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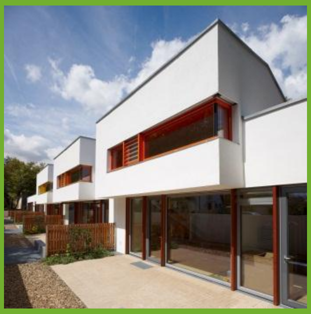
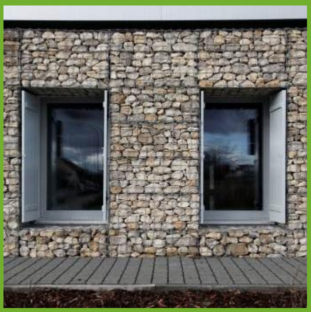
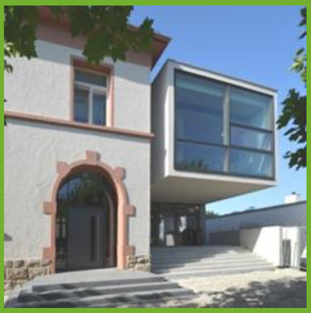
STADT FRANKFURT AM MAIN

Guidelines for economic building 2013







Imprint

Published by
Magistrate of the City of Frankfurt on Main
Department of Urban Planning, Construction, Housing, and Property Ownership
Construction Office
May 2013

Editor
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Printer
Dygy GmbH, Frankfurt

ISSN 2190-5177

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Sources of images on cover
KT Eulenberg: Jörg Hampel
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1 Goal and applicability

Not cheap, but economic!

The goal of these guidelines is to minimize annual total costs (sum of capital costs, operational costs, and environmental impact costs) over the building's entire lifecycle (planning, construction, operation, destruction, and disposal) based on a certain quality standard. The time span for total renovation is assumed to be 40 years.

The level of quality includes the following:

- health and comfort for users,
- the greatest extent of accessibility for the handicapped in line with Frankfurt's standards
- a local contribution to global climate protection
  (a ten percent reduction of carbon emissions in Frankfurt on Main every five years)
- consideration of climate change already taking place (hotter summers, worsening storms, greater flash flooding)
- proper design of new buildings to help users identify with their buildings so they will take better care of the structures
- protection of high-quality designs and heritage buildings
- minimization of material consumption and the primary energy demand of building materials
- the durability and dismantling capacity of structures and components

These guidelines apply for all new construction and renovation projects conducted by the City's administration, municipal institutions, city businesses, and all buildings constructed for the City of Frankfurt as a PPP model (StVVB-§2443). The guidelines do not, however, imply that existing buildings must be renovated if not otherwise specified by law (such as in the Energy Conservation Ordinance).

Each chapter lists resolutions adopted by the **Magistrate and/or city officials and standards** especially for the aforementioned purpose. They are underscored in a box and must be complied with in all cases. These lists are not, however, exhaustive.

If an economic benefit can be demonstrated based on the **life cycle cost calculation** (www.energiemanagement.stadt-frankfurt.de > Information in english), all other items can be deviated from. In such cases, 50 € / t CO_2 in environmental impact costs is to be budgeted (contribution to climate protection). Each deviation from these guidelines must be justified in writing in the checklist provided (see Annex).

2 Implementation of the guidelines

Integrated planning makes users happy!

The following guidelines apply for all contracts with architects and engineers.

Project directors from the Construction Office review compliance with these guidelines at **four milestones** (completion of preplanning, application for construction permit and financing, building inspection, and after two years of operation) based on the **checklists** provided (see Annex).

For all measures **exceeding 250,000 €**, an updated life cycle cost calculation is to be provided at each milestone, including operational costs and subsequent expenses in addition to investment costs (www.energiemanagement.stadt-frankfurt.de > Information in english). **Multiple variants** must be shown **for preplanning** (basic service based on HOAI!).

Project management must send the checklists and the total cost calculation (as an Excel file) to energiemanagement@stadt-frankfurt.de, where the data will be stored in a central information system.

The department director for project management must sign the life cycle cost calculations and the checklists. The Energy Management Department will then issue a **certificate** demonstrating compliance with the Guidelines and total costs.

The guidelines take account of the current state of technology and are updated each year (www.energiemanagement.stadt-frankfurt.de > Leitlinien zum wirtschaftlichen Bauen). As with all sets of construction rules, the standards to be used are those valid when the construction permit is applied for.

2.1 Determining targets and requirements

a) Even before contracts are signed with third parties, the planning targets are to be specified in a carefully coordinated, approved **target agreement**, which is updated jointly as planning proceeds. This target agreement must contain at least the following items: spatial planning with surfaces, types of usage; usage requirements (such as duration of use, times of use, number of people, indoor air conditions, daylighting requirements, and hot water consumption); quality; percent for art; design of outdoor grounds; budget for investments and operational costs; and deadlines for the aforementioned milestones. Municipal committees must resolve spatial planning before planning begins.

b) In formulating the usage requirements, requirements for possible future **conversion** (such as to accommodate demographic change) must be taken into account and assessed economically.

c) The **request for proposals (RFP) from architects** must take equal account of the important targets of affordability, energy efficiency, and sustainability in addition to quality in terms of urban planning, function, and design. Experts must already be involved in the RFP phase to ensure that these targets are met, and the investment and operating costs must be estimated by this point. The jury that awards the contract must also contain an expert in each category (see StVVB 1658 of 29 March 2007).

d) Contracts awarded in what is known as the **VOF Procedure** in Germany must include consideration of experience with affordable, energy-efficient, and sustainable building.

2.2 Planning

a) Careful, coordinated planning plays an important role in ensuring the affordability of construction. Project management shall therefore appoint the **complete planning team** at the beginning of preplanning, and the team shall consist of the building owner, (where applicable) future building users, operating staff, the architect, all trade planners, and representatives from the respective departments at the Construction Office. In addition, project management also organizes a **startup date**.

b) The **fee** for planners does not have to be based on the cost calculation but can be a **flat rate** based on spatial planning and relevant cost parameters (Construction Office target). In addition, a bonus/penalty rule can also be agreed, though it should be based not on manufacturing costs, but on total costs. This approach ensures that planners have an interest in minimizing total costs with no loss in quality.

c) Project management constantly documents the project in a timely fashion in **IPASS**.

d) In addition to procurement costs, the specifications must include probable **operating costs**, especially for the energy consumed by appliances/devices to be purchased. Ancillary offers can be made. Contracts should then be awarded to the most affordable bids based on the overall cost calculation (AVV-EnEff of 18 January 2012).

2.3 Final building inspection

a) Project management must ensure that the planners complete a **detailed manual** for building and technical equipment use that is easy to understand no later than negotiations for the final inspection. This manual must be separately and explicitly assigned. The manual must contain sections on at least the following:
- Emergency phone numbers and a list of contacts for the building owner, the Construction Office, planning bureaus, and construction firms,
- A site map that clearly designates all of the buildings,
- Escape route plans,
- Floor plans,
- List of rooms with area, type of usage, usage times, and target conditions (such as temperature, air volume, and illumination) during usage,
- Brief description of the building and all technical equipment (with photos, roughly 2 pages),
- usage and operating instructions for all trades, especially how to set usage times and target conditions (with photos, roughly 20 pages),
- Diagram of power meters,
- Diagrams of heating system, ventilation system, plumbing, electrical lines, and building automation equipment
- Records of hydraulic adjustment for heating system and calibration of ventilation system,
- Calculation of life cycle cost and checklists for guidelines,
- Maintenance calendar and instructions for all equipment that requires maintenance.

b) In addition, staff and users must confirm that they have received detailed, easy-to-follow **training**.

c) When the building is completed and handed over to the owner, all of the important **existing documents** for future building maintenance are to be provided to the planning chamber and the service department. The documents must reflect the actual technology implemented. Planners and experts must review the documents created by the firms involved in construction and sign off as confirmation of their accuracy (especially the specifications of HOAI). All of the documents are to be provided on paper and in standard file formats (dxf, dwg, doc, xls, pdf, and jpg). The documents also must comply with current documentation guidelines from the City of Frankfurt's Construction Bureau (www.energiemanagement.stadt-frankfurt.de > Dokumente).

2.4 Operation

After two years of operation, the following parameters should be studied:

a) An independent third party shall conduct a survey based on a standard questionnaire to determine **satisfaction among building users and operating staff** (www.energiemanagement.stadt-frankfurt.de > Leitlinien zum wirtschaftlichen Bauen). The goal is to ensure that users and operating staff are basically satisfied with the building (average value at least satisfactory).

b) **Indoor air quality** (temperature, CO_2 levels, and humidity) is to be reviewed by evaluating the building management system or taking measurements at typical points. The goal is to keep the values (4.1.3.c, 4.2.1.a), 4.2.1.d), and 4.3.3.a)) from leaving the tolerance range more than ten percent of usage time.

c) **Actual operating costs** (cleaning, maintenance, servicing, energy, and water costs) are to be compared to the life cycle cost calculation. The goal is to keep the values from exceeding the life cycle cost calculation by more than ten percent.

3 Construction

Good architecture requires little technics!

3.1 Determining targets and requirements

a) Before any **new buildings** are constructed, there must be a review of whether the requirements can be met in **existing buildings**. A decision should only be made for a new building if implementation in existing buildings is not possible or affordable.
b) Before green areas are developed, disused and sealed areas should be investigated to see if they are suitable (**land recycling**).
c) When a building is **gutted** (the entire building envelope is renovated along with technical equipment), check whether it would be less expensive to simply tear down the building and put up a new one. Generally, the latter option is better if the building's loadbearing structure or its floor plan is not suitable for another renovation cycle.
d) For **large renovation projects** (greater than 100,000 euros), check whether additional changes to the building can be made at the same time (see Energy Pass). For instance, uninsulated façades can be renovated when the windows are renewed (the School Director's Energy Saving Campaign, 12-point plan for kindergartens and schools). At the very least, connections are to be planned so that façade insulation can be added later without creating any thermal bridges.
e) If external insulation is not an option for design reasons, **interior insulation** can also be taken into consideration when the building **interior is renovated** (especially when heating radiators are renewed).
f) When **new** (airtight) **windows are installed**, a **ventilation concept** is to be produced to prevent mold and a worsening of indoor air quality. The safest solution is controlled air exchange with heat recovery (see 4.2).

