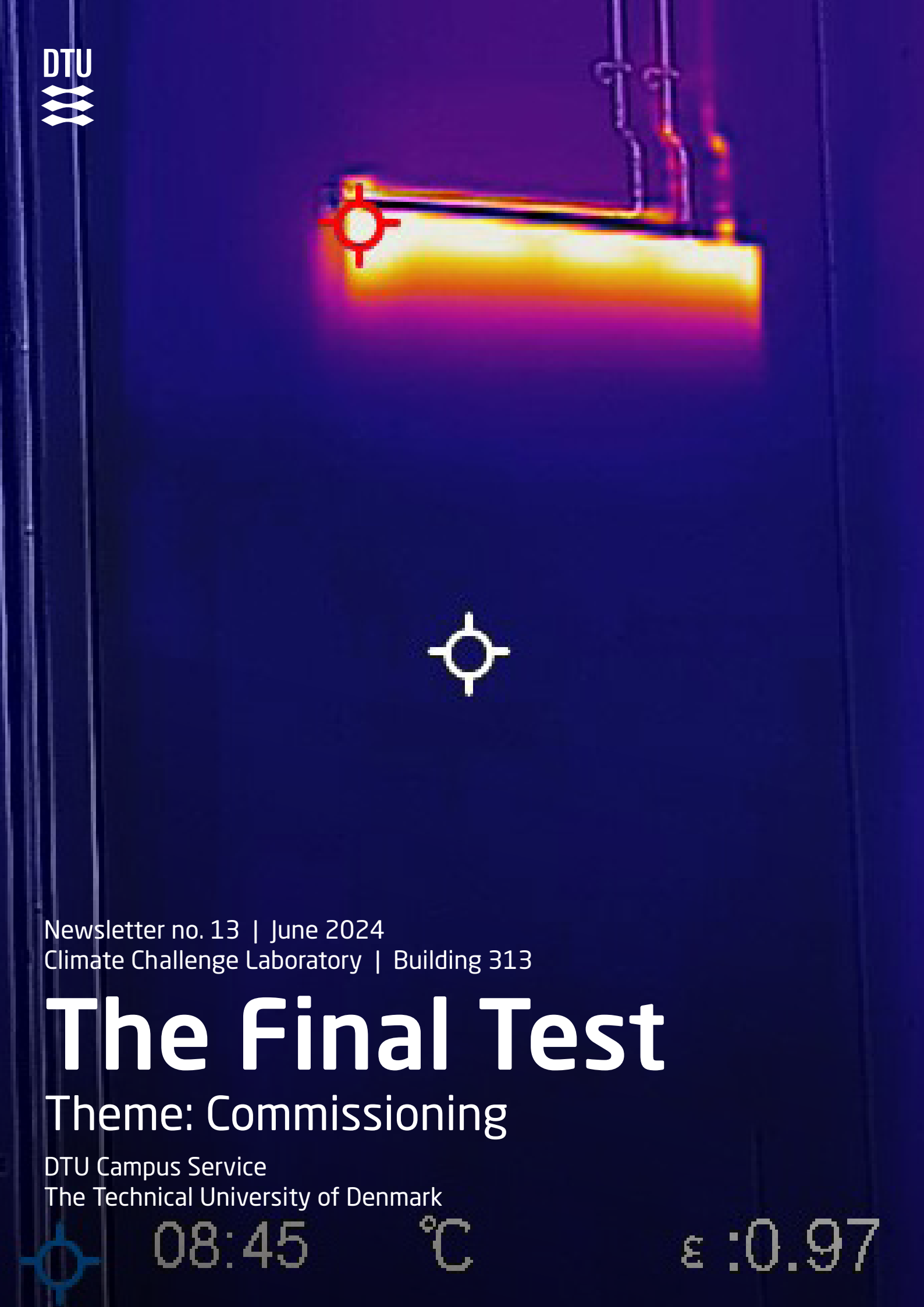


Newsletter no. 13 | June 2024
Climate Challenge Laboratory | Building 313

The Final Test

Theme: Commissioning

DTU Campus Service
The Technical University of Denmark

The Final Test

Research places significant demands on laboratory installations. Operations must be able to control temperatures to within 0.1 degrees and ensure minimal fluctuations. Therefore, DTU places a strong focus on commissioning and testing installations before users move into B313.

