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Encapsulation plant at Forsmark

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Summary

SKB has already carried out a preliminary study of an encapsulation plant detached from Clab. This stand-alone encapsulation plant was named FRINK and its assumed siting was the above-ground portion of the final repository, irrespective of the repository's location.

The report previously presented was produced in cooperation with BNFL Engineering Ltd in Manchester and the fuel reception technical solution was examined by Gesellschaft für Nuklear-Service mbH (GNS) in Hannover and by Société Générale pour les Techniques Nouvelles (SGN) in Paris.

This report is an update of the earlier preliminary study report and is based on the assumption that the encapsulation plant and also the final repository will be sited in the Forsmark area.

SKB's main alternative for siting the encapsulation plant is next to Clab. Planning of this facility is ongoing and technical solutions from the planning work have been incorporated in this report. An encapsulation plant placed in proximity to any final repository in Forsmark forms part of the alternative presentation in the application for permission to construct and operate an installation at Clab.

The main technical difference between the planned encapsulation plant at Clab and an encapsulation plant at a final repository at Forsmark is how the fuel is managed and prepared before actual encapsulation. Fuel reception at the encapsulation plant in Forsmark would be dry, i.e. there would be no water-filled pools at the facility. Clab is used for verificatory fuel measurements, sorting and drying of the fuel before transport to Forsmark. This means that Clab will require a measure of rebuilding and supplementary equipment.

In purely technical terms, the prospects for building an encapsulation plant sited at Forsmark are good. A description of the advantages and drawbacks of siting the encapsulation plant at Clab as opposed to any final repository at Forsmark is presented in a separate report.

Contents

1 Introduction

1.1 General

Since the 1970s, SKB has been carrying out research and development work based on the ultimate storage of spent nuclear fuel in the bedrock. The method requires an encapsulation plant in which the spent nuclear fuel is encapsulated in copper canisters before transport down into the rock and a deep rock facility (final repository) for canister deposition.

Irrespective of the location of the final repository, SKB plans to seek a licence to build and operate an encapsulation plant at the Central Interim Storage Facility for Spent Fuel (Clab) on the Simpevarp Peninsula in Oskarshamn. Planning of this installation is ongoing. It has not yet been decided where SKB will apply for a licence to build and operate the final repository. Site surveys are progressing in Oskarshamn and Forsmark.

An encapsulation plant sited in the proximity of any final repository in Forsmark forms part of the alternative presentation in the application and Environmental Impact Assessment (EIA).

A description of the advantages and disadvantages of siting the encapsulation plant at Clab as opposed to any final repository at Forsmark is presented in a separate report.

1.2 Background

An encapsulation plant sited at the final repository was SKB's main alternative up to 1992, when SKB decided on a new encapsulation technique /PLAN 92 1992/ and that operation of the final repository should take place in two stages /Lönnerberg and Pettersson 1998/. The motives for siting the encapsulation plant at Clab were many. One good reason was that deposition in the final repository was to take place in stages and that it could not be excluded that the chosen site would have to be abandoned at the detailed survey stage or after initial operation had been concluded. Construction of and investment in an encapsulation plant at the final repository would then have been a mistake and would need to be repeated at a new site. After 1992, SKB began planning an encapsulation plant to be situated at the Central Interim Storage Facility for Spent Fuel (Clab) on the Simpevarp Peninsula in Oskarshamn. The documentation for an application to build the plant was produced /Gillin 1998/. Since the choice of suitable sites for a final repository had been delayed, this meant that no application to build an encapsulation plant was submitted.

At present an encapsulation plant adjacent to Clab is being planned, and an alternative is presented in the application to build the plant.

1.3 Purpose

The aim of this report is to indicate what is involved in siting an encapsulation plant at any final repository in Forsmark. The report concentrates on descriptions of prerequisites for and conditions during plant lifetime. Activity during the building and phasing-out stages and modifications necessary to the existing transport system for the site chosen are not included in the report.