3.2 Preplanning

3.2.1 Use quality

a) When new buildings and open spaces are designed, **urban climate aspects** must be taken into consideration (such as passageways for cool air streams, unsealed surfaces, and surfaces with light colors). The City of Frankfurt's Climate Planning Atlas provides further information (www.energiemanagement.stadt-frankfurt.de > Leitlinien zum wirtschaftlichen Bauen).
b) To improve quality in **outdoor areas** where people spend time, **different** areas have to be offered for different weather conditions (sun, shade, wind protection, rain protection, and seating).
c) All rooms are to be arranged so that they have **daylighting** and **natural ventilation**. Here, it is a good idea to have a proper balance between room depth and ceiling clearance, keep the window lintels as high up as possible, and use bright colors.
d) The **ratio of (transparent) glass and opaque façade area** should be optimized with respect to views, good use of daylight, natural ventilation, heat conservation, the cost of sun and fall protection, and cleaning costs depending upon orientation. Reference values are 20-30 percent to the north, 30-40 percent to the east and west, and 40-50 percent to the south. Glazing should be arranged and designed so that no crane lifts are needed for cleaning.

e) To stabilize the **indoor climate in the summer**, thermal storage mass should be sufficient, exterior sun protection should be effective and variable, and the building should be able to cool down overnight.

f) To increase the **subjective sense of safety**, pathways should be clearly marked, niches should be done without, and natural lighting should be let in. Building administration staff (such as school and day care administration) should be able to see the entry area.

g) A sufficient number of safe **bicycle parking spaces** (with ADFC quality label) should be provided near the main entrance, under a roof if possible.

h) **Changing rooms and showers** should be provided for employees who commute by bicycle (StVVB 3541 of 28 February 2008).

3.2.2 Energy efficiency

a) New municipal buildings must fulfill the **Passive House Standard** (www.passiv.de) and remain affordable (very good insulation, no thermal bridges, and ventilation with heat recovery throughout the building). Justification is required if this standard cannot be achieved. In all cases, the minimum standard is 30 percent greater energy efficiency than the current EnEV requires (StVVB 7502 of 28 January 2010).

b) The building envelope must be kept to a minimum relative to the interior volume; in other words, the building must be as **compact** as possible.

c) The **building must be oriented** to allow solar energy to be used passively in the winter (little shading of windows, most of which face the south, east, and west).

d) New buildings and annexes must have sufficiently large **unheated wind traps** in front of the main entrance (door distance greater than 2.5 m).

e) Rooms with similar usage conditions should be put together (**thermal zones**).

f) **Rooms with great internal thermal loads** (such as IT training rooms, server rooms, LAN distributors, and kitchens) should be as close as possible to the north side or in naturally ventilated basements.

g) **Technology rooms** should be located as **centrally** as possible within the areas served (especially central ventilation units).

h) The option of installing **photovoltaics** should always be taken into consideration for new buildings or when roofs are renovated. If no own array is installed, the roof should be provided to investors without additional costs (StVVB 1491 of 1 March 2007). The current municipal template for such contracts available at www.energiemanagement.stadt-frankfurt.de > Regenerative Energiequellen is always to be used in such cases.

i) Because of the potentially high cost, **fire protection** should be included **early** during the planning phase. Through proper design, costly heat and smoke vents, fire dampers, pressurized elevator shafts, and automatic fire protection doors (which are especially prone to fail in schools) can be avoided.

3.3 Design and execution planning, specifications

3.3.1 Use quality

a) The **target resonance times** in DIN 18041 no. 4.3.2 must be complied with without unlinking the thermal storage mass of the ceilings from the rooms. The options include profiling for solid ceilings, rear-ventilated partially suspended ceilings, sound-absorbing layers, bulletin boards, perforated cabinets, etc.

b) DIN 18040-1 on **handicapped accessibility** – Planning basics – Part 1 on publicly accessible buildings – must be complied with. In justified exceptional cases, there can be deviations here, though they must be indicated in the construction and financing documents.

c) New buildings and annexes must have **handicapped-accessible bathroom facilities** in accordance with AMEV guideline "Sanitäranlagen 2011," chapter 2.3.4.

d) To provide natural ventilation in rooms where classes and meetings are held, it must be possible to **open** at least **0.1 m² of glazed area per person** if the windows open on different walls and at least **0.2 m² per person** if they open on the same wall. This stipulation also applies even if a mechanical ventilation system is used (passive house).

e) The **daylight factor** (ratio of indoor to outdoor light intensity calculated in DIN 18599-4) should be at least five percent wherever 300 lux or more is required and at least three percent in the hallways and staircases. In general, these levels are reached if the window surface area makes up at least 15 percent of the floor area, the room is no more than seven meters deep, windows reach as high up to the ceiling as possible, light is allowed to pass above doors to hallways, and the ceiling is sufficiently high relative to room depth.

f) The following **minimum degrees of reflection** must be complied with for indoor surfaces unless otherwise required by building use: ceiling > 0.8, walls > 0.5, floor > 0.3 (based on DIN 5036 Part 4, AMEV Lighting 2006).

g) To prevent overheating in the summer, **sufficient storage mass** (> 100 Wh/m²K) should be connected to the rooms (for instance, by doing without suspended ceilings and by using solid indoor walls and cement floor slabs). In the process, acoustics must be kept in mind. Any acoustic elements necessary can be rear-ventilated. In cases of doubt, a thermal building simulation should be conducted.

h) In general, effective **outdoor sunscreens** should be used (adjustable, highly reflective, rear-ventilated Venetian blinds on the south, west, and east sides, reduction factor Fc <= 0.25 based on DIN 4108-2). The sunscreens must be adjustable so that no artificial lighting is needed even when full shade is provided. In particular, these sunscreens must be especially robust for schools, kindergartens, and buildings used by young people in addition to being able to withstand wind velocities of at least **13 m/s** (fixated side guide rails).

i) Any shading needed should be adjusted automatically via a **weather station** (temperature sensor, insolation sensor, and wind vane) depending on the façade's orientation (possibly time-delayed to reduce peak power demand). When the heating system is on, the shades should be open (passive solar energy input). Building users should be able to override the automatic sunscreen system manually for a maximum increment of one hour via a wall switch to let light in or darken the room.

j) In addition, **night ventilation vents** should be large enough (cross-section area of around 1 m² without cross ventilation, around 0.5 m² with 0.1 m² of overflow openings for cross ventilation) to prevent overheating in classrooms and meeting rooms in the summer and also be equipped with burglary prevention, driving rain protection, and insect screens (open at indoor temperature > 22°C and outdoor temperature < indoor temperature - 2 K). If users want automatic operation, a switch must be provided to allow for temporary manual overrides. The switch must be out of the reach of children.

3.3.2 Materials

a) Upon signing the contract, the contractor must **declare** all of the materials, products, byproducts, and construction components proposed for the project with an indication of their properties, manufacturer information, an exact product designation, technical data sheets, and any applicable technical certificates.

b) The products and materials used must be **low in pollutants** and solvents, be odorless, and not cause reactions in humans. Buildings must at least comply with the category of "**low pollution**" as defined in Appendix C of DIN EN 15251.

The following construction materials must **not** be used:

c) Components and byproducts made of **tropical, subtropical, or boreal timber** without FSC certification (Forest Stewardship Council, www.fsc-deutschland.de, MB 2561 of 8 December 1989)

d) The following components made of **polyvinyl chloride (PVC)**:
flooring, wallpaper, windows, door profiles, cables, and tubing (MB 525 of 16 February 1990).

e) **Synthetic mineral wool** must be completely sealed off from indoor air and must comply with the criteria for biosolubility (RAL GZ 388).

f) All design steps must be taken to **protect wood**. Chemicals should be kept to a minimum in protecting the wood. Indoors, chemicals should not be used to protect wood.

g) Construction materials should contain as little **formaldehyde** as possible. Wood products and composite boards must fulfill the requirements for the Blauer Engel label (RAL UZ 38 or RAL UZ 76).

h) **Solvents should not be used** or at least kept to a minimum in substances used to treat surfaces, as paint, and as adhesives (powder coating, firing, etc.). If substances containing a small amount of solvents have to be used, they should have an environmental label for "low pollution" (such as RAL UZ 102, RAL UZ 12a, RAL UZ 113, www.blauer-engel.de – also see 3.2 Ventilation).

i) **Bitumen coatings** and adhesives with GIS code BBP 40-70 cannot be used **(**www.gisbau.de**).**

j) **Epoxide resin products** with GIS code RE 4-9 cannot be used.

k) **Polyurethane resin products** with GIS code 20-80 cannot be used except for performance classes B and C (ZDB memo on composite sealants).

l) **DD varnishes** with GIS code DD1 and DD2 cannot be used.

m) The structures used should be long-lasting and easy to recycle and **dismantle** (screws instead of adhesives and nails), especially for handles, flooring borders, tubes, channels, and lines. Dismantling, disposal, and recovery costs should be taken into consideration when comparing affordability. For instance, a curtain-type façade or dual-shell brickwork with core installation could be better than EIFS in this respect.

n) In solid construction, loads should not be passed across insulation. For instance, floor insulation can be applied on the floor slab (thermally separated from the uprising masonry) and/or insulation aprons can be applied.

o) To reduce building maintenance requirements, windows should generally have **wooden frames with aluminum cladding** on the outside or consist of frameless glass composite panes (except for old buildings with special design requirements).

p) When **external insulation finishing systems (EIFS)** are used, they must be protected from damage (balls, woodpeckers, etc.) for the long term in accordance with ETAG 004, such as with anti-vandalism boards, reinforcement, and vapor-permeable quarter bricks.

q) To **prevent algae** from building up, mineral or silicate plaster (not artificial resin or silicon resin) must be used.

r) Special attention has to be paid to **fire protection** when external insulation finishing systems are used. Whenever possible, fire-resistant boards (B1 as stipulated in DIN 4102-1) should be used, at the very least. To prevent fire from spreading to other stories, nonflammable EIFS (stone wool or mineral wool) at least 200 mm tall must be used above window and door lintels.

s) To prevent **storm damage**, the external insulation finishing system must be attached with dowels as prescribed by the system manufacturer. Adhesives alone do not suffice.

