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Approval guide for hydrogen refuelling stations

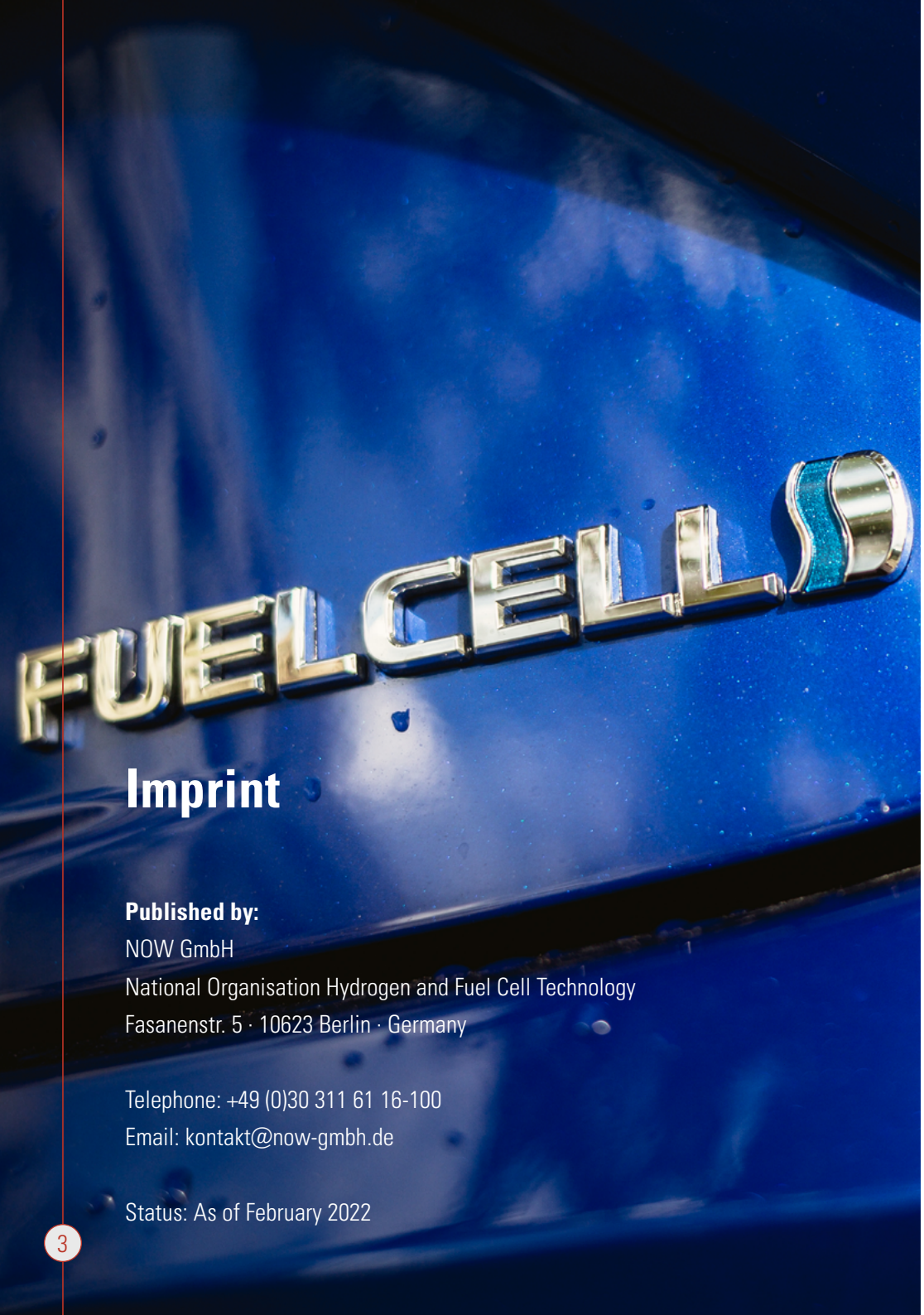
Foreword

Renewably produced hydrogen has the potential to play a central role in successfully achieving the energy transition in Germany and enabling zero carbon mobility. With this guide, we are providing information on the approval process for hydrogen refuelling stations (HRS). The central focus of this brochure are the approval guidelines according to the approval procedure § 18 BetrSichV (German Ordinance on Industrial Safety and Health). It contains in-depth information and summarises best practice experiences. Also included are checklists for relevant documents and expert opinions, information on relevant stakeholders as well as a flow chart of the approval process.

This guide is primarily aimed at investors, service station operators as well as public authorities and monitoring organisations. It is intended to support investors, builders and operators of HRS facilities as well as regional and local authorities in the approval process. It addresses technical, safety-related and regulatory issues. The approval guide focuses on HRS refuelling stations for road vehicles. Publicly usable hydrogen refuelling stations with a maximum H_2 storage tank volume of less than three tonnes of H_2 are considered. The legal requirements for the continued operation of HRS delivery vehicles are not listed in the guide. The filling process of low-pressure HRS tanks is also not covered in this guide.

The guide does, however, take the national regulations for the Federal Republic of Germany into account. Nevertheless, the different regulations in the respective federal states are not dealt with. Existing European or international codes and standards will also be taken into account before the publication of the guide.

The approval guideline aims to support approval procedures for hydrogen refuelling stations. The guide does not claim to be a regulatory document. It was developed in cooperation with authorities and industry partners.
We would like to thank all those involved for their excellent support.



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Introduction

A brief introduction to hydrogen

Hydrogen is the smallest, lightest and simplest element in the universe and bears the chemical designation "H" (Greek Latin: hydrogenium = "water-former"). Hydrogen consists of a negatively charged electron and a positively charged proton. It is the most common element in the universe, but on Earth it occurs almost exclusively in chemically bound form, e.g., in water or hydrocarbons such as natural gas and biomass. Pure hydrogen always occurs in pairs (H_2) and is produced either in gaseous form (CGH_2, CG for "compressed gaseous"), as a combination of compressed and cooled hydrogen (CcH_2) or as liquid LH_2 ("L" for liquid). Hydrogen can be released using energy and thus become both an energy storage medium and an energy carrier. In combination with oxygen, CGH_2, CcH_2 and LH_2 react to form pure water. Of all fuels, hydrogen has the highest energy density by mass. One kg of hydrogen contains as much energy as 2.8 kg of petrol.

Hydrogen refuelling stations (HRS)

According to the Alternative Fuels Infrastructure Directive 2019/94/EU of the European Parliament and of the Council of 22 October 2014 (AFID) and the currently valid delegated regulation (EU) 2019/1745 supplementing AFID 2014/94, the following terms are applicable in the sense of the directives, as well as the European standards of CEN mentioned therein, in brief:

1. A "hydrogen refuelling station" is a gas filling station for the refuelling motor vehicles with hydrogen
2. "Publicly accessible hydrogen refuelling stations" refers to those hydrogen refuelling stations to which all users from the European Union have access on a non-discriminatory basis
3. "Motor vehicles" denote hydrogen powered motor vehicles, including fuel cell vehicles

Provision of gaseous hydrogen at the refuelling station as a fuel

Hydrogen can be stored in three different forms:

Liquefied hydrogen (LH_2)	At a temperature of - 253 °C and a pressure of 16.5 bar
Cryocompressed hydrogen CcH_2	Cryocompressed hydrogen is cooled down to temperatures not far from the critical temperature, but still remains gaseous
Compressed gaseous hydrogen (CGH_2)	At a temperature of + 20 °C and a pressure of 350 bar
	At a temperature of - 40 °C and a pressure of 700 bar

At present, the HRS infrastructure in Germany is based on the storage form of gaseous hydrogen CGH_2. A pressure level of 700 bar is primarily preferred for passenger cars with fuel cell systems. For commercial vehicles such as buses and trucks, which can carry a larger tank, the storage and refuelling of compressed gaseous hydrogen (CGH_2) at a pressure of 350 bar has established itself at this point in time.

Fuel pumps are specifically designed for one pressure level, which means that vehicles with a 350 bar tank cannot be refuelled at 700 bar pumps. Conversely, vehicles with 700 bar tanks should not be refuelled at 350 bar pumps.

Due to the high increase in pressure during compressed gas refuelling, considerable heat is generated during the filling process. For this reason, at refuelling pressures above 350 bar, the gaseous hydrogen is precooled at the H_2 refuelling station and stored at -33 °C to -40 °C where it is used for compressed gas refuelling. In order to protect tank components from overheating, the temperatures in the tanks of the fuel cell vehicles must not rise above 85 °C. Further information on this can be found in the refuelling protocol SAE J2601 for light duty vehicle fueling or EN 17127 and ISO 19880-1 for passenger cars and light commercial vehicles.

