressing out the importance of comprehensive ventilation and air conditioning design allowing a smooth installation and balancing and proper operation of HVAC systems. In construction phase moisture control and cleanliness of construction work and ventilation system are the main issues. To control these, special moisture and cleanliness control plans are required and numerous instructions and requirements are given for construction timing. Experience from pilot buildings has proven that realistic and enough detailed construction timetables seem to be

one important condition for a healthy building. Criteria for balancing the systems and commissioning will ensure the realization of planned end result – healthy and comfortable indoor environment.

Installation Guide for Clean Ventilation

This guidebook shows how to install compounds of ventilation system in order to get clean ventilation system.

Control of room temperature in block of flats

The better insulation and use of preheated supply air can cause too high temperature levels inside single apartment in block of flats. This short guideline shows the effects of window ventilation, window type and solar shades on room temperature levels. When mechanical cooling is need guidelines for design are given.

Energy labelling

New energy labelling regulations where introduced in the beginning of 2008 [9].

Table 2. The energy labelling criteria for all kind of buildings with six or more apartments. Also for detached houses.

Class	Energy use kWh/br-m^2/year
A	EU≤100
B	101 ≤EU ≤ 120
C	121 ≤ EU ≤ 140
D	141 ≤ EU ≤ 160
E	181 ≤ EU ≤ 230
F	231 ≤ EU ≤ 280
G	EU≥281

Guidelines for indoor climate investigation in residential buildings

Contents of guidelines

The guidelines present a method to investigate the problems of indoor climate in dwellings in phases. Measurements of parameters that are often difficult to interpret will be made only after preliminary walk-through. The starting point is to examine the performance of the mechanical equipment and the defects in them. The necessary and urgent repairs for the buildings, for example technical breakdowns and the need for basic balancing of ventilation and heating system, will be presented as a result of the indoor climate investigation. In the report, some example methods to improve the indoor climate in buildings are presented.

The investigations proceed, deepen and expand in phases. Typical indoor climate investigations in dwellings as well as the methods of measurement and interpretations of

the results are described. A previous condition assessment of the building can be the starting point for the indoor climate investigation. It is beneficial and also cost saving if other investigations can be performed simultaneously in the same building, especially the investigation of mould problems where moisture and mould damages will be dealt more precisely. Descriptions of typical malfunction and defects of ventilation systems with a recommendation for improvement are a part of the guidelines for the indoor climate investigation.

Structure of indoor climate investigation

The structure of the indoor climate investigations is presented in Figure 4.

Acquisition of basic information

In the first phase, the necessary background data of the building are collected. e.g. the construction and HVAC-technical solutions, the operating time and zones of the ventilation system. The data are used to design measurements. A survey of previous evaluation assessments and investigations as well as other reports, measures and renovation will be made. Furthermore, the design and service documents are acquired in advance.

Overview of the recognized problems in dwellings is the starting point of the investigation: the complaints by the occupants and symptoms associated with indoor climate, and the defects of the building and of its mechanical equipment. The aim is also to try to find out the extent and seriousness of the problems.

The basic data are gathered with the help of the manager and janitor of the building. For a residential building, these data can be collected already in the order of indoor climate investigation by the client. The model of the order is included in the guidelines.

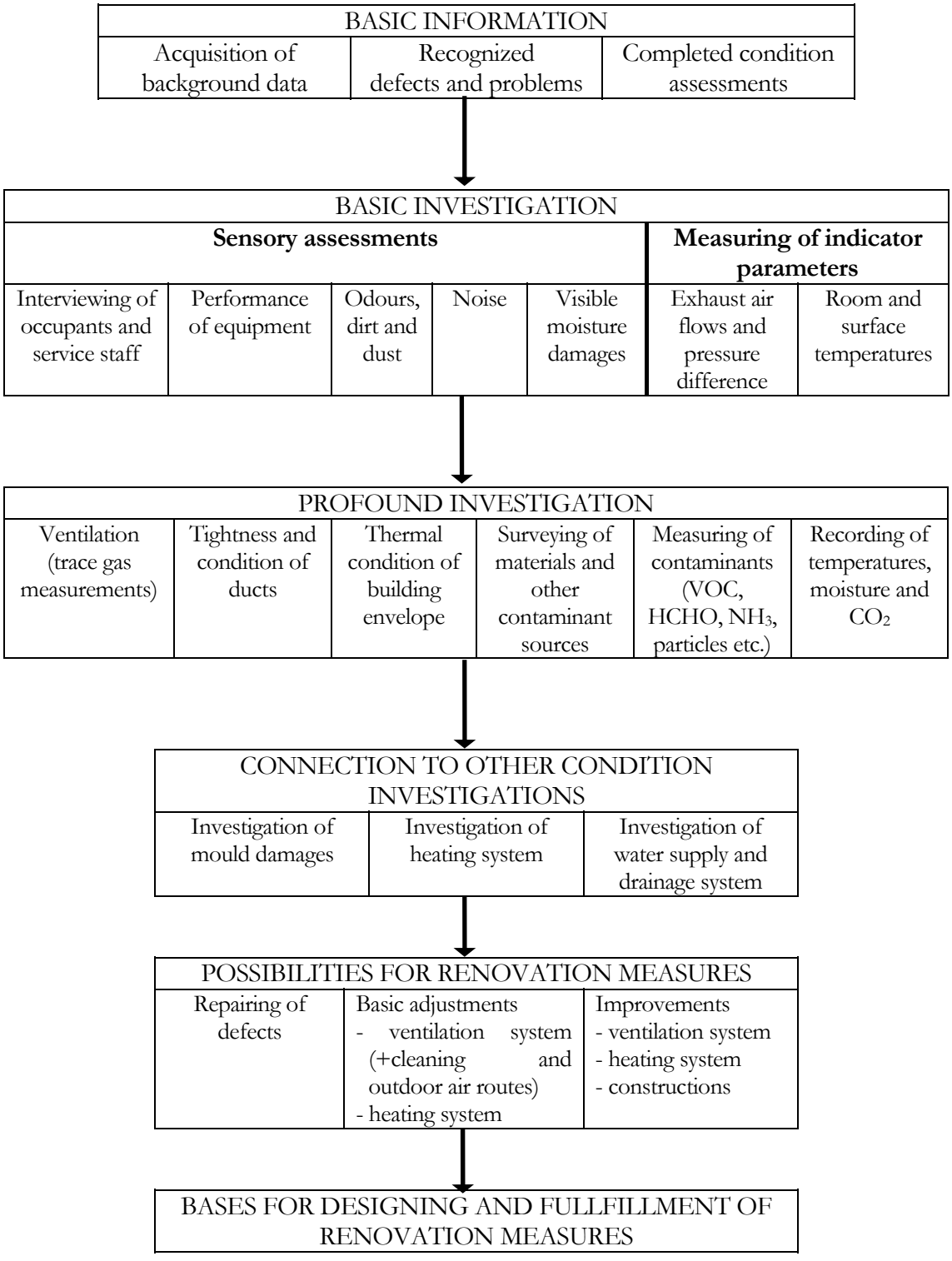

Figure 4. The structure of the indoor climate investigations.

Sensory assessment

When specifying the quality and extent of the problems, the key persons of the building are interviewed. Depending on the size and ownership of the building, the key person include the chair of the building board or a representative of the tenants, the manager of the building, and the janitor. At the same time, inadequate data are completed. The need for a questionnaire for the occupants is estimated. For example, in large building complexes with the questionnaire for the occupants, poor operation of ventilation and heating system can be located to certain zones.

This phase is based on a walk-through survey. The building is examined from outside and by walking through the common spaces and the roof. The functioning and operating times of the ventilation equipment are checked in the machine rooms of air handling units and the main distribution board; operation of the fans and timers are checked at each speed. The set values, control curves and the functioning of timers of the heating system are checked in the neat exchanger room.

All apartments in the building must be investigated. In the apartments, the indoor air quality is assessed on sensory basis. In the assessment, the stuffiness of the room air is evaluated and possible odours qualified and their sources located. The condition and operation of the ventilation system in the dwellings are assessed. The cleanliness and the position of the supply air inlets, exhaust air outlets, and the kitchen range hood as well as transfer air routes are examined; special attention is paid to the flow routes of outdoor air. The condition and performance of heating equipment are examined (e.g the type of radiator valves). Visible moisture damages are recorded with the help of the check list of mould problem investigations. Based on the results, the need for special mould investigation is assessed.

Measuring of indicator parameters

Very seldom a single contaminant in the air is the reason for the problems. This is why there is usually no need to measure the concentration of single substances in the beginning of the investigation unless there is a good reason to suspect that some material emit that special substance. On the other hand, measuring or assessing of some indoor climate parameters as an indicator is often very useful. The occurrence of a factor and order of its magnitude may describe the quality of the building or a special kind of problem.

Some apartments are selected by taking into account the zones of the ventilation and the heating system (in apartment buildings for example at different staircases both on the top and the first floor). The following factors are suitable to be taken as the base of first hand conclusions; exhaust air flows, pressure differences, air temperature, surface temperatures, carbon dioxide concentration, and the noise caused by ventilation and heating system. It is often plausible to do the evaluation of indicator parameters simultaneously with sensory assessments. The condition, cleanliness and adjustment of ventilation equipment are worked out more precisely (fans, air intake, filters, heat recovery, ductwork).

Air temperature is compared during the heating period to the value of 21,5 oC. The reason for an air temperature value deviating more than +/- 1,5 oC has to be found out. Exhaust air flows are compared to design or guideline values. When this deviation is more than +/-

20%, this part of ductwork needs to be adjusted. When the exhaust air flows are clearly lower than their target values, the need for outdoor air routes are assessed by measuring the exhaust air flows with the window open and closed. The sufficiency of the fan power is also assessed. With the trace smoke, outdoor air routes and internal air flows are studied, and draughty locations and air leakage in the building envelops are searched for. The pressure difference between room air and outdoor air and staircases are checked. The moisture loads of the apartment are evaluated (the use and type of humidifiers, the amount of laundry and the way of drying it, and the frequency of use of shower and sauna). Also the sources of contaminants are recorded (e.g. pets and amount of dust accumulating surfaces).

In the common spaces, the same indicator parameters as in the apartments are measured (sauna department, laundry rooms, drying rooms, club rooms, store rooms, garbage rooms, survival shelters, and possible commercial spaces).

Profound investigations

The thermal insulation of the building envelop is assessed when it is suspected that the capacity of the radiators is inadequate. Measuring of air leakage in dwellings is needed when designing the basic improvement of ventilation system. The air tightness of the external envelope in buildings with natural or mechanical exhaust ventilation system has been a typical constructional deficiency impairing indoor air quality in dwellings. In a building with tight envelope, the air change in dwellings is almost systematically lower than the target values. Measuring the operative temperature is necessary in older dwelling and in those with floor or ceiling heating. A long-term recording of room temperature may be needed for example when night setback is used. The CO_2 concentration in the buildings is measured if the CO_2 load before the measuring is representative. By the long-term recording of CO_2 concentration, the adequacy of air change in bedrooms can be checked.

In a building with natural ventilation, or with mechanical exhaust with , the air tightness of the ducts are measured when needed. With trace gas measurements, contaminant transfer between apartments can be investigated. Also, the actual air change rate in a dwelling can be measured exactly with trace gas techniques.

A material survey is made when searching for a reason for an exceptional odour or high contaminant concentrations, for example dust, carbon monoxide, ammonia, formaldehyde and volatile organic compounds, are measured when high concentration is suspected. The need for measuring radon is estimated on the basis of soil, type of foundation and ventilation system.

Possibilities for renovation measures

Reporting of indoor climate investigations includes the recommendations for essential and urgent measures for renovation, for example poor operation of the ventilation and heating system, and the need for basic adjustment and cleaning of them. In the report, also other possibilities for improving the indoor climate in apartments are described. They include 2-3 alternative ways of repair of different quality and cost. These include, for example, equipping the apartments with simple outdoor air inlets (low level), heating of outdoor air

with supply air heater or supplying it through a radiator (medium level), or installing of mechanical supply and exhaust ventilation system in every dwelling (high level).

Reporting of the method

Indoor climate investigation produces the basic data for the renovation. The guidelines include also typical malfunctions of ventilation and heating system and their causes. Furthermore, they include the measurements and equipment used in the investigations as well as possibilities for measures of renovation. There are also instructions to the client on how to order the indoor climate investigation.

Guidelines for energy inspection in apartment buildings

Since 1993 Motiva has been administrating the national Energy Auditing Programme. A uniform system for auditing has been developed including approaches like energy analysis for the industrial sector, energy inspections for SMEs and energy audits for buildings. (www.motiva.fi). It is also possible to get State subvention for energy inspection.

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Appendix C1

Certification rules for P-marking of indoor environment and energy use

SPCR 114E

SP Sveriges Tekniska Forskningsinstitut
SP Technical Research Institute of Sweden
Certification
January 2007

Preface

SP has been involved in work on the indoor environment for several years now. As part of this work, certification for SP's certification symbol, the P-symbol, has been introduced for schools, child day-care centres, offices, shops and apartment buildings in order to create a driving force for improvements.

In addition to having good indoor environmental conditions, it is important that a building should also have low energy use, with minimum effect on the external environment. However, concentrating solely on low energy use can result in conflicts with the requirements for a good indoor environment. It is therefore in order to avoid this that the rules for P-marking of the indoor environment have been extended to include P-marking of energy use.

The rules involve an initial assessment of the building's status, technical measures, questionnaire surveys, measurements and the application of management systems for operating and using the building, as well as for maintenance of the necessary performance and conditions for P-marking of the indoor environment and efficient use of energy.

The rules are based on current regulations, standards, practice and knowledge of factors that affect the indoor environment and energy use. The rules will be updated as necessary to reflect new knowledge or developments.

These rules are an extension of SPCR 114, Certification Rules for P-marking of the Indoor Environment, published in April 2005.

Borås, January 2007

SP Technical Research Institute of Sweden
Certification

Lennart Månsson

Contents

1 Introduction

1.1 P-marking

Certification involves confirmation by an independent third party that a product fulfils requirements specified in standards or in some other form of specification. The P-symbol is SP's own certification symbol.

Within SP, certification is performed by a special department, SP Certification, that is organisationally completely separate from SP's other testing and inspection departments. It is responsible to a Certification Board, comprising representatives of various industry sectors. The Board can appoint expert groups for various product areas, e.g. as technical committees. Certification of products by SP is performed in accordance with EN 45011, while certification of management systems in performed in accordance with EN 45012.

Products or management systems that, after initial assessment that includes (for example) testing, show that they fulfil specified requirements, can be certified by SP. This is confirmed by the issue of a certificate, which includes permission (a licence) to use the P-symbol. Certified companies and buildings will be entered on a list that is available from SP.

Requirements for P-marking are set out in special certification rules (SPCR), developed for each product sector. Before certification starts, the certification rules shall have been discussed with interested parties and then have been approved by SP's Certification Board. The P-symbol means that the product or management system meets the requirements set out in legislation, standard, generally accepted codes of practice and in the P-marking system. In addition to these requirements, the certificate-holder may have his own environmental and/or quality requirements, set out in policy documents.

