

Quality Assurance



QUALITY ASSURANCE REQUIRES PLANNING AND PRIORITISATION

Quality assurance is the activities during the construction process that the client, the consultants and the contractors carry out to ensure that there is consistency between the client's wishes and the work carried out, and that the applicable rules within the construction industry are complied with. Quality assurance is thus a crucial part of construction projects – be it new builds, construction work or renovations.

Good quality assurance saves the parties involved a lot of conflicts and extra costs, because possible errors, defects, uncoordinated interfaces or ambiguities are discovered before they become expensive to rectify. Adjustments and changes in the project will always be necessary, but with good quality assurance these changes are made in a timely and coordinated manner. This means that costly repair work on the construction site can be avoided and that errors and defects, which in the worst case can have catastrophic consequences, are caught and repaired in time.

Nevertheless, many practitioners – including clients, project planners and contractors – experience that quality assurance is deprioritised, especially when the schedule tightens towards a deadline. It is also experienced that quality assurance becomes a very cumbersome and bureaucratic process, where a large amount of documentation is produced without an immediate buyer or function.

With this guide, we would like to dispel the misconception that quality assurance does not create value or that it is unnecessarily time-consuming and resource-intensive. The purpose of this guide is therefore partly to demystify the content and scope of the quality assurance process – how the various activities, organising, etc. fit together and how they create value – and partly to give concrete recommendations on how the various activities are carried out in practice.

The guide is in three parts. **Part 1** provides recommendations for planning and prioritising quality assurance, including how the quality assurance process and collaboration are planned, organised and carried out. **Part 2** of the guide describes the connections between the central quality assurance activities in the construction's phases and provides good advice on what the respective actors should consider in terms of quality assurance. **Part 3** consists of examples of checklists for the client, the project planner and the contractor. The checklists include the activities that are often considered critical and can be used as inspiration when planning or adapting your own processes for quality assurance.

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QUALITY ASSURANCE

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Part 1

Planning and prioritisation of quality assurance

THE GOOD QUALITY ASSURANCE PROCESS

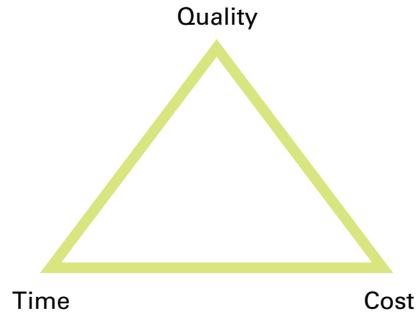
It is a requirement for the success of any construction project that the final construction is completed on time, within budget and with the desired quality. The quality assurance process focuses on the part of the project triangle that deals with quality, and it aims to ensure that the final construction lives up to the desired quality level. Time, financial factors and quality are inextricably linked, and therefore good quality assurance also helps to ensure that the final construction is completed on time and within budget.

In accordance with AB18 and ABR18, contractors and project planners are obliged to carry out a minimum of quality assurance of their own work – even if no further requirements are made in relation to it. Nevertheless, it is recommended that all parties set requirements and make an effort to contribute to the quality assurance process – because everyone wins with good quality assurance!

A good quality assurance process can save the parties involved many conflicts if errors are discovered during the design phase instead of on the construction site. If errors or failures still occur, good quality assurance documentation can clearly show where things have gone wrong and help clarify any responsibilities. Identifying the cause of an error will also provide an opportunity to adapt the process so that the error is avoided in the future.

A GOOD STRATEGY AND INTERDISCIPLINARY PLANNING

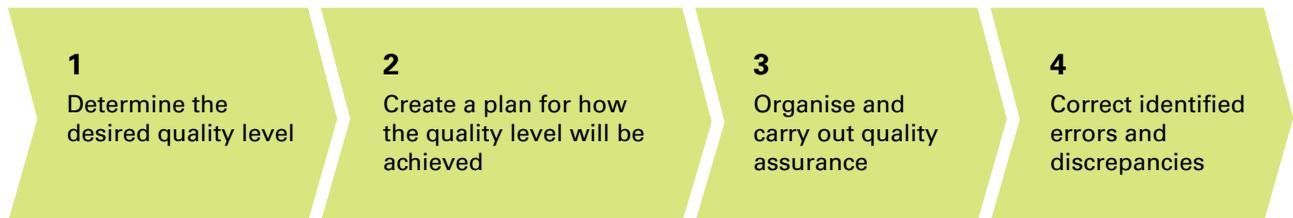
It is therefore necessary to have a plan or strategy for how quality assurance is implemented systematically and in a coordinated manner, on time and with the right focus and scope. The quality assurance process involves many different actors, trade groups and stakeholders, whose work and input work closely together in terms of ensuring the quality of the project.



BENEFITS OF A GOOD QUALITY ASSURANCE PROCESS

- A better and more efficient construction process for all parties, which minimises the risk of conflicts.
- Better collaboration, which subsequent projects can potentially build on.
- Fewer errors, defects and failures. Errors are discovered during the design phase and not during execution, which minimises the risk of financial consequences and conflicts.
- Fewer surprises and problems also mean a greater chance of a timely delivery and commissioning.
- A construction that lives up to the expectations of function, maintenance and service life.
- Continuous compiling of experience and opportunities to make improvements along the way – both on the project and in one's own processes.
- Knowledge of how some errors can be defined and avoided in future projects.
- Opportunity for better task handover during the process if employees or companies are replaced.
- Should design errors or mistakes occur during execution, it is easier to find the cause and thus how to rectify it, as well as clarification of responsibilities.

The overall strategy for how to achieve good quality assurance is basically simple:



It is crucial that the quality assurance process is planned and coordinated throughout the entire construction process and across the actors involved. The quality assurance activities of the client, the project planners¹ and the contractors must work together, so it is important to have clear interfaces between the actors involved. It is recommended that the client determines their need and requirements for the level of quality assurance already in the idea phase so that the subsequent actors have the opportunity to adapt and prepare their work. In addition, it is important to have clear lines of communication and close cooperation throughout the entire construction process.

QUALITY ASSURANCE MUST NOT BE DEPRIORITISED!

It is very important to emphasise that there must be organisational support for the employees who perform quality assurance in practice – at the client as well as consultants and contractors. The tasks of quality assurance must not be deprioritised or neglected when deadlines approach and the schedule peaks. There is no winner for a lack of quality assurance!

Quality assurance is an item on the agenda at the project review meeting, where the project planners and the contractor meet for the first time. However, there may often be a need for additional coordination meetings between the actors, where the various quality assurance activities are discussed and coordinated in more detail. The project planner and the contractor can take

the initiative to ensure a matching of expectations and coordination of quality assurance activities early in the process. But the client has the opportunity to ensure good cooperation – amongst other things, by highlighting quality assurance and reserving sufficient time and space in the budget for coordinating meetings.

LEGISLATION, STANDARDS AND INSTRUCTIONS

This guide should be seen as a series of recommendations for creating an overview, planning and carrying out the quality assurance process. It is important to emphasise that the applicable legal requirements must always be complied with, including BR18 with the associated standards and regulations (DS/EN 1990, DS 1140 and SBi 271), as well as the services in YBL18, YBB19, AB18, ABT18 and ABR18.

¹ Projects often involve several project planners (e.g., architects, construction engineers, installation engineers). This guide refers to these as 'the project planners'.

FLEXIBLE AND PROJECT-SPECIFIC QUALITY ASSURANCE PROCESS

There can be changes to the construction in all the phases. Therefore, it is important to have a flexible quality assurance process that also takes into account the ongoing changes – both so that these changes are quality assured, but also so that the associated changes (e.g., in terms of time and finances) are coordinated.

The quality assurance process must reflect the needs of the specific project, and the scope and weighting of the activities will vary depending on the construction project's contract type, size and complexity. It is clearly simpler to ensure quality in a project with many repetitions and few contractors (e.g., a large window replacement) than, for instance, a complex project involving many trades. On the other hand, there can be major financial risks associated with a window replacement, since there is a risk of a single error being repeated many times if it is not detected early. A clear recommendation is therefore that the client prepares a risk assessment of the current project and that the quality assurance process focuses specifically on the areas of the project that are particularly risky.

NEW IN AB18, ABR18 AND YBL REGARDING QUALITY ASSURANCE:

- Documentation for quality assurance must be submitted after each phase.
- Time- and cost-related consequences of changes, etc. must be clarified on an ongoing basis.
- The schedule needs to be more detailed.
- Project review before construction starts has become mandatory.
- All parties have the opportunity to request a supervisory review during the project review.
- Consultants and contractors have a duty to provide information on the use of unproven methods and materials.
- The possibility of charging an agreed penalty from the project planner in the event of defects.
- Holding of a pre-review before the final delivery for the purpose of, amongst other things, planning and coordinating the testing of technical facilities and installations, as well as creating an overview of the extent of defects so that the contractor can correct these before delivery.
- If defects appear during the contractor's delivery, a remedial review must be held with a view to an overall review of the remediation of the identified defects.

THE QUALITY LEVEL FORMS THE FOUNDATION FOR QUALITY ASSURANCE



It is the client's responsibility to ensure that the construction is of a satisfactory quality that suits the given purpose. Public clients have a specific duty to ensure realistic facility and operating costs (i.e., that the construction, with regard to purpose and costs, achieves a satisfactory quality)². It also means that it is the client's task to define and set requirements for what the quality level should be in the current project³.

The purpose of all quality assurance activities is to ensure that all the solutions live up to the quality level, as well as – and above all – that all regulatory requirements are complied with (e.g., in relation to fire and load-bearing structures). The focus, nature and scope of the quality assurance activities change as the construction project becomes more and more detailed and moves from the drawing board to the construction site – but the goal is the same. The defined quality level thus forms the foundation for all the quality assurance activities carried out throughout the entire construction project.