As there are currently no public LH_2 stations or any CcH_2 filling stations, this guide only refers to gas filling systems for gaseous hydrogen CGH_2 and the approval process required for these in accordance with the German Ordinance on Industrial Safety and Health (BetrSichV) under Section 3 § 18 to No. 3 Approval Procedure.

Refuelling station types

Hydrogen refuelling stations for motor vehicles are essentially categorised according to the way in which the hydrogen is made available on site. Essentially, two types can be distinguished here:

Green hydrogen production may take place at a hydrogen refuelling station:

H_2 gas refuelling station with own production of hydrogen on site (H_2 production refuelling station)	H_2 station with fuel pump, H_2 storage and electrolyser
H_2 gas refuelling station without own production of hydrogen on site (H_2 delivery refuelling station)	H_2 station with fuel pump and H_2 storage; supply by truck (CGH_2, CcH_2 or LH_2) or connection to H_2 gas pipeline

- Via electrolysis with electricity from renewable energies ("green hydrogen")
- Via production from biomass through a certified green thermochemical or biological conversion process ("green hydrogen")

Please note that hydrogen refuelling stations with on-site electrolysis systems are not covered in this guide, as they are not part of the approval guide. For more information on the approval of refuelling stations with on-site electrolysis plants, consult the DVGW website for a detailed guide under Portal Green Approval Guide pursuant to the Federal Immission Control Act.

Portal Green Approval Guide: www.dvgw.de

At delivery refuelling stations, the hydrogen is delivered by tanker truck – as at conventional refuelling stations. It is transported either in gaseous form (200 bar) or, in the case of larger quantities, in liquid form. About 3.5 t of hydrogen can be delivered in a trailer. In the future, the H_2 refuelling stations could also be connected to H_2 gas pipeline networks.

A gaseous HRS consists of the following components:

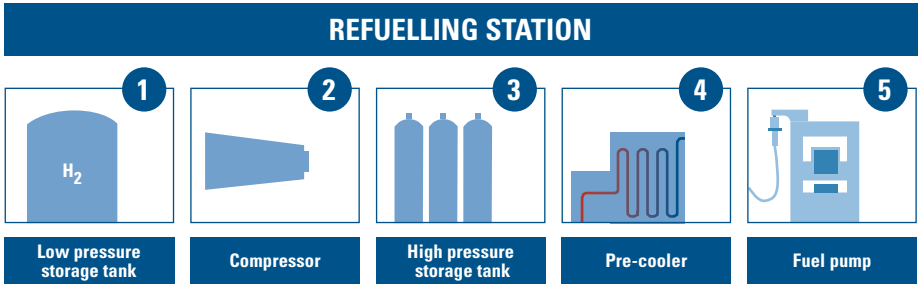


Figure 1: Components of a hydrogen refuelling station

Every hydrogen refuelling station requires equipment for the storage and pre-conditioning (cooling, compression) of gaseous hydrogen (CGH_2) as well as an integrated fuel pump. For the refuelling of 700 bar tanks, the SAE-J2601 standard for fuelling nozzles and communication, EN 17127 and ISO 19880-1 apply worldwide. For the refuelling of 350 bar CGH_2 commercial vehicles, an international standard is currently being developed, which will then be reflected in ISO 19885-3 Gaseous hydrogen – Fueling protocols for hydrogen-fueled vehicles – Part 3: High flow hydrogen fueling protocols for heavy duty road vehicles.

Further information can be found at: **prhyde.eu**

Procedure for the approval of hydrogen refuelling stations

Approval procedure

Parameters relevant to approval according to the storage quantity or on-site electrolysis.

Parameters relevant to approval	Procedure
H_2 storage less > **3 t total storage**	According to the German **Ordinance on Industrial Safety and Health** (BetrSichV – **Betriebssicherheitsverordnung**), Section 3 § 18, **approval required with building permit.** Notes and explanations on implementation can be found in LV 49 of the State Committee on Industrial Safety and Health (LASI – Länderausschuss Arbeitsschutz und Sicherheichstechnik) of 2017.
H_2 storage less **≥ 3 t** and **< 30 t total storage**	**Federal Immission Control Act** (BImSchG – Bundes-Immissionsschutzgesetz) **Simplified procedure**
H_2 storage less **≥ 30 t total storage** and/or **on-site electrolysis on an industrial scale**	According to the **Federal Immission Control Act** (BImSchG) **Formal procedure**
For storage of **> 5 t taking into account other substances** with respective weighting	**Störfall-Verordnung** (12. BImSchG) **Hazardous Incident Ordinance** ("Störfall-Verordnung" – 12th BImSchG).

Figure 2: Approval procedure

H_2 gas filling systems with an H_2 storage capacity of less than three tonnes are classified as natural gas filling systems and generally require a permit. They fall within the scope of the German Ordinance on Industrial Safety and Health (BetrSichV – Betriebssicherheitsverordnung) under section 3 § 18 to No. 3. Notes and explanations for the implementation of the approval procedure can be found in the "LV 49" publication of the State Committee on Industrial Safety and Health (LASI – Länderausschuss Arbeitsschutz und Sicherheichstechnik) of Ocotber 2017.

The LV 49 of the State Committee for Industrial Safety and Health LASI can be found under the following link: **lasi-info.com**

Hydrogen filling stations with H_2 storage of more than three tonnes of hydrogen must be approved in accordance with the BImSchG procedure. The DVGW website contains the approval guideline "Power-to-gas Guidelines for the Integration of Renewable Energies" ("Power-to-Gas-Leitfaden zur Integration Erneuerbarer Energien"), which explain the approval procedures according to the Federal Immission Control Act in detail: **dvgw.de**

Commencement of the approval procedure in accordance with § 18 of the BetrSichV

Prior to drafting the approval application, the applicant and later operator of the facility must first identify the responsible approval authority. The responsible approval authorities differ depending on the federal state and municipality, i.e., different authorities – e.g., trade inspectorate (Gewerbeaufsicht) or state office for the environment – are responsible throughout Germany. In addition, different approval authorities may also be responsible within a region, depending on whether a delivery H_2 refuelling station or a H_2 station is to be approved. Once the approval authority has been identified, it is helpful to maintain regular contact with the authority's contact persons at the working level.

From the applicant's perspective, it is important to first gain an overview of the contents, scope, time and cost duration of a licensing procedure.

Essentially, a distinction must be made between the approval procedure for delivery H_2 refuelling stations and for H_2 stations.

If a delivery H_2 refuelling station is to be planned, established and put into operation, an approval procedure according to the German Ordinance on Industrial Safety and Health (Betriebssicherheitsverordnung) and a building permit procedure according to the State Building Code (Landesbauordnung) must be registered.

If, on the other hand, an H_2 station is planned or if more than three tonnes of H_2 are to be stored at the site, a procedure under the Federal Immission Control Act (BImSchG) and a building permit procedure under the State Building Code are required.

Even in the case of a concentrated procedure according to § 13 BImSchG, a permit for the refuelling station must be applied for in accordance with § 18 of the German Ordinance on Industrial Safety and Health (BetrSichV).

Relevant approval criteria for the implementation of gas filling systems

Other relevant criteria include the design of the gas filling system. Here, a distinction is made not only according to the H_2 storage quantity, but also whether it is a stand-alone or an integrated refuelling station.

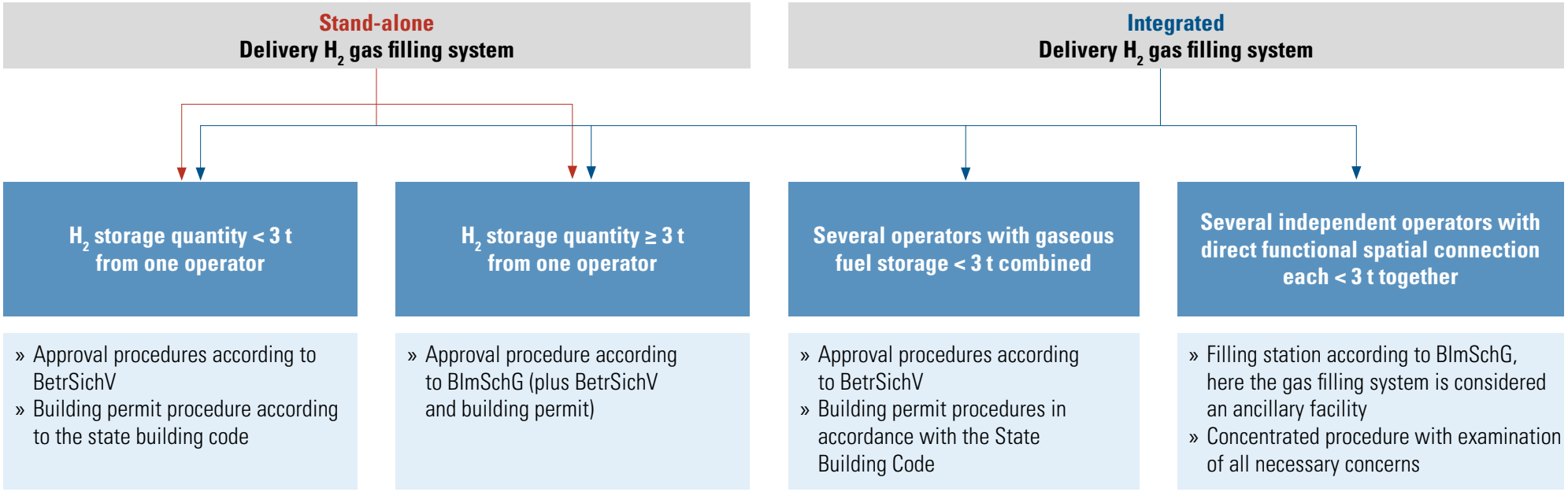


Figure 3: Approval guideline for H_2 gas filling systems

Necessary documentation for the approval procedure according to § 18 BetrSichV

In order to become better acquainted with the framework conditions on site, it is advisable to inform the approval authority in detail about the installation site and its specific conditions. At present, the number of H_2 plants is still limited, so there are few practical reports available from the authorities. It is to be expected that existing standards from other procedures (e.g. natural gas filling stations) can be applied in an adapted form.