1.2 Scope and application

1.2.1 The indoor environment

As used in these rules, the concept of 'indoor environment' refers not only to the indoor environment that a property owner or building operator provides for the tenant/user, but also to the information or instructions for use/occupation of the building. The function requirements should be acknowledged and applied by all those who work on and/or are involved in the construction process and subsequent administration/operation of the building. They help the developer/purchaser to set targets for the building's indoor environment and, in the case of new buildings and/or conversion/renovation projects, be used by the designer and architect to ensure that the building achieves the intended quality. The construction contractor shall fulfil the function requirements and apply the criteria in order to ensure that the quality of construction is as intended, while the property manager shall ensure that the indoor environment maintains a good quality in subsequent use.

The parameters to be considered are thermal comfort, air quality, moisture, noise, radon, lighting and domestic hot water temperature, in accordance with the function requirements set out in Appendix 1, and as defined in 'Criteria for healthy buildings and materials' (Ministry of Housing, Building and Planning, 1998). Further, more stringent, requirements can be added by the purchaser for any particular building, such as anti-allergenic design/construction or materials recycling considerations.

1.2.2 Energy use

In these rules, the term 'energy use' refers to the energy supplied to a building or building stock while in use/occupation in order to maintain the desired indoor environment conditions and other functions. Energy targets are set, representing the amount of energy use that must not be exceeded when the building is in use. These targets shall be used by all those involved in the construction process and in administration/operation of the building. They shall be observed by the designers, architects and contractors working on new or renovated/converted buildings, and help the developer/purchaser to ensure that energy use during occupation/use does not exceed the intended values. It shall be the responsibility of the property manager to ensure that the targets are met during occupation/use, while also maintaining the building's function requirements in terms of indoor environment etc.

For new buildings or major conversions, energy targets can be set for each specific building, while targets for existing buildings can be set for the type of building. Characteristics and requirements for energy targets cover all forms of energy supplied to the building or type of building as needed in order to maintain the required functions in terms of indoor climate, building services systems and activities in the building. Energy input is divided into electricity, heating and cooling, with heating and cooling further broken down into the different forms of energy carriers. The requirements also extend to the associated greenhouse gas emissions (defined as CO_2 equivalents).

Energy targets are defined in accordance with requirements as set out in Appendix 3. the purchaser may add special voluntary targets for particular components or parts of the building to them.

The description, document control, action plans for energy efficiency improvements, and presentation of results as used in these rules follow their use as set out in SS 62 77 50.

1.2.3 Scope

These rules relate to the indoor environment and energy use in both existing and new or renovated/converted buildings, as defined below.

Existing buildings. Existing building stock. Certification covers:

- TFI (Thorough First Investigation) and FEA (First Energy Analysis),
- preparation of an action plan for the indoor environment and for energy use,
- establishment of follow-up systems for monitoring the indoor environment and energy use of the building after it has been taken into use.

Renovation / conversion. Properties that have been renovated or converted to such as extent that their functions and performance have essentially been updated to those of present-day requirements. Certification involves:

- TFI and FEA,
- preparation of a description of planned measures for improving the indoor environment and levels of energy use,
- necessary planning for outline design and construction,
- establishment of follow-up systems for monitoring the indoor environment and energy use of the building after it has been taken into use.

New buildings. Certification involves:

- TFI and FEA,
- construction,

- establishment of follow-up systems for monitoring the indoor environment and energy use of the building after it has been taken into use.

Declared values. Values of the indoor environment and energy use objectives that the property manager has undertaken to achieve, both obligatory and voluntary.

Energy aspects. That part of the building's activities/businesses that affect its energy use.

1.3 Relation to guarantees and other inspections

If a property is P-marked, the holder of the certificate can show that it is being operated/used in accordance with a documented system for energy use and maintenance of the indoor environment. Faults can be prevented and/or corrected through an effective internal monitoring system, which includes response to complaints. The buildings have the requirements needed in order to be able to fulfil the requirements in these rules.

Apartment buildings, schools, child day-care centres etc. are required to have regular ventilation system inspections. The system on which P-marking is based can also be used by the property manager as an element of complying with these requirements, but does not replace other guarantees or inspections.

2 Certification conditions for P-marking of the indoor environment and energy use

2.1 General

Certification involves an initial assessment of whether the technical requirements, as set out in Section 5, are fulfilled and whether the requirements in respect of the management system, as set out in Section 4, are fulfilled. This is complemented by an annual surveillance assessment intended to ensure that both the technical requirements and the requirements of the management system continue to be fulfilled.

After successful completion of the initial assessment, a certificate will be issued that permits its holder to use the P-symbol. The certification relates to the specific building or buildings operated by the company or organisation and having the certified indoor environment and energy use systems. Additional certificates will be supplied for each additional specific building to be covered by the same indoor environment and energy use systems. Certificates remain valid only provided that the indoor environment and energy use systems continue to operate as intended, which will be checked annually by SP, as described in Section 5 of these rules. Other terms and conditions are set out in Section 7.

If a building is to meet the requirements for a good indoor environment and efficient energy use, and if it is to continue to do so, requires careful and comprehensive preparatory work. This means that a thorough first investigation, TFI, and a first energy analysis, FEA, must always be carried out, with the results forming the starting point of any improvements found to be necessary. If the requirements have been observed during the design and construction stages of new buildings and renovation/conversion projects, the results of the TFI and FEA investigations should not result in a need for any substantial improvements or changes in order to meet the requirements for P-marking. However, in the case of existing buildings, the results of the investigations may require improvements to be made.

Appendix 1 describes the function requirements for P-marking of the indoor environment, and Appendix 2 presents an example of a checklist for a thorough first investigation. Appendix 3 describes the requirements for determining appropriate energy targets, together with the function requirements for P-marking of energy use. SP Report no. Xxxx, 'A Guide for Determining the Requirements for Energy Use when P-Marking Indoor Environments and Energy Use Systems' gives examples of checklists for a first energy analysis.

2.2 Application and material from the client

2.2.1 The first application

Applications shall be submitted in writing, and shall be accompanied by:

- Reports of the results from TFI and FEA, including the applicant's own measurements etc. for the building concerned.
- Descriptions of planned actions etc. for the indoor environment and energy use.
- Descriptions of objects (the building, technical systems and local conditions that could affect the indoor environment or energy use.)
- Targets and guide values for indoor environment parameters, both obligatory and voluntary.

- Targets and guide values for energy use, broken down by form of energy, plus voluntary energy requirements for individual components or items of equipment.
- Reports from the applicant's own measurements, with information on methods of measurement and equipment used that show that the requirements of Section 5 have been met for the buildings to which the application relates.
- Documentation information on the indoor environment and energy use management systems, e.g. manuals, with information as described in Section 4.
- Maintenance and performance auditing plans, including measurement/metering and inspection plans.
- Review and rectification of any negative effects caused by conflict between the requirements of the indoor environment and those of the energy system.

2.2.2 Application for extension

Applications for extension of certification to cover additional buildings shall be submitted in writing, and shall be accompanied by:

- Reports of the results from TFI and FEA, including the applicant's own measurements etc. for the building(s) concerned.
- Descriptions of planned actions etc. for the indoor environment and energy use.
- Descriptions of objects (the building(s), technical systems and local conditions that could affect the indoor environment or energy use.)
- Targets and guide values for energy use, broken down by form of energy, plus voluntary energy requirements for individual components or items of equipment.
- Reports from the applicant's own measurements, with information on methods of measurement and equipment used that show that the requirements of Section 5 have been met for the buildings to which the application relates.
- Maintenance and performance auditing plans, including measurement/metering and inspection plans.
- Review and rectification of any negative effects caused by conflict between the requirements of the indoor environment and those of the energy system..

2.3 Certification

2.3.1 Introduction

SP starts by checking the documentation as described above in Item 2.2, making measurements and auditing the indoor environment and energy use managements systems.

2.3.2 Technical assessment

SP checks and assesses the plans for TFI and FEA, the results from them, planned and completed measures, the setting of energy objectives, plans for measurement and monitoring, and results, which must meet the requirements set out in Sections 3 and 5. If the requirements are not fulfilled, the proposed measures to do so will be assessed.

SP performs sample tests and inspections of representative P-marked objects, partly or wholly in accordance with the requirements of Section 5. The results of these measurements provide a basis for assessment of whether the technical requirements are being fulfilled, and for assessment of the quality of the property-owner's/administrator's own measurements or readings.

2.3.3 Initial assessment of the indoor environment and energy use management systems

SP makes an initial assessment of whether the internal auditing system - 'the indoor environment and energy use system' - meets the requirements as set out in Section 4 of these rules. This is done partly by inspection of documents, and partly by site visits. It is not repeated for applications for extension to additional buildings if the application relates only to extension of the same management systems, i.e. if energy use is monitored by the same procedures, definition documents, physical monitoring systems and energy use monitoring computer programs.

In the case of buildings already having a certified ISO 9001 or ISO 14001 quality system, the basic management systems for P-marking can thereby be regarded as fulfilled. The ways in which the systems cover indoor environment and energy use in accordance with these rules must then be covered by the systems.

2.3.4 Certificate

When the initial assessment has been carried out and approved, a certificate can be issued. It gives details of such points as the particular building(s) to which it applies, any exceptions that have been made, and the declared values for all indoor environment parameters and energy use targets that have been approved, both obligatory and (if any) as added by the property manager.

2.3.5 Surveillance inspection

After a certificate has been issued, continued compliance with the requirements of the certification is ensured by regular annual surveillance inspection of the indoor environment and of the energy use system, to ensure that they are working as intended and that function requirements are being fulfilled. See also Section 6.

2.3.6 Marking

Marking of buildings (whether by a sign or otherwise) shall show SP's P-symbol, the name of the holder of the certificate and the name or other identification of the building. The design of the sign etc. shall be approved by SP. A model form of sign is shown in Appendix 6, and such signs can be provided by SP.

2.4 Validity of the certificate

The certificate is valid for a maximum of five years, but can be extended by a maximum of a further five years at a time.

2.5 Extension of validity

Validity of certification can be extended after application from the certificate-holder. This requires submission of the following material:

- A re-certification report, supported by auditors,
- SP's reports from its surveillance inspections, *and*
- approved results from a questionnaire carried out by the property-owner/administrator prior to the extension application.

2.6 Changes to the indoor environment and energy use management systems

In the event of any larger changes to the building, in its use or in its management systems, that could affect the results of inspection, inspection intervals, methods of measurement, use of the premises, ability to clean, amount of energy used etc., the holder of the certificate is required to notify SP, who will decide whether the change is of such a type that it either can be accepted without renewed verification or that it does require re-verification.

3 Technical material for P-marked indoor environment and energy use

3.1 Requirements

The technical material required for assessment for P-marked indoor environments and energy use includes reports of the results of the thorough first investigation (TFI) and first energy analysis (FEA), measurements and calculations by the property manager, target values and guide values for indoor environmental conditions and energy use, plans for proposed measures, and measurements and calculations made by SP.

3.1.1 Thorough first investigation - TFI

The TFI consists of a survey and preparation of an inventory of the building and premises, and of a questionnaire. The indoor environmental status of the building is determined through *inspection and* measurement. This investigation may be carried out on one particular building, or on groups of buildings of the same technical design and with similar heating and ventilation systems. For new buildings and for those undergoing major renovation/conversion, the investigation may also require the submission of design and construction documents.

There must be a plan for the number or proportion of apartments or premises to be surveyed, covering not less than about 20 % of the total number of apartments etc. and comprising a representative cross-section of the apartments etc.

A questionnaire survey must be carried out among the users of occupiers. The results from the TFI will provide a basis for preparation of action and maintenance plans.

Measurements must be made to check that the legal requirements that applied at the time of constructing the building are still being fulfilled, and that subsequent requirements and regulations such as limitation of radon, PCB or formaldehyde concentrations, are also being fulfilled.

Shortcomings or faults identified through function measurements or TFI must be dealt with. Those that are of a more long-term character must be included in the maintenance plan. Adjustments of such systems etc. as heating, domestic hot water or ventilation shall be made as necessary, and documented. The record of such adjustments shall provide a reference for day-to-day operation.

The presentation of the results of the survey shall include the results of inspection.

3.1.2 First energy analysis – FEA

FEA consists of a presentation of an inventory/survey of the building or building stock, with details of its present energy status, energy aspects and energy performance. This inventory/survey can consist of material from drawings, operational monitoring programs, supervisory systems and other documentation, inspections, interviews with operating personnel and possibly additional complementary measurements. For new and renovated buildings, the FEA material can also consist of documents from the design and construction stages. The material must also include descriptions of shortcomings and faults that have been found in physical systems, information on earlier energy efficiency improvement work and details of the most recent adjustments etc. of heating, water, ventilation and other systems.

The results from the FEA shall provide a basis for deciding on energy targets and for a prioritised working and maintenance plan, together with reasons for the various choices. The FEA also provides a basis for an energy declaration.

Clarification of the various parts of the FEA.

The description of the building or types of buildings contains the name(s) of the building(s), its/their details on the property register, the building category, address, the name of the property-owner and building data (floor area, year of construction etc.).

Energy status is a description of the technical design and standard of the climate screen and building services systems (heating, cooling, ventilation, water, lighting and control systems).

Energy aspects are presented in the form of a description of the work and activities carried out in the building, and therefore the sources of internal heat load and electricity use, together with a description of the local environment and conditions that can have a significant effect on energy use in the building.

Energy performance refers to energy input in the form of electricity, heating and cooling, with heating and cooling further broken down into figures for different forms of energy carriers or sources. The material must include historical data for energy supplies, with energy use that varies as a result of varying ambient conditions having been corrected to corresponding values for a statistically average year.

3.2 SP's assessments, measurements and report

SP evaluates and assesses the results of TFI and FEA, and makes sample measurements of its own, with the aim of verifying the measurements made for the TFI and FEA, after which it writes a report.

The indoor environment and energy use system is assessed after an initial examination of documents and after a site audit, complemented by interviews and checks of how procedures etc. operate. The results are presented in a report.

4 The indoor environment and energy use systems for P-marking

4.1 Operational planning and targets/conditions for operation/use of the building

4.1.1 The indoor environment

The parameters to be considered are thermal comfort, air quality, moisture, noise, radon, lighting and domestic hot water temperature, in accordance with the function requirements set out in Appendix 1, and as defined in 'Criteria for healthy buildings and materials' (Ministry of Housing, Building and Planning, 1998). See also Section 5. Further requirements that the company could consider for any particular building could, for example, include anti-allergenic design/construction or materials recycling considerations.

4.1.2 Energy

The energy targets to be considered cover all forms of energy supplied to the building or type of building as needed in order to maintain the required functions in terms of indoor climate, building services systems and activities in the building. Energy input is described in terms of electricity, heating and cooling, with heating and cooling further broken down into the different forms of energy. The requirements also extend to the associated greenhouse gas emissions (defined as CO_2 equivalents).

