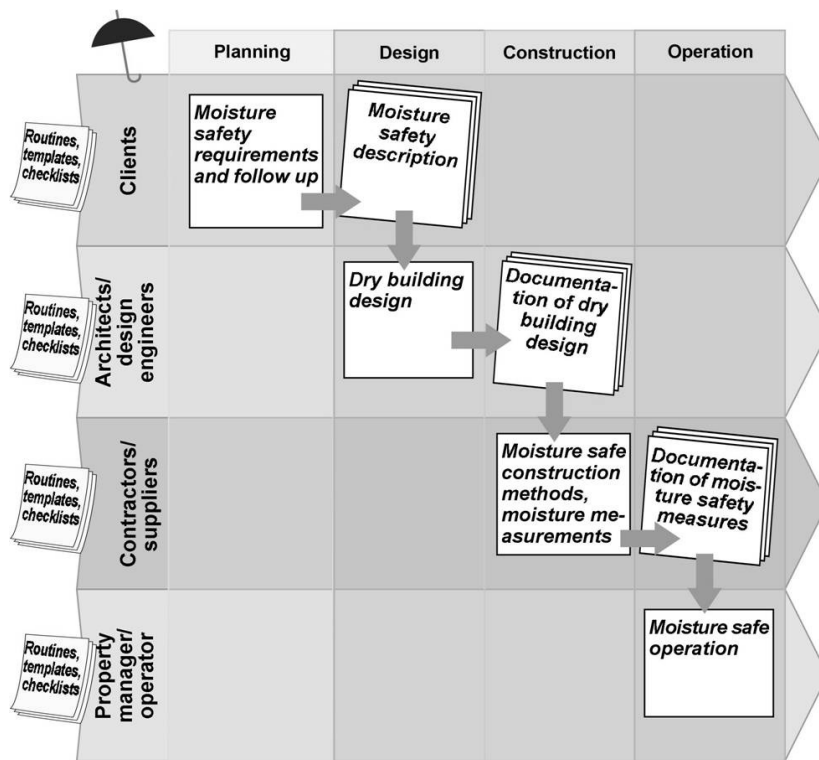


Industry standard ByggaF

– method for moisture safety of the construction process



ByggaF – method for moisture safety of the construction process.

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1 Industry standard ByggaF – method for moisture safety of the construction process

Industry standard ByggaF is a method that guarantees, documents and communicates moisture safety throughout the construction process, from planning to management. The method includes procedures and aids for all participants from developers, architects and other consultants, material suppliers, contractors to operations staff and managers.

1.1 Background

Moisture damage that affects our buildings is a major problem. Despite today's modern construction methods, the trend is not declining in terms of this type of damage. Moisture damage often causes a deterioration of the indoor environment, which in turn can have an adverse effect on human health. For home-owners, moisture problems often cause major unexpected expenses. The reason for moisture damage arising in buildings is due to a number of different factors. This could be an ambiguous allocation of responsibilities, unclear requirements, lack of monitoring, unrealistic schedules, unclear communication between the stages, a lack of skills and inadequate procedures for moisture safety, but it could just as well be due to many different and often new types of structures, materials and components that are used where the materials are liable to degrade in the presence of moisture, with emissions, microbial growth and stability problems as a result. It is therefore extremely important to design moisture-proof structures composed of materials that can withstand the moisture load that the structure is expected to be exposed to during its service life, and to ensure a suitable environment for the building both during the construction stage and the operational stage. Requirements for moisture safety may often conflict with other requirements such as accessibility, architectural and design requirements as well as energy requirements. These conflicts need to be addressed and resolved throughout the entire construction process.

1.2 Purpose

The purpose of ByggaF is to highlight moisture issues at an early stage in new construction, renovation and refurbishment projects and to document the activities and actions that are required and performed in a structured way to ensure a moisture-proof building. By formulating and setting moisture requirements and requirements for the activities, these can be incorporated into the programme documents, system documents, construction documents and control plans, etc. This means that the important systems and material selection and production methods that will impact the moisture safety of the building can be made from the beginning.

1.3 Statement of intent

The purpose of the industry standard is to describe a standard way of working with moisture safety in the construction process based on the already developed methodology ByggaF. The development of the industry standard is has been financed by SBUF (the Swedish construction industry's organization for research and development), participating companies and organizations.

A number of people from various companies, institutes, universities, industry associations, consultants and government agencies have been involved in developing the industry standard. These companies are: PEAB AB, NCC AB, Skanska AB, JM AB, SydArk Konstruera AB, Akademiska Hus AB, Polygon Sverige AB, FuktCom AB, SP (Technical Research Institute of Sweden), IVL, Lund University, Chalmers

University, The Swedish Construction Federation, FoU-väst, Säker Vatten AB, The Swedish National Board of Housing, Building and Planning (The Swedish National Board of Housing, Building and Planning) and Byggherrarna (The Building owners organization).

2 Terms and definitions

For the purposes of this document, the terms and definitions are specified in the applicable Swedish Building Regulations, BBR in addition to the following. The document also has remarks (NB) to certain terms and definitions.

2.1 Moisture safety

The probability of the moisture condition deviating from the range between the minimum and the maximum permitted moisture condition that is deemed as acceptable.

2.2 Critical moisture condition

Moisture condition whereby the properties of a material and its intended function are not met. For microbial effects the moisture condition is critical when growth occurs. The factors of importance for biological growth, such as temperature, duration and their interaction can be included in the determination of the critical moisture condition.

NB: The critical moisture condition could be a range that includes a variation in the limit condition and uncertainty in the determination of this.