The relevant information for an application according to § 18 BetrSichV includes:

- Who is the operator of the hydrogen facility or hydrogen refuelling station?
- Where is the operating site located?
- Who is responsible for operation at the site (existing filling station)?
- Who is the manufacturer of the entire hydrogen refuelling station?
- What is the storage capacity of the facility?
- How high do you estimate the costs of the facility? (This is needed for the assessment of fees according to the state building code)

Among the most important documents and reports are:

- Building application with sketches and building forms (architect)
- Official site plan (surveyor)
- Written informal statement on the use of the property (property owner)
- Structural analysis calculation (structural engineer)
- Fire protection report (independent expert)

In an initial preliminary discussion with the respective approval authority and the building authority, the application documents can be substantiated and their scope and content adapted. In this context, it must be clarified which expert opinions are required and, if applicable, which ones must be commissioned and how and where this can be done.

Installations requiring inspection are generally assessed by the Authorised Inspection Agency (ZÜS – Zugelassene Überwachungsstelle) in accordance with the Ordinance on Industrial Safety and Health (Betriebssicherheitsverordnung). As soon as the required reports from expert have been prepared, these can be submitted to the ZÜS for inspection together with the application for approval and the building application. The ZÜS will subsequently forward a corresponding test report to the applicant.

With this, all the required documents for the application to be submitted are now available. At this point in the approval process it is decided whether it is a concentrated approval procedure or not. If it is a concentrated procedure, it is sufficient to send the application with the building application and expert's report to the responsible approval authority.

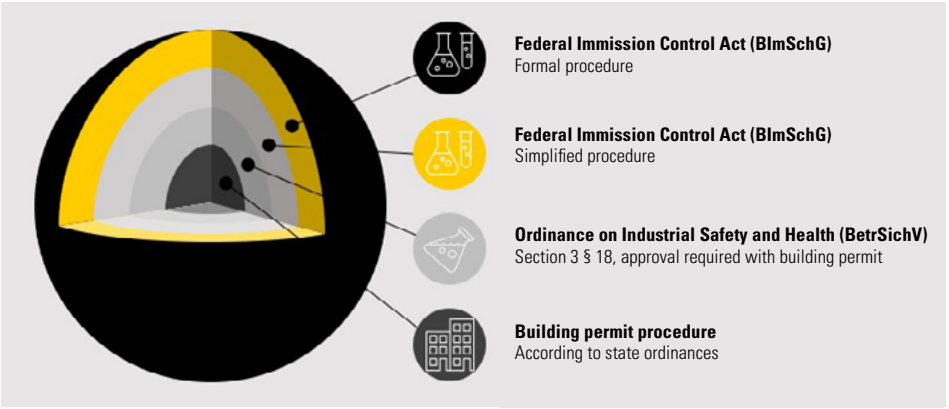


Figure 4: Concentration effect of the procedures

If the application is not a concentrated type, the applicant must submit multiple copies of the application, the building application and the expert's report to both the approval authority and the building authority. For the building authority, a building application is required in accordance with the relevant building regulations.

It is helpful to make a list of the number of copies and their recipients and to mark the individual application copies accordingly. Generally, three copies of the entire application are required: one copy is submitted to the responsible approval authority, one copy goes to the building authority and one remains with the applicant. Last but not least: The application should be signed by the applicant!

Important: Please make sure that you receive confirmation of receipt of your application from the respective offices. This is important as the three-month rule applies from the date of receipt. According to § 75 clause 2 VwGO, the three-month rule states that an authority has at least three months from the date of application to process an application.

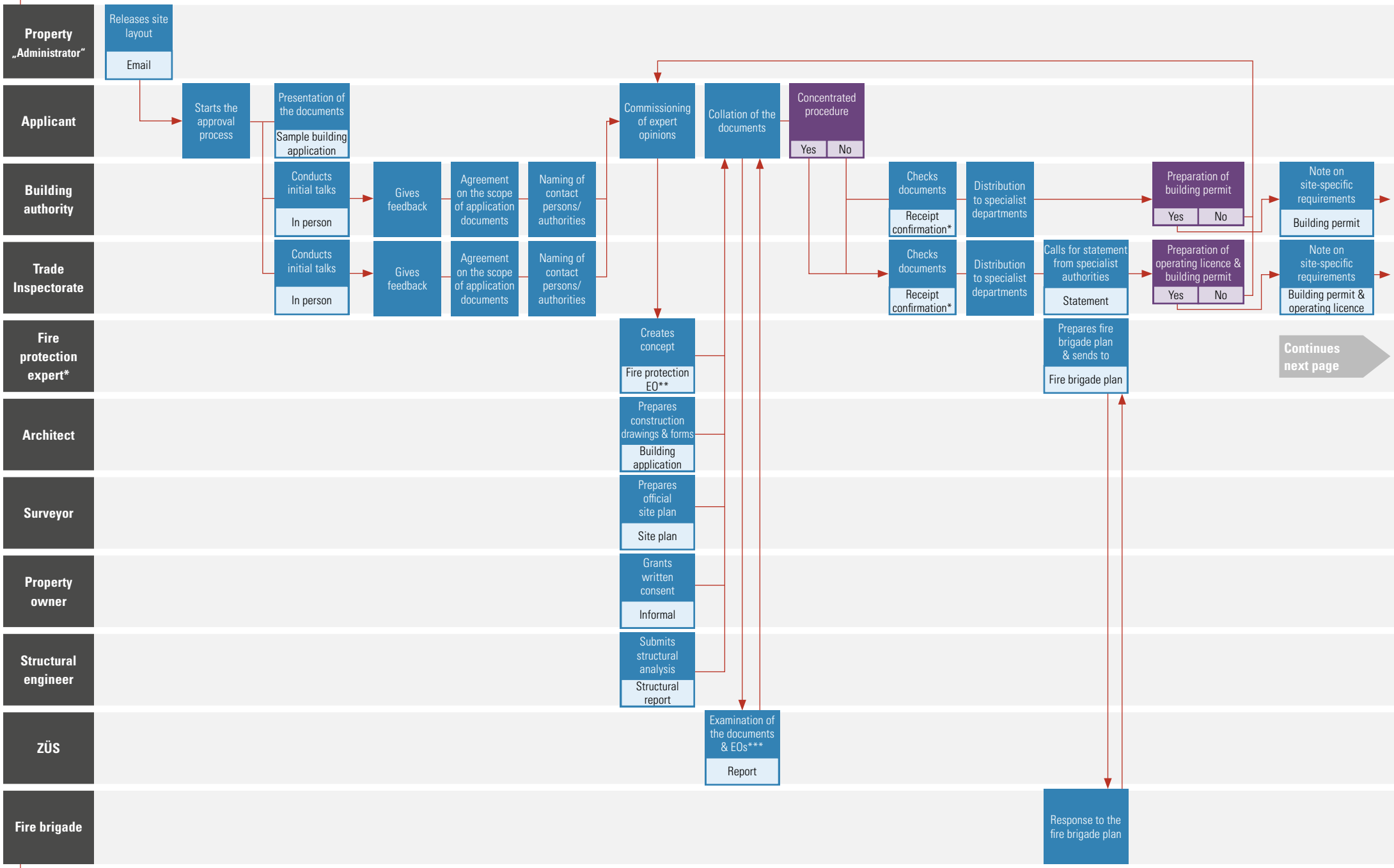
The respective authorities (approval authority and, if applicable, building authority) consult internally with the specialist departments and summarise the results in a statement. In the case of a concentrated procedure, in the event of a positive assessment, the opinions of the authorities are bundled and sent directly to you by the approval authority. This includes the granting of the operating permit and the building permit. In a non-concentrated procedure, the respective approval authority sends the operating permit and the building authority sends the building permit separately.