3.3.3 Energy efficiency

a) **Passive House components** are to be used when municipal buildings are **renovated** (insulation, windows, ventilation with heat recovery > 75 percent). The Passive House Standard should be the target. Justification is required if this standard cannot be achieved. In all cases, the minimum standard is 30 percent greater energy efficiency than the current EnEV requires. Even for heritage buildings and existing buildings with high-quality design, the goal should be to reach that target with consideration of heritage aspects (StVVB 7502 of 28 January 2010).

Renovating components	Max. U-value (W/m²K)	Generally corresponds to at least
Exterior wall (external insulation)	0.16	20 cm for thermal conductivity group 035
Exterior wall (internal insulation)	0.24	14 cm for thermal conductivity group 045
Roof	0.14	26 cm for thermal conductivity group 035
Ceiling of top floor	0.15	22 cm for thermal conductivity group 035
ground floor / ceiling of basement	0.25	12 cm for thermal conductivity group 035
Windows / glazed doors	0.80	3 panes
Glazing	0.70	3 panes
Ceiling windows	1.00	2 panes
Outer doors	1.00	5 cm for thermal conductivity group 025

The g-value of glazing should exceed 0.5.

b) **Capillary-active** materials should be used for **interior insulation whenever possible**. The standard is 140-millimeter mineral foam plates of thermal conductivity group 045. A construction physicist must plan and calculate connection details.

c) The building is to have **so few thermal bridges** that no more than 0.05 W/m²K is added to the U-values to account for thermal bridges in accordance with EnEV.

d) **Proof of EnEV** and energy requirements is created based on the Passive House Planning Package (PHPP) and the calculation of life cycle cost. The certifier shall provide construction supervisors with written confirmation that EnEV was complied with. Project management must proof of EnEV compliance based on the PHPP calculation (as an Excel file) to energiemanagement@stadt-frankfurt.de, where it is stored in a central information system.

e) In accordance with EnEV based on DIN 4108 T2, **summer heat protection** must be demonstrated.

f) External doors must **automatically close** (without arrestors, closing time less than 5 s). In kindergartens and elementary schools especially, children must be able to open and close the doors on their own.

g) In new buildings and complete renovations, the **airtightness** of the building's membrane must be demonstrated based on a **test** of airtightness conducted in accordance with Procedure A in DIN EN 13829 (n50 <= 0.6/h for passive houses or n50 <= 1.0/h otherwise, with the measurement tolerance range not exceeding these values by more than ten percent). Potential leaks must be identified by smoke detection or thermography.

3.3.4 Other

a) All of the **roof space** suitable for solar energy (no shading, not publicly accessible, and few sources of dirt) must be statically designed so that a solar thermal or photovoltaic array can be added (an additional 30 kg/m² for slanted roofs and flat roofs with the possibility of roof anchoring, and an additional 100 kg/m² for flat roofs without the option of anchoring; the weight of gravel used as dead weight for module racks can be added; module racks with dead weight should always be connected in case of storms). This static reserve is not necessary if the photovoltaic array is integrated in the roof membrane. Cable channels and empty tubes for lines must be provided and appropriately labeled (StVVB § 1491 of 1 March 2007).

b) Flat roofs must have an **angle** of **at least** two percent, with rainwater drained towards the outside, not the inside.

c) Because **flash flooding** will be more severe in the future, doors, windows, and other openings should be at least 20 centimeters above street level or otherwise protected from flooding.

d) **Heat and smoke vents** should be protected from the weather (such as vertically installed) because they have to be open if the fire alarm malfunctions (prevention of water damage).

3.4 Construction phase and final inspection

3.4.1 Use quality

The usage qualities described in 3.3.1 must be demonstrated based on appropriate measurements and test results for final inspection.

3.4.2 Materials

a) Insulation should be added between window frames and the structure of the building, with empty space being filled in with pre-compressed seal strips. **Insulation foam** does not hold up well.
b) The **separated waste** from construction across all trades (mineral mixed construction waste, metals, synthetic foam, foam insulation, plastic foils, solid wood and untreated timber, hazardous wood materials (such as sound absorbers, medium-density fiber boards, and glued laminated timber) and possibly paper and cardboard) is to be centrally collected on-site and taken away for recycling
c) **Pollutants** (such as residue or excess hydraulic oil) must not come into contact with the **soil** or seep into the soil.
d) The **concentration of hazardous substances** in indoor air is **measured** during final inspection if there are any odors.

3.4.3 Energy efficiency

a) The building envelope only passes final inspection if the detailed **results of an airtightness test** are provided (as described in 3.3.3.g). This item is to be explicitly listed in the specifications. The firm which caused the leaks shall cover any costs of subsequent measurements that have to be taken.
b) The **declaration of EnEV conformity** from the auditor is to be provided for final inspection to demonstrate that the building complies with EnEV (PHPP).

3.4.4 Other

a) **Power meters** and **water meters** should be used on the construction site for major projects (> 100,000 euros). The contractor shall cover the cost of power and water consumed during construction in the case of general contractors, and the cost should be included in the bid.
b) Construction machines can only be used if they fulfill the **noise protection** requirements in RAL UZ 53.
c) **Construction** machines must be within the "Limit values for mobile machines and equipment" at www.uba.de (B 591 soot filters for construction machines from 10 September 2010).

4 Technics

Little, but efficient!

a) **Planning concepts that minimize building service equipment and related control systems are preferred (low-tech to reduce operational and maintenance work).**
b) The **structures** used should be easy to recycle and **dismantle**, especially for tubes, air ducts, and cables (install empty tubes!). Dismantling, disposal, and recovery costs should be taken into consideration when comparing affordability.
c) For all technical systems that require maintenance, **maintenance contracts** (full maintenance contracts for cogeneration units) must be included in the request for proposals / requested in accordance with the AMEV template **for the theoretical system service life** (at least ten years) so that the bids can be compared to determine which is the most affordable including costs during the operational phase. A clause indicating price ranges for wages and materials must be included. In accordance with VOB/B, these contracts are signed for four years initially.
d) Manufacturers of all technical systems must be asked to confirm that **spare parts** will be on stock for **the theoretical system service life**.
e) Each technical trade is responsible for the **insulation and sealing** of its own **penetrations** in the thermal building envelope. If the airtightness test described in 3.3.3.g finds that the limit value is exceeded, improvements will have to be made. The firm entrusted with the task shall cover any costs of subsequent measurements that have to be taken.

4.1 Heating equipment

4.1.1 Preplanning

a) The heat supply should be based on **renewables** or **cogeneration**. In new buildings and heating system renovations, check whether district heat from cogeneration, a cogeneration unit, woodchip-fired systems, solar thermal arrays, or another source of heat (downhole heat exchangers, sewage ducts, waste heat from air conditioners, etc.) is most affordable. When selecting planners, check their references (Energy Conservation campaign, 12-point plan for kindergartens and schools, and EEWärmeG).
b) For gymnasiums and sports facilities, check whether **service water** could be **solar heated**; the goal is to reduce standby losses, electricity for pumps, heat losses in lines, frequent switching of boiler.
c) In outdoor swimming pools, solar thermal heat should always be used to **heat the pool** if necessary.
d) Direct electric heaters are often not economic even in **temporary buildings** (trailer offices). Therefore, check whether connections are available to central heating systems or mobile heating stations. The minimum requirements for control systems are room thermostats and a central weekly timer.
e) When new heat generators are installed in old buildings, calculate the **heating demand** based on heat consumption actually measured or by regression analysis at the reference outdoor temperature of -12 degrees Celsius, and subtract the losses from the old heating generator. The boundary conditions specified in the supplementary sheet 1 from July 2008 for DIN EN 12831 are to be used for new buildings. Stay within the limits thus determined to minimize investment costs and system losses.

f) The **heat generator** should be installed **within** the building's thermal envelope for waste heat to be used.