Soon, physicists and energy researchers will be able to occupy offices, laboratories, and kitchenettes in B313. Beforehand, Campus Service tests whether the installations work as planned, because there will be no research if the ventilation does not run as, it should.

The installations also have a significant impact on the building's energy consumption. DTU, therefore, places a strong focus on commissioning (Cx). Since the beginning of the construction project, a Cx group has defined the requirements for heating, cooling, and ventilation that the building must meet and developed test paradigms to be used until handover. This means that DTU can look forward to the building being used as intended from day one and that consumption can be managed efficiently.
The Cx group is led by Søren Schriver, while Joachim Nørgaard Nielsen represents the contractor side, and John Graversen assists as an advisor. In the newsletter, you will meet all three, and they talk about the work of the Cx group and how it helps to elevate DTU's sustainability ambitions.

Part of the process from start
At DTU, commissioning is integrated from the beginning of a construction project. This is crucial to ensure that DTU receives a building that meets the performance requirements set by the research. The close collaboration between the client, the operator, advisors, and the contractor in all phases of B313 helps achieve DTU's goal of reducing energy consumption.

What are your respective roles?
SS: I have been the commissioning leader from the beginning of the project. I oversee the process and create the overall commissioning plan, which we execute and test in collaboration with Artelia and MT Højgaard.

JNN: I have been involved in the process from the beginning to the end. I help structure the commissioning and address the technical challenges we encounter. Together with DTU, we have developed the commissioning paradigms for B313.

Søren Schriver (right) from the company Schriver, Børthy, and Lundemann is the CX construction manager and represents DTU in the commissioning work. John Graversen is a maschine engineer at Artelia and an advisor for DTU, while Joachim Nørgaard Nielsen (left) is on the contractor side and has been involved from the beginning, first as part of MT Højgård and today as an external consultant in the company PME. Photos: Søren Schriver/Joachim Nørgaard Nielsen.

COMMISSIONING

Commissioning is a quality management process that verifies, documents, and tests that a building meets the specified requirements. The commissioning process establishes measurable, function-based requirements at the beginning of a project. These requirements are checked for compliance throughout all phases of the project: the design phases, the execution phase, and the operational phase.

The commissioning process originates from the shipbuilding industry. A commissioned ship is fully built and ready to sail. Before a ship can receive this title, it must pass a series of tests.

JG: John Graversen, Artelia. My role is to create the Cx-Log and ensure it is completed. We are responsible for the performance tests, for which we have developed the paradigm and are currently conducting the tests (June 2024, ed.).

What does the Cx process consist of?
JNN: The process encompasses several elements. The Cx plan serves as the framework for what we need to do. It also includes Cx requirements, a commissioning plan, and a description of how we should test, along with Cx logs. It is a long, continuous process.

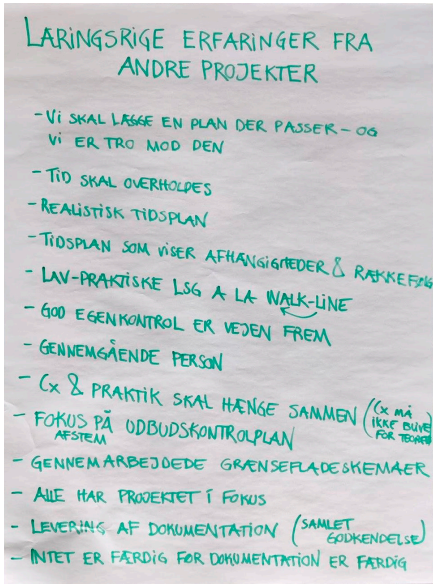
SS: At the beginning of the project, we didn't know who we were building for, or which laboratories needed to be in the building – and therefore, which installations we needed to test. Only after we identified the users could we delve into the details and define the Cx requirements. Then we decided what to test and could describe the paradigm. You always need to test lighting, heating, and cooling, but in B313 the work with the research center, VISION, has been particularly special. We didn't know precisely what the requirements would be, so the emergency power supply was added later. In case of a power outage, a battery takes over to keep the installations running.