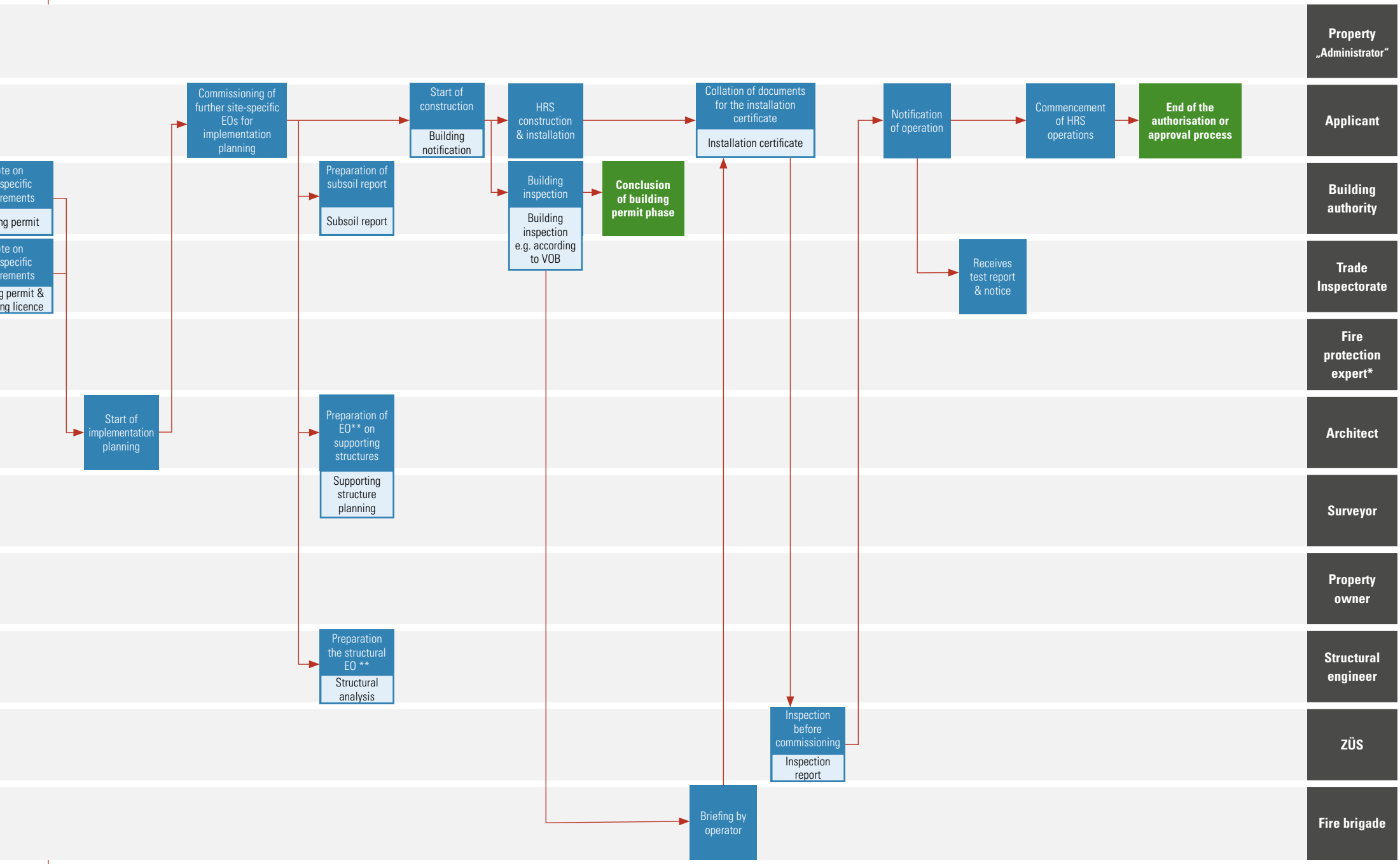
Approval process for a hydrogen refuelling facility

In order to gain a clear insight into the process, the respective steps are explained with the help of a flow chart. It depicts the stakeholders involved (WHO) in grey, DOES WHAT in blue, and WHAT IS NEEDED / WITH WHAT in light blue. The steps of the process are defined in detail over eight stages.

A different authority is responsible for each federal state. In most federal states, the Trade Licensing Office (Gewerbeamt) is responsible for the operating licence, however, in some federal states this is the responsibility of the District Office (Landratsamt) or the Environmental Agency (Umweltamt).
For the sake of simplification, only the Trade Licensing Office is mentioned here as an example. Please check beforehand which office is responsible for the permit.

WHO | DOES WHAT | WITH WHAT | OR


Property „Administrator“
Releases site layout
Email
Applicant
Starts the approval process
Presentation of the documents
Sample building application
Commissioning of expert opinions
Collation of the documents
Concentrated procedure
Yes
No
Building authority
Conducts initial talks
In person
Gives feedback
Agreement on the scope of application documents
Naming of contact persons/ authorities
Checks documents
Receipt confirmation*
Distribution to specialist departments
Preparation of building permit
Yes
No
Note on site-specific requirements
Building permit
Trade Inspectorate
Conducts initial talks
In person
Gives feedback
Agreement on the scope of application documents
Naming of contact persons/ authorities
Checks documents
Receipt confirmation*
Distribution to specialist departments
Calls for statement from specialist authorities
Statement
Preparation of operating licence & building permit
Yes
No
Note on site-specific requirements
Building permit & operating licence
Fire protection expert*
Creates concept
Fire protection EO**
Prepares fire brigade plan & sends to
Fire brigade plan
Continues next page
Architect
Prepares construction drawings & forms
Building application
Surveyor
Prepares official site plan
Site plan
Property owner
Grants written consent
Informal
Structural engineer
Submits structural analysis
Structural report
ZÜS
Examination of the documents & EOs***
Report
Fire brigade
Response to the fire brigade plan
WHO
DOES WHAT
WITH WHAT
OR
* Independent expert
** EO: Expert opinion
*** List of all relevant documents and expert opinions to be submitted to the ZÜS