4.1.2 Design and execution planning, specifications

a) Wood-fired systems must comply with the **emissions limits** for Blauer Engel (www.blauer-engel.de, RAL UZ 111/112, less than 20 mg/m³ of particles in exhaust, CO below 400 mg/m³ in exhaust). Larger systems (> 500 kW) must remain below 15 mg/m³ for emissions. The heating value is to be determined for wood-fired heating systems as well.

b) **Condensation boilers** are to be used to serve the baseload if there is a gas supply.

c) Each building should have its own **flow regulator valve**, generally spread across two heating circuits (N-E, S-W). This stipulation is not necessary for Passive House buildings.

d) Install **additional heating circuits** if the usage requirements deviate (administration, gymnasiums with showers and changing rooms, atria, etc.).

e) Check whether individual rooms in **uninsulated old buildings** could have their **own controllers** if the rooms are used at different times of the day (such as classrooms in schools). Here again, two heating circuits should be provided (such as N-E, S-W).

f) New heating radiators should not exceed **60°C/40°C**. To facilitate cleaning, hang radiators on the wall and connect them via the wall. Radiators should be very effective at radiating heat (so use surface radiators, for instance, not conductors).

g) **Heater radiators** should not be installed in front of glass surfaces in new buildings, and where such are found during renovation, heat screens should be added unless the windows have triple glazing. In Passive House buildings, heater radiators do not need to be below windows but can instead be installed on the inside of the room.

h) In **Passive House buildings**, only rooms that need to be above 17 degrees have a significant heating demand. In such cases, a single heating radiator per room suffices, though it is generally only needed when no one is in the room and during long cold spells.

i) **Heat distribution lines** (outside the building's thermal envelope and in shafts) and hot water lines / mountings must be insulated shown below with materials containing no halogen (StVVB 7502 of 28 January 2010):

Dämmung von Rohrleitungen		(Wärmeleitfähigkeit = 0,035 W/mK)						
Rohrdurchmesser DN	(mm)	15	20	25	32	40	50	100
Mindestdämmung	(mm)	40	40	50	50	60	60	100
Maximaler U*-Wert	(W/mK)	0,132	0,149	0,151	0,171	0,168	0,191	0,210

j) Cogenerators, wood-fired systems, solar thermal units, and heat pumps must have **heat meters**. In addition, a **heat meter and a water meter** must be used for **hot water supply** if there is a central hot water system (cf. 4.8.2.d).

k) Pumps with an **energy efficiency index of EEI ≤ 0.23** are to be used in accordance with the ErP guideline. If demand varies, the pumps must have **timers and flow controls** (pay attention to frost protection!). During final inspection, the settings should be customized. If a central control unit is available, it must handle malfunction messages from the pump controller.

l) The control system must have a user-friendly setting to accommodate **lower demand at night, on the weekend, and during vacation**. Outside of usage times, the **boiler and heating circuit pumps must be switched off** if the outdoor temperature exceeds five degrees Celsius.

m) The control unit must have an **optimization program** to ensure that the regulatory curve, the heater cut-on point, and the cutoff point are at the optimal energy-saving level.

n) If there is a control unit in an individual room, it must be able to detect that a **window opening** is suddenly reducing room temperature and react by throttling heat input. If the frost prevention mechanism is set off when the window is left open too long, building management should receive a message.

o) Heat storage must be designed to increase the annual capacity utilization, so use thermo-hydraulic **layered storage** with an external heat exchanger and/or layered loading system. To prevent free convection, all connections must be made to the bottom of the storage tank.

4.1.3 Construction phase and final inspection

a) **Documentation of initiation** must be provided for all heat and cooling meters in accordance with TR-K09 of the Physikalisch-Technische Bundesanstalt.

b) A heating system can only undergo final inspection once a detailed test of **hydraulic compensation** has been provided. This item is a secondary service in VOB but should nonetheless be explicitly included as an item in the specifications.

c) If no individual thermostats are used in single rooms, **thermostat valves** with **limited ranges** with a preset display of the kv value should be installed. The valve heads should be preset as follows: max = desired temperature, min = frost protection = 5°C. Only operating staff should be able to adjust the max and min levels, and the special tools required should be provided to such staff. It must be possible to use the thermostat valve or return flow screw to block or adjust the flow through the radiator.

d) When **systems are calibrated**, the desired heating temperatures indicated in the AMEV heating system guideline of 2001 apply during usage times (for instance, 20 degrees Celsius for offices, classrooms, and meeting rooms; 12 degrees Celsius for entrance hallways and stairwells; 15 degrees Celsius for halls used sporadically; 15 degrees for restrooms; 18 degrees for gymnasiums; and 22 degrees Celsius for changing rooms and showers). The **tolerance range** of +/- 1 degree Celsius may only be exceeded in exceptional cases.

e) The heating system is to be set so that the heaters can only be switched on when outdoor temperatures fall below the **limit temperature for heating** (such as 15 degrees Celsius for uninsulated old buildings, 10 degrees Celsius for Passive House buildings – AMEV heating guideline 2001).

f) During final inspection, make sure that **all control functions** have been enabled (see 4.1.2.f, l, m, n). In particular, the usage times should be set and documented in cooperation with users (see 2.3.a).

4.2 Ventilation system

4.2.1 Preplanning

a) Concentrations of pollutants must be kept below the recommended limit values (**CO_2 < 1.500 ppm**), especially in rooms that generally contain a large number of people (classrooms, meeting rooms, etc.). Generally, these concentrations can only be kept low with controlled air exchange.

b) Wherever possible, **Passive House components** are to be used (ventilation with heat recovery, effective **heat exchanger efficiency** determined based on outgoing air for dry air > 75 percent, StVVB Section 7502 of 28 January 2010.) The recommended heat exchanger efficiency is > 80 percent.

c) The **volume of air flow** and the share of external air should be kept to a minimum (generally **IDA 4** based on DIN EN 13779, i.e. 5.5 l/Ps, or 20 m³/Ph). The design should be based on the typical/average number of people. In storage areas, hallways, showers, restrooms, etc., CO_2 concentrations are less important; instead, the focus should be on the take-up of as much outgoing air from other rooms (classrooms, changing rooms, etc.) as possible to the extent allowed by considerations of hygiene and fire protection.

d) By keeping the volume of air relatively low, **air humidity** can be maintained at between 40-60 percent **without artificial humidification** (except as required by conservation).

e) The ventilation system only serves to provide the air exchange required for proper hygiene. Aside from heat recovery and filtering, fresh air is **not conditioned**. Any need for heating or cooling is met via static heating and cooling surfaces. Rooms that may need cooling (such as server rooms) should have separate fresh air (without heat recovery).

f) The ventilation system should only be in operation **during the heating season** (except for rooms with no walls to the outside). Outside the heating season, windows must be opened for fresh air. Users therefore need to be able to recognize the ventilation system's operating mode from a **display in the entryway** (with explanations!).

g) Integrated planning must largely avoid designs that are high-maintenance, such as those requiring numerous fire dampers. The **fire protection concept** therefore has to be worked up during predraft planning (conduits and airflow). In **renovation projects**, it is often a good idea to have the fresh air and outgoing air run through a separate channel for each classroom (possibly together in an F90 shaft) vertically over each floor to the central unit (fewer noise reduction devices and fire dampers needed along with lower static requirements).

4.2.2 Design and execution planning, specifications

a) **Revision openings** must be arranged so that the entire channel network can be completely inspected and cleaned (VDI 6022).

b) During operation, ventilation systems must be of efficiency class **SFP 1 or SFP 2** in accordance with DIN 13779, and the pressure loss within the shaft network should be normal to low based on Tables A4 and A5.

c) The specific **power consumption** for the entire system should be **< 0.45 Wh/m³** (Passive House criterion).

d) For reasons of hygiene, **no renewable heat recovery** is used in schools and kindergartens and air is not circulated in order to reduce the risk of transmitting pollutants between the fresh air and the outgoing air.

e) **Air filters** must have energy efficiency class A in accordance with Eurovent (www.eurovent-certification.com).
f) **Controls** are generally based on **IDA-C3** as specified in DIN 13779 (time programs). User controls should be limited to a suitable timeframe of no more than three hours (45 minutes for classrooms).
g) Ventilation systems with **greatly fluctuating** usage requirements (such as in atria) have to be adjustable to serve actual demand (number of people), such as with **speed controls** that are easy for users to adjust. In general, these adjustments should be based on air quality (CO_2).
h) Ventilation systems used at indoor pools and showers should be adjusted using **hygrostats**, whereas those in restrooms should use **timed motion detectors**.
i) **Thermal insulation [U] / the thermal bridge factor [Kb]** should be at least T3/TB3 for ventilation units and at least T2/TB2 for outdoor devices (see ventilation unit guideline 01).
j) **Ventilation ducts** must be **insulated** with **halogen-free** materials (including condensation protection; aluminum-coated insulation does not suffice). The following insulation thicknesses apply for thermal conductivity group 040:
Within the thermal envelope: outdoor air 100 millimeters, exhaust air 100 millimeters, fresh air 30 millimeters, extract air 30 millimeters
Outside the thermal envelope: outdoor air 25 millimeters, exhaust air 25 millimeters, fresh air 80 millimeters, extract air 80 millimeters
k) Ventilation units with a connection capacity exceeding 10 kW require their own meter for power consumption.

4.2.3 Construction phase and final inspection

a) A ventilation system can only undergo final inspection if the detailed results of measurements of heat exchanger efficiency, air volume, power consumption (based on 4.2.1.b), 4.2.1.c) and 4.2.2.b)), and noise levels in the rooms studied are provided. This item is to be explicitly listed in the specifications.
b) During final inspection, make sure that all control functions have been enabled (see 4.2.2.e and f). In particular, the usage times should be set and documented in cooperation with users (see 2.3.a).
c) In accordance with DIN 13779 (p. 20), ventilation **ramps up** for the period of heavy building usage 30 minutes before that usage begins.
d) The final invoice is only to be submitted when all of the shortcomings listed in the **expert audit** have been remedied.

4.2.4 Operation

a) During operation, make sure that the ventilation system is switched off **outside of the heating season** and that windows are opened to provide fresh air (4.2.1.e).

4.3 Air-conditioning

4.3.1 Preplanning

a) Try to **avoid** having to use **active air-conditioning** (reduce glass surfaces, provide shading, arrange storage mass properly, use night ventilation, reduce or shift internal heat sources, and put devices that need cooling towards the north and in basements or exterior rooms).

b) If air-conditioning is required, first see how much good **overnight cooling, adiabatic cooling** (of extract air) and **sorption-supported air-conditioning** would do. Drinking water may only be used for adiabatic cooling.

c) If active cooling is necessary, the use of renewable energy, such as solar energy or a downhole heat exchanger, should be planned (StVVB Section 2443 of 6 September 2007).

d) **Mobile air-conditioners** should only be used if heritage protection requires them in existing buildings.