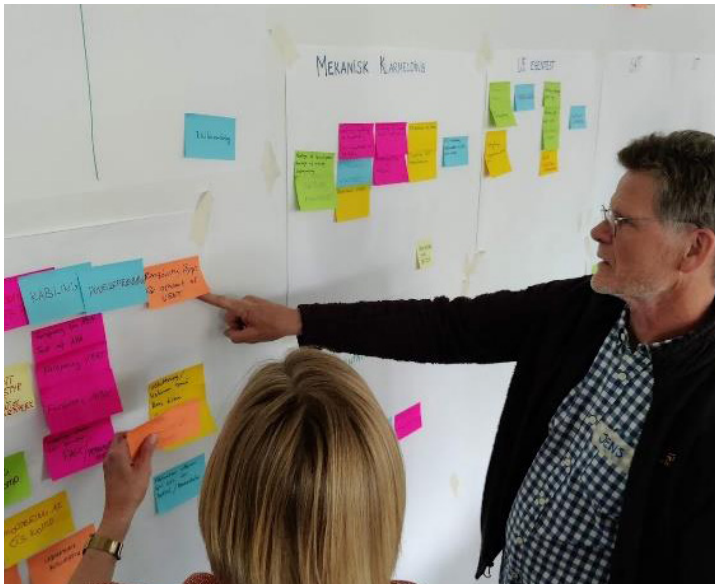
Is this an atypical way of working?
SS: Yes, I haven't experienced this approach before. Normally, when starting a project, there are clearly defined requirements from the users. The engineer designs it, the contractor builds it, and finally, it is tested to see if it works. Here, we have helped define the requirements along the way. At DTU, there is a clear stance on how they want to run the commissioning process. It is quite unusual for a client to be so precise about what they want, and it was quite liberating. So, we start the process with the design phase accommodating this.

For DTU and the building, this has been an advantage because it saves time. If we had waited for DTU to know which users would be in the building, we would have started a year and a half later. The process and the design phase have been different, but we were prepared for it. It has been both educational and challenging.

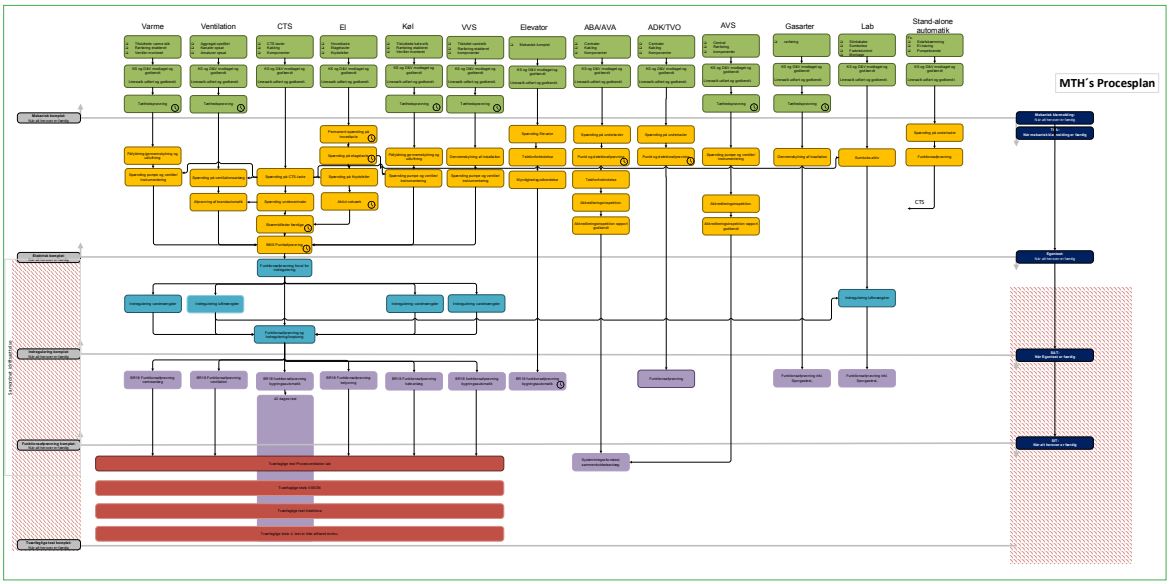
What significance does the Cx work have for the sustainability of the building?
JNN: The Cx work is a part of the sustainability certification DGNB. Here, we have several obligations regarding the scope of testing, as well as documentation and manuals, to achieve the necessary points for certification. Moreover, it is about ensuring that the building is used correctly so that energy consumption is as low as possible. This is achieved by ensuring that the systems function as intended and are correctly calibrated.