The quality level of a construction project does not necessarily have to include requirements for 'high quality' on all parameters. It may be both economically sensible and necessary to prioritise a high level of quality in some areas and make less ambitious, but still adequate, requirements in others. For instance, greater demands can be made for the standard of execution of the surfaces in an entrance than in a storage room.

EXAMPLES OF QUALITY LEVEL REQUIREMENTS:

When setting requirements for the quality level, the client should consider:

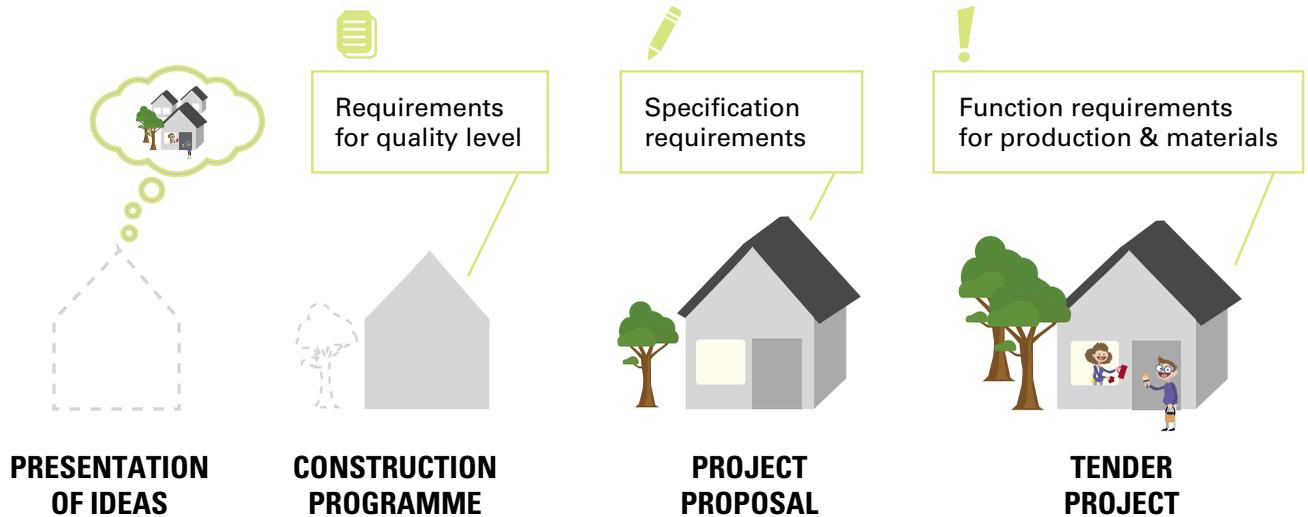
- **Architectural qualities**, including the building's interior design and integration into the existing environment as well as the adjustment of outdoor areas
- **Material use**
- **Indoor climate**, including: sound, light, noise, temperature, humidity and how these are controlled
- **Functionality**
- **Energy and resource consumption**
- **Sustainability**
- **Lifespan**
- **Buildability**
- **Operational stability**

The more precisely the requirements are formulated, the easier it is to follow up on and document whether they have been met.

² Cf. [Executive order on quality, PPP and overall economy in public construction](#) (Executive order no. 1179 of 04/10/2013).

³ Please note that there are special rules that apply to the contractor regarding documentation for inspection of the execution of load-bearing structures, cf. BR18 and [DS 1140:2019 'Execution of load-bearing structures - General control'](#).

The client determines the quality level early on in the construction process as a series of requirements for the quality that continuously become more and more concrete and specific as the project is worked on:



ONCE BITTEN, TWICE SHY

Through quality assurance, the parties involved continuously build up extensive knowledge of how common errors can be identified and avoided in future projects. These experiences, if made use of, can help to improve both the construction process during the project and provide valuable input for future construction projects.

It is recommended that the actors involved gather experiences – both good and bad – in their own companies and within their own trades. In this way, an overview is thus created of known errors and solutions to them, and this knowledge can be used actively in future projects by focusing on the critical areas.

FOCUS ON RISK AREAS

It is recommended that the efforts for quality assurance are directed in particular at conditions subject to risk, and that the client's requirements for the quality level are based on an early risk assessment of the project. It can be an advantage for the client to set specific requirements in the construction programme for the quality and quality assurance of the building parts, materials, execution processes, etc. that are particularly subject to risk⁴

⁴ See also Værdibyg's [guides on risk management](#).

SCRUTINY AND CONTROL ARE CENTRAL QUALITY ASSURANCE ACTIVITIES

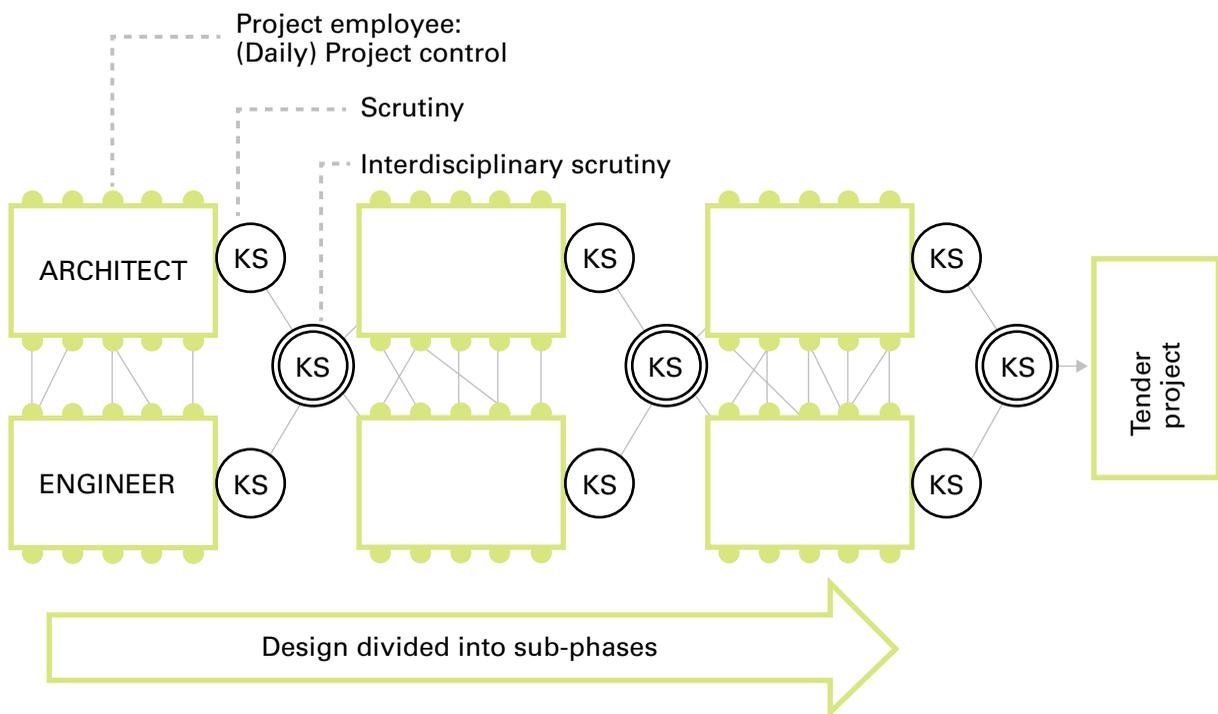
Quality assurance consists of many different activities that vary during the construction process. The goal of quality assurance activities is, however, largely the same – namely to ensure that the project meets the applicable legal requirements and that all solutions live up to the quality level. There are often two types of activities that play a key role in the quality assurance process: scrutiny and control.

SCRUTINY SHOULD EXPOSE ERRORS AND WEAK POINTS

Scrutiny is an important part of the design phase quality assurance. Scrutiny is a coherent and systematic re-

view of the project with a view to detecting and correcting errors, inconsistencies and inappropriate choices of solutions. In addition, there is a focus on identifying particular risks and weak points that can lead to failures in the construction if they are not followed with special attention. It is recommended that scrutiny is specifically aimed at:

- Tolerances
- Buildability
- Work environment
- Future operation and service
- Interfaces



The basis for the scrutiny is primarily the technical documents (i.e., models, drawings and descriptions). Once the scrutiny has been carried out, the comments from it must subsequently be incorporated into the project.

Scrutiny is carried out both as internal scrutiny and interdisciplinary scrutiny. Internal scrutiny is carried out in the individual organisation, where it is most often performed by employees who do not otherwise participate in the preparation of the project in question.

Interdisciplinary scrutiny

Interdisciplinary scrutiny takes place across the trades and organisations involved and is absolutely central to ensuring coordination and interaction between the many different solutions. The quality assurance activities are to a large extent connected across trades and phases, and it is crucial that the individual actors' actions are considered and coordinated in relation to the others'. Unfortunately, interdisciplinary scrutiny is often not carried out to a sufficient extent, which means that many challenges have to be 'rescued' on the construction site. It must therefore be emphasised that interdisciplinary scrutiny should be a priority for all parties involved.

The project manager coordinates the interdisciplinary scrutiny carried out by the involved project planners. It is recommended that scrutiny focus in particular on the critical interfaces between different trades and contractors (e.g., between the technical trades such as plumbing, ventilation, CTS and electrical work, as well as between constructions and installations. In addition, the scrutiny should focus on parts of the project subject to risk, such as hidden constructions or installations, complicated facade solutions, as well as particularly difficult details that need to be clarified. At the same time, it is recommended to maintain a general overview so that possible changes are coordinated in relation to the overall architecture, functionality, etc.

CONTRACTOR AND SUPPLIER PLANNING

Contractor and supplier planning must be quality assured on an equal footing with other planning, and the project manager must therefore plan an interdisciplinary scrutiny when the contractor has completed their part of the project. It is recommended that the tender documentation contains a clear deadline for the contractor's contribution to the planning so that it is completed with time for interdisciplinary scrutiny prior to starting the construction. It is crucial for the process that the final execution project is thoroughly worked out, completed and quality assured before the execution begins.