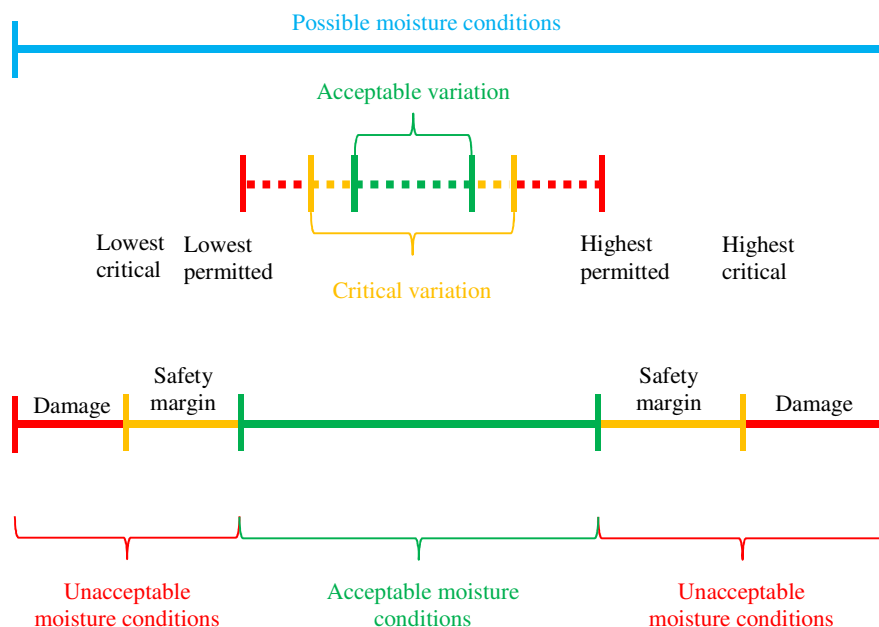


Figure 1 Illustration of the concepts regarding permissible and acceptable moisture conditions.

2.3 Safety margin

Uncertainty in the calculation model, input parameters (e.g. material data) or measurement methods.

2.4 Highest permitted moisture conditions

Highest critical moisture condition, less a safety margin.

According to the Swedish building regulations BBR: In determining the maximum permitted moisture condition, the critical moisture condition is used taking into account the uncertainty in the calculation model, the input parameters (e.g. material data) or measurement methods.

Materials and material surfaces where mould and bacteria can grow must be properly studied, and documented critical moisture conditions must be used. When determining a material's critical moisture condition, the possible contamination of the material must be taken into account. If the critical moisture condition of a material is not properly researched and documented, a relative humidity (RH) of 75 % is used as a critical moisture condition.

2.5 Lowest permitted moisture condition

Lowest critical moisture conditions increased by a safety margin.

NB: A material may have unacceptable shrinkage due to the lowest critical moisture condition not being met.

2.6 Permitted moisture condition

The moisture condition between the lowest permitted and the highest permitted moisture condition. Sometimes the permitted moisture condition are further limited by a maximum moisture range between the highest and lowest permitted moisture condition.

2.7 Moisture sensitive structures

Structures or building elements with a high probability that the permitted moisture condition is not met and the consequence of damage is significant.

2.8 Moisture source

Water in different stages.

NB: The moisture source could be rain, snow, ice, melt water, condensate, air humidity, water vapour in the air, building moisture, excess moisture in the material resulting from its manufacture or construction, water in and on the ground or leakage from installations.

2.9 Moisture load

The volume of water in different stages that burden a surface or a building element.

Individual moisture loads may, for example, be leakage from hydronic installations, water used for drilling in concrete, floods due to stoppages in the sewage system etc.

2.10 Participants

2.10.1 Moisture expert

A person who has special expertise and experience in moisture safety and represents the developer.

NB: A certified expert according to the FuktCentrums (Moisture Centre) method for Moisture safety in the Construction Process

FuktCentrum has developed and manages a training program for moisture experts. A certified moisture expert is an initiative supported by FuktCentrum at LTH (Lund University), SP - Technical Research Institute of Sweden, Föreningen Sveriges Byggnadsinspektörer (The Swedish Association of Building Surveyors) and Byggherrarna (The Building Owners Association) and Fastighetsägarna (Construction Clients and Property Owners).

2.10.2 Expert in moisture

See moisture expert.

2.10.3 Planners and designers

Participants who select, design, draw and construct materials, building elements or installations that affect the moisture safety of the building.

2.10.4 Contractors

Participants who produce, assemble materials, building elements or installations that affect the moisture safety of the building.

2.10.5 Suppliers

Participants who manufacture and supply materials, building elements or installations that affect the moisture safety of the building.

2.10.6 Moisture safety officer for planning

Person at the relevant planners who is responsible for implementing and documenting moisture safety planning.

NB: Planners refer to architect, designer, HVAC planner and others.

2.10.7 Coordinating moisture safety officer for planning

Person who can be designated to coordinate the moisture safety planning in large scale projects.

2.10.8 Moisture safety officer for production

Person responsible for moisture safety at each supplier or contractor.

2.10.9 Coordinating moisture safety officer for production

Person who can be designated to coordinate the moisture safety work in the production stage.

NB: May be the moisture safety officer at the contractor.

2.11 Documents

2.11.1 Moisture safety program

Governing documents, or part of some other governing documents, prepared by the developer describing the developer's requirements for moisture safety.

NB: The moisture safety program is prepared before the planning.

NB: The developer's requirements can be both technical requirements and requirements for how work with moisture safety is to be conducted and documented in the planning, production and management stages.