JG: Commissioning is about optimization, which aligns with a sustainability agenda. One could say that sustainability requirements are defined elsewhere, but the Cx group's work is crucial for meeting those requirements. The installations must work as intended for the building to have minimal energy consumption. In recent years, there has been an increasing focus on commissioning because many buildings do not perform as expected. In Building 313, we will achieve our goals, especially because resources have been allocated to it, both from DTU

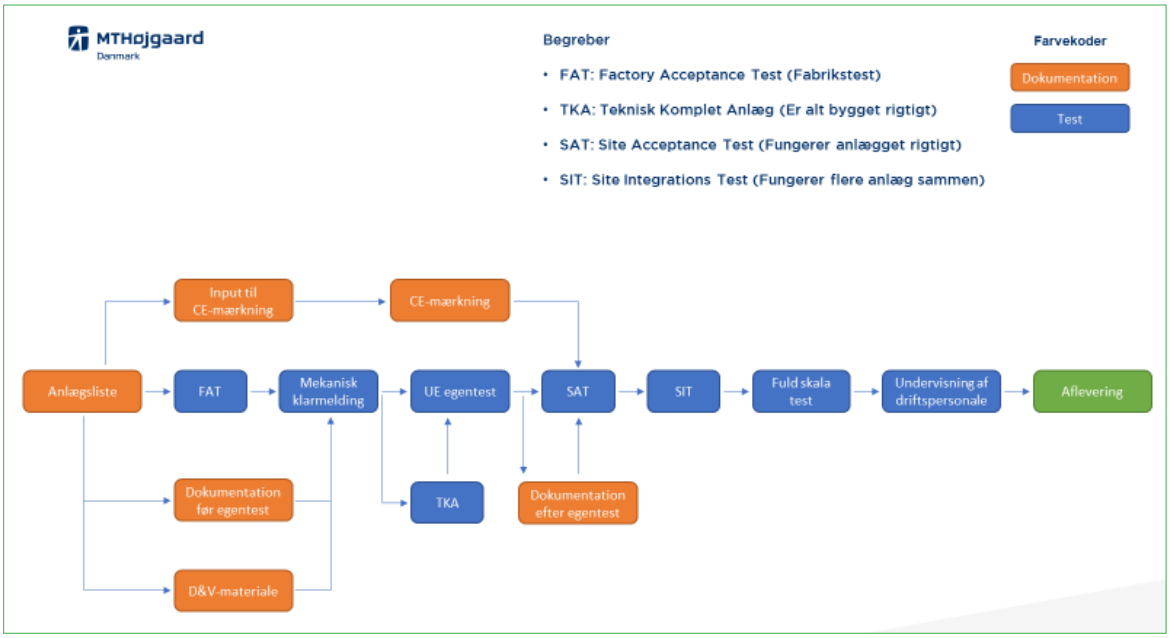




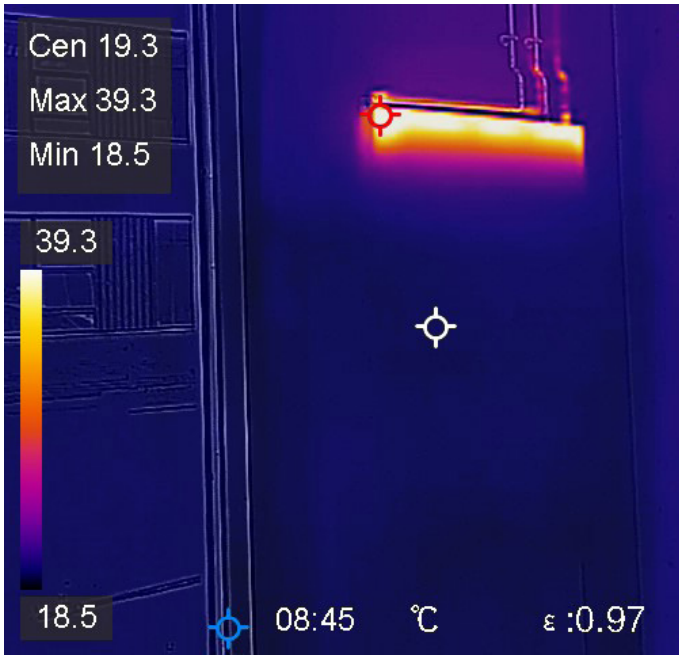
Workshop. The Cx-group held a workshop for all subcontractors in the beginning of the commissioning phase to establish a common understanding of the demands for testing and documentation. Photo: DTU

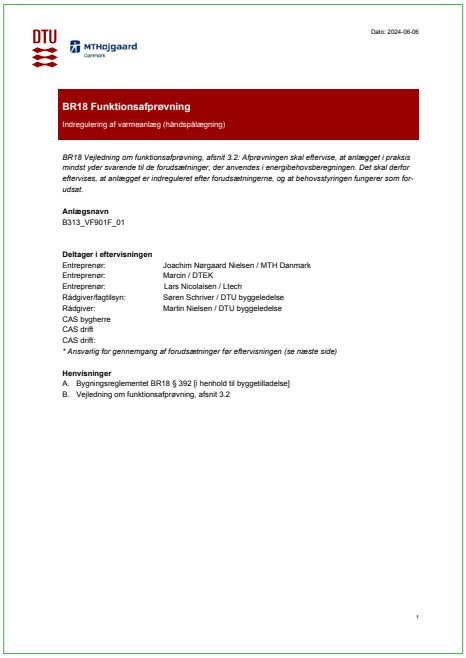


Flowchart for commissioning at B313. Photo: DTU



MTH Commissioning Process Plan. Photo: MTH




DTU MTHøjgaard Danmark

Dato: 2024-06-06

BR18 Funktionsafprøvning

Indregulering af varmeanlæg (håndspålægning)

BR18 Vejledning om funktionsafprøvning, afsnit 3.2: Afprøvningen skal eftervise, at anlægget i praksis mindst yder svarende til de forudsætninger, der anvendes i energibehovsberegningen. Det skal derfor eftervises, at anlægget er indreguleret efter forudsætningerne, og at behovsstyringen fungerer som forudsat.

Anlægsnavn
B313_VF901F_01

Deltager i eftervisningen

Entreprenør:	Joachim Nørgaard Nielsen / MTH Danmark
Entreprenør:	Marcin / DTEK
Entreprenør:	Lars Nicolaisen / Ltech
Rådgiver/fagtilsyn:	Søren Schriver / DTU byggeledelse
Rådgiver:	Martin Nielsen / DTU byggeledelse
CAS bygherre	
CAS drift	
CAS drift:	

** Ansvarlig for gennemgang af forudsætninger før eftervisningen (se næste side)*

Henvisninger
A. Bygningsreglementet BR18 § 392 [i henhold til byggetilladelse]
B. Vejledning om funktionsafprøvning, afsnit 3.2

Example from testing. The radiator was installed incorrectly, which was detected during testing. Photo: MTH

and MT Højgaard. It is also significant that we include operational staff. There is a dedicated maintenance person here.

