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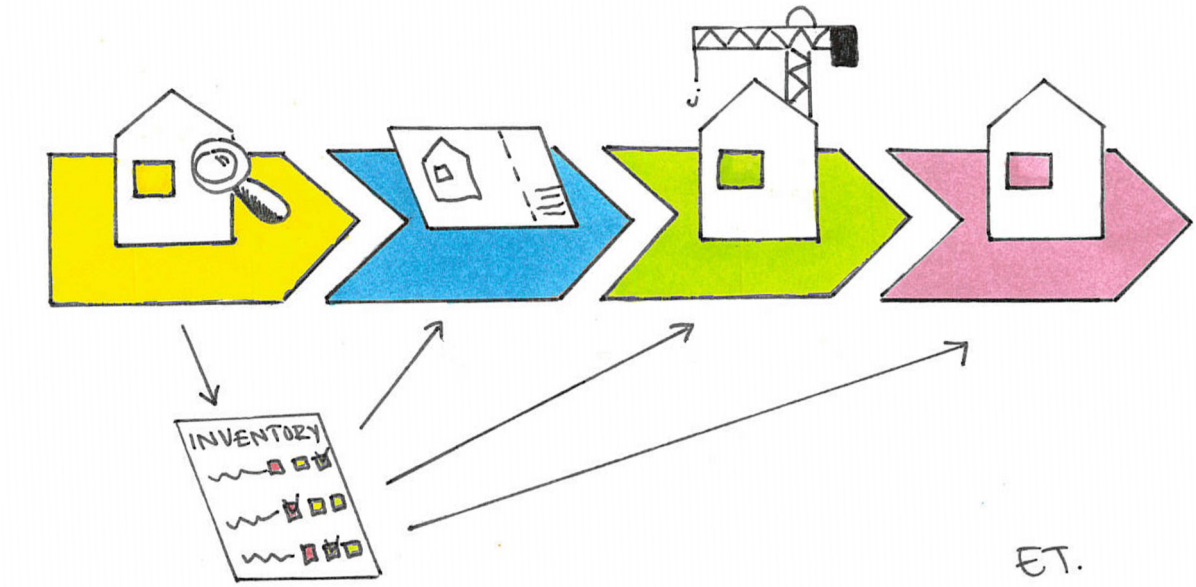

Suggestions for adjustment of ByggaF to improve the current use and suit the process of renovation

Master's Thesis in the Master's Programme Structural Engineering and Building Technology

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CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden 2016

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Cover:
Visual inventory checklist from program stage (yellow) is communicated to design (blue), production (green) and operation stage (pink).
Elin Tjäder, 2016

Department of Civil and Environmental Engineering
Göteborg, Sweden, 2016

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ABSTRACT

ByggaF, a methodology for including moisture safety in the building process, was developed in 2007 and is today used in the Swedish construction industry. The purpose of ByggaF is to highlight moisture issues at an early stage in the building process by introducing documents, activities and actions. Today ByggaF is structured in a way suitable for new building.

Adjustments of ByggaF are needed to improve the current use and to suit the process of renovation. This report provides suggestions to improve the ByggaF-documents, which are based on current acts and regulations, research reports from the field and interviews with moisture experts and representatives of property developers.

The results from the interviews conclude that the average knowledge in moisture safety is low in the construction industry, and there are problems to introduce ByggaF to other participants.

For adapting ByggaF to the renovation process, a visual moisture inventory is suggested to be included as a compulsory procedure in the program stage. This provides information about the existing building for all involved. Visual moisture inventory checklists are created and recommended to use.

Another main finding is the issue with using the ByggaF document *Moisture safety planning with risk evaluation* in the design process. Moisture safety officers for planning need clearer competence requirement. Designers need better guidance in moisture safety design to fully use the document, especially to perform the risk evaluation. Earlier risk assessments from research, expert system and software products are suggestions to simplify the designer's work. A change of the numeric risk evaluation is also a suggested solution. This document has also been updated to reduce conflicts with other industry regulations and to have better consistency and to better suit the process of renovation. All suggestions requires both to be tested and further developed.

Finally, the suggestions are implemented in the main document *Industry standard ByggaF*.

Key words: ByggaF, moisture, renovation, moisture inventory, moisture risk evaluation

Förslag på justeringar av ByggaF för att förbättra nuvarande användning samt anpassa den till renoveringsprocessen

Examensarbete inom mastersprogrammet Konstruktionsteknik och Byggnadsteknologi

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SAMMANFATTNING

ByggaF är en metod som syftar till att implementera fuktsäkerhet i byggprocessen. Metoden introducerades 2007 och används numera i den svenska byggbranschen. Syftet med ByggaF är att i tidiga skeden uppmärksamma fuktrelaterade risker och ta hand om dem genom dokumentation, rutiner och krav. Idag är ByggaF främst anpassat för nyproduktion.

Vissa justeringar av ByggaF behövs för att förbättra nuvarande användning samt för att anpassa metoden till renovering. Rapporten föreslår förbättringar av vissa dokument i ByggaF. Förslagen är baserade på nu gällande lagar och förordningar, rapporter inom området samt en intervjustudie med diplomerade fuktsakkunniga och representanter till byggherren.

Resultatet från intervjustudien visar att den generella kunskapen om fuktsäkerhet är låg i byggbranschen och att det finns problem med att introducera ByggaF till andra aktörer.

Ett förslag för att anpassa ByggaF till renoveringsprocessen är att införa en okulär inventering av befintlig byggnad som ska genomföras i programskedet. Inventeringen ska förse involverade aktörer med information om den befintliga byggnaden. För att underlätta utförandet av en inventering har ett antal checklistor tagits fram.

En av slutsatserna från intervjuerna är att det finns en del problem med ByggaF-dokumentet *Fuktsäkerhetsprojektering med riskvärdering* som används i projekteringsfasen. Rollen som fuktsäkerhetsansvarig för projekteringen behöver tydligare beskrivas utifrån kompetenskrav. Projektörerna behöver bättre vägledning i fuktsäkerhet, speciellt vid utförande av riskvärderingen. Förslag på vägledning baseras på tidigare riskbedömningar från forskning, expertsystem och simuleringsprogram. Justering av numeriska fuktriskanalysen är också ett förslag. Dokumentet behöver även uppdateras för att undvika konflikter med andra branschstandarder och förbättra kontinuitet mellan de olika delarna i dokumentet. Samtliga förslag behöver dock testas och utvecklas vidare.

Slutligen anges även förslag på hur justeringarna kan implementeras i huvuddokumentet Branschstandard ByggaF.

Nyckelord: ByggaF, fukt, renovering, fuktinventering, fuktriskvärdering

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Preface

This Master's thesis was prepared in spring 2016 at Chalmers University of Technology in cooperation with SP technical research institute of Sweden. The work consists of suggested improvements to ByggaF and adjustments to suit the process of renovation and has been carried out with support of interviews, literature studies and study visits.

Firstly, we would like to thank Kristina Mjörnell from SP and Carl-Eric Hagentoft from Chalmers. Kristina Mjörnell initiated this project and was project supervisor together with Carl-Eric Hagentoft. They have been very helpful and have guided us in the right direction during the entire project.

We would also like to thank all people supporting us in our work who have provided us with useful feedback. Special thanks to Bengt Olsson, Magnus Hansén, Kent Bergström, Jörgen Wadman, Carl Edelberg, John Watson and Judy Watson.

Finally, thanks to everyone taking their time to answers our questions in the interviews. Your thoughts and ideas have been very valuable for this work.

Göteborg, May 2016

Patrik Olsson and Elin Tjäder

Definitions

AMA – Guidance for the preparation of particular conditions for Building and Civil Engineering Works and Building Services Contracts. Swedish: *Allmän Material- och Arbetsbeskrivning*

BBR – Building regulation. Swedish: *Boverkets byggregler*

BBV – Trade Rules of the Swedish Ceramic Tile Council for Wet Areas. Swedish: *Byggkeramikrådets Branschregler för Våtrum*.

Boverket – The Swedish National board of housing, building and planning.

Byggkeramikrådet – the Swedish Ceramic Tile Council.

Design-bid-build – contract form, with two separate contracts, one between the property developer and the designer, and the other between property developer and contractor. The contractor has the responsibility for subcontractors. Swedish: *Generalentreprenad*

Design-build – contract form, where the contract is between the property developer and the contractor. The contractor is responsible for the design, and to hire consultants and subcontractors. Swedish: *Totalentreprenad*

Folkhälsomyndigheten – The Public Health Agency of Sweden

Fuktcentrum – Moisture Centre

GVK – Foundation comprising various organisations and companies which dealing with water damage in wet rooms. Swedish: *Golvbranschens Våtrumskontroll*

HVP – Heat, Ventilation and Plumbing. Swedish: *VVS*

Miljöbalken – Law in Sweden to ensure a healthy and good environment, for present and future generations.

Moisture expert – person with expertise in moisture safety. Swedish: *Fuktsakkunnig*

Municipal Building Committee – Swedish: *Byggnadsnämnd*

MVK – Organisation working to supporting companies in the painting industry. Swedish: Måleribranchens våtrumskontroll

Måleribranschens Regler för Våtrum – Painting Industry's regulations for wet rooms.

PBA – Plan and Building Act. Swedish: *Plan och bygglagen*

Planning and Building regulation – Swedish: *Plan och byggförordningen*

Property developer – person representing the house owner or client. Swedish: *Byggherre*

RH – Relative humidity. Swedish: *Relativ fuktighet*

SGBC – Sweden Green Building Council

Säker vatten AB – company concerning safe water installations.

Säker vatteninstallation – safe water installation

Säkra våtrum – safe wet room

1 Introduction

Moisture has the potential to cause damage to buildings. Typical problems caused by moisture are not only mould damage and rot but also chemical emissions. Mould and rot produce sometimes unpleasant odour which spread in the building. This may lead to health problems for inhabitants in some cases, such as asthmatic reactions or other allergic related problems due to poor indoor environment (Rosen, 2009). Even if the inhabitants cannot sense the odour, the mould can still cause problems in the buildings.

A way of dealing with moisture risks during the entire life time of the building is to use the industry regulation ByggaF. This tool is mainly developed for new construction of buildings. Through guidance to the participants in the building process, in order to decrease the risk of moisture problems.

ByggaF has been used as a construction industry regulation since 2012-2013. The regulation is today in need of monitoring to know the current use and potential improvements.

This regulation has potential to fit more purposes such as renovation. Existing buildings have other moisture issues which are not described in the existing ByggaF. An adaption of this tool would therefore highlight more specific risks which only occur during renovation. Critical structures need to be investigated carefully to prevent impacts of moisture during and after a renovation. Documentation for these structures need to be updated in the adapted ByggaF with new recommendation and risk criteria.

1.1 Aim

The aim of this report is to suggest adjustments and improvements to ByggaF to improve the use of documents in the building process and renovation projects.

1.1.1 Questions to be answered

- What parts can be improved in the existing ByggaF?
- How can ByggaF be adjusted to better fit the purpose in the process of renovation?
- What are the problems with moisture safety in the process of renovation?
- How can ByggaF prevent moisture damage which is detected in the production stage in the process of renovation?

1.1.2 Limitations

This report only covers the 2013-version of ByggaF.

To narrow down the range of various moisture problems only certain parts of the building with their associated problems are described in this report. These parts are chosen based on the fact that they are among the most common renovation types and that moisture problems in these parts are widespread.

Result from the interviews cover only answers from those working in projects using the ByggaF method. Other answers were excluded in the statistical data. However, comments and proposals from these persons were still valuable in this report.

The interviews did not cover how much the interviewees used each ByggaF document. Only their experience and views for each document were noted.

The suggestions for adjustment are mainly focused on three documents in ByggaF: *Industry standard ByggaF- method for moisture safety of the construction process, Moisture inventory in existing building* and *Moisture safety planning with risk evaluation.*

ByggaF is a Swedish industry regulation and suggested adjustments are published in Swedish in the appendices. However, all appendices are explained in the report.

1.2 Methodology

An initial literature study was carried out to collect useful information concerning ByggaF. The literature study was used to find suitable interview questions which later were controlled by the supervisor at SP.

1.2.1 Interviews

In order to obtain a better understanding of how ByggaF is currently used and to find potential adjustments for renovation, interviews were held with moisture experts and property developers' representatives. Their different perspectives and experiences provided guidance about which part of ByggaF should be in focus for further developments.

For the selection of interview subjects among the moisture experts, a list of 107 certified moisture experts from Fuktcentrum in Lund was used. The certified moisture experts were working for property developers, consultant, designers or contractors. Time limitation narrowed down the amount of interviewees to 18 persons. To achieve a broader view, persons selected from different companies were chosen.

The selection of property developers was made by contacting those companies using the SGBC-tool called Miljöbyggnad with residential buildings having a Gold standard rating. The reason for choosing these companies was because this grade required usage of ByggaF or an equivalent tool. SGBC could only provide a list of buildings certified with the total grade. A list for buildings graded with Gold or Silver for the moisture indicators were not available. In total, four persons working as project managers or environmental coordinators for different property developers were interviewed.

The interviewees received a telephone call where a date for an interview was booked and the questions were sent in advance. This gave them time to prepare answers before the interview. The questions focused on the current use of ByggaF and possible adjustments for the renovation process. Current problems and possible solutions were also part of the question sheet. The question sheet intended for moisture experts had more questions concerning the renovation process than the property developers' because they were assumed to have a better knowledge in this area. Question sheets are found in Appendix 1.

During the interview one asked the questions and the other wrote down the answers. In total 22 phone interviews were held, however one interview did not cover the questions about renovation due to time limitations. Everything was documented by taking notes during the call and summarized in two steps. In the first step, immediately after the

interview, the notes were summarized. This was carried out to simplify the material for later use and to emphasize the essence of the interview.

In the second step, when all the interviews were done, a compilation of all points of views from moisture experts and property developers was made, one for moisture experts and one for property developers. Shared answers and opinions were summarized for each question. This was carried out with care so the formulations of their answers were interpreted correctly.

1.2.2 Developing proposals

The material from the interviews has been used as base to discover problems with the current documents in ByggaF and possible ways to improve them, as well as to adjust the documents to better fit renovation projects. To properly establish the changes and adjustments, the thoughts, experience and knowledge from the construction industry is important. In this case the moisture experts' and property developers' opinions together with a literature study, including research reports and other relevant material, have been the foundation of the suggestions in the proposals.

Two documents, *Moisture inventory in existing building* and *Moisture safety planning with risk evaluation,* needed more extensive changes, which were shown in the interviews.

The result from the interviews regarding the document *Moisture inventory in existing building* suggested a more extensive and detailed inventory. One way of doing this was to simplify the inventory by making checklists for each structure. In order to achieve a better understanding of how inventories are carried out today, several study visits have been made to different companies working with inventories.

The first study visit was with SP Technical research institute of Sweden, SP. The task for SP was to determine the status of the building by doing an investigation. To obtaining more information about how an inventory is carried out was by interviewing a moisture inspector, working with inspections of buildings at Anticimex. The results from the first study visit and the interview led to a proposal for an inventory template, which was reviewed by educator in moisture working with inventory at Polygon. Final adjustments of the document were done after another review by a moisture expert at Integra.

The document *Moisture safety planning with risk evaluation* require adjustments according to the interviews. To improve this document three different suggestions are proposed. Firstly, improvements in the document for easier usage for the designers, based on the result from interviews and literature study. Secondly, adjustments in the document to be more consequent and prevent conflicts with other industry regulations. Existing texts were rewritten to better suit other sections in the document. This was carried out to make the document more consequent. Finally, adjustments in the documents to suit the process of renovation, based on the literature study.

The suggested changes in these two documents are implemented in the document *Industry standard ByggaF*. Other changes and updates to make the document more understandable are also suggested, which are based on the comments from moisture experts and property developer.

2 Theoretical background

The theoretical background includes information about the building process, regulations in Sweden, the ByggaF method and moisture problems in renovation projects.

2.1 Building process

There are four phases in the building process; program stage, design stage, production stage and operation stage (Nordstrand, 2008), see Figure 1. The four main participants in the building process are property developer, designer, contractor and property manager.

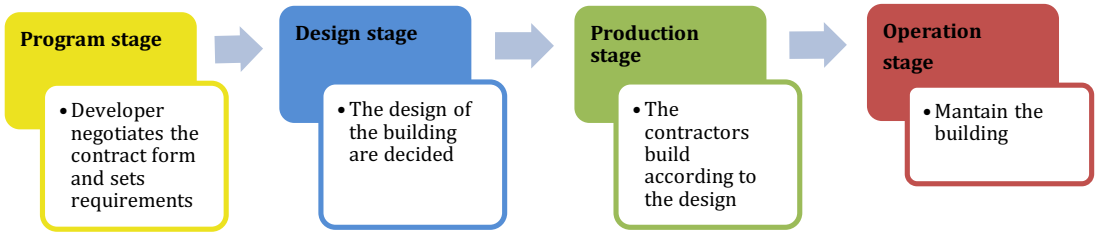


Figure 1 Different stages in the building process

The property developer is responsible that laws and regulations are followed (SFS 2010:900). A property developer does not need to be a physical person, this can for example be a company (Boverket, 2016a). Designers are responsible to follow the property developers' requirements and describe solutions for the building in drawings and descriptions (Nordstrand, 2008). Contractors and sub-contractors are responsible to build according to the design. The property manager is responsible for maintaining the building during the operations stage.

2.1.1 Acts and regulations concerning moisture

There are acts and regulations in Sweden concerning moisture, which need to be considered when adjustments in ByggaF are made.

PBA

The Ministry of Enterprise and Innovation is responsible for PBA (Sveriges riksdag, 2016). The property developer has the overall responsibility to follow PBA when a new building or renovation is planned (SFS 2010:900). The property developer hands in a proposal for inspection and test plan to the municipal building committee which decide if the requirements are fulfilled (Boverket, 2016b). An inspector is often required and helps property developers to write and follow the inspection and test plan.

The building should have the technical properties to protect health, hygiene and environment, according to the PBA (SFS 2010:900). This is further explained in chapter 3 §9 of Planning and Building regulation (SFS 2011:338). It is stated that design and execution of the building should be done in such a way that moisture in structures or moisture on surfaces on the inside of building should not cause an unacceptable risk for user's health and hygiene.

BBR

Boverket is the central governmental authority, responsible for BBR (Boverket, 2014a). BBR is legally binding. The regulation describes requirements and recommendations, both for new constructed buildings and renovation of existing buildings. According to BBR, the design of the building should be done in such a way that moisture does not cause damage, odour or microbial growth, which may affect health and hygiene (BFS 2014:3). The same requirement is for both new production and renovation.

Miljöbalken

Chapter 26 §22 in Miljöbalken state that a person or company who lets someone use a building as residence or for public purpose, is obligated to investigate the building and take measures to reduce hazards affecting the health for humans (SFS 1998:808). This is carried out when there is a reason to assume hazards to human health caused due to the building's condition.

The authority, Folkhälsomyndigheten, has given recommendations of indications of moisture related hazards affecting human health (Folkhälsomyndigheten, 2014). The recommendations are applications of Miljöbalken.

Industry regulation Säker vatteninstallation

Säker vatten AB owning and managing *Industry regulation Säker vatteninstallation* (Säker Vatten AB, u.d.). The industry regulation states requirements on products, HVP companies and performance of installation (Säker Vatten AB, 2016). The property developer or the insurance company may require HVP installations according to the industry regulation. The industry regulation is written to fulfil the requirements in BBR.

BBV

BBV is an industry regulation provided by Byggkeramikrådet (Byggkeramikrådet, 2015).The industry regulation is used for wet rooms and provides rules for a vapour tight system underneath tiles and mosaic. Property developers and contractors agrees to use of the industry regulation in contracts (Byggkeramikrådet, n.d.).

Säkra Våtrum

Säkra Våtrum is an industry regulation describing solutions for safe vapour barriers in wet rooms (GVK, 2014). It is based on BBR and companies using this regulation have to be authorised. *Säkra Våtrum* is provided by GVK.

Måleribranschens Regler för våtrum

MVK provides an industry regulation concerning requirements about painting in wet rooms and is called *Måleribranschens Regler för Våtrum*. MVK encourages companies painting wet rooms by follow their requirements which includes education of the employees, approved painting system of the producers and following the building regulations (Måleribranschens våtrumskontroll, 2012).

AMA

There is a general material and work description in Sweden called AMA, which uses codes to communicate material and work descriptions.

2.1.2 Renovation

The renovation process needs to follow PBA, according to chapter 8 §5 (SFS 2010:900). The renovation project is similar to the procedure and activities in a new

construction project and it is usual that the property developer also is the property owner (Nordstrand, 2008).

One important issue with renovation work is the lack of possibility to know the initial status of the building, such as defects or other unknown conditions (Nordstrand, 2008). Some decisions and technical solutions therefore need to be delayed for a later stage in the process, sometimes as late as in the production stage. This has an impact in the designing process and in choice of contract form. However, the most common contract form is design-build. The procedure is similar to new construction process, see Chapter 2.1.

An initial study in the program stage is the same as for new construction but especially important for a renovation project (Nordstrand, 2008). At this stage, relevant documents are collected for the building, such as drawings and technical documents. In the program stage important decisions are made concerning the building's construction and technical installations. Investigations of the building are carried out to support the decisions. BBR chapter 6:951, state that moisture conditions in the existing building which should be well investigated and documented (BFS 2014:3).

A general problem with planning a renovation work is the lack of documentation of the buildings. From a study investigating the building stock in Sweden 30% of the drawings were missing or poor quality. More than half of the technical description were missing (Boverket, 2010a)

2.2 ByggaF method

In 2007 ByggaF was introduced and categorised as an industry regulation in 2012-2013 (Mjörnell, 2014). ByggaF is a method to ensure moisture safety in the building process and is an industry regulation in Sweden (Fuktcentrum, 2013a). The aim of the regulation is to ensure, communicate and document moisture safety through the entire building process. These are divided into program, design, production and operation stage. In BBR, ByggaF is advised to be used to achieve moisture safety (BFS 2014:3).

ByggaF follows the same stages as a normal building process, see Chapter 2.1, and the method includes additional requirements of activities to ensure moisture safety. The document *Industry standard ByggaF- method for moisture safety of the construction process* describes the method of ByggaF and recommends the use of documents at different stages (Fuktcentrum, 2013a), see Figure 2.

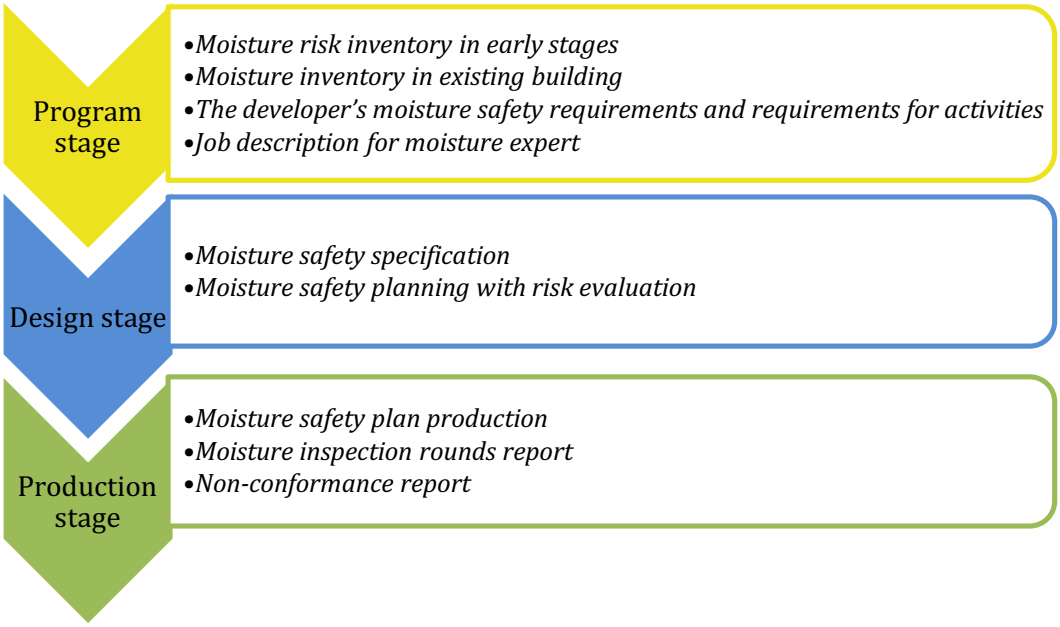


Figure 2 Recommended documents to be used in different stages according to ByggaF

According to ByggaF, a moisture expert should be selected in the program stage (Fuktcentrum, 2013a). In the design stage should each designer select a moisture safety officer for design, which are responsible to follow the requirements and documenting the moisture safety criteria. The same procedure is also required in the production stage, there each contractor appoint a moisture safety officer for production. All responsible participants can be seen in Figure 3.

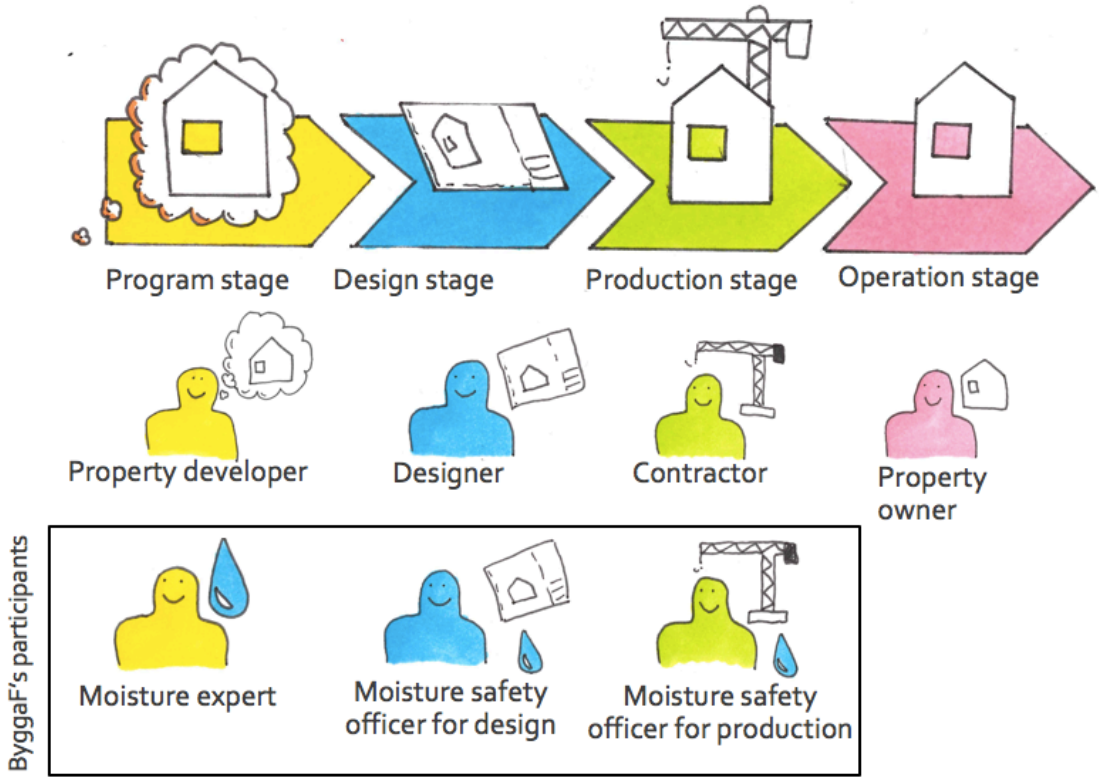


Figure 3 Participants at different stages in the building process, according to Industry standard ByggaF.

Fuktcentrum provides a course for moisture safety officer for design and production (Fuktcentrum, 2015), but it is not obligated according to *Industry standard ByggaF*.

An early moisture risk inventory is required to identify moisture risks and should be carried out by a moisture expert (Fuktcentrum, 2013a). Guidelines for a moisture risk inventory can be carried out using the checklist in the document *Moisture risk inventory in early stages* (Fuktcentrum, 2013b). In this document the moisture expert is responsible for evaluating whenever there is a need to do an inventory of the existing building. Consequentially, according to the current ByggaF document, there is no requirement to do an inventory in existing buildings. *Moisture inventory in existing building* is a document giving proposals how an inventory of an existing building can be carried out (Fuktcentrum, 2013c). This document also states some examples of risk constructions.

The property developer should set out requirements during the program stage regarding technical requirements and requirements of skills and activities (Fuktcentrum, 2013a). The moisture safety program is a document which describes the property developer's requirements, and is prepared before the design stage. This document has no template in current ByggaF.

Job description for moisture expert describes the moisture expert's responsibilities through the building process and necessary competences for the moisture experts (Fuktcentrum, 2013d).

The design stage is divided into system and detailed design. Designers who have an impact on moisture safety get information from the moisture expert concerning the requirements (Fuktcentrum, 2013a).

Moisture safety specification is a report template where information relevant to the project is specified (Fuktcentrum, 2013e) and is prepared in the end of system design (Fuktcentrum, 2013a). The aim is to summarize the requirements and routines before the detailed design and production. The document is completed as the project progresses, and as the building technical and production technical conditions are identified.

Moisture safety planning with risk evaluation is a document used for systematic documentation of the moisture safety design (Fuktcentrum, u.d.). The document is divided into sections for each part of the structure, where the designer must identify the relevant moisture loads. For each critical detail a validation of probability and consequences is stated which results in a risk assessment, see Figure 4

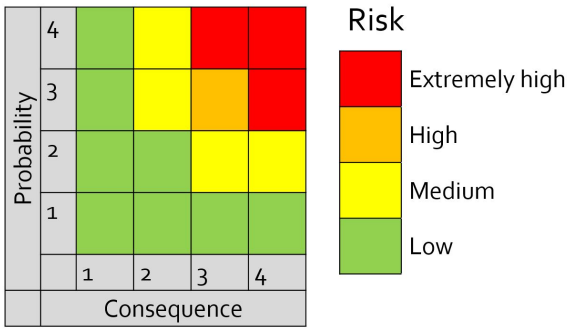


Figure 4 Level of the risk is a relation between probability and consequence.

Moisture safety plan production is a governing document (Fuktcentrum, 2013f), prepared by the moisture safety officer for production (Fuktcentrum, 2013a). The aim

is to describe how the requirements in moisture safety program and moisture safety specification should be fulfilled.

Moisture inspection rounds report is a template with proposed controls to ensure the moisture safety plan is followed (Fuktcentrum, 2013g). Moisture inspections rounds should be done by the moisture safety officer for production and the moisture expert. *Non-conformance report* is a template documenting non-conformance in the production stage (Fuktcentrum, 2013h).

At the end of the production stage, necessary data is collected to ensure moisture safety during operation stage (Fuktcentrum, 2013a). Moisture safety documentation is completed by the moisture expert, including both information from the design and production stage, and handed over to the property developer.

The operation stage starts with a review of the moisture critical structures and required measurements during the operation stage to ensure moisture safety (Fuktcentrum, 2013a). The property owner is responsible for the moisture inspection rounds during operation stage.

2.3 Moisture problems in renovation projects

It is important to fully understand the relation between heat, moisture and air movement in order to determine the hydrothermal conditions. For example, a change of heating system from furnace-based chimney exhaust to a district heating system changing the temperature in the attic as well as air pressure in the building. Both changes may lead to an increased risk of moisture problems (Hagentoft, 2015).

Other changes of the building may increase moisture problems, according to Bednar and Hagentoft (2015):

- Change of ventilation system or reduction of supply air
- Increased indoor moisture production
- Increased interior thermal insulation in the building envelope
- Decreased ability for moisture to dry out in the structure

Buildings might already have problems with moisture. Critical constructions or sensitive material such as organic material has an increased risk of moisture damage.

2.3.1 Cold ventilated attic

Cold ventilated attics with normal or reduced ventilation is a commonly used construction in Sweden with 88 % of the building stock, were visible mould growth is found in 21 % of them (Boverket, 2010b). According to Rode (2015) are there several reasons for mould growth in the attic and some of them are because of:

- Natural ventilation or mechanical ventilation system creating an internal positive pressure which increase the risk of convection
- A large moisture production indoors with a non-airtight ceiling increase the risk of diffusion or convection
- Roof underlay made of wooden board such as plywood
- Increased thickness of the attic floor insulation
- Ventilation of attics in cold and maritime climate

The vapour barrier in the ceiling might be missing, damaged or not working sufficiently which results in moisture transportation from the indoor climate up to the attic due to convection or diffusion (Samuelsson, 2002). The inside air can condensate on the roof underlay and be absorbed into the surface material which may lead to mould or rot.

The outside air circulation occurs mainly from the vents in the attic (Hagentoft, 2002). The ventilation rate should not be too high or too low (Kalagasidis, 2004). A too high ventilation rate together with under cooling results in high relative humidity. On the other hand, a too low ventilation rate is risky for cases of construction damp or leaky attic floor (Arfvidsson & Harderup, 2005). The optimum ventilation rate differs and depends on the surrounding climate and the fixed ventilation in the attic is not always the best choice (Sasic Kalagasidis & Hagentoft, 2010).

2.3.2 Outer wall

Problems with moisture are most common in joints and details such as around windows. To avoid these problems, the wall should be designed to drain water or at least let it dry out property (Antretter, et al., 2015). A non-air cavity solution increases the pressure of the wall, which also increases the moisture sensitivity of the structure (Hansén & Jansson, 2015).

For brick walls, one of the most common damage in Sweden is caused by freeze attacks (SP, u.d.). This happens when the façade is exposed to rain together with a cold shifting climate. Extremely wet winters are the most critical. Freeze attacks result in cracks in the façade which increase the risk of moisture ingress into building structure.

A wall construction sensitive to moisture were built during the last decades in Sweden. The structure consist of rendered, unventilated and undrained stud wall with external insulation (Jansson & Samuelsson, 2009a). Due to this problem, Boverket (2009) recommends all property developers having this wall structure built during the last 20 years to investigate their buildings. They also recommend the use of a method to investigate these walls developed by SP (Jansson & Samuelsson, 2009b)

Buildings listed worthy of preservation or for other reasons not suitable for outside insulation require additional solutions. By adding interior insulation existing thermal properties are changed in the wall which has an impact on the risk of moisture damages. A consequence of adding interior insulation is that existing structures get colder. This increases the risk of condensation or too high moisture content in the interface between the existing and new part of the wall. Other moisture problems may occur at thermal bridges at connections or other details in the wall. (Bednar & Hagentoft, 2015)

The stack effect might be a problem in cold climates, especially if the vapour barrier is not property sealed (Antretter, et al., 2015). Other moisture risks using interior insulation are according to Hagentoft (2015):

- Freeze-thaw damage due to lower temperature in the wall
- Organic material is sensitive
- Reduced drying potential
- Surface moisture damage close to the inside insulation
- Moisture damage inside the construction

2.3.3 Naturally ventilated crawl space

The crawl space is in most cases natural ventilated with air cavities evenly distributed around the foundation walls. Modern crawl spaces often have problems with odour and mould and therefore categorized as a risk construction, especially floor structure made out of wood (Antretter, et al., 2015).

The problems regarding moisture occurs when relative humidity increases in the space and at the same as a sufficiently high temperature. This condition is favourable for mould and rot grow which can cause moisture problems. (Arfvidsson, et al., 2007). Pressure distribution which leads to the transports of air from the crawl space up to the living area is another moisture problem. The air transport spores, mould, radon or polluted particles which may be harmful (Antretter, et al., 2015).

The use of a dehumidifier keeps the RH at an acceptable level in the crawl space. An exhaust fan creating a constant under pressure in the foundation compared to the living area. By doing so the air leakage up to the indoor environment is reduced (Antretter, et al., 2015).

2.3.4 Basement

The complication of designing a basement wall with respect to moisture is due to the fact that parts of the wall are above the ground while others are below (Arfvidsson, et al., 2007). Sunshine on the wall drives diffusion of moisture in the wall above the ground to transfer to the inside part of the wall. Moisture sources from the ground can cause problems, both liquid and gas, which usually occurs in high content.

Insulation of the interior side of the wall may cause moisture damage in the structure and should be avoided (Samuelsson, u.d.). One option to reduce these risks is to replace the organic and moisture sensitive material in the existing wall. An air cavity between the bearing structures to the new construction can also reduce the risk of moisture problems.

2.3.5 Wet room

Wet rooms have a high moisture production due to the inhabitants' activities (Samuelsson, 2002). Moisture sources from installations and inhabitants increase moisture risks and result in extra caution in designing, specifying and renovating these rooms. The choice of vapour barrier and material in a wet room is therefore important for the moisture safety.

From investigations and research reported by Jansson (2015), the following are highlighted as common risks regarding moisture problems:

- Vapour barrier underneath tiles
- Built in moisture in concrete
- Double vapour barriers in a wall
- Connection to floor drain
- Damage of the existing vapour barrier during operation stage

According to Mögeltalkoot (2016) these risks are also common in wet rooms:

- Not enough ventilation
- Old, leaky plastic carpet underneath the outer layer
- Insufficient connection at the inlets in the walls or floor
- Cracks on surfaces or joints

The connections and details of the vapour barrier as well as splices and connections of inlets need to be carefully designed and built to avoid moisture problems. Contamination of material may also be a risk for mould growth and needs to be maintained and followed up properly (Samuelsson, 2002).

Industry regulations can be used to perform moisture safe wet rooms. Example of industry regulations are *Industry regulation Säker vatteninstallation*, *BBV*, *Säkra våtrum* and *Måleribranschens regler för våtrum*, see Chapter 2.1.1.

2.3.6 Ventilation

Extract air ventilation is especially important in wet rooms and kitchens where moisture production is high whereas supply air ventilation is preferable in rooms occupied for a longer time such as bedrooms and living rooms (Boverket, 2014b).

A natural ventilation system usually has an over pressure in the upper part of the building due to the stack effect (SP, u.d.). This increases risks of moisture convection which causes a risk of moisture damage in the structure. A renovation involving a replacement of natural ventilation system to a mechanical extract air ventilation system changes the air pressure distribution in the building. This changes reduces the risk of moisture convection.

When renovating a building, supply air vents should be installed (Boverket, 2014b). Older buildings, built before 1976, usually have natural ventilation without supply air vents and the supply air entering the building through cracks or other cavities in the building envelope. The buildings built today are more air tight which therefore require supply air vents. Insufficient ventilation may cause moisture damages such as mould on walls or ceilings.

2.3.7 Drainage system

It is important to protect the building from standing water towards the ground plate because this may lead to moisture damages in the ground or basement (Anticimex, 2016). The ground plate should not have cracks and the ground should fall away from the building. Standing water on the roof increase the risk of moisture damage in the building and to avoid this, pipes and gutters should be clean from organic material.

3 Result from interviews

Phone interviews were held to achieve an overview of how the current use of ByggaF works in the construction industry. The main focus of the interviews were to collect information from moisture experts and property developer's use and thoughts about the current ByggaF and possible options to adapt ByggaF to the renovation process. In total 22 persons were interviewed and all their answers were noted and later summarized into columns charts. Four persons representing property developer were interviewed and their answers are summarized in Appendix 2. 18 moisture experts were interviewed and all their answers are summarized in Appendix 3. In the result, only shared thoughts in the result are presented and opinions expressed by only one person is found in Appendix 3.

The result from the interviews is helpful for understanding the issues of current use of ByggaF and could serve as base for developing improvements of the document. The result is useful to develop adjustments of ByggaF-document to suit the renovation process.

3.1 Moisture experts' complaints regarding ByggaF

18 moisture experts were participating in interviews and general opinions about ByggaF was noted. Their answers to the question *"Have there been any complications to use ByggaF?"* are summarized in Figure 5. Each moisture expert might have several opinions represented in tables below.

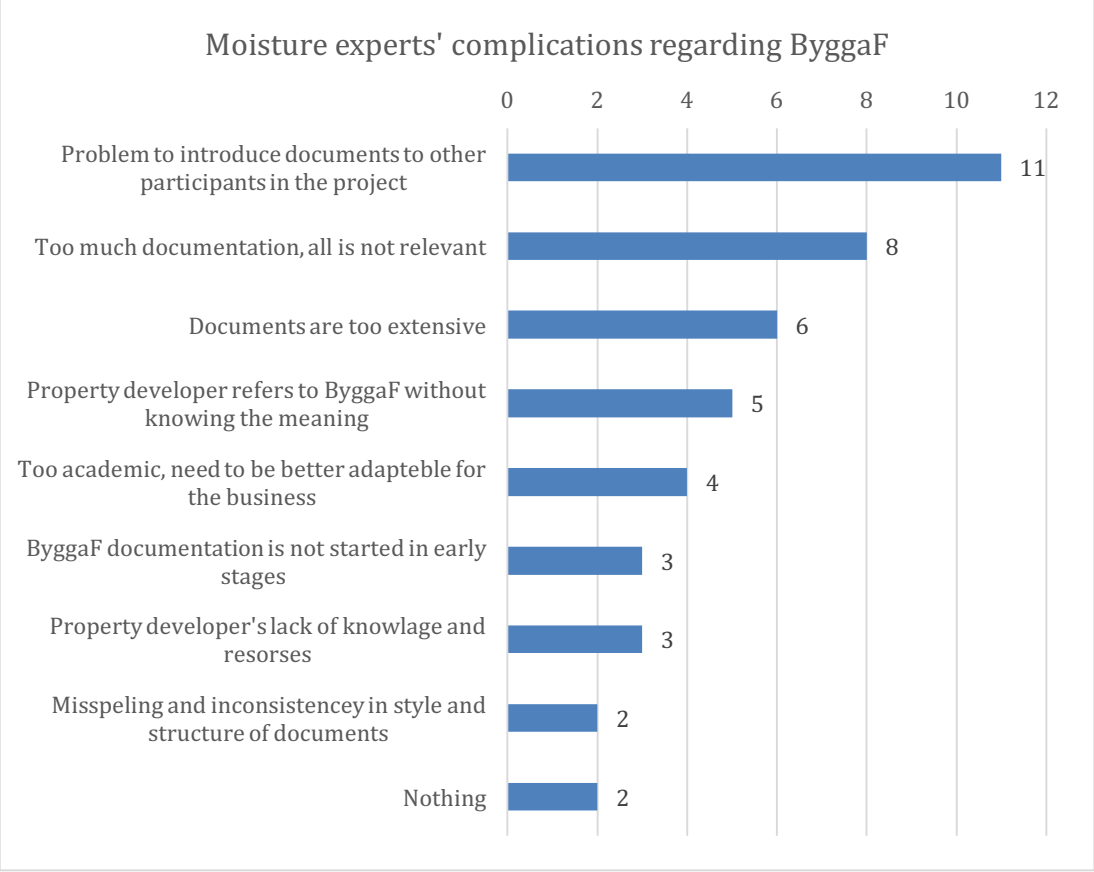


Figure 5 Quantity of moisture experts shared opinion about complications with ByggaF.

The majority, 11 out of 18 moisture experts share experience about the difficulty to introduce ByggaF documents to other participants in the project. The difficulty is because of several reasons such as too much, academic or extensive documentation, other participants do not have enough knowledge or ByggaF has specific documents which are difficult to introduce to other participants.

Half of the interviewees stated the documents are too extensive, which inhibits communication of documents to property developers, designers and constructers. Designers and constructors do not know what to focus on in the project regarding moisture. This is also connected to another problematic area where large number of papers will not be read through, due to time limitation.

Another shared opinion among the moisture experts was the lack of knowledge in moisture among other participants. This results in wrong usage of ByggaF, for instance where parts are skipped or delayed such as an early moisture inventory. If the property developer not invest in moisture safety it can also lead to wrong usage of ByggaF.

One interviewee mentioned that the property developers are sceptical to use ByggaF when they have smaller projects and think this will cost too much. Then it will be difficult to secure adequate moisture safety in those projects.

Two moisture experts pointed out an inconsistency in style regarding language. Documents need to be reviewed in order to get the same language and structure.

3.2 Moisture experts' suggestions for improvement of ByggaF

Moisture expert's suggested improvements of ByggaF are shown in Figure 6.

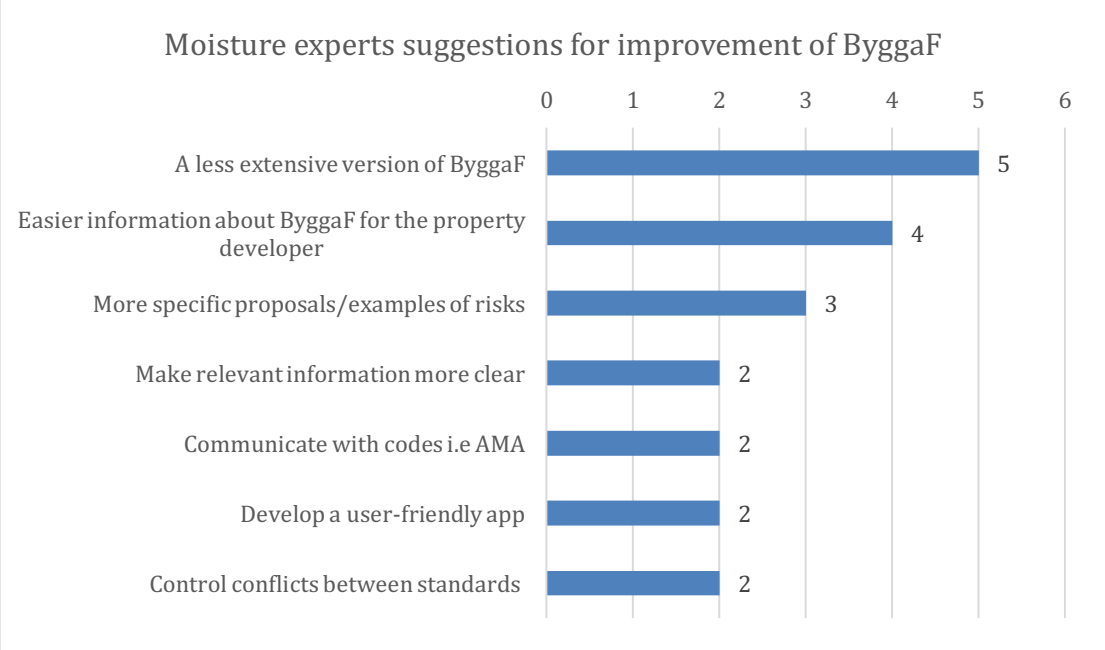


Figure 6 Quantity of moisture experts having the same suggestion of improvements of ByggaF in general.

A third of the interviewees preferred a less extensive version of ByggaF, such as different versions dependent of the size of the project. A simplification of ByggaF is

also linked with other suggestions such as to make relevant information more clear. A too extensive document increases the risk of missing important information in the documents. A way to highlight moisture risks for the specific project is therefore required, according to some of the moisture experts.

It is not required to use ByggaF documents in the original form. A number of companies have developed their own versions of the documents in ByggaF, but where the original ByggaF documents serves as a foundation. These new documents better fit their purpose and abilities and enable them to add own requirements for the specific project.

Moisture experts want simple information to communicate the importance of moisture safety to the property developer. The property developer does not have time to read extensive documents, according to both moisture experts and property developers. Better information to property developers on moisture safety issues offer the increased possibility for the moisture expert to be involved in the process earlier.

Some moisture experts suggests to transform relevant ByggaF-document into an app. This kind of technology is commonly used in the construction industry. An app has potential to increase the spread of ByggaF as well as doing the work more user-friendly, according to some moisture experts.

Property developers communicate AMA codes to the contractors, see Chapter 2.1.1, and a redesigned ByggaF consisting of codes could, according to moisture experts, improve the communication.

Some of the documents have conflicts with other industry regulations, such as *BBV* and *Säkra Våtrum*, see Chapter 2.1.1. These conflicts appear when other industry regulations are updated to newer versions whereas ByggaF remain the same as before.

3.3 ByggaF in program stage

According to moisture experts, property developers lack in knowledge regarding moisture results in problems in terms of; not enough moisture safety measures such as weather protection or drying time, not enough or too late inventory of existing building or a too small budget for moisture prevention.

Moisture experts state that documents in program stage are less used when a moisture expert is not hired at this stage. The result from the interview concerning usage of the document *Moisture inventory in early stages,* confirms that the main reason for not using the document is because the moisture expert is not hired at an early stage in the process. ByggaF method is not working as intended when activities are used in later stages or neglected.

The document *The developer's moisture safety requirements and requirements for activities* was not used by any property developer. One reason according to a moisture expert could be the unclear advantages of using the document. The developers do not have the time to understand this document unless they see any advantage to do so. The moisture expert uses this document to a greater extent and usually includes the requirement in the document *Moisture safety specification*.

Several moisture experts used the document *Job description for moisture experts* as a presentation of themselves in the projects. Some expressed the advantages to have a document which clearly describes the tasks of a moisture expert. This document was also included in the *Moisture safety specification* by some moisture experts.

Half of the moisture experts said they had used the document *Moisture inventory in existing buildings* and most of them used this as a support tool.

3.4 ByggaF in design stage

14 out of 18 interviewed moisture experts' use the document *Moisture safety planning with risk evaluation,* see Appendix 3. The designers are meant to fill in document during the design process. The result from the interviews states several issues with the use of the documents, see Figure 7.

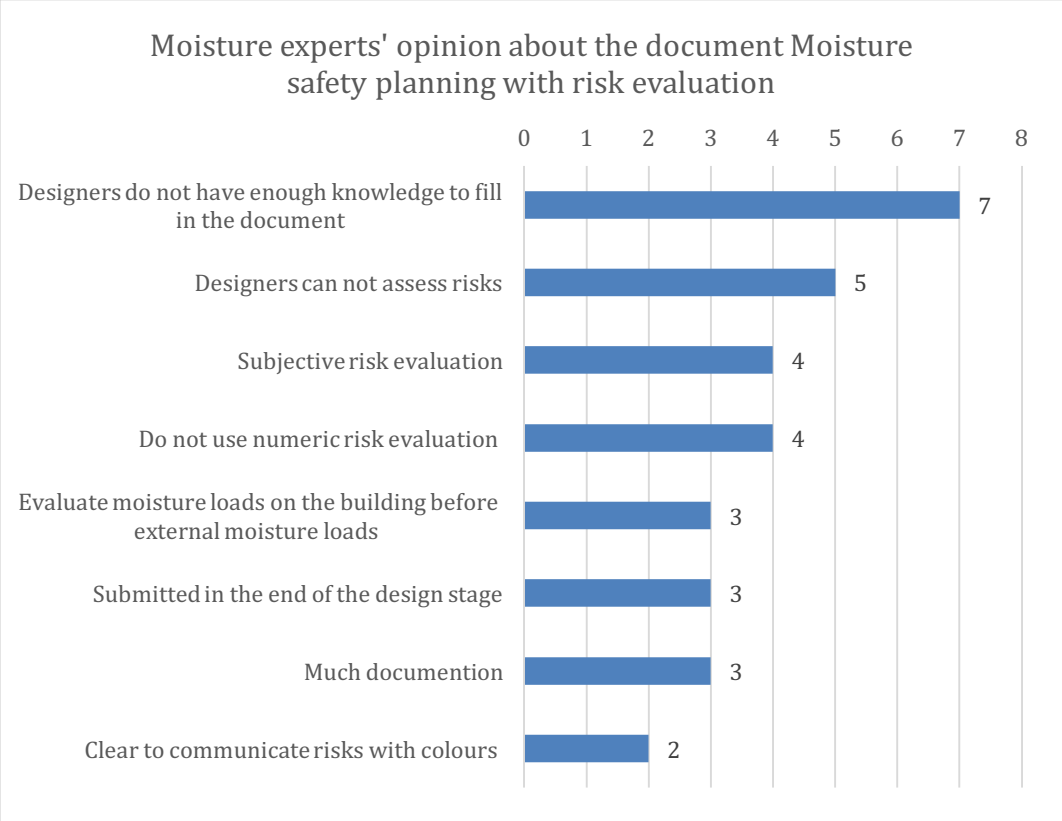


Figure 7 Moisture experts sharing opinion about the document Moisture safety planning with risk evaluation

Four moisture experts filling in the document instead of the designers. Eight moisture experts modify the document four of then removing the numeric risk evaluation from the document. They either replaced this with a question about how the designer is planning to handle the problem or ask the designer to describe the risk with words instead of numbers.

According to moisture experts answers the most common problems with this document is designers' lack of knowledge in moisture. Designers do not have the experience to assess probabilities and consequence connected to moisture loads. This may result in incorrect risk validation. A subjective assessment is carried out which depends on what designers have experienced before. One moisture expert mention that the risk also depends on the contractor and the person carrying out the design. The issues required

to complete the document lead to submission in the end of the design stage according to three moisture experts.

Having more specific examples and proposals of risk would simplify the risk evaluation, according to three moisture experts, see Appendix 3. Two moisture experts would like to include economic risk in the risk evaluation which is a language people in the industry use and understand.

Colour is used in the document to express the degree of risk which some moisture experts think it is a good way to communicate the risk level to the property developer. They understand the concept easier by focusing on the problem.

Three moisture experts said they were using another way to manage the moisture issues which include a thinking of the moisture load influencing on the building structure first and then handle the external moisture loads. This method can be implanted by instead using drawings or virtual reality models to point out potential moisture problems. A clearer checklist were also suggested, due to the current one is too complicated to fill in, see Appendix 3.

The document *Moisture safety specification* was used by almost all the interviewed moisture experts but half of them said they used a modified version. One suggestion from the moisture experts is to make the most important information clearer, because the document is usually too extensive.

3.5 ByggaF in production stage

The document *Moisture safety plan production* is used by the majority of the interviewed moisture experts. This document usually is a relatively long description and an extensive document for the contractors to use. Lack of time or interest from the contractor's side could result in difficulties to reach out with the document as planned according to moisture experts. They also state a knowledge gap between the designers and contractors when communicating routine matters and requirements about the moisture safety.

Communication from the responsible site mangers to the builders are also a problem according to some moisture experts. The information regarding moisture safety needs to be provided to them in a way to avoid simple mistakes or other non-conformities. To improve the communication, some moisture experts suggest to introducing work descriptions in ByggaF for the contractors.

The majority of moisture expert use *Moisture inspection round report* and are overall positive about the document. It is a support during meetings and does direct the focus to relevant moisture safety problems. One moisture expert mentioned the outcome improve when the document is used. Another mentions that the document is written to suit the moisture expert and property developer rather more than the supervisors at the construction site. When the moisture expert or property developer does not control the reports, the contractor has no incentive to perform the inspection rounds.

One moisture expert used the non-conformance report. The others are instead writing companies' or the project's non-conformance report or integrate in the *Moisture inspection round reports*.

3.6 Handling moisture problems in the renovation process

The moisture experts described problems with renovation and the results are presented in Figure 8.

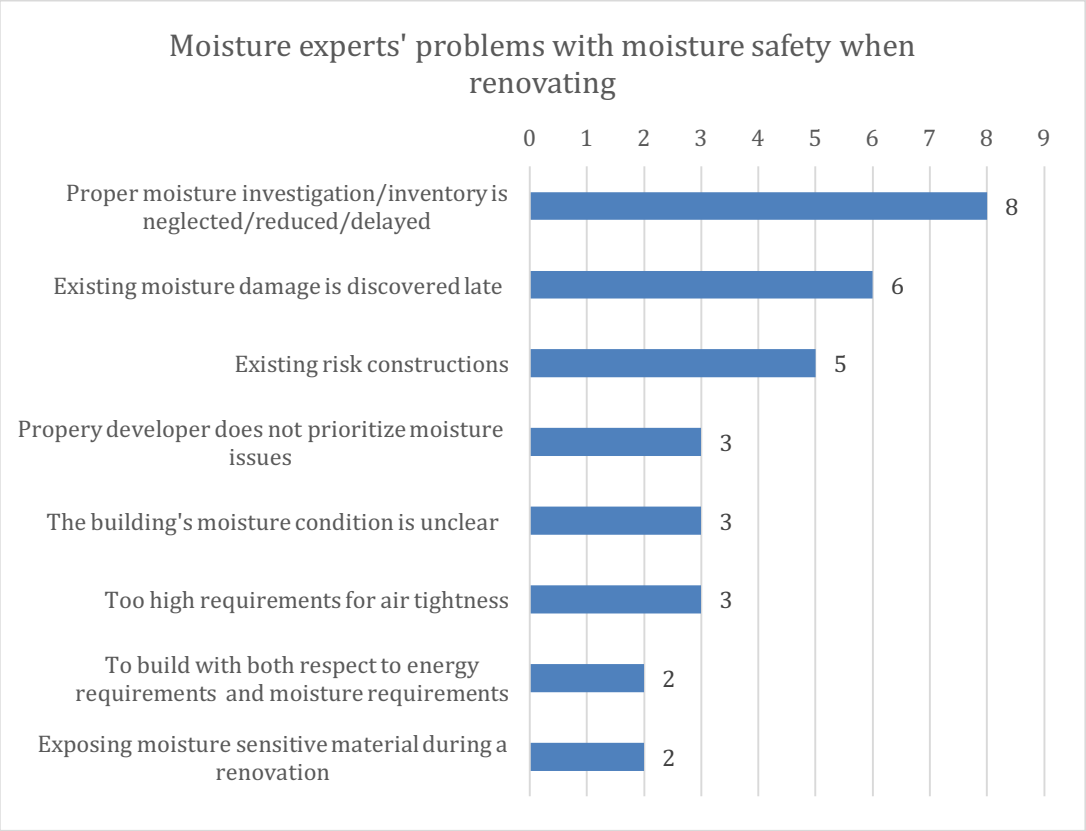


Figure 8 Moisture experts sharing opinion with moisture safety when renovating

Eight out of 17 moisture experts describe problems with the moisture inventory and moisture investigations. When the inventory is neglected, there is a higher risk of finding existing moisture damages later, according to moisture experts. 15 of 17 moisture experts experience finding existing hidden moisture damages in renovation project, see Appendix 3. Seven of them explained damage was repaired which resulted in unexpected costs. One moisture expert described the advantages of doing an early moisture inventory which in this case results in a rethink and stopped the planned renovation due to the findings of severe moisture damage.

The type of project governs the level of inventory for each specific case, according to moisture experts, see Appendix 3. Property developers also decide the level of inventory at the beginning of the project. Some of the moisture experts claim property developers do not prioritize the inventory due to lack of understanding of moisture safety. An extended inventory would be necessary if moisture damage is found, according to two moisture experts. To improve the inventory, eleven of 17 moisture experts suggest a more complete inventory and five suggest a checklist as a technical aid. There is also a suggestion to integrate the moisture inventory with other inventories, such as inventory for hazardous materials.

Buildings with existing risk constructions are problematic in renovation projects. They may already have moisture damage or moisture problems may occur after a renovation due to changing conditions.

In renovation projects, measurements to improve energy efficiency are sometimes made without considering the moisture safety. This may in the end result in damage to the building. For example, better U-value or air tightness of the building envelope affect the building's moisture condition. A requirement set without considering the possible moisture condition may result in a moisture damaged building.

It is important to cover moisture sensitive materials in the existing building during the production stage. According to two moisture experts, this is neglected which may result in moisture damaged materials.

If moisture damage is found, it is difficult to decide how much to remove of the existing construction, according to two moisture experts. In BBR it is described that the moisture damage should not affect health and hygiene, see Chapter 2.1.1, but the difficulty is to assess how much of the structure should be removed to fulfil the requirement.

4 Suggestion to introduce visual inventory checklists to ByggaF

According to the interviews, see Chapter 3.6, the moisture inventory of existing building needs to be improved by implementing checklists. The following chapter describes the document with the visual inventory checklists and the suggested document is found in Appendix 4. BBR put requirements in investigation and documentation of the existing building, see Chapter 2.1.2, and the inventory checklist aims to fulfil BBR's requirement.

A moisture inventory highlights non-conformances and is used to survey an existing building for potential moisture risks. The procedure is already briefly described in the current document *Moisture inventory of existing building* (Fuktcentrum, 2013c). The method described is a non-destructive visual inventory, followed by further investigation if needed. Moisture experts suggested to implementing checklists of the moisture inventory of the existing building, see Chapter 3.6. Based on these suggestions, the document *Moisture inventory of existing building* is complemented by checklists to use with a visual inventory.

The property developer together with a moisture expert decide the scope of the moisture inventory. The decision can be based on the type of renovation or relevant information from the desk study for the specific project.

The new document is separated into two parts. The first part includes tasks to be performed before visiting the building, such as collecting information from users, earlier renovations, earlier moisture investigations and drawings, see Figure 9. The drawings should be checked with respect to construction risks. The suggested construction risks are collected from the original document *Moisture inventory of existing building* (Fuktcentrum, 2013c).

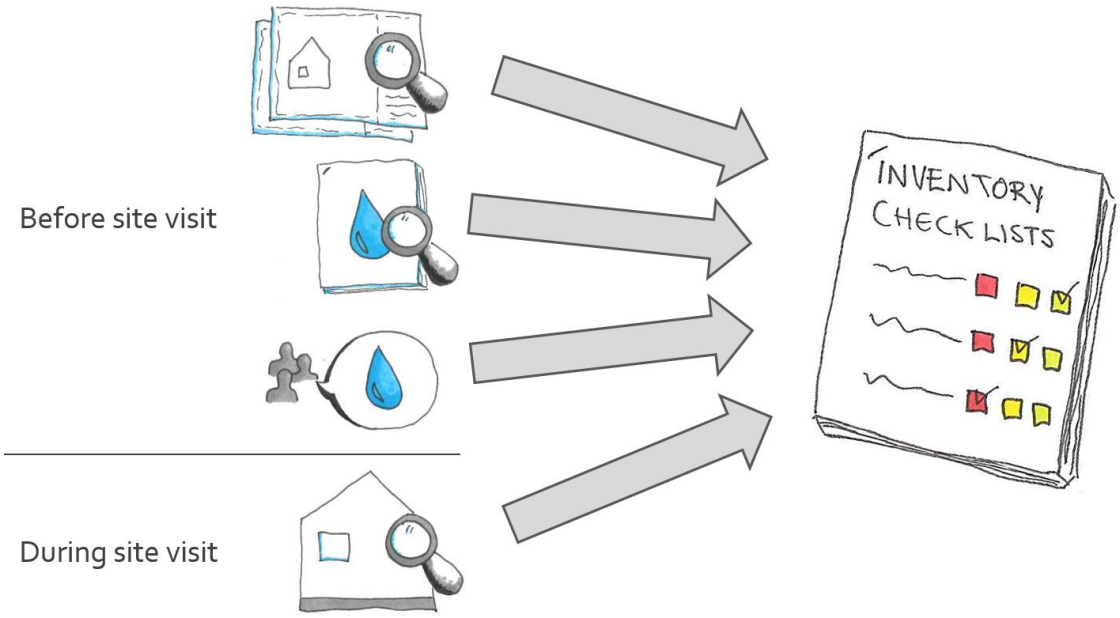


Figure 9 All activities performed before and during site visit are summarized into inventory checklists.

The second step contains visual moisture inventory of the building. The inventory has to be done at the program stage before work specification to the designers and contractors are sent out. Results from the moisture inventory should be distributed to participants who are supposed to submit a tender for the work. This information results in a more correct evaluation of the planned work and extra costs due to unknown moisture damages can be avoided.

All deviations found during the moisture inventory are supposed to be noted and documented with help of photos. The photo numbers in the checklists refer to photos to systematically document the errors for use in further stages. To simplify communication, the level of non-conformance in each category of evaluation is based on a colour green, yellow and red. Control points without remarks are green, further investigations are yellow and red symbolise that further measures are required.

4.1 Control points for the visual inventory

The control points are based on literature, study visits and interviews with independent moisture technicians. The control points have subsequently been developed in an interactive process with moisture technicians and further study visits.

The document includes the most common structures of a building. The type of renovation together with the decision from the property developer decide which structures are required to be inspected. For an outer moisture inventory this document includes control points for the ground, façade and roof[1]. For the façade and roof, each category also includes specific control points for specific materials. The interior moisture inventory includes a general part to include control points includes all rooms. Rooms with higher risk of moisture damages have also a more detailed description of control points, which are: wc, wet room, kitchen, cold ventilated attic, basements and crawlspace.

Some of the control points are based on guidelines from Folkhälsomyndigheten, see Chapter 2.1.1. Indications such as visible moisture damage, damp patches and discolouring, and extensive condensation on the interior side of windows, for outside temperature below 5 ℃ (Folkhälsomyndigheten, 2014). They also describe the risk of microbial odour affecting human health, which potentially comes from other areas in the building. Odour is usually an indication of moisture problems, and should be controlled in all indoor areas.

Attention should be paid to surfaces, joints, connections and inlets during visual inspection[1]. These are critical to vapour proof performance and hence sensitive to moisture. Cracks or other damages in the surface are also a risk for moisture damage.

For the non-destructive visual inventory, the use of moisture indicator equipment is an option to detect non-conformances of moisture levels on the surfaces[2]. Examples of those tools are protimeter moisture detectors and RH-sensor. Example of controls with protimeter moisture detector is underneath windows on the interior side of the wall[3].

[1] Bengt Olsson moisture inspector at Anticimex, interviewed 12 Mars 2016
[2] Kent Bergström moisture educator at Polygon, interviewed at study visit 8 April 2016
[3] Magnus Hansén moisture technician at SP, interviewed at study visit 7 Mars 2016

Another use is in wet rooms where indications can be used to detect high moisture level underneath plastic carpets. The level of usage of these tools is depended on the specific building[1].

In the renovation process, the new design should fulfil today's requirements from PBA and BBR, see Chapter 2.1.1. *Industry regulation Säker Vatteninstlatation*, see Chapter 2.1.1, set measurements and requirements. For example: the distance from wall to floor drain minimum 200 mm (Säker Vatten AB, 2016), an existing floor drain closer than 200 mm needs to be moved to fulfil the requirements of *Industry regulation Säker Vatteninstallation*, which can lead to extra costs[2]. It is therefore of interest to the property developers to know the existing distances from the moisture inventory to better plan a budget for a renovation.

Control points are also linked with common moisture problems in the renovation process, see Chapter 2.3. Notes about the building condition and design can make the design process more moisture safe, for example if there is an air cavity.

[1] Jörgen Wadman building physicist at Integra, interviewed at study visit 21 April 2016
[2] Kent Bergström moisture educator at Polygon, interviewed at study visit 8 April 2016

5 Suggestion to adjust *Moisture safety planning with risk evaluation*

In this chapter, suggestions are presented of possible improvements to the document *Moisture safety planning with risk evaluation*. The suggestions are derived on the interviews from moisture experts, see Chapters 3.2 and 3.4, and literature study from this field, see Chapters 2.1.1 and 2.3.

To improve this document three different suggestions is stated. Firstly, improvements in the document for easier usage for the designers. Secondly, adjustments in the document to be more consequently and prevent conflicts with other industry regulations. Finally, adjustments in the documents to suit the process of renovation.

5.1 Develop guidelines for risk evaluation

The main issues, according to the interviews, is designers´ lack of knowledge regarding moisture. The improvements to increase the moisture safety level could be carried out in various ways such as education or better guidelines. In this section, guideline proposals are presented which have potential to develop further to ease designers' work.

5.1.1 Computer simulation

An increased knowledge of computer simulations for the designers provide another tool to assess moisture risks and enhance the chances to improve the risk evaluation. Computer software such as WUFI, which calculate one and two dimensional moisture transport in building structures, is a suitable tool to detect possible risk of mould growth (WUFI, 2016). WUFI, together with other computer software, is mentioned in the *Industry standard ByggaF* when estimating moisture conditions.

Further devolution of models may establish better accuracy of the result. An improved model takes into account factors and parameters to avoid or limit the risk of mould growth. To determine measures and risks of mould growth in buildings can use of charts from the report *Moisture risk evaluation and determination of required measures to avoid mould damage using the Folos 2D visual mould chart* (Mundt-Petersen, et al., 2012). The charts are recommended to be used in the design stage of ByggaF to evaluate moisture risks.

5.1.2 Expert system - Artificial Neural Network

One method to carry out a risk evaluation is with help of an Artificial Neural Network, ANN (Yverås, 2008). By using empirical data, the tool learns to understand the relationship between the input values and thereafter predict output values similar to reality. The result from ANN with help of real world input values recognise and foresee problems with odour, moisture and rot in a construction. The tool was tested on unforeseen real crawl spaces with an outcome of classifying the conditions regarding odour, moisture and rot with reasonable result.

5.1.3 Guidelines based on research

A way of guidance in evaluating the risks could also be carried out with help of previous research from this field. Researcher usually use a method to quantify the risks called probabilistic risk assessment (Pallin, 2012). The method is divided into two steps, first a qualitative probabilistic analysis and second a quantitative probabilistic analyses.

In the qualitative probabilistic analysis hazards are identified and influential parameters and their uncertainties determined (Pallin, 2012). To identify and categorize hazards could for example Fault tree analyses or Event tree analyses be used. Evaluation of the result is carried out afterwards and checking if further analyses is required.

Quantitative probabilistic analysis is used to provide probabilities of hazardous events and validates the result (Pallin, 2012). This carries out with help of example computer simulations or uncertainty analyses using sampling methods such as Monte Carlo.

In this section, examples of cold attics and exterior wall were assess based on risk analyses. This gives an indication for the designers to know potential risk for specific structure. To develop this assistance further, examples should be presented in terms of structures and geographical differences. To use this the designer should have enough knowledge to understand the limitations and use it as a guide for the risk evaluation.

Cold attic

From the report *Moisture safe cold attics – assessment based on risk analyses of performance and cost* (Hagentoft & Sasic Kalagasidis, 2014), the risk assessment is based on risk of mould growth for the different designs of attics. The assessment using a validated deterministic model for heat and moisture transfer and the referece case represents a conventional cold ventilated attic from a multi-family house, where two construction types of the attic floor are considered. Alternative designs of the attic which are considered in the report are conventional, thermal insulation roof, controlled ventilation, diffusion open membrane and moisture buffering insulation material.

The results present the different designs associated with a risk which are linked with a colour, see Figure 10.

Another example of a risk assessment of cold attics is found in the report *RAP-RETRO, Appendix 2, Solution C - Framework for probabilistic assessment of performance of retrofitted building envelopes* (Sasic Kalagasidis & Rode, 2015).

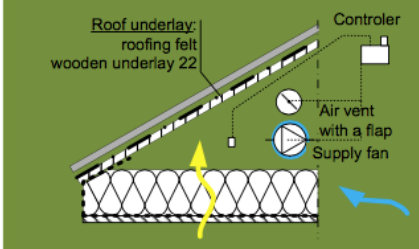
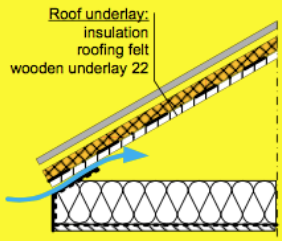
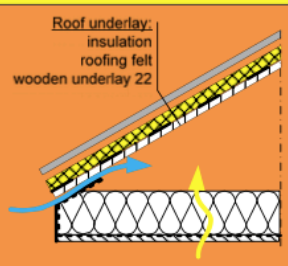
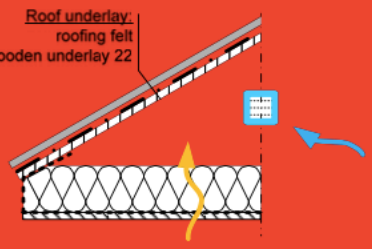
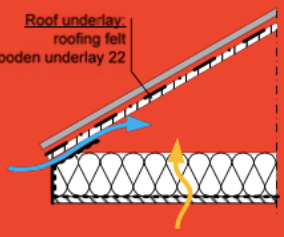
	Cold attic construction	Requirements and sensitivity
Risk free	 Controlled mechanical ventilation	The airtightness of the attic should be 10 1/h @ 50Pa or better Ventilation should start directly after completeness of attic construction Requires alarm function for failure of mechanical devices Lowest total life cycle cost
Low risk	 Insulated roof, good air tightness of the attic floor	Requires durable solution for the airtightness of the attic floor. Works better at low moisture excess in the building (well ventilated housing - preferably exhaust only mechanical ventilation system). Sensitive to the building orientation. Some sensitivity to the local and future climate. Should be supplemented with dehumidifiers in the construction phase to eliminate built-in moisture.
Semi-high risk	 Insulated roof, some air leakage in the attic floor	Works better at low moisture excess in the building (well ventilated housing - preferably exhaust only mechanical ventilation system). Sensitive to the local and future climate. Should be supplemented with dehumidifiers in the construction phase to eliminate built-in moisture.
High risk	 Reduced ventilation – only through gable vents; air tight roof eaves.	Extra sensitive to the lack of air-tightness in the attic floor and high moisture excess in the home. Should be supplemented with dehumidifiers in the construction phase to eliminate built-in moisture. Sensitive to future climate.
High risk	 Traditional cold attic	Extra sensitive to the lack of air-tightness in the attic floor and high moisture excess in the home. Sensitive to future climate. The most expensive technical solution when lifecycle cost is assessed. Should be supplemented with dehumidifiers in the construction phase to eliminate built-in moisture.

Figure 10 Summarized risk level of attics with various designs (Hagentoft & Sasic Kalagasidis, 2014)

Exterior wall
To evaluate the usage of interior insulation on an exterior masonry wall a case study where five various solutions was tested, from the report *RAP-RETRO, Appendix 1, Solution A - Framework for probabilistic assessment of performance of retrofitted building envelopes* (Sasic Kalagasidis & Rode, 2015). The research assessed the performance in terms of durability regarding mould damage and three materials were tested with different thicknesses. They communicate the durability in form of signs where "+" is preferable whereas "- -" less preferable.

Tabell 1 summarized risk table. The thicknesses of insulation and porosity of the material is important where thinner and porous walls are more durable regarding moisture problems (Sasic Kalagasidis & Rode, 2015).

Material	Durability
A: Plates of porous insulation material – 3 cm	+
A: Plates of porous insulation material – 6 cm	0
B: Mineral wool with vapour barrier and gypsum board – 3cm	-
B: Mineral wool with vapour barrier and gypsum board – 6cm	--
C: Plates of insulation material with plaster on the inside – 6cm	-

5.2 Replace numeric risk evaluation
Results from the interview with moisture experts indicate four of 18 exclude the numeric risk evaluation in the document *Moisture safety planning with risk evaluation,* see Chapter 3.4. The moisture experts replace the numeric risk evaluation with descriptions in words. The exclusion of numeric risk evaluation results in an easier usage of the document for them and the designer, according to these moisture experts.

The idea is to let the designers describes the moisture safety solutions with support of drawings and the moisture experts decides if further moisture simulations are needed or the details are made in an acceptable way.

5.3 Update wet room and installation section
There is an inconsistency in the document *Moisture safety planning with risk evaluation* in the part describing the sensitivity and relevant importance for different structures. The introduction page in this sheet state that this part includes examples of critical structures and details which designers should be aware of during the designing process. The wet room and installation section are not following information as stated in the introduction and therefore inconsistent to the other parts. Instead there are explanations in how to build a wet room with requirement according to the *Industry regulation Säker Vatteninstallation*. This causes problem in both inconsistency and contradiction if example the *Industry regulation Säker Vatteninstallation* updates more frequently compared to ByggaF.

One way to improve this issue, in terms of better consistency and less contradiction, is to rewrite the sections and suggest to use the present industry regulations such as *Industry regulation Säker Vatteninstallation, BBV, Säkra våtrum and Måleribranschens regler för våtrum*, see Appendix 5. This is to avoid conflicts between ByggaF and other industry regulations and keep ByggaF updated when other industry regulations releases new versions.

5.4 Suggested updates to suit the process of renovation

The conditions differ for designers in renovation projects when performing the *Moisture safety planning with risk evaluation* document. In these projects they have the advantage in using the moisture inventory report for existing buildings to evaluate the condition.

Besides that, further updates are made in the document *Moisture safety planning with risk evaluation* to better fit its usage for renovation projects. The focus of suggested updates is to ease the designers work by adding further key points to be aware of when evaluating external moisture sources. The suggested key points are only meant for renovation. However, current key points in the list may still be useful for renovation projects. The updates are only done for the structures; roof and attic; outer wall and façade; foundation and basement, see Appendix 6 for all suggestions. These structures may have other conditions in a renovation process which therefore also have suggested updates.

5.4.1 Roof and attic

Renovation of a roof or cold ventilated attic may change the moisture condition in a way which potentially damage the structure, see Chapter 2.3.1. Suggested updates in this section are following:

- A changed activity in the building which lead to higher moisture production increase the risk for diffusion.
- Increased floor insulation of the attic increase risks of convection.
- Change of ventilation rate may impact the moisture condition in the attic.
- Be aware of the moisture risks during production stage. Uncovered existing structure may be sensitive to moisture.

5.4.2 Outer wall and façade

The outer wall may be more sensitive to moisture after adding insulation on the interior side of the wall, see Chapter 2.3.2. A change of the ventilation rate is also critical. Suggested updates in this section includes the following points to be aware of:

- A longer drying time as well as creating a colder outer structure when adding interior insulation.
- A change of ventilation rate may change the interior pressure in the building which increase moisture problems due to convection.
- Reduced ventilation increase the risk of mould due to internal moisture production
- Control existing vapour barrier, avoid double layers.
- Increased relative humidity due to adding interior insulation.

5.4.3 Foundation and basement

Most of the existing control points are already applicable on a renovation project. The only suggested change is in the basement wall section, see Chapter 2.3.4, and should be aware of additional interior insulation increase the risk of mould damage.

Another change involves both new production and renovation which include floor heating on a ground plate without insulation. This increase the risk of moisture damage when moisture transmits to other parts of the building due to the heat from the floor heating (Antonsson & Jansson, 2015).

6 Suggested changes of *Industry standard ByggaF*

The document *Industry standard ByggaF* needs changes to implement suggested improvements of the documents *Moisture inventory in existing building* and *Moisture safety planning with risk evaluation*, see Chapter 4 and Chapter 5. This chapter also includes suggested changes to improve the current ByggaF, based on interviews.

6.1 Improve the current use

The existing document needs to be updated to make this distinct. The suggested adjustments are made in order to implement moisture experts and property developer's suggestions with the aim of improving the industry regulation to make it more user-friendly. The main issue with the current industry regulation is that parts are unclear. To make the indistinct parts clearer, adjustments are suggested, see Appendix 7 for all proposals.

In the document *Industry standard ByggaF,* only the organisation of a design-bid-build contract is described in a figure. The organisation for design-build contracts is described only in the text. To simplify for the reader an organisation tree even for a design-build organisation is suggested, see Figure 11. Each participant who are obligated to have a moisture safety officers are highlighted with white boxes according to the text in *Industry standard ByggaF*.

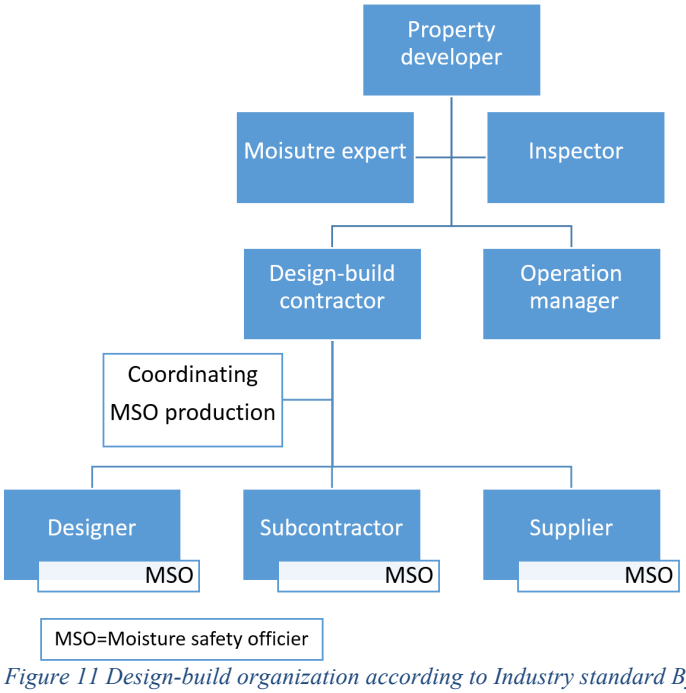


Figure 11 Design-build organization according to Industry standard ByggaF

According to moisture experts, there is a problem with introducing ByggaF to the property developers and therefore are they requesting an easier guide to the document, see Chapter 3.2. A suggestion is to explain ByggaF's procedure in a schematic figure which clarify the participant's involvement for each activity. The activities are listed in chronological order and the participants and activities are named as in *Industry standard ByggaF*. The order of activities follows the same as in the building process to encourage the property developer. The suggested schematic figure is found in Appendix 8.

6.1.1 Improvements of design stage

The document *Moisture safety design with risk evaluation* is described as difficult for designers to use. One of the difficulties is designers' problem in assessing the probability and consequences in a risk evaluation, see Chapter 3.4. The guidance in ByggaF suggests the use of qualified assessments for the risk analysis, but the guidance does not explain how to carry out this assessment. Instead, there is a description of how a preferred risk analysis is done, which does not help the designers to evaluate the risks at this stage. There is a need to have a better description in how a qualified assessment could be carried out, see Chapters 5.1 and 5.2.

One measure to achieve a better moisture safety is to introduce clearer requirements or qualifications for the moisture safety officer in design. According to *Industry standard ByggaF* should the moisture safety officer be responsible for the moisture risk analyses. This is needed to ensure a qualified person is responsible for the risk evaluation. The person should have a good understanding of ByggaF and risks concerning moisture. The requirement should be stated as guidelines or requirement in *Industry standard ByggaF*. Designers ask for help from the property developer's moisture expert. It can lead to consequences in law if the moisture expert helps and the design leads to a moisture damage.

6.2 Suit the process of renovation - include visual inventory

Adjustments are needed to include a visual inventory in the document *Industry standard ByggaF*. All the suggested changes are found in Appendix 9. The idea is to perform a visual moisture inventory in the program stage and communicate the result to design, production and operation stage, see Figure 12.

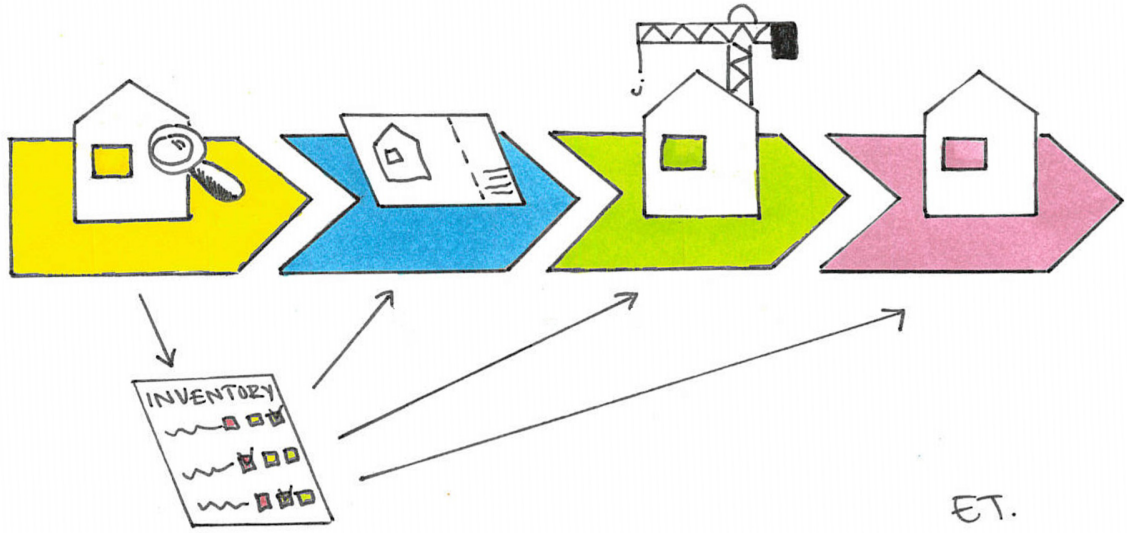


Figure 12 Visual inventory checklist from program stage (yellow) communicated to design (blue), production (green) and operation stage (pink).

Performing a visual moisture inventory of existing building in the program stage should be compulsory in the method. The document visual inventory checklist, see Appendix 4, is suggested as a guidance in the document *Industry standard ByggaF*.

BBR require investigations, see Chapter 2.1.2, and a moisture inventory provide indications for further investigations, which may be important for the designers. It is necessary for the property developer to decide if further investigation is necessary at

the program stage. It should also be possible for investigations at the design stage, if designers need it to estimate moisture conditions and do a proper moisture safe design.

Another aspect is the communication of the results of the inventory to the designers and contractors. Moisture safety program, moisture safety specification and moisture safety documentation communicate the property developer's requirements and the project conditions from a moisture aspect. By adding guidance to respective chapters in the document it is possible to highlight results from the inventory of the existing building.

Information about the project is communicated also during meetings at the start of the design stages and production stage, according to ByggaF. Results from the inventory of the existing building should also be communicated during these meetings. Other documents, such as *Moisture safety plan production*, can also be updated to provide better communication of results from the visual inventory checklist.

7 Discussion

This chapter includes discussion about the results from the interviews and suggested improvements. Some of the suggestions require further investigations, which is discussed.

7.1 Interview results

18 moisture experts and four representatives from property developers where questioned. Moisture experts worked in different stages of the building process and described possible improvements in ByggaF for the program, design and production stage. However, the results from interviews would be more accurate if designers and contractors also were interviewed. The results from the property developers' representatives are insufficient due to the small selection group. A larger interviewee group would increase the possibility of analysing their opinions. The organisation managing Miljöbyggnad, SGBC, could not provide a list with projects achieving silver or gold for the moisture indicator in their standard. The interviewee group might have been larger if these lists existed and hence give a better chance to find right persons.

It is recommended but not compulsory to use the different documents from ByggaF according to *Industry standard ByggaF*. This enable the participants to complete activates in ByggaF without using the original documents. In the interviews, it was asked which documents were used and how these were used, see Appendix 1 for all questions. It was not discussed to what extent the document was used. The moisture experts could say they used the document, but it was not clear if it was in one or in several projects. Another option is to ask the interviewees in how they performed the described activities in ByggaF and how well the documents supported the activity.

Opinion based questions, where the interviewee could answer with their experience, got a large spread of answers. Some opinions were consistent for several moisture experts and used as base for further suggestions for development of ByggaF. Opinions stated by a few or just one person were difficult to proceed with. Interviewees may have had the same opinions, but did not mention this during the interview, this might be because other issues were discussed instead. The uncommon opinions may also be valuable for further development, even if expressed by a few. As an example, only two moisture experts stated ByggaF has conflicts with other industry regulations, which turns out to be the case which led to suggestion of changing this in the document *Moisture safety planning with risk evaluation,* see Chapter 5.3. However, most opinions expressed by only one person were excluded in the report because it not possible to know if the opinion is wide spread.

ByggaF-projects are not registered and hence is not possible to follow up in order to determine how many projects or in what way ByggaF is used. One way to chart the usage of ByggaF could be with use of a database, where moisture expert fill in how they used ByggaF and explain complications. This tool has the potential to provide useful information such as trends and common issues on a large scale selection of people. A database has potential to facilitate the process of developing ByggaF by letting moisture experts exchange experience. However, there is a risk this also could lead to extra obligation in the ByggaF-method which moisture experts do not appreciate, some already express problems with too much documentation.

7.2 Introduce ByggaF to other participants

Moisture experts found it complicated to introduce ByggaF-documents to other participants in the construction industry, see Chapter 3.1. The documents are too extensive and needs to be clearer. Complicated documents increase the risk that important findings are lost.

The schematic figure of ByggaF, see Appendix 8, may be one solution to simplify the introduction of ByggaF. However, the guide is not proposed to replace the original document. Detailed information from the *Industry standard ByggaF* still is important. The purpose of the guide is to introduce property developers to easier use ByggaF in an early phase of the project and highlight the importance to participate in early activities.

Other documents such as *Moisture safety specifications* and *Moisture safety plan production* are considered as extensive and need development. However, improvements of these documents is not suggested in the report's result. The reason is that focus instead has been on other ByggaF-documents. Further research is needed to develop all ByggaF-document to be less extensive and more user-friendly. This was confirmed by interviews, which indicate revision of the documents in ByggaF for easier introduction to other participants. Suggestion such as introducing an app, better visualization or guidance in how to summarize the document are some solutions of the problem.

7.3 Changes in *Industry standard ByggaF*

The suggestion of introducing a schematic figure for property developers, see Appendix 8, could either be placed in the *Industry standard ByggaF* or as a separate document. A separate document could ease the distribution, but on the other hand there are several interviewees, expressing concern over adding documentation to ByggaF. This needs to be considered before adding further documents.

Several moisture experts suggested that ByggaF to better fit smaller projects. A smaller project might not require as extensive organisation to ensure moisture safety. However, the definition of "smaller project" is unclear and there is a risk larger project might claim to be a small project to reduce the moisture safety organisation.

7.4 Moisture safety planning with risk evaluation

The interviews with moisture experts clearly state problems with the risk evaluation in the document *Moisture safety planning with risk evaluation*. Moisture experts changing the document to ease the work for the designers, which indicate this document needs further development. There are at least two possible suggestions, either improve the guidance in how the risk can be evaluated or change how the risk evaluation is carried out, see Chapters 5.1 and 5.2. All suggestions to improve this document should be evaluated and tested by the users, to ensure the improvements simplify the usage.

The aim of ByggaF is to ensure, communicate and document moisture safety through the entire building process. If the design stage has a complicated document, there is a risk for insufficient moisture safety through the rest of the process. The document *Moisture safety planning with risk evaluation* is recommended to use. Even if the document is not obligated, there is a need to make the document better for the user.

The suggested improvements were based on interviews with moisture experts. These improvements might have been different if the designers also were interviewed and got the chance to come up with suggestions.

7.4.1 Guidelines to improve the risk evaluation

The report present three possible guidelines for risk evaluation. The first option includes usage of a computer software such as WUFI. The result from software guide the user to perform a risk evaluation but require a good understanding of the tool to be useful. Increased competence in software usage is required to have this as a guide in risk evaluation.

The analysis can also be carried out using an expert system such as ANN which provides risks directly when input with data concerning the building. At the moment, the system is only developed and tested on crawl spaces but a more developed ANN is likely to ease designers work and assessment. Possible scenarios in the future could lead to a system with potential to evaluate other structures and enhanced assessment of the existing parts. A more user-friendly tool also has potential to spread to more of the designers in the construction business. However, this development should be carried out with care so designers still have enough knowledge to understand the limitations and result that ANN provides and be capable of making their own assessment.

Guidelines based on research could be used for example a risk assessment. Examples performed by researchers provide a highly reliable standard in the assessment and a help for similar designs as the examples. The problems with these guidelines turns out to be due to the limitations of the research examples, which often is performed for unique design and conditions. In addition, another aspect is also the accessibility of research results and the time aspect to find relevant research material. Nevertheless, give these a direction in how to validate a moisture safe design.

Finally, all the guidelines are possible to be used as useful tools for the designers but need further development before they could be truly adoptable and user-friendly. Some of them might be easier to develop and used in the near future. This depends in how the construction business chooses to develop with the suggested guidelines. They all have potential to be helpful to perform risk evaluations but each tool has their advantages and disadvantages. The sort of object and competence of the designer also influences the choice of the most suitable guidelines.

7.4.2 Additional changes

One way of simplify the design process is to replace the numeric risk evaluation and instead describe the risk with words. However, exclusion of a risk evaluation might result in missing information in the document which would weaken the purpose of highlighting critical structures. Further investigations need to ensure this option leads to better or equally good moisture safety as the numeric risk evaluation.

Another way of improving the risk evaluation is to make sure moisture safety officer has the right competence. This could be based on the requirements stated for moisture safety officer for production, as suggested, or achieved by attending a specific course or perform an examination. To find suitable requirements, this needs to be evaluated with respect to scope and level. Fuktcentrum provide a course for moisture safety

officers which might be a suitable course to recommend in the document *Industry standard ByggaF*.

In the wet room and installation sections, suggested updates have been done to reduce conflicts with other industry regulations and improve the consistency. The relevant industry regulations have been proposed to be referred to instead. The original text has been summarized as things to be aware of, instead of detailed requirements. However, there is a risk more things described in *Industry regulation Säker vatteninstallation* to be aware of as well as relevant information from the other industry regulations. This information may be useful in the document but also be complicated when integrating several industry regulations in one single document. One way to resolve this issue is to summarize shared key points from the regulations, however this is not covered in the suggestions.

7.4.3 Suit the process of renovation

Most of the existing control points in the document can be applied to a renovation projects. The suggested control points need to be controlled by designers to confirm that the updates are useful. Further research to control the updates are necessary.

7.5 Visual moisture inventory

There is a risk property developers do not use the ByggaF method in the program stage which might lead to the visual moisture inventory is not being done in the right phase, as stated in the Chapter 3.3. A postponed moisture inventory may not have the effect due to important decisions already have taken place without usage of the information from this inventory.

To better handle this inventory in real cases. It is preferable to be implemented in a computer software or app for a mobile device. The construction industry is trying to develop in a way to use more technical devices which was confirmed by some moisture experts who expressed deciare for an app version. This probably would improve the efficiency of performing an inventory as well as easing integration of photos into the report immediately at the site.

After a visual inventory should the property developer decide if further investigations are needed, according to the suggestion. Preferable is this decision taken in the program stage but if this is neglected should designers also have the ability to decide if further investigation is considered necessary. However, investigation in the design stage may be problematic due to important plans or decisions already have taken place as well as time limitations or money issues.

This first version requires tests in real cases by experienced persons, to control the usage. The results from the moisture inventory needs to be evaluated by designers and other persons using the document to perform moisture evaluation.

8 Conclusions

This master thesis has dealt with suggestions of adjustment of ByggaF to improve the current use and suit the process of renovation. This report provides suggestions to improve the ByggaF-documents, which are based on current acts and regulations, research reports from the field and interviews with moisture experts and representatives of property developers.

To be useful also for renovation, ByggaF requires a visual moisture inventory in existing buildings in the program stage. A visual moisture inventory checklist is suggested and property developers should decide if further investigations is needed.

The document *Moisture safety planning with risk evaluation* needs the following improvements to simplify the use:

- Improved guidelines or make the risk evaluation more user-friendly
- Add control points to suit the process of renovation
- Reduce the conflicts with other industry regulations and be more consistent
- Moisture safety officer for design needs clearer competence requirements

Other main findings are:

- The interviews indicate that the average knowledge in moisture safety is low in the construction industry and some of the involved participants need better understanding and competence
- Moisture experts should be involved early in the building process
- ByggaF is problematic to introduce to other participants and a schematic figure is needed to easier describe the ByggaF-method
- A wider interview group also including representatives from designers, contractors and property developer would have been preferable to support the common thoughts to conclude the result

Suggested changes should be implemented in the *Industry standard ByggaF*. Further evaluation and tests in the construction industry is recommended.

9 References

Anticimex (2016). *Skydda och inspektera sockeln på ditt hus.* Available at: https://www2.anticimex.com/sv-SE/fuktproblem/misstanker-du-fukt-eller-mogelskada/sockel/ [Accessed 28 04 2016].

Antonsson, U. & Jansson, A. (2015). *Utmaningar och möjligheter av våtrum,* Borås: SP Technical Research Institute of Sweden.

Antretter, F., Fink, M. & Holm, A. (2015). *Annex 55 Reliability of Energy Efficient Building Retrofitting- Probability Assessment of Performance and Cost,* Gothenburg: Chalmers University of Technology.

Arfvidsson, J., Hagentoft, C.-E. & Samuelsson, I. (2007). *Få Bukt med Fukt.* 1st Edition ed. Stockholm: Research institute Formas.

Arfvidsson, J. & Harderup, L.-E. (2005). *Moisture Safety in Attics Ventilated by Outdoor Air.*. Reykjavik, The 7th Symposium in Building Physics.

Bednar, T. & Hagentoft, C.-E. (2015). *Annex 55 Reliability of Energy Efficient Building Retrofitting- Probability Assessment of Performance and Cost,* Gothenburg: Chalmers University of Technology.

BFS 2014:3. *Boverkets byggregler,* Karlskrona: Boverket.

Boverket (2010a). *Teknisk status i den svenska bebyggelsen,* Karlskrona: Boverket.

Boverket (2010b). *God bebyggd miljö – förslag till nytt delmål för fukt och mögel,* Karlskrona: Boverket.

Boverket (2014a). *About Boverket's Building Regulations, BBR.* Available at: http://www.boverket.se/en/start-in-english/building-regulations/national-regulations/boverkets-building-regulations-bbr/ [Accessed 18 04 2016].

Boverket (2014b). *Välj ventilationssystem när du bygger eller renoverar.* Available at: http://www.boverket.se/sv/byggande/halsa-och-inomhusmiljo/ventilation/valj-ventilationssystem/[Accessed 28 04 2016].

Boverket (2016a). *PBL Kunskapsbanken.* Available at: http://www.boverket.se/sv/PBL-kunskapsbanken/Lov--byggande/Byggprocessen/Byggherrens-ansvar/[Accessed 20 04 2016].

Boverket (2016b). *The construction process.* Available at: http://www.boverket.se/en/start-in-english/building-regulations/the-construction-process/the-construction-process/[Accessed 02 05 2016].

Byggkeramikrådet (2015). Trade Rules of the Swedish Cermic Tile Council for Wet Areas BBV15:1. *Branschregler.* Available at: http://www.bkr.se/fakta/branschregler/ [Accessed 02 05 2016].

Byggkeramikrådet (n.d.). *Branschregler.* Available at: http://www.bkr.se/fakta/branschregler/[Accessed 19 04 2016].

Folkhälsomyndigheten (2014). FoHMFS 2014:14 Allmänna råd om fukt och mikroorganismer. *FoHMFS 2014:14.* Available at: https://www.folkhalsomyndigheten.se/publicerat-material/foreskrifter-och-allmanna-rad/fohmfs-201414/[Accessed 28 04 2016].

Frejd, B. (2009). Boverket informerar 2009:3. *Om fukt i byggnader.* Available at: http://www.boverket.se/sv/byggande/halsa-och-inomhusmiljo/om-fukt-i-byggnader/ [Accessed 12 05 2016].

Fuktcentrum (2013a). Industry standard ByggaF – method for moisture safety of the construction process. *ByggaF-metoden.* Available at: http://www.fuktcentrum.lth.se/verktyg-och-hjaelpmedel/fuktsaekert-byggande/byggaf-metoden/[Accessed 18 04 2016].

Fuktcentrum (2013b). Fuktriskinventering i tidiga skeden (XLSX). *ByggaF-metoden.* Available at: http://www.fuktcentrum.lth.se/verktyg-och-hjaelpmedel/fuktsaekert-byggande/byggaf-metoden/[Accessed 22 04 2016].

Fuktcentrum (2013c). Fuktinventering i befintlig byggnad. *ByggaF metoden.* Available at: http://www.fuktcentrum.lth.se/verktyg-och-hjaelpmedel/fuktsaekert-byggande/byggaf-metoden/[Accessed 22 04 2016].

Fuktcentrum (2013d). Tjänstebeskrivning för fuktsakkunnig. *ByggaF-Metoden.* Available at: http://www.fuktcentrum.lth.se/verktyg-och-hjaelpmedel/fuktsaekert-byggande/byggaf-metoden/[Accessed 22 04 2016].

Fuktcentrum (2013e). Fuktsäkerhetsbeskrivning. *ByggaF-metoden.* Available at: http://www.fuktcentrum.lth.se/verktyg-och-hjaelpmedel/fuktsaekert-byggande/byggaf-metoden/[Accessed 22 04 2016].

Fuktcentrum (2013f). Fuktsäkerhetsplan produktion. *ByggaF-metoden.* Available at: http://www.fuktcentrum.lth.se/verktyg-och-hjaelpmedel/fuktsaekert-byggande/byggaf-metoden/[Accessed 22 04 2016].

Fuktcentrum (2013g). Fuktrondsprotokoll. *ByggaF-metoden.* Available at: http://www.fuktcentrum.lth.se/verktyg-och-hjaelpmedel/fuktsaekert-byggande/byggaf-metoden/[Accessed 22 04 2016].

Fuktcentrum (2013h). *Avvikelserapport. ByggaF-metoden.* Available at: http://www.fuktcentrum.lth.se/verktyg-och-hjaelpmedel/fuktsaekert-byggande/byggaf-metoden/[Accessed 22 04 2016].

Fuktcentrum (2015). *Kurser.* Available at: http://www.fuktcentrum.lth.se/kurser/ [Accessed 17 05 2016].

Fuktcentrum (n.d.) Fuktsäkerprojetering med riskvärdering. *ByggaF-metoden.* Available at: http://www.fuktcentrum.lth.se/verktyg-och-hjaelpmedel/fuktsaekert-byggande/byggaf-metoden/[Accessed 22 04 2016].

GVK (2014). *Vår verksamhet.* Available at: https://www.gvk.se/om-gvk/var-verksamhet[Accessed 19 04 2016].

Hagentoft, C.-E. (2002). *Vandrande fukt Strålande värme,* Lund: Studentlitteratur.

Hagentoft, C.-E. & Sasic Kalagasidis, A. (2014). *Moisture safe cold attics - assessment based on risk analyses of performance and cost,* Gothenburg: Chalmers University of Technology.

Hansén, M. & Jansson, A. (2015). *External thermal insulation composite system walls.* Borås, SP Technical research institute of Sweden.

Jansson, A. & Samuelsson, I. (2009a). *Putsade regelväggar,* Borås: SP Technical research institute of Sweden.

Jansson, A. & Samuelsson, I. (2009b). *Handledning Mätning av fukt i putsade fasader,* Borås: SP Technical Research Institute of Sweden.

Kalagasidis, A. S. (2004). *The whole model validation for HAM-Tools Case study: hygro-thermal conditions in the cold attic under different ventilation regimes,* Gothenburg: Chalmers University of technology .

Mjörnell, K. (2014). *ByggaF - metod för fuktsäker byggprocess.* Stockholm, SP Technical research institute of Sweden.

Mundt-Petersen, S. O., Wallentén, P., Toratti, T. & Heikkinen, J. (2012). *Moisture risk evaluation and determination of required measures to avoid mould damage using the Folos 2D visual mould chart.* Podkylava, Lund University.

Måleribranschens våtrumskontroll, (2012). *Om MVK.* Available at: http://vatrumsmalning.se/startsida/om-mvk/[Accessed 19 04 2016].

Mögeltalkoot (2016). *Våtutrymmen.*Available at: http://omakotitalot.hometalkoot.fi/sv [Accessed 15 04 2016].

Nordstrand, U. (2008). *Byggprocessen.* Stockholm: Liber.

Pallin, S. (2012). *Probabilistic Risk Assessment of Energy Efficent Retrofitting Techniques,* Göteborg: Chalmers university of technology.

Samuelsson, I. (2002). *Hållbar sanering av fuktskadade byggnader,* Borås: SP - Technical research institute of Sweden .

Samuelsson, I. (n.d). *Fuktsäkra konstruktioner.* Available at: https://www.sp.se/sv/index/services/moist/constr/Sidor/default.aspx[Accessed 15 04 2016].

Sasic Kalagasidis, A. & Hagentoft, C.-E. (2010). *Mould Growth Control in Cold Attics through Adaptive Ventilation. Validation by Field Measurements.* Clearwater Beach, Florida, 12th International Conference on Performance of the Exterior Envelopes of Whole Buildings.

Sasic Kalagasidis, A. & Rode, C. (2015). *Annex 55 Reliability of Energy Efficient Building Retrofitting- Probability Assessment of Performance and Cost,* Gothenburg: Chalmers University of Technology.

SFS 1998:808. *Miljöbalken ,* Stockholm: Miljö- och energidepartementet.

SFS 2010:900. *Plan- och Bygglagen,* s.l.: Näringsdepartementet RS N.

SFS 2011:338. *Plan och byggförordningen,* s.l.: Näringsdebartementet RS N.

SP, (n.d). *Fuktteknisk bedömning.*Available at: http://www.fuktsakerhet.se/sv/delar/vaggar/massiva/fukttekn/Sidor/default.aspx#tegel vägg[Accessed 28 04 2016].

SP, (n.d). *Ändringar av ventilationssystem.* Available at: http://www.fuktsakerhet.se/sv/byggnad/andringvent/Sidor/default.aspx[Accessed 28 04 2016].

Sveriges riksdag, (2016). *Plan och bygg lagen.* Available at: http://www.riksdagen.se/sv/Dokument-Lagar/Lagar/Svenskforfattningssamling/Plan--och-bygglag-2010900_sfs-2010-900/) [Accessed 28 04 2016]

Säker Vatten AB (2016). Industry regulation Säker vatten 2016:1. *Branschregler 2016:1.* Available at: http://www.sakervatten.se/branschregler/branschregler-20161 [Accessed 29 04 2016].

Säker Vatten AB, (n.d.) *Branschregler.* Available at: http://www.sakervatten.se/branschregler[Accessed 18 04 2016].

WUFI (2016). *Home.* Available at: https://wufi.de/en/[Accessed 07 04 2016].

Yverås, V. (2008). *Predicting service life of outdoor ventilated crawl spaces by neutral networks,* Göteborg: Chalmers University of Technology.

Appendix 1

Interview questions to moisture experts and property developers' representatives.

The following questions were asked during the telephone interviews. The original questions are in Swedish and are followed by an English translation.

Questions to moisture experts

Generellt om ByggaF – *General about ByggaF*

1. Har du använt ByggaF? *Have you used ByggaF?*
2. I vilka projekt har du använt ByggaF? *In which projects have you used ByggaF?*
3. Vilka dokument från ByggaF användes vid projektet? *Which documents were used in the project?*
    a. ByggaF branschstandard
    Industry standard ByggaF- method for moisture safety of the construction process
    b. Fuktriskinventering i tidiga skeden
    Moisture risk inventory in early stages
    c. Fuktinventering i befintlig byggnad
    Moisture inventory in existing building
    d. Byggherrens fuktsäkerhetskrav och krav på aktiviteter
    The developer's moisture safety requirements and requirements for activities
    e. Tjänstebeskrivning för fuktsakkunnig
    Job description for moisture expert
    f. Fuktsäkerhetsbeskrivning
    Moisture safety specification
    g. Fuktsäkerhetsprojektering med riskvärdering
    Moisture safety planning with risk evaluation
    h. Fuktsäkerhetsplan produktion
    Moisture safety plan production
    i. Fuktrondsprotokoll
    Moisture inspection rounds report
    j. Avvikelserapport
    Non-conformance report
4. Har det uppstått några komplikationer vid användningen av ByggaF? *Have there been any complications in the use of ByggaF?*

Renovering och ByggaF

I vårt examensarbete undersöker vi möjligheterna att anpassa ByggaF till renovering, då den i första hand är utvecklad för nyproduktion. Därför vill vi gärna ha din åsikt om möjliga förbättringsåtgärder.

Renovation and ByggaF

In our master thesis we are investigating the possibility to adjust ByggaF to renovation. The method is now mainly used in new production. Therefore do we want your opinion about improvements.

1. Vad är problematiskt vid renovering vad gällande fuktsäkerhet?
What is problematic with moisture safety when renovating?
2. Hur omfattande är inventeringen i början av projekten? *How extensive is the inventory in the beginning of a project?*

3. Har du varit med om att det har upptäckts dolda fuktskador vid renovering? *Do you have experience of a renovation project where a hidden moisture damage were discovered?*
    a. Hur hanterades detta?
    How was it handled?
4. Vilken typ av hjälpmedel hade behövts för att öka fuktsäkerhet vid renovering? *What kind of support tool is needed in renovation projects to increase the moisture safety?*
5. Vilka delar i ByggaF hade behövt förbättras/utvecklats? *Which parts in ByggaF need to be improved?*

Questions to property developers' representatives

1. Vilken metod användes i arbetet med fuktsäkerhet?
What method was used when working with moisture safety?
    a. ByggaF
    b. Annan motsvarande metod, vilken? *Other equivalent method. Which?*
2. Vilka dokument från ByggaF användes vid projektet? *Which documents were used in the project?*
    a. ByggaF branschstandard
    Industry standard ByggaF- method for moisture safety of the construction process
    b. Fuktriskinventering i tidiga skeden
    Moisture risk inventory in early stages
    c. Fuktinventering i befintlig byggnad
    Moisture inventory in existing building
    d. Byggherrens fuktsäkerhetskrav och krav på aktiviteter
    The developer's moisture safety requirements and requirements for activities
    e. Tjänstebeskrivning för fuktsakkunnig
    Job description for moisture expert
    f. Fuktsäkerhetsbeskrivning
    Moisture safety specification
    g. Fuktsäkerhetsprojektering med riskvärdering
    Moisture safety planning with risk evaluation
    h. Fuktsäkerhetsplan produktion
    Moisture safety plan production
    i. Fuktrondsprotokoll
    Moisture inspection rounds report
    j. Avvikelserapport
    Non-conformance report
3. Anlitades en fuktsakkunnig till projektet? *Was a moisture expert appointed in the project?*
4. Har det uppstått några komplikationer vid användningen av ByggaF? *Have there been any complications regarding the use of ByggaF?*

I vårt examensarbete undersöker vi möjligheterna att anpassa ByggaF till renovering, då den i första hand är utvecklad för nyproduktion. Därför vill vi gärna ha din åsikt om möjliga förbättringsåtgärder. *In our master thesis are we investigating the possibility to adopt ByggaF to renovation. The method is now mainly used in new production. Your opinion about improvements are valuable for us.*

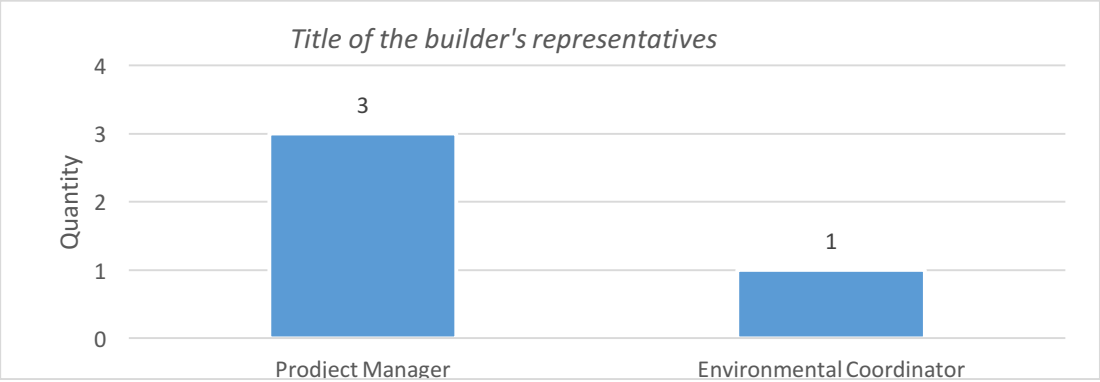
5. Vad hade behövt förbättras i ByggaF för att anpassa den till renovering?
What in ByggaF needs improvements to adapt it to renovation?

Appendix 2

Summary of property developer's representatives' answers

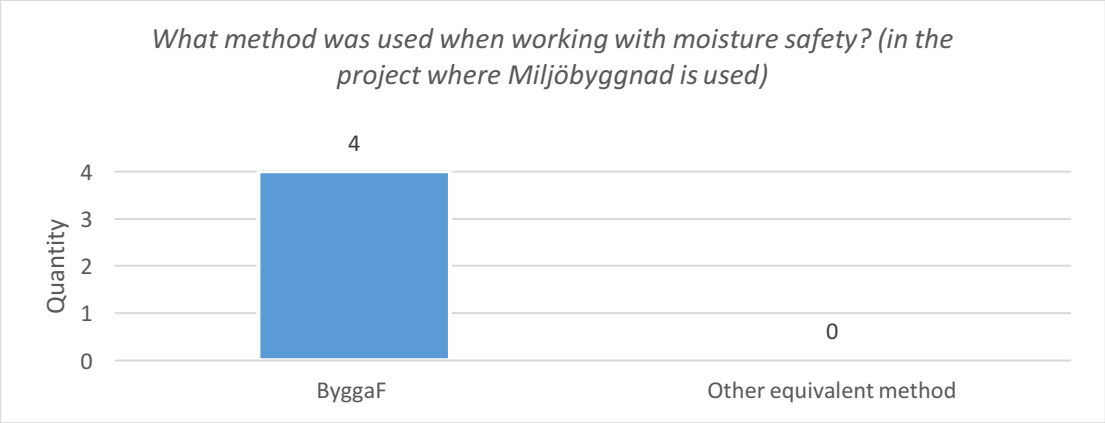
Each question is followed by diagrams with answers.

Totally four interviews were made with property developer's representative.

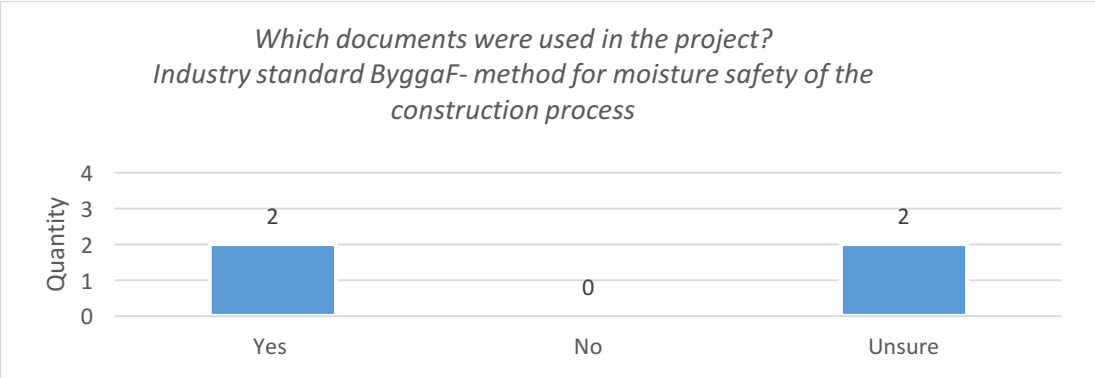


Questions -

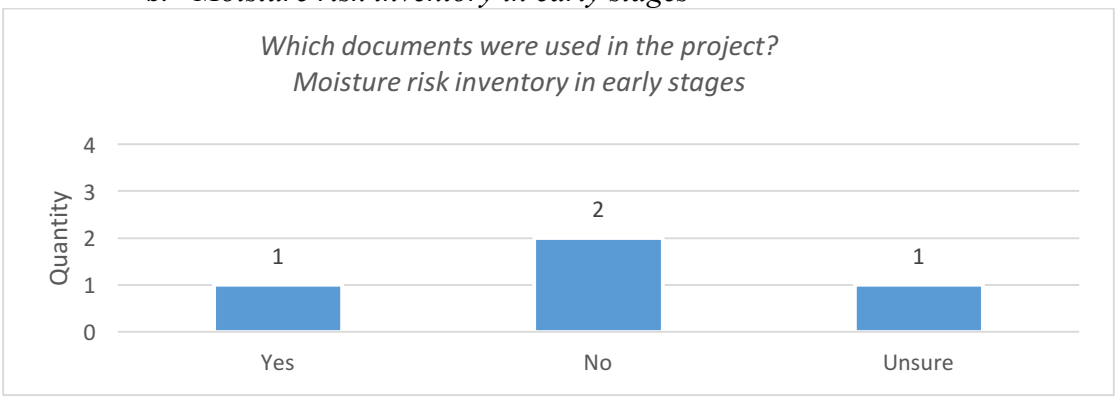
1. *What method was used when working with moisture safety?*



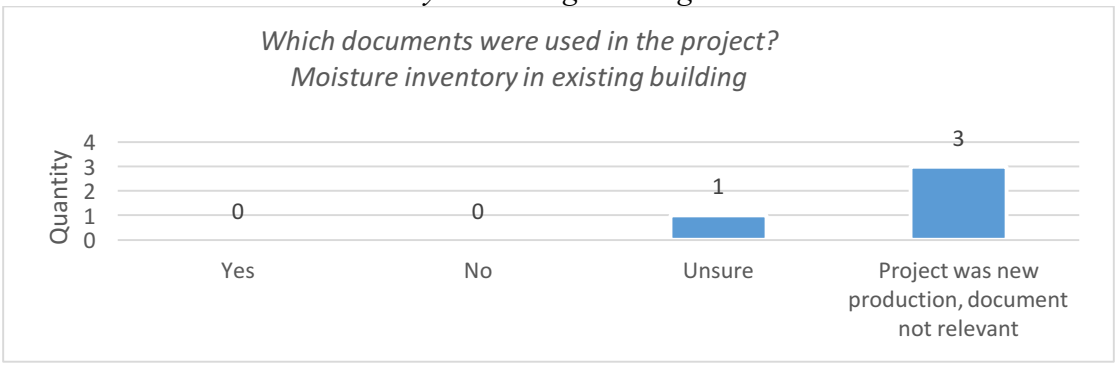
2. *Which documents were used in the project?*
    a. *Industry standard ByggaF- method for moisture safety of the construction process*



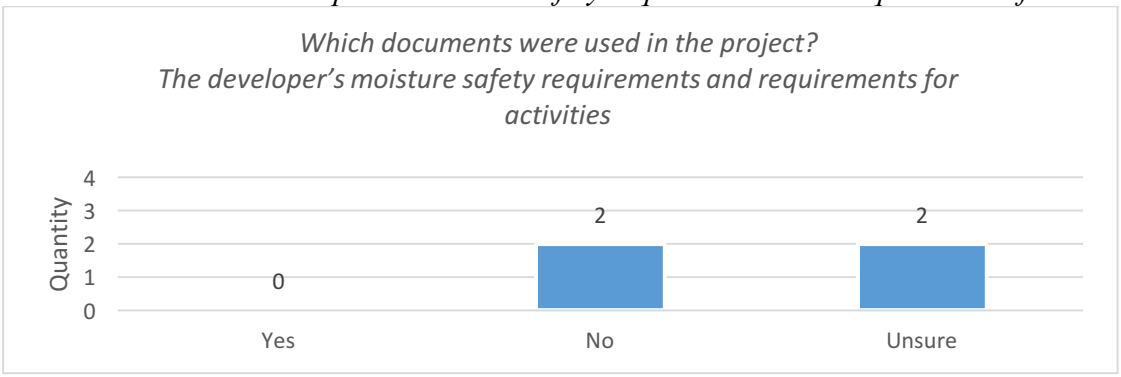
b. *Moisture risk inventory in early stages*



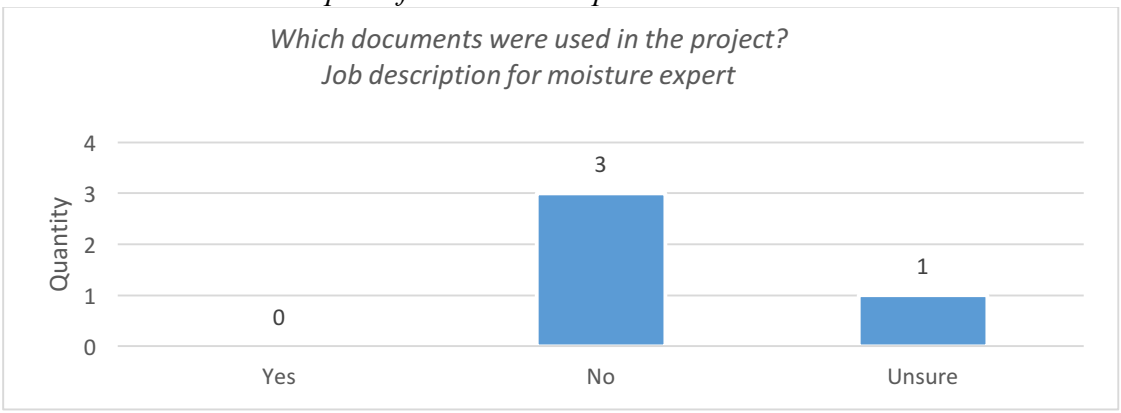
c. *Moisture inventory in existing building*



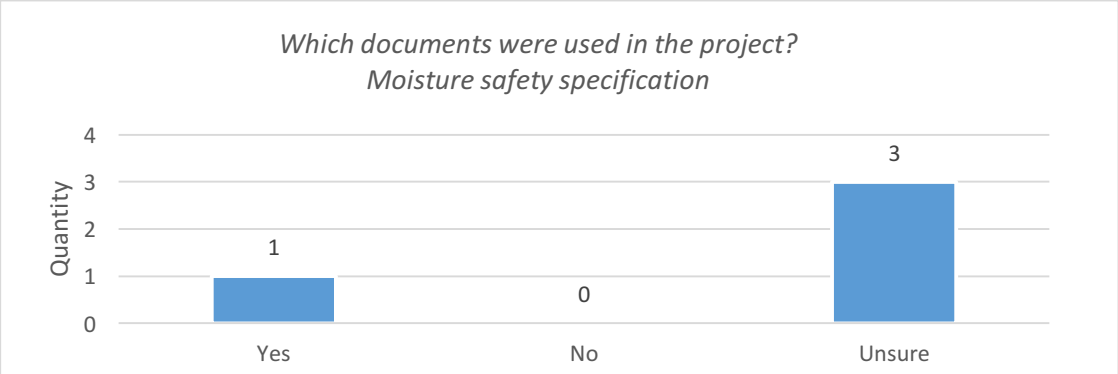
d. *The developer's moisture safety requirements and requirements for activities*



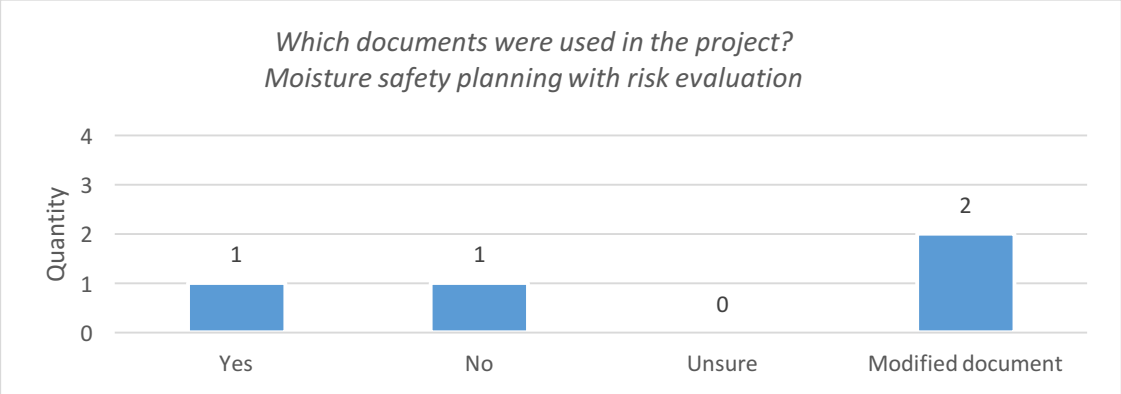
e. *Job description for moisture expert*



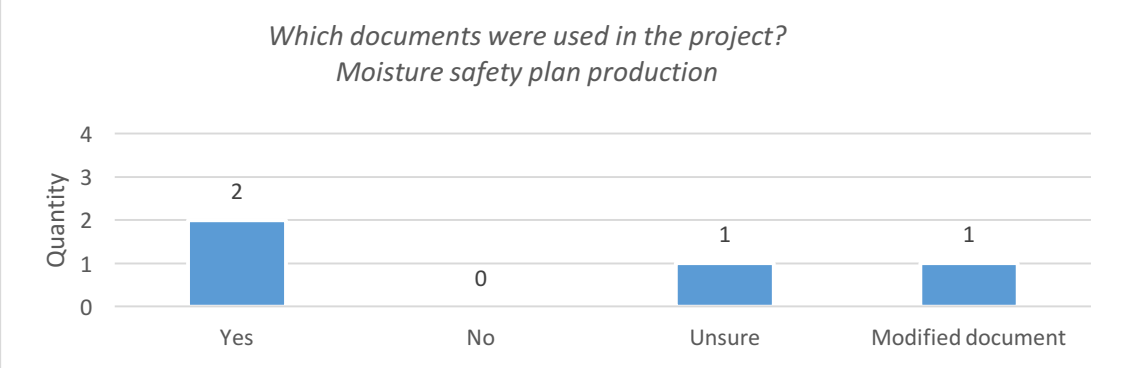
f. Moisture safety specification



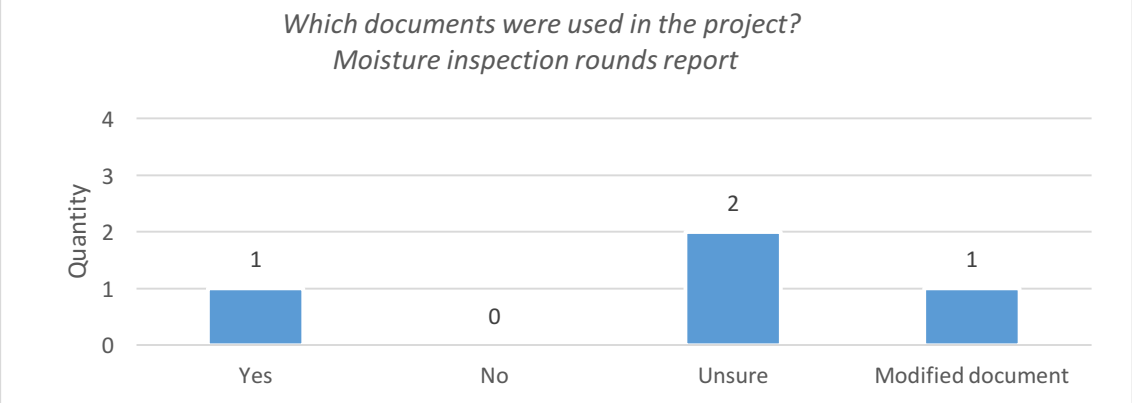
g. Moisture safety planning with risk evaluation



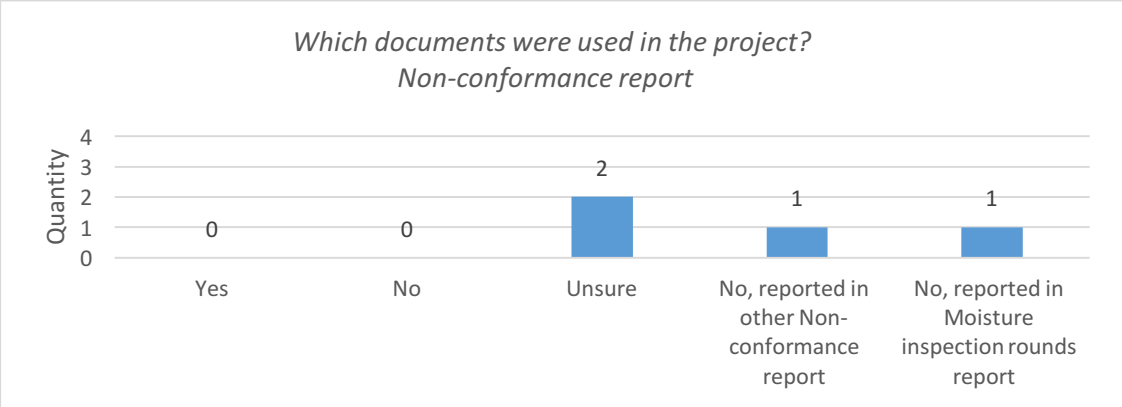
h. Moisture safety plan production



i. Moisture inspection rounds report

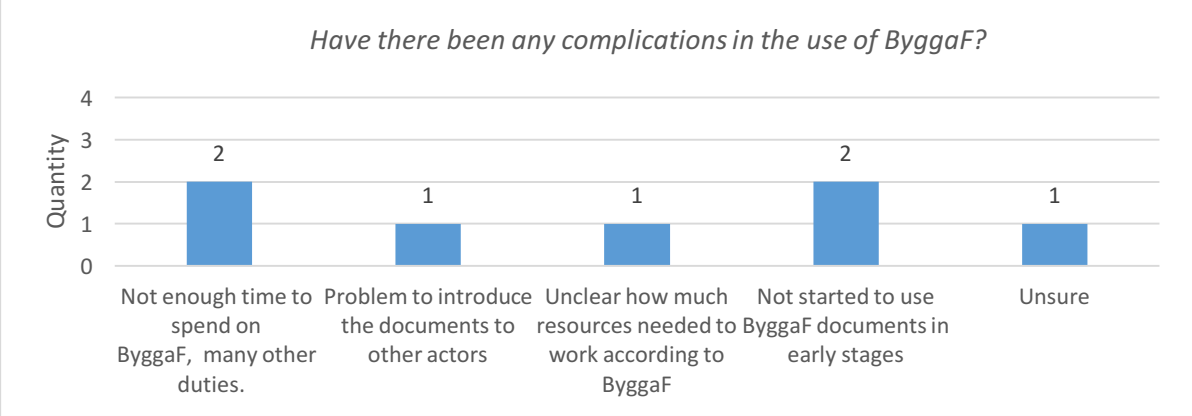


j. Non-conformance report



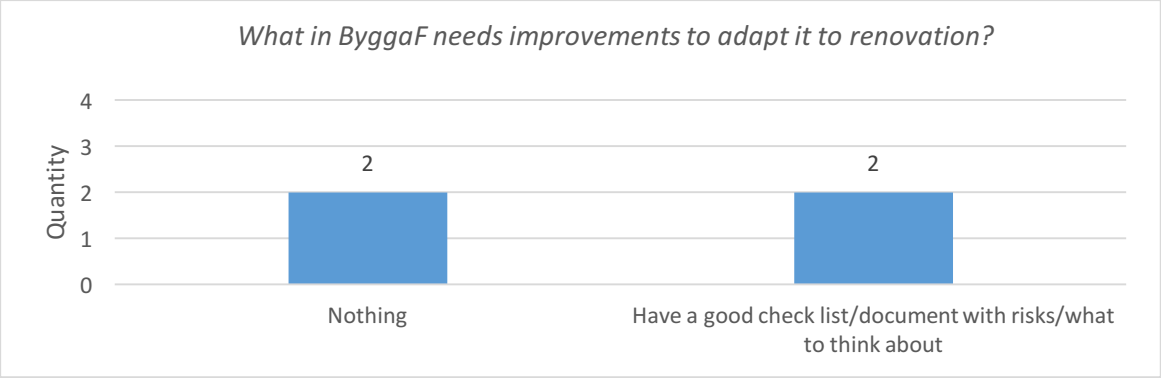
3. Was a moisture expert hired in the project?

4. Have there been any complications in the use of ByggaF?



Renovation

5. What in ByggaF needs improvements to adapt it to renovation?



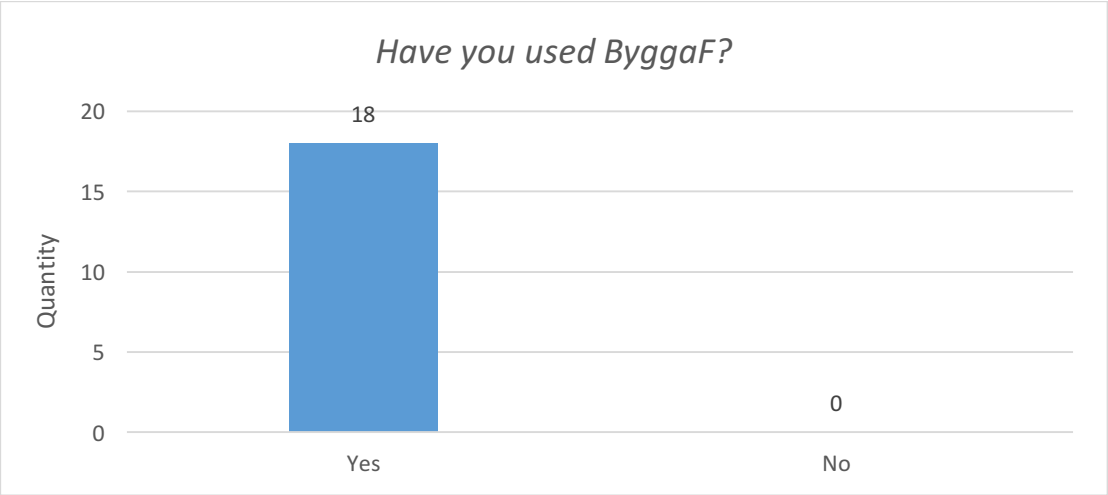
Appendix 3

Summary of Moisture experts' answers

Each question is followed by diagrams with answers. Some of the questions have also diagrams with more detailed answers and diagrams with opinions.

Totally 18 interviews were made. One moisture expert did not answer the question about renovation, due to time limitations.

1. *Have you used ByggaF?*

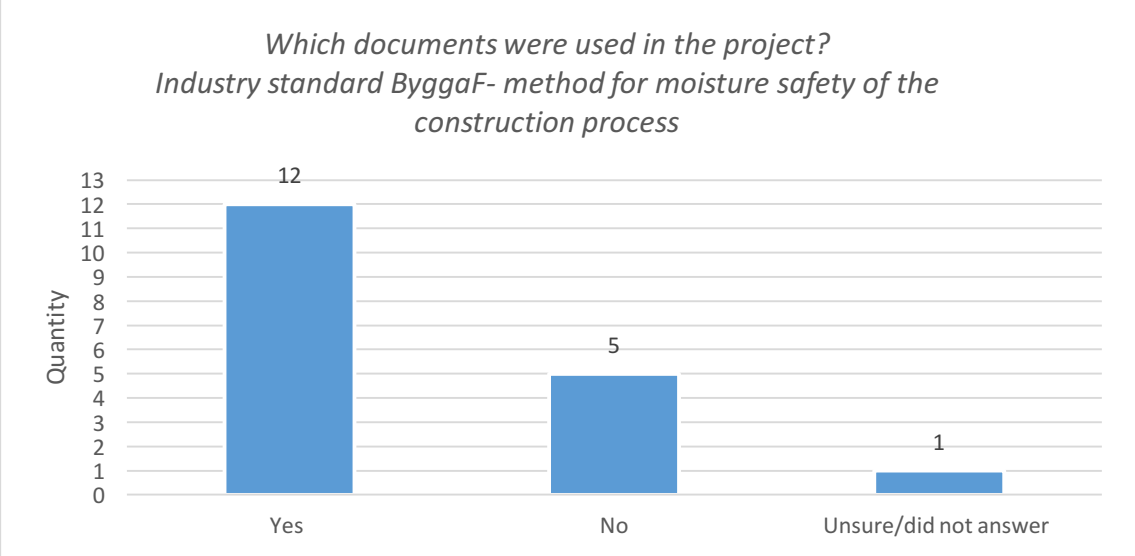


2. *In which projects have you used ByggaF?*

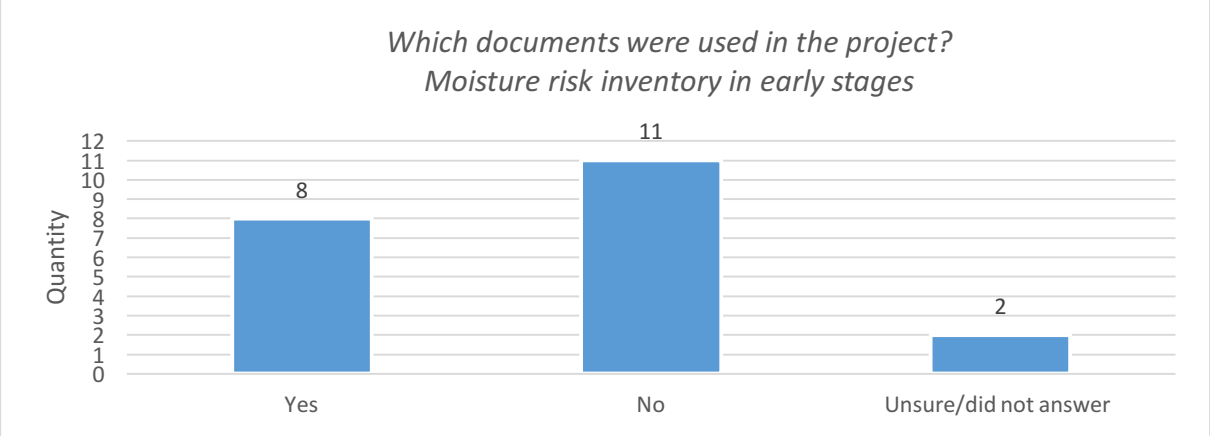
The question was not asked during the interviews.

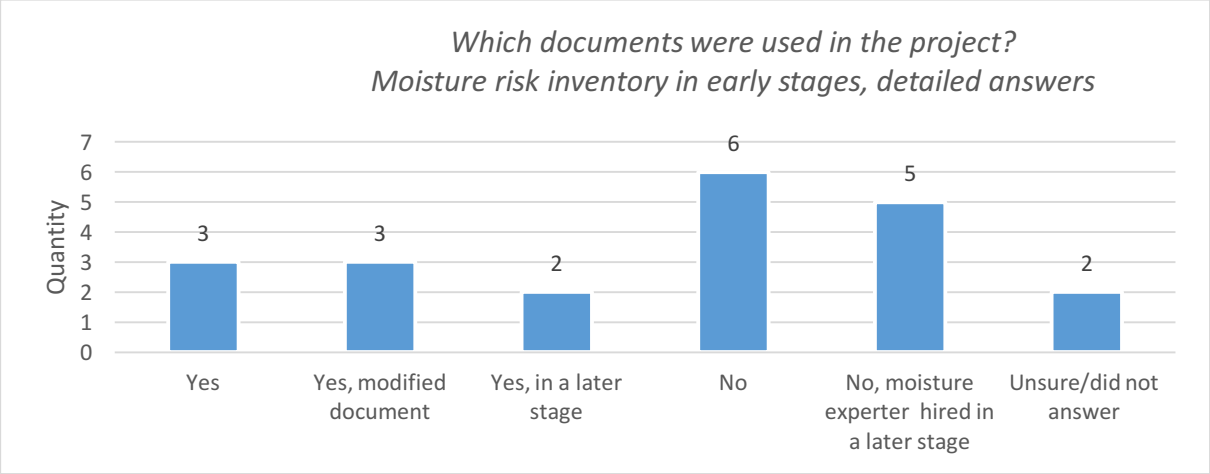
3. *Which documents were used in the project?*

    a. *Industry standard ByggaF- method for moisture safety of the construction process*

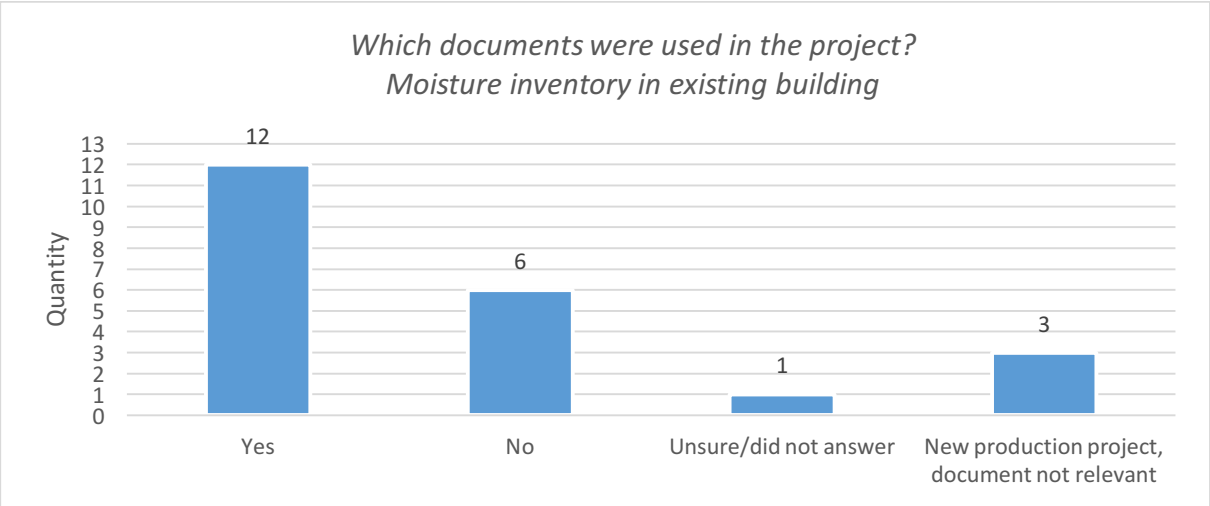


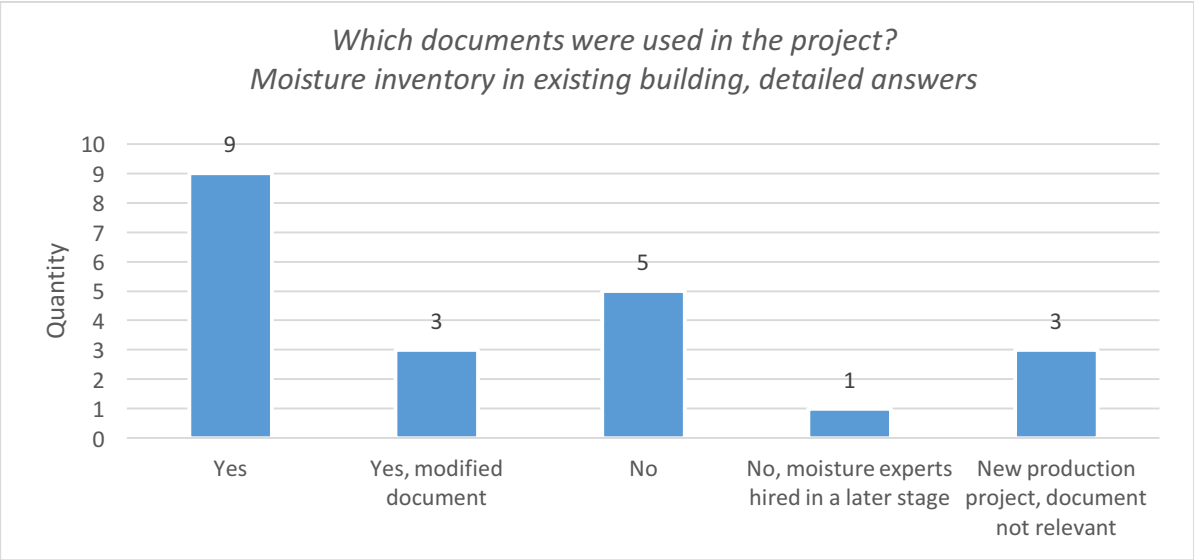
b. *Moisture risk inventory in early stages*



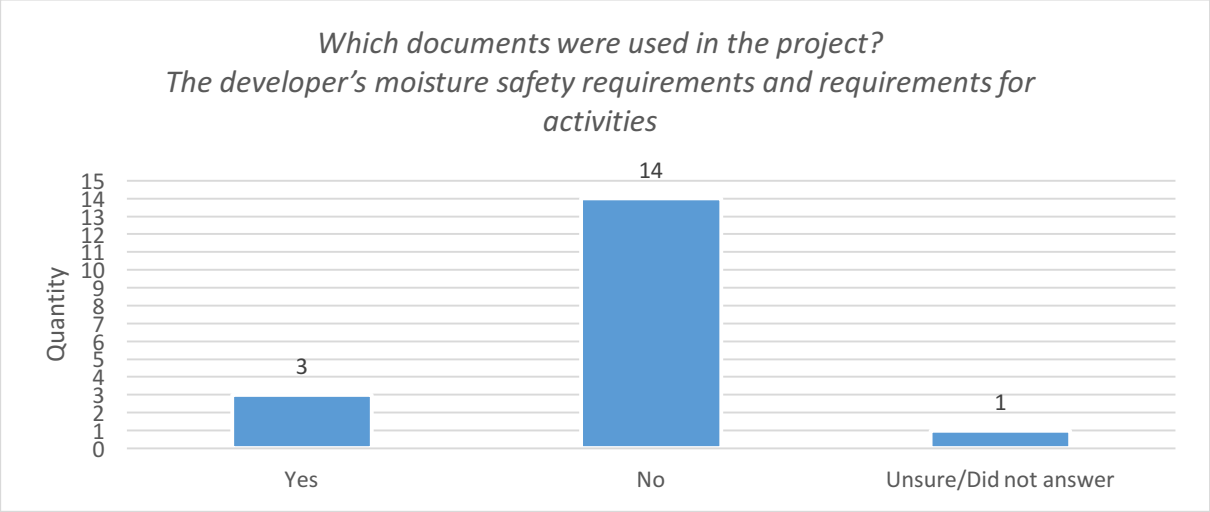


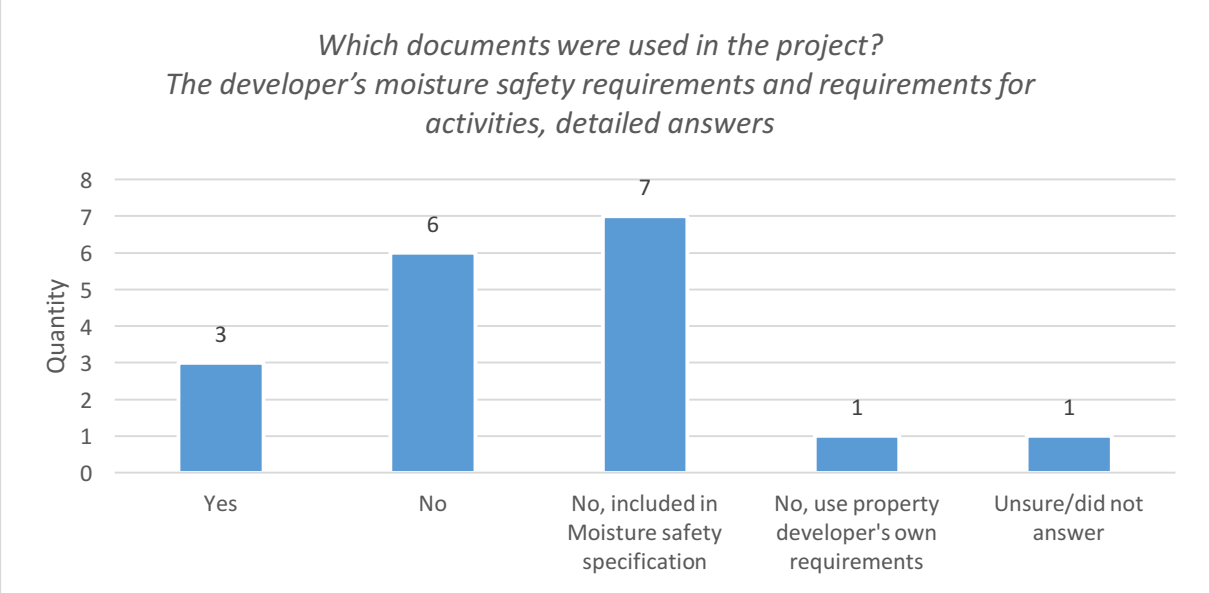
c. *Moisture inventory in existing building*



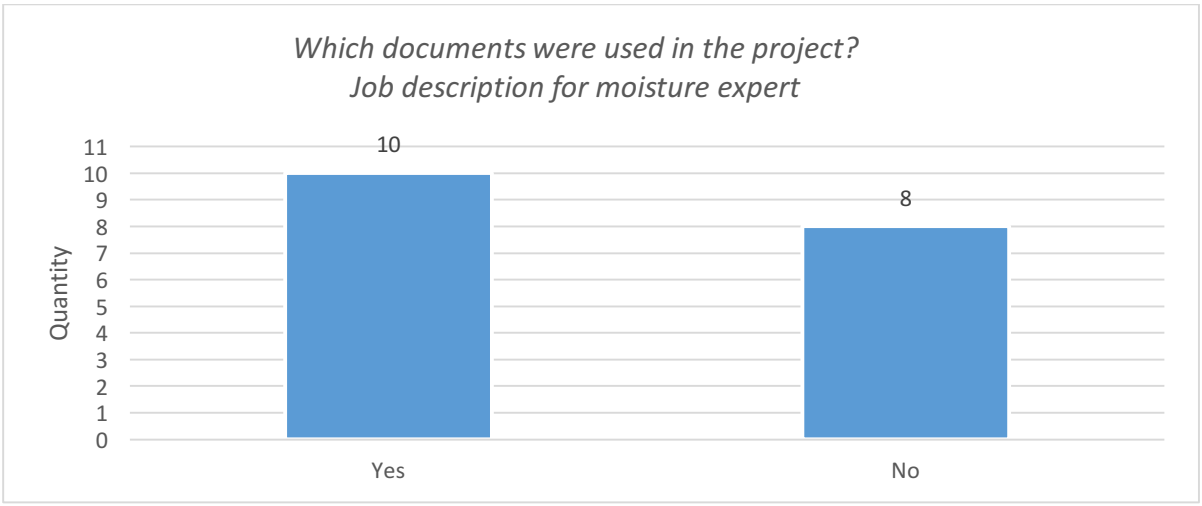


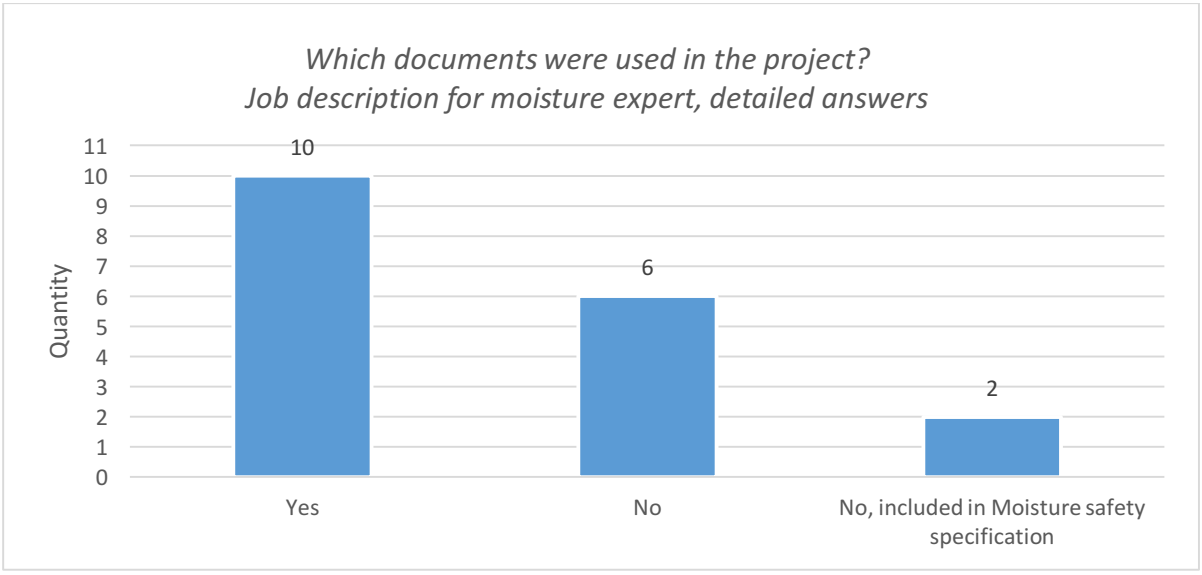
d. The developer's moisture safety requirements and requirements for activities



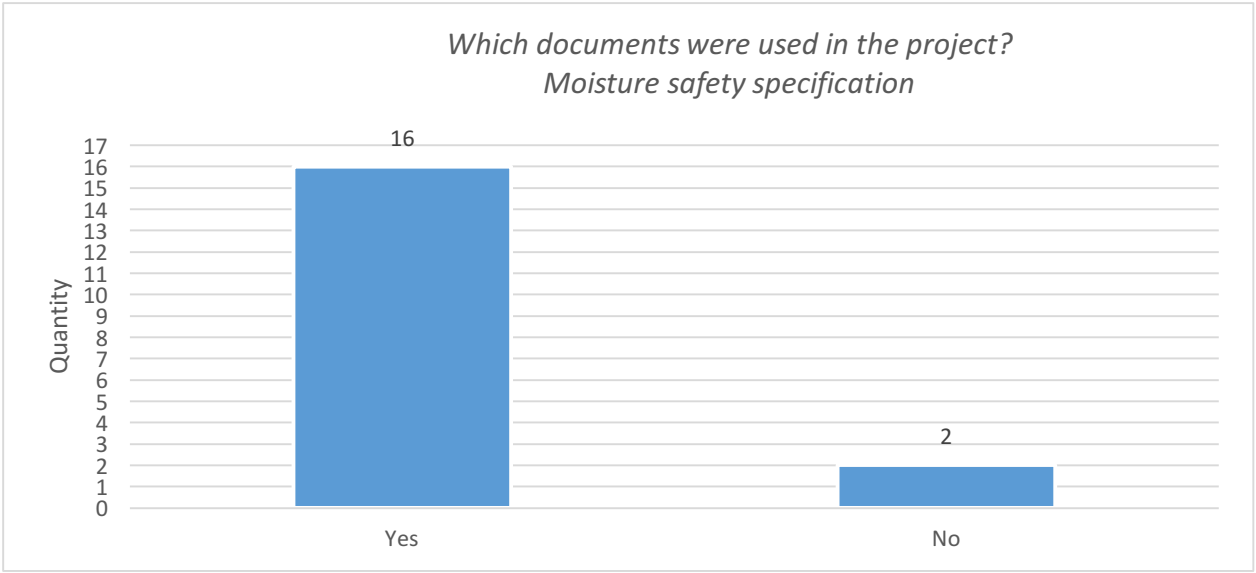


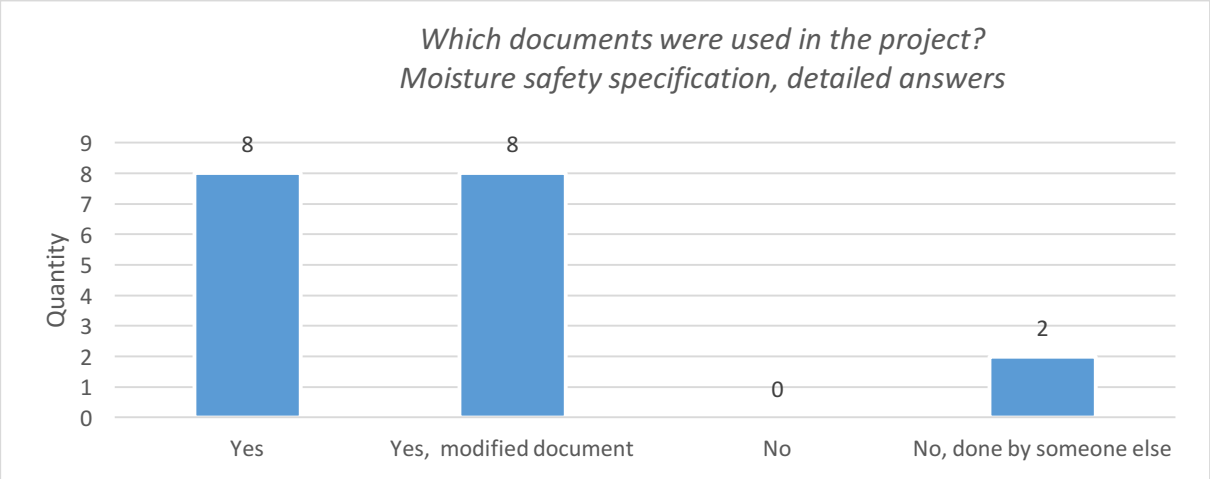
e. *Job description for moisture expert*



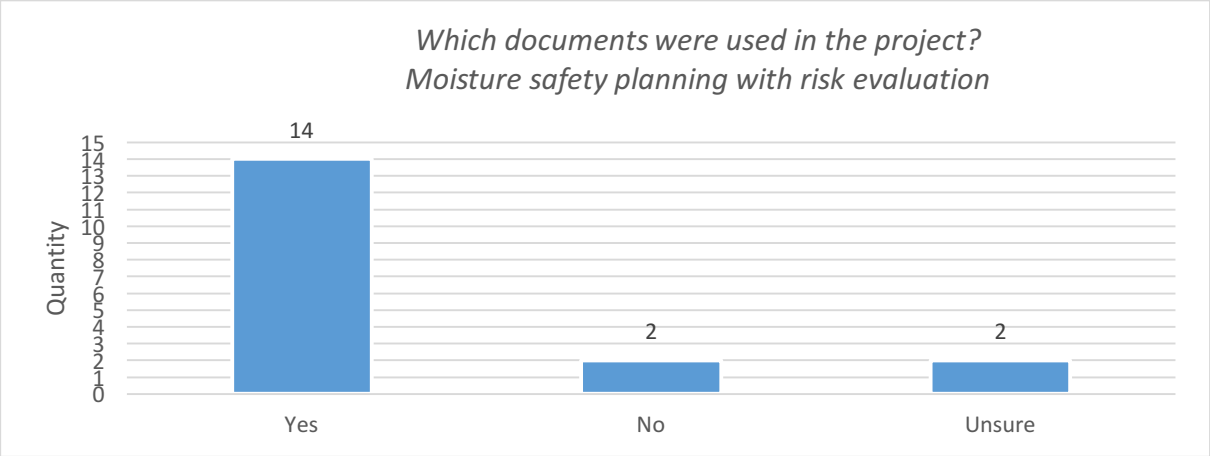


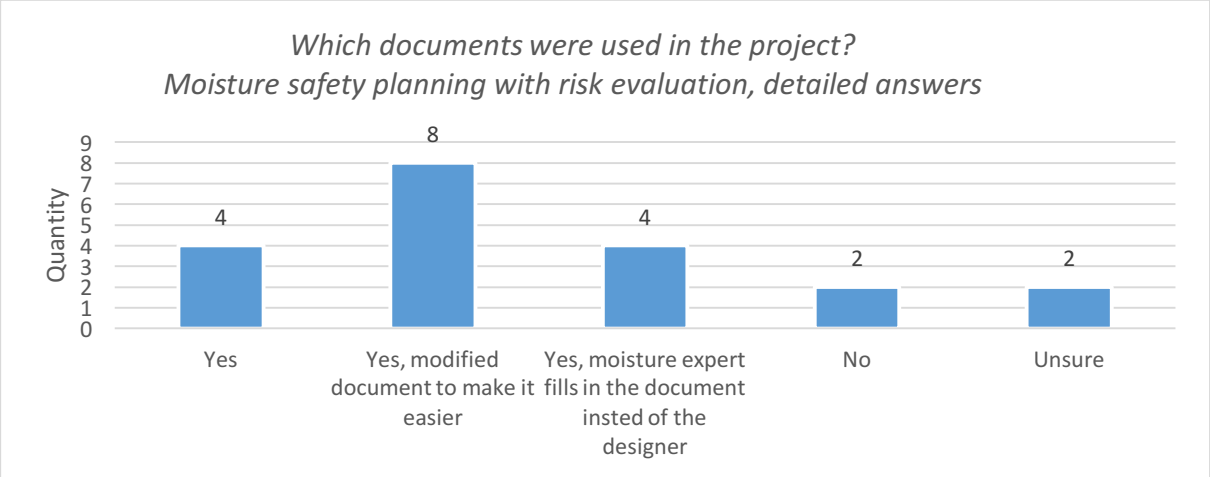
f. Moisture safety specification



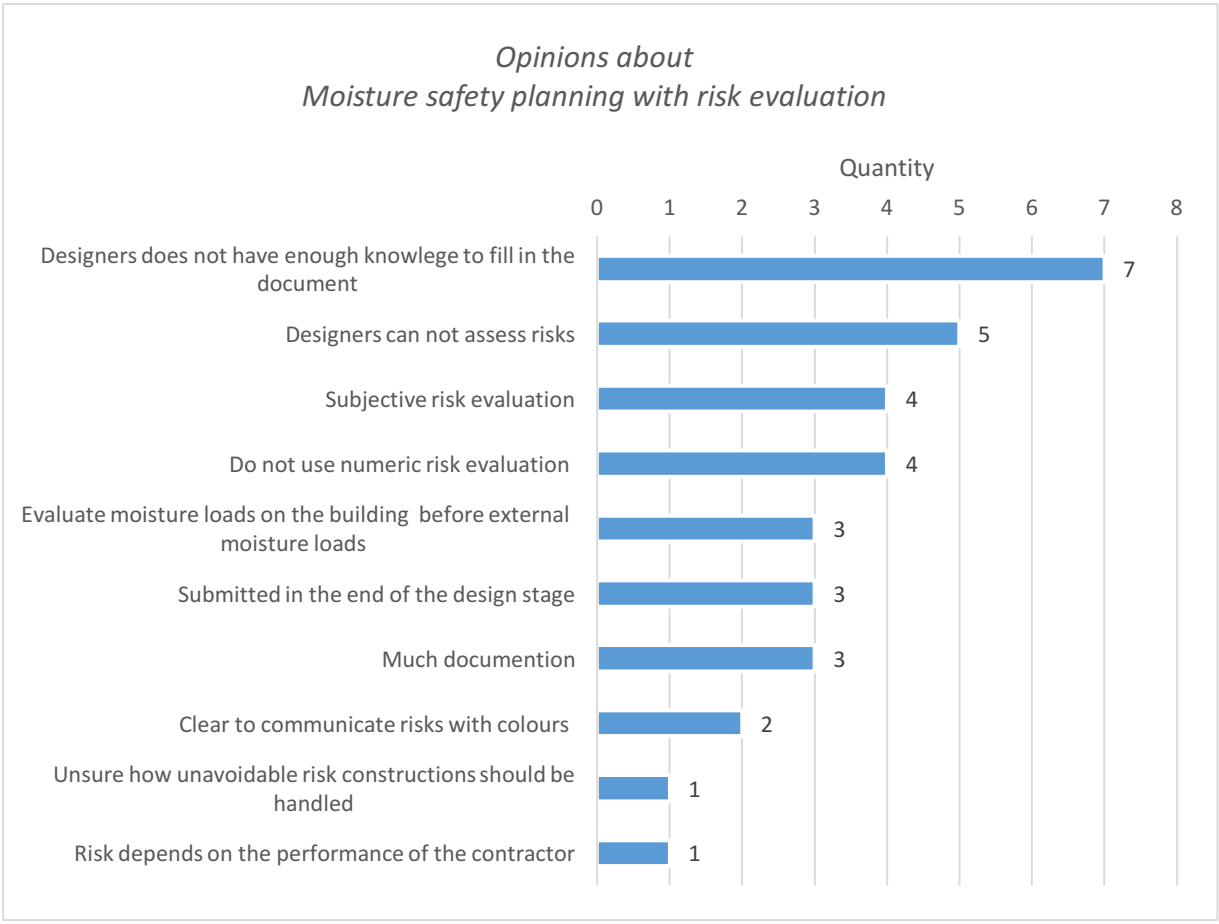


g. *Moisture safety planning with risk evaluation*

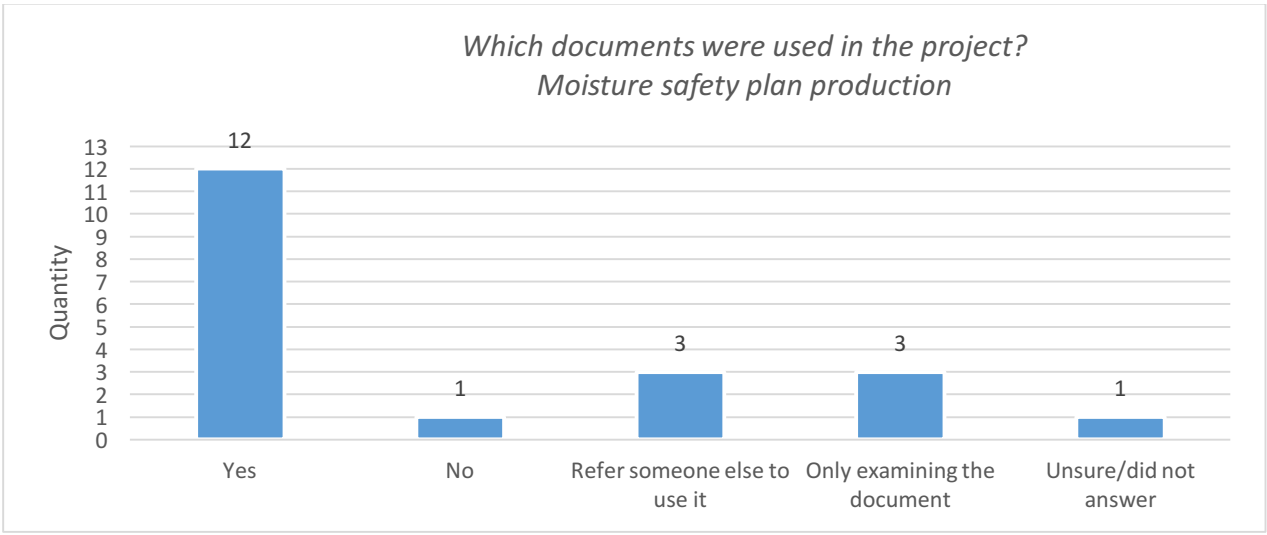


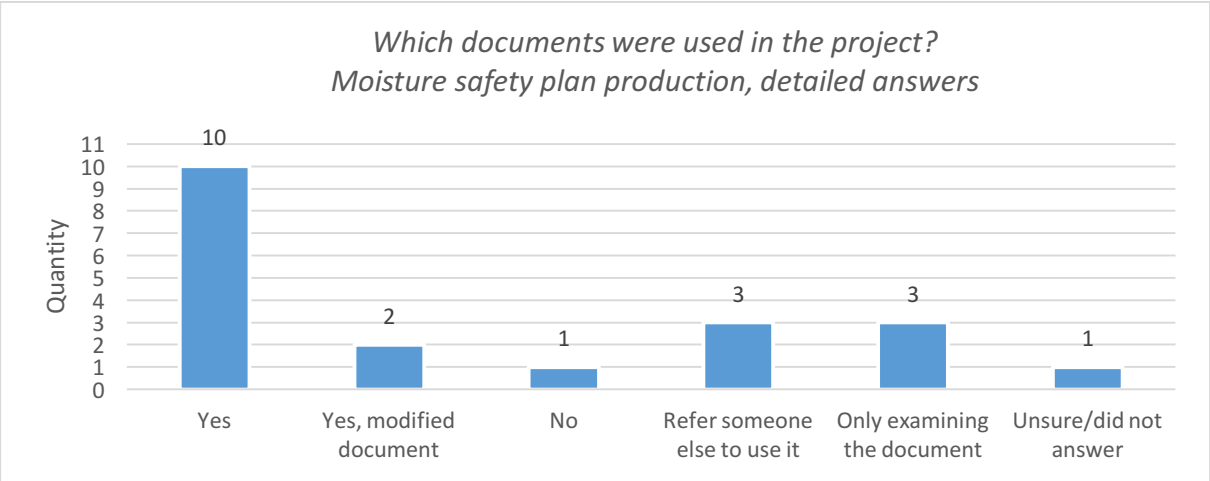


One moisture expert has a modified document and helps the designer to fill in the document.

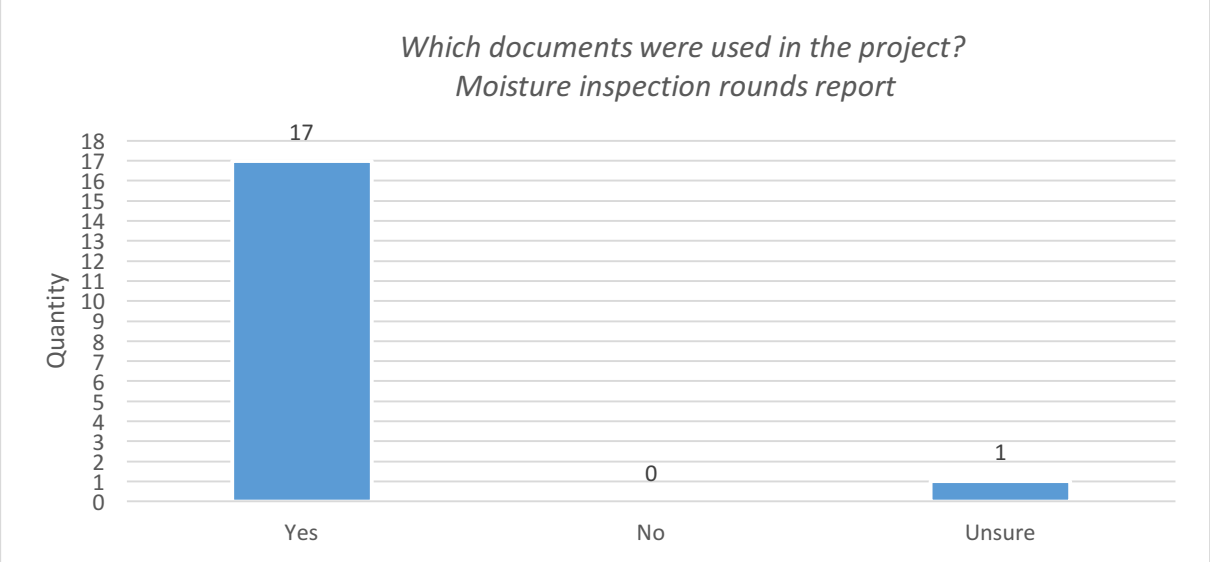


h. *Moisture safety plan production*

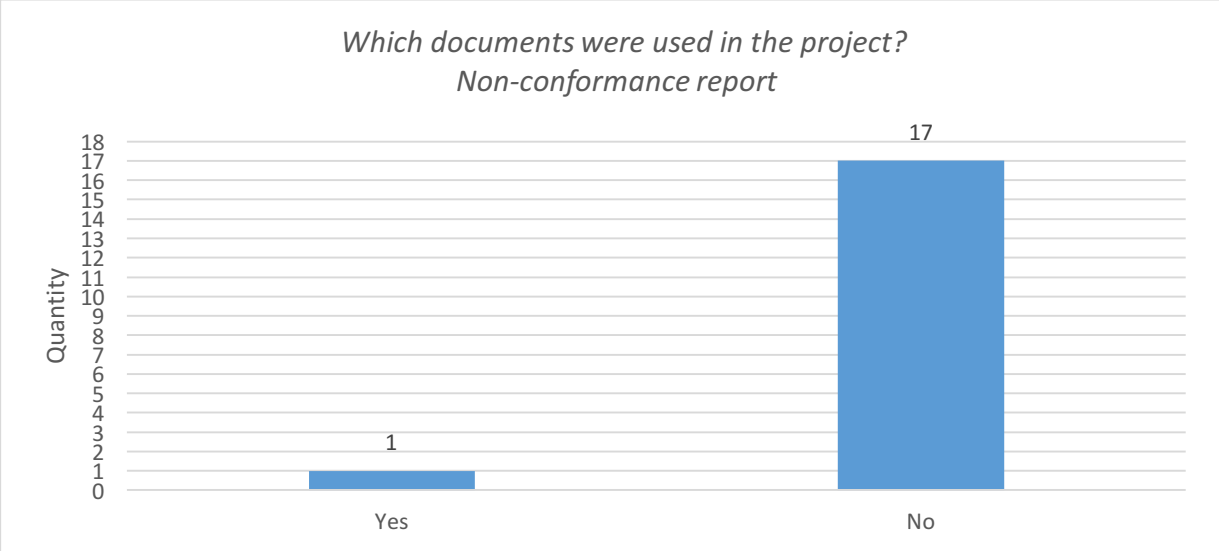


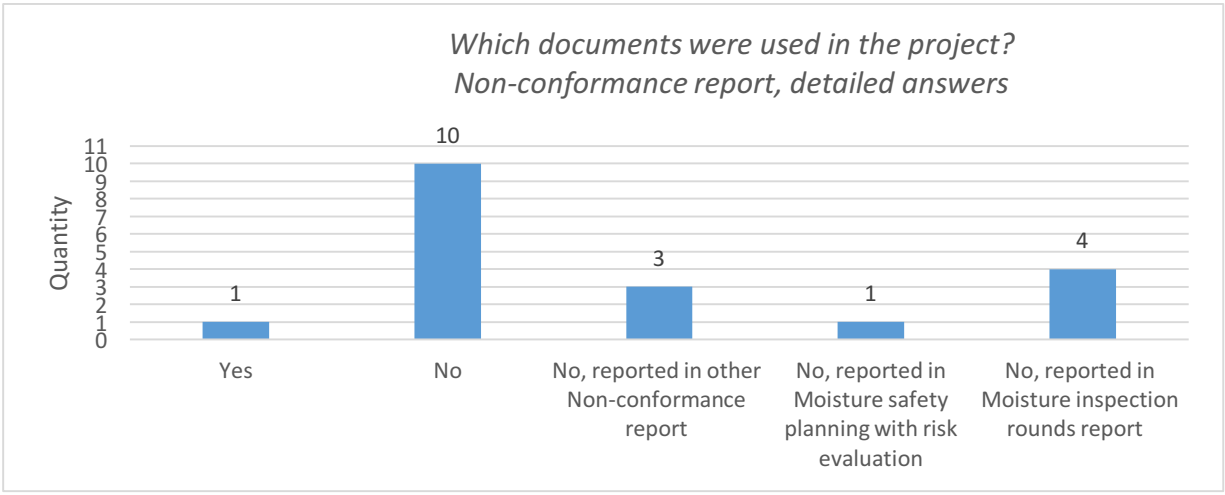


i. *Moisture inspection rounds report*



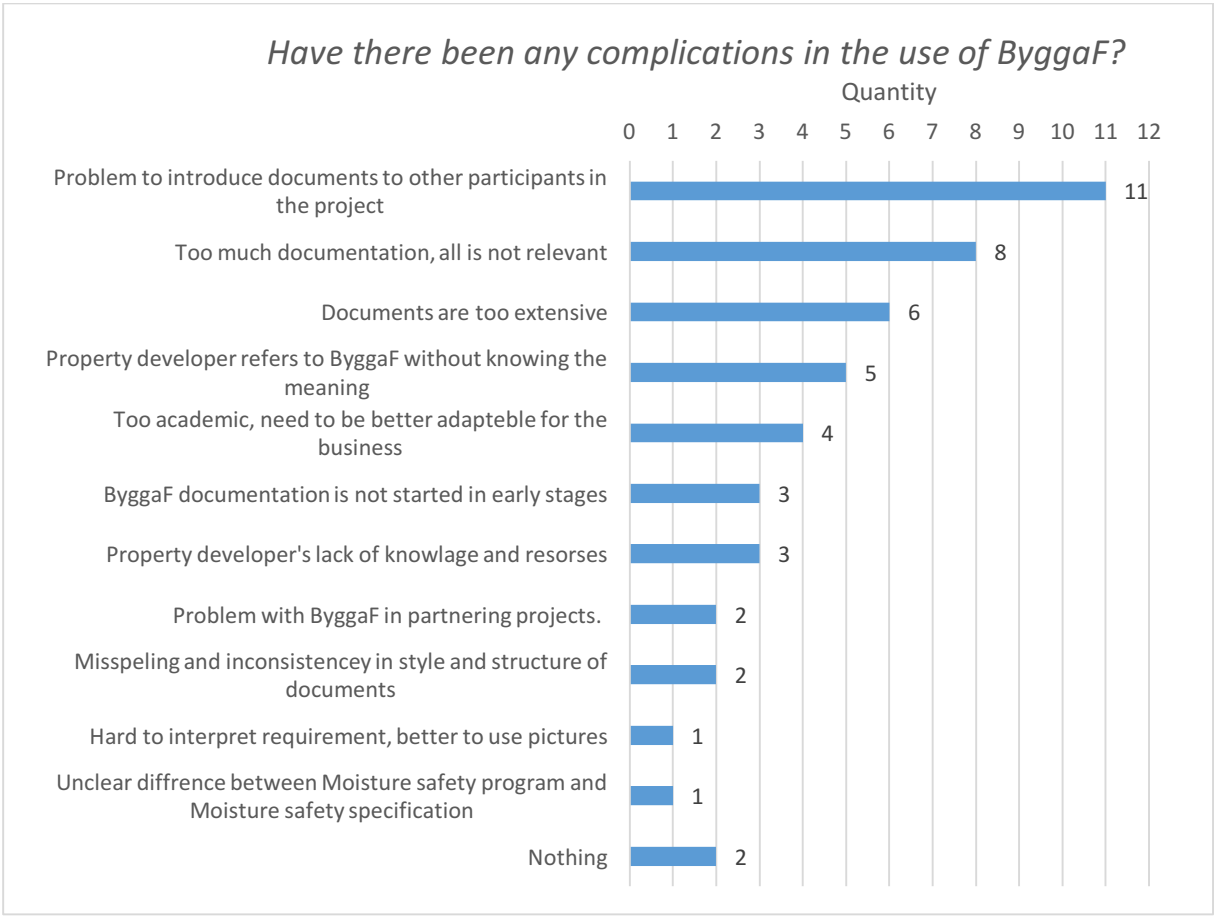
j. *Non-conformance report*



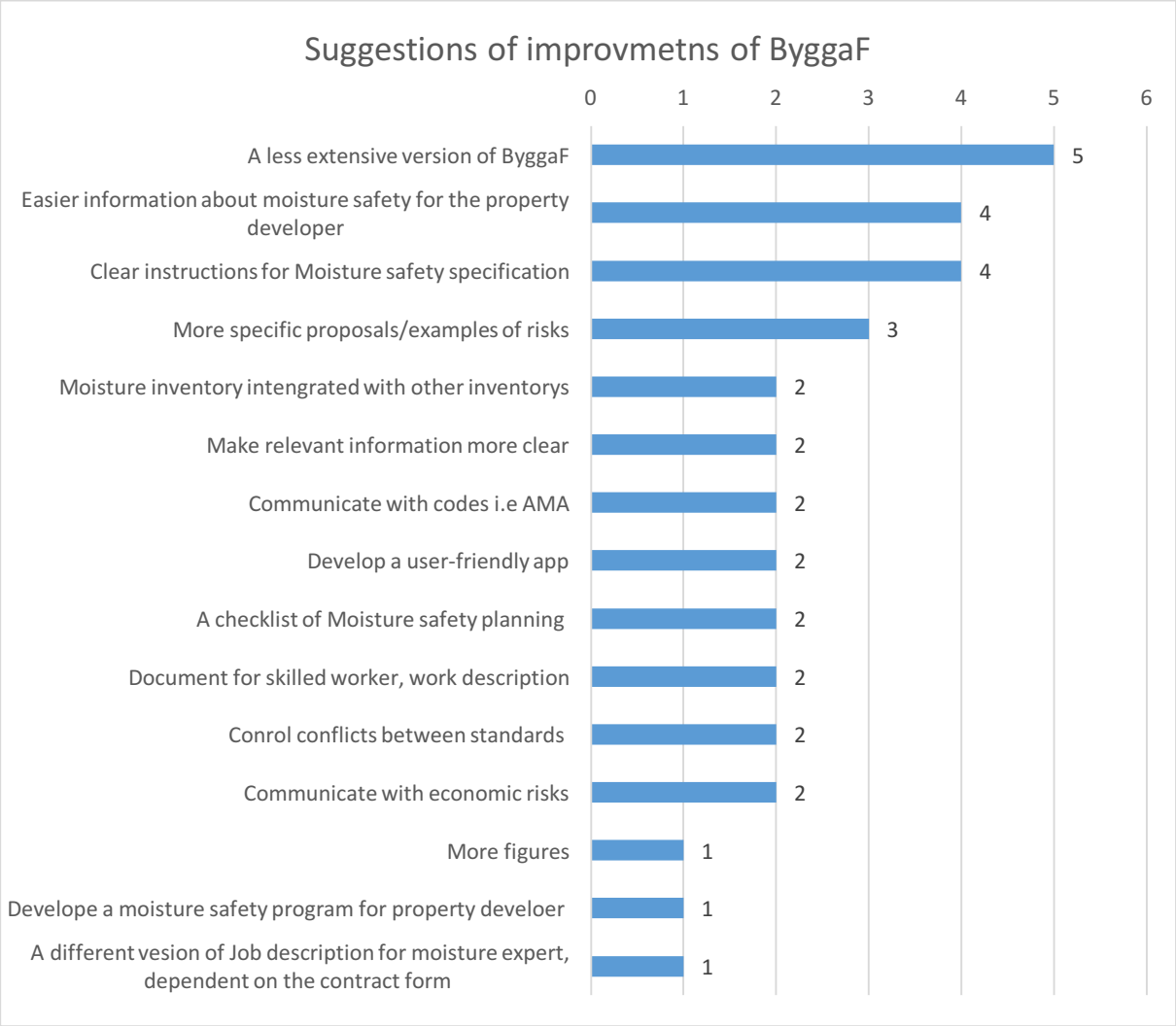


One moisture expert answered that the non-conformance where reported in both Moisture safety planning with risk evaluation and in Moisture inspection rounds reports.

4. *Have there been any complications in the use of ByggaF?*

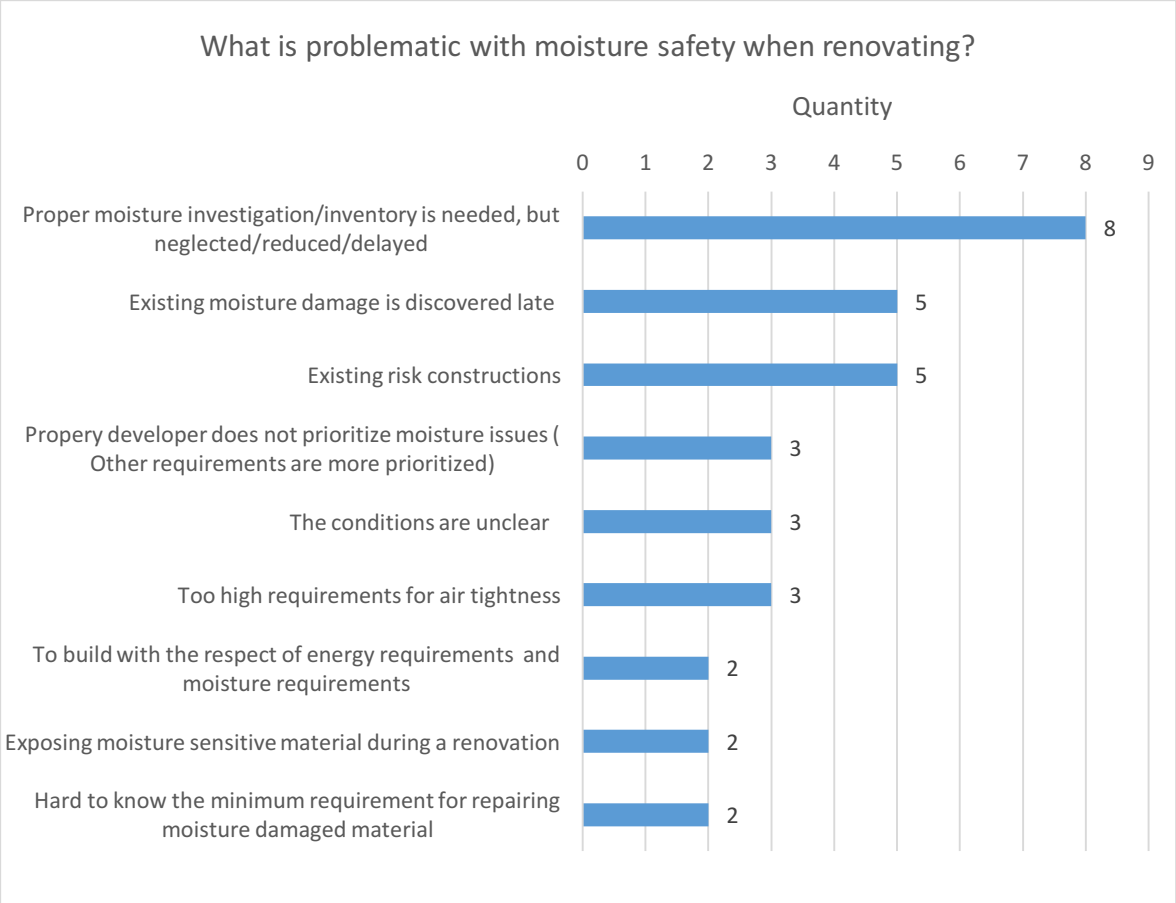


Extra question: Suggestions of improvements

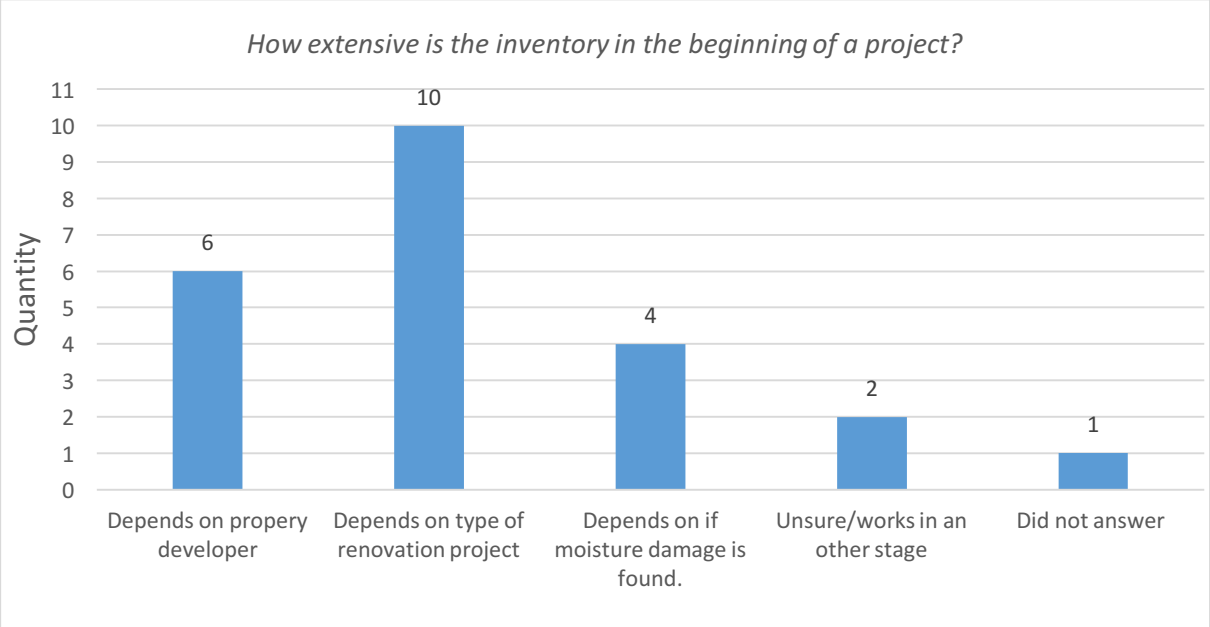


Renovation

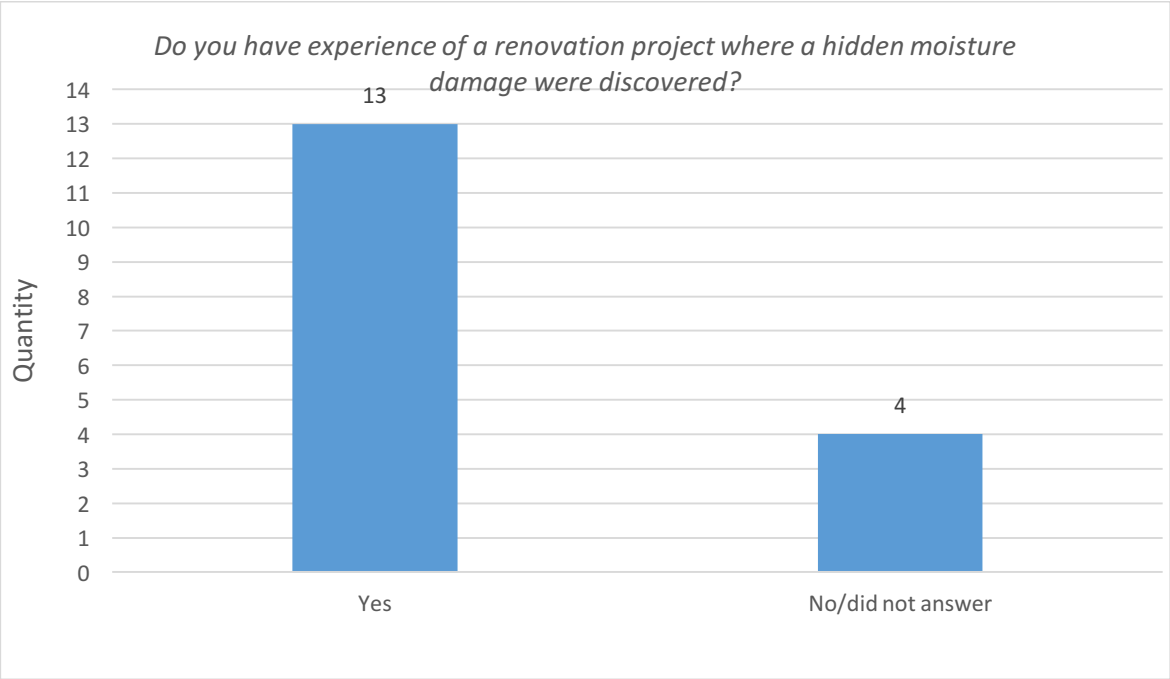
1. *What is problematic with moisture safety when renovating?*



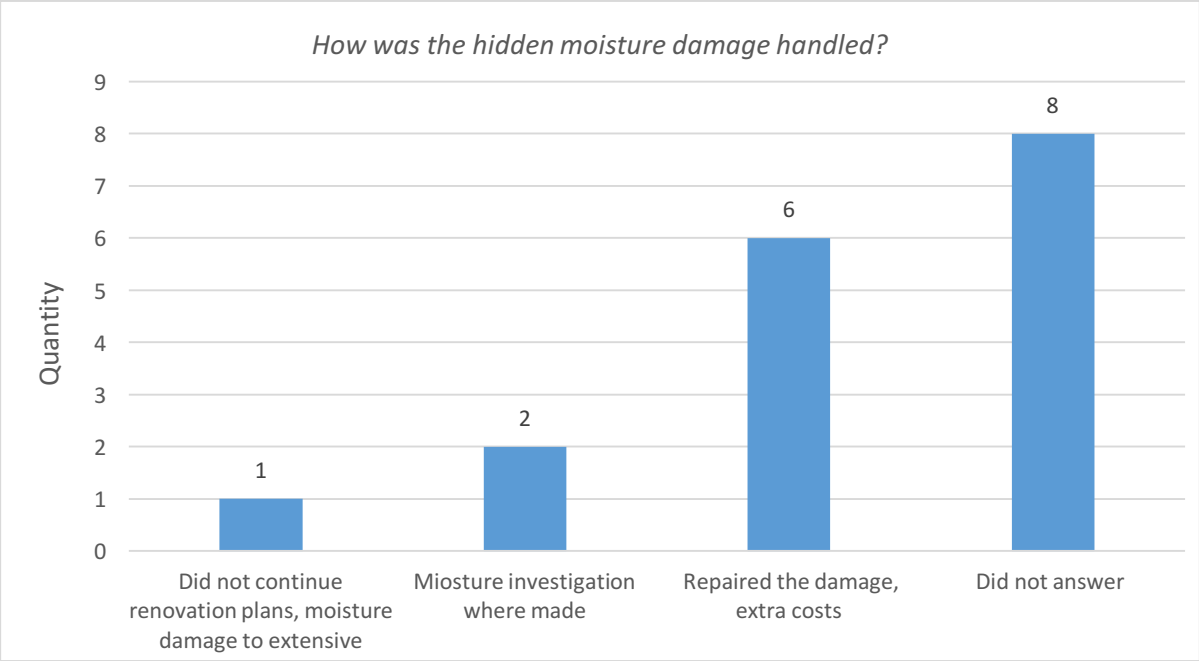
2. *How extensive is the inventory in the beginning of a project?*



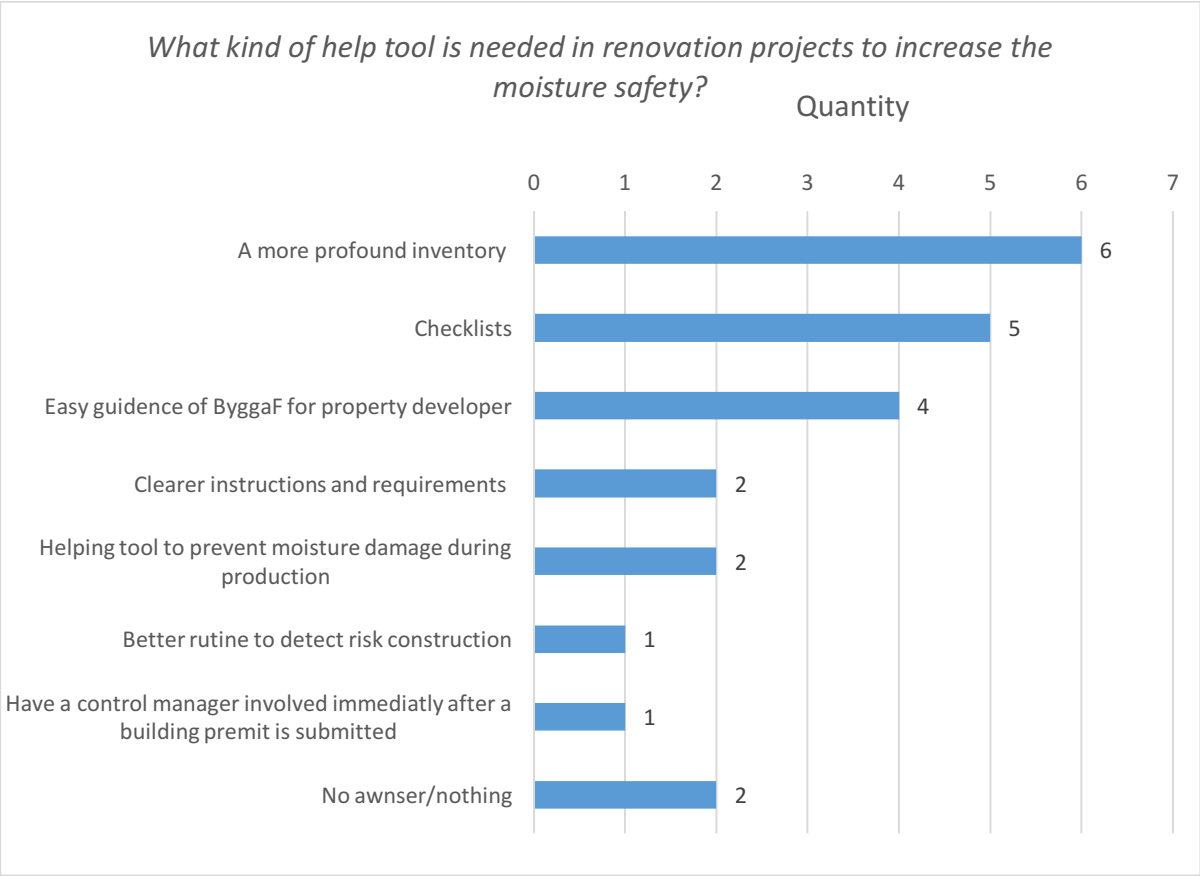
3. *Do you have experience of a renovation project where a hidden moisture damage was discovered?*



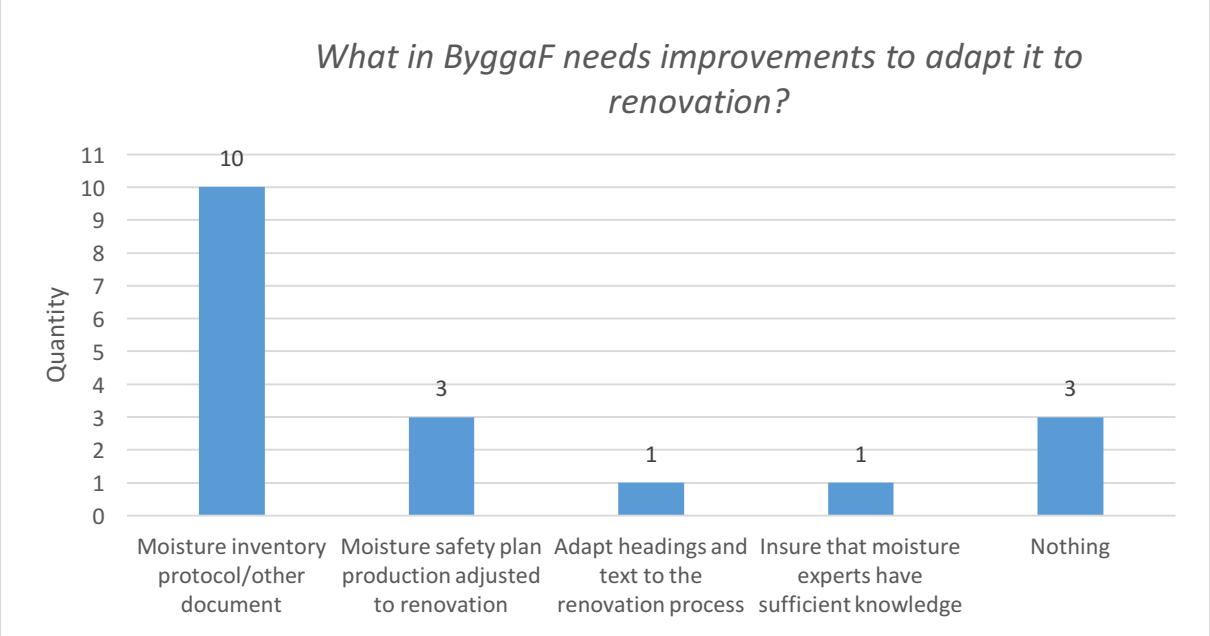
a. *How was it handled?*



4. *What kind of help tool is needed in renovation projects to increase the moisture safety?*



5. *Which parts in ByggaF need to be improved?*



Appendix 4

Suggestion for visual inventory checklists (in Swedish)

Following appendix contain suggestion of a document including visual inventory checklists, written in Swedish. The document is intended to be used in renovation projects.

Fuktinventering i befintlig byggnad

Följande dokument består av checklistor med kontrollpunkter som rekommenderas att användas vid en fuktinventering inför ombyggnad eller renovering.

Byggherren, med stöd av fuktsakkunniga, beslutar om vad som skall inventeras utifrån renoveringens omfattning. De checklistor som inte är relevanta kan tas bort från dokumentet.

Först samlas information och ritningar om byggnaden in. Ritningarna granskas innan platsbesök för att finna eventuella riskkonstruktioner. Därefter görs en okulär fuktinventering på plats, där följande bedömningar används:

Bedömning	Förklaring
Bör kontrolleras invändigt	Utvändig inventering indikerar att en kontroll bör göras invändigt. Tex en skada i fasaden som kan orsaka fuktskador invändigt.
Åtgärd krävs	En skada har upptäckts som skall beaktas i senare skede.
Följ upp	Indikation på skada där vidare utredning rekommenderas.
Ok	Ingen avvikelse är funnen.

Utifrån resultatet av fuktinventeringen i befintlig byggnad ska byggherren bedöma om fördjupad utredning är nödvändig. Kontrollpunkter som får anmärkning ”Åtgärd krävs” eller ”Följ upp” rekommenderas att utredas vidare.

Inhämtning av information

Inför platsbesök

Nr	Kontrollpunkt	Kommentar *Notera tidigare fuktskador och hur de har åtgärdats. Notera potentiella fuktskador*	Anmärkning	Genomförd	Saknas
1.1	Granskning av ritningar				
1.2	Granskning av tidigare utförda fuktutredningar				
1.3	Granskning av tidigare utförda fuktmätningar				
1.4	Inhämtning av material från tidigare projektering och byggnation				
1.5	Övriga dokument för specifikt projekt				
1.6	Uppgifter inhämtade från förvaltare lokalvårdare och driftpersonal				
1.7	Uppgifter inhämtade från hyresgäster (vid behov)				

Granskning av gamla ritningar Inför platsbesök				
Nr	**Riskkonstruktion**	**Kommentar**	**Misstanke om problem**	**Kontrollerad**
2.1	Kallvind			
2.2	Krypgrund			
2.3	Platta på mark med ovanpåliggande isolering			
2.4	Platta på mark med underliggande värmeisolering av lättklinker			
2.5	Platta på mark utan underliggande isolering			
2.6	Övergolvskonstruktioner			
2.7	Motfyllda väggar			
2.8	Enstegstätade fasader. *Är konstruktionen tidigare undersökt enligt Boverkets riktlinjer, Boverket 2009:3?*			
2.9	Terrasser och balkonger			
2.10	Välisolerade konstruktioner			
2.11	Befintliga byggnader som saknar eller har bristfällig ångspärr			
2.12	Övrig konstruktion för specifikt objekt			

Tak

Checklista för platsbesök

Nummer	Ritning / Kontrollpunkt	Kommentar	Bildnummer	Bedömning: Bör kontrolleras invändigt	Åtgärd krävs	Följ upp	OK	Ej relevant
3	**Allmänt**							
3.1	Finns synliga fel på plåtanslutningar? *T.ex huvar, skorsten?*							
3.2	Finns synliga fel på nockanslutning?							
3.3	Finns synliga fel på genomföringar?							
3.4	Fungerar avrinningssystemet? *Organiska material kan fastna i stuprör*							
3.5	Finns det avvikelser vid vinkelrännor och anslutningar?							
3.6	Är det kvarstående vatten?							
4	**Tegel-, eternit- eller betongpannor**							
4.1	Är taktäckningen hel? Sitter pannorna på plats?							
4.2	Är underlagstaket helt? *Stickprov under takpannor. Södersidan är kritisk*							
5	**Papptak**							
5.1	Finns det sprickor? *Var uppmärksam vid blåsbildningar*							
6	**Plåttak**							
6.1	Är skarvar täta?							
6.2	Är det korrosionsfritt?							

Fasad

Checklista för platsbesök

Nummer	Ritning / Kontrollpunkt	Kommentar	Bildnummer	Bedömning: Bör kontrolleras invändigt	Åtgärd krävs	Följ upp	OK	Ej relevant
7	**Allmänt**							
7.1	Finns det avvikelser vid plåtbeslag fönster?							
7.2	Finns det avvikelser på fönstrets kitt mellan glas och båge?							
7.3	Avvikelser genomföringar?							
7.4	Avvikelser övriga anslutningar? (*Exempelvis vid balkonger, takfot mm)*							
7.5	Synliga mikrobiella skador?							
8	**Grund och avrinning**							
8.1	Finns sprickor i grundmuren?							
8.2	Är grundmuren uppfuktad?							
8.3	Lutar marken bort från byggnaden?							
8.4	Leds dagvatten bort från grund?							
9	**Träfasad**							
9.1	Inga synliga rötskador? *torrsprickor i panelen*							
9.2	Avstånd mellan bottenpanel och mark?							
9.3	Finns luftspalt? *Inte alltid möjligt att kontrollera*							

10	**Tegel- och kalksandstenfasad**							
10.1	Är tegelstenar frostskadade?							
10.2	Är det synliga sprickor i fogar? *Kan finnas ovanför dörrar och fönster om armeringsjärn rostat sönder*							
10.3	Buktar väggen? *Kan förekomma om kramlor har rostat sönder*							
10.4	Synliga fuktskador?							
11	**Putsade fasader**							
11.1	Är det sprickor i putsen? *Kan bero på temperatur-förändringar eller sättningar*							

Invändigt Allmänt

Checklista för platsbesök

Nummer	Kontrollpunkt	Kommentar	Bildnummer	Bedömning: Åtgärd krävs	Följ upp	OK	Ej relevant
	Ritning	Våning					
		Rum					
13	**Lukt**						
13.1	Luktstatus direkt vid ankomst.* *Kontrollera alla utrymmen direkt*						
13.2	Luktkontroll vid golvlist * *Lukt från syll*						
14	**Ventilation**						
14.1	Typ av ventilation?						
14.2	Är ventilationen ombyggd?						
15	**Fönster**						
15.1	Fuktindikeringsmätning runt fönster						
15.2	Finns det avvikelser i anslutning karm och vägg?						
15.3	Finns synliga mikrobiella skador?**						
15.4	Finns kondens på fönstrets insida?** *Relevant vid utomhustemperatur under -5°C*						
16	**Golv**						
16.1	Sviktar golvbjälklag?						
16.2	Finns det två eller fler lagar limmade skikt? *Kan kontrolleras vid lister*						

16.3	Fuktindikering						
16.4	Synliga bubblor?** (Plastmatta)						
17	**Övrig kontroll**						
17.1	Finns synliga fuktskador?** *T ex färg- eller tapetsläpp*						
17.2	Finns missfärgningar?**						
17.3	Finns fuktfläckar?**						
17.4	Vattenburna radiatorer Är det något läckage? *kontrollera bl.a. tapetsläpp, termostat och kopplingar*						
17.5	Fuktindikering						
* skall beaktas enligt FoHMFS 2014:14, **indikationer enligt FoHMFS 2014:14, som hänvisar till Miljöbalken 26kap. 22§							

WC

Checklista för platsbesök

Nummer	Kontrollpunkt	Kommentar	Bildnummer	Bedömning: Åtgärd krävs	Följ upp	OK	Ej relevant
	Ritning	Våning					
		Ytskikt					
18							
18.1	Missfärgningar* runt wc-stol och handfat?						
18.2	Finns avvikelser/skador i ytskikt?						
18.3	Finns rörgenomföringar i golv?						
18.4	Fuktindikering (plastmatta)						

* indikationer enligt FoHMFS 2014:14, som hänvisar till Miljöbalken 26kap. 22§

Bad-, tvätt- och duschrum

Checklista för platsbesök

Nummer	Kontrollpunkt	Ritnin		Våning		Rum		Ytskikt		Kommentar	Bildnummer	Bedömning: Åtgärd krävs	Följ upp	OK	Ej relevant
19															
19.1	Missfärgningar* runt wc-stol och handfat?														
19.2	Fuktindikering golv (plastmatta)														
19.3	Fuktindikering runt rörgenomföringar (plastmatta)														
19.4	Fuktindikering vägg (plastmatta)														
19.5	Finns avvikelser/skador på fogar/skarvar i golv?														
19.6	Finns avvikelser/skador på fogar/skarvar i vägg?														
19.7	Är det fall mot golvbrunn?														
19.8	Finns avvikelser i dörrfoder? *Ligger dörrfoder mot golvet.*														
19.9	Är plastmattan uppvikt upp på väggarna?														
19.10	Avstånd rör till vägg/golv**														
19.11	Avstånd golvbrunn till vägg**														

* Indikationer enligt FoHMFS 2014:14, som hänvisar till Miljöbalken 26kap. 22§
**Skall kontrolleras enligt Säkert vatteninstallation.

Kök

Checklista för platsbesök

Nummer	Ritning		Våning		Bildnummer	Bedömning			
	Kontrollpunkt		Kommentar			Åtgärd krävs	Följ upp	OK	Ej relevant
20									
20.1	Har diskmaskin fuktskydd?								
20.2	Är golvet i vaskskåpet fuktskyddat?								
20.3	Finns det synliga avvikelser på rörgenomföringar?								
20.4	Fuktindikering *Bakom/i anslutning till vitvaror och i diskbänkskåp*								

Kallvindsutrymme

Checklista för platsbesök

Nummer	Ritning / Kontrollpunkt	Kommentar	Bildnummer	Bedömning: Åtgärd krävs	Följ upp	OK	Ej relevant
21							
21.1	Är hela vinden inspekterbar?						
21.2	Finns synliga springor vid invändig vindslucka?						
21.3	Avvikande lukt? *(Mögellukt från isoleringspapp, förvarat material mm. Kemisk lukt kan komma från råspont)*						
21.4	Synliga skador/missfärgningar isoleringspapp?						
21.5	Har vinden tilläggsisolerats?						
21.6	Mögelpåväxt på underlagstak?						
21.7	Missfärgningar eller mögel pga läckage?						
21.8	Finns konvektionsspärr?						
21.9	Finns avfuktare eller fläktar installerade? *Kontrollera deras skick*						

Uteluftsventilerad krypgrund

Checklista för platsbesök

Nummer	Ritning		Material golvbjälklag		Bildnummer	Bedömning			
	Kontrollpunkt		Kommentar			Åtgärd krävs	Följ upp	OK	Ej relevant
22									
22.1	Är hela grunden inspekterbar?								
22.2	Finns invändig lucka?								
22.3	Avvikande lukt?								
22.4	Finns det organiskt material på marken?								
22.5	Finns synligt läckage från installationer?								
22.6	Finns missfärgningar eller mögel?								
22.7	Fritt vatten på marken?								
22.8	Plasttäckning på marken? *Är den hel och finns det organiskt material under plasten?*								
22.9	Finns avfuktare eller fläktar installerade? *Kontrollera deras skick*								
22.10	Finns det loggning? *Fukt, temperatur och RH*								
22.11	Har yttermuren synliga fuktskador? *Undersök om det finns lossnande puts eller murbruk*								

Biutrymme/förråd

Checklista för platsbesök

Nummer	Ritning		Våning		Bildnummer	Bedömning			
			Rum			Åtgärd krävs	Följ upp	OK	Ej relevant
	Kontrollpunkt		Kommentar						
23									
23.1	Avvikande lukt?								
23.2	Finns det invändigt isolerade väggar? *Kritiskt i källare*								
23.3	Indikeringsmätning Är yttervägg fuktig? *Kontrollera hörn, stuprör, fönster eller andra kritiska delar*								
23.4	Finns det träbaserade golv eller väggar? *fuktkontroll*								
23.5	Förekommer färgsläpp på ytskikt?								

Appendix 5

Suggested changes in *Moisture safety planning with risk evaluation* to prevent conflicts with other industry regulations and to improve the consistency of the document. (in Swedish)

Förslag på ändringar i *Fuktsäkerhetsprojektering med riskvärdering* för att undvika konflikter med andra branschstandarder och för att göra dokumentet mer konsekvent.

De föreslagna ändringarna är skrivna i grön text och svart text är den ursprungliga texten från dokumentet. Föreslagna ändringarna avser:

- Våtrum
- Installationer

Våtrum		
Fuktbelastning	Att beakta	Att beakta (redigerad)
Generellt		
Fukttillskott från dusch, bad, tvätt, bastu	• Ångspärr i vägg • Tätskikt på vägg • Vad händer med fukt som kommer in bakom tätskiktet • Placering och montage av brunn • Anslutning till brunn • Skarvar på tätskikt • Rörelser i underliggande material • Genomföringar ledningar, skruvar • Minimerat antal håltagningar	• Ångspärr i vägg • Tätskikt på vägg • Fukt som kommer in bakom tätskiktet • Placering och montage av brunn • Anslutning till brunn • Skarvar på tätskikt • Rörelser i underliggande material • Genomföringar ledningar, skruvar • Minimerat antal håltagningar • Gällande branschregler t.ex. Säker vatteninstallation, BBV, GVK och MVK
Läckage från installationer	• Vattnets väg vid läckage • Skvallerfunktion • Fuktkänsliga material • Synliga rör och skarvar så att läckage snabbt kan upptäckas • Ledningar för tappvatten med kortare livslängd än byggnadens avsedda brukstid bör vara lätt åtkomliga och lätt att byta ut • Skvallerfunktion - Rörledningar ska förläggas så att eventuellt utläckande vatten snabbt upptäcks • Dolt placerade installationer ska utföras utan fogar • Fogar på tappvattenledningar ska placeras i rum med vattentätt golv eller	• Vattnets väg vid läckage • Skvallerfunktion • Fuktkänsliga material • Synliga rör och skarvar så att läckage snabbt kan upptäckas • Ledningar för tappvatten med kortare livslängd än byggnaden • Utrymmen för fogar i inbyggnader, installationsschakt eller kopplingsskåp • Fogning av dolt placerade installationer • Gällande branschregler t.ex.

	i särskilda inbyggnader eller i kopplingsskåp • Utrymmen för fogar i inbyggnader, installationsschakt eller kopplingsskåp ska ha vattentät botten och vara försedd med indikering för läckage med tillräcklig kapacitet	Säker Vatteninstallation, BBV, GVK och MVK
WC-stol med inbyggd cistern och inbyggd armatur		
Läckage från installationer	• WC-stol med inbyggd cistern ska ha spolcistern placerad i ett vattentätt och ventilerat utrymme med läckageindikering. Läckage ska mynna till rum med golvavlopp eller vattentätt golv. I WC-rum förses utrymmet där cisternen placeras med tätskikt på golv samt på vägg bakom och på sidor om cistern. 2) Armatur, t.ex. duschblandare ska placeras i ett vattentätt utrymme med läckageindikering. Läckage ska mynna till rum med golvavlopp eller vattentätt golv.	• Placering av tätskikt • Läckageindikering • Utmynning av läckage • Gällande branschregler t.ex. Säker Vatteninstallation, BBV, GVK och MVK
Rörgenomföring i golv och vägg med tätskikt		
Läckage i tätskikt	• Hål för rörgenomföring i golv- eller väggskiva eller motsvarande ska vara utfört med högst 2 mm mellanrum mellan skiva och rör. 2) Tappvatten-, värme- eller spillvattenrör genom vägg med tätskikt ska vara monterade och fixerade innan tätskiktet monteras sa att rörelse inte kan uppstå mellan rör och vägg med tätskikt. 3) Rörgenomföring med tappvatten- eller värmerör ska inte förekomma i golv med tätskikt. Vid avsättningar för tex WC-stol, tvättställ eller andra avloppsenheter får mått mellan spillvattenrör och väggens tätskikt inte understiga 60 mm. Genomföring av servisledning för tappvatten till småhus ska inte placeras i bad- eller duschrum. Servisledningen förläggas i skyddsrör, mått mellan skyddsrör och väggen får inte understiga 60 mm. 4) Förutom anslutning av kar- eller duschblandare ska inga rörgenomföringar finnas i plats för bad eller dusch. Vid rörgenomföring i vägg får mått mellan rör och Intilliggande väggs tätskikt inte understiga 60 mm. 5) Tätning ska göras mellan rör eller annan genomföringsdetalj och golvets eller väggens tätskikt.	• Rörgenomförnigar vägg och golv med tätskikt • Avstånd mellan rör, vägg och golv • Gällande branschregler t.ex. Säker Vatteninstallation, BBV, GVK och MVK

Skruvinfästningar och tätningar i golv eller väggar med tätskikt.		
Läckage i infästning	• Skruvinfästningar i våtzon 1 ska göras i massiv konstruktion, i betong reglar eller enligt Våtrumsvägg 2012. 2) Tätning av skruvinfästningar gäller i våtzon 1 och våtzon 2. 3) Tätningsmassan ska fästa mot underlaget vara vattenbeständigt, mögelresistent och åldersbeständigt.	• Våtrumszoner • Material i konstruktionen • Gällande branschregler t.ex. Säker Vatteninstallation, BBV, GVK och MVK
Golvbrunnar		
Läckage vid golvbrunn	• Golvbrunnar tillverkade före 1991 eller inte uppfyller kraven enligt standarden SS-EN 1253 ska bytas ut vid renovering gäller även golvbrunnar som inte är monterade och fixerade i bjälklaget enligt nu gällande monteringsanvisningar. 2) Golvbrunn ska vara monterad med ett minsta avstånd av 200 mm mellan väggens tätskikt och yttre fläns. 3) Golvbrunn ska vara monterad och fixerad i bjälklag med de fastsättningshjälpmedel som finns t.ex. monteringsplatta eller fixtur. 4) Golvbrunn ska vara monterad i våg i höjd med anslutande tätskikt och en vågrätt tolerans p+/- 2 mm. 5) Väggnära golvbrunn som monteras närmare vägg än 200 mm ska golvbrunn och tätskikt vara provade och godkända tillsammans.	• Ålder på golvbrunn vid renovering • Golvbrunnens montering samt avstånd till vägg • Anslutande tätskikt • Gällande branschregler t.ex. Säker Vatteninstallation, BBV, GVK och MVK

Installationer		
Fuktbelastning	Att beakta	Att beakta (redigerad)
Dolda tappvatten-installationer		
Läckage från rörinstallation	• Ledningar för tappvatten med kortare livslängd än byggnadens avsedda bruks tid bör vara lätt åtkomliga och lätt att byta ut. • Installationer som är dolt placerade och inte inspekterbara i schakt, väggar, bjälklag eller bakom fast inredning ska utföras utan fogar • Tappvatten- eller värmeledningar får inte monteras i ouppvärmda utrymmen som till exempel krypgrund eller vind.Tappvatten- eller värmeledningar får inte monteras i isolering i golv, ytterväggar eller vindsbjälklag. • Rörsystem ska tryck- och täthetskontrolleras innan det tas i drift. Kontrollerna ska dokumenteras.	• Ledningar för tappvatten med kortare livslängd än byggnadens avsedda bruks tid • Fogning av dolt placerade installationer • Kondensering • Kontroll av tryck och täthet • Gällande branschregler t.ex. Säker vatteninstallation, BBV, GVK och MVK
Placering av fogar, vatten och värme		
Läckage från fogar	• Fogar på tappvattenledningar ska placeras i rum med vattentätt golv eller i särskilda inbyggnader eller i kopplingsskåp. Utrymmen för fogar i inbyggnader, installationsschakt eller kopplingsskåp ska ha vattentät botten och vara försedd med indikering för läckage. I inbyggnader och installationsschakt ska väggarna vara vattentäta 50 mm över schaktbotten och tätt anslutna mot denna. Läckage ska mynna till rum med golvavlopp eller vattentätt golv. • Fogar på värmefördelare ska vara synliga eller placerade så att det är åtkomliga. Utrymmen för fördelarrör med fogar, luftningar, ställdon med mera, i inbyggnader, installationsschakt eller kopplingsskåp ska ha vattentät botten och vara försedd med indikering för läckage. Läckage ska mynna på plats där man snabbt kan upptäcka detta. I inbyggnader och installationsschakt ska väggarna vara vattentäta 50 mm över schaktbotten och tätt anslutna mot denna. Läckage ska mynna på plats där man snabbt kan upptäcka detta. • Utrymme för fogar, värmefördelare, luftningar, ställdon mm ska ha serviceöppning som är tillräckligt stor för kontroll, reparation eller byte av	• Vattentätt golv, inbyggnader, installationsschakt och kopplingsskåp • Läckageindikering • Utmynning av läckage • Tillgänglighet fogar på värmefördeare • Möjlighet till kontroll och placering av serviceöppningar • Gällande branschregler t.ex. Säker vatteninstallation, BBV, GVK och MVK

	fogar. Serviceöppning får inte placeras i våtzon 1.	
Vattenanslutna apparater i kök		
Läckage från fogar	• Rörledning för tappvatten i kök ska monteras utan fogar fram till blandare eller apparat. • Under diskbänk, diskmaskin, kyl, frys, ismaskin eller dylikt, ska det finnas ett tätt ytskikt, till exempel en fogtät golvmatta. Ytskiktet bör vara tätat vid golvgenomföringar och uppvikt minst 50 mm mot angränsade vägg eller dylikt, så att utläckande vatten eller kondens snabbt blir synligt.	• Ytskikt under diskbänk, diskmaskin, kyl, frys eller dylikt • Gällande branschregler t.ex. Säker vatteninstallation, BBV, GVK och MVK

Appendix 6

Suggestions for improvements in *Moisture safety planning with risk evaluation* to suit the process of renovation (in Swedish)

Förslag på förbättringar i *Fuktsäkerhetsprojektering med riskvärdering* för att anpassa det till renovering.

Text markerad med grönt är förslag på tillägg med avseende på renovering. Svart text är ursprunglig text från Fuktsäkerhetsprojektering med riskvärdering. Föreslagna ändringarna avser:

- Tak och vind
- Yttervägg och fasad
- Grund och källare

Tak och Vind	
Fuktbelastning	**Att beakta**
Stående vatten	• Taklutning, takform • Välj takmaterial som rek. för vald taklutning och underlag • Tätskikt • Utförande av genomföringar, anslutningar, infästningar, skarvar, överlapp
Rinnande, drivande vatten, slagregn	• Utforma taket så att vattnet kan rinna av och inte in i anslutningar, skarvar, spalter, fogar • Ventilerade spalter • Rörelser vid temperaturändring • Vattenavledande bleck, plåtar • Rätt antal brunnar • Finns genomföringar i anslutning till brunnar? • Placering av brunnar i lågpunkter • Tillgänglighet för rensning av brunnar, hängrännor och stuprännor • Breddavlopp
Fuktdiffusion till följd av ånghaltsskillnader	• Placering av ångspärr • Kontrollera fukttillstånd vid vinterfall, sommarfall • Håltagning i ångspärr vid genomföringar, infästningar (speciellt viktigt då ånghaltsskillnaden är stor) måste tätas • Ventilera bort kondenserat vatten • Fuktbuffring i takmaterialen • Kritisk fuktnivå för ingående material • Köldbryggor • Speciella förhållanden i kyl och frysrum, badhus, ishall och sommarstugor *• Ändrad verksamhet kan leda till ökad fuktproduktion efter renovering*
Fuktkonvektion till följd av tryckskillnader och luftläckage	• Undertryck inne • Fukttillskott • Lufttäthet för att hindra konvektion. Klämda skarvar, tejpade skarvar, tätning runt genomföringar, luckor • Lufttäthet vid anslutningar, genomföringar • Temporärt invändigt övertryck *• Tilläggsisolering vid renovering* *• Ändring av ventilationssystem i byggnaden vid renovering*

Fukt från uteluften	• Ventilerade tak • Temperatursänkning pga nattutstrålning • *Temperatursänkning pga. tilläggsisolering*
Fukttillskott från installationer	• Ventilations- eller avluftningskanaler får inte ha utlopp på vinden Roterande värmeväxlare med fuktåtervinning får inte leda till problem
Nederbörd under byggtiden	• Möjlighet att bygga provisoriskt tak eller väderskydd • Förvaring av material under regnskydd • *Befintlig konstruktion kan vara fuktkänslig*
Uttorkning av byggfukt från betong och lättbetong	• Uttorkningstider för betong • Ångspärr på vindsbjälklaget? • Rengöring av betongytor innan ångspärr eller fuktspärr läggs på. • Tillförd fukt under byggtiden
Byggfukt i trä	• Fuktigt material som byggs in. • Tillförd fukt under byggtiden • Specificera högsta tillåtna FK för trä innan inbyggnad
Läckage från installationer på tak	• Placering av vattenrör så att läckage kan upptäckas snabbt och så att skadorna minimeras.
Kondens från kalla installationer	• Tillräckligt tjock kondensisolering för att undvika kondens på kalla rör.

Yttervägg och fasad	
Fuktbelastning	**Att beakta**
Slagregn	• Uttorkning av regn som absorberats av fasadmaterial Frostbeständigt material i skalmur, fasad • Luftspalt, dränering, luftning • Inget fogbruk i luftspalt • Avvattning från fasad • Lutning på vattenavledande plåtar • Takutsprång för att minska belastning av slagregn • Flerstegstätning i fogar i fasader och fönster • Sommarkondens till följd av slagregn • Fuktkänsliga material som trä skall vara skyddat mot fukt • *Långsammare uttorkning av fasad vid invändig tilläggsisolering* • *Yttre delar av fasaden blir kallare vid invändig tilläggsisolering*
Vattenfilm, rinnande vatten	• Fogar • Anslutningar, genomföringar, skarvar, fogar • Droppbleck, vattenavledande plåtar • Lämpligt färgsystem
Vatten stänk (särskrivet) från mark	• Sockelhöjd • Anslutning sockel-fasad • Inga rabatter i direkt anslutning till byggnaden
Fuktkonvektion	• Säkerställ undertryck inne • Förutsätt temporärt övertryck inne • Lufttäthet för att hindra konvektion. • Beständig täthet vid genomföringar, skarvar och anslutningar • *Befintligt ventilationssystem, tidigare ändringar och om det skall ändras vid renovering* • *Ändras tryckförhållanden vid renovering* • *Finns befintlig ångspärr, undvik dubbla lager*
Fuktdiffusion	• Ångspärr rätt placerad • Täthet vid genomföringar, skarvar, anslutningar • Fuktkänsliga material som trä skall vara skyddat mot fukt • Speciella förhållanden i kyl och frysrum, badhus, ishall och

	sommarstugor mm • Undvik köldbryggor • Speciella rum med hög luftfuktighet som våtrum, tvätt, befuktade rum *• Höjd relativ fuktighet i befintlig konstruktion vid invändig tilläggsisolering*
Byggfukt i betong och lättbetong	• Uttorkning av byggfukt i betong innan tätskikt appliceras • Fuktisolering under syllar som monteras på betongbjälklag • Gipsskivor skall inte monteras direkt mot betong
Byggfukt i trä	• FK vid inbyggnad av träregelvägg • Omfattning fuktmätning
Läckage från installationer på eller i vägg och fasad	• Fuktkänsliga material • Skvallerfunktion • Dolda installationer i fasad • Läckande stuprör och hängrännor skall inte skada vägg eller fasad
Fukt från inneluften	*• Reducerad ventilation efter renovering* *• Invändig tilläggsisolering*

Grund och källare	
Fuktbelastning	**Att beakta**
Slagregn, vattenfilm, drivande vatten	• Avledning av vatten från fasad • Tätning runt ventiler • Tätning av springor, spalter • Vattenuppsugning i tegel, puts, betong
Vattenstänk från mark	• Sockelhöjd tillräcklig för att hindra vattenstänk från marken
Vatten på mark	• Avledning av regnvatten från byggnaden • Lutning från byggnaden • Markens beskaffenhet
Fuktdiffusion pga ånghaltsskillnad över väggen	• Hög ånghalt i våtrum • Ytskikt på insida källarvägg eller motfylld vägg
Fukttillskott i ventilerade konstruktioner	• Fukttillståndet i uteluftsventilerade konstruktioner (kryprum) årsvariationer • Ventilationsöppningar
Rinnande vatten i eller på marken	• Dräneringsledningens kapacitet och placering • Dränerande material • Rensmöjlighet i brunnar och dräneringsledning • Schaktbotten • Kapillärbrytande skikt
Vattentryck	• Stående vatten mot källarvägg och grund • Skvallerfunktion om det börjar läcka
Ånghalt i mark under platta, bjälklag, i krypgrund	• Markens RF=100 % • Ångspärr • Värmeisolering under grundkonstruktionen • Värmeisolering på utsidan, kallaste sidan • Kontrollera temperaturgradienten över platta på mark (obs speciellt för stora byggnader) • Tag hänsyn till värmekällor i marken, i grunden eller i plattan. Gör beräkning. • Undvik köldbryggor • Lufttät konstruktion för att undvika golvdrag, dålig lukt och ev. radon • Undertryck i grunden

	• Hindra avdunstning av markfukt • Ventilation • Inget organiskt material i krypgrunder eller i kontakt med betongplatta på mark *• Golvvärme i platta på mark utan underliggande isolering* *• Invändig isolering vid renovering*
Byggfukt i betong	• Uttorkning av byggfukt i betong • Behov av fuktmätningar • Ensidig uttorkning • Kritisk fuktnivå för fuktkänsliga ytskikt och intilliggande material • Tätskikt på insidan i våtrum som förhindrar uttorkning • Rengöring av betongplatta innan fuktspärr appliceras
Läckage från installationer	• Vattnets väg vid ett läckage • Fuktkänsliga material • Skvallerfunktion • Lutning mot golvbrunnar

Appendix 7

Suggestions for improvement in the document *Industry standard ByggaF.* (in Swedish)

Förslag på generella ändringar i *Branschstandard ByggaF metod för fuktsäker byggprocess*

Vid hänvisning av anmärkning eller vägledning kommer följande system användas:
ANM (1) – *första anmärkningen i kapitlet*
ANM (2) – *andra anmärkningen i kapitlet*
osv
Vägledning (1) – *första vägledningen i kapitlet*
osv

Föreslagna ändringar är skriven i grön text och svart text är den ursprungliga texten från dokumentet.

Kapitel	kommentar	Nuvarande text	Revidering
-	Dokumentnamnen på hemsidan stämmer inte överens med titeln i dokumentet På hemsidan är branschstandard felstavat	Hemsidan: ByggaF Branchstandard Titel dokument: Branschstandard ByggaF metod för fuktsäkert byggande	Hemsidan: Branschstandard ByggaF metod för fuktsäkert byggande Titel dokument: Branschstandard ByggaF metod för fuktsäkert byggande
-	Dokumentnamnen på hemsidan stämmer inte överens med titeln i dokumentet	Hemsidan: Fuktriskinventering i tidiga skeden Titel i dokument: Tidig inventering av fuktrisker, behov av fuktutredning och fuktkompetens	Hemsidan: Fuktriskinventering i tidiga skeden Titel i dokument: Fuktriskinventering i tidiga skeden
-	Dokumentnamnen på hemsidan stämmer inte överens med titeln i dokumentet	Hemsidan: Fuktinventering i befintlig byggnad Titel i dokument: Fuktinventering och fuktstatusbedömning i befintlig byggnad	Hemsidan: Fuktinventering i befintlig byggnad Titel i dokument: Fuktinventering i befintlig byggnad
2.10.7	Samordnande fuktsäkerhetsansvarig projektering nämns inte när den är aktuell i resterande dokument.		
2.11.2	Om det inte ändras så motsäger den 2.11.1 ANM (1)	ANM (2): Fuktsäkerhetsprogram upprättas före detaljprojekteringen	ANM (2): ~~Fuktsäkerhetsprogram~~ Fuktsäkerhetsbeskrivningen upprättas före detaljprojekteringen

2.12	Oklart vad **2.12.2 Fuktriskinventering** avser. Aktiviteterna i kapitlet inte i kronologisk ordning om det avser tidig fuktriskinventering. Annars är fuktriskinventering en aktivitet som ej nämn i resterande branschstandard.		
3.3	Den schematiska bilden av ByggaF för byggherrar bör stå med. Se Appendix 8	-	Vägledning: Förslagsvis används den schematiska bilden av ByggaF för att introducera byggherren och övriga aktörer om ByggaF.
3.4	Första meningen av stycket. Låter det som att det har stått något innan.	Det praktiska fuktsäkerhetsarbetet utförs däremot av alla berörda aktörer, projektörer, entreprenörer och leverantörer	Det praktiska fuktsäkerhetsarbetet utförs ~~däremot~~ av alla berörda aktörer, projektörer, entreprenörer och leverantörer
3.4	Tydligare beskrivning av organisationen vid totalentreprenad		Inför organisationsträd för totalentreprenad.
4.2	Är projektören upphandlad i programskede?	Vägledning: Fuktsakkunnig tillsammans med projektörer identifierar och analyserar ur fuktsynpunkt kritiska förutsättningar. […]	Vägledning: Fuktsakkunnig ~~tillsammans med projektör~~ identifierar och analyserar ur fuktsynpunkt kritiska förutsättningar. […]
5.1.2	Liknande beskrivning som i 6.3 av vilken typ av person som skall vara fuktsäkerhetsansvarig. Kan vara bra för att underlätta fuktsäkerhetsprojektering med riskvärdering.	-	Vägledning: Fuktsäkerhetsansvarig projektering är en person som har god kännedom om ByggaF och ha dokumenterad kunskap om fukt i luft och material. Om det finns många personer som är fuktsäkeransvarig projektering är projekteringsledaren samordnande alternativt en samordnande fuktsäkerhetsansvarig projektering.
5.1.5	Förtydligande av text. Oklart om vem som har ansvaret. Är det här som Samordnade fuktsäkerhetsansvarig projektering blir aktuell?	Projekteringsgruppen ska gemensamt utföra och dokumentera en fuktriskanalys. Projekteringsledaren är ansvarig för samordning av fuktriskanalysen. Ny	Projekteringsgruppen ska gemensamt utföra och dokumentera en fuktriskanalys, där fuktsäkerhetsansvarige projektering är ansvarig. Projekteringsledaren är ansvarig för samordning av

		fuktriskanalys ska utföras om förutsättningar ändras. Vägledning: Förslagsvis användas checklistor för att göra fuktriskidentifiering och fuktriskanalys i olika skeden. Ändrade förutsättningar omfattar även ändrad användning av lokaler eller ändrad styrning av installationer eller klimat	fuktriskanalysen. Ny fuktriskanalys ska utföras om förutsättningar ändras. Vägledning: Förslagsvis användas checklistor för att göra fuktriskidentifiering och fuktriskanalys i olika skeden. Ändrade förutsättningar omfattar även ändrad användning av lokaler eller ändrad styrning av installationer eller klimat Vägledning: Samordnande fuktsäkerhetsansvarig projektering kan även ansvara för samordningen i större projekt.
5.3.2	Beskriv vilka egenskaper som fuktsäkerhetsansvarig projektering behöver, likt 6.3. Kan behövas för att förbättra användningen av dokumentet fuktsäkerhetsprojektering med riskvärdering.		Vägledning: Fuktsäkerhetsansvarig projektering är en person som har god kännedom om ByggaF och ha dokumenterad kunskap om fukt i luft och material.
5.3.3.5	Enligt intervjuer har fuktriskanalys visat sig vara komplicerat att göra för projektörer. Det har även kommit fram att ByggaF är för akademisk. I vägledningen beskrivs hur ”en riktig riskanalys” går till, vilket är ej relevant i sammanhanget, det kan förstärka det akademiska intrycket av ByggaF. Det bör istället beskriva hur en kvalificerad bedömning ska göras.	Vägledning (2): För att få en uppfattning om fuktsäkerheten för en byggnad eller byggnadsdel kan man göra en fuktriskanalys. Metoden med säkerhetsfaktorer som används i statisk dimensionering är svår att applicera vid fuktsäkerhetsprojektering, däremot kan man göra en kvalificerad bedömning av sannolikheten att något inträffar och konsekvensen av detta d v s risken för fuktskada eller annan olägenhet orsakad av fukt uppstår. För att göra en riktig riskanalys krävs att varje beräkningsparameter beskrivs med en fördelningskurva.	Vägledning (2): För att få en uppfattning om fuktsäkerheten för en byggnad eller byggnadsdel kan man göra en fuktriskanalys. Metoden med säkerhetsfaktorer som används i statisk dimensionering är svår att applicera vid fuktsäkerhetsprojektering, däremot kan man göra en kvalificerad bedömning av sannolikheten att något inträffar och konsekvensen av detta d v s risken för fuktskada eller annan olägenhet orsakad av fukt uppstår. ~~För att göra en riktig riskanalys krävs att varje beräkningsparameter beskrivs med en fördelningskurva. Beräkningen utförs sedan med ett~~

		Beräkningen utförs sedan med ett slumpmässigt värde ur de olika parametrarnas fördelningskurvor. Genom att göra ett stort antal beräkningar får man ett statistiskt underlag utifrån vilket man kan utläsa en risk för att t ex fukttillståndet i ett material överstiger ett visst värde. Hänsyn måste tas till samvariation mellan olika parametrar. Detta är komplext men börjar användas mer och mer vid olika typer av dimensionering.	~~slumpmässigt värde ur de olika parametrarnas fördelningskurvor. Genom att göra ett stort antal beräkningar får man ett statistiskt underlag utifrån vilket man kan utläsa en risk för att t ex fukttillståndet i ett material överstiger ett visst värde. Hänsyn måste tas till samvariation mellan olika parametrar. Detta är komplext men börjar användas mer och mer vid olika typer av dimensionering.~~
5.3.3.6	Vad händer om risken kvarstår även om den har minimeras? En lägsta nivå krävs.		
5.3.6	Förtydliga ”ska”	Fuktsäkerhetsansvarig projektering samlar in underlag och dokumentation från sitt eget fuktsäkerhetsarbete samt fuktsäkerhetsarbete som ut förts av eventuella underentreprenörer och underleverantörer och överlämnar det till fuktsakkunnig.	Fuktsäkerhetsansvarig projektering ~~samlar~~ ska samla in underlag och dokumentation från sitt eget fuktsäkerhetsarbete samt fuktsäkerhetsarbete som ut förts av eventuella underentreprenörer och underleverantörer och ~~överlämnar~~ ska överlämna det till fuktsakkunnig.
6.6	Fuktsakkunnig har benämnts som ”fuktsakkunnig” genom hela texten förutom i detta kapitel där den benämns vid ”byggherrens fuktsakkunnig”. Se definitionen av fuktsakkunnig 2.10.1	Byggherrens fuktsakkunnig ska sammankalla till, genomföra och dokumentera regelbundna uppföljningsmöten med entreprenörer och leverantörer	~~Byggherrens~~ fuktsakkunnig ska sammankalla till, genomföra och dokumentera regelbundna uppföljningsmöten med entreprenörer och leverantörer
6.8	Förtydliga ”ska”	Fuktsäkerhetsansvarig produktion ansvarar för att mätningar och kontroller enligt fuktsäkerhetsplanen utförs och dokumenteras.	Fuktsäkerhetsansvarig produktion ~~ansvarar~~ ska ansvara för att mätningar och kontroller enligt fuktsäkerhetsplanen utförs och dokumenteras.
6.9	Förtydliga ”ska”	Fuktsäkerhetsansvarig produktion ansvarar för att dokumentera avvikelser från fuktsäkerhetsplanen och	Fuktsäkerhetsansvarig produktion ~~ansvarar~~ ska ansvara för att dokumentera avvikelser från

		rapportera föreslagen åtgärd till byggherrens fuktsakkunnig.	fuktsäkerhetsplanen och rapportera föreslagen åtgärd till byggherrens fuktsakkunnig.
6.10.1	Förtydliga ”ska”	Fuktsäkerhetsansvarig produktion samlar in underlag för drift- och underhållsinstruktioner avseende fuktsäkerhet från underentreprenörer och leverantörer och överlämnar till fuktsakkunnig.	Fuktsäkerhetsansvarig produktion ~~samlar~~ ska samla in underlag för drift- och underhållsinstruktioner avseende fuktsäkerhet från underentreprenörer och leverantörer och överlämnar till fuktsakkunnig.
6.10.2	Förtydliga ”ska”	Fuktsäkerhetsansvarig produktion samlar in underlag från sitt fuktsäkerhetsarbete samt från underentreprenörer och leverantörer och överlämnar till fuktsakkunnig	Fuktsäkerhetsansvarig produktion ~~samlar~~ ska samla in underlag från sitt fuktsäkerhetsarbete samt från underentreprenörer och leverantörer och överlämnar till fuktsakkunnig
6.11	Förtydliga ”ska”	Fuktssakkunnig sammanställer fuktsäkerhetsdokumentation från projektering och produktion och överlämnar den till byggherren.	Fuktssakkunnig ~~sammanställer~~ ska sammanställa fuktsäkerhetsdokumentation från projektering och produktion och överlämnar den till byggherren.
7.2	Förtydliga ”ska”	Fastighetsägaren är ansvarig för att driftronder utförs i driftskedet där fukt är en aspekt.	Fastighetsägaren är ansvarig för att driftronder ~~utförs~~ ska utföras i driftskedet där fukt är en aspekt.

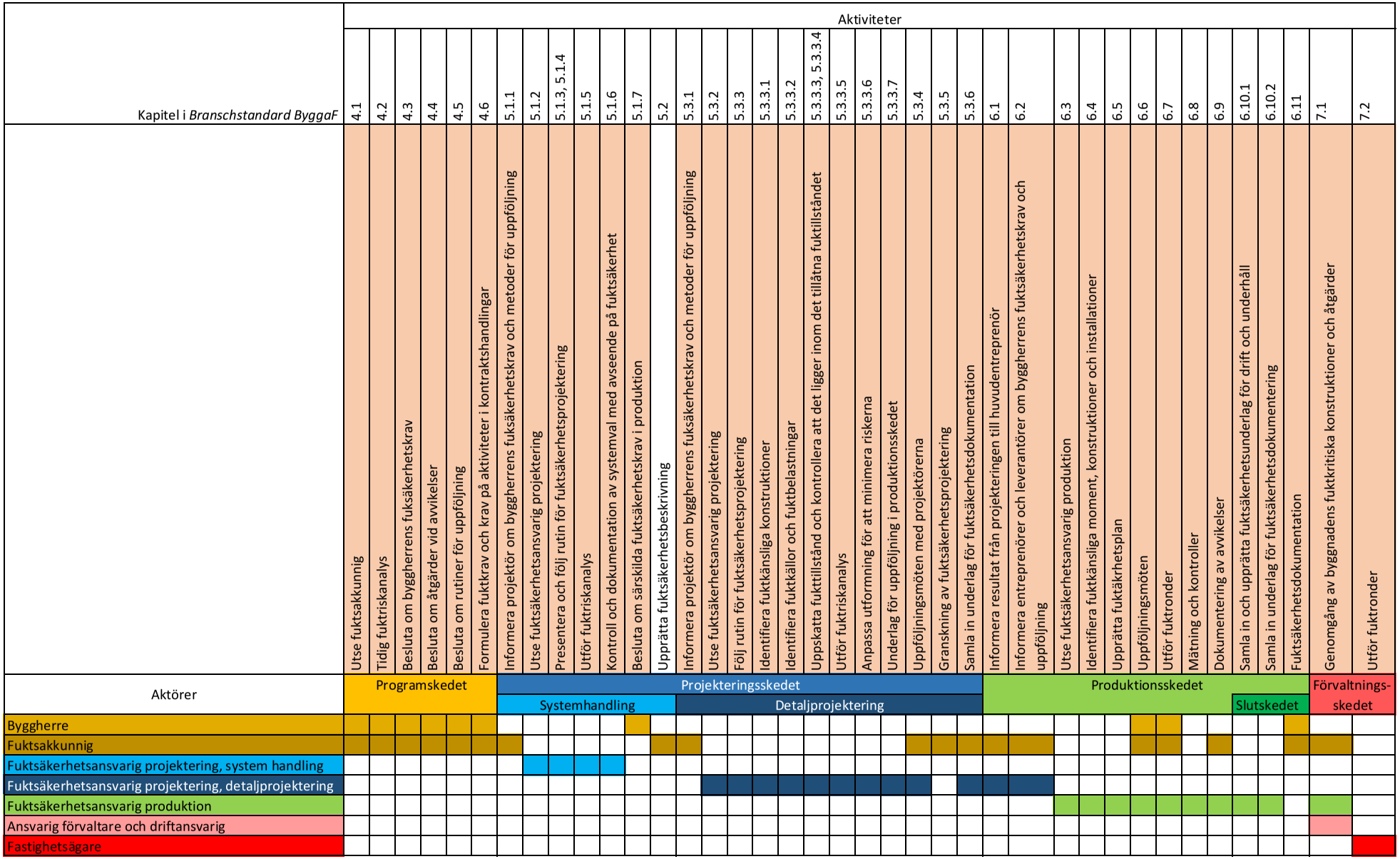
Appendix 8

Schematisk bild av ByggaF

Följande schematiska bild beskriver aktiviteter som är inkluderade i ByggaF och vilka aktörer som är involverade i varje aktivitet

= Aktivieter som **ska** genomföras enligt ByggaF

= Aktiviteter som **bör** genomföras enligt ByggaF

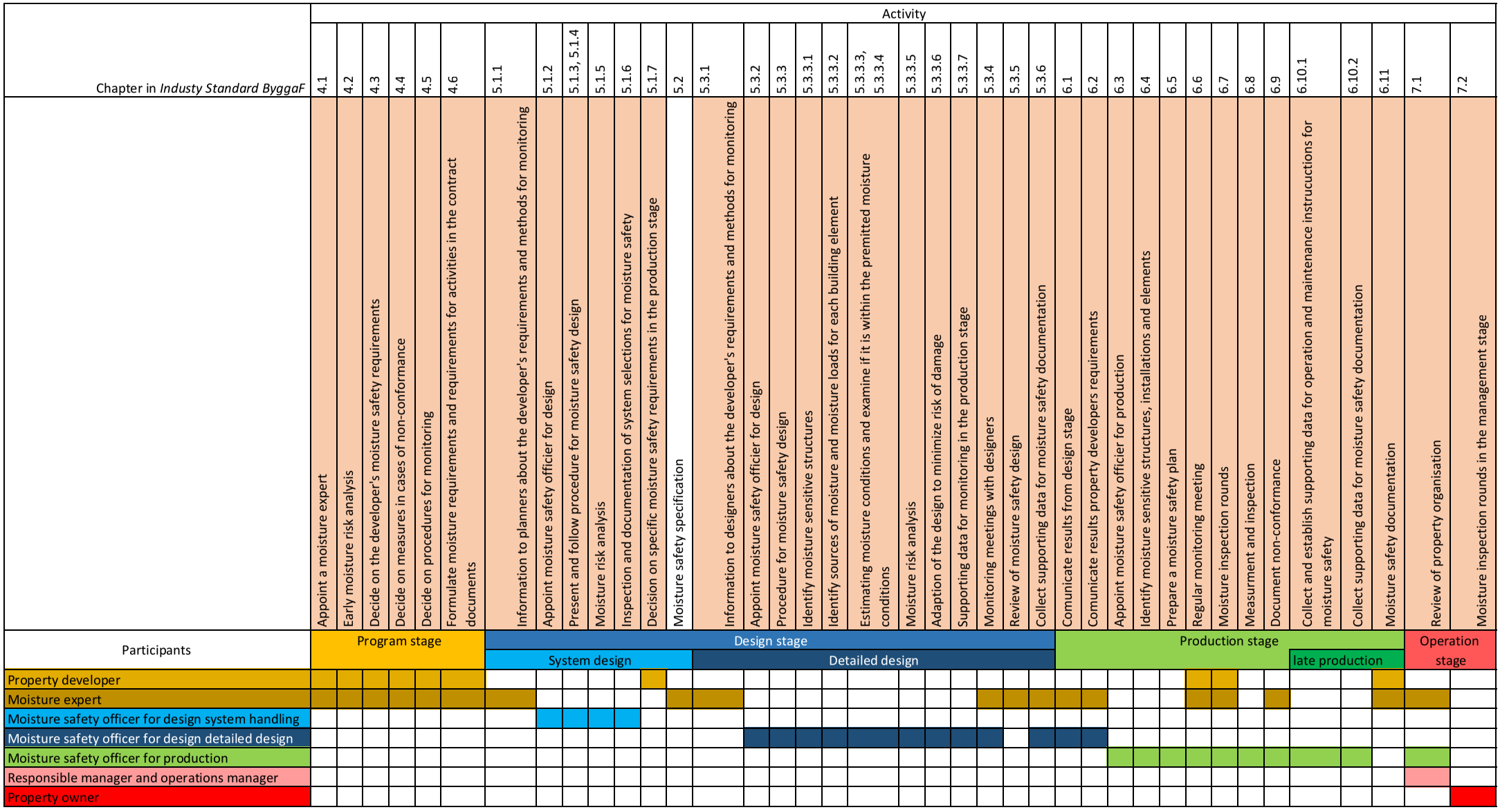


Schematic figure of ByggaF

Following chart is an overview describing activities included in ByggaF and participants involved in each activity.

= Activity that **should** be done according to ByggaF

= Activity that is **recommended** according to ByggaF



Appendix 9

Suggestions for adjustment to suit the process of renovation in document *Industry standard ByggaF*. (in Swedish)

Förslagna ändringar med avseende på renovering i *Branschstandard ByggaF metod för fuktsäker byggprocess.*

Vid hänvisning av anmärkning eller vägledning kommer följande system användas:
ANM (1) – *första anmärkningen i kapitlet*
ANM (2) – *andra anmärkningen i kapitlet*
osv
Vägledning (1) – *första vägledningen i kapitlet*
osv

Föreslagna ändringar är skrivna i grön text och svart text är den ursprungliga texten från dokumentet.

Kapitel	kommentar	Nuvarande text	Revidering
2.12	Tillägg av kapitel: ”2.12.0 Fuktinventering i befintlig byggnad”	-	**2.12.0 Fuktinventering i befintlig byggnad** Granskning av ritningar, utfrågning brukare och förvaltare samt inventering av befintlig byggnad med avseende på fuktskador.
4	Tillägg av kapitel: ”4. X Fuktinventering i befintlig byggnad”	-	**4. X Fuktinventering i befintlig byggnad** Vid renovering och tillbyggnad ska byggherren ansvara för att fuktinventering av befintlig byggnad genomföras för att uppmärksamma avvikelser, synpunkter och anmärkningar. Vägledning: I en inventering ingår granskning av relevant dokumentation, inhämtning av uppgifter från parter med god kännedom om byggnaden och icke förstörande inspektioner. Byggherre bör tillsammans med fuktsakkunnig bestämma vilka delar av byggnaden som ska inventeras. Se checklistor för inventering av befintlig byggnad för detaljerad information.

			Vägledning: Vid inventeringen av befintlig byggnad bör fuktskador följas upp i projekteringen och som bör kontrolleras i produktionen.
4	Tillägg av kapitel: ”4. Y Utvärdering av behov av fördjupad undersökning”		**4. Y Utvärdering av behov av fördjupad undersökning** Byggherren ska ansvara för att utvärdera behovet av en djupare undersökning av fuktskador baserat på resultatet av fuktinventeringen av befintlig byggnad.
4.6	Resultatet från fuktinventeringen bör finnas med i kontraktshandlingar.	Vägledning: Byggherrens krav på fuktsäkerhet kan formuleras i fuktsäkerhetsprogram eller återfinnas i andra dokument. Fuktsäkerhetsprogrammet kan innehålla: […]	Vägledning: Byggherrens krav på fuktsäkerhet kan formuleras i fuktsäkerhetsprogram eller återfinnas i andra dokument. Fuktsäkerhetsprogrammet kan innehålla: […] • Resultat från fuktinventering av befintlig byggnad
5.1.1	I informationen till projektörerna bör det även förklaras om vilka fuktskador som upptäcktes under inventeringen	Fuktsakkunnig ska informera projektörerna om fuktsäkerhetskraven och de metoder som kommer att användas för uppföljningen av att kraven uppfylls.	Fuktsakkunnig ska informera projektörerna om fuktsäkerhetskraven, resultat från fuktinventering och de metoder som kommer att användas för uppföljningen av att kraven uppfylls.
5.1.5	Lägg till vägledning ROT		Vägledning: Vid renovering och tillbyggnad bör fuktriskanalys med riskvärderingen och åtgärdsförslag baseras på resultatet från fuktinventeringen.
5.2	Resultat från inventeringen kan även vara aktuell att inkludera i fuktsäkerhetsbeskrivningen	Vägledning: […] Fuktsäkerhetsbeskrivningen kan innehålla: •Byggherrens krav på fuktsäkerhet, dock lägst samhällets krav på fuktsäkerhet (hänvisning till regelverk). •Projektets förutsättningar ur fuktsynpunkt. […]	Vägledning: […] Fuktsäkerhetsbeskrivningen kan innehålla: •Byggherrens krav på fuktsäkerhet, dock lägst samhällets krav på fuktsäkerhet (hänvisning till regelverk). •Projektets förutsättningar ur fuktsynpunkt.

			• Resultat från fuktinventering av befintlig byggnad […]
5.3.1	I informationen till projektörerna bör det även förklaras om vilka fuktskador som är funna under inventeringen	Fuktsakkunnig ska informera projektörerna om fuktsäkerhetskraven och de metoder som kommer att användas för uppföljning av att kraven uppfylls	Fuktsakkunnig ska informera projektörerna om fuktsäkerhetskraven, resultat från fuktinventering och de metoder som kommer att användas för uppföljning av att kraven uppfylls
5.3.3	Lägg till vägledning ROT för att förtydliga att inventeringen ligger till grund för fuktsäkerhetsprojekteringen		Vägledning: Vid renoveringen och tillbyggnad kommer resultat från fuktinventeringen bestämma förutsättningarna för fuktsäkerhetsprojekteringen. Behövs fördjupad utredning ska det utföras utefter projektörens behov för att åstadkomma en fuktsäker utformning.
5.3.3.3	Resultat från inventeringen är aktuell att använda vid uppskattningen av fukttillstånd		Vägledning: Vid renovering och tillbyggnad kan fuktinventering ge en indikering på rådande fukttillstånd och bör användas som grund för vidare bedömning
5.3.3.4	Vid renovering är det inte alltid känt vilka material som används. Inventeringen av byggnaden bör visa på det. Om ej ritningsunderlag finns kan det enda alternativet vara att göra en fördjupad inventering, som är förstörande.		Vägledning: Vid renovering och tillbyggnad beakta egenskaper hos befintligt material.
5.3.3.5	Just vid renovering kan byggnaden vittna om vilka belastningar som är relevanta.		Vägledning: Utgå från fuktinventeringen vid renovering och tillbyggnad för att göra en kvalificerad bedömning av fuktriskerna. Fukt- och temperaturförhållanden kan komma att ändras för befintlig konstruktion.
5.3.3.6	Hur skall det bedömas för en renovering där det finns en befintlig riskkonstruktion eller t ex energieffektiviseringen leder till en riskkonstruktion?		Vägledning: Bedöm möjligheten att kombinera nya konstruktioner med den befintliga byggnaden. Renovering och

	Tillägg vägledning		tillbyggnadsarbeten får inte leda till oacceptabla fukttillstånd i byggnaden.
6.1	Entreprenörer måste även få informationen som kommit fram under inventeringen.	Fuktsakkunnig med stöd av projektörerna ska informera huvudentreprenörer om resultatet från fuktsäkerhetsprojekteringen.	Fuktsakkunnig med stöd av projektörerna ska informera huvudentreprenörer om resultatet från fuktsäkerhetsprojekteringen och fuktinventeringen.
6.4	Intervjuer har även visat att vid renovering är det vanligt att känsliga material i den befintliga byggnaden blottas under renoveringen. Det kan vara bra att ha ett tillägg i ByggaF om det.		Vägledning (2): Vid renovering och tillbyggnad ska fuktexponering av befintligt fuktkänsligt material undvikas.
6.11	Resultaten från inventeringen är även relevanta i fuktsäkerhetsdokumentationen och bör stå med i listan i vägledningen	Vägledning: All dokumentation som är relevant för byggnadens fuktsäkerhet sammanställs till ett slutdokument som benämns fuktsäkerhetsdokumentation. […] Fuktsäkerhetsdokumentationen bör innehålla: • Byggherrens fuktsäkerhetskrav • Fuktsäkerhetsbeskrivning […]	Vägledning: All dokumentation som är relevant för byggnadens fuktsäkerhet sammanställs till ett slutdokument som benämns fuktsäkerhetsdokumentation. […] Fuktsäkerhetsdokumentationen bör innehålla: • Byggherrens fuktsäkerhetskrav • Resultat från fuktinventering • Fuktsäkerhetsbeskrivning […]

SUGGESTIONS FOR ADJUSTMENT OF BYGGAF

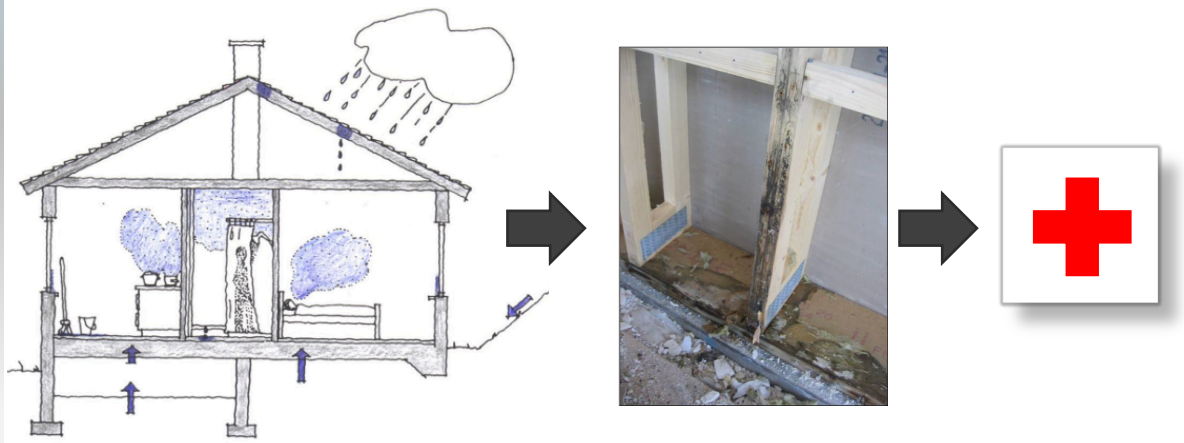
TO IMPROVE THE CURRENT USE AND SUIT THE PROCESS OF RENOVATION

Patrik Olsson and Elin Tjäder

Agenda

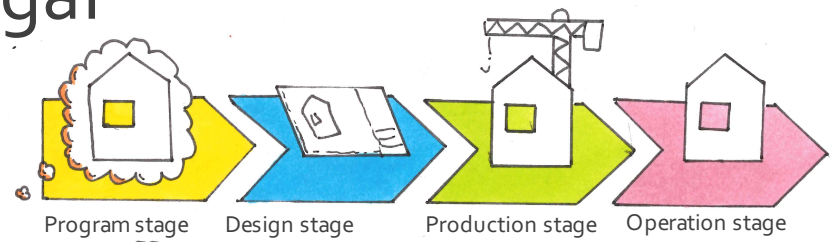
- Background ByggaF
- Aim
- Interviews
- Problems and improvements
- Implements to Industry standard ByggaF
- Future

Moisture problems

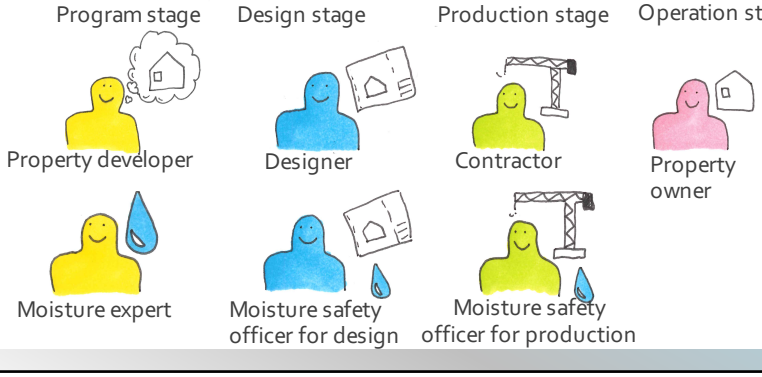


Pictures: SP

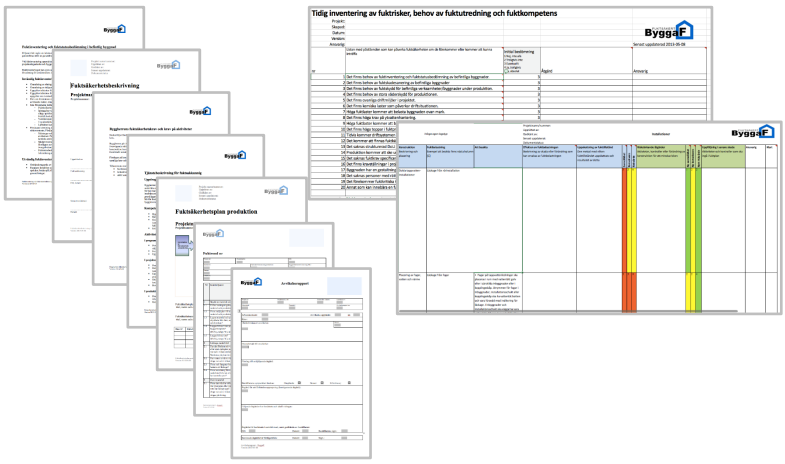
ByggaF



ByggaF participants



ByggaF-documentation



Industry standard ByggaF

Use of ByggaF

Property developer

- Recommended in BBR
- Part of Miljöbyggnad

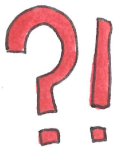
- No registration of ByggaF-projects

Aim

- Suggest adjustments of ByggaF
  - Improve the current use
  - Suit the process of renovation

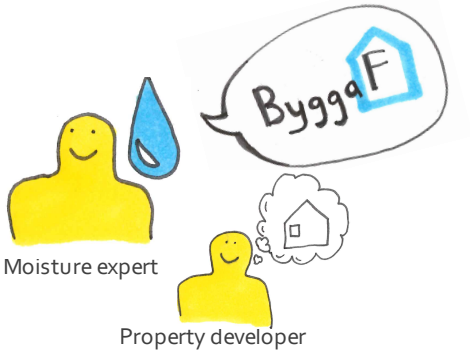
Methodology

Interviews → Problems → Developing improvements → Implement adjustments

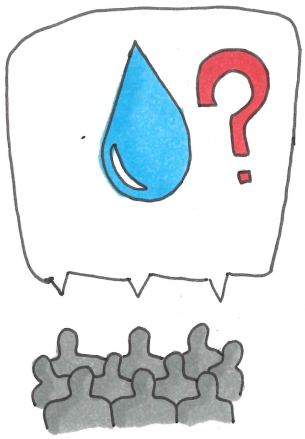


Interviews

- Collect information about usage of ByggaF
- 18 moisture experts and 4 property developers

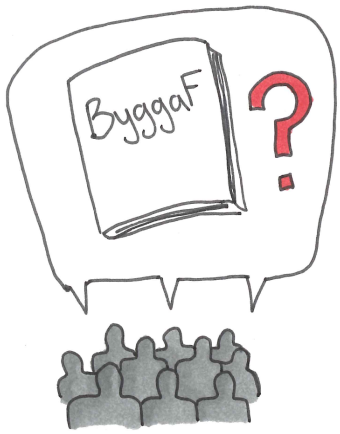


General problems



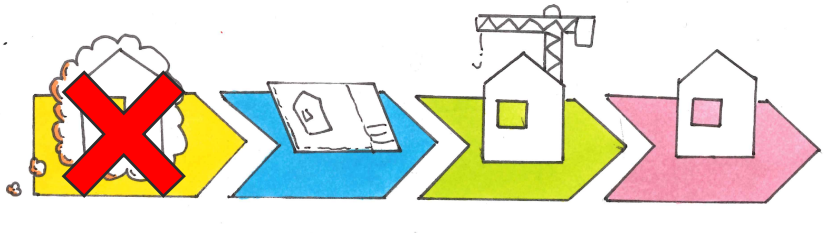
Average knowledge in moisture safety is low

?! General problems



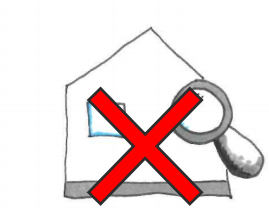
Difficult to introduce ByggaF

?! General problems



ByggaF is not used as intended in the program stage

General problems



A proper inventory is missing in renovation project

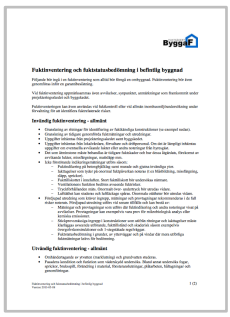
Interviews | Problems | Developing improvements | Implement adjustments

General problems

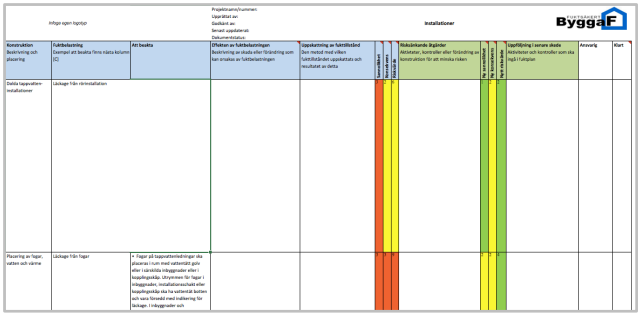
Designers can't assess the moisture risks

Documents to upgrade

Industry standard ByggaF



Moisture inventory in existing building

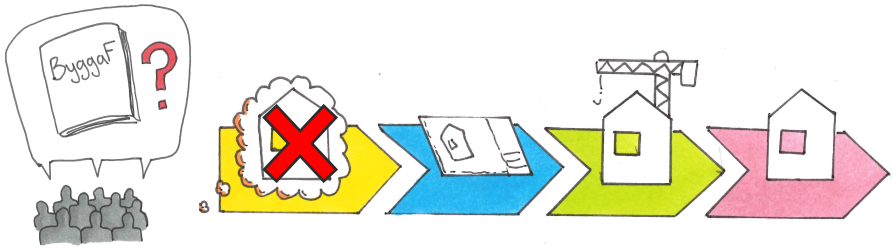


Moisture safety planning with risk evaluation

Introducing Industry standard ByggaF

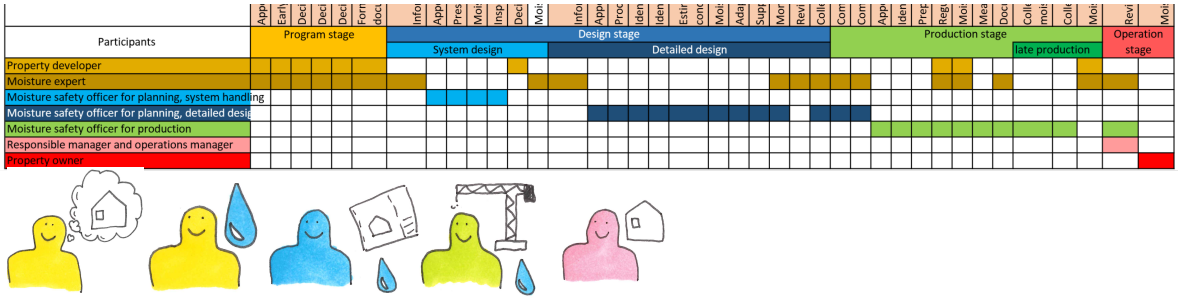
Problems:

- Unclear purpose to use ByggaF for property developers
- Extensive and long documents



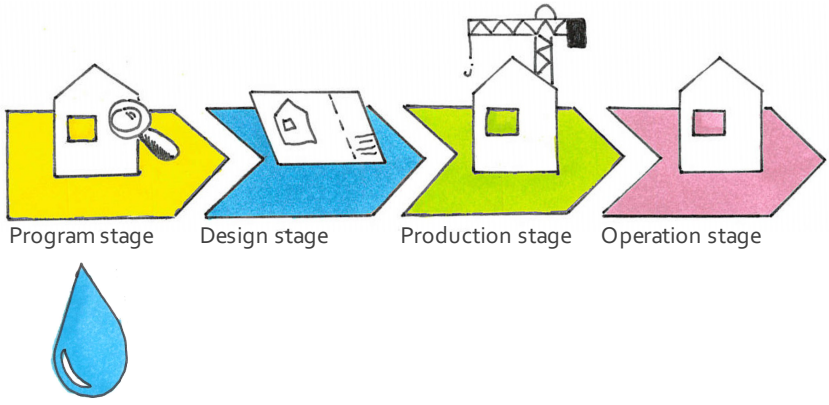
Interviews | Problems | Developing improvements | Implement adjustments

ByggaF-Guide



Interviews | Problems | Developing improvements | Implement adjustments

Moisture inventory in existing buildings



Interviews > Problems > Developing improvements > Implement adjustments

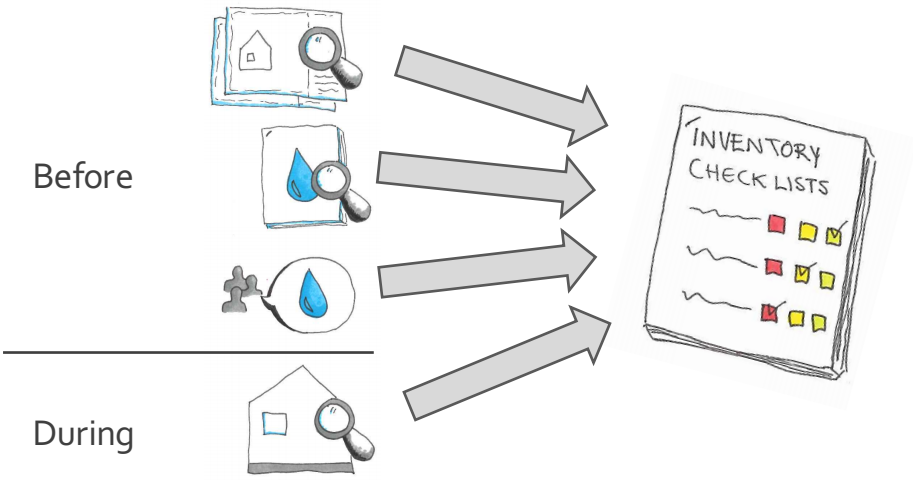
Moisture inventory in existing building

Problems:

- Too general written
- Delayed or neglected
- No requirement in Industry Standard ByggaF

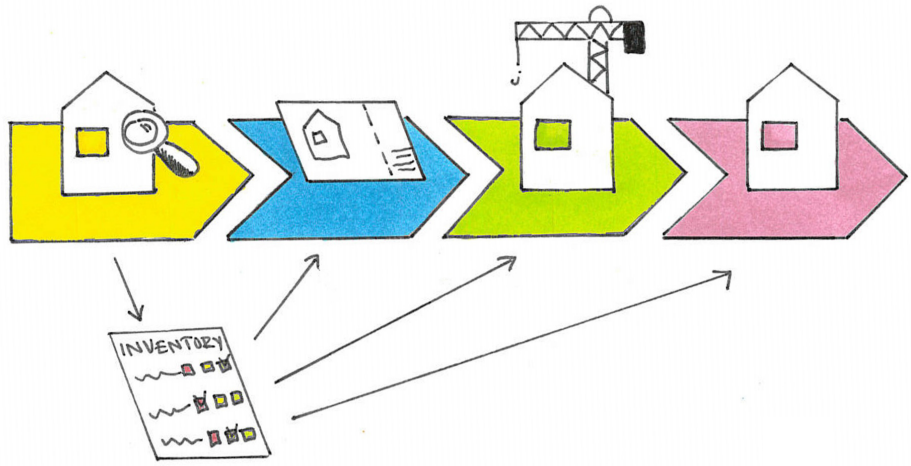
Interviews > Problems > Developing improvements > Implement adjustments

Visual moisture inventory checklists



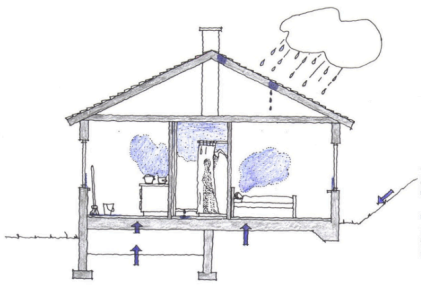
Interviews > Problems > Developing improvements > Implement adjustments

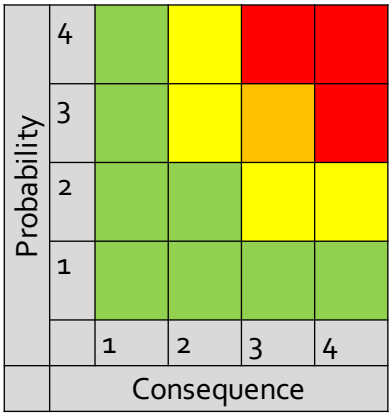
Visual moisture inventory checklists

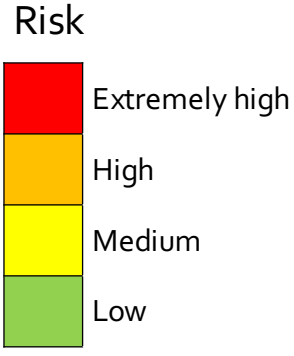


Interviews > Problems > Developing improvements > Implement adjustments

Moisture safety planning with risk evaluation







Interviews > Problems > Developing improvements > Implement adjustments

Moisture safety planning with risk evaluation

Problems:

- Designers don't know how to assess moisture risks
- Conflicts with other industry regulations
- Not completely suited for renovation
- Competence for moisture safety officer for planning

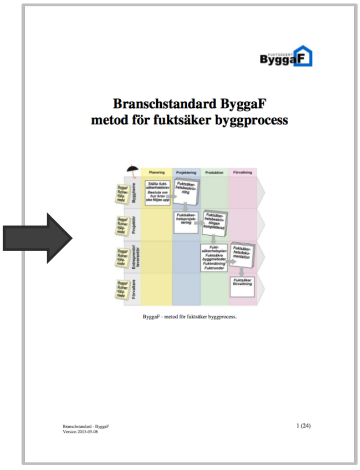
Interviews > Problems > Developing improvements > Implement adjustments

Improve Moisture safety planning with risk evaluation

Simplify the use	Free from conflicts	Adapt to renovation
• Guidelines • Replace the numeric risk evaluation	• Edit existing text • Refer to other industry regulations	• Add missing information

Implement adjustments in Industry Standard ByggaF

- ByggaF-guide
- Moisture inventory in existing building
- Competence for moisture safety officer in planning



Future

- Implement and test suggested changes
- Continue developing all documents
- ByggaF-app

- Increase usage of ByggaF in renovation projects
- Easier usage of ByggaF in all projects