4.3.2 Design and execution planning, specifications

a) Refrigerants may only be used if they are **not halogenated, even partially**. For instance, water (R 718), carbon dioxide (R 744), and ammonia (R 717) can be used.

b) Lines for coolant must be **insulated** with **mineral fibers** or halogen-free foam.

c) The desired room temperature for air-conditioning should be **gradually increased as the outdoor temperature** rises (above an indoor temperature of 26 degrees Celsius, desired indoor temperature = outdoor temperature minus 3 K, tolerance +/-1 °C).

d) In conservation environments (such as **museums**), the target humidity level and temperature should be **seasonally adjusted**. The rate of change for temperature and humidity should be limited based on usage requirements (such as Δ humidity < 1 %/day).

e) Cooling is only to be allowed when the **shading is activated** and the windows closed in the rooms to be cooled.

4.3.3 Construction phase and final inspection

a) Controls for cooling should be set so that the system can only switch on **above** an indoor temperature of **26 degrees Celsius** and then keep the indoor temperature **3 K below the outdoor temperature** (in IT rooms without set workstations, desired temperature of 27 degrees Celsius, tolerance of +/-1 degree Celsius).

4.4 Sanitation technology

4.4.1 Preplanning

a) When a lot of service water will be consumed (>60 m³/a without drinking water requirements), the **use of rainwater** should be studied to see if it would be affordable. For the irrigation of open spaces (sports lawns, greenery, etc.), rainwater is generally an affordable option if enough roof area is available. Otherwise, check whether **seepage** is possible on the property.

b) If **service water** is available nearby (such as Mainova's Main Water Network or the subway's groundwater reserve), check whether it can be used.

c) Sinks and cleaning rooms generally should only have **cold water** taps (except for kindergartens and nursery schools).

4.4.2 Design and execution planning, specifications

a) **PVC** feed and return lines cannot be used within buildings (MB 525 of 16 February 1990).

b) Drinking water lines should be made of **stainless steel** or **PE**.

c) Drinking water lines must be planned so that the lines **do not** have to be **automatically rinsed**, as specified in the Drinking Water Ordinance (no branch lines without regular consumption).

d) To facilitate maintenance and future exchanges, pipes should be **easily accessible**. Gutters should also be easily accessible on the façade.

e) To reduce cleaning costs, sanitation devices should be **hung on the wall** wherever possible.

f) Toilet seats must have stable attachments (**completely stainless-steel hinge shafts**).

g) Toilet tanks must have a **stop button** or a separate button for small doses along with a label for users.

h) **Toilet tanks** should have a volume of **no more than 4.5 liters** (except for existing facilities).

i) **Sinks** should have taps with volume limiters (**3 - max. 5 l/min**).

j) **Showerheads and taps** should have volumes within **max. 7 l/min** but nonetheless provide a strong force.

k) Showers and sinks used mainly for hand-washing should have **taps that automatically close** after 40 seconds and five seconds, respectively. The taps require a filter to keep out foreign objects.

l) Urinals used more than ten times a day should be **dry individual urinals** unless otherwise justifiably desired by users.

m) To prevent **Legionella disease**, showers should only have **distributed fresh water stations or instantaneous heating systems** (see DST memo number 3.4). The amount of water between the heat exchanger and the showerhead must not exceed three liters. No control unit is needed downstream of the heat exchangers.

n) Hot drinking water storage tanks do not need to be used for freshwater stations. If **boilers** are needed to cover peak demand, they should be limited to demonstrated need (without safety margins) and be installed as close to consumption locations as possible. In old buildings, take measurements to determine the hot water demand.

o) In addition, **cold water lines** should not be heated (use small cross-sections with sufficient insulation instead) to prevent the growth of Legionella.

p) Storage tank loading pumps and circulation pumps must have an **energy efficiency index ≤ EEI 0.23** in accordance with the ErP Directive (no electric control system needed) and be controllable via a timer (and possibly a thermostat).

q) A **separate heat supply** (such as from a condensation boiler) can be taken into consideration for hot water supply if boilers are large, hot water lines are long, and hot water demand is low.

r) If there is a central supply of hot water, the **amount of hot water** must be **metered** (in the cold water feed for hot water provision).

s) For **showers that are remote and rarely used** (such as in kitchens and kindergartens), instantaneous gas or electric boilers (13.5 kW) should be installed.

t) Small tanks installed inside cabinets should not be used because of the great standby losses. Use **micro instantaneous heaters** (5.7 kW) instead.

4.4.3 Construction phase and final inspection

a) Pipes and fixtures must pass a **pressure test** with respect to drinking water hygiene. Before final inspection, check for any **leaks** throughout the system (measured creepage at the water gauge). Water volume (4.4.2.h-j) and automatic closure times (4.4.2.k) must also be checked. These inspections are to be documented.

4.5 Electro-technics, electrical devices

4.5.1 Preplanning

a) Electricity should mainly come from **renewable sources or cogeneration**, to the extent affordable (StVVB Section 1491 of 1 March 2007).

b) Before a **transformer** or electrical connection is **enlarged**, check whether power conservation would counteract the need for greater power supply in old buildings (for instance, with new lighting, by switching the kitchen to gas, or by limiting peak demand).

c) In major renovation projects, **old fluorescent lamps** should also be **renewed** (energy conservation campaign, 12-point plan for kindergartens and schools).

d) In selecting lighting equipment for rooms, make sure that the **illuminance** does not exceed the target in DIN EN 12464 or DIN EN 12193 by more than ten percent. A certified program (such as Dialux) is to be used to demonstrate illuminance for each room type.

e) Avoid using electric heaters if possible.

4.5.2 Design and execution planning, specifications

a) Power lines and installation material must not be made of PVC. **Always use halogen-free cables** unless partially renovating a current system with PVC cables and underground lines (MB 525 of 16 February 1990).

b) **No heavy metals** can be used (such as cadmium telluride PV panels).

c) The upper limit for the **power consumption of lamps** including electric ballast is 2.5 W/m²100lx, whereas the **target value is 2 W/m²100lx**. Additional effect lighting should only be available temporarily via switches or time relays. The result is, for instance, a limit of 7.5 W/m² and a target value of 6 W/m² for a classroom with 300 lux. A standard classroom can generally be sufficiently lit with eight single-row, efficient, wide-beam 35-watt T5 parabolic reflectors (two of them for the chalkboard). Experience suggests that a maintenance factor of 0.8 suffices for this arrangement. The marginal strip of 0.5 meters does not have to be taken into consideration when calculating nominal illuminance and evenness.

d) The **luminous efficacy** of the lamps including electric ballast should be **at least 50 lm/W** on average (use florescent lamps, compact fluorescent lamps, or LED lamps instead of conventional light bulbs).

e) **Electric ballast** should be used.

f) The **operating efficiency of the lights** should be at least **80 percent** (parabolic reflector lamps are standard).

g) **Emergency lighting** should consist of LED technology.

h) Lighting is generally **switched on and off by users**. An automatic system should only be used for switching off the lights.

i) For new installations in **classrooms**, for instance, lights can be automatically switched off five minutes after recess begins. For other types of usage, lighting should be switched off centrally when there is sufficient daylight and at the end of usage periods.

j) In all cases, users can **manually switch** the lights **back on** right after they have been switched off.

k) In larger rooms (such as classrooms), it should be possible to switch individual **rows** of lights on and off to provide the amount of artificial light actually needed based on demand and daylighting. The light **switches** should be properly **labeled** (such as "hall side" and "window side").

l) Less frequented rooms (**hallways, staircases, storage rooms, and basements**) should have a timer or motion detector (power consumption < 0.35 W, time adjustable with standard value at five minutes). If daylighting is possible, motion detectors should also have a light sensor set to the nominal illuminance.

m) It should be possible to switch on artificial lighting **separately** for areas with and without **daylighting.**

n) For **restrooms, changing rooms**, etc. without windows to the outside, the motion detectors at the entrances should also have sound sensors.

o) Illuminance should reach **300 lux** for **school gymnasiums** used for school events and training. **For regional tournaments**, illuminance can be increased to 500 lux **by means of a key-protected switch**.

p) **Motion detectors** (in areas with daylighting and a light sensor) should always be installed in areas with large arrays of artificial lights (> 1 kW, such as in gymnasiums).

q) **Outdoor lighting** should be switched on and off via light sensors and timers (unless otherwise required for traffic safety) and possibly also via motion detectors.

r) Even if there is an installation bus system, **conventional switches and buttons** should be used to keep costs down if possible. All switches and buttons must have uniform labels.

s) To the extent affordable (such as in kitchens), a system should be included to **limit peak demand**. At the least, space should be provided within the main distributor cabinet for control lines for electrical appliances.

t) Reactive power must be limited to the power factor (cos phi) set by the local utility. If necessary, install **compensation systems** (for individual, group, or central compensation).

u) If **backup power systems** are required, systems of efficiency class 3 should be used in accordance with EN 62040-3.

v) **Household appliances** should have an energy label of at least A+ (www.spargeraete.de/frankfurt).

w) If **monitors** are installed in a necessary escape route, they must have a nonflammable, smoke-proof **casing**. In addition, they must be switched off via a motion detector or a timer when the building is not being used.

4.5.3 Construction phase and final inspection

a) Lighting systems should only undergo final inspection after the results of a detailed **measurement of illuminance and power consumption** have been provided (test of 4.5.2.a). The sensitivity and timing of motion detectors must be configured and documented. These items must be explicitly mentioned as requirements in the specifications.

b) The final invoice is only to be submitted when all of the shortcomings listed in the expert audit have been remedied.