NB: All or parts of the moisture safety program may be included in other governing documents such as environmental program, operational program, technical specifications, etc.

2.11.2 Moisture safety specification

Describes the project's preconditions from a moisture perspective as well as object-specific requirements on how moisture safety in the detailed planning, production and management stages is ensured.

NB: In a construction contract, the document is to be prepared by the developer's moisture expert. In a design and construct contract, the document is to be prepared by the design and construct contractor as a description of how they will work with moisture safety.

NB: The moisture safety program is prepared before the detailed planning.

2.11.3 Results from moisture safety planning

Description of the structural design in documents, results of calculations, documentation of verifications and inspections.

2.11.4 Moisture safety plan

Governing documents, prepared by the moisture safety officer for production which describe the activities and checks to be performed in the design stage in order to meet the requirements in the moisture safety program and moisture safety specification.

NB: The moisture safety plan can be included in other inspection plans.

NB: The moisture safety plan can also be called moisture plan.

2.11.5 Moisture safety documentation

Records covering the project's overall moisture safety work.

NB: The moisture safety documentation may be included in other documentation.

2.12 Activities

2.12.1 Moisture safety planning

Systematic measures in the planning stage as well as the conditions that apply to the production and management stages which aim to ensure that the permitted moisture condition is met during the service life of the building.

NB: Systematic measures could be a risk analyses, assessments, calculation and testing that are documented.

NB: Some building elements have a shorter life span than the building.

NB: Moisture safety planning is to be conducted by planners.

2.12.2 Moisture risk inventory

Inventory of moisture risks in structures.

NB: Can be based on experience of similar design solutions.

2.12.3 Moisture review

Review of documents with respect to moisture safety.

NB: A moisture review should include an analysis of the probability that the maximum permitted moisture condition is exceeded, and the consequences of this.

NB: To be carried out by the moisture safety planner (proprietary inspection).

NB: Can be performed by a moisture expert or by a third party (external inspection) using the documents (descriptions, drawings, etc.) provided.

2.12.4 Moisture inspection round

Inspection at the construction site in order to check that the work is being performed in accordance with the moisture safety plan.

NB: Moisture inspection rounds can be performed in conjunction with other inspection rounds during the design stage, e.g. environmental inspection round.

2.12.5 Moisture safety measures, production

Activities that ensure that materials and structures are not exposed to moisture conditions that deviate from the permitted moisture condition.

NB: Examples of moisture safety measures during the construction stage could be moisture-proof material handling, weather protection and covers, drying climate, building heating, dehumidification, moisture inspection rounds, moisture measurement, water vacuuming, etc.

2.12.6 Moisture inspection

Inspection, measurement or analysis with respect to moisture.

NB: Examples of moisture inspections can be:

- *Acceptance inspection: Inspection, measurement or analysis related to the moisture of a building product or material upon arrival at the construction site.*
- *Moisture measurement: Using the selected method, determine the quantity of a material that is directly or indirectly related to the material's moisture condition.*

3 Description of the method

3.1 Overall description

Industry standard ByggaF includes a method that guarantees, documents and communicates moisture safety throughout the construction process, from planning to management. The method involves a way of working designed to meet the demands of society and the developer's requirements for moisture safety.

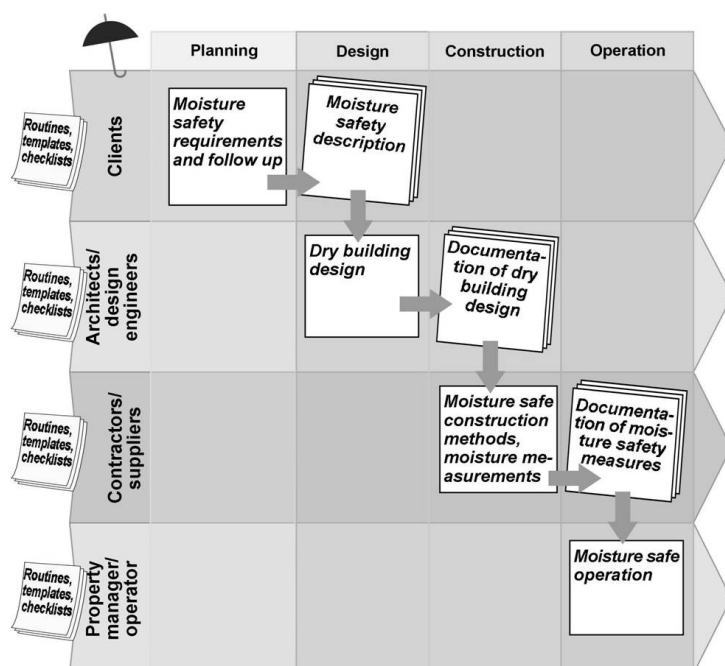


Figure 2 Overall picture of the ByggaF method.

Under each heading in the standard there is text that contains “must-have requirements” that must be met. In addition, there is a guidance text that can clarify, explain or give examples of what the “must-have requirement” means. The guidance may also contain advice.

3.2 Legislation, building regulations, industry regulations and assembly instructions

The Planning and Building Act (PBL) provides for the planning of land and water, and for construction. The provisions are designed to promote the development of society with equal and good living conditions and a sound and sustainable living environment. PBL regulates the implementation of the plan and the building permit process and the essential performance requirements are specified. One requirement is protection with regard to hygiene, health and the environment.

The Planning and Building Decree (PBF) contains more detailed provisions than those in PBL. For the performance requirement for a construction entity for protection, PBF states that a construction entity with regard to hygiene, health and the environment is to be planned and built in such a way that moisture in

parts of the construction entity or on its surface does not present an unacceptable risk to hygiene or health. (PBF Chap 3 Section 9).