2 Principal plant data

Capacity:	
Filled copper canisters	200/yr (c 400 tonnes U/yr)
Fuel transports from Clab:	
Four TN17/2 transport casks	BWR: 4 × 17 = 68 or
arriving at Forsmark each week	PWR: 4 × 7 = 28
Work stations for encapsulation of fuel:	
Handling cell	1
Inerting station	1
Welding station	1
Nondestructive testing station	1
Machining station	1
Measurement and decontamination station	1
Shielded frames:	
Shielded frames for copper canister	7
Store for transport cask and its transport frame:	
Positions for TN17s lying on transport frames	10
Electricity supply:	
Connections to external grid	2
Local power source (diesel unit)	2
Diesel unit rated output	500 kW

3 Safety requirements and prerequisites for design

3.1 General safety aspects of the encapsulation plant in Forsmark

The safety aspects that control the design of the encapsulation plant are the safety of persons in the vicinity of the plant and personnel safety.

The total quantity of activity in the encapsulation plant is small and is bound within the fuel. Before the spent fuel is taken to the encapsulation plant, it has decayed for about 30 years, by which time the radioactivity of the fuel has diminished considerably. Of the gaseous fission products in the fuel, Kr-85 is more or less the only one that remains. This is an advantage in terms of environmental safety, both in normal operation and in possible mishaps.

Before licensing of the encapsulation plant, a criticality analysis will take place to show that the fuel can always be handled in a safe, subcritical manner. The critical safety of the plant must always be achievable with a wide margin.

The ventilation system in the handling cell, where the fuel elements are handled dry and without enclosure, is provided with HEPA (High-Efficiency Particulate Arresting) filters to prevent the spread of radioactive particles. To further reduce the risk of such spread, there is negative pressure in the handling cell. If fuel damage should occur in the canister, the consequences to the environment would be very moderate because of the lack of effective mechanisms for spreading activity from spent nuclear fuel enclosed in copper canisters.

In designing the plant, attention has been paid to the principle that people must be allowed to make errors without this leading to serious consequences for the environment, personnel and plant.

The various types of safety measure that apply to nuclear power stations, in particular automatic safety systems and consequence-reducing systems, are not justified in the encapsulation plant because of the slower development of mishaps. The safety level of the plant may be compared with that of Clab.

3.2 Prerequisites for plant construction and operation

The encapsulation plant shall be of a high degree of functionality and operating accessibility so that copper canisters can be delivered at the same rate as the planned deposition in the final repository. Insofar, as safety permits, visitors should be able to observe the operation of the plant.

Clab is to be used for verificatory gamma measurements and sorting and drying of spent fuel before it is transported to the encapsulation plant. This means that Clab will require a measure of rebuilding and supplementary equipment. Operating logistics must be modified to deal with the expanded activity at the plant. It is assumed that the nuclear power stations will be in operation, which means that spent fuel will be continually arriving at Clab.

Spent nuclear fuel will be received from Clab at the encapsulation plant. The fuel is to be encapsulated in copper canisters for onward transport to the final repository. The plant shall be capable of receiving empty copper canisters, handling them and filling them with spent fuel, and subsequently sealing and monitoring them.

The plant shall be capable to produce c 200 canisters with fuel annually, handling them only during normal working hours (8-hour day).

It is intended that four transport casks of fuel will arrive at the encapsulation plant once a week. The plant shall maintain a production rate of one filled copper canister per working day. In the buffer store in the handling cell, there is space for one week's canister production (i.e. 60 BWR elements or 20 PWR elements). The buffer store comprises 60 fuel positions, of which 20 positions may be used for both BWR and PWR fuel. 40 positions are for BWR fuel only. Encapsulation of fuel will take place in cycles, i.e. alternate handling of BWR fuel and PWR fuel. An encapsulation cycle of BWR or PWR fuel should not be shorter than two working weeks.