Energy targets are defined in accordance with requirements as set out in Appendix 3. the company may add special voluntary targets for particular components or parts of the building to them.

4.1.3 Legal and other requirements

The company shall have procedures for ensuring that information on relevant legislation and other requirements is brought to the notice of personnel who need to know. In this respect, the legislation and other requirements that are particularly relevant are the law about technical quality requirements of buildings (BVL), the Obligatory Ventilation Inspection Ordinance, the Environmental Framework Code, the Work Environment Act, the Planning and Building Act, the Directive Concerning the Energy Performance of Buildings (EPBD, 2002/91/EC), the law about energy declarations of buildings (SFS 2006: 985), maintenance procedures with legal requirements for building services systems and this document (SPCR 114E).

4.1.4 Energy use and the indoor environment programme

The company shall have a programme to establish objectives and set guide values. Programmes/procedures or plans shall be prepared for each building, type of building or part of the organisation.

4.2 Introduction and operation/resources

4.2.1 Organisational structure and responsibilities

It is the company's most senior management that is ultimately responsible for the indoor environment and energy use. It shall appoint a person having main responsibility (operative) for both the indoor environment and the energy use system within the company.

The company's organisation, with clear details of who is responsible, and who has authority, for each part of the organisation, shall be defined, documented and communicated. Further, within each part of the organisation, there shall be documentation defining who is responsible for the main part of the indoor environment and energy use systems.

4.2.2 Training and competence

There shall be methods and requirements for qualification of personnel for various duties. Programmes shall be prepared for meeting the needs of training of personnel: not only general training, but also that as needed for those functions that require special competence. Examples of the latter include personnel for operation and maintenance. There shall be procedures for ensuring that all personnel are aware not only of the requirements imposed by the indoor environment and energy use system, but also of the opportunities, roles and responsibilities for achieving the requirements within the organisation and through individuals' own work.

4.2.3 Communication

Procedures shall be prepared, and shall be kept up to date, for:
a) internal communication between different levels and functions in the company's own organisation, *and*
b) the reception, documentation of and responding to relevant views from external parties, e.g. tenants and the mass media.

4.2.4 Documentation of the indoor environment and energy use systems

The company shall prepare and maintain information as needed to:
a) Describe the main parts, elements and features of the indoor environment and the energy use system, together with their associated procedures;
b) provide necessary references to related documentation;
c) identify and describe which buildings are covered by the system.

4.2.5 Document control of the indoor environment and energy use systems

Procedures shall be prepared, and kept up to date, for identification and management of all instructional and descriptive documents that are needed in accordance with these rules. These documents shall kept in such a manner that they can be easily found.

4.2.5.1 Controlling documents

Examples of controlling documents include procedures, instructions and check-lists.

4.2.5.2 Presentational documents

Model forms (typical examples) shall be prepared, showing how the documents are to be identified, used and archived.

For the indoor environment, presentational documents are:
- a list of the buildings
- input from tenants, replies to questionnaires
- records from adjustments, indoor climate condition audits, calibrations
- information on contractors and suppliers
- list of training courses
- records from system audits
- records from management reviews
- discrepancy/fault reports
- property and building maintenance plans
- work carried out
- audit plans (indoor environment and systems)

For energy use, presentational documents are:
- a list of the buildings
- information on technical systems, with details of suppliers, functions, warranty periods and maintenance/service
- records from monthly metering/reading of energy use
- records from monthly monitoring of energy use, including reports of changes in energy use, with an initial analysis report and information on any actions taken
- an annual collation of monthly monitoring, with information on changes, analyses and planned and completed actions
- records from adjustments of technical systems, Obligatory Ventilation Inspections and calibrations
- records from maintenance and service visits
- list of training courses
- records from system audits
- records from management reviews
- maintenance plan for technical systems in the building or type of building
- energy efficiency improvement measures that have been taken, with details of results
- audit plans (energy audits and systems).

4.3 Activity management/control

Procedures shall be prepared and kept up to date for control of activities, covering planning, operation and monitoring.

4.3.1 Planning

Operational planning (for day-to-day normal operation) shall specify the activities that it covers, and who is responsible for them. If this involves the service of contractors, care must be taken to inform the contractor about the system in order to ensure that the system will be fulfilled.

Inspection and maintenance plans shall be documented, shall contain time plans and shall cover a period of at least one certification cycle (five years).

4.3.2 Operation and maintenance

Procedures for maintaining the indoor environmental conditions and energy use targets shall be documented. Operation and maintenance instructions shall be prepared for the building or type of buildings and its/their technical systems. These instructions shall also include instructions for cleaning, inspection (calibration) of meters and sensors, and regular inspection and adjustment of technical systems. The results shall be recorded. The instructions shall include criteria and clear and simple descriptions of functions and lists of system components (functions, position, instruction manual, setting values). In addition, they shall include details of procedures for evaluation of energy use in connection with the purchase of system components and/or energy-demanding equipment or with renovation of the building. Checklists shall be designed in such a way as to assist follow-up and maintenance. The results of inspections, work carried out etc. shall be documented and saved.

4.3.3 Monitoring

Residents or users shall be kept informed of how they can affect the indoor environment and energy use. There shall be procedures to ensure that relevant views from residents or users concerning the indoor environment or improvements in energy use are accepted, examined and documented, and that appropriate actions are taken to deal with departures from approved requirement performance levels. Residents' views can be obtained via questionnaire surveys.

4.4 Inspections and corrective actions

4.4.1 Monitoring and measurement - internal climate audits

Check measurements shall be made, in accordance with documented procedures, to monitor that indoor environmental conditions and function requirements are being maintained. Audit plans shall ensure that all apartments or premises are inspected during the validity of the certificate, i.e. of five years. The results of measurements shall be recorded and kept.

Questionnaire surveys of the tenants shall be carried out at time intervals as set out in the auditing plan (but at least once in each certification period), for correction and comparison between measured and as-experienced conditions.

4.4.2 Non-compliances, corrective and preventive actions for the indoor environment

There shall be procedures for dealing with faults, shortcomings and non-compliances. Resources shall be assigned and available for preventive actions and to deal with faults as quickly as possible. All complaints shall be investigated, even if questionnaires show that more than 80 % of respondents are satisfied.

4.4.3 Supervision and metering - internal energy audits

Checks to ensure that energy targets and voluntary energy requirements are being met shall be carried out in accordance with documented procedures. Energy targets shall be monitored monthly, and the figures collated into an annual report. Voluntary energy requirements shall be checked preferably when they are introduced into the energy management system, or at least once during the certificate's five-year validity. Audit plans shall require the technical systems in the building or the building stock of the same type to be inspected at least once during the certificate's validity, by means of a service inspection involving updating of the description of energy aspects, measurement, adjustments and maintenance. The results of service visits shall be documented.

4.4.4 Changes in quantities, corrective and preventive actions for energy use

There shall be procedures for rectifying faults, shortcomings and non-compliances. Resources shall be made available for dealing as quickly as possible with larger non-compliances and for applying preventive measures. Changes in energy use revealed by monthly monitoring that exceed 10 % shall be documented, with an initial analysis of the cause and details of any actions taken. Changes in energy use exceeding 5 % over a year shall be documented, with details of a thorough analysis, actions taken to deal with the problem and documentation of subsequent monitoring, in accordance with Item 5.2 (below).

4.4.5 Internal system auditing

Audits shall be carried out, in accordance with documented procedures and programmes, in order to monitor the efficiency of the indoor environment and energy use system. The persons performing the audits shall possess the necessary knowledge of the particular working area concerned and of the associated management system functions. Such audits shall be performed at least once a year within each part of the organisation, and the results shall be documented and archived.

4.5 Management reviews of the indoor environment and energy use systems

Each year, the company's senior management shall review the indoor environment and energy use systems in order to ensure their continued efficiency and suitability. In connection with these reviews, the management shall review and make any necessary decisions concerning the company's energy use policy, indoor environment policy and targets and guide values, as well as review the necessary resources for introduction and operation of the systems. The results of these reviews shall be recorded.

4.5.1 Material for indoor environment management reviews

The material examined for the management system reviews includes records from system audits and other audits, as well as complaints and the results of questionnaire surveys.

4.5.2 Material for energy use management system reviews

The material examined for the management system reviews includes records from system audits and other audits. In addition, the potential for constant improvement is considered through the use of record material from system monitoring and analysis of energy targets containing updated reference values for similar buildings, energy aspects and other changed conditions for energy use.

5 Technical requirements for the indoor environment and energy use

5.1 Testing and inspection of indoor environment conditions

5.1.1 Test methods and requirements

Testing shall be performed and assessed in accordance with the requirements set out in Appendix 1 in respect of thermal comfort, air quality, radon, ventilation, moisture resistance, airtightness, noise, light, domestic hot water, administration and any company-specific or building-specific requirements.

Any voluntary requirements or undertakings that the company has elected to apply shall be tested or measured using methods approved by SP. The approval/acceptance criteria shall be as agreed by the company in conjunction with SP.

5.1.2 Non-compliances with, departures from, and additions to specified requirements

It shall be possible to verify all function requirements by means of measurements. In addition, users' views, checked by means of standardised questionnaire surveys of environmental conditions, shall also be considered when assessing thermal comfort, air quality, noise, artificial lighting and natural light conditions.

If any of the requirements should not be fulfilled, but at the same time be regarded as only a lesser non-compliance (e.g. if it has not given rise to complaints from users), P-marking can still be completed provided that a maintenance or action plan has been prepared. SP shall decide whether the maintenance or action plan convincingly shows that the non-compliance will be rectified and that the function requirements as in Appendix 1 will be fulfilled. However, this presupposes that any regulatory requirements that applied at the time of construction of the building, together with any that may have been subsequently applied by the authorities, such as limitation of radon concentrations, PCB or formaldehyde, are complied with.

Exceptions can also be permitted in premises where it is regarded as very difficult to meet the function requirements without (for example) excessive architectonic encroachment or unacceptable cost. However, any departures from function requirements shall be documented at an early stage and be assessed and approved by SP. Such departures shall be justified, and the user shall be informed of them.

The reasons for complaints in questionnaire surveys shall always be investigated. Even if the proportion of complaints is less than the 20 % level that is regarded as acceptable, the property manager must make sure that the complaints are not caused by damage to the building structure, poor ventilation etc. that must be corrected.

Questionnaire surveys shall be carried out every five years, although SP may require them to be held more frequently, e.g. if P-marking was granted to a building in which one of the technical requirements was not fulfilled, but where surveys have shown that the proportion of complaints was nevertheless less than 20 %. The history of earlier complaints shall be considered when deciding on survey intervals.

5.2 Testing and inspection of energy use

5.2.1 Test methods and requirements

Testing shall be carried out monthly, by means of metering energy use for electricity, heating and cooling, with quantities for heating and cooling being broken down into those for the various types of energy used. The resulting associated greenhouse gas emissions shall be calculated and expressed as CO_2-equivalents. The monthly figures shall be collated into an annual report and be compared with the energy targets defined in accordance with the requirements as set out in Appendix 3. The company's own voluntary energy requirements for individual systems or components shall be monitored during the certificate's five-year validity period.

Cases may occur in which the company wanting the information cannot access the meter readings for electricity use by individual tenants, due to commercial or other confidentiality requirements. If, in such cases, the amount of energy used is not likely to have any greater effect on other energy use in the building, it may be omitted for the purposes of P-marking. However, the tenant shall have been requested voluntarily to notify his energy use quantities, pointing out that it ought to be in the tenant's interests to learn whether his electricity use is unnecessarily high.

Tests or measurements shall be performed using methods and equipment approved by SP, preferably (and if possible) using the same instruments as used for billing of energy use. It shall be possible to verify all energy targets and voluntary energy requirements for individual components by means of measurements and ancillary calculations.

5.2.2 Non-compliances with, departures from, and additions to specified requirements

Changes in annual energy use that exceed ±5 % shall always be investigated. The property operator must determine whether the change has been caused by (for example) damage to the building structure or poor indoor environmental conditions (ventilation etc.) that needs to be dealt with. Details of the change, and of its investigation, shall be documented, together with details of plans for dealing with it (if so decided) and subsequent monitoring. If the change is of a less important character, or if there is some relevant temporary reason for it, the situation shall be looked at again to check that it has been put right within twelve months. If no action should be taken, as a result (for example) of changes in the energy aspects such as in activities or businesses (other energy use being required for maintaining the indoor environmental conditions), the energy targets shall be reviewed. If the investigation shows that necessary actions cannot be taken within twelve months, a more long-term action and monitoring plan shall be prepared. SP shall be notified, and will decide whether the plan can reasonably be expected to put right the non-compliances and/or whether the change is such that it can be approved without requiring renewed verification or modification of the certificate.

It is assumed that any regulatory requirements that applied at the time of construction of the building, together with any that may have been subsequently applied by the authorities are complied with. Any non-compliances shall be justified, and the user shall be informed of them.

6 SP's surveillance inspection

6.1 Indoor environment and energy use systems

SP will normally carry out an audit of the management system once a year, by means of examination to ensure that procedures, instructions and plans are being complied with in accordance with Sections 4 and 5.

6.2 Inspections

Once year, SP will normally make sample-based technical measurements and audits of the management system.

6.3 Actions if the results of inspection are not approved

If the results of a review of the management system and inspections cannot be approved, the reasons shall be investigated. This may result in a requirement for a further inspection visits and new examinations or inspections/

SP may perform further inspections in order to decide whether important shortcomings have been put right. If they remain, the certificate for the building concerned will be recalled.

6.4 Reporting

The results of surveillance inspection shall be reported in writing to the certificate-holder.

7 Other terms and conditions for certification

7.1 General

The terms and conditions in these certification rules are based on principles set out in SP's Quality Manual for Certification. Sub-contractors for testing and surveillance inspection shall be approved by SP Certification.

7.2 Responsibilities of the certificate-holder

The holder of the certificate (the holder of the P-symbol) is responsible for ensuring that buildings covered by the certificate and which are entitled to display the P-symbol conform in all respects with the certificate.

7.3 The right of the certificate-holder to use the P-symbol

The holder of the certificate is entitled to mark the buildings covered by the certificate with SP's P-symbol (i.e. to display the symbol on or in them), and is also entitled to use the symbol in connection with advertising or marketing. Advertising shall not be performed in such a way that there is any risk of confusion between marked (entitled) and unmarked (unentitled) buildings.

7.4 Certificate

Certificates are not transferable.

7.5 Recall of the certificate

With immediate effect, SP can recall the certificate, definitively or temporarily, if:

a) the holder of the certificate has displayed the quality symbol on, or used it in connection with, buildings that do not fulfil the requirements, *or*
b) ongoing inspection has ceased, or has resulted in failure, *or*
c) the results of questionnaire surveys (see Section 5) show that requirements are not being fulfilled, *or*
d) the holder of the certificate has in some other way failed to comply with the terms and conditions associated with the certificate, *or*
e) the holder of the certificate has not paid fees within the prescribed time, *or*
f) the holder of the certificate has been declared bankrupt, has gone into liquidation or has transferred the business, *or*
g) the certificate-holder fails to comply with important laws or requirements of the authorities, *or*
h) the certificate has been found to have been issued incorrectly. However, the holder of the certificate shall be granted a reasonable time for adjusting to changed circumstances, unless there are special reasons to the contrary. *or*
i) the building has shown itself to be unsuitable for its purpose or in some other way can cause harm or nuisance.