CHECKING COMPLIANCE WITH LEGAL REQUIREMENTS

Both during the planning and execution, *controls* are carried out as part of the quality assurance. A control is an examination of whether a task performed, a solution or a material is satisfactory and in accordance with the applicable requirements.

Project control

In connection with planning, all project employees must regularly carry out project control to determine whether the project documentation and calculations live up to the set requirements. Project control includes:

- Has the project design been followed?
- Have regulatory and building regulation requirements been met?
- Is there agreement between the project documents?
- Are there special risk areas that have, for instance, been identified during a previous risk assessment or scrutiny?

The basis for project control is primarily the technical documents (models, drawings and descriptions). Errors and deviations that can affect the quality are corrected and the project documentation must subsequently be updated.

FOCUS ON CHANGE MANAGEMENT DURING PLANNING

Scrutiny and project controls often give rise to changes in the project. After a completed quality assurance activity, it is therefore necessary that the entire project is updated and quality assured once again. It is always recommended to carry out consistency and collision controls of the overall project – and that these controls lead to further corrections in the project if they reveal critical conditions. Also, indoor climate, energy, acoustic or lighting calculations must be updated when changes are made in the project.

Contractor controls

During the execution, the contractor ensures the quality of the work performed, materials, solutions, etc. by carrying out a series of controls. For instance, delivery control of critical materials and components must be performed. Here, it must be checked, amongst other things, that there is consistency between the delivered goods and those ordered, whether the goods are correctly labelled and whether any damage has occurred in transit or similar. Other examples are execution control, final control, control of documentation of materials and products, etc.

The scope and content of the various controls are described in control plans that, amongst other things, should indicate:

- What has to be controlled
- When in the construction process the control has to be carried out (control times)
- Acceptance criterion for the control
- Scope and method of control
- Who should carry out the controls (own-control or independent control)
- How the result must be documented

TOOLS, FORMS AND MANUALS FOR THE CONTRACTOR

The Danish Construction Association (DI Dansk Byggeri) has developed a number of tools, proposals for forms and handbooks that can support the contractor's quality assurance activities. Amongst other things, a model has been developed (with support from Grundejernes Investeringsfond) for the quality assurance of load-bearing structures, which follows DS 1140 and the new provisions in AB18 on documentation for control of load-bearing structures.

Find the different tools at The Danish Construction Association.

DOCUMENTATION SHOULD NOT BE A BUREAUCRATIC BURDEN

In working with quality assurance, large amounts of documentation are produced. It is documentation in the form of check lists and scrutiny reports during the planning as well as pictures and control forms during the execution. For some, it can be difficult to see the value of all that documentation, and therefore many perceive quality assurance as a bureaucratic, unnecessary exercise and deprioritise it. We have to put an end to this attitude, because quality assurance and documentation provide great value if they are handled correctly and in a timely manner.

It is recommended that the client, project planners and contractors base requirements for the documentation of quality assurance on a specific risk analysis of the project's critical conditions or building parts. In this way, the degree of detail or the method by which the quality assurance is documented is adapted so that less critical areas are documented to a lesser extent than the particularly critical ones. This also applies to the controls that the contractor is responsible for (e.g., control of the execution of load-bearing structures).

The important thing here is to consider what needs to be documented and how. The easy solution would be to say 'everything', based on the idea that the more documentation, the better. But if the requirement is that everything must be documented, there can easily be a risk that nothing will be documented – at least, not to a degree so that the documentation can create value (e.g., by clearly showing the correct execution of critical joints or clarifying where and when an error has occurred in the project). A prioritised breakdown of the project, in relation to how detailed the documentation must be, can help to ensure that the right documentation is carried out correctly.

SAVE MONEY AND CONFLICTS WITH GOOD DOCUMENTATION

Good documentation shows clearly that the project has been carried out correctly. If errors or defects are discovered – either in use or in connection with the 1- or 5-year review – then photographic documentation can, for instance, show at what step in the construction process an error has occurred. This means that in some cases expen-

sive and destructive investigations can be avoided, and this enables clarification of any responsibilities.

Photographic documentation is often a really good method for documenting solutions and conditions during the execution of the construction. Here, however, it is important that photographs (e.g., a close-up of a bolt) connect to the context in which they were taken and why. In general, it is recommended – regardless of whether it is during the planning or execution – that documentation takes into account who will use the documentation, for what and when. This can be a good guideline for ensuring that the documentation is specific in terms of its form and scope so that an 'over-production' of unnecessary documentation is avoided.

FOLLOW UP ON THE DOCUMENTATION

In addition, it is of course important to follow up on the ongoing documentation during the project. Here, it is not enough to state that the quality assurance has been carried out simply because there are pictures and a completed form – it is also necessary to follow up on whether the documentation shows that the work has been carried out correctly.

During the execution, it is primarily the contractor's task to ensure that there is necessary documentation that the work has been carried out correctly – that is, that the contractor has carried out work to the quality required by the contract with the client, and that the work process has been carried out correctly in terms of craftsmanship. The advisory team can then, by further agreement with the client, carry out random control of the documentation.

GENERAL CLIENTS MUST ENSURE DOCUMENTATION FOR BYGGESKADE-FONDEN (THE BUILDING DAMAGE FUND)

As a general client, it is important to be aware that you get the right documentation, which must be used for Byggeskadefonden's control at the 1- and 5-year inspection. Read more and get inspiration for this in Byggeskadefondens

["Guide til kvalitet ved bygningsrenovering"](#) and ["Guide til kvalitet ved nyt boligbyggeri"](#) (in Danish).

DIGITAL TOOLS FOR GOOD QUALITY ASSURANCE

More and more digital tools and aids are used in construction, also in relation to quality assurance. There is great potential for supporting the process and activities with digital tools, but this also places great demands on working methods, coordination and version control, etc. so that errors do not occur.

POTENTIALS OF DIGITAL TOOLS

In the design phase, digital tools can:

- Help the project planners in finding the places where there are collisions between the different trades in a 3D model (consistency and collision control)
- Document decisions and ensure easy and clear access for the parties to files
- Ensure straightforward and unambiguous communication in the tender process

In the execution phase, digital tools can:

- Document the quality assurance – both for the supervisors and the client
- Contribute to the preparation and dissemination of the operation and maintenance documentation
- Contribute to those carrying out the work having easy access to material and the project planners' thoughts behind the individual processes

ICT SPECIFICATION SUPPORTS QUALITY ASSURANCE

For digital design, the client must prepare an ICT specification⁵, which amongst other things specifies the requirements for the digital collaboration. In relation to this, it is recommended that the client carefully considers how the ICT specification should support the quality assurance process. For example, the ICT specification must determine which collision and consistency control is desired and how to check that it is implemented and documented as described. It is recommended here

to pay special attention to specifying which trades' interfaces are to be controlled. For example, heating and ventilation must be controlled both in relation to the constructions and in relation to other installations so that they do not collide in the joint conduits. In buildings with many installations, this is a fairly extensive task for which sufficient time must be set aside after the individual trades have been planned.

MOLIO'S PARADIGMS

Molio's paradigms can be used to prepare the ICT specification as an aid to ensuring that all aspects are looked into and considered – if not all, than as many aspects of the project as possible.

DIGITAL QUALITY ASSURANCE AS SYSTEMATIC DOCUMENTATION

Digital tools have created good opportunities for the documentation of planning, communication, decision-making and the work performed.

Special photographic documentation is often used in connection with documentation of the work performed, since it means that the clarification of questions and decisions can be done quickly, because those carrying out the work can send a picture directly from the construction site to a decision-making actor. It is recommended here that the client's construction management team establishes a clear framework for the decision-making process so that it is clear how an approval takes place (e.g., with the involvement of the necessary actors).

⁵ An ICT specification is an agreement document attached to the agreement between the client and consultant and the agreement between the client and the contractor that determines the client's requirements for the use of ICT (information and communication technology) in a given project.

If the construction project's parties work on different platforms, it is important that the quality assurance material is collected in a common place upon delivery. Here, it is important to have specific requirements for the format in which the final data is delivered so that the relevant data is compatible and can work together.

The client must make it clear whether they want to demand that all parties use a common digital platform. On the one hand, a common digital platform enables all documentation to be available in one place. On the other hand, there is a risk that the various actors may have difficulty working in the chosen platform, since they will often have to use several different digital platforms, depending on which projects they are working on. A common platform collects data in one place, but it can be difficult for the individual parties to access the information when the construction project is completed. It is therefore a good idea that the platform includes the option for the parties to extract the necessary data from the system.

THE CONTRACTORS' NEEDS IN RELATION TO DIGITAL TOOLS

Often, the contractor will use a digital tool to document the different activities and to maintain an overview of the progress of the individual trades.

For the contractors on site, it is important that the digital tool:

- works well on a smartphone.
- is able to handle defect lists and photographic documentation.
- is able to subsequently extract the documentation, which can be passed on to the client.

Regardless of the choice of digital platform – and whether one common solution is chosen or many separate ones – it is important to have a structure that makes it easy to find relevant material. In addition, it is recommended that a strategy is developed for data exchange and for version control, so that you are sure that you are always working with the latest material.

Full openness to all construction management parties is very important – both when working on one or more platforms. The parties must have the rights they need to be able to work on the current platform.

MAKE USE OF THE OPPORTUNITY FOR AN INTRODUCTION

It is recommended to use the opportunity to get an introduction to the chosen digital system, which most platforms make available free of charge or for a small fee.

If the client wants to use a specific system, they should set aside time and resources for the actors involved to be trained in it. In addition, the requirement to use a given digital platform should already be included in the tender documentation, since it can otherwise lead to an additional cost.