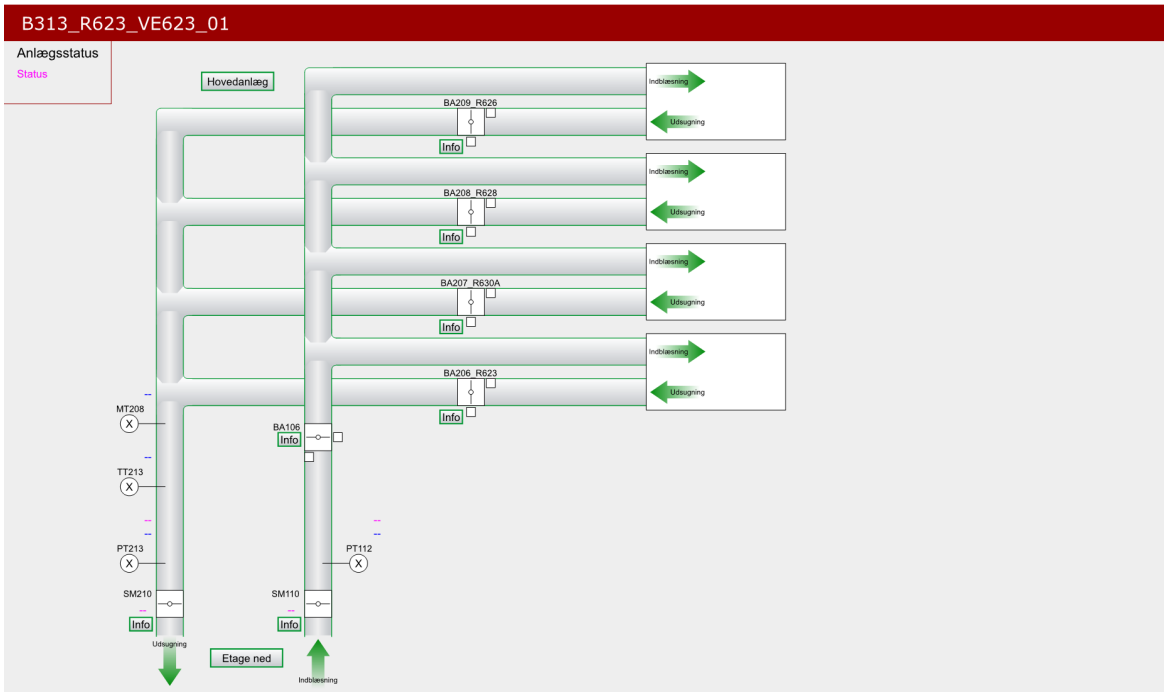
JNN: Our work aims to create a better overview and help the process towards commissioning, focusing on critical aspects for the early use phase. Additionally, we ensure that we conduct our tests before the building is tested across disciplines. At the start of the commissioning phase, we spent considerable time creating a commissioning plan, so everyone (Artelia, MT Højgaard, and DTU) had a common understanding of how we would achieve our goals and how we should test. Sometimes, we find that subcontractors do not always have the necessary interdisciplinary knowledge to ensure that the system as a whole functions correctly. Last spring, we held a workshop where we reviewed the plan with the subcontractors and established a shared understanding of the Cx process. It is important to have the same understanding when discussing terms for testing and commissioning, such as having the same understanding of terms like "electrically complete." It is also crucial that we understand each other when identifying the critical path for the project, meaning the dependencies that need to happen for us to reach our goals, for example, ensuring the building's technical network functions early in the project.
Additionally, it is about conveying the correct information from our subcontractors to Campus Service so they can also operate the building correctly. We create an overview of relevant documents for operations, such as damper and valve settings, and how pumps and radiators are pre-set. If we do not focus on this, there is a risk of losing this information. We must know which documents are necessary to request.