In addition to recall of the certificate, misuse of the quality symbol or certificate can result in legal action.

7.6 Obligations of the certificate-holder in the event of recall of the certificate

The holder of a certificate who has been notified that the certificate has been recalled, whether definitively or temporarily, shall:

a) immediately cease making any reference to the certificate in publicity material or other similar material;

b) ensure that the symbol is removed from the building or the building stock.

7.7 Re-issue of certificates

The same rules apply to re-issue of certificates that have been temporarily recalled as applied to the original issue of the certificate, as described in Section 3.3. Renewed testing to verify that the requirements set out in Section 5 are fulfilled will not be required if less than one year has passed since the certificate was withdrawn, unless changes have been made to the structure of the building, its ventilation system etc.

7.8 SP's responsibility

SP is responsible for ensuring that the technical requirements in these certification rules are based on available knowledge and experience, such as accepted standards or corresponding specifications. Updated rules and interpretations, showing latest version numbers, are published on SP's web site. SP is responsible for ensuring that assessment of certified buildings against the requirements in these rules has been carried out with all due care and in accordance with the procedures set out in SP's quality system. SP is not responsible for certified/P-marked buildings.

7.9 Confidentiality

With the following exceptions, all information obtained by SP will be treated as commercially confidential:

- SP, or other parties working with SP, maintain(s) registers of current certificates. These registers can contain details of the names and addresses of the holders of each certificate, the certificate number, certified buildings, classification and the validity period of the certificate.
- SP shall be entitled to publish decisions concerning recall of certificates and misuse of certificates or marking.

7.10 Revised certification rules

SP reserves the right to modify certification rules. In the event of extension of the validity of certificates issued under older rules, the holder of the certificate will be required to comply with the revised rules. However, unless there are special reasons to the contrary, the holder of the certificate shall be allowed a reasonable time for adjustment to the revised rules.

7.11 Fees

Fees for initial assessment (certification), review and extension of the validity of a certificate, and surveillance inspection, shall be paid by the holder of the certificate.

7.12 Appeals

Appeals against SP's decisions shall be submitted to SP in writing, and will be considered by SP's Certification Board.

References

- ”Kriterier för sunda byggnader and material” [Boverket, 1998].
- BVL, Law about technical quality requirements of buildinings
- the Obligatory Ventilation Inspection Ordinance
- the Environmental Framework Code
- the Work Environment Act
- EPBD, 2002/91/EC of 16 December 2002, The European Community Official Journal, no. L 001, 04/01/2003 pp. 0065-0071.
- SFS 2006: 985, the law about energy declarations of buildings.
- PBL.
- ISO 9001
- ISO 14001
- SS 62 77 50, Swedish Standard 62 77 50, Energy mangement system – specifikation, SIS Swedish Standards Institute, **2003**.
- BBR 12 Boverkets byggregler, BFS 2006:12 . (Building regulations of the National Board of Housing, Building and Planning)
- ”Klassindelade inneklimasystem – Riktlinjer and Specifikationer”, R1, VVS-Technical föreningens riktlinjeserie 2000.
- EN 12464-1 ”Light and lighting - Lighting of work places – Part 1: Indoor work places”
- ”Programkrav för god and energieffektiv belysning i skolor och daghem” NUTEK
- SPCR 114, Certifieringsregler för P-marking avseende innemiljö, SP Sveriges Provnings- and Forskningsinstitut, April **2005**.
- Wahlström, Å., Ekstrand-Tobin, A.: “Quality assurance of indoor environment and energy use”, Proceedings of the 7th Symposium on Building Physics in the Nordic Countries, pages 1041- 1048, Reykjavik, June 13-15, **2005**.
- EFFem, 2005, Internetverktyg för miljöbedömning vid energianvändning, (www.effektiv.org/miljobel).
- Wahlström, Å., 2003, Environmental assessment of energy systems for heating in dwellings, Proceeding of ISES Solar World Congress 2003, Paper no. O6 8, Gothenburg, Sweden, June 14-19.

Function requirements for P-marked indoor environments

The following requirements relate to P-marked indoor environmental conditions in existing and new buildings. In addition to the function requirements, questionnaire surveys are used in order to obtain the views of users on the indoor environment. In existing buildings, in certain cases (which are indicated in each section) the requirements that applied when the building was constructed, can be accepted: however, this is conditional upon a sufficient proportion of users (> 80 %) being satisfied with the indoor environment in their overall assessment. Nevertheless, all complaints shall be followed up even if the proportion of complainants is less than 20 %. The replies to surveys are a useful aid to identifying faults when carrying out the Thorough First Inspection.

Thermal comfort

The values given in the following table relate to the building's occupancy zone which, in this context, is regarded as being an area bounded by a line 0,6 m from the outer wall and extending in height from floor level to 1,8 m above floor level. The requirements given in the table are largely in accordance with those given in the heating, water and sanitation technical association's rules 'R1 Classified indoor climate systems - Guidelines and specifications', of thermal quality class TQ2.

Factor	P-marking requirement	Source
Overall rating***	**> 80 % satisfied**	
Air temperature	**20-24 °C */****	R1, TQ2
Temperature gradient	**<2,5°C/m**	R1, TQ2
Operative temperature, winter	**20 - 24 °C */****	R1, TQ2
Operative temperature, summer	**20 - 26 °C */****	Modified R1, TQ2
Floor temperature in the occupancy zone	**19-26 °C, 20-26 °C in child day-care centres** **> 16 °C**	New building, R1, TQ2 Existing building
Air velocity	**<0,18 m/s winter** **<0,22 m/s summer**	R1, TQ2 R1, TQ2
Radiation asymmetry	**< 10 °C**	R1, TQ2

* Most people regard thermal conditions within this temperature range as comfortable, but not everyone likes the same temperature. What can be comfortable for one person can be too hot or too cold for someone else. A good environment is therefore one that makes it possible for occupants to control their own indoor temperature.

** Other values can be temporarily accepted during periods of extreme outdoor conditions. During the summer, the indoor temperature may not be more than 3 °C higher than the outdoor air temperature.

*** To be valid, an overall rating based on the results of a questionnaire survey requires a sufficient number of respondents (normally at least 20) and a sufficiently high response rate (normally > 70 %). A suitable question in this context can be "What is your opinion of the thermal comfort in your apartment during the summer/winter on the whole?"

Air quality

Factor	P-marking requirement	Source
Overall rating*	**> 80 % satisfied**	
Formaldehyde	**< 50** $\mu g/m^3$ **under normal conditions**	
Volatile organic compounds (VOC) and odour	**There are no guidelines for individual VOCs. However, elevated concentrations can indicate (for example) moisture damage. Unpleasant smells or the smell of mildew from/in the building cannot be accepted.**	**SOS Notice no. 4/98**
NO_x, mg/m^3	**Values exceeding the limit values for outdoor air cannot be accepted. ** A special extraction shall be provided if the apartment etc. contains a gas cooker or other gas appliance.**	
Carbon dioxide, CO_2	**<1000 ppm.** **Under normal conditions.**	
Carbon monoxide, CO, mg/m^3	**Values exceeding the limit values for outdoor air cannot be accepted. ****	
Particles, $\mu g/m^3$	**Values exceeding the limit values for outdoor air cannot be accepted. ****	

* To be valid, an overall rating based on the results of a questionnaire survey requires a sufficient number of respondents (normally at least 20) and a sufficiently high response rate (normally > 70 %). A suitable question in this context can be "What is your opinion of the air quality in your sitting-room / bedroom / apartment on the whole?". Respondents can be assisted in qualifying their air quality by such questions as "Do you notice any of the following odours in your apartment: a sharp acid smell / mildew / stuffiness / stale air?".

** WHO publishes guidelines for maximum permissible values for outdoor air quality. Exceptions apply if the outdoor air, despite suitable positioning of air intakes, contains higher concentrations than the permitted values.

*** A new EU directive value for PM 10 applies from 2005-01-01.

Materials

This table provides advice on the choice of materials in respect of their potential emissions.

The inherent emissions and materials contents of surfacing materials, such as floor coverings, wallpapers, ceiling boards and paints, as well as formless materials such as adhesives, fillers and mastics, should be declared in accordance with the relevant industry sector standards or construction materials declaration regulations. Instructions for use, together with any restrictions or limitations, shall be stated, e.g. maximum moisture content, suitable pH values, maximum and minimum temperatures or limitations concerning combinations with other materials, together with advice on care and maintenance.

The following considerations should dictate the choice of materials:

- **choose the material or product which, within its group, has the lowest emission level**
- **do not choose materials for which the declaration of contents states that they contain substances that are classified as allergens, or which in some other way can affect health or comfort**
- **choose materials that are suitable for the intended environment .**

Radon

Factor	P-marking requirement	Source
Mean value of indoor radon concentration	< **200** Bq/m^3	**Building Regs. (2002) 6:223 new building, SOSFS 2004:6**

Ventilation

Property/ function	P-marking requirements and recommendations	Source
Outdoor air flow	Unless otherwise required as a result of activities or businesses in the building, residential apartments, offices, schools and child day-care centres shall be ventilated in relation to the number of occupants at a rate of at least 7 l/second per person (or, for bedrooms, at least 4 l/s per bed), and in relation to the building's emissions at a rate of at least 0,35 l/s per m^2 *. It shall be possible to force the ventilation rate in kitchens and bathrooms. There shall at all times be a basic ventilation flow that ensures that air flows in the correct direction in the duct system, or a system or systems that prevents air flow in the wrong direction.	AFS 2000:42 §20 BBR 12 (BFS 2006:12)
Efficiency of air exchange	> 40 %	BBR 12 (BFS 2006:12)
Airtightness	Ventilation ducts shall be of airtightness Class C (or better)	VVS-AMA 98 table 57/1
Recirculation of extract air	Extract air systems in buildings shall be designed so that unpleasant smells or pollutants are not recirculated into the building's air intakes, openable windows or to nearby buildings.	AFS 2000:42 §20 BBR(2002) 6:23
Recirculated air	Recirculated air should not be used. However, within one and the same apartment, it can be permitted from a cleaner to a less clean area if it can be shown that this does not result in a deterioration of air quality.	AFS 2000:42 §20 BBR 12 (BFS 2006:12)
Flexible ducts	It shall be possible to inspect ducts and to replace them if necessary.	
Filtering the supply air	It may be necessary to use Class F7 air filters and gas filters to remove particulates and gases from the supply air in balanced ventilation systems. If such filters are necessary, they shall be P-marked.	
Pressure difference	Unintentional air leaks may not introduce dirt into clean areas. The pressure conditions in the building shall be controlled such that undesirable effects caused by inward leakage of fouled air or outward leakage of moist air that could cause condensation do not arise.	
Condensation	Building services systems shall be so run or insulated that damage caused by condensation does not occur.	
Operating instructions for users	Instructions shall be provided, describing how the ventilation rate can be increased (forced), how the apartment or premises should be aired, and how the air terminal devices should be cleaned without altering their settings.	
Operation and maintenance, property caretakers	Written instructions shall available in the building, describing how the system shall be operated and maintained. Ventilation systems and components shall be accessible for cleaning, and it shall be possible to clean them without damaging them.	

* This means that homes, schools, child day-care centres and other premises may need demand-responsive ventilation, i.e. that the ventilation rate is higher when the premises are occupied than when they are empty.

Moisture resistance

The current relevant requirements for new buildings, as set out in the Building Regulations, Chapter 6, in HusAMA-98, Chapter HSD (moisture resistance), and in the Building Regulations (2002), Chapter 9 (airtightness), applies for new buildings and major renovation/conversion projects. Designs shall be suitable for withstanding the expected moisture loads, and the construction process shall ensure protection of materials and structures against damaging dirt and moisture.

For existing buildings, structures shall be surveyed for risk areas (designs) and damage, against a checklist.

Part of the building	P-marking requirement	
Roof, walls and foundations	**Moisture resistance in accordance with the FuktCentrum's (Moisture Centre's), or equivalent, checklist**, with a value of permissible relative humidity chosen as appropriate to the materials used.**	
Wet areas	**Protected against water damage in accordance with applicable industry sector rules**	**PER's Rules for waterproof ceramic wall coverings and floor covering in wet areas** **GVK's 'Safe Wet Areas' - Surface and sealing layers/plastic** **GVK's 'Safe Wet Areas' – sealing layers/ceramic** **The Painting and Decorating Industry's standard for wet areas** **VASKA**
Penetrations and connections	**Protected against moisture in accordance with the FuktCentrum's (Moisture Centre's) checklist. ****	

* See appendix.

** FuktCentrum's **(**Moisture Centre's) checklist, Eva Harderup.

Airtightness

The building's airtightness is an important property for ensuring good thermal comfort (no draughts), good air quality, good energy conservation and reduced risk of moisture damage due to convection.

Part of the building	P-marking requirement	
Airtightness of climate-separating parts of structures	**Air leakage shall not exceed 0,8 l/s, per m^2 at a pressure difference of 50 Pa**	**This requirement is specified in order to reduce the risk of moisture damage caused by convection.**

Acoustic conditions

The P-marking requirements are based on Swedish Standards SS 02 52 67, Edition 3, 2004-02-20 for residential buildings, and SS 02 52 68, Edition 1, 2001-06-21 for health-care premises, education premises, day-care centres and play centres, offices and hotels. The relevant regulations for new buildings are set out in Chapter 7:1 of the Building Regulations.

- For residential buildings, the requirement is Class B of SS 02 52 67 for new buildings and for conversions. **

- For health-care premises, education premises, day-care centres and play centres, offices and hotels, the requirement is Class C of SS 02 52 68 for new buildings and for conversions. **

- General areas in child day-care centres and infant schools shall be regarded as classrooms.

- As far as noise from building services systems is concerned, the same requirements apply for group rooms as for classrooms, i.e. 30 dB(A) and 50 dB(C).

- The C-weighted noise requirement for noise from building services systems in classrooms is 50 dB(C).

- Infant schools shall be regarded as day-care and play centres.

- It is recommend that, for premises other than residential premises, noise from machines in the activity carried out in the premises, e.g. computers, refrigerators, dishwashers etc., should also be included.

Factor	P-marking requirement
Overall rating	**> 80 % satisfied**

* To be valid, an overall rating based on the results of a questionnaire survey requires a sufficient number of respondents (normally at least 20) and a sufficiently high response rate (normally > 70 %). A suitable question in this context can be "Are you disturbed by noise from taps, water pipes, the ventilation system, other apartments, stairwells, lifts or outside, e.g. from traffic, industry or from children playing?".

** For existing buildings, the requirements that applied at the time of their construction must be fulfilled, provided also that the overall level of > 80 % of occupants are satisfied applies.