Part 2

Quality assurance in the construction phases

QUALITY ASSURANCE ACTIVITIES AND ROLES THROUGH THE CONSTRUCTION PHASES

Throughout the construction phases – from programming to planning and on to execution – it is important that all the relevant actors participate and contribute to ensuring good quality assurance. The actors’ quality assurance activities vary as the project progresses:

	 CLIENT	 PROJECT MANAGER	 PROJECT PLANNER
PROGRAMMING	<ul style="list-style-type: none"> • Determines the framework for quality assurance and the quality level for the project in the construction programme • Allocates resources and sets requirements in connection with consultancy tenders 		
DESIGN	<ul style="list-style-type: none"> • Approves the quality plan for design • Reviews the quality assurance documentation • Involves potential users and the operating organisation • Holds project review meetings • Ensures interdisciplinary scrutiny of the final execution project • Appoints supervision • Approves the supervision plans 	<ul style="list-style-type: none"> • Prepares a quality plan for the project • Coordinates interfaces and interdisciplinary scrutiny • Collects documentation and handles changes • Coordinates the inspection plans and sets requirements for the contractor’s quality assurance • Leads the preparation of the execution project • Coordinates project changes 	<ul style="list-style-type: none"> • Implements quality assurance in accordance with the quality plan • Carries out project control, examines project material and coordinates interfaces • Prepares the tender control plan with requirements for the contractor’s quality assurance activities • Prepares and examines the execution project • Participates in interdisciplinary project scrutiny • Prepares a draft supervision plan
EXECUTION, DELIVERY AND COMMISSIONING		<ul style="list-style-type: none"> • Delivers all relevant documents to the client 	<ul style="list-style-type: none"> • Updates and examines the ‘as-built’ material



**CONSTRUCTION
MANAGER**
(the client's representative)



CONTRACTOR



SUPERVISOR

- Updates the schedule and budget in relation to quality assurance during execution

- Examines the tender project and familiarises themselves with the project's prerequisites
- Contributes to the execution project
- Prepares a **quality plan** and **control plan** for quality assurance activities during execution

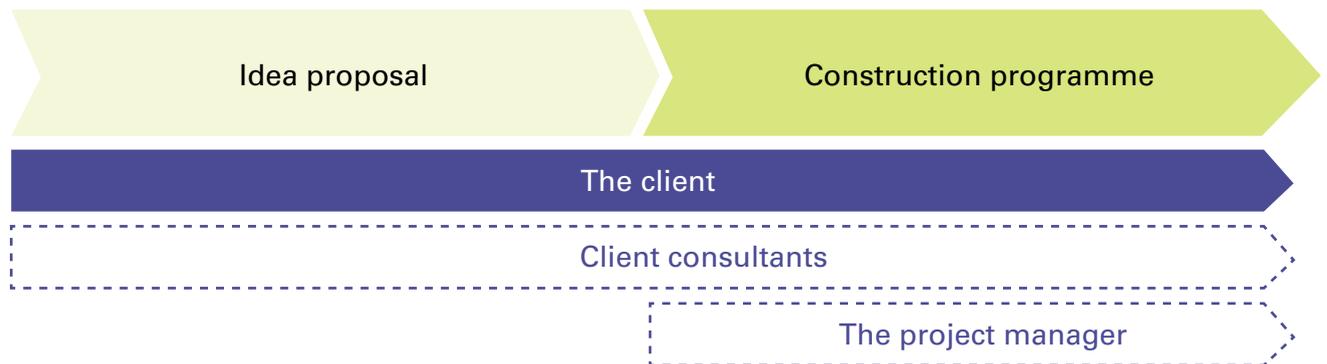
- Prepares a **supervision plan** on the basis of the tender control plan

- Reports on quality-related challenges and promotes solutions
- Ensures compliance with change management procedures
- Updates the schedule
- Organises the delivery and carries out error and defect reviews

- Implements quality assurance in accordance with quality and control plans in order to document that the work is in accordance with the plan
- Follows up on subcontractors' quality assurance and documentation
- Ensures the necessary qualifications for the execution of the work
- Contributes with documentation, control and tests as well as O&M material

- Carries out control of the work performed in accordance with the supervision plan
- Helps to correct identified errors quickly and efficiently
- Controls the delivered O&M material

QUALITY ASSURANCE IN THE PROGRAMMING PHASE



THE DESIRED QUALITY LEVEL IS DETERMINED IN THE CONSTRUCTION PROGRAMME

In the initial programming phase, the construction programme is prepared, where the client's wishes and needs for the construction are described and where the desired quality level is determined. Prior to this, the client has typically had a process in which future users, residents, operating staff and others have been involved in qualifying wishes, needs and particular quality requirements for, for instance, accessibility, energy consumption, operability or daylight.

In order for the desired quality level to constitute concrete and usable guidelines for the involved actors' future quality assurance activities, the requirements in the construction programme must be specified clearly and with measurable criteria (e.g., with requirements for material lifetimes or energy consumption in future operations). In addition, the client must describe the desired quality assurance process so that the project can achieve the desired quality level. It is recommended that the construction programme sets clear requirements to, for instance, the projecting planners for regular meetings, reporting, documentation for controls or scrutiny, etc.

In addition, the construction programme must describe if there are particular areas or conditions in the project

subject to risk that require attention. It is recommended that the client's starting point is a risk assessment of the specific construction and that the construction programme clearly describes the critical conditions as well as the areas where there is a risk of the requirements colliding, and there is therefore a need for a prioritisation of requirements. The construction programme must also clarify if the client has particular needs that are unchangeable – for instance, a defect-free delivery if the building has a special user group who cannot accept craftsmen in connection with rectification of defects.

PARTICULAR WISHES FOR, FOR EXAMPLE, MOCK-UPS MUST BE STATED IN THE CONSTRUCTION PROGRAMME

If there are particular wishes for, for example, preparation of mock-ups in connection with the project, this must be stated in the construction programme. If the client is able to describe their particular wishes as early as possible, sufficient finances and time can also be set aside for this. For instance, mock-ups require that time is included for both an inspection and decision-making process, which is important knowledge for the contractor before entering into a contract.

THE CLIENT MUST COME TO TERMS WITH THEIR OWN INVOLVEMENT

Bygherren skal gøre sig klart, hvor meget og hvordan bygherreorganisationen skal involveres i de forskellige kvalitetssikringsaktiviteter i projektfaserne. Det anbefales at indskrive dette i udbudsmaterialet, så det bliver en del af aftalegrundlaget. Bygherren skal bl.a. afklare, i hvilken grad bygherreorganisationen vil godkende de enkelte kvalitetssikringsaktiviteter. Her er det vigtigt, at bygherren er realistisk ift. ressourceforbrug og egne kompetencer.

Det skal også afklares og beskrives, i hvilken grad driftsorganisationen skal involveres i kvalitetssikringsprocessen. Ved en tidlig inddragelse kan driftsorganisationen bidrage med viden om eventuelt eksisterende forhold, hvilket kan forebygge overraskelser i udførelsesfasen. Involvering af driften kan også synliggøre det konkrete behov for drift- og vedligeholdelsesmateriale, så det er præcist og brugbart i praksis til opfølgning m.m.

NEED FOR SPECIALISTS?

Based on the project's scope, complexity, finances, etc., the client must consider whether there is a need to involve specialists in the quality assurance process. In larger projects with complex installations, it may be an option to employ external scrutiny, a commissioning manager⁶ or a system integrator with interdisciplinary competencies within installations.

The client can also consider introducing auditing of the quality assurance. The purpose of auditing is to ensure that consultants and contractors live up to the requirements for quality assurance that are in the contract and that the QA plan's activities are delivered. The auditor (e.g., the client consultant) prepares a report for the client.

ALLOCATE RESOURCES AND PLACE FOCUS IN THE TENDER

The requirements for the quality assurance process must be reflected in the budget and in the schedule, where the client has allocated the necessary resources to perform the quality assurance. Among other things, it is essential that sufficient time is set aside in the schedule for the necessary scrutiny of material. In addition, it is recommended that budgeting is carried out with a degree of flexibility, so that the requirements for quality assurance can be continually updated as the project develops.

The client must assess the need for competence in relation to achieving the desired quality level. In the consultancy tender, it is recommended that the client specifies the requirements for documented qualifications and experience with quality assurance from similar projects – for a potential client consultant and the project planners, as well as a potential turnkey contractor. In the case of turnkey contracts, it is recommended that the client sets requirements for the turnkey contractor's quality assurance system and for the contractor's consultant's qualifications in relation to quality assurance.

6 See Værdibyg's guide "[Commissioning-processen](#)" (in Danish).

THE ICT SPECIFICATION SUPPORTS THE QUALITY ASSURANCE PROCESS

In the construction programme's ICT specification, the client must describe the framework for the project's digital collaboration. This is of great importance for how the quality assurance process can proceed, and for how the client can monitor that the project lives up to the required quality level.