SS: Yes, and the world has changed a bit in the last 5-10 years. The documentation requirements are extensive, and there is more focus on the fact that a majority of buildings are delivered with errors. In this context, performance tests are important because they verify the installations and serve as a baseline for the building's operations. This means everything for DTU. It will cost DTU a lot of time and money if the building does not work when they take over.

In detail

Building 313 (B313) has been executed according to DTU's model for integrated collaboration. Six phases guide the team through the process from idea to move-in. The Cx group has been involved from the start, reviewing drawings and calculations to ensure optimal building operation.

Where have you arrived at a better solution because of the Cx process and collaboration?
JNN: We have continuously reviewed the consultants' material and made changes to things that could have become problematic in operation. Specifically, we changed VISION's ventilation system, which could have had issues with fluctuating temperatures.
We examined the control system as a group and, together with Artelia, modified the system, resulting in better and more stable operation today. During



CTS-system. The maintenance department can monitor the energy consumption and regulate the installations offsite. Photo: DTU

the project review, we determined that the VISION area should be disturbed as little as possible and early on decided to include shut-off valves, allowing the building to be regulated without shutting down the operational areas. Additionally, time was spent ensuring that all our penetrations were completed 100% during partial handovers, so fire seals would not have to be broken later. We also managed to plan to get a supply and temporary network from the neighboring building B310.

SS: VISION is not just the room in the building with the strictest requirements and tolerances; it was also put into use three-quarters of a year before the rest of the building. The success is due to designing the installations for that situation. It turned out really well. The microscope was set up in November, and researchers began their work in January. We were told that there is no better room for a microscope in the Northern Hemisphere. This success was crucial because the microscope is funded by basic research funds, and if they couldn't start on time, the funds would have disappeared.

JG: Another example is the installations in the laboratories in B313. There is a shared CTS (Control and Monitoring System), whereas in B310, it is individual. It was also planned for B313, but now we have central control, so operations can manage it from B409 and monitor energy consumption. This is important for DTU to optimize energy. For example, operations can choose to use ventilation for cooling if it is cold outside.

The Final Test

Before DTU takes over B313 from the contractor, Artelia conducts the final and concluding test of the building's performance.

What needs to be tested?

JG: We closely follow the Building Authority's paradigm for performance tests for the regulation of cooling, heating, and ventilation. During the tests, all installations run at 100%, and we measure whether there is a match between the regulation report and the project. Finally, we conduct a full-scale test to see if the office building can maintain the specified temperature for 24 hours, meaning it can deliver the projected cooling and sustain the heat load in the rooms. Additionally, we perform several step responses, where during the full-scale test, we change the temperature of the cooling or heating system by 5 degrees and see if it stabilizes correctly within a certain time frame. Then we review everything together with the operations team.

What happens after the final test is approved?

SS: Then we conduct the handover process. The building is handed over to operations, and the users move in. I also need to compile a Cx report that summarizes the entire process. It describes the overall Cx requirements, test paradigms, tests, approvals, and the handover to operations with the necessary instructions. This is the final task for the Cx group.

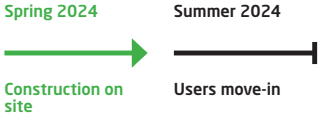
JNN: In the months following, we also perform two 21-day tests: a summer test focusing on cooling and a winter test focusing on heating. We test when the users and equipment are in the building, so it is loaded and in operation. Another part of our commissioning is user training. We instruct the staff on how to operate the building correctly, so they understand the installations and can manage energy consumption as intended. There are many options for user customization; for example, there are many electrical panels. This way, the building is secured for future use without requiring major changes.

Basisinfo

Project status

The building is about to be delivered and the users will move in August 2024

Timeplan



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