4.6 Kitchen technology

a) A **neighborhood concept** with a central kitchen and multiple kitchen suppliers of fresh food is to be created. This concept can also compensate for local fluctuations in the number of hot meals.

b) If the **primary energy consumption** of the kitchen (including storage, cooking, and waste disposal) per warm meal (wm) does **not exceed 2 kWh/wm**, the amount of air that passes through the range hood does not have to be taken into account in the building's Passive House calculation. If, however, that value is exceeded, the additional energy consumption must be compensated for within the PHPP balance.

c) **Cooling/freezing zones** must be **thermally separated** from hot/warm areas.

d) **Kitchen equipment** such as stoves and convection ovens should run **on gas**, which is generally affordable.

e) They should have their **own range hood** in addition to the kitchen's ventilation system.

f) If available, **kitchen equipment with condensation hoods or internal heat recovery** should be used; such combinations considerably improve the work environment for staff.

g) If no device certifications are available, **calculate consumption values based on DIN 18873** for planning. Use the criteria according to the ENERGY STAR® Guide for Restaurants and, for refrigeration and cooling technology, the Eurovent Certification Company ECC.

h) In addition, see the Construction Office's **planning recommendations** in "Energy efficiency in kitchens and cafeterias."

4.7 Mechanical systems

a) All electric drives should have **energy-saving motors** (IE3 motors for more than 1,000 h/a in accordance with DIN EN 60034-30).

b) If **elevators** are necessary, they should be of **energy efficiency class A** in accordance with VDI 4707. Cabin illumination should employ LED technology and automatically switch off in long periods of standstill (> five minutes).

c) If an engine is to be used to **provide backup power**, check whether an option that includes cogeneration is also possible.

d) Avoid using constantly open **shaft ventilation openings** and chimneys to prevent heat losses (heat and **smoke vents** driven by motors).

f) The final invoice is only to be submitted when all of the shortcomings listed in the expert audit have been remedied.

4.8 Building automation

4.8.1 Preplanning

a) For economic reasons, an open control system must be available for operation and monitoring. All trades must be planned for later inclusion in an **overall process visualization system** (IAS/InTouch View from Wonderware). In this way, central management and operation optimization are possible, and staff training is simplified. For the exact requirements, see the **Specifications for building control systems** (www.energiemanagement.stadt-frankfurt.de > Gebäudeautomation).

b) **Integration planning** should be ensured across all technical trades for measurement and control systems. Keep the **number of data items as low as possible**.
c) In planning building control systems, the **overriding functional diagram**, the **list of functions** (GA-FL), and an **automation scheme** for each subsystem must be created in accordance with DIN EN ISO 16484-3 and coordinated with the operation optimization concept.

4.8.2 Design and execution planning, specifications

a) All of the data items are to be designated in the SPS/DDC and in all documentation as follows according to a standard 28-character **general designation system (AKS)** (see specifications for building control systems):
   Position 1-4: Street code
   Position 5-7: House number
   Position 8-9: Building
   Position 10-11: Story
   Position 12-14: Cost group
   Position 15-17: System number
   Position 18-24: Operating resources
   Position 25: Physical designation
   Position 26: Function
   Position 27-28: Consecutive number
   For key directories for individual fields, visit www.energiemanagement.stadt-frankfurt.de.
b) Work with the Energy Management Department to come up with a **consumption meter concept** for power, heat, water, and hot water and implement it during planning. Here, external consumption/users need to be taken into account, as do the possibilities for follow-up consumption records to review building quality. Energy Management will approve the meter concept and inspect it after installation.
c) For every completed building – including temporary trailers – with more than 500 m² of net floor area (such as gymnasiums) and for every usage point within a building (such as school cafeterias), a **meter** must be installed for electricity, heating energy, and water. All meters (utility meters and subordinate meters) must have floating pulse outputs (and possibly an M-bus) for central data collection. The value of the pulses should not exceed the following:
   Electricity: 0.01 kWh/pulse, gas: 0.1 m³/pulse, heat: 1 kWh/pulse, water: 1 l/pulse.
d) Wherever annual costs exceeding 2,500 euros are expected for power, heating energy, and water (buildings, building sections, and devices), **submeters** must be installed in accordance with the device equipment guidelines for energy and media metering in FKGB/AMEV. In particular, the cold water supply and the amount of heat for central **hot water** supply systems must be metered (see 4.1.2.j).
e) On properties with annual energy and water costs exceeding 15,000 euros (and generally for mine water meters), all consumption meters are to be connected to a data logger (for **automatic consumption records**) and/or the process visualization system. A data connection is to be provided for this purpose in the low voltage main distribution board.
f) **Room sensors** should have an **accuracy** of <= 3 % of the typical measurement range for usage for at least ten years (temperature <= +/- 0.5 °C, humidity <= +/- 3%, CO_2 concentration <= +/- 100 ppm).

They must be installed in an undisturbed location within the room (at least two meters from windows, doors, fresh air openings, heat sources, etc.).

g) In general, **digital control systems that run independently** (distributed DDC technology) are to be used. They must continue to work properly and with full functionality even if the management level (PVS/building control system) fails and go back into full operation automatically after **power outages**.
h) DDC substations must have a standard **vendor-independent interface** for connections to the automation level (such as Modbus, LONtalk (LONMark-certified)).
i) In facilities with annual energy costs exceeding 30,000 € (such as all schools), a vendor-independent **process visualization system** (PVS) with the IAS/InTouch View software from Wonderware must be established as the management level on-site or in a remote control center. On the site property, the PVS replaces the central control computer for a vendor-specific building control system.
j) The graphical user interface must be **standardized** to facilitate operation of the building control system in different properties. Access is controlled via a standard selection window with an aerial photo and a list of trades.
k) The PVS is to be installed in the **facility management room**. It must be possible at all times to move the control system to the operation center via a modem connection or intranet.
l) Incoming **alarms** of high priority are to be sent from the building control system/PVS via **text message** to a D1/D2/E-Plus mobile telephone to alert staff.

4.8.3 Construction phase and final inspection

a) Documentation of initiation must be provided for all heat and cooling meters in accordance with TR-K09 of the PTB.
b) Measurement and control systems, including the building control system, shall only undergo final inspection after the detailed results of a **check of each data item** (calibration of all sensors and correct display of values on DDC and building control system) and all essential functions have been provided. All DDC stations must continue to work properly and with full functionality even if the management level (PVS/building control system) fails and go back into full operation automatically after **power outages** (check 4.7.2.f). This item is to be explicitly listed in the specifications.
c) All **sensors and actuators** must be clearly **labeled** on site, in the DDC, and in building services with the AKS and plain text (70 x 20 mm sign, black letters on white background).

4.9 Communication technology

a) The current version (available from Office 16's download section on the intranet) of the **"Basics on cabling technology" guideline** published by Office 16 for IT cabling applies.
b) For all offices and classrooms, a common **cable topology** for telecommunications (ISDN) and data networks (100BT) must be planned so that future extensions run smoothly.
c) Rooms with a single workstation must have **two ISDN connections and two 100BT** data connections. An additional ISDN and data connection must be provided for each additional workstation.
d) A **logically separated technology network** (yellow patch cables) connects the building automation system to the IAS/InTouch server at the Construction Office. There is a central connection point in the Office's electrical cabinet 16 for this purpose.
e) **Separate cable networks** must be provided for communication systems in **case of crisis**.

f) **Devices that produce a lot of waste heat** (printers, copiers, servers, etc.) are to be installed outside of rooms where people spend a lot of time.

g) **IT and office equipment** should fulfill the Energy Star (www.eu-energystar.org/de) and Office Top10 (www.energieeffizienz-im-service.de/it-geraete.html) requirements. Peripheral devices should be hooked up to power strips that can be switched on and off to ensure they are safely disconnected from the mains. There must be a central switch for IT rooms.

5 References

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6 Checklists

HOCHBAUAMT
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Checklist Guidelines for economic building 2013

A1	Property	
A2	Street, house number	
A3	Component	
A4	Measure	
A5	Trade	Implementation

2. Implementation

No.	Criterion	Determination of demand	Preplanning	B+F-Vorlage	Final building inspection	2 years of operation	Justification (attached)
	latest total cost calculation provided along with variants						
2.1	**Determining targets and requirements**						
a)	Target compliance provided in full						
b)	Conversion options considered						
c)	Architect competition equally assesses sustainability targets						
d)	VOF process assesses experience with sustainable building						
2.2	**Planning**						
a)	Start-up event with complete planning team took place						
b)	Flat fee agreed						
c)	Documentation provided quickly in IPASS						
d)	Specifications cover operating costs						
2.3	**Final building inspection**						
a)	Building operation folder complete with all registers						
b)	Operating staff and users confirm detailed instructions						
c)	up-to-date current documents provided in full						
2.4	**Operation**						
a)	User satisfaction independently confirmed						
b)	Indoor air quality within tolerance range						
c)	Operational costs within tolerance range						
	created by (project management) Name:						
	Date:						
	Signature:						
	seen by (department head) Name:						
	Date:						
	Signature:						

Legend: v =compliance, - = noncompliance, justification required, / = does not apply, only white fields must be filled in

Checklist Guidelines for economic building 2013

A1	Property	
A2	Street, house number	
A3	Component	
A4	Measure	
A5	Trade	Construction