* Independent expert

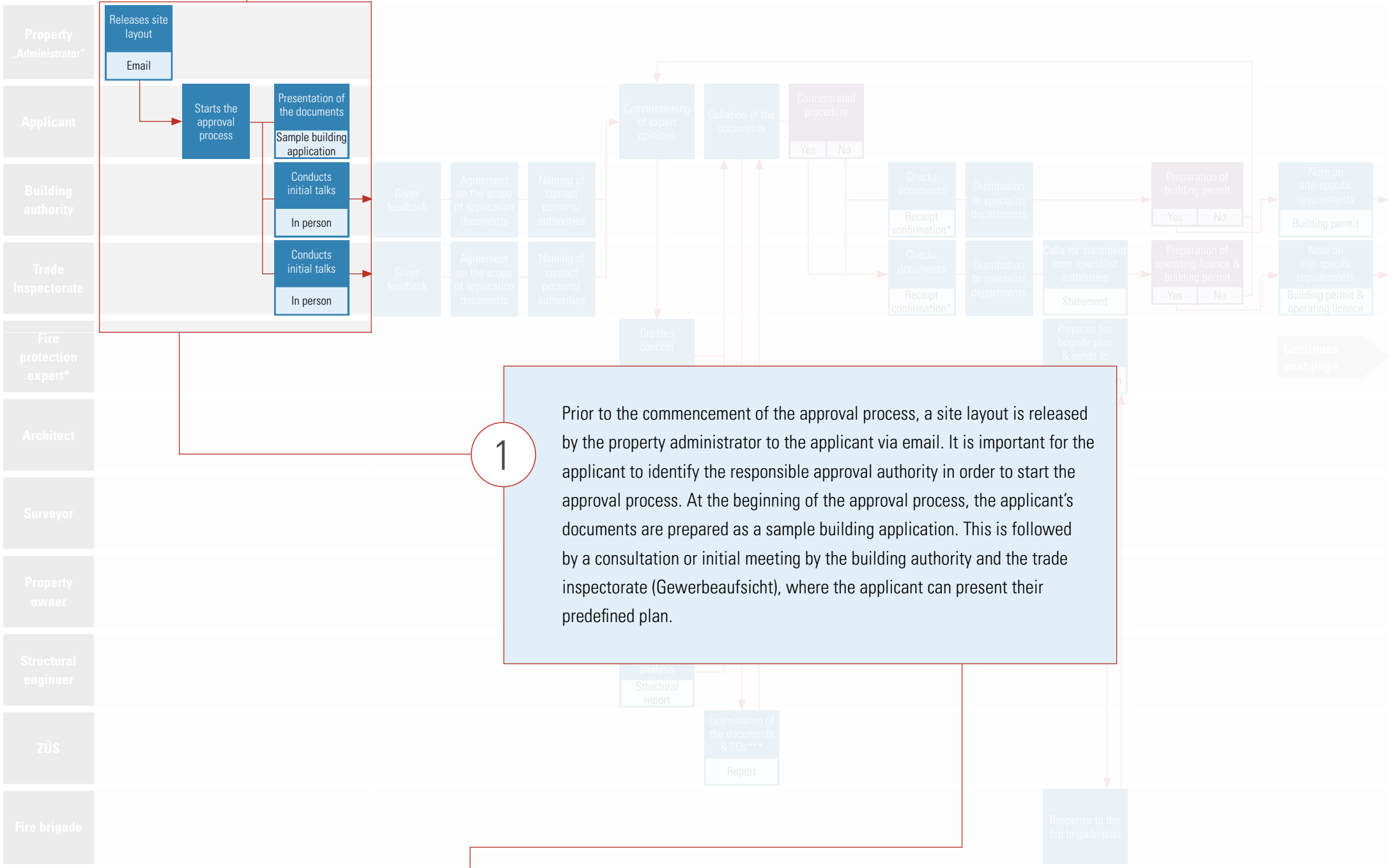
** EO: Expert opinion

*** List of all relevant documents and expert opinions to be submitted to the ZÜS

Approval process for an H_2 refuelling facility

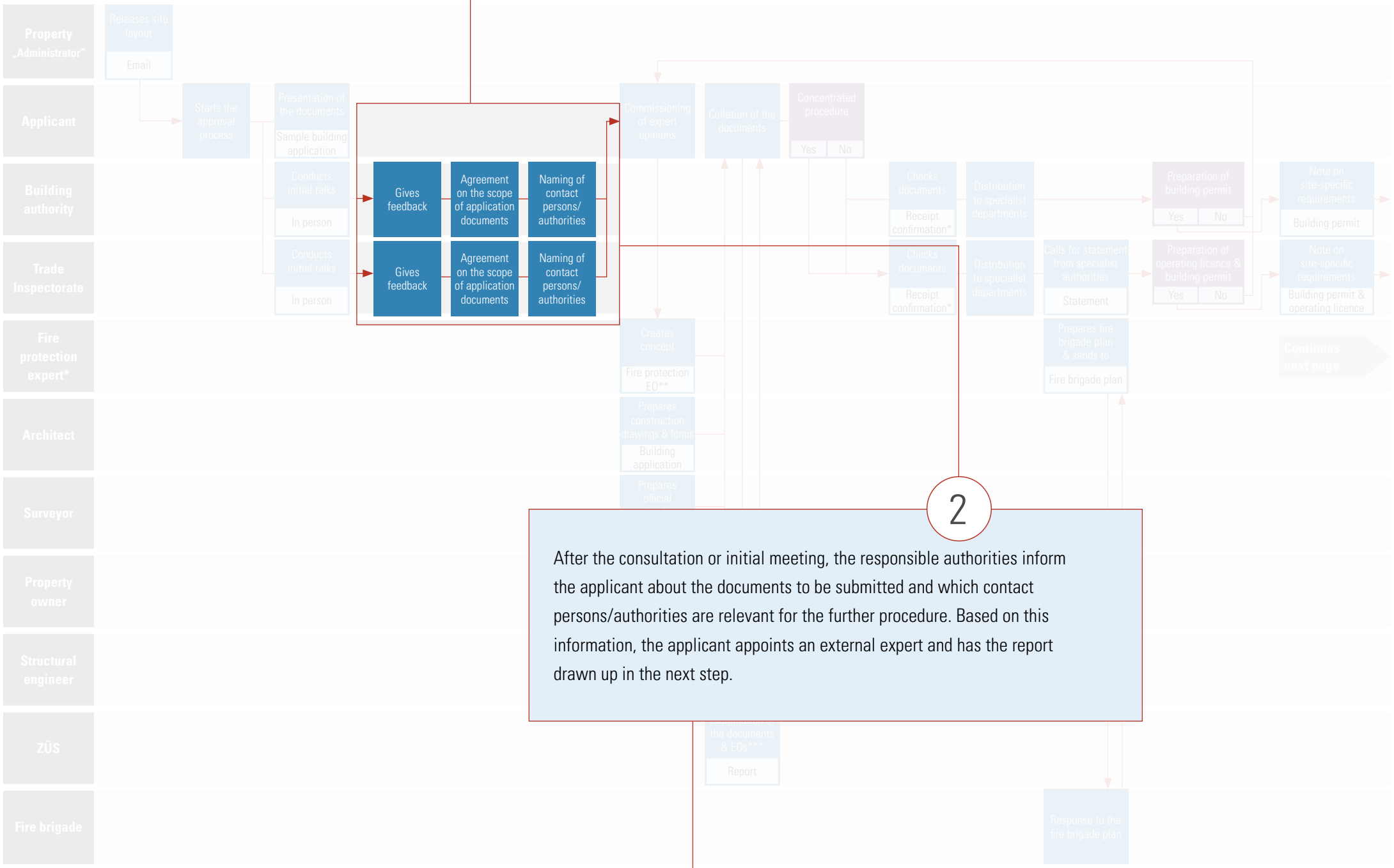
The applicant is the party responsible for the process vis-à-vis the approval authority.
This responsibility includes:

- Initiating the approval procedure
- Advancing the approval procedure
- Completion of the approval procedure



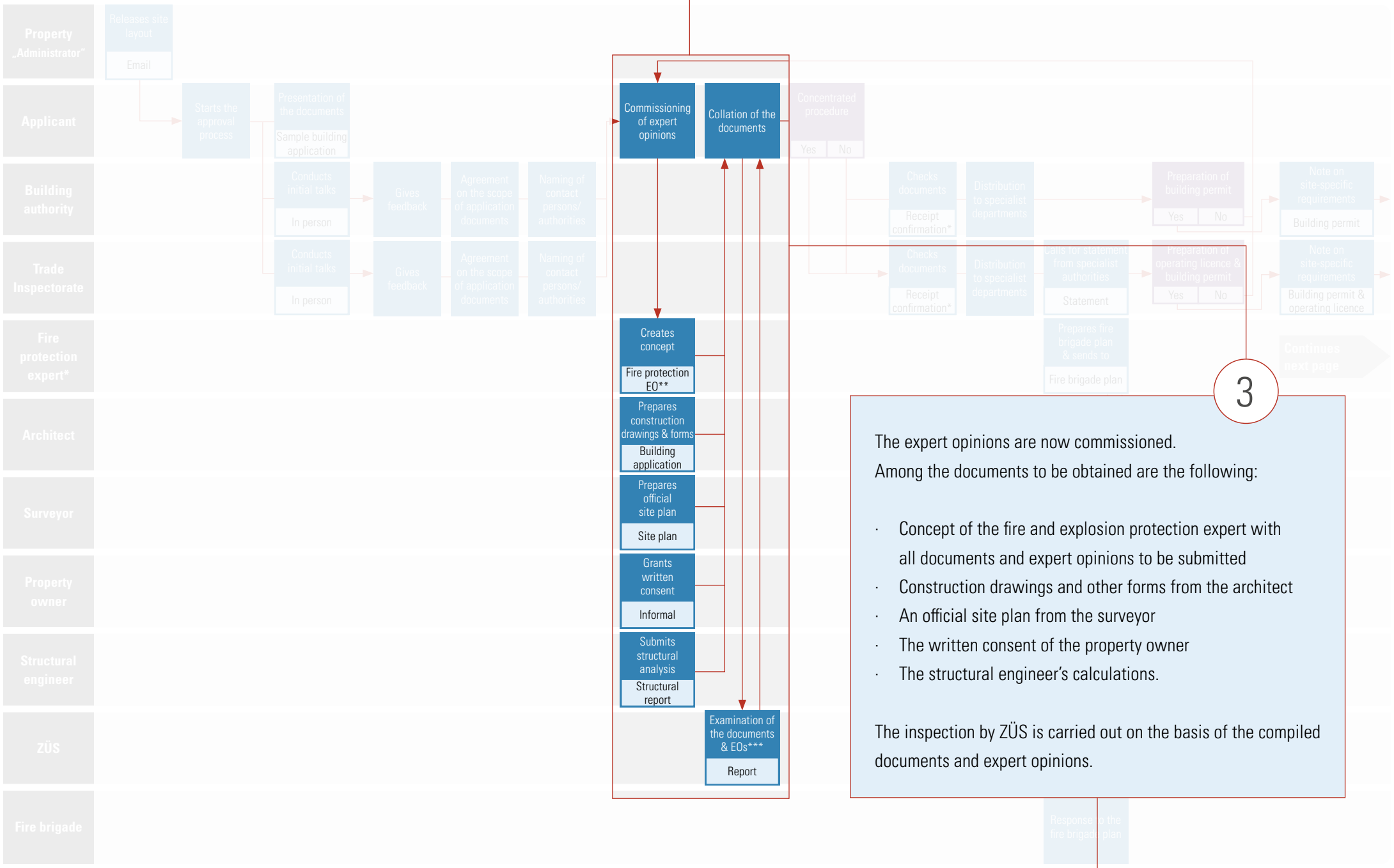
1

Prior to the commencement of the approval process, a site layout is released by the property administrator to the applicant via email. It is important for the applicant to identify the responsible approval authority in order to start the approval process. At the beginning of the approval process, the applicant's documents are prepared as a sample building application. This is followed by a consultation or initial meeting by the building authority and the trade inspectorate (Gewerbeaufsicht), where the applicant can present their predefined plan.