Light

The relevant regulations for new buildings are set out in Chapter 6.3 of the Building Regulations.

Residential buildings shall be provided with sufficient lighting points to enable good quality lighting to be provided.

In addition, the property manager should provide information on how good lighting conditions can be arranged. This applies to the choice of:

- **general lighting**
- **local lighting**
- **materials for surface coverings, in terms of their suitability in respect of contrast and dazzle**
- **colours of ceilings, walls and floors.**

For schools and child day-care centres, values as given in the National Board for Industrial and Technical Development's (NUTEK's) document 'Programme Requirements for Good and Energy-efficient Lighting in Schools and Child Day-care Centres', are recommended. Recommendations for workplaces are given in EN 12464-1 ”Light and lighting – Lighting of workplaces – Part 1: Indoor workplaces”.

Risk of dazzle shall be avoided by limiting the luminance of luminaires in the relevant sight lines to acceptable levels (less than 3500 cd/m^2).

The energy efficiency of fixed lighting arrangements shall be optimised in terms of such considerations and parameters as the use of HF light sources, installed powers, lighting control and automatic extinguishing of lights (presence detectors) where appropriate.

The following values shall be provided in workplaces, in apartments, and in common areas:

Factor	P-marking requirement
Overall rating*	**> 80 % satisfied**
Lighting - stairwells - entrances - general lighting - local lighting - kitchens, cooking and dishwashing - bathrooms and toilets	 **100 lux** **200 lux** **300 lux** **500 lux** **500 lux** **500 lux**
Daylight factor	**>1**%

* To be valid, an overall rating based on the results of a questionnaire survey requires a sufficient number of respondents (normally at least 20) and a sufficiently high response rate (normally > 70 %). Typical questions in this context can be "Do you think that your apartment is too bright or too dark?" or "Do you think that you get too little or too much direct sunlight into the apartment during the winter/summer?”.

Tap water

Factor	P-marking requirements	
Domestic hot water temperature	**>50°C** **<60°C**	To avoid risk of Legionnaires' Disease. To avoid risk of scalding.
Radon	<100 Bq/l	

Administration

Operation and maintenance instructions shall be prepared:

- **for the administrator concerning ventilation, heating and maintenance of the building**
- **for the cleaners (where employed), e.g. for common areas**
- **for the users with information on suitable cleaning materials and methods of cleaning, as well as advice on care and maintenance, e.g. cleaning of ventilation air terminal devices, cooker canopy fans etc.**

The Purchaser's own requirements

The Purchaser may have additional or special requirements relating to such aspects as energy conservation, environmental matters etc. These will be discussed from case to case with SP, in order to decide how they shall be met without reducing the quality of the indoor environment.

Checklist for TFI (example)

A purpose of the Thorough First Investigation (hereinafter: TFI) is to show that the building(s) fulfil(s) the requirements for a P-marked indoor environment in terms of

- thermal comfort
- air quality
- moisture
- noise
- light
- radon
- electric and magnetic fields
- domestic hot water temperature

TFIs shall be carried out by a party or parties having a suitable level of ***competence***, based on sufficient theoretical knowledge, experience and familiarity with appropriate methods of measurement. This competence may be demonstrated by reference to previous work, training and/or experience, and shall cover

- Building physics
- Moisture
- Ventilation (corresponding to that required for Obligatory Ventilation Inspection)
- Acoustics
- Thermal comfort
- Experience of similar investigations.

Calibrate ***instruments*** shall be used. Methods of measurement, instruments and calibration are described in SPCR 114E, Appendix 4.

TFI consists of the following ***stages:***

1. A study of the drawings.
2. Carrying out a survey to provide a basis for TFI. Its results will provide and early warning of any problems in the building(s) that must be considered as part of the work of the TFI.
3. Review of any complaints.
4. Review of any earlier measurements or investigations.
5. Interviews with operating personnel, caretakers etc.
6. Planning of which apartments/premises should be inspected as part of the work of TFI, including consideration of the results of items 1-5 above. This selection to be made by the party who will be making the TFI measurements. In this context, experience from previous similar investigations is of considerable value.
   In a group of similar buildings, the selection shall cover at least 20 % of the total number of apartments, premises etc., representing a cross-section of the inventory of apartments/premises.
   In a unique building, (school, child day-care centre, offices etc.), the entire building shall be inspected.
7. Preparation of a plan for presentation to SP before starting the inspection or measurements. It should contain a summary of the results of the questionnaire survey, planned measurements (their scope and method of performance), a presentation of the available specialisms and of the hardware that is planned to be used.
8. Visits to selected apartments / premises, with measurements and observations to see whether they meet the requirements for P-marked indoor environments.

9. Inspections of roofs, roof spaces, exterior walls, windows, foundations, ventilation systems, heating systems, stairwells, utility rooms etc. Measurements and observations to see whether they meet the requirements for P-marked indoor environments.
10. A collation and presentation of the results of the TFI, and indicating whether the building(s) fulfil(s) the requirements for P-marked indoor environments, or what actions are needed in order to meet the requirements.

Energy targets and voluntary commitments for P-marking of energy use

Targets for energy use refer to all energy input to the building in the form of electricity, heating and/or cooling. They shall be determined by the company or organisation, expressed as the target values for each form of energy carrier after correction to the expected value for a statistically average year. This means that the use of heating and cooling shall be specified for each form of energy carrier, after correction to express them as values for a statistically average climate year.

In addition to values for energy use, energy targets can also include reduced environmental impact through optimised use of different forms of energy carrier. Maximum values of total annual emissions of greenhouse gases, expressed as CO_2-equivalents, are therefore set for the entire building or group of buildings.

Emissions of greenhouse gases shall be expressed as the total Global Warming Potential (GWP), i.e. as grams of CO_2-equivalents in a 100-year perspective. GWP can be calculated from the following equation, using the characterisation factor of greenhouse effect for the respective substance:

$$CO_2 \cdot 1 + N_2O \cdot 310 + CH_4 \cdot 21 + SF_6 \cdot 23900 \text{ (g } CO_2\text{-equivalents)}$$

When determining the energy target, use input from:

- the FEA with information on energy status, energy aspects and energy performance.
- reference values for the building's energy use from existing statistics, bearing in mind the age of the building, its type, its location and its uses. If no relevant statistics from similar buildings are available, use a reference value arrived at in consultation with SP.
- availability of various forms of energy in the neighbourhood of the building
- energy use requirements in the Building Regulations, or other legal requirements.
- the management's energy use policy.

Examples of a purchaser's voluntary energy requirements for particular components

The Purchaser may add voluntary energy targets for individual items or equipment in the building. It can be appropriate to introduce these additional targets in connection with replacement of equipment or with conversion or rebuilding. There can be opportunities to introduce one or more voluntary energy targets in each individual case: examples of such voluntary targets include:

- Thermal insulation / transmission losses
    - U-values for particular parts of the building (W/m²K):
        - Exterior walls

        - Ceiling/roof space structures
        - Windows
    - U-values for the entire building (W/m²K):
        - This defines a specific heat loss if it is expressed together with ventilation losses.
- Air handling and treatment installations
    - Temperature efficiency of heat exchangers (70 %)
    - SFP [kW/m³] – for the entire air handling and treatment systems
    - Thermal power / design air flow rate (kW per m³/s)
    - Electrical power / design cooling power (kW/kW)
    - Installed cooling power (W/m²)
- Lighting and electric equipment
    - HF lighting
    - Maximum power ratings in corridors (W/m²)
    - Maximum power ratings at work positions (W/m²)
- Water use
    - Domestic hot water (l/year)
    - Cold water (l/year)
    - Low flow / low flush items/ware etc.

Measurement methods, instruments and calibration (examples)

Temperature

Make temperature measurements in air and on surfaces using instruments having an accuracy of at least ±0,3 °C. Pt100 sensors are normally suitable for these purposes. Make comparison measurement tests of the thermometers in water with melting ice for a reference at 0 °C. For other temperatures, compare the thermometers against other, more exact instruments by measuring in water or oil. Thermometers should be calibrated by an accredited laboratory about every third year.

Measure **air temperature** in the centre of the room, 1,1 m above the floor. Wave the thermometer in the air to make it settle more quickly (allow about one minute before taking the reading). This also eliminates the risk of a wrong reading due to radiation.

Measure the **temperature profile** in the room at the centre of the room and close to windows (0,6 m from the window). Measure at two heights at both positions: 0,1 m and 1,1 m above the floor.

Measure the **floor temperature** in the occupancy zone, i.e. not closer than 0,6 m to any outer wall. Measure the surface temperature by pressing the sensor to the floor surface, moving it a short distance, pressing it into contact with the floor again, and continuing until a steady-state value is reached. This procedure eliminates the risk of incorrect measurement due to the sensor itself warming the floor surface.

Measure **operative temperature** in the centre of the room, 1,1 m above the floor. The operative temperature is the mean value of the radiated temperature from surrounding surfaces and the air temperature. Fitting a ball (such as a table-tennis ball or something a little larger) around the ordinary temperature sensor gives an idea of the operative temperature.

Measure the **domestic hot water temperature** in the water after running the water at a high rate.

Moisture

Measure temperature and relative humidity indoors and outside. Use tables or a Mollier diagram to find the moisture content of the air in g/m^3, and compare the value for the indoor air with that for the outdoor air. If there is a substantial difference (> 3 g/m^3), this indicates either low ventilation rate or high internal moisture production, or both together.

Measure **relative humidity**, e.g. using an electric sensor. Accuracy must be better than ±4 %. Sensors must be compared against each other or against some other type of RH sensor for each measurement. In addition, the instrument shall be calibrated at least twice a year. This can be done using salt solutions with a known relative humidity.

Measure the **moisture ratio** in wood (if there are any suspicions of damage) by an electrical method, with the electrical resistance of the wood providing a measure of the moisture ratio in the material. This methods gives good accuracy in untreated wood, but there can be a considerable error (> 5 percentage points error) in treated wood or in wood that has been contaminated in some other way.

Moisture in structural parts, such as in basement walls, ground slabs or around floor drains, can be indicated using electromagnetic indicating instruments. The instruments provide information on differences in density between different test points: these differences can be caused by moisture (although also by other mechanisms). A high measured value can (but not necessarily) indicate high moisture content.

Noise

Measure **indoor noise level** using a sound pressure level meter of at least Type 2 performance to SS-IEC 651:1979, preferably with equivalent level display capability. The meter shall be able to measure both A-weighted and C-weighted sound pressure levels. Make measurements in accordance with SS 025263:1996.

Acoustic insulation performance of exterior walls and windows can be estimated only by making simultaneous measurements outdoors and indoors, i.e. requiring the use of two instruments. See SS 02 52 67 for advice on making such measurements: expert help is required for more exact measurements.

Ventilation flow rates

Measure **air flows** through exhaust air terminal devices using and air velocity sensor and a measurement duct. Place the duct over the air terminal device and measure the air velocity at the centre line of the duct. This method can also be used for supply air terminal devices, but a length of straight duct must first be connected to the terminal in order to reduce the risk of turbulence.

Air velocity sensors of the hot wire type must be calibrated about once every two years. This must be done by an accredited laboratory.

Air currents

Smoke is a suitable way of estimating draughts due to air currents. Discharging a puff of smoke and then seeing how far it travels in a given time, it is possible to estimate both air velocity and flow direction.

Air velocity around some local air leak can be measured with a hot wire anemometer (see above).

Pressure differences

Measure **pressure difference** using a liquid manometer, or preferably an electric micro-pressure gauge. Measure the difference between the apartment and the stairwell, and also between the apartment and the outside of the building.

Electric micro-pressure gauges do not normally need to be calibrated more frequently than about once every five years.

CERTIFICATE

No. xx xx xx

Appendix 5 to SPCR 114E

Indoor environment and energy use in apartment buildings

Holder of the certificate / Property manager
…….

Properties
Apartment buildings in accordance with the property manager's list of P-marked properties.

Certified:
The property manager's indoor environment and energy use systems, as used in properties listed above, fulfil the requirements in SP's Certification Rules for P-marking of the Indoor Environment and Energy Use, SPCR 114E. The energy use features covered by the requirements relate to all forms of energy use supplied as electricity, heating and/or cooling, together with related emissions of greenhouse gases (expressed as CO_2-equivalents).

The properties of the indoor environment covered by the requirements are thermal comfort, air quality, radon, moisture, domestic hot water, noise, light, static electricity, and electrical and magnetic fields.

* The premises at ..... do not meet the requirements for noise.

Marking
Properties as indicated above shall display SP's P-symbol (shown at bottom right), the name of the certificate-holder, and the property's name as shown on the register of properties (or equivalent). The notice shall be displayed in a position clearly visible to the residents of the building, e.g. in stairwells.

Validity
This certificate is valid until …...

Miscellaneous
SP exercises surveillance inspection of the property manager's indoor environment and energy use system in accordance with Section 6 of SPCR 114E.

Borås, ……

SP Technical Research Institute of Sweden
Certification

…….
Person authorised of certification

……..
Technical administrator

SP Technical Research Institute of Sweden AB

Postadress	*Tfn / Fax*	*Org.nummer*	*E-post / Internet*
SP	0105-16 50 00	556464-6874	info@sp.se
Box 857	033-13 55 02		www.sp.se
501 15 Borås			

An example of the P-marking notice

Adres street 2

The indoor environment and energy use in this building fulfil (as shown by certificate no. xx xx xx) the requirements specified by SP Technical Research Institute of Sweden in its certification rules no. SPCR 114E.

P-marking means:

- that, together with [**Company name**], SP has determined the requirements for the building's indoor environment and energy use. These requirements concern thermal comfort, air quality, moisture, domestic hot water temperature, radon, light, noise, electrical and magnetic fields, energy use for electricity, heating and cooling, and the associated emissions of greenhouse gases.

- that [**Company name**] has carried out a survey of the building in terms of its indoor environment and energy use, and that its quality is maintained through established procedures for maintenance, operation, care and inspection.

- that SP exercises ongoing surveillance of the procedures, and monitors that the indoor environment and energy use requirements continue to be fulfilled.

Borås, xx month 200x

SP Technical Research Institute of Sweden

Appendix C2

P-marking of indoor environment and energy use
- Considerations prior to certification of energy use

Åsa Wahlström

SP Technical Research Institute of Sweden

Energy Technology

SP Report 2008:10

P-marking of indoor environment and energy use

- Considerations prior to certification of energy use

Åsa Wahlström

Abstract

P-marking of indoor environment and energy use - Considerations prior to certification of energy use

SP Technical Research Institute of Sweden's P-marking quality assurance scheme for buildings, products, services etc., now includes P-marking of the indoor environment and energy use performance of buildings. The rules for the system, which cover new buildings, renovation and existing buildings, are set out in SP's Certification Rules no. SPCR 114E, specifying requirements in respect of both energy use and indoor environment management.