The building regulations of Boverket, the Swedish Board of Building, Planning and Housing (BFS), contain regulations and general recommendations for the technical performance requirements in PBF. The regulations specify the minimum requirements for buildings from society, and they are mainly formulated as functional requirements. In connection to the regulations, there are general recommendations. These are set at levels for the regulation to be met. By complying with the general recommendations, you can satisfy the regulations. If you choose not to comply with a general recommendation, the alternative performance must be at least as good as the performance in the general recommendation. The Swedish building regulations, BBR includes a code of statutes and reading instructions.

The minimum requirements of society for moisture safety of a building are included in The Swedish National Board of Housing, Building and Planning's building regulations, section 6:5 for new construction and 6:95 for building alterations.

Industry regulations, such as safe water installation, are design regulations that meet the requirements in The Swedish Building Regulations BBR and represent the industry's experience of good performance. Performance according to industry regulations is considered as professional performance. Insurance companies require that performance is in accordance with industry regulations in order for the insurance to be fully effective. Today, there are industry regulations for HVAC installations, safe water installation and for waterproofing BBV, GVK and MVK.

From July 1, 2013, construction products that are covered by a harmonized standard are to be CE marked and have a declaration of performance. Building product manufacturers must indicate the characteristics of their products and how they are used and assembled in order to fulfil the function that the supplier has indicated that the product has. A CE mark is a reliable indication of certain performance allowing different brands to be compared. Using the data, you can determine whether the product is suitable for its intended use. It contains no approval, and is not a measure of product quality.

3.3 The developer is responsible

The developer is the one that performs or fails to perform the planning, construction, alteration, renovation, demolition or excavation work. The developer must ensure that this is carried out in accordance with the requirements applicable to the measures in the Planning and Building Act (PBL), or regulations or decisions communicated with support of the Act. If the measures are subject to permits or notification, the developer must ensure that they are checked according to the inspection plan that the local building committee determines in the start-up statement. (Chap 10, Section 5). Regulations are given in The Swedish National Board of Housing, Building and Planning's building regulations that set society's minimum requirements for the building.

In order for the building to be planned and designed correctly, the developer should engage the appropriate skills for the different work tasks. In many cases, the developer hires a project manager as an extended arm in the construction process. However, the developer is still responsible for compliance with the laws and regulations.

The developer does not always possess enough knowledge or time to pursue and monitor the moisture safety work in the project. It can be very helpful for the developer to hire a person who is an expert in moisture safety, a *moisture expert*. The moisture expert can help the developer to set requirements for moisture safety and to monitor compliance of the requirements.

3.4 Organisation for moisture safety work

However, the practical moisture safety work is performed by all participants, planners, contractors and suppliers.

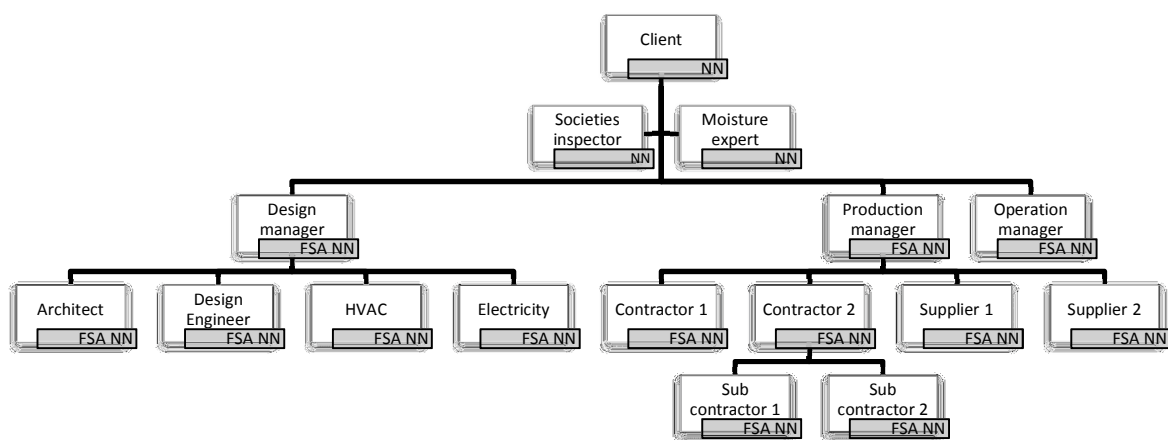


Figure 3 Example of the organisation of the responsibility for the moisture safety work. Each participant designates a moisture safety officer (MSO) whose name (NN) is listed in the organisational chart.

The allocation of responsibility for different activities at different stages may vary with different forms of construction contract. Depending on the contract form, the responsibility boundaries are moved between systems planning, detailed planning and production. In the forms of contracts where the contractor also has the role of the planner, the contractor must also take responsibility for what in this document are called planners' activities and responsibilities. In design and construct contracts, the responsibility for continually monitoring the moisture safety work lies with a coordinating moisture safety officer for production. The developer usually establishes the moisture safety specification, but for a design and construct contract the developer may want to transfer all responsibility to the contractor. In these cases, the design and construct contractor can formulate the moisture safety specification on behalf of the developer. The information in the moisture safety specification can also be found in other documents.

4 Moisture safety in the programme stage

4.1 Appoint a moisture expert

The developer is to appoint a moisture expert.

Guidance: A moisture expert can be a person who is qualified or is a certified moisture expert or have equivalent skills and experience. Exceptions can be made if the projects are smaller and less complex.