2

After the consultation or initial meeting, the responsible authorities inform the applicant about the documents to be submitted and which contact persons/authorities are relevant for the further procedure. Based on this information, the applicant appoints an external expert and has the report drawn up in the next step.



3

The expert opinions are now commissioned.
Among the documents to be obtained are the following:

- Concept of the fire and explosion protection expert with all documents and expert opinions to be submitted
- Construction drawings and other forms from the architect
- An official site plan from the surveyor
- The written consent of the property owner
- The structural engineer's calculations.

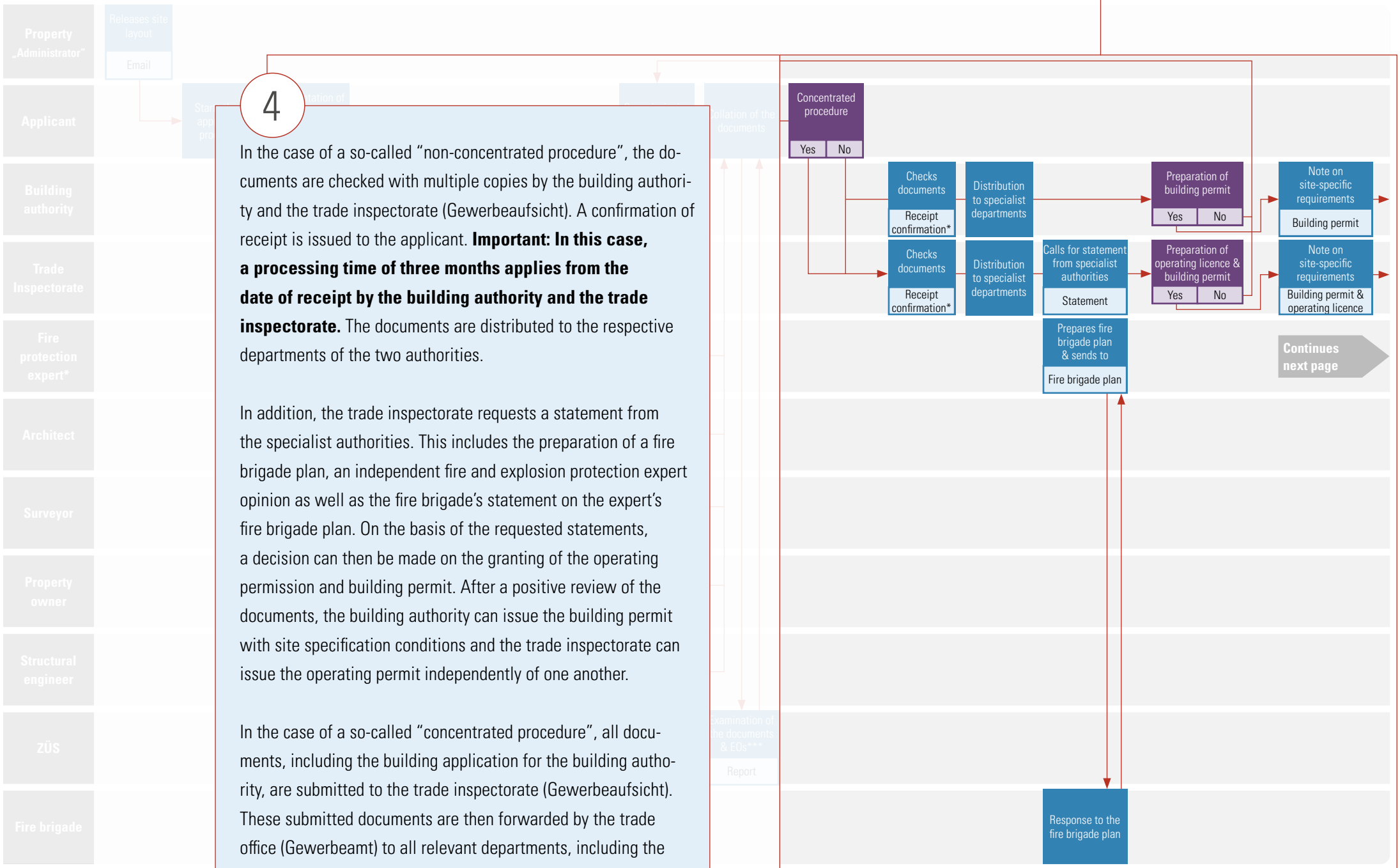
The inspection by ZÜS is carried out on the basis of the compiled documents and expert opinions.

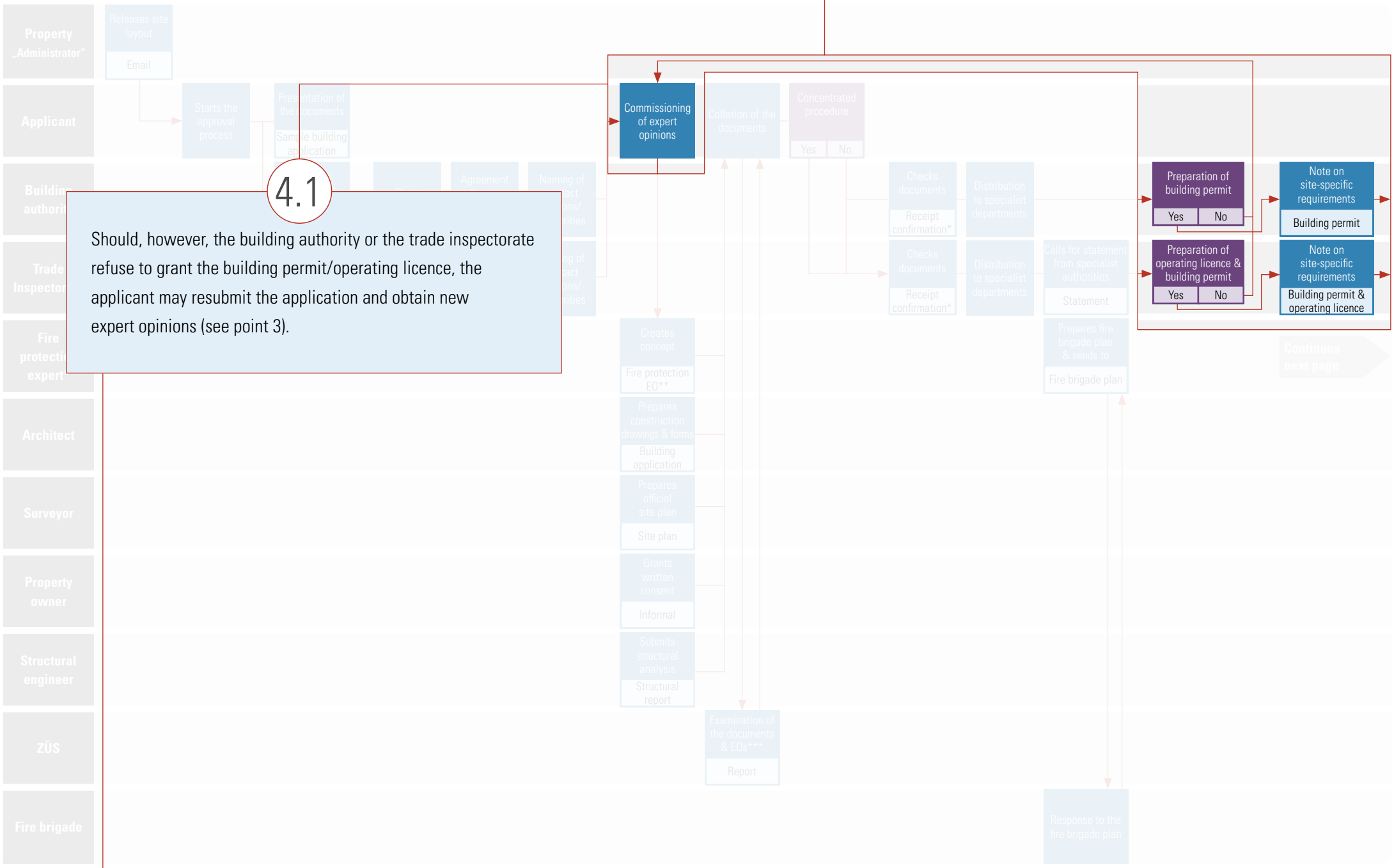
4

In the case of a so-called “non-concentrated procedure”, the documents are checked with multiple copies by the building authority and the trade inspectorate (Gewerbeaufsicht). A confirmation of receipt is issued to the applicant. **Important: In this case, a processing time of three months applies from the date of receipt by the building authority and the trade inspectorate.** The documents are distributed to the respective departments of the two authorities.