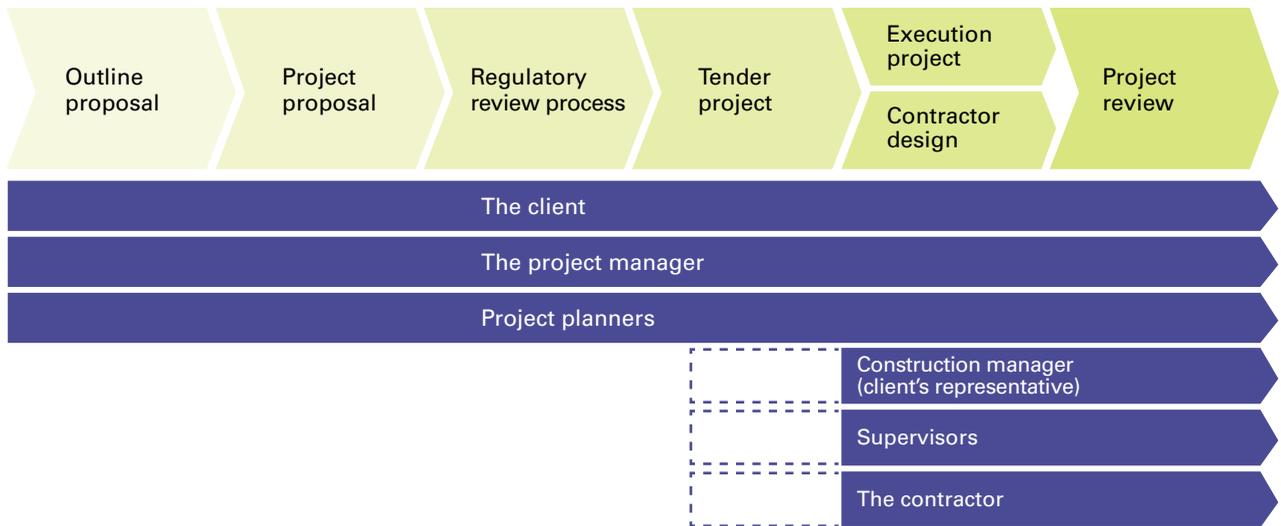
If the client has a special wish that the contractor's IT tools for quality assurance should be compatible with the client's own system, this must be stated in the tender documentation. The ICT specification is based on the tools available to the client and the operating organisation, so that, for instance, the operation and maintenance documentation matches the operating organisation's needs and IT systems, and so that the client can receive and read files with drawings and the other project material. In addition, a system must be established for the documentation of the various actors' quality assurance activities.

The client can also choose to use the quality assurance (or elements herein) as a qualitative sub-criterion if the client wants a quality assurance that differs from what is described in YBL18. In this case, the tenderers must describe in the tender how they will implement the quality assurance on the specific project. When the contract is being agreed, it is recommended that the client include this description as part of the contract.

STANDARDS AND PARADIGMS FOR THE QUALITY ASSURANCE ACTIVITIES

Experienced clients can reap many benefits by taking advantage of their experience from previous constructions and their operation. Through client standards or paradigms for quality assurance activities, the client's experiences – good and bad – can be translated into requirements that can help to improve the result of the current construction. Standards and paradigms convey in a systematic and clear way the client's requirements to the actors in the construction project, and can from time to time be further developed, reused and adapted to the current project.

QUALITY ASSURANCE IN THE DESIGN PHASE



THE ROLE OF THE PROJECT MANAGER

In this phase, the project manager has the overall responsibility for quality assurance across the actors involved in the planning. The project planners control and examine their material to see if the quality meets the quality level and the applicable legislation. But it is the task of the project manager to ensure that the project documentation sets requirements for the necessary quality assurance, and to follow up that this quality assurance takes place.

After each sub-phase of the design, the project manager must collect documentation that shows that the quality assurance activities have been carried out by the project planners. The documentation must clearly show how the individual activities have been carried out. It is important that the documentation also shows how the result of the quality assurance will affect the work in the coming phases – for instance, if space problems are found around a ventilation system, which have to be solved in the next phase.

If there are challenges with the quality assurance activities or suspicions that the quality assurance activities are being deprioritised, the project manager must inform the client. This applies not least in relation to the interdisciplinary quality assurance of the final project documentation at the end of the design phase. Here, it is often found that time is running out and that crucial quality assurance activities are therefore deprioritised. It is the responsibility of the project manager to anticipate and prevent this from happening.

THE QUALITY PLAN FOR DESIGN MUST ENSURE THE QUALITY LEVEL

Based on the construction programme's requirements for the construction's quality level, the project manager prepares a detailed quality plan for design. The plan describes the necessary quality assurance activities (including scrutiny and project control), the schedule for these activities and how they are staffed.

QUALITY PLAN FOR DESIGN

The term *quality plan for design* means a plan for the quality management and the quality assurance activities to be performed in connection with the construction's planning – including both consultant design and contractor design.

The quality plan for design must determine the scope of *scrutiny* – that is, describe how the project planners and potentially the contractor should:

- systematically review the project
- assess whether the project meets the requirements for the quality level
- identify possible problems or risk areas

It is also in the quality plan for design that the project manager must determine the scope of *project control*. Here, the project planners review the project documentation and calculations, partly to identify discrepancies and errors, and partly to check that standard and regulatory requirements have been complied with (e.g., BR18's requirements for fire and statics). In digital design, the quality plan for design must also describe when and who performs consistency and collision controls.

The elements of the quality plan should be incorporated into the project's service plan (e.g., specific times must be set aside for when scrutiny and control must take place). Here, the project manager must decide on the amount of time used for the individual quality assurance activities, including the client's own quality assurance activities. It is recommended that the quality assurance activities are combined with phase changes, where the project documentation is collected to ensure that scrutiny and control take place on the basis of an adequate amount of material. The client must ensure that they have received the requested documentation and that the documentation is sufficient. In addition, a joint meeting can be arranged (e.g., after a partial delivery), where the client and the project planner jointly

review the quality assurance documentation. In this review, the level of documentation is discussed – whether it is sufficient or whether it should be improved on specific points in the subsequent phases.

The client must ensure that the necessary finances and time have been set aside for the implementation of the quality plan for the project – including that the necessary resources have been set aside for the client's own quality assurance activities. It is recommended that the client and the project manager continually assess whether the agreed quality assurance activities are sufficient in relation to the task (e.g., as a fixed item on the agenda at ordinary client, planning and construction meetings).

THE TENDER CONTROL PLAN DETERMINES THE REQUIREMENTS FOR THE CONTRACTOR'S QUALITY ASSURANCE

Tender control plans are prepared by the project planners and describe the minimum requirements for the content and scope of the quality assurance documentation that the contractor has to deliver to the client. The tender control plan is typically designed as a form with references to the job description, where the activity is described in more detail. On the basis of tender control plans, the contractor prepares their own control plans.

It is important that there is a clear connection between tender control plans and the job description and that current legislation and standards have been followed (e.g., that tender control plans are in accordance with DS 1140's requirements for load-bearing structures⁷, which stipulates that it is the contractor who must prepare a control plan for load-bearing structures).

The requirements for the contractor's quality assurance in tender control plans are based on the final project documentation and place particular emphasis on areas and solutions that can be particularly risky, and where

⁷ [DS 1140:2019 'Execution of load-bearing structures – General control](#) (in Danish) describes the rules for planning, execution and documentation of general control of execution.

it is therefore crucial for the quality of the overall construction that they are carried out as planned. The project planners have the best knowledge of the project's design, and it is important that their knowledge of any critical topics and necessary controls is passed on to the contractor in tender control plans.

Tender control plans must contain information on the method, scope and time for each requirement. For example, this can be that a visual control or measurement (method) is required for every 5th execution (scope). The time indicates when in the construction process the activity takes place. The concepts used must be explained so that it is clear what, for instance, is meant by 'visual control' or a specification of the desire for 'photographic documentation'. Percentage indications, such as '10% of the floor is controlled', should be avoided, as well as random sampling, since it is rarely precise and can lead to misunderstandings. Instead, it is recommended to use precise descriptions, such as 'Every 5th execution' or '1 out of 10 bathrooms'.

ITEMS THAT SHOULD ALWAYS BE INCLUDED IN THE TENDER CONTROL PLANS

It can be an advantage to use Molio's paradigm for tender control plans⁸ as long as it is adapted to the specific case. It is recommended that the following items are included in the tender control plan:

- Approval of contractor design (also covering supplier design)
- Approval of the contractor's control plan
- All standard tests and controls
- Material and component approvals
- Any first-time controls and reference fields/mock-ups
- Supervision approvals
- Control of places where tolerances in the execution have particular importance (e.g., installation meeting points or where several structural elements meet).
- Authority requirements (e.g., CE marking and operational tests)

SUPERVISION AND INSPECTION PLANS

Before starting construction, the client must appoint *supervisors*⁹ who check that the contractors' quality plans and control plans live up to the tender's requirements for the quality level. During the actual execution, the supervisors carry out random inspections of the work performed, as described in the *supervision plan*, and compile inspection reports. The client allocates resources to carry out the supervision and establishes requirements for supervision reports as documentation for the supervision work, including a fixed procedure for follow-up.

The project planners provide input to the supervision plan within their respective areas of responsibility, after which the supervisors prepare an overall supervision plan that describes the scope of the necessary supervision tasks on the construction site. The supervision plan must show the areas that the client really wants to focus on and must include control of all the points in the tender control plan where requirements have been set for the supervisor's approval. It is recommended that the supervision plan is prepared during the execution project; however, it may be necessary for it to be adjusted after the project review has taken place.

It is important that the supervision plan focuses on the places where it will later be particularly difficult to rectify any errors and defects, or where it is not immediately visible in the handover process whether the execution is correct. This applies to, for example, hidden pipes and joints, foundations as well as drains. It is also recommended that the supervision plan includes a review of the final operation and maintenance documentation, the contractor's quality assurance documentation and a scrutiny of the 'as-built documentation' to ensure that the building is ready for subsequent operation.

⁸ Molio is working on a new version of the paradigm for tender control plans. See www.molio.dk for updates and the latest versions.

⁹ Read more in Værdibyg's guide 'Fagtilsyn' (in Danish).

FROM TENDER PROJECT TO EXECUTION PROJECT

At the end of the design phase, the project planners must prepare the execution schedule for tender. It must include sufficient detail so that it is clear that the necessary quality assurance activities can be completed within the set time. It is particularly important that the execution schedule takes into account the time it takes the contractor to carry out adjustments as well as check, test and document (e.g., the technical installations). In addition, sufficient time must be set aside for the client's approval procedures.