4.2 Early moisture risk analysis

The developer is to be responsible for implementing an early moisture risk analysis.

Guidance: The moisture expert together with planners identify and analyse the critical conditions from a moisture aspect. By way of suggestion, use check-lists to conduct a moisture risk identification in the early stages.

4.3 Decide on the developer's moisture safety requirements

The developer must decide the moisture safety requirements to be set in the project. It must be possible to verify and monitor the moisture safety requirements. The requirements must include both technical requirements and requirements for activities and skills.

The moisture safety requirements must be documented in a moisture safety programme, in the moisture safety specification or in other documents.

Guidance: Examples of technical requirements can be highest permitted moisture condition for various materials during assembly and installation, requirements that measurements must be performed using a certain measurement method and at a certain frequency, requirements that materials and structures are to be protected from moistening, etc. Requirements for a specific structural design may occur in some cases. Requirement to material layers and solutions are verified and evaluated with splices and connections at inlets and the construction details.

The developer should also set requirements for the skills of the staff involved in the project. A requirement may be, for example, that the project's moisture safety officer has certain expertise in moisture and that all project participants have undergone moisture training.

The developer should also set requirements that certain activities are carried out. For example, this could be by demanding that the various participants attend the information meeting on moisture safety, regular moisture meetings, that moisture inspection rounds are carried out and that certain procedures are followed for documenting moisture safety. It is important that the requirements are formulated to ensure they can be monitored and that it is clear who is responsible for ensuring the requirement is met and the consequences and the measures to be taken if the requirement is not met.

The client may demand that the constructions, layers and solutions should ideally be tested and evaluated. If designers develop solutions and perform calculations, material suppliers label certified material properties and contractors ensure proper performance based design documents, it is still not clear that the end result will be good as long as no construction or solution has been evaluated in the correct conditions and has been tested and evaluated as a system. Product System or building systems should be installed by trained installers to achieve the expected result.

4.4 Decide on measures in cases of non-conformance

The developer must describe how non-conformance is to be handled and what measures should be taken if non-conformance occurs. The measures must meet the requirements of the developer and society.

Guidance: Non-conformance in relation to moisture safety requirements should be handled according to the same procedures as other non-conformance and be documented in non-conformance reports. The non-conformance report must contain proposals for measures and how they should be monitored.

4.5 Decide on procedures for monitoring

The developer must describe the methods to be used in the project to monitor compliance with these requirements.

Guidance: The developer specifies, for example, the meetings that participants must attend, and when and how to review what has been performed and in what form the results are to be documented. Examples of activities include:

- Developer requirements for moisture safety are presented in a start-up meeting for planners.
- Moisture is an item on the agenda at planning meetings.
- Planners document moisture safety planning and submit this to the developer.
- The developer's requirements for moisture safety are presented at a start-up meeting for contractors and suppliers. The planners present the results of the moisture safety planning at this meeting.
- Moisture is an item on the agenda at construction meetings.
- The moisture safety officer for production conducts and documents moisture inspection rounds at the construction site.
- The moisture expert conducts his own moisture inspection rounds or with the moisture safety officer for production.
- The contractor collects data from the work and from subcontractors and suppliers, and submits it to the developer or to the moisture expert.
- The moisture expert compiles the moisture safety documentation
- The moisture expert and contractor presents the moisture safety documentation for the management organisation.

4.6 Formulate moisture requirements and requirements for activities in the contract documents

The developer's requirements for moisture safety are invoked in the contract documents relating to moisture safety.

The moisture safety programme, or similar, must contain compliance requirements in relation to ByggaF.

Guidance: The developer's requirements for moisture safety can be formulated in a moisture safety programme or be contained in other documents. The moisture safety programme can contain:

- The developer's requirements for moisture safety, although these must not be less than society's requirements for moisture safety with reference to regulatory frameworks.
- The project's preconditions from a moisture aspect, for example how the building will be used.
- Requirements for procedures for how moisture safety must be implemented and documented in the project.
- Requirements for procedures for how moisture safety must be implemented and documented in the management stage
- Requirements for procedures for monitoring and verifying the moisture safety work throughout the entire process.

5 Moisture safety in the planning stage

5.1 System handling

5.1.1 Information to planners about the developer's moisture safety requirements and methods for monitoring

The moisture expert must notify the planners about the moisture safety requirements and the methods that will be used to monitor compliance of the requirements.

Guidance: In conjunction with the information about the developer's requirements, it is appropriate to explain why the requirements have been set and what the consequences will be if the requirements are not met. It may also be appropriate to combine the information with a general training programme in moisture safety for participants to have a shared

knowledge base. It is also appropriate at this time that the developer explains in general about the project and the project's goals and requirements, and how it will be implemented in order for participants to see the big picture of the project. The aim is to create a common set of objectives and encourage all participants to work towards the common goal.

5.1.2 Appoint moisture safety officer for planning

Each participant who selects, designs, draws and constructs materials, building elements or installations that affect the moisture safety of the building must designate a person as responsible for performing a moisture risk analysis and inspection ensuring the systems selections meet moisture safety requirements and that this is documented and reported to the moisture expert and developer.

5.1.3 Present a procedure for moisture safety planning

Each participant who selects, designs, draws and constructs materials, building elements or installations that affect the moisture safety of the building must present a procedure for how they plan to carry out a moisture risk analysis and inspection showing that the system selections meet moisture safety requirements and how this is to be documented.

5.1.4 Moisture safety planning

Each participant who selects, designs, draws and constructs materials, building elements or installations that affect the moisture safety of the building must comply with the procedure for moisture safety planning. See procedure for moisture safety planning in section 3.3.3 below.