It must also be possible to open copper canisters and empty them of fuel if sealing is unsuccessful.

The plant must be able to prepare copper canisters to the high quality requirements required for the long-term safety of the final repository. The requirements posed apply to such matters as the atmosphere in the insert and sealing of the canister.

The encapsulation plant shall be designed to handle all the fuel types interim-stored at Clab. It must be possible to handle transport casks of fuel and filled copper canisters in the dispatch hall.

The radiation protection in the encapsulation plant shall be designed in accordance with the principles that apply to nuclear installations. The plant shall be designed so that the average individual dose of the personnel does not exceed 5 mSv per annum.

Radioactive waste from the encapsulation plant shall be managed and treated so that it can be safely transported to Clab where it will be dealt with by existing waste facilities. Liquid radioactive waste from the plant will be treated in an evaporation plant, the concentrate being transported to Clab.

It is essential for construction of the plant that the rebuilding needed at Clab can be done while maintaining safety and operation.

It is assumed that transport to and from the encapsulation plant will be by terminal vehicles and vessels.

3.3 Radiation protection

The Swedish radiation protection regulations that apply to nuclear plants also apply to the encapsulation plant. The radiation protection regulations are based on the recommendations of the International Commission on Radiological Protection (ICRP). The ALARA (As Low As Reasonably Achievable) principle shall be applied, i.e. radiation doses shall be minimised. This means that a separate radiation protection programme will be created, which in addition to ongoing operation will also include strategies for the long-term radiation protection of personnel. The programme shall be well known at all levels within the organisation.

3.4 Functional requirements

3.4.1 General

The nuclear requirements that are to form the basis of design, dimensioning, construction, safety reporting and operation of the plant are to be found in SKI (Swedish Nuclear Power Inspectorate) regulations.

3.4.2 Separation requirements

There is no general requirement for separation in the encapsulation plant. However, fire protection requirements require that stand-by equipment should be separated in certain cases. Such a separation is to apply to both component installation and electricity and control systems.

In the case of cable runs it shall be possible to replace a disabled cable section within 72 hours of a mishap, so that no separation is required if the function can be dispensed with for this period without affecting safety.

Based on current fire-load density, separation of components should take the form of distance separation or placement of components in separated fire cells. In distance separation of components, a distance of one metre is considered sufficient to prevent the spread of fire. There are no separation requirements for cables within respective subs.

3.4.3 Power supply

The power supply of the encapsulation plant shall be divided into two parts (A- and B-sub), both connected to the mains. In the event of a fault in one feed channel, switch-over shall be possible so that the plant can be supplied with electrical power from the remaining feed channel.

If power fails, the fuel must be able to remain in the plant without risk that it will be damaged. However, access to electrical power is essential to provide good plant availability, maintain controlled ventilation and reduce the probability that minor incidents will lead to consequences for the internal safety of the plant. Because of this, certain requirements apply to the plant's power supply as follows.

If both the ordinary feed channels are lost, the plant's diesel generators are to supply certain objects with power to the extent needed so that ongoing work can be concluded and the plant put into a safe condition. Power supply from the diesel generators shall also guarantee that an acceptable environment can be maintained in the plant. Alarm and communication systems, emergency lighting and stack monitoring shall also be supplied with power by these generators if mains power is lost.

Central control systems and certain surveillance equipment shall be available immediately after mains power loss. This equipment shall therefore be supplied by battery backed systems.

Emergency lighting in the control room is to be supplied by independent local batteries.

3.4.4 Equipment for measurement and supervision

From the environmental point of view it is important to check whether any activity is leaving the plant with the ventilation air. Activity meters shall therefore be fitted to exhaust air ducts from spaces where airborne activity may occur. The exhaust air ducts in the ventilation systems are to converge in the ventilation stack from which the air is released to the environment. Central activity measurement equipment is to be installed in the stack.

For personal safety, it is important to measure the radioactive emissions at the points in the plant where faults may lead to elevated radiation levels.