In addition, the trade inspectorate requests a statement from the specialist authorities. This includes the preparation of a fire brigade plan, an independent fire and explosion protection expert opinion as well as the fire brigade’s statement on the expert’s fire brigade plan. On the basis of the requested statements, a decision can then be made on the granting of the operating permission and building permit. After a positive review of the documents, the building authority can issue the building permit with site specification conditions and the trade inspectorate can issue the operating permit independently of one another.

In the case of a so-called “concentrated procedure”, all documents, including the building application for the building authority, are submitted to the trade inspectorate (Gewerbeaufsicht). These submitted documents are then forwarded by the trade office (Gewerbeamt) to all relevant departments, including the building authority. The applicant only receives a confirmation of receipt from the trade office.





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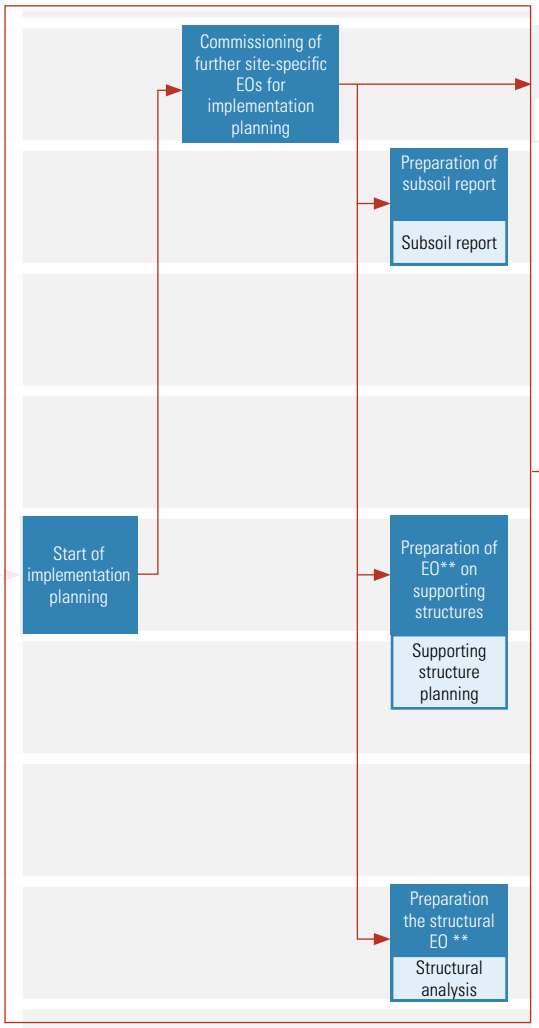
Should, however, the building authority or the trade inspectorate refuse to grant the building permit/operating licence, the applicant may resubmit the application and obtain new expert opinions (see point 3).

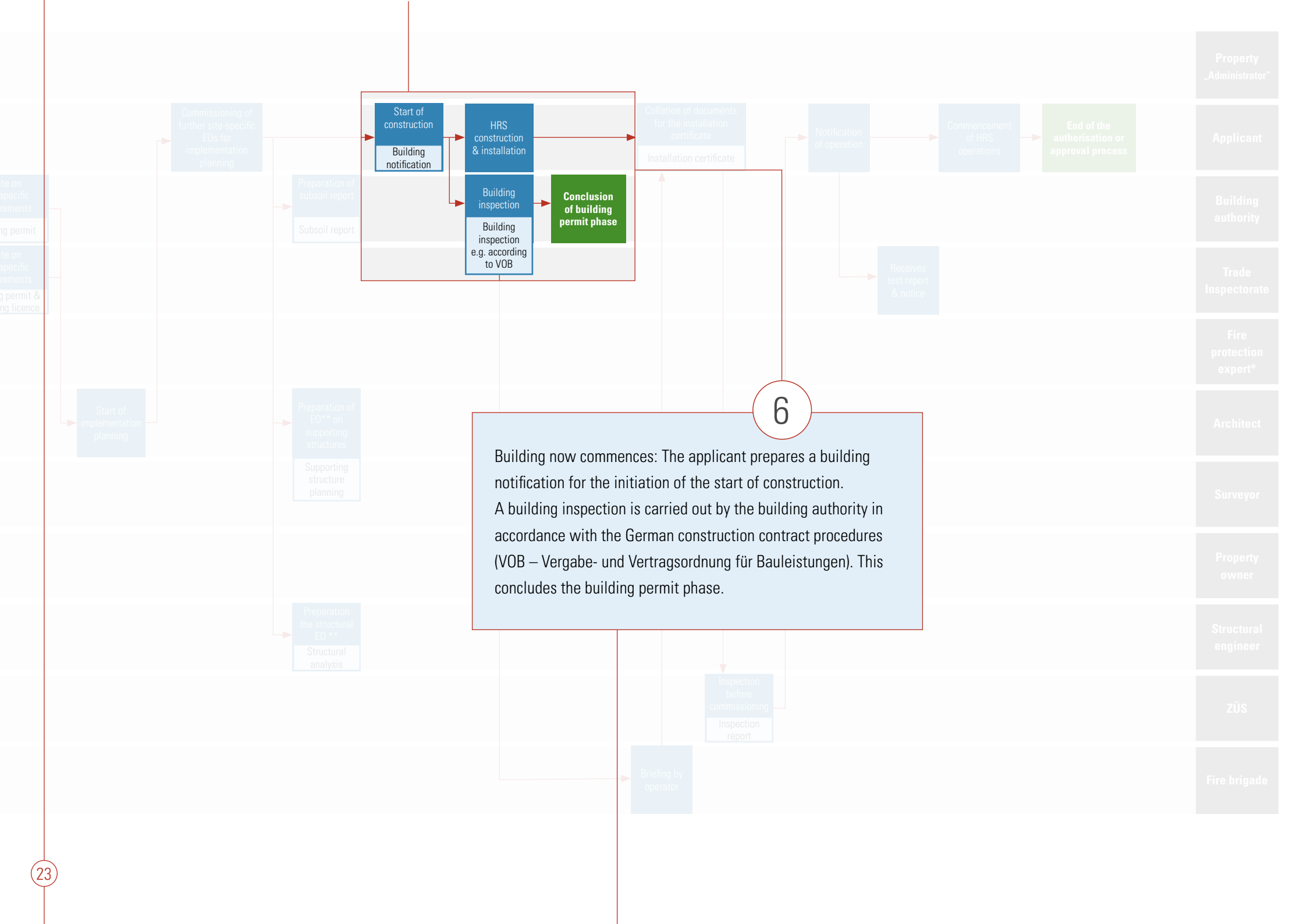


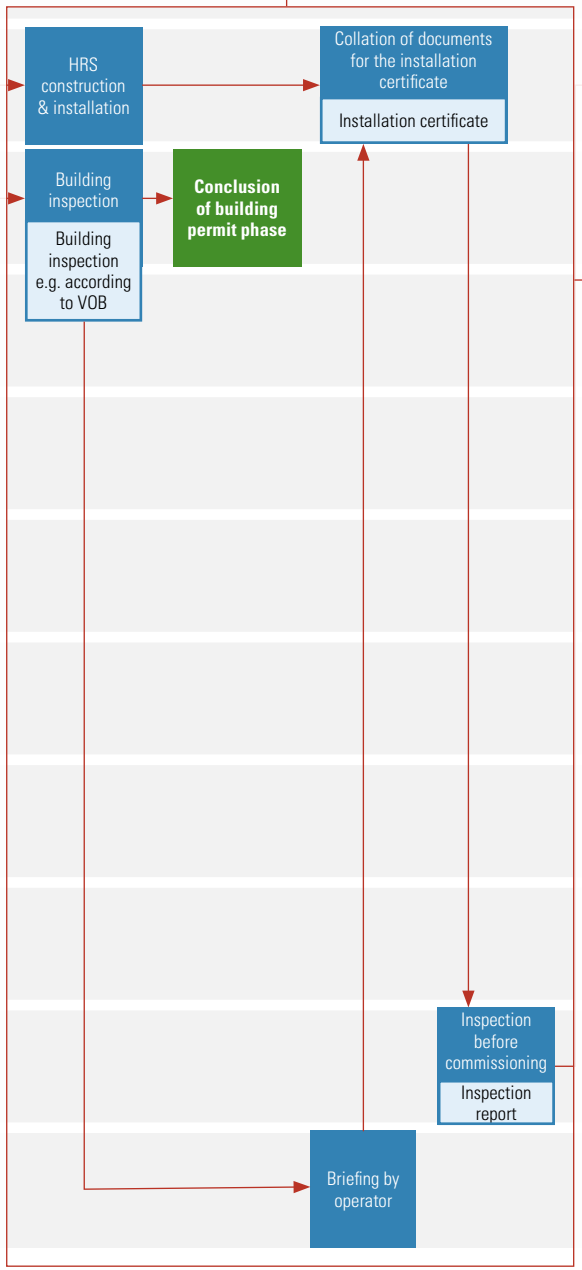
5

The implementation planning is initiated by the architect. The architect instructs the applicant to commission further site-specific expert opinions for the implementation planning.