5.1.5 Moisture risk analysis

The planning group must jointly conduct and document a moisture risk analysis. The planning manager is responsible for the coordination of the moisture risk analysis. A new moisture risk analysis should be performed if conditions change.

Guidance: By way of suggestion, use check-lists to conduct a moisture risk identification and moisture risk analysis in the early stages. Changed conditions also include a change of use of premises or change control of the installations or climate.

5.1.6 Inspection and documentation of system selections for moisture safety

Each participant who selects, designs, draws and constructs materials, building elements or installations that affect the moisture safety of the building must conduct an inspection ensuring the systems and materials meet the moisture safety requirements. Systems and materials selections and justification for selecting these must be documented.

Guidance: Reading instructions for BBR 2012, Chap 6.5.

5.1.7 Decision on specific moisture safety requirements in the production stage

The developer must take decisions on requirements arising from systems and materials selection and must be formulated in the tender documents.

Guidance: The requirements could be, for example, a matter of how moisture sensitive materials and systems are to be protected from moisture during the production stage and the type of weather protection that is to be used.

5.2 Moisture safety specification

A moisture safety specification can be prepared after the system document stage to complement the moisture safety programme.

Guidance: After the system document stage, a moisture safety specification can be prepared that summarises the requirements for detailed planning and production. The template for moisture safety specification can be used to prepare a moisture safety specification. The moisture safety specification can contain:

- *The developer's requirements for moisture safety, although these must not be less than society's requirements for moisture safety (with reference to the regulatory framework)*
- *The project's preconditions from a moisture aspect*
- *Procedures for how moisture safety in the planning stage is to be implemented and documented*
- *Procedures for how moisture safety in the production stage is to be implemented and documented*
- *Procedure for the submission of documentation to the developer at the end of the project.*
- *Procedures for how moisture safety in the management stage is to be implemented and documented*
- *Procedures for monitoring and verifying the moisture safety work throughout the entire process*

The information may also be included in another document.

5.3 Detailed planning

5.3.1 Information to planners about the developer's moisture safety requirements and methods for monitoring

The moisture expert must notify the planners about the moisture safety requirements and the methods that will be used to monitor compliance of the requirements.

Guidance: In conjunction with information being given about the developer's requirements, it is appropriate to explain why the requirements have been set and what the consequences will be if the requirements are not met. It may also be appropriate to combine the information with a general training programme in moisture safety for participants to have a shared knowledge base. It is also appropriate at this time that the developer explains in general about the project and the project's goals and requirements, and how it will be implemented in order for participants to see the big picture of the project. The aim is to create a common set of objectives and encourage all participants to work towards the common goal.

5.3.2 Appoint moisture safety officer for planner

Each participant who selects, designs, draws and constructs materials, building elements or installations that affect the moisture safety of the building must designate a person as responsible for ensuring that moisture analysis planning is performed, documented and reported to the moisture expert and developer.

5.3.3 Procedure for moisture safety planning

Each participant who selects, designs, draws and constructs materials, building elements or installations that affect the moisture safety of the building must comply with the procedures for moisture safety planning below.

5.3.3.1 Moisture sensitive structures

Moisture sensitive structures and work operations must be identified.

Guidance: Similarly to static dimensioning, dimensioning for moisture is carried out whereby structures are checked to ensure they can handle the different moisture loads to which they may be exposed.

5.3.3.2 Identify sources of moisture and moisture loads

Each building element is to be subject to all possible sources of moisture.

Guidance: Moisture sources could be rain (vertically and horizontally), snow, melt water from ice and snow, air humidity, water vapour from people, plants, cooking, laundry and showers and construction moisture in the material when it is assembled, etc. Moisture sources could also be moisture during the construction period in connection with transport, storage or after installation that burdens the building or building materials in the form of precipitation or soil moisture, water and water vapour from the ground and water from installations.

5.3.3.3 Estimating moisture conditions

The moisture condition that the various building elements are to be exposed to is to be estimated and described as to how they vary in time.

Guidance: The moisture condition of the material can be estimated using various methods, both quantitative and qualitative. There are various types of calculating tools, guidance and guidelines available. Examples of moisture calculation tools are: WUFI, TorkaS 3.0, BIDry. For procedures for calculations we refer you to RäknaF.

5.3.3.4 Permitted moisture condition

The planners are to examine the estimated moisture conditions within the permitted moisture conditions.

Guidance: Review all the moisture loads and check with support of calculations, tests or documentation from long-term solutions to ensure the maximum permitted moisture conditions are not exceeded in any building element (BBR 6:53). The highest permitted moisture conditions are determined by the critical moisture condition of the material including a safety margin. The planner selects the safety margin taking into account any uncertainties in the planning methodology and material data. The critical moisture condition of the material is the moisture condition whereby the intended properties of a material and its function are not met. The critical moisture condition for mould and bacteria can be determined by the material being well-researched and documented through testing. For materials that are not well-researched and documented from a mould aspect, BBR indicates that the critical moisture condition is to be 75 % Relative Humidity (BBR 6:52). The manufacturer of the material and client may also require maximum or minimum permitted moisture conditions for other reasons. This could be discolouration, physical degradation (frost erosion), chemical degradation (corrosion of metals, saponification of floor adhesive), bio-degradation (rot, blue stain), health (odour, humidity, mites, emissions, mould), strength, deformation and moisture-related movements (swelling, shrinkage) and reduced insulation capacity.

5.3.3.5 Moisture risk analysis

The planning group must jointly conduct and document a moisture risk analysis. The planning manager is responsible for the coordination of the moisture risk analysis. A new moisture risk analysis should be performed if conditions change.

Guidance: By way of suggestion, use check-lists to conduct a moisture risk identification and moisture risk analysis in the early stages. Changed conditions also include a change of use of premises or change control of the installations or climate.

Guidance: To get an idea of the moisture safety required for a building or building element, you can conduct a moisture risk analysis. The method with safety factors that is used in static dimensioning is difficult to apply for moisture safety planning, although you can make a qualified assessment of the likelihood of its occurrence and the consequence of this, i.e. that there is a risk of moisture damage or other inconvenience caused by moisture. Conducting a proper risk analysis requires that each calculation parameter is described with a distribution curve. The calculation is then performed with a random value from the distribution curves of the various parameters. By making a large number of calculations you can get a statistical basis from which you can deduce a risk that, for example, the moisture condition of the material exceeds a certain value. Consideration must be given to the correlation between the different parameters. This is complex but is starting to be used more and more for different types of dimensioning.

Guidance: Theoretical assessment of rain, water and air tightness is not sufficient and do not answer if the tightness can be achieved practically. Therefore, the whole function must be considered when materials are assembled into a complete system whereas a material layer or solution are to function adequately whether there are seams, joints, penetrations and connections. This should be verified. The sealing products / materials should also be compatible with each other as well as the underlying substrate and the working life of the products should be verified.

5.3.3.6 Adaptation of the design

Structures, systems and materials are to be selected and designed to ensure the risk of damage or other inconvenience is minimised.

Guidance: Adapt the design of the building element and material selection to suit the moisture loads that may prevail in such a way that the risk of damage or other inconvenience arising is minimised.

5.3.3.7 Supporting data for monitoring in the production stage

Inspections and verifications that are required in the production stage based on the selected structures, systems and materials are to be reported and documented.

Guidance: The moisture safety planning reveals a variety of things to be checked and monitored in the production stage. These are documented and presented ahead of production.

5.3.3.8 Document moisture safety planning

Conditions and results from the moisture safety planning must be reported in a systematic manner to ensure it is easy to follow which measures have been carried out to ensure that the building complies with the moisture safety requirements.

The results of the planning are to be reviewed by the moisture safety officer for planners.

Guidance: All documents are reviewed. The report can be compiled as comments and mark-ups on drawings and as comments in tabular form with reference to actions and be added as an attachment to the moisture safety specification. In the final stage of the planning, the moisture safety officer for planners must make a review of the planner's actions with respect to moisture safety. The moisture examination is to be documented.

5.3.4 Monitoring meetings with planners

The moisture expert is to hold regular meetings with the planners to monitor moisture safety planning. The meetings are documented with minutes.

5.3.5 Review of moisture safety planning

The moisture expert is to review that the planners have conducted and documented the moisture safety planning and that they have verified that the documents meet the moisture safety requirements.

Guidance: The moisture expert is to conduct a limited review of the documents with respect to moisture safety. The results are to be documented.

5.3.6 Collect supporting data for moisture safety documentation

The moisture safety officer for planning collects data and documentation from his own moisture safety work and any moisture safety work performed by subcontractors and suppliers, and submits it to the moisture expert.

6 Moisture safety in the production stage

6.1 The results of moisture safety planning are communicated to production

The moisture expert supported by project planners must notify the main contractor of the result of the moisture safety planning.

Guidance: The planners prepare the relevant information from the planning stage that is to be communicated to contractors and suppliers. The planners should be involved and notify subcontractors and suppliers on how the requirements of the developer have been complied with along with the results from the moisture safety planning and justify the selection of the design and system solutions. This information can be given in relation to an information meeting for contractors and suppliers.

6.2 Information to contractors and suppliers about the developer's moisture safety requirements and methods for monitoring

The moisture expert must inform contractors and suppliers about the moisture safety requirements and the methods that will be used to monitor compliance of the requirements.

Each planner is to forward any written documentation to the moisture safety officer for production regarding identified critical elements, structures and installations resulting from the moisture safety planning. The documentation must specify the type of measure along with the documentation required by the moisture safety officer for production in order to reduce the risk of moisture damage and other inconveniences caused by moisture arising in production.

Guidance: In conjunction with the information about the developer's requirements, it is appropriate to explain why the requirements have been set and what the consequences will be if the requirements are not met. It may also be appropriate to combine the information with a general training programme in moisture safety for participants to have a shared knowledge base. It is also appropriate at this time that the developer explains in general about the project and the project's goals and requirements and how it will be implemented for participants in order to see the big picture. The aim is to create a common set of objectives and encourage all participants to work towards the common goal. The documentation from the planner may include construction documents and control points proposed in the moisture safety planning that are to be incorporated into the moisture safety plan.

6.3 Appoint a moisture safety officer for production

Any participant who produces, assembles materials, building elements or installations that affect the moisture safety of the building must designate a person responsible for ensuring moisture safety work is performed, documented and reported in the production stage to the developer.

Guidance: The moisture safety officer for production is a person who has a sound knowledge of Bygga F, and has theoretical documented expertise of moisture in the air and materials. The person has sufficient knowledge in terms of moisture measurement in air, wood and concrete. If there are several people who are moisture safety officers for production, one of these can be appointed to be coordinator in relation to the developer and the developer's moisture expert. The moisture safety officer for production may transfer parts of the moisture safety work to various participants who are to designate their own person responsible for ensuring moisture safety is performed, documented and reported in the production stage to the moisture safety officer who then notifies the developer's moisture expert and incorporates this material into the moisture documentation.

6.4 Identify moisture-sensitive elements, structures and installations

The moisture safety officer for production is to identify moisture-sensitive elements, structures and installations that are important in production.

Guidance: Examples could be waterproofing on floors and walls in wet rooms and in concealed spaces where the risk of water leakage or condensation may occur, or leak detection in concealed spaces such as shafts, linings or kitchen cabinets.

6.5 Prepare a moisture safety plan

A moisture safety plan is to be prepared by the moisture safety officer for production. The moisture safety plan describes the moisture safety measures to be undertaken in order to protect the building and construction materials from damaging moisture during production and must also include the control points identified during the planning stage. The moisture safety officer for production must ensure the implementation of the activities in the moisture safety plan.

Guidance: When the planners have taken into account moisture safety, the management of moisture safety is crucial during the production stage. If any of the stages of goods acceptance, storage, installation, protection and drying of construction moisture are mishandled causing the material to be exposed to high moisture loads, the material may be damaged and subsequently replaced. As part of this work, everyone involved with the construction plays an important role and it is therefore essential that knowledge about moisture resistance is disseminated to everyone. The moisture safety officer for production must also ensure that the required measurements, inspections, moisture safety procedures etc. are performed on time and are reported. If any failures in moisture safety occur, these must be reported to the client along with proposals for an appropriate fix to the problems. See also handling non-conformance.

The moisture safety plan also contains the critical building elements and other elements identified and submitted by the planners after moisture safety planning. Any additional moisture critical elements and structures that are revealed by the moisture safety officer for production before or during the construction stage are to be incorporated into the moisture safety plan.

6.6 Developers' monitoring meetings with contractors and suppliers

The developer's moisture expert must convene, conduct and document regular monitoring meetings with contractors and suppliers.

Guidance: During the production stage, the moisture safety officer at the workplace has overall responsibility for the moisture safety plan being followed, and manages and compiles non-conformance reports as well as ensuring that current information about the moisture safety work is reported at construction meetings, and that supporting data for the moisture safety documentation is prepared and submitted to the developer's moisture expert.

6.7 Moisture inspection rounds

The moisture safety officer for production must conduct and document moisture inspection rounds at the construction site at a rate agreed between the contractor and the developer and depending upon what activities are ongoing.

The moisture expert is to conduct moisture inspection rounds by himself or with the moisture safety officer for production.

Guidance: The number and times of the moisture inspection rounds are planned for each stage. There should also be a plan to provide moisture inspection rounds in emergency situations. Relevant observations are noted as part of the moisture inspection round and the photos taken are to be included with the documentation. Documentation from the moisture inspection rounds is grouped together in a special digital folder or binder or a tab for moisture safety documentation in the production binder.

6.8 Measurement and inspections

The moisture safety officer for production is responsible for implementing and documenting the measurement and inspection of the moisture safety plan.

6.9 Document non-conformance in relation to the moisture safety plan

The moisture safety officer for production is responsible for documenting non-conformance in relation to the moisture safety plan and reporting on the proposed measures to the developer's moisture expert.

Guidance: The moisture safety officer for production agrees the non-conformance and the intended measures with the developer. The non-conformance should be monitored with a reported measure.

6.10 End of production stage

6.10.1 Collect and establish supporting data for operation and maintenance instructions for moisture safety

The moisture safety officer for production collects data for operation and maintenance instructions for moisture safety from subcontractors and suppliers and submits this to the moisture expert.

6.10.2 Collect supporting data for moisture safety documentation

The moisture safety officer for production collects data from the moisture safety work and from subcontractors and suppliers, and submits this to the developer or to the moisture expert.

6.11 Moisture safety documentation

The moisture expert compiles moisture safety documentation from planning and production and submits it to the developer.

Guidance: All documentation relevant to the moisture safety of the building is compiled into a final document called moisture safety documentation. The moisture safety documentation should be submitted to the developer no later than the final inspection.

The moisture safety documentation should include:

- The developer's moisture safety requirements
- Moisture safety specification
- Report of moisture safety planning
- Updated moisture safety plan
- Moisture inspection rounds report
- Relevant labelling, product approvals and certificates relevant to moisture safety of the building
- Revisions of structures, materials and designs that may affect future moisture safety
- Results of calculations

- *Results from measurement and inspections according to the moisture safety plan*
- *Non-conformance and reporting of measures performed*
- *Quality records according to BKR's industry regulations for wet rooms, MVK's painting industry rules for wet rooms, GVK's industry regulations for safe wet rooms and certificates for safe water installation.*
- *Instructions for operation and maintenance relevant to moisture safety such as cleaning of surface water inlets, any soft joints that need overhauling and maintenance, etc.*
- *Inspection reports and statements regarding moisture safety*
- *Other documentation (e.g. photographs, minutes of meetings where moisture issues are addressed)*

7 Moisture safety in the management stage

7.1 Review of property organisation

The developer's moisture expert and the moisture safety officer for production are to hold a review with the responsible manager and operations manager about the moisture critical structures of the building and the measures to be carried out to ensure that moisture safety is maintained.

7.2 Moisture inspection rounds in the management stage

The property owner is responsible for the operational inspection rounds being conducted in the operations stage where moisture is one aspect.

Guidance: Inspections in the operating stage could include the clearing of wells, drainage systems, wide overflows, areas for joints in enclosures, installation shafts and connection cabinets, leak detection from pit bottoms, backfilled or water exposed building elements, connection components, humidified spaces, fridge and freezer rooms etc. This is shown in the operating and maintenance instructions.