3. Construction

No.	Criterion	Determination of demand	Preplanning	B+F-Vorlage	Final building inspection	2 years of operation	Justification (attached)
3.1	**Determining targets and requirements**						
a)	For new buildings, check whether renovation is possible						
b)	Conversion options checked						
c)	Destruction and new building checked for gutting						
d)	Implementation of economic measures checked (energy certificate)						
e)	Interior insulation checked for interior renovation						
f)	Ventilation concept created for window renovation						
3.2	**Preplanning**						
3.2.1	**Use quality**						
a)	Urban climate aspects considered (climate planning atlas)						
b)	Open spaces differentiated by weather						
c)	All common rooms naturally ventilated and lit						
d)	Share of glazed area optimized for orientation						
e)	Sufficient storage mass, shading, overnight ventilation						
f)	Sidewalk network easy to follow with natural lighting						
g)	Sufficient space to park bicycles properly						
h)	Changing rooms and showers for commuters by bike						
3.2.2	**Energy efficiency**						
a)	Passive House standard or at least EnEV 2009-30 percent						
b)	Compactness						
c)	Building orientation favors passive use of solar energy						
d)	Main entrances have unheated wind traps						
e)	Thermal zoning						
f)	Rooms with great internal heat input on northern façade or basement						
g)	Technology rooms centrally located for areas supplied						
h)	Option of solar power array checked						
i)	Preventive fire protection planned from outset						
3.3	**Design and execution planning, specifications**						
3.3.1	**Use quality**						
a)	Compliance with target echoing times in DIN 18041						
b)	Compliance with handicapped accessibility in DIN 18040-1						
c)	AMEV sanitary facilities 2011, compliance with chapter 2.4.3						
d)	Windows open 0.1 – 0.2 m² per person						
e)	Daylight ratio at least 5 % or 3%						
f)	Compliance with minimum degree of reflection (bright rooms)						
g)	Sufficient storage mass						
h)	External shading Fc<= 0.25 for 13 m/s						
i)	Motor control via weather station with user controls						
j)	Overnight ventilation vents 1 m² or 0.5 m² per classroom						
3.3.2	**Materials**						
a)	All materials, products, and elements declared						
b)	Products do not contain pollutants or emit odors (DIN 15251)						
c)	Only domestic timber with FSC certificate						
d)	No PVC for floors, wallpaper, windows, doors, etc.						
e)	Synthetic mineral fibers sealed off against interior						
f)	Chemical timber treatment not used						
g)	As little formaldehyde as possible, timber RAL UZ 38 or 76						
h)	Paint and adhesives contain little solvent RAL UZ 102, 12 a, 113						

Checklist Guidelines for economic building 2013

A1	Property	
A2	Street, house number	
A3	Component	
A4	Measure	
A5	Trade	Construction

3. Construction

No.	Criterion	Determination of demand	Preplanning	B+F-Vorlage	Final building inspection	2 years of operation	Justification (attached)
i)	Bitumen coatings and adhesives not GIS BBP 40-70						
j)	Epoxide resin not GIS RE 4-9						
k)	Polyurethane resin products not GIS 20-80 (except for class B and C)						
l)	DD coatings not GIS DD1 and DD2						
m)	Constructions can be disassembled (screws instead of adhesives/nails)						
n)	Solid construction not across insulation						
o)	Low-maintenance windows, for instance wood-aluminum						
p)	EIFS has long-term protection from damage in accordance with ETAG 004						
q)	Mineral or silicate plaster used to prevent algae from building up						
r)	Fire prevention EIFS: at least B1 and fire protection over lintels						
s)	EIFS has dowels to prevent storm damage						
3.3.3	**Energy efficiency**						
a)	For renovations, passive house components in table						
b)	Interior insulation is capillary-active if possible						
c)	Design with as few thermal bridges as possible						
d)	EnEV proof based on PHPP (Excel file provided)						
e)	Summer heat protection in DIN 4108 T2 demonstrated						
f)	External doors that close automatically ≤ 5 s without arrestors						
g)	Airtightness n50 <= 0.6 /h						
3.3.4	**Other**						
a)	Roof solar-ready						
b)	Flat roofs have slope of at least two percent with drainage to side						
c)	Doors and windows 20 cm above street in case of flooding						
d)	Heat and smoke vents protected from weather						
3.4	**Construction phase and final inspection**						
3.4.2	**Materials**						
a)	Insulation without installation foam						
b)	Waste separated and recycled						
c)	Pollutants must not come into contact with floor						
d)	Pollution measured if odors detected						
3.4.3	**Energy efficiency**						
a)	Results of airtightness test provided						
b)	Proof of EnEV compliance provided by authority						
3.4.4	**Other**						
a)	Projects above 100,000 euros have meter for site power and water						
b)	Construction machines with noise protection in RAL UZ 53						
c)	Construction machines have exhaust filter (UBA limit)						
	created by (architect) Name:						
	Date:						
	Signature:						
	seen by (project/department head) Name:						
	Date:						
	Signature:						

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Checklist Guidelines for economic building 2013

A1	Property	
A2	Street, house number	
A3	Component	
A4	Measure	
A5	Trade	**Heating equipment**

Nr.	Criterion	Determination of demand	Preplanning	B+F-Vorlage	Final building inspection	2 years of operation	Justification (attached)
	Heating equipment						
4.	**Technology, general**						
a)	Building technology and controls minimized						
b)	Constructions easy to disassemble						
c)	Maintenance contracts considered for entire service life						
d)	Spare parts deliverable for calculated equipment service life						
e)	Trade-specific penetrations sealed and insulated						
4.1	**Heating equipment**						
4.1.1	**Preplanning**						
a)	Heat supply from renewables or cogeneration						
b)	Solar heating of service water checked						
c)	Pool heated by solar thermal array						
d)	Alternatives to electric heaters in containers checked, timer!						
e)	Heat requirement via regression or DIN 12831 supplement 1						
f)	Heat generators within thermal building envelope						
4.1.2	**Design and execution planning, specifications**						
a)	Wood heaters within emission limits of Blauer Engel						
b)	If gas covers baseload, condensation boiler						
c)	Flow regulator valve per building and orientation						
d)	Separate heating circuits for special uses						
e)	Individual room controls checked for uninsulated old buildings						
f)	New radiators max. S0°C/40°C						
g)	Avoid radiators before glazed surfaces (renovation: radiation screen)						
h)	In passive houses, radiator in room above 17°C						
i)	Heat distribution lines and fixtures insulated based on table						
j)	Heat meter for cogeneration, solar array, heat pump, central hot water						
k)	Pumps with EEI ≤ 0.23 and possibly speed control						
l)	Reduced flow at night, on weekends, and holidays with switch-off						
m)	Optimized ramp-up and ramp-down point						
n)	Detection of open window for individual room thermostat						
o)	Heat storage is layered						
4.1.3	**Construction phase and final inspection**						
a)	Initiation protocol provided based on TR-K09 of PTB						
b)	Documentation of hydraulic balance provided						
c)	Thermostat valves limited and preset						
d)	Target heat temperatures in AMEV and preset						
e)	Heat operation only via heat limit temperature						
f)	All control functions enabled and usage times set						
	created by (engineer) — Name: / Date: / Signature:						
	seen by (project/department head) — Name: / Date: / Signature:						

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Checklist Guidelines for economic building 2013

A1	Property	
A2	Street, house number	
A3	Component	
A4	Measure	
A5	Trade	Ventilation system

Ventilation system

No.	Criterion	Determination of demand	Preplanning	B+F-Vorlage	Final building inspection	2 years of operation	Justification (attached)
4.	**Technology, general**						
a)	Building technology and controls minimized						
b)	Constructions easy to disassemble						
c)	Maintenance contracts considered for entire service life						
d)	Spare parts deliverable for calculated equipment service life						
e)	Trade-specific penetrations sealed and insulated						
4.2	**Ventilation system**						
4.2.1	**Preplanning**						
a)	Pollutants within limits (CO2 < 1,500 ppm)						
b)	Passive house components (heat exchanger efficiency > 75-80 %)						
c)	Air volume IDA 4 in DIN EN 13779 (20 m³/Ph)						
d)	No humidification (except for conservation requirements)						
e)	No air-conditioning via air; static surfaces used instead						
f)	Ventilation system only in operation during heating season (display)						
g)	Fire protection concept to minimize fire dampers						
4.2.2	**Design and execution planning, specifications**						
a)	Revision openings available for complete inspection/cleaning						
b)	Ventilation efficiency in operation SFP 1 or 2 in DIN 13779						
c)	Specific power consumption < 0.45 Wh/m³						
d)	No moisture recovery						
e)	Air filters of energy efficiency class A in accordance with Eurovent						
f)	Control better than IDA-C3 DIN 13779 (timer, control keys)						
g)	Speed control for varying demand requirements						
h)	Control in sanitation areas via hygrostats and motion detectors						
i)	Thermal separation/ thermal bridge factor < T3/TB3 or T2/TB2						
j)	Insulation of air ducts without halogen as in guidelines						
k)	Power meter for ventilation system larger than 10 kW						
4.2.3	**Construction phase and final inspection**						
a)	Final inspection only after measurement of heat recovery, air volume, power consumption						
b)	All control functions enabled and usage times set						
c)	Ventilation starts some 30 min before use						
d)	Expert audit available, main defects remedied						
4.2.4	**Operation**						
a)	Ventilation system switched off outside of heating season						
	created by (engineer) Name:						
	Date:						
	Signature:						
	seen by (project/department head) Name:						
	Date:						
	Signature:						

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Checklist Guidelines for economic building 2013

A1	Property	
A2	Street, house number	
A3	Component	
A4	Measure	
A5	Trade	Air-conditioning

Air-conditioning

No.	Criterion	Determination of demand	Preplanning	B+F-Vorlage	Final building inspection	2 years of operation	Justification (attached)
4.	**Technology, general**						
a)	Building technology and controls minimized						
b)	Constructions easy to disassemble						
c)	Maintenance contracts considered for entire service life						
d)	Spare parts deliverable for calculated equipment service life						
e)	Trade-specific penetrations sealed and insulated						
4.3	**Air-conditioning**						
4.3.1	**Preplanning**						
a)	Avoid active cooling systems						
b)	If air-conditioning required, overnight and adiabatic cooling						
c)	With active air-conditioning, renewable energy						
d)	Mobile air-conditioners only for conservationist purposes in existing buildings						
4.3.2	**Design and execution planning, specifications**						
a)	No (partially) halogenated refrigerants						
b)	No synthetic foam containing halogens						
c)	Comfort cooling: Indoor target temperature 3K below outdoor temperature						
d)	Conservation requirement: seasonally adjusted ΔF < 1%/d						
e)	Cooling only possible if shading enabled						
4.3.3	**Construction phase and final inspection**						
a)	Cooling unit only runs above 26°C, roomT = outdoorT - 3 °C						
	created by (engineer) Name:						
	Date:						
	Signature:						
	seen by (project/department head) Name:						
	Date:						
	Signature:						