Over the last ten years, SP has carried out considerable work in the field of the indoor environment, resulting in the development of a quality assurance system concentrating on achieving a high-quality indoor environment. This quality assurance system has been successfully applied to schools, offices and dwellings. However, the performance of a building is determined not only by a good indoor environment, but also by low impact on the external environment as a result of energy use in the building. In some cases, concentrating on either good indoor environment or energy efficiency may result in an adverse effect on the other aspect, and so the quality assurance system for indoor environments been extended with a section dealing with energy use.

This document is a handbook for inspection of documentation concerning quality assurance of energy use (primary energy analysis, determination of energy targets, energy management systems etc.). It can also be helpful for the organisation that is applying for P-marking when drawing up checklists.

The document concentrates on requirements for approved certification of energy use in connection with P-marking of indoor environments and energy use in existing buildings: it does not cover requirements for certification of indoor environments. It starts by describing targeting, aims and requirements for P-marking of energy use, followed by presentation of some examples of inspections of collected documentation.

Key words: quality assurance, indoor environment, energy use, buildings

SP Sveriges Tekniska Forskningsinstitut
SP Technical Research Institute of Sweden

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Preface

This report is an interim report in the Coordinated Quality Assurance of the Indoor Environment and Energy Use (SKVAL) project. This is a joint project by SP (the project manager), the Borås Town Council Property Management Department and the Bostad AB Poseidon housing company in Gothenburg. The work is being carried out with an expert group consisting of scientists, property operators, property developers, environmental and energy managers, with financing provided by Formas BIC 11, Poseidon, Borås Town Council and SP.

The main purpose of the project is to expand an existing quality assurance system for the indoor environment to include energy use, under the name of 'P-marking of the indoor environment and of energy use'. This interim report is a handbook for assisting applicants for certification of energy use in connection with P-marking of the indoor environment and of energy use of existing buildings. This is an direct translation of the report “P-märkt innemiljö och energianvändning -Handbok inför certifiering av energianvändning”, (SP Rapport 2005: 41, ISBN 91-85303-73-9), that was written in December 2005.

Borås, Sweden
February 2008

Åsa Wahlström

Summary

SP Technical Research Institute of Sweden has developed a quality assurance system for buildings under the name of P-marking of the indoor environment and of energy use. The rules for the system are given in SP's Certification Rules SPCR 114E. The system sets out requirements in respect of energy use and the quality of the indoor environment of the building when in use. It can be applied to new buildings, conversion work and existing buildings.

SP has been involved for several years in many aspects of work concerning the indoor environment. To accelerate the process of moving from an idea to actual physical implementation, the concept of certification under SP's P-symbol certification scheme is used for schools, child day-care centres, offices, shops and apartment buildings. However, the performance of a building depends not only on a good internal environment, but also on low impact on the external environment resulting from its energy use. In some cases, unilateral concentration on either good indoor environmental conditions or energy conservation can have an adverse effect on the other aspect, and so it is to avoid this that the rules for P-marking indoor environmental conditions have been expanded to include energy use.

This document is a handbook for assisting potential applicants for quality assurance of energy use (first energy analysis, determination of energy targets, energy management systems etc.). It can also be helpful for companies or organisations applying for P-marking in assisting them to prepare the necessary check lists.

The handbook concentrates on what is needed in order to obtain approved certification of energy use when applying for P-marking of the indoor environment and of energy use in existing buildings, but does not consider the requirements for certification of the indoor environment as such. It starts by describing the targets, purposes and requirements for and of P-marking, followed by a number of examples of the review procedure of documentation submitted in support of applications for certification.

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1 Certified P-marked indoor environment and energy use

Good indoor environment is an obvious objective of building construction and use, but is one that all too often fails to be achieved due to giving priority to many other requirements. A quality assurance system, in the form of P-marking of indoor environments on the basis of a specific design and construction methodology, has therefore been developed and applied for several buildings over the last ten years in order to ensure that the buildings actually have the intended indoor environment.

In addition to requirements for a good indoor environment, today's requirements for the overall performance of a building include requirements for reduced external environmental impact. In addition, the new Energy Performance Directive will almost certainly include stricter requirements in respect of energy use improvements. Concentration on only one factor, to the exclusion of others, whether on energy conservation or on a good internal environment, can in certain cases have mutually adverse effects. In order to avoid sub-optimisations, the quality assurance system is now being expanded to include efficient energy use. The rules have been developed in conjunction with two residential property owners, the commercial Bostads AB Poseidon and the local authority-owned Borås Town Council Property Management Department, whose present practices are described respectively in Appendices 1 and 2.

Quality assurance works by the organisation that owns or operates the building to be quality-assured performing most of the work itself, perhaps with the support of external energy consultants. SP Certification then makes inspection visits in order to ensure that the method is being followed, and that the building has achieved the required performance. The expansion of the administration and operating requirements to include routines for energy use in the quality assurance system complies with the performance specification for energy control systems set out in Swedish Standard SS 62 77 50. Entitlement to P-marking approval of a building's indoor environment and energy use means that the building's operational organisation possesses a certified energy control system.

2 Targets for P-marking of energy use

The characteristics of, and requirements relating to, energy targets apply to all energy supplied to a building or building stock for the purposes of maintaining its functions in respect of indoor climate, facilities and activities. Energy use is divided into supplied energy to the building or building stock in the form of electricity, heating and cooling, with heating and cooling involving distinction between different forms of energy (carriers). The targets also include greenhouse gas emissions (defined as CO_2 equivalents) resulting from the energy use. To these targets, the purchaser can also add voluntary commitments in respect of energy requirements for individual components or equipment in the building.

2.1 Direct targets for P-marking of energy use

The targets for P-marking of energy use are that:

- the company should prepare targets and guide values for all energy use on the basis of the results of a first energy analysis (FEA) of the building;
- the targets are in respect of energy performance in the form of all use of electricity and thermal energy, but can also include changes to, or replacement of, forms of energy (carriers);
- the company should introduce management systems to ensure that energy performance in respect of reaching energy targets is systematically monitored as part of the overall administration of the property;
- the company should review its energy targets at regular intervals, in order to improve its guide values where possible;
- the requirement levels for the indoor environment are at least equivalent to those given in SPCR 114E.

2.2 Indirect targets for P-marking of energy use

Other targets for P-marking of energy use include:

- monitoring energy use (budgeting etc.)
- identifying simple improvement measures
- quality assurance of maintenance work, and thus of the working lives of equipment and physical systems
- quality assurance of maintenance of good energy conservation
- the provision of material for energy declarations
    - necessary data
    - the existence of energy and indoor environment systems are valuation parameters that simplify declarations
- reduction of external environmental impact through reduced energy use or changeover to environmentally less harmful forms of energy
- the generation of a quality stamp for environmental and energy work.

3 Requirements for P-marking of energy use

Issue of approved certification for P-marking of energy use presupposes that requirements have been drawn up in respect of all energy use, and that effective routines are in place for monitoring and controlling energy use.

The following material shall have been satisfactorily prepared and approved, in accordance with the instructions in SPCR 114E, before the property can be P-marked:

- A first energy analysis (FEA), shall have been performed, and the results, which are a presentation/description of the building, its building services systems and its energy use, shall be available.
- The results from determination of the building's energy targets shall be available.
    - the organisation shall prepare targets and establish guide values for energy use through consideration of results from the FEA, other sources, and reference values.
- A description of planned actions / maintenance work to improve energy use, in priority order, shall have been prepared.
- A description of the intended method of measurement, and of the equipment to be used, for monitoring energy use.
- A documented management system for energy use by the company / organisation, e.g. in the form of a hand-book.

4 The first energy analysis – FEA

A first energy analysis (FEA) of the energy status of the building(s) must be performed prior to application for certification of energy use in existing buildings. It presents the results of a survey/inspection of the building(s), with details of the energy status, energy aspects and energy performance. It can be produced by inspection of drawings, operational monitoring programmes, supervisory systems and other documentation, physical inspection, interviews with operational personal and possibly with additional measurements or metering. Whenever possible, FEAs should be carried out in conjunction with any basic first investigation of the indoor environment as far as visual inspections and interviews with operational personnel are concerned.

Where an FEA relates to a new building or to conversion work, it can also include documents from the designers and constructors.

4.1 Description of the first energy analysis (FEA)

The FEA is an *'as-is'* presentation of the condition of the building, that can be divided into four parts:

- The building or buildings:
  - exact name etc. (as on land registry or similar documents), building category, owner, operator, address and building data (area, year of construction etc.).
- the energy status of the building(s) (technical status):
  - physical construction and standard of the climate screen and building services systems (heating, cooling, ventilation, water, lighting, control and supervisory systems).
  - identification of shortcomings and defects
  - previous work or measures that affect energy use
  - most recent adjustments of heating, water, ventilation and/or other systems
- Energy-related considerations:
  - businesses and activities that present internal heat loads and use electricity
  - ambient conditions, local surroundings and other factors that have a significant effect on energy use
- Energy performance of the building(s):
  - this covers all supplied energy, as electricity, heat and cooling, with heating and cooling broken down to identify relevant energy sources and/or energy carriers
  - records of energy supplies, with energy use that is affected by ambient conditions having been corrected for statistically average climate conditions
  - investigation of the effects of previous energy efficiency improvement measures.

4.2 The purpose of the first energy analysis

The purpose of the first energy analysis (FEA) of the properties is to produce:

- a carefully documented review of the building or building stock and its actual energy status, energy aspects and energy performance;
- material as needed to determine energy targets;
- material as needed in order to decide on necessary actions and maintenance work, and their relative priorities;
- material for energy declarations;
- material for maintenance and audit plans for the building(s) covered by the application;
- together with the energy targets, maintenance and audit plans and a documented energy management system, a final application for P-marking of the building(s) concerned;
- material for SP's review and sample inspections of the buildings concerned.

5 Energy targets

Energy targets must be set for the use of all energy supplied to the building(s) in order to maintain its/their operation in terms of indoor climate, facilities and activities.

Energy targets are set by the applicant company/organisation, and cover energy use in the form of electricity, heating and/or cooling. Values are expressed in the form of annual energy usage of each carrier, corrected for statistically average climate conditions. This means that the use of heating and cooling is specified for different forms of energy carriers, and that energy use that is affected by ambient climate conditions must be corrected to statistically average year values.

In addition to ambitions for energy use, energy targets can also include reduced environmental impact as a result of optimised use of appropriate energy sources or carriers. For this reason, targets also include maximum annual emissions of greenhouse gases (expressed as CO_2 equivalents) for the entire building or buildings.

5.1 The purpose of energy targets

The purpose of setting energy targets is to provide pressure for constant improvement and, in the long term, to reduce external environmental impact. Improvement can relate to better energy performance in the form of lower energy use, or a change in, or replacement of, energy source or carrier.

Energy targets can be set as short-term targets, intended to improve energy use and then maintain this lower use. They can also relate to energy use in the perspective of a long-term plan for reducing energy use or changing energy carrier.

5.2 Determination of energy targets

Deciding on energy targets uses input from:

- The FEA, with details of energy status, energy aspects and energy performance
- Reference values from existing statistics of the building's energy use, with appropriate consideration of the building's category, age, situation and use. If reliable statistics are not available from or for the building or similar buildings, use reference values arrived at in conjunction with SP.
- Consideration of what energy sources or energy carriers are available in the vicinity of the building.
- Energy use requirements set out in the Building Regulations or other legal requirements.
- ”Energy use policy” set by the applicant company's/organisation's management.

6 Action and maintenance plan

The results from the FEA provide a basis for preparing a plan of priority improvement work and maintenance. Faults and shortcomings that have been identified (e.g. in the FEA) must be dealt with or, if they require a more long-term approach, must be included in the improvement and maintenance plan.

This plan must clearly show that the energy targets will be achieved and maintained. The results of monthly monitoring, in parallel with progress of completed and planned work, must be presented in an annual report on progress of the overall improvement and maintenance plan.

6.1 Priorities of and for planned actions / maintenance

The maintenance plan must include and describe planned routines for:

- service visits,
- adjustment of services such as heating, domestic hot water and ventilation,
- inspection (calibration) of meters and sensors.

The action plan must contain descriptions of, and planning for, priority short-term and long-term measures, such as those that can advantageously be carried out in connection with other renovation work, or as possible investments.

6.2 The purpose of an action and maintenance plan

The aim of a maintenance plan is to ensure maintenance of the quality of physical systems, and thus of their performance and energy use.

The aim of an action plan is to introduce a priority list of work that can be coordinated with other renovation work etc., or which is suitable for carrying out as an investment.

7 Measurements and metering/measuring equipment

It must be possible to verify achievement of all energy targets and voluntary energy requirements for individual components by measurement or metering and any necessary calculations. Such measurements and metering must be performed monthly, covering all input energy in the form of, and identified as, electricity, heating or cooling, with heating and cooling allocated to their relevant energy sources or energy carriers.

In those cases where commercial or other confidentiality considerations prevent the applicant organisation from making specific electricity meter readings of individual tenants, and this energy use does not have much effect on the overall amount of energy use in the building, dwellings' electricity use may be ignored for the purposes of P-marking. However, the organisation shall have attempted to persuade the tenant to allow details of his electricity use to be given, with the motivation that it ought to be in the tenant's interests to receive feedback on possible unnecessary energy use.

7.1 Monthly metering/measurement

A detailed description of the proposed metering arrangements, and associated calculations, must be provided, so that it can be ensured that all energy supplies are metered, but at the same time not double-metered. This presentation must include:

- descriptions of meters
    - identification of those parts of the building or building stock to be covered by the metering
    - specification of the service(s) to be metered (e.g. domestic hot water, space heating etc.)
- a list of all billing meters
- a list of other meters available for
    - providing more, or more detailed, information on energy use, in order to identify where simple improvement measures can be applied
    - identifying areas of uncertainty of measurement
- identification of where more meters are needed.

All meters must be calibrated.

8 Energy management system

P-marking of indoor environment and of energy use means that the administrative or management organisation operates a certified energy management system in accordance with Swedish Standard SS 62 77 50.

8.1 Description of the energy management system

The organisation shall have a documented energy use management system, in accordance with Chapter 4 of SPCR 114E, comprising:

1 Organisational structure and responsibilities:
   - Roles, responsibilities and authorities to be defined, documented and communicated

2 Present competences and training requirements of personnel to be determined and ensured through the provision and appliance of appropriate routines;

3 Preparation of routines for communication with internal and external contacts;

4 Documentation of the management system:
   - E.g. in the form of an electronic handbook
   - Can be integrated with (for example) indoor environment, environmental or quality management systems

5 Document control with routines for dealing with all documents:
   - Control documents; routines, instructions, check lists
   - Descriptive documents; descriptions and forms

6 Routines for control of operational, maintenance, procurement and renovation: activities
   - planning, with activities, details of responsibilities, authorisations, resources and times
   - operating, care and maintenance instructions, including inspection (calibration) of meters and sensors, and adjustments of technical systems
   - monitoring results and performance, with information and documentation to occupants and/or users

7 Routines for monitoring and metering:
   - Monthly metering of energy use and comparison against target values
   - Checking of voluntary energy requirements preferably in connection with the introduction the energy control system, or at least once during the validity period of the certificate (five years);
   - Preparation of an annual summary
   - At least one service visit every five years.