The following expert opinions are required:

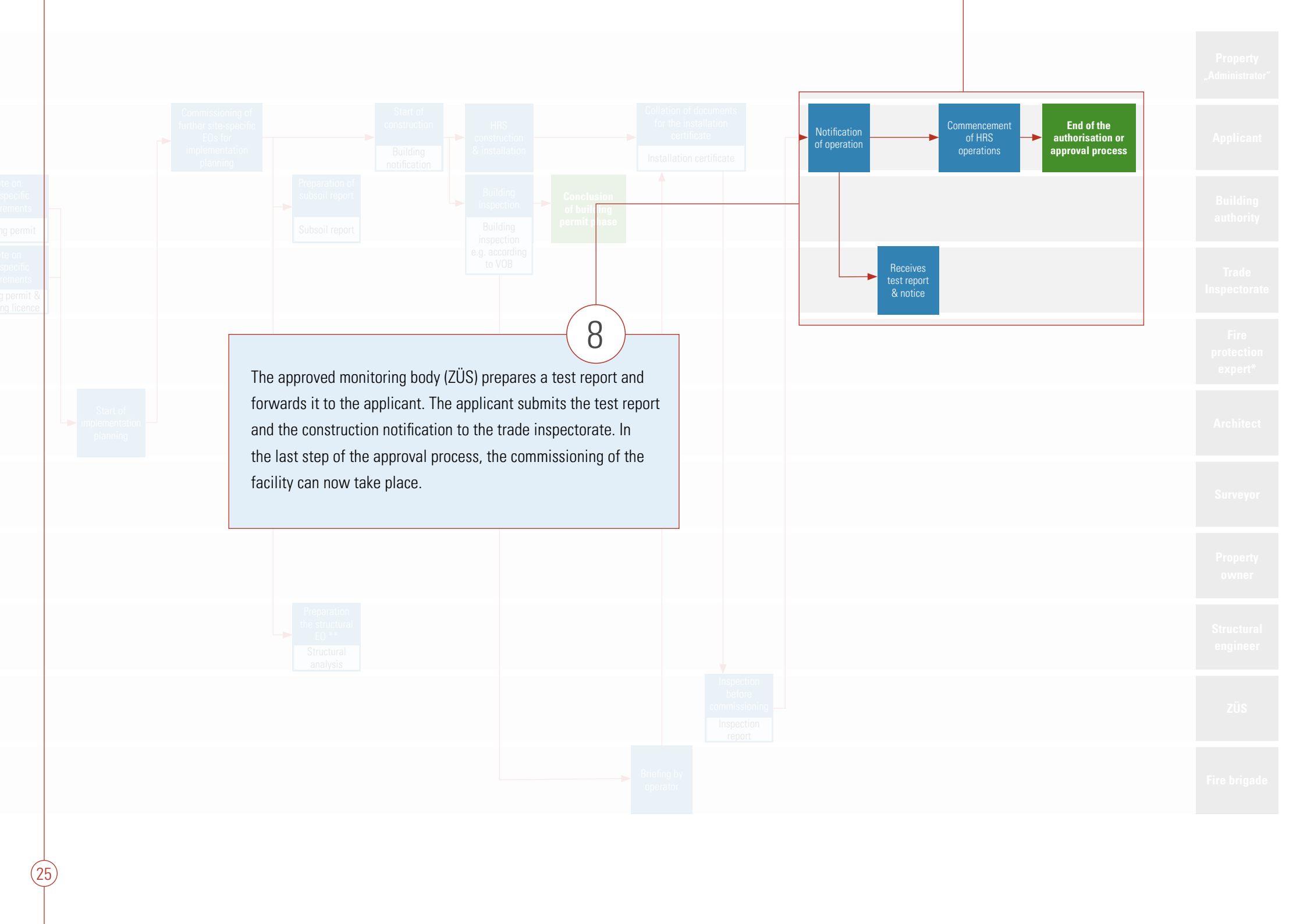
- A subsoil report from the building authority
- An assessment of the supporting structure by the architect
- A test structural analysis report from the structural engineer


Property „Administrator"
Applicant
Building authority
Trade Inspectorate
Fire protection expert*
Architect
Surveyor
Property owner
Structural engineer
ZÜS
Fire brigade
Start of construction
Building notification
HRS construction & installation
Building inspection
Building inspection e.g. according to VOB
Conclusion of building permit phase
Collation of documents for the installation certificate
Installation certificate
Notification of operation
Commencement of HRS operations
End of the authorisation or approval process
Receives test report & notice
Commissioning of further site-specific EOs for implementation planning
Preparation of subsoil report
Subsoil report
Start of implementation planning
Preparation of EO** on supporting structures
Supporting structure planning
Preparation the structural EO **
Structural analysis
Inspection before commissioning
Inspection report
Briefing by operator
6
Building now commences: The applicant prepares a building notification for the initiation of the start of construction.
A building inspection is carried out by the building authority in accordance with the German construction contract procedures (VOB – Vergabe- und Vertragsordnung für Bauleistungen). This concludes the building permit phase.



7

The applicant commissions the construction and installation of the hydrogen refuelling station. Here, a briefing of the fire brigade is conducted by the operator. The documents for the installation certificate are forwarded by the applicant to the ZÜS for inspection before the refuelling station is put into operation.



8

The approved monitoring body (ZÜS) prepares a test report and forwards it to the applicant. The applicant submits the test report and the construction notification to the trade inspectorate. In the last step of the approval process, the commissioning of the facility can now take place.

Appendix

Compressed gas filling systems
Checklist for application documents

General information

- ☐ Operator: Name or company name/organisation and operator's address.
- ☐ Builder: Name or company name/organisation and address of the builder.
- ☐ Operating site: Intended operating site (address)

Points for describing the filling system and the intended mode of operation

- ☐ What are the characteristic features of the filling system (outdoors or indoors, designation/type of compressed gases, type of vessels to be filled, operating procedure during filling)?
- ☐ Output (maximum output of the system)
- ☐ Information on fill level monitoring, which monitoring equipment is provided (scales, pressure gauges)
- ☐ Devices for aeration and deaeration
- ☐ Brief description of the filling system
- ☐ List of filling devices (pumps, dosage equipment, automatic filling machines, number of filling connections)
- ☐ Details of hose and pipe rupture safety devices
- ☐ Information on the monitoring of the installation / surveillance of the filling process in the case of self-service filling stations and those without service personnel.
- ☐ Operating equipment and electrical installations
- ☐ Gas and fire protection information

Conceptual description of the facility

- ☐ Stationary containers, capacity specifications
- ☐ Max. operating pressure
- ☐ Pressurised gas flow during filling/backfilling
- ☐ Pipes (incl. fitting and other equipment)
- ☐ Components of the device to protect against excess pressure (by liquefaction, evaporation, conveyance, discharge, shut-off, switching and securing).
- ☐ Control parts for measuring the quantity of pressurised gas filled into pressurised gas containers
- ☐ Pipes for blowing off, venting and expansion
- ☐ Apparatus for the safe discharge of escaping gases or their destruction
- ☐ Layout plan of the filling installation
- ☐ In the case of filling stations in buildings: construction drawings and construction descriptions
- ☐ Site plan
- ☐ For components of the system that must be placed on the market in accordance with an EU directive, if already known, information on the corresponding conformity assessment procedures (Machinery Directive 2006/42/EC; Pressure Equipment Directive 2014/68/EU, ATEX 94/9/EC for equipment where hazardous explosive atmospheres can arise)
- ☐ Explosion protection concept
- ☐ Test report from an approved inspection body showing that the installation, design and operation of the equipment comply with the requirements of the regulations
- ☐ Total costs incl. applicable value-added tax

List of illustrations

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