The spaces in which high radiation levels may occur (e.g. in the handling cell, inerting station, welding station, nondestructive testing station and machining station) shall be provided with interlocking devices that prevent personnel from opening the door to the space at excessive levels. If the detecting capacity of the measurement equipment fails or is reduced, a low-level alarm shall be triggered.

3.4.5 Ventilation system

So that airborne activity discharge from the plant can be determined, it is essential that all ventilation air leaves the plant through the ventilation stack containing the activity measurement equipment. The ventilation system for controlled areas should therefore be designed so that negative pressure against the environment is maintained in the event of any fan failure. For example, the above requirements mean that the exhaust air fans should be duplicated (2 × 50%) and connected to a diesel-secured power supply.

At certain places there is a pronounced risk that airborne activity may be spread to spaces in the plant. In this type of space there should be connections to a local extraction system. This shall be provided with duplicated fans (2 × 100%) which should be connected to a diesel-secured power supply.

To reduce the risk of activity spread in the plant, the ventilation should be directive with an air flow from potential less active areas to potential more active areas. The handling cell (in which the fuel elements are handled dry) shall also have a HEPA filter to prevent the dissemination of radioactive particles.

3.4.6 Hoisting devices

Dropped fuel elements constitute a risk of the release of airborne activity. Dropped transport casks or dropped copper canisters may lead to substantial consequences for the plant with damage to buildings, transport casks and canisters, even if fuel is not damaged. Hoisting devices used for these loads shall therefore be designed for a high level of safety to prevent handling mishaps.

Hoisting devices that use line systems, hydraulic systems or screw jacks should be used to handle fuel. Line hoisting devices shall be equipped with duplicate line systems and brakes. Hydraulic hoists shall be fitted with pressure and flow valves for normal braking. There should also be break away valves that close and prevent involuntary movements in the event of major hydraulic system leakage.

All hoists for fuel and copper canisters shall be designed so that handling can be concluded in a safe position even if the ordinary power supply fails during a lift.

3.5 Quality requirements

The plant shall be classified as regards quality, safety and functional class in accordance with the requirements that apply to nuclear plants.

In principle the encapsulation plant shall form part of seismic class N, which means that buildings and equipment are not designed for earthquakes. However, excepted from this are the components and parts of the building that may increase the risk of activity spreading if they fail. Among these (seismic class P) are bogies with fuel transport casks, shielded frames and handling cells with buffer store and overhead crane.

3.6 Safeguards

The encapsulation plant shall comply with the requirements posed of safeguards by both Swedish and international control authorities, i.e. SKI, Euratom and IAEA.

The fundamental principle of the safety system in the plant shall be that sufficient information shall always be available on the inventory of fissile material. The safeguards reporting shall include specification of how the nuclear fuel is handled within the plant and information about fuel quantity, position and identification.

Space shall be allocated for safeguards equipment when the plant is designed. Possible equipment for installation shall include fuel measurement equipment, cameras and radiation monitoring instruments. It shall be possible to furnish the transport casks with a seal if the supervisory authorities require this.

4 Plant description

4.1 General

A system and design proposal has already been produced by BNFL Engineering Ltd /Havel 2000/. The result of this work forms the basis of the technical part of this report. Where appropriate, the technical solutions have been adapted to ongoing planning for an encapsulation plant sited adjacent to Clab. The plant description below gives the proposed technical solution for an encapsulation plant sited at a possible final repository in Forsmark.

The encapsulation plant layout and encapsulation technique are based on the encapsulation plant at Clab /SKB 2004/. The decisive difference between these two plants is that fuel reception at the Forsmark encapsulation plant is a dry process, i.e. there are no water-filled pools in the plant. All fuel is sorted and dried at Clab before being transported to Forsmark where the actual encapsulation takes place. New infrastructure is created for the plant which is coordinated with the above-ground portion of the final repository and the Forsmark plant. Power and service systems will also be coordinated where possible.

The