CHANGES DURING THE TENDER PROCESS MUST BE QUALITY ASSURED

In the time that passes from the project being sent out for tender to the client having accepted an offer from a contractor, there is in practice a minor degree of further design or error correction of the project documentation (e.g., based on questions and comments during the tender process). It is important that the client and/or project manager draw up a plan for how these changes are quality assured and integrated into the project and included in the process.

Following the tender, the contractor must examine the tender project in order to ensure that it is sufficient, fair and buildable. It is important that the contractor receives answers to any questions regarding the schedule, uncertainties, tender control plan, interfaces, etc. It is recommended to involve the project planners, the client and those responsible for risk assessment and working environment (working environment coordinator P and B) in any project changes. The project manager must ensure that changes are quality assured and that established procedures for project changes are complied with, including the updating of adjacent building parts and, for example, indoor climate, energy, acoustics and lighting calculations.

In digital design, the project planners must also carry out consistency and collision controls of the execution project. It is recommended that any errors, collisions, etc. are highlighted in the documentation from the implemented quality assurance together with an explanation of how the error has been (or will be) corrected.

THE PROJECT REVIEW MUST ENSURE A GOOD HANDOVER

The project review¹⁰, which should take place immediately after signing the agreement with the contractor or at the start of the execution phase, aims to ensure a good handover of the consultants' project to the contractors, where risks are identified and a common understanding of the project is achieved before the work is carried out. During the project review, the contractors are given the opportunity to comment on and influence the project, including interfaces, working environment conditions, the schedule and the level of ambition for quality assurance so that any inconveniences or errors and defects can be corrected. It is important that any project changes are quality assured across the various interfaces, and that there is a clear approval procedure for the proposed project changes.

It is the client's responsibility to carry out the project reviews, but in practice the task is often performed by the project manager and/or the construction manager¹¹. This should be clearly stated in the consultant agreement.

The project manager should ensure that the project reviews are incorporated into the design and execution schedule, and that the reports from these meetings (including any material) are collected with the project documentation.

¹⁰ See Værdibyg's guide '[Projektgennemgang](#)' (in Danish).

¹¹ In the guide, the 'construction manager' is used as a term for the client's representative who is present on the construction site.

QUALITY PLAN FOR EXECUTION AND CONTROL PLAN

On the basis of the execution project, the tender control plan and a risk assessment, the contractor must prepare a case-specific *quality plan* for the *execution*, which states the quality assurance activities that are necessary in connection with the construction's execution.

One of the main topics in the quality plan for the execution is the control plan, which describes in more detail the nature, scope and documentation requirements for how the contractor's quality assurance activities of the completed work should be carried out, checked and documented. For larger or very complex constructions, there can be several hundred control points, some of which are all the way down to the 'nail-and-screw' level. For instance, it is important that the control plan for the installation of a new balcony door section describes the checks needed on the location, type and number of fastenings, as well as the placement of spacer blocks, the number of joint strips, etc.

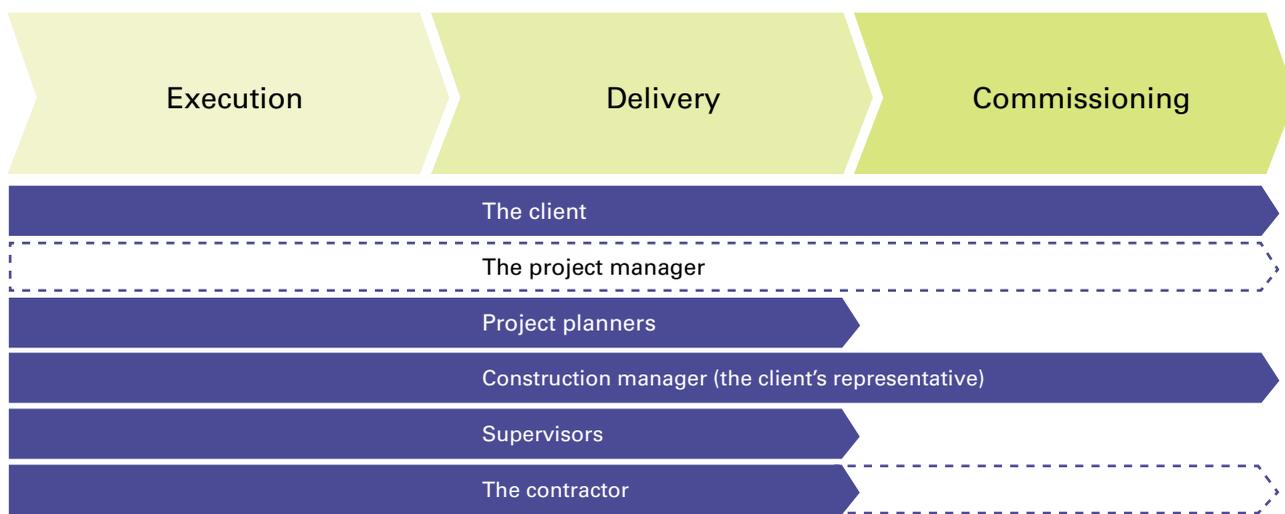
The control plan must cover all areas where there may be uncertainty or doubt. Here, it is important that the contractor is aware of both his own risks and the client's risk assessment. It can be beneficial to hold a risk review or workshop, where the client, the project planners and the contractor jointly review the project with a focus on clarifying risks. The relevant quality assurance activities are then adjusted for the identified risks so that the risk of errors is minimised.

It is recommended that the control plan includes delivery, handover, process and final control. Delivery control deals with, for instance, control of the delivered materials – are the requirements met and do the delivered materials correspond to those ordered in terms of type, size and condition? It is, for example, moisture-resistant plasterboard that has been delivered and not regular plasterboard? Is the quantity correct? Are the packages undamaged? Are the boards properly covered? Major delays can be caused if the defect is first discovered when the materials are to be used, and even greater problems if the defect is first discovered after assembly.

Handover control covers the control of previous work from one contractor to another contractor. It is, for instance, important that the bricklayer controls that the foundation on which work will be carried out has been completed correctly. For example, are the heights of footings and floors in accordance with the bricklayer's drawings and job description so that the bricklayer does not continue to work on a defective foundation? The supervision plays a significant role here – it must support the individual craftsman so that their work builds on the right basis.

The process control and final controls, both of which are often performed by the craftsmen, include, respectively, quality control of their ongoing work and the final control of the work performed, cf. the control plan.

QUALITY ASSURANCE IN THE EXECUTION, DELIVERY AND COMMISSIONING PHASE



At the start of the execution phase, the project manager hands over the project to the construction manager. Throughout the execution phase, the construction manager (the client's representative on the construction site) must follow up that the project is carried out at the right quality and coordinate with the client, the project planners and the contractor if challenges arise that need to be clarified and solved. At the handover, it is important that the project manager shares their knowledge of the project's risks as well as the background for tender control plans and supervision plans.

During execution, the contractor may send technical enquiries (TEs) to the project planners if there is a need for technical clarifications or additional project documentation. The project planners are responsible for ensuring that these clarifications live up to the quality requirement. It may be necessary to involve the client in major decisions, and it is therefore important that the client is always available as a central decision-maker for the project planners and the contractor. However, as far as possible, most matters and issues should be addressed at the construction meeting.

AB18 ON REGISTRATION OF CHANGES

According to AB18 § 23 (1), the client can require variations to the work when such variations are naturally linked to the services agreed upon. The client must continuously register required changes (cf. § 25, subclause 5). If the contractor finds that there is an error in the client's registration, the contractor must notify the client as soon as possible.

The contractor must ensure that the quality assurance activities are carried out as described in the quality plan for execution, in the tender control plan and in their own control plans, and that the necessary documentation is carried out on an ongoing basis. This applies to both the contractor's own work and to any trade contractors' contracts. It is recommended that the contractor, as far as possible, involves the supervisors on an ongoing basis in the review of the stage and scope of the quality assurance work. This will usually ease the

SPECIAL LEGAL REQUIREMENTS FOR DOCUMENTATION FOR EXECUTION CONTROL

BR18 requires that documentation for a building's load-bearing structures must include documentation for control of execution. This means that the executing contractors and craftsmen's companies must plan and document general control of what is carried out. There are thus both requirements that quality assurance for the construction of the building is documented and that the QA system is documented. The standard DS 1140 sets the framework for planning and carrying out the general control, which must always be performed in connection with the execution of a load-bearing structure. Read more about DS 1140 at www.ds.dk.

delivery process in the end if the supervisors have previously been presented with the documentation. It is recommended that the contractor's documentation of the quality assurance does not only include the points in the control plan but also takes into account the contractor's own needs for documentation (e.g., in relation to trade contractors, supplier and installation instructions, warranty, additional requirements or an extension of the deadline). The scope of this should be clarified in connection with the preparation and approval of the control plan.

TRADE CONTRACTORS MUST BE INVOLVED

It can be an advantage for the contractor to hold a quality assurance start-up meeting with each trade contractor before they begin work at the construction site. At the meeting, the contractor reviews partly the general requirements that the client and the contractor have for the quality assurance that must be carried out on the

construction site and partly the specific requirements for the trade contractor's quality assurance. In addition, the trade contractor's quality plan and control plans are reviewed, and any corrections are carried out before the quality plan and control plan are passed on to the consultant for review.

If there is a specific digital platform that the trade contractor has to use for the construction project, this should also be an item at the meeting. It must be ensured that the subcontractor has access to the platform, and if the trade contractor does not have knowledge of the digital platform there must be an opportunity for training for the people who will use the platform. It is important that there is an opportunity for employees on the construction site, both in own production and with the trade contractors, to have ongoing opportunities to receive training in the use of the chosen digital platform. As a minimum, there should be an experienced user on the construction project who can partly teach how to use the system and partly be responsible for the project-oriented setup and ongoing adjustment.