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Checklist Guidelines for economic building 2013

A1	Property	
A2	Street, house number	
A3	Component	
A4	Measure	
A5	Trade	Sanitation technology

Sanitation technology

No.	Criterion	Determination of demand	Preplanning	B+F-Vorlage	Final building inspection	2 years of operation	Justification (attached)
4.	**Technology, general**						
a)	Building technology and controls minimized						
b)	Constructions easy to disassemble						
c)	Maintenance contracts considered for entire service life						
d)	Spare parts deliverable for calculated equipment service life						
e)	Trade-specific penetrations sealed and insulated						
4.4	**Sanitation technology**						
4.4.1	**Preplanning**						
a)	Rainwater use checked if service water demand high						
b)	Option of service water use checked						
c)	Sinks and cleaning rooms only have cold water						
4.4.2	**Design and execution planning, specifications**						
a)	Supply and waste lines not PVC						
b)	Drinking water lines stainless steel or PE						
c)	Automatic rinsing not required						
d)	Gutters and downspouts easily accessible						
e)	Sanitation equipment hung onto walls						
f)	Toilet seats have fully stainless steel hinges						
g)	Toilet tanks have labeled stop key						
h)	Toilet tank max. 4.5 l						
i)	Sinks with flow limiters max. 5 l/min						
j)	Caps have strong force at max. 7/min						
k)	Automatically closing taps for sinks max. 5 sec Shower max. 40 sec						
l)	Dry individual urinals if used more than 10 times a day						
m)	Showers only via distributed freshwater stations/instantaneous heaters						
n)	Heating water storage only for demonstrated demand						
o)	Heating of cold water lines avoided						
p)	Pumps of energy efficiency EEI ≤ 0.23 with timers						
q)	Check separate heat generation for hot water supply						
r)	For central hot-water supply, submeters						
s)	Showers used only occasionally have instantaneous heaters						
t)	Small instantaneous heaters, not undercounter storage						
4.4.3	**Construction phase and final inspection**						
a)	Documentation of pressure test (creepage)						
	created by (engineer) Name:						
	Date:						
	Signature:						
	seen by (project/department head) Name:						
	Date:						
	Signature:						

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Checklist Guidelines for economic building 2013

A1	Property	
A2	Street, house number	
A3	Component	
A4	Measure	
A5	Trade	Electro-technics

Electro-technics

No.	Criterion	Determination of demand	Preplanning	B+F-Vorlage	Final building inspection	2 years of operation	Justification (attached)
4.	**Technology, general**						
a)	Building technology and controls minimized						
b)	Constructions easy to disassemble						
c)	Maintenance contracts considered for entire service life						
d)	Spare parts deliverable for calculated equipment service life						
e)	Trade-specific penetrations sealed and insulated						
4.5	**Electro-technics**						
4.5.1	**Preplanning**						
a)	Power from renewables or cogeneration						
b)	Reduce peak load before increasing transformer size						
c)	Install new lighting in large renovation projects						
d)	Max. 10 % illuminance deviation from DIN EN 12464						
e)	Avoid electric heat						
4.5.2	**Design and execution planning, specifications**						
a)	Power lines and installation materials without halogen						
b)	No heavy metals used (CdTe in PV panels, for instance)						
c)	Power consumption of lights max. 2.5 W/m²100lux						
d)	Luminous efficacy 50 lm/W						
e)	EVG						
f)	Operational efficiency of lighting min. 80 %						
g)	Emergency lighting with LEDs						
h)	Users always switch on lighting Lights poss. switched off automatically						
i)	Central switch off 5 min after recess in classrooms						
j)	Can be switched on manually anytime						
k)	Large rooms have rows of individually switchable lights with labeled switches						
l)	Hallways, staircases, storage, and basements with timers or motion detectors						
m)	Areas with daylighting have separate switches						
n)	Toilets and changing rooms have motion detectors at doors with noise sensors						
o)	Extra lighting for games in school gymnasiums only via key switch						
p)	Lighting groups above 1 kW have motion detectors with light sensors						
q)	Exterior lighting has daylighting switch and timer						
r)	Labeled buttons and keys (no bus components)						
s)	Limit on peak load checked/prepared for kitchens						
t)	Reactive power limited/compensated for						
u)	If backup power needed, efficiency class 3 in EN 62040-3						
v)	Office equipment only EnergyStar appliances at least A+						
w)	Monitors in escape routes have smoke-proof casings						
4.5.3	**Construction phase and final inspection**						
a)	Final inspection only after measurement of illuminance and power consumption						
b)	Expert audit available, main defects remedied						

created by (engineer)	Name:	
	Date:	
	Signature:	
seen by (project/department head)	Name:	
	Date:	
	Signature:	

Legend: v =compliance, - = noncompliance, justification required, / = does not apply, only white fields must be filled in

Checklist Guidelines for economic building 2013

A1	Property	
A2	Street, house number	
A3	Component	
A4	Measure	
A5	Trade	Kitchen technology

Kitchen technology

No.	Criterion	Determination of demand	Preplanning	B+F-Vorlage	Final building inspection	2 years of operation	Justification (attached)
4.	**Technology, general**						
a)	Building technology and controls minimized						
b)	Constructions easy to disassemble						
c)	Maintenance contracts considered for entire service life						
d)	Spare parts deliverable for calculated equipment service life						
e)	Trade-specific penetrations sealed and insulated						
4.6	**Kitchen technology**						
a)	Neighborhood concept with central kitchen provided						
b)	Primary energy factor max. 2 kWh/wM or compensated for						
c)	Cooling & freezing zones thermally separate						
d)	Kitchen appliances fired with gas						
e)	Separate exhaust hood independent of ventilation system						
f)	Kitchen appliances have condensation hood or internal heat recovery						
g)	Consumption values available based on DIN 18873						
h)	Planning recommendations from "energy efficiency in kitchens" heeded						
	created by (engineer) Name:						
	Date:						
	Signature:						
	seen by (project/department head) Name:						
	Date:						
	Signature:						

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Checklist Guidelines for economic building 2013

A1	Property	
A2	Street, house number	
A3	Component	
A4	Measure	
A5	Trade	**Mechanical systems**

Mechanical systems

No.	Criterion		Determination of demand	Preplanning	B+F-Vorlage	Final building inspection	2 years of operation	Justification (attached)
4.	**Technology, general**							
a)	Building technology and controls minimized							
b)	Constructions easy to disassemble							
c)	Maintenance contracts considered for entire service life							
d)	Spare parts deliverable for calculated equipment service life							
e)	Trade-specific penetrations sealed and insulated							
4.7	**Mechanical systems**							
a)	DIN EN 60034-30 for energy-efficient motors above 1,000 h/a eff2							
b)	Elevators of energy-efficiency class A in VDI 4707							
c)	If engines used for backup power, check cogen options							
d)	Aeration and deaeration ducts never constantly open							
b)	Expert audit available, main defects remedied							
	created by (engineer)	Name:						
		Date:						
		Signature:						
	seen by (project/department head)	Name:						
		Date:						
		Signature:						

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Checklist Guidelines for economic building 2013

A1	Property	
A2	Street, house number	
A3	Component	
A4	Measure	
A5	Trade	Building automation and communication technology

Building automation and communication technology

No.	Criterion	Determination of demand	Preplanning	B+F-Vorlage	Final building inspection	2 years of operation	Justification (attached)
4.	**Technology, general**						
a)	Building technology and controls minimized						
b)	Constructions easy to disassemble						
c)	Maintenance contracts considered for entire service life						
d)	Spare parts deliverable for calculated equipment service life						
e)	Trade-specific penetrations sealed and insulated						
4.8	**Building automation**						
4.8.1	**Preplanning**						
a)	All trades can be connected to central process visualization						
b)	Integration planning with minimal number of data items						
c)	Functional diagram, list, and automation diagrams provided						
4.8.2	**Design and execution planning, specifications**						
a)	All data items labeled according to AKS						
b)	Consumption meter concept coordinated with energy management						
c)	One pulse counter per building, user, and medium						
d)	Submeters for all consumption points exceeding 2,500 €/a and hot water						
e)	Meters connected centrally for annual costs exceeding 15,000 €						
f)	Room sensors with tolerance of max 3% for 10 years						
g)	Independent function even if building services fail and power outage						
h)	DDC substations have manufacturer-independent interface						
i)	Meters connected to IAS/InTouch for annual costs exceeding 30,000 €						
j)	Standard layout for graphical user interface						
k)	PVS installed in facility management room						
l)	Major alarms sent as text message to cell phone						
4.8.3	**Construction phase and final inspection**						
a)	Initiation documentation provided for heat/cooling meters						
a)	1:1 data point test, functional test, grid outage test provided						
b)	All sensors and actors labeled locally and in DDC/building services						
4.9	**Communication technology**						
a)	Compliance with "Grundsätzliches zur Verkabelungstechnik"						
b)	Common cable topology for IT and telephone						
c)	Per room, 2 phone and 2 IT connections + 1 phone + 1 IT per extra user						
d)	PVS connected to HBA via logically separated network						
e)	Measurement & control systems crisis-proof via separate cable networks						
f)	Equipment with great waste heat outside common rooms						
g)	IT and office equipment with Energy Star and central switch off						

created by (engineer)	Name:						
	Date:						
	Signature:						
seen by (project/department head)	Name:						
	Date:						
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