8 Routines for dealing with non-compliances, corrective and preventive actions:
- Departures of monthly energy use from the target values of more than 10 % to be documented, with a preliminary analysis of the cause and possible remedial actions
- Departures of annual energy use from the target values of more than 5 % to be documented, with a thorough analysis of the cause, appropriate remedial actions and subsequent monitoring.
  - In the case of smaller non-compliances, or of non-compliances caused by relevant temporary factors, carry out a check within twelve months to ensure that the non-compliance has been corrected.
  - In the case of non-compliances due to changes in energy aspects, such as activities or businesses that require more energy in order to maintain the indoor environment standards, the energy targets must be reviewed.
  - In the case of non-compliances that cannot be dealt with within twelve months, prepare a more long-term plan of action and monitoring.
  - Notify SP, who will decide whether the non-compliance can safely be expected to be dealt with, and/or if the change is of such a type that it can be approved without renewed verification or change to the certificate.

9 Routines for internal audits of the management system.

10 Routines for management review of:
- Audit reports
- Energy targets
  - based on updated energy aspects, energy use, reference values and energy use policy
- Non-compliances, corrective and preventive actions
- Resources

8.2 The purpose of the energy management system

The purpose of an energy management system is to ensure the provision of the necessary organisation, routines, responsibilities and resources in order to achieve and maintain the energy targets. It also includes, at regular intervals, review of the energy targets in connection with any changes of circumstances, e.g. of activities in the building.

9 Summary

Before an approved certificate of energy use in connection with P-marking of the indoor environment and energy use can be issued, SP will prepare a report summarising the submitted documentation on the first energy analysis (FEA), determination of energy targets, action and maintenance plans, methods of metering and necessary equipment and the overall introduction of the energy use management system. The energy efficiency improvement measures that are planned shall be evaluated that the measures will not affect the performance specification for the indoor environment.

SP will identify, and notify the applicant of, where the submitted material is inadequate and/or where the applicant organisation/company has weaknesses, so that appropriate corrective actions can be taken. SP will also actively contribute proposals for action and maintenance plans. SP Certification will then check that the proposed systems have been installed and are operating, and will arrange for an annual surveillance inspection.

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Appendix 1 Interview with Bostad AB Poseidon

Notes from a visit to:
Göran Leander and Tomas Lepik
Bostads AB Poseidon, Angereds Torg 14
16 December, 2004.
By: Åsa Wahlström, SP Technical Research Institute of Sweden

The company

Poseidon, with 180 employees, manages 23 000 apartments throughout Greater Gothenburg (Angered, Kortedala, Olskroken, Karlaplan, Guldheden, Frölunda, Linné and Backa).

Poseidon's strategy

Poseidon has five-year plans for energy and environmental targets. The energy plan was drawn up in 2000, with target values for 2005. It set a demanding target of saving energy to the value of SEK 25 million per year, i.e. about SEK 1000 per apartment. The strategy plan includes a work plan for optimisation of energy and operation.

Work plan

The work plan includes an assessment of the savings to be achieved by various means:

- adjustment of heating systems (supply temperatures, flow rates etc.)
- computer-controlled operation
- billing of water use
- measures to cut down waste of domestic hot water
- matching services to requirements (mainly cooling)
- weatherstripping and upgrading insulation
- work in connection with new building and conversion.

The target is to get down to an average energy use of 186 kWh/m^2 (giving a total of 288 567 MWh).

Organisation

Poseidon purchases all its facilities management through:

- Riksbyggen, which has overall responsibility for facilities management.
- Caretakers, who are responsible for facilities management of one or more properties (paid by Poseidon).
- Five 'energy hunters' who are employees of five firms of consultants (ÅF VVS Projekt, Beng Dahlgren, Canmera Comfort, Wikström VVS Kontroll and Carl Bro). Their job is to find where energy savings can be made, and to improve Poseidon's system, so that unnecessary energy use is quickly spotted and dealt with.

Service aids

Poseidon uses the following service aids in order to ensure efficiency of operation:

- Operational monitoring by a program under the name of Positiv, supplied by Riksbyggen.
- Operational monitoring by the ESS200 program.
- Temporary comfort condition measurements in the event of complaints.
- P-marking of the indoor environment.
- Acknowledgement and investigation of complaints.

Operational monitoring

Operational monitoring is carried out by a program under the name of Positiv (**Po**seidon's **IT**-baserade system **i v**ärmeövervakning *[Poseidon's IT-based heating system monitoring system]*). All of Poseidon's properties are connected to the program, which monitors performance of space heating, domestic hot water and ventilation systems.

The program provides a schematic diagram of the services systems of each property, with the ability to display on-line measurements of temperatures (set values and actual values), and whether fans, pumps etc. are running (under time-controlled starting and stopping). Each property has reference sensors in apartments and/or other areas that provide the data on indoor climate. The caretakers can see the conditions in their properties in real time, with a historical display over the three previous days. However, changes to operational performance can be made only by Riksbyggen.

Alarms

The program provides three levels of automatic alarms for pumps, fans, temperatures etc.:

1. Round-the-clock alarms of events that require immediate attention (e.g. failure of a heating system circulation pump). Riksbyggen responds immediately to such alarms.
2. Alarms for events that can be dealt with during normal working hours (e.g. for replacement of a ventilation fan in a laundry utility room).
3. Alarms to property caretakers, i.e. simpler events that can be dealt with by the caretaker, such as replacing fuses.

Each activated alarm has an identification number and an alarm text . Alarms are acknowledged by entry of indication of what has been done, which is stored by the system.

Maintenance routines

Some maintenance routines (those that are legally required, such as inspection of safety valves on expansion tanks) are already digitalised and monitored by alarms requiring formal acknowledgment. Poseidon will digitalise further routines, such as replacement of filters, as time progresses.

Complaints

Complaints by tenants concerning temperatures are dealt with by:

- Looking at the history of temperatures as shown by the relevant sensor
- Long-term measurement in the relevant apartments, using mobile sensors
- Investigation by an 'energy hunter'.

It is only after this that any necessary performance changes can or will be made by Riksbyggen.

Operational monitoring

The ESS200 statistics program is used for operational monitoring. A few properties have remotely-read meters, while the caretakers report other operational data. Electricity and water use are reported quarterly, and heat supplies are reported monthly. It is intended that, in due course, all meters will be remotely read. The program produces and displays area statistics for different properties in bar graphs, with the width of the columns indicating the sizes of the properties. Energy use can be compared against the same month in the previous year, using values corrected for statistically average years. The program also generates a forecast of expected continued use during the current year.

Calibration

Electricity, water and heat meters are calibrated by the suppliers, while temperature sensors are calibrated by Riksbyggen on a sample basis every second year. This applies to both outdoor and indoor sensors.

District heating valves are inspected during the summer (when no heating is being supplied) in conjunction with Göteborgs Energi.

The 'energy hunters'

Each energy hunter works one day per month in his/her district, with the following main duties:

1. To analyse performance in the district, identifying properties having high energy use or a rising trend of energy use. This is done by going through data for the properties in the ESS200 system, comparing specific energy usages (kWh/m^2), identifying rising usage trends, operational analysis etc.
2. Investigating the reasons for high energy use or rising trends, by analysing operational data as shown by the Positiv system (alarm settings, temperatures, pump shutdown settings, running times, leaking valves, speed control of fans, lighting, daylight sensors etc.), and by visits to the site, interviews etc.
3. Reducing energy use by making changes via the Positiv system, requesting adjustment of fans etc. that are not working properly by the suppliers when the equipment is still under warranty, or requesting Riksbyggen to carry out appropriate work in the property.
4. Documenting measures or whether there is some natural explanation for the high energy use, and making suggestions for what could be done via renovation of the relevant building services systems or in connection with rebuilding (e.g. introduction of forecast-controlled delivery)
5. Suggest how alarm settings etc. could be improved in the Positiv system, so that unnecessary energy use can be quickly identified and dealt with.

The 'energy hunters' approach has been used for about a year, and has so far been very cost-effective, with savings of about SEK 7 million having been found. As the 'worst' properties are identified and dealt with, with resulting reductions in energy demand, their duties are likely to change. Poseidon can see that they might shift to concentrating on observation and analysis of properties having low energy use, or uncommon reductions in energy use, with a view to transferring the reasons to other properties.

Appendix 2 Interview with Borås Town Council

Notes from a visit to:
Fredrik Wahlberg
Property Management Department
Borås Town Council
4 May, 2005.
By: Åsa Wahlström, SP Technical Research Institute of Sweden

The Property Management Department

The Property Management Department administers about 200 properties, with a total floor area of about 500 000 m^2. Properties can consist of several buildings.

The Property Management Department's strategy

The Department works to an energy plan approved by Borås Town Council on 21st August 2003, which includes working towards an ecologically sustainable energy system. The plan includes the following objectives for residential and non-residential properties by 2010:

- A 20 % reduction in energy use in comparison with 1998.
- A maximum of 20 % of energy use to be supplied from fossil fuels.
- A 20 % reduction in electricity use in comparison with 2001.

Action plan

Average energy use is somewhere below 160 kWh/m^2, and work is concentrated first and foremost on properties with high energy use. Active work in progress at present includes:

- Adjustment of operational control in several larger schools, which is expected to produce substantial savings for a modest input. Modern schools with modern control systems and equipment should not have unnecessary energy use.
- Several larger properties have computerised district heating substations that can be controlled from the council's network.
- A review of ventilation control systems in terms of their use at night and over weekends.
- Replacement of oil-fired boilers, mainly by district heating or heat pumps.
- Other measures as appropriate in connection with new building work or conversion work.

Organisation

Facilities are managed by the following organisation:

- The Property Management Department has seven administrators with overall responsibility for facilities management (planning and monitoring of operation, budget, maintenance and necessary work).
- The ten parts of the town have caretakers responsible for care and operation of one or more properties. Other properties are looked after by an outsourced management department's operation and care organisation.
- The outsourced management department also has three full-time service technicians who provide maintenance services as needed and/or on an annual basis.
- The outsourced management department has one member of staff who monitors energy use in all the properties and prepares work plans for necessary measures.

Service aids

The Property Management Department employs the following aids in order to ensure efficient operation and management:

- Many of the larger properties have operational monitoring systems (Honeywell INU Control and Siemens Desigi Insight).
- The REPAB maintenance program, which records larger maintenance jobs, such as painting, renovation of façades etc., as they are carried out. It is not used for maintenance of physical systems for heating or ventilation.
- The ESS200 program is used for energy statistics.
- The caretakers decide on how they will perform planned maintenance of their properties on a budget of SEK 70/m^2. This amount covers all maintenance such as painting, and not just heating or ventilation.
- P-marking of the indoor environment.
- Alarms from the operational supervisory system are connected to the caretakers' telephones.
- The caretakers have a weekly meeting in order to update on events, exchange information etc.

Operational monitoring

Many of the larger properties have operational monitoring systems for heating, domestic hot water and ventilation. The program provides a schematic diagram of the services systems of each property, with the ability to display on-line measurements of temperatures (set values and actual values), and whether fans, pumps etc. are running (under time-controlled starting and stopping). The caretakers have computers from which they can monitor daily operation (direct monitoring from the district heating substations is too complicated for a daily routine). The caretakers, the outsourced service technicians and the Property Management Department administrators all have authorisation levels for making changes. It is therefore most important that all changes are documented, explained and signed, in the operational program, in order to avoid changes being made back and forth or unnecessarily excessively.

Alarms

The program has automatic alarm indication of pumps, fans, temperatures etc. Alarms are divided into two categories: those that require immediate attention on a 24-hour basis, and those that can be dealt with during normal working hours. Where possible, the caretakers provide the first response level for dealing with faults, calling in the Service Department or an outside company to deal with more complicated faults. In the case of serious problems, the Property Management Department is notified, and decides how the work will be tackled.

Each activated alarm has an identification number and an alarm text . Alarms are acknowledged by entry of indication of what has been done, which is stored by the system. Alarms from the operational supervisory system are forwarded to caretakers' telephones.

Maintenance

The service technicians from the Service Department make an annual service visit to each property, with details from the visit being logged. Minor faults are rectified, and any future maintenance needs are noted. In addition to these visits, the legally required

obligatory ventilation system inspections are carried out by authorised inspectors, as are pressure vessel inspections and other legally required maintenance work.

Maintenance plan

The Department prepares an annual maintenance plan, under which the caretakers decide on planned maintenance for their properties to a value of SEK 70/m^2. This amount covers all maintenance such as painting, and not just heating and ventilation. Larger jobs that have been carried out are noted by the caretakers in the REPAB maintenance program. However, maintenance of physical systems for heating and ventilation is not noted there, but nor is it included in the following year's maintenance plan. Investment budgets for work are sought in connection with preparing each year's maintenance plan.

Complaints

There are few complaints, and those that do occur generally relate to high indoor temperatures from insolation, mainly in May. Few properties have cooling equipment, but ventilation systems in many properties are used for passive night cooling.

Operational performance monitoring

The ESS200 statistics program is used for operational performance monitoring. The caretakers make monthly readings of heating supplies (oil or district heating) and electricity use, and report them to the Department, where they are entered into the statistics program. The results provide documentation of energy use, and all readings are filed for all users.

A monthly report is produced by the administrator, with monthly details (corrected for statistically average conditions) going back over the last three years, and shown in the form of bar graphs. The program also generates a forecast of expected energy use during the rest of the year. The administrator has set up realistic targets for energy use for each meter, and the report shows any departures from these targets. The reports are always sent to the caretakers. If departures from target values are substantial, and the administrator does not know why this is so, he notes this on the report. (If the reason is known, then this is seldom noted.) No further action is taken if the caretaker takes steps to deal with the high energy use. The administrator files the report, although this can vary from one administrator to another.

Calibration

Electricity, water and heat meters are calibrated by the suppliers. CO_2 sensors and temperature sensors are calibrated when the controls firm makes service visits.

Summary

Each year, a report is prepared of all properties' energy use, with key indicator values and realistic targets, together with a presentation of work that is needed in accordance with the administrator's maintenance plan. It provides input for the Council's statistics, and for deciding on the priorities to be given to various items of work. The Town Council decides on the budget available for the work.

Appendix 3 Checklist for reviewing submitted material (example)

Requirement element / function requirement	**Description**	**Assessment**
FEA description		
FEA energy status		
FEA energy aspects		
FEA energy performance		
Previous energy efficiency improvement work		
Energy target		
Maintenance and action plan		
Method of metering and equipment used		
Energy management system		

Appendix 4 Model form for review of FEA (example)

A First Energy Analysis (FEA) must be performed before applying for P-marking. The following table is a check list for ensuring that all requirements have been met.

FEA requirement element	**Description**	**Assessment**
Description		(e.g.) OK
Energy status	Climate screen	
	Heating systems	
	Cooling systems	
	Ventilation	
	Lighting	
	Water	
	Control and monitoring systems	
Energy aspects	Business	
	Activities	
	Surroundings	
Energy performance	Electricity	
	Heating	
	Cooling	
Previous energy efficiency improvement work		

Model form for FEA description (example)

Location	**Description**
Building name, number etc. as stated by property-owner	
Type code as shown on taxation register (building category)	
Address	
Building name, number etc. as shown in Swedish Land Register	
Property number as shown in Swedish Land Registry's property register	
Property-owner	
Name	
Address	
Registration / organisation number	
Name of authorised person / contact person	
Building data	
Floor area[1]	
Year of construction	
Year of conversion	
Most recent change of ownership	

[1] Can be stated as gross floor area (BTA) or net floor area (BRA), and should be the same area as that used for the relevant reference values. The area to be used for declaration of the building's energy performance is that bounded by the inside of the climate screen (as stated in report SOU 2005:67).

Model forms for FEA energy status (example)

Climate envelope

Climate screen	**Type**	**Proportion %**	**Description** (repairs, replacement, adjustments or other work)
Type of construction	Suspended foundation		
	Slab on ground		
	Souterrain		
	Cellar / basement		
Type of structure	Massive / light		
Facade	Brick, stone material		
	Wood, metal cladding, plaster or plastic		
Roof	Slate, copper sheet, tiles		
	Concrete tiles, sheet		
	Asbestos cement, roofing felt		
Windows	Proportion of façade area	E.g. 30	E.g. 80 % of window area on south side
	Single-glazed		E.g. should be replaced within a year
	Double-glazed		E.g. sealed glazing units
	Triple-glazed	E.g. 50	E.g. replaced in 2004
Insulation	**Type**	**Thickness**	**Description**
	Floor		
	Walls		
	Roof		
Additional insulation	Roof		
	Walls		
	Floor		

Further information
Summary of further information that is of importance for energy use, such as:

- Calculated U-values
- Known thermal bridges
- Recurrent / known problems
- Work carried out (when and why)

Heating equipment

Heat	Type	Proportion (%)	Description
Distribution system	Waterborne radiators		
	Electric radiators		
	Waterborne floor heating		
	Electric floor heating		
	Airborne heating		
	Supply air radiators		
Heating system	District heating		
	Oil-fired boiler		
	Natural gas boiler		
	Direct electric heating		
	Pellets boiler		
	Rock heat pump		
	Exhaust air heat pump		
	Air/air heat pump		

Operating times, heating	Proportion (%)	Time
24 hours runt		
Night set back		
Morning boost		
Weekend set back		
Holiday set back		

Documentation, heating	Available?	Attached
Drawings		
Flow diagrams		
Operating instructions		
Operation and maintenance procedures		
Inspection/service records	E.g.: Yes, from 051010	
Design documents		

Cooling systems

Cooling	Type	Proportion (%)	Description
Distribution system	Via the ventilation		
	Local coolers		
Cooling system	District cooling		
	Free cooling		
	Compressor cooling		

Operating times, cooling	Proportion (%)	Time
24 hours		
All year		

Documentation, cooling	Available?	Attached
Drawings		
Flow diagrams		
Operating instructions		
Operation and maintenance procedures		
Inspection/service records	E.g.: Yes, from 051010	

Ventilation

Ventilation		**Proportion (%)**	**Description**
Ventilation system	Natural draught		
	Mechanical exhaust ventilation		
	Balanced mechanical		
	Balanced mechanical with heat recovery		
	Exhaust air heat pump		

Operating times, ventilation	**Proportion (%)**	**Time**
24 hour		
All year		
Night set back		
Morning boost		
Weekend set back		
Holiday set back		
Temporary boost		

Documentation, ventilation	**Available?**	**Attached**
Drawings		
Flow diagrams		
Operating instructions		
Operation and maintenance procedures		
Obligatory ventilation inspection	E.g.: Yes, from 051010	
Design documents		

Control of ventilation	**Type**	**Proportion (%)**
Control sensors	Occupancy sensors	
	CO_2 sensor	
Time control	Time switch	
	Timer	

Lighting

Lighting	Type	Power (W/m^2)	Description
Corridors			E.g. recently replaced by low-energy lamps
Workplaces			
Other areas, e.g. kitchenettes, toilets			

Control, lighting	Type	Proportion (%)
Sensors	Occupancy sensors	
Time control	Time switch	
	Timer	

Water

Water	Type	Proportion (%)	Description
Domestic hot water heating, storage tank			
Distribution system			
Domestic hot water piping			
Valves, taps, fittings etc.			

Documentation, domestic hot water system	Available?	Attached
Drawings		
Flow diagrams		
Operation and maintenance procedures		
Inspection/service records	E.g.: Yes, from 051010	
Design documents		

Control and monitoring systems

Control and monitoring systems	Proportion of the building or property (%)	Description

Control and monitoring systems/	Type	Description
Ventilation system	Central or decentralised monitoring	
	With maintenance routines	
	With alarms	
	With calibration routines	
Heating system	Central or decentralised monitoring	
	With maintenance routines	
	With alarms	
	With calibration routines	

Documentation, control and monitoring systems	Available?	Attached
Drawings / Description		
Operating instructions		
Operation and maintenance procedures		
Log book		

Energy monitoring systems

Energy form/carrier	Reading - manual/automatic	Interval		
		Monthly	Quarterly	Annually
Electricity				
Heat				
Cooling				
Water				

Model forms for FEA energy aspects (example)

Activity	**Proportion (%)**	**Description** of factors affecting internal loads (design and actual occupancy load, indoor temperature requirements etc.)	**Description** of factors affecting electricity use
Residential		E.g. 5 apartments with 12 residents	
Hotel			
Restaurant			
Offices and administration buildings			E.g. 1 computer per employee E.g. Including dining room
Shops/storage, foods			
Shops/storage, other retail			
Health care			
Training / schools			
Sports facilities			
Theatre, concerts, conference halls etc.			
Other			
…..			
….			
Activity	**In use**		
24 hours			
Daytime			
Evenings			
Night			
Weekends			
Significant energy aspects	**In use**		**Description**
Aspect (e.g. need for sunshading)			

Model forms for FEA energy performance (example)

Energy performance covers all input energy in the form of, and identified as, electricity, heating and cooling, with heating and cooling allocated to their relevant energy sources or energy carriers. The material must include historical values of input energy (preferably three years'), corrected as applicable for a statistically average climatic year, i.e. that heat energy used for space heating should be corrected, while that used for domestic hot water heating should not be. Figures can be taken from archived statistics or from going through old energy bills. In addition, the information must include data on CO_2-equivalent emissions arising from the energy use.

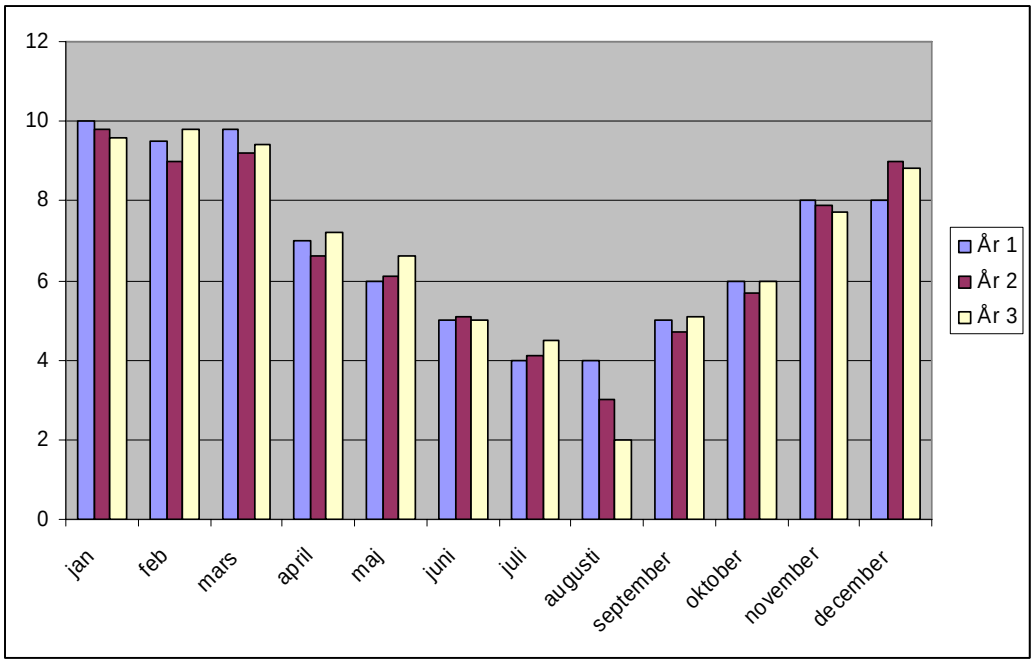
Energy supplied (corrected for average climate year)	**Year 1 MWh**	**Year 2 MWh**	**Year 3 MWh**	**Average MWh**	**CO_2 / kWh**	**CO_2 total**	**kWh/ m^2**
Electricity							
Oil							
Gas							
District heating							
District cooling							
Free cooling							
Compressor cooling							
…..							
…..							
Total heating							
Total cooling							
Total electricity							

Water usage	**Year 1 m^3**	**Year 2 m^3**	**Year 3 m^3**	**Average m^3**	**m^3/m^2**
Domestic hot water					
Total water usage					

Total energy use is apportioned over the area of the building. The net floor area bounded by the inside of the climate screen is that to be used for energy declarations. Gross floor areas or usable floor areas may be needed for reference values.

Monthly, statistically corrected figures must be given for each service meter (e.g. printouts from a statistics program or monthly values on an Excel sheet) in order to be able to assess the monthly energy target.

Energy declaration figures must be on a per-building basis in order to provide complete data. This is why it is necessary to provide figures from each individual meter, and to indicate to which building the values apply, so that the energy quantities can be correctly assigned.



Energy efficiency improvement measures that have been applied

Presentation of follow-up of previously applied energy efficiency improvement measures.

Appendix 5 Model form for determination of energy objectives (example)

Energy target (corrected for average climate year)	**Performance, average**		**Reference value** kWh/m^2	**Energy target**		**CO_2 equivalent**	
	MWh	kWh/m^2		kWh/m^2	MWh	Per kWh	Total
Electricity							
Oil							
Gas							
District heating							
District cooling							
Alternative energy source in the vicinity							
…..							
Total heating							
Total cooling							
Total electricity							
Total energy use							

CO_2 equivalents

Greenhouse gas emissions must be presented in the form of total Global Warming Potential (GWP), i.e. as g CO_2-equivalents in a 100-year perspective. GWP can be calculated using the relevant characterisation factors for each substance from the following equation:

$$CO_2 \cdot 1 + N_2O \cdot 310 + CH_4 \cdot 21 + SF_6 \cdot 23900 \text{ (g } CO_2\text{-equivalents)}$$

When calculating GWP, use reference values for emissions from each form of energy. These can be calculated, for example, by EFFem, which is an internet tool that can be freely downloaded from www.effektiv.org/miljobel. The calculation methodology used in the program is described in Wahlström (2003).

Voluntary energy requirements for individual components

The above-described energy target can be complemented by special voluntary commitments in respect of energy performance of particular individual equipment in, or elements of, the building. Such additional targets can be appropriate in connection with replacement of equipment, conversion of buildings or for new buildings. One or more voluntary energy targets can be considered in each individual case. Examples of voluntary energy requirements include:

- Thermal insulation / transmission losses

    - U-value requirements for particular parts of the building (W/m²K):
        - Exterior walls
        - Roof spaces
        - Windows
    - Total U-value limits (W/m²K):
        - An average value for the entire envelope area

- Air treatment systems
    - Temperature efficiency of heat exchangers (70 %)
    - SFP [kW/m³] – for entire air treatment systems
    - Electrical power / design cooling power (kW/kW)
    - Installed cooling power (W/m²)

- Lighting and electrical equipment
    - HF lighting
    - Maximum lighting power in corridors (W/m²)
    - Maximum power at workplaces (W/m²)

- Use of water
    - Domestic hot water (l/year)
    - Cold water (l/year)
    - Low-flow taps

Appendix 6 Model form for measurement methods and equipment (example)

Diagrams of metering systems, e.g. from monitoring systems or plan drawings of all building services systems:

- Heating
- Cooling
- Ventilation
- Water
- Lighting
- Control and monitoring systems

Energy supplied (corrected for average climate year)	**Description**	**Area**	**Area, m^2**
Electricity meter 1	Borås Energi, induction meter	Building no. 1	542
Electricity meter 2	Borås Energi	Buildings nos. 2 and 4	342
Oil meter 1	Own, volume flow meter	Building no. 3	
Oil meter 2			
Gas meter 1			
District heating meter 1			
District heating meter 2			
District cooling			
…..			
…..			
Total heating			
Total cooling			
Total electricity			

Appendix 7 Model form for energy management system (example)

The organisation must have a documented management system for energy use, in accordance with Section 4 of SPCR 114e, e.g. in the form of a written instruction manual. The following table is a check list of the requirements for such a management system, to ensure that it complies with the requirements of SS 62 77 50.

Content	**Description**	**Assessment**
Organisational structure and responsibilities	E.g. described in the manual	E.g. OK
Training requirements and competence of personnel		
Routines for communication		
Documentation of management systems	E.g. Electronic guide, available on the domain	
Routines for document control		
Routines for activities control		
Routines for monitoring and metering		
Routines for dealing with non-compliances, corrective and preventive actions		
Routines for internal system audits		
Routines for management reviews		

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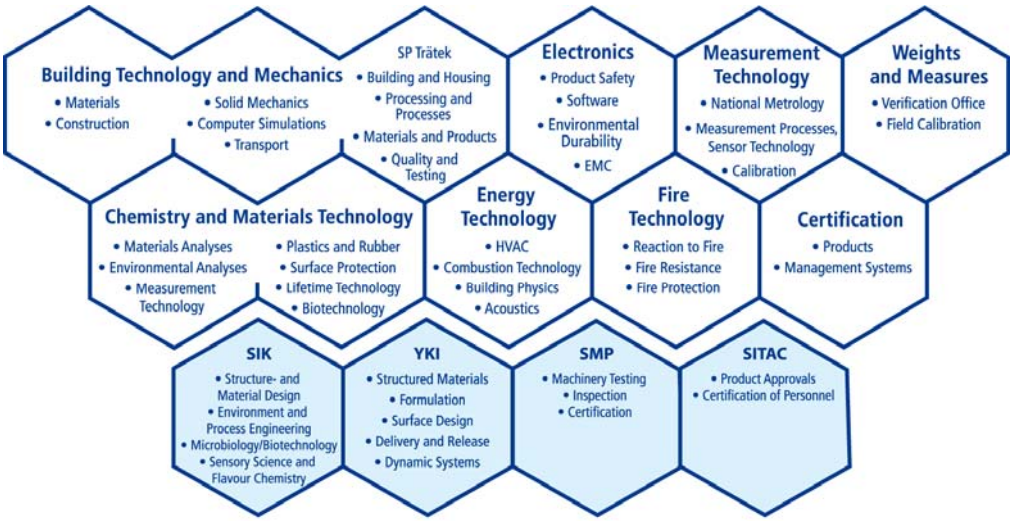

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