The contractor must incorporate the necessary quality assurance activities and controls into the execution schedule. It is important that the schedule reflects milestones for the completion of the construction so that there is time to carry out the necessary tests and controls – taking into account that some work can only be considered completely finished when there is approved documentation for adjustment, testing, and function as well as operation and maintenance documentation. Especially technical systems can appear to be finished but turn out not to work when they are started.

THE CRAFTSMEN ON SITE PERFORM THE QUALITY ASSURANCE

It is important that the craftsmen carrying out work are aware of the requirements for the quality level of the construction, since in practice they are the ones carrying out the solutions and quality assurance in relation

to receiving materials and handing over tasks. Therefore, the craftsmen should be involved in the contractor's process start-up meeting together with the project planners, suppliers and the client. It is recommended that the contractor focuses on having as direct and easily accessible communication channels as possible between those carrying out the work (e.g., by planning and conducting

control of first-time installations of work that will be repeated multiple times). It could, for example, be control of the installation of the first window section or the first valve unit in the heating system. At the first-time installation, the craftsmen carrying out the work, foremen, the client, the project planner, the supervisor and the contractor's contract management participate in the control process so that everyone is involved in approving the quality level performed.

MAKE THE CRAFTSMEN ACTIVE PARTNERS IN QUALITY ASSURANCE

The craftsmen go to the construction site every day and follow the execution of the construction closely. There is a great potential in involving the craftsmen in quality assurance. Both by letting them perform part of the quality assurance and documentation (e.g., with the help of photographs and smartphones) but also by giving them the opportunity to send a report if they see something that is not right.

The construction manager is responsible for continuously following up that the craftsmen on the site perform quality assurance, cf. the tender control plan. In this connection, it is important that the communication goes both ways and that the construction manager takes the craftsmen's observations seriously and reacts to their reports and remarks.

If the craftsmen are involved in playing an active part in the quality assurance, many errors and defects can be caught during the execution process and it is possible to avoid being left with annoying repairs at the end.

It is also recommended to carry out a delivery control of a work area to ensure that the previous activity has been carried out correctly before continuing the build. In this way, you do not build on a mistake that can end up being very expensive to fix.

EXECUTION OF SUPERVISION

The supervisors perform random checks on the construction site to ensure that the work carried out is in accordance with the project documentation and the construction agreements. It is recommended that the supervisors' control is documented on an ongoing basis in supervision reports with photographs accompanied by text describing what the photograph shows, where and when it was taken, and what the supervisors have concluded on the basis of this. There are various apps and web platforms for this that can facilitate the supervisor's administrative work and ensure a faster construction flow.

The supervisors must report back to the contractor, the construction manager and the client if problematic conditions are identified. It is recommended that the supervision plan contains clear, effective procedures for handling supervision reports, how they are followed up and by whom. If the supervisors have documented an error (e.g., a trade contractor who does not deliver to the agreed quality), it is crucial that the supervision report is handled clearly and quickly so that the problem can be rectified in a timely manner. It is recommended that the supervision plan's handling of changes includes a special procedure for urgent and critical cases.

DELIVERY AND COMMISSIONING MUST BEGIN IN GOOD TIME

In the delivery phase¹², the construction is handed over to the client, the users and the future operating organisation. The construction manager is responsible for the practical organisation of delivery and commissioning, as well as the errors and defects review.

¹² See Værdibyg's guide ['The Handover Process'](#).

It is recommended that the construction manager starts well in advance of the handover, as it is a large and resource-intensive task – in particular, the work of testing, documenting and preparing operation and maintenance documentation should not be underestimated.

The contractor submits documentation for the work carried out and the required operation and maintenance documentation, which the supervisors control in accordance with the agreement. It is important here that the as-built documentation is in proper accordance with what has been built. The project planner must update their own project documentation according to the contractor's as-built documentation and carry out scrutiny and control of the final project documentation. The contractor must also be aware that trade contractors deliver the agreed documentation, etc. before they leave the site, as well as control of the quality of this. The client can follow up on whether the submitted documentation meets the requirements (e.g., via random checks).

INVOLVE THE OPERATING ORGANISATION IN THE ERRORS AND DEFECTS REVIEW

It is often an advantage that the client includes the future operation in the delivery phase, so that the operating organisation gains a good knowledge of the construction when it is handed over. If the operating organisation attends tests and trials of various facilities and systems, they get the opportunity to talk to the installers and technicians, and thereby the opportunity to ask questions and become familiar with the construction and the individual components. In addition, involving the operating organisation can help to ensure that the relevant documentation, guidelines, etc. are known, accessible and usable in terms of operation.

Some items can first be quality assured when the building is in use (e.g., lighting and acoustics). The client must ensure that the operating organisation receives the necessary information on how this is done.

Part 3

CHECKLISTS

- 1. The client's checklist**
- 2. The project planner's checklist**
- 3. The contractor's checklist**

1. THE CLIENT'S CHECKLIST

The following checklist for the client should be seen as inspiration for planning and adapting your own processes and activities associated with the quality assurance of a project – the list is not exhaustive.

CONSTRUCTION PROGRAMME

- Is the internal organisation of the project clarified and have any agreements been entered into with the client consultants?
- Are the quality goals set, measurable and clear?
- Has a decision been made on the quality assurance of the presentation of ideas and construction programme?
- Has a decision been made as to whether there is a need for external scrutiny (particularly relevant for complex constructions or in projects where there is a need for specialist knowledge)?
- Is there a connection between quality requirements, price and time?
- Does the allocated fee to the consultants take into account the quality assurance activities?
- Does the timetable take into account the quality assurance activities?
- Are the activities related to quality assurance decided on?
- Which competence requirements does the project place on the consultants?
- Has any of the client consultant's internal quality assurance documentation of the idea and construction programme phase been received (possibly uploaded on the digital platform) and reviewed?

PROJECT MANAGEMENT AND PLANNING

- Is there a quality plan from the client's consultant and has it been reviewed by the client?
- Are the roles and responsibilities for the quality assurance activities and follow-up clearly defined in accordance with the chosen form of tender?
- Has a decision been made on how and when the project planner has to carry out quality assurance and provide documentation?
- Are the budget and fees consistent with the quality assurance activities and the documentation of this?
- Are supervision plans prepared, clear and adapted to the specific conditions?
- Is the schedule realistic in relation to the quality assurance activities and the phases that are planned, including procedures cf. ABR18/ABT18 (e.g., project reviews)?
- Is there a realistic plan for the client's, users' and the operating staff's involvement, follow-up and decisions?
- Is the material regarding existing conditions quality assured (for renovation)?
- Has it been checked that agreed services for each phase (e.g., cf. YBL18) are delivered?
- Has an ICT specification been prepared and has a common understanding of the use of the IT platform been created?
- Has a stakeholder analysis, risk analysis and overall economic assessments been prepared?
- Has work environment coordinator P played an active role during the planning?
- Are the finances updated and approved in connection with the change of phase?
- Has documented quality assurance of the phases been presented and approved?
- Has the necessary quality-assured documentation been submitted to the authorities?

THE TENDER DOCUMENTATION

- Has the consultant uploaded documentation for internal quality assurance?
- Is the tender control plan adapted to the specific conditions?
- Is there a need for auditing and has time been included for this?
- Has an interdisciplinary scrutiny been carried out and have the conditions found been incorporated in the tender documentation?
- Do the control activities also relate to the risk assessment?
- Has the ICT specification been complied with and have requirements been passed on to those carrying out the work?
- Has a collision and consistency control been carried out to the relevant extent (digital design)?
- Is there a requirement for client approval of components, building parts or mock-ups?
- Is the main time schedule for tendering realistic in relation to the execution and does it contain the necessary procedures, cf. AB18/ABR18/ABT18 (e.g., project reviews, supplier planning, pre-delivery, etc.)?
- How and to what extent has commissioning and functional testing been carried out?

EXECUTION

- Has the contractor's quality plan and control plan been prepared, examined and approved?
- Are quality assurance activities included in stage reports to the relevant extent?
- Are there clear requirements for documentation of quality assurance activities?
- Is there a clear framework for how identified problems are handled in a timely manner?
- Has a clear process been established for project changes and the review of consequences derived from the changes across the trades?
- Does work environment coordinator B have an active role during execution of the project?
- Are inspections and control activities documented on an ongoing basis?
- Have defect lists been made and followed up on?
- Are ICT requirements in terms of communication, classification, 'as built', etc. being followed?
- Has the ICT specification been complied with regarding delivery to the operating organisation (O&M)?
- Have all functional tests been carried out and documented?
- Has the client been invited for meetings on commissioning as well as for participation in functional tests, including performance tests?
- Have the authorities received a notice of completion of the project and has the occupation permit been received?

2. THE PROJECT PLANNER'S CHECKLIST

The following checklist for the project planners should be seen as inspiration for planning and adapting your own processes and activities associated with the quality assurance of a project – the list is not exhaustive. It is a prerequisite for the checklist that the agreement between the client and the project planners is based on YBL18.

PLANNING

- Has a decision been made on the implementation of the individual quality assurance activities, such as the preparation of trade-specific quality plans, project control, scrutiny, interdisciplinary scrutiny, screenings, work environment assessment, assessment of conditions subject to risk as well as consistency and collision control in the individual phases?
- Are the individual quality assurance activities planned in relation to the implementation of the project and incorporated in the service plan?
- Have expectations been aligned with the client and other partners on how the process and documentation of the individual quality assurance activities will be carried out?
- Has a decision been made as to who is responsible for quality assurance activities and/or who has the role of QA manager, if this is required?

INITIAL CONSULTANCY – PRESENTATION OF IDEAS AND CONSTRUCTION PROGRAMME

- Has a documented (internal) scrutiny been carried out for your own professional area of the presentation of ideas and its basis?
- Has a documented systematic and cohesive (internal) scrutiny been carried out for one's own professional area of the construction programme and its basis in order to ensure that the requirements of the construction programme in terms of quality (architecture, function, construction technique, etc.) are adequately described as a basis for preparing proposals?
- Has a documented (internal) scrutiny of one's own professional area been carried out regarding the construction programme's requirements for construction planning, design, work with authorities, scheduling conditions, etc.
- Has a documented (internal) scrutiny been carried out for one's own professional area of the construction programme's requirements for the construction's finances to ensure that the allocated budget reflects the requirements and wishes of the construction programme?
- Has the agreed quality assurance documentation for initial consultancy been handed over to the project management?
- Have conditions that give rise to stricter controls in the future been reported?
- Have conditions that are particularly subject to risk and give rise to adjustment of the planned quality assurance activities been identified?

OUTLINE PROPOSAL AND PROJECT PROPOSAL

- Has documented project control (own and peer control) been carried out for one's own professional area?
- Has a documented (internal) scrutiny been carried out for one's own professional area, and has the project manager been informed about new particular conditions that are subject to risk?

- Has any project documentation prepared by the supplier and contractor been reviewed to ascertain whether the project documentation meets the tender project requirements and intentions, including interfaces to other works?
- Has an interdisciplinary scrutiny been carried out and is your own professional area documented?
- Have the completed assessments been followed up on (e.g., of working environment and risk conditions, etc.), and has input been received from the contractor for this?
- Have the individual trade models been included in the quality assurance, has consistency and collision control of the individual trade models been carried out, and has the ICT management been informed of this?
- Has participation in project review meetings with the individual trade contractors, as set in the tender project and contractor contract, been completed?
- Have the tender control plans for the individual jobs been updated, and has input for this been received from the contractor?
- Is the execution project in accordance with the tender project's set requirements and intentions?
- Has the agreed quality assurance documentation for the execution project been handed over to the project manager?

EXECUTION

- Has participation in the agreed project review meetings with the individual trade contractors for project follow-up and supervision, as stipulated in the contractor contract, been carried out?
- Have supervision plans for the agreed supervision with the client been completed, and are specific risk conditions, as noted during scrutiny and project review, incorporated?
- Are supervisory activities registered on an ongoing basis in the supervision plan via prepared inspection reports?
- Are the contractors' quality plans and control plans checked to verify that they live up to the tender project's requirements and intentions?
- Has documented project control (own and peer control) and (internal) scrutiny of own project clarifications been carried out to ensure that the execution project lives up to the set requirements and intentions?
- Has the agreed quality assurance documentation for execution been handed over to the project manager?

DELIVERY

- Has a pre-review been carried out for the individual trades, as stipulated in the agreement for supervision?
- Has a handover process been completed with the individual trade contractors, as stipulated in the agreement for supervision?
- Have defect lists been prepared for use in delivery, and have defects been rectified during an inspection?
- Has a 1-year inspection been carried out with the individual trade contractors, as stipulated in the agreement for supervision?
- Have defect lists for use in the 1-year inspection been prepared and have defects been rectified during an inspection?
- Is the contractors' documentation checked to the extent specified in the supervision plans?
- Has as-built documentation and project documentation to the extent stated in the ICT agreement been received from the contractors via supervision? Including any digital as-built building models?
- Is one's own as-built project updated as a result of one's own project changes and project clarifications to an extent that enables regulatory approval and an occupation permit for one's own professional area?
- Has documented project control (self- and peer control) and (internal) scrutiny been carried out for one's own as-built project documentation?
- Has the agreed QA documentation for delivery been handed over to the project manager?
- Has operation and maintenance documentation been carried out to the extent specified in the agreement?
- Has the notice of completion been submitted and has the occupation permit been received?

3. THE CONTRACTOR'S CHECKLIST

The following checklist for the contractor should be seen as inspiration for planning and adapting your own processes and activities associated with the quality assurance of a project – the list is not exhaustive.

PLANNING (FOR TURNKEY CONTRACTS)

- Has the turnkey contractor's consultant carried out quality assurance in accordance with the agreement entered into, BR18 and the client's wishes?
- Have the consultants submitted a project-specific quality folder containing, for instance, scrutiny report, risk assessment, supervision plans and tender control plans, among other things based on the risk assessment?
- Have requirements been set for the tender control plans prepared by the consultant? Are the tender control plans realistic in relation to, for instance, the control percentage?

PLANNING

- Has the selected digital platform been created and adapted to be project-specific?
- Has an internal quality assurance coordinator been appointed who is an experienced user of the chosen digital platform, and who can advise and solve tasks in relation to the quality assurance work?
- Has an internal quality assurance start-up meeting been arranged with the participation of the project manager, construction manager and quality assurance coordinator, where, amongst other things, the quality plan (incl. attachments) is adjusted for the project?
- Has the construction project (incl. the digital quality folder) been created in the chosen digital platform?
- Has the chosen digital platform been coordinated and clarified with other digital platforms, including where and when which documents are saved?
- Has the project-oriented quality plan (incl. attachments) been forwarded to the consultant for approval?
- Has the client appointed a 'client supervisor', who is responsible for the construction management, supervision, etc.?
- Has the client appointed a client consultant or other consultant who can act on behalf of the client?
- Have any clarifying quality assurance meetings been held with the turnkey contractor's project planners? Including clarified expectations for what and how the contractors and individual trade contractors perform the quality assurance and O&M work?
- Are the requirements in the tender control plans clarified, including the scope of control?
- Has it been agreed with the involved parties how the digital platform is used in connection with the quality assurance work?
- Has it been clarified what the quality assurance and O&M material should include and how it should be delivered?
- Has the construction management and working environment coordinator B carried out scrutiny of the project?
- Has the client made a written statement about the use of methods and materials that have not been thoroughly tested?
- Has the client been made aware of any risks associated with these (or is their use prescribed by the client)?

START-UP

- Has the client arranged a tender and project review meeting before the contractor design begins? Have the contractor and the client here reviewed the tender and the contractor's offer with regard to achieving a common understanding of the project?
- Has the construction management ensured various reviews, permits, certificates, inspections, etc.?
- Have the individual trade contractors submitted project-specific quality plans and detailed control plans to the contractor?
- Has the construction management forwarded any corrections/defects to the subject contractors and sent the adjusted quality plans and control plans for approval by the project planner?
- Has the construction management prepared project-oriented and detailed control plans for the work processes that must be carried out in own production? Including the control points based on relevant appendices, such as the job description, data sheets, ERFA sheets, assembly instructions, tender control plans, risk assessment, etc.?
- Have the control plans been submitted for approval to the project planner?
- Have all necessary employees at the individual trade contractors, project planners, the client and the contractor's own organisation been taught how to use the chosen digital platform?
- Has a plan been drawn up for which building parts need a start process?
- Have any mock-ups, test areas, etc. been made?
- Is there material that is not specifically described in the job descriptions that the project planners must forward?
- Has the consultant called project review meetings – both regarding own production and the individual trade contracts?
- Have the necessary supervision reviews been discussed and agreed at the project review meeting with a focus on hidden and risky topics?
- Has documentation of system deliveries (i.e., drawings, calculations, descriptions, data sheets, etc.) been submitted for approval by a consultant?

EXECUTION

- Have the construction management and the client arranged a supervision review of specific jobs or materials identified during the project review?
- Has a start process (first-time execution) been held for all building parts that are subject to high risk, and where failure will have major consequences?
- Have registrations of delivery, process and final control been carried out on an ongoing basis in the chosen digital platform?
- Have the craftsmen had a thorough review of the work process, which registrations they have to carry out and the control method? And have they then carried out the registrations of the work?
- Has the construction management completed the registrations in the chosen digital platform?
- Has it been agreed who is responsible for the other quality assurance work (in addition to delivery, process and final control)?
- Has a status meeting been held (e.g., 15% meeting) for the quality assurance work for both own production and the individual trade contractors?
- Does the quality assurance coordinator carry out ongoing control and follow-up of the individual trade contractors' quality assurance?

- Are supervision and technical enquiries followed up on – do the answers include written and photographic documentation, and are they completed?
- Are changes in the project documentation followed up on – have they been risk assessed, has the control plan changed and is there a need for a new start process?
- Should an internal audit of the own and individual trade contractors' quality assurance be carried out? Has an internal quality assurance report been produced that is sent to the individual trade contractors and own production?
- Has a status meeting been held (e.g., 50% meeting) for the quality assurance work for both own production and the individual trade contractors?
- Has a 'master review' been held for the contractor, the individual trade contractors and the 'master' for the work process in question?
- At the quality assurance meeting, have the requirements and scope of the O&M documentation been agreed with the client, including special wishes for, for example, building element cards?
- Has O&M documentation, and any building card elements, been gathered and prepared?
- Have functional tests been carried out that are on a critical path in connection with the final functional tests, cf. BR18, or agreed performance tests?

DELIVERY

- Has quality assurance and O&M material been submitted regarding own production and the individual trade contractors for review and approval by one's own consultants? Have any issues regarding the material been corrected before delivery to the client?
- Has an internal defect review been held, where general defects are located, and has a defect list been prepared?
- Has a pre-defect review been held with the individual trade contractors, and has a defect list been prepared?
- Has a pre-review with the client been held, and has a defect list been prepared?
- Have functional tests been held, cf. BR18, and have these been documented prior to the occupation permit?
- Have any performance tests been carried out, and have these been documented?
- Has a defect review been held with the client, and has the client prepared a defect list?
- Has the individual trade contractors' finished quality assurance and O&M documentation been read and have potential defects been pointed out?
- Has one's own quality assurance and O&M documentation been completed?
- Has the digital quality assurance and O&M documentation been completed and delivered to the client? Has the delivery letter been signed by the recipient and archived in the project?
- Has the construction project been delivered? Has a copy of the project been created if the client's or consultant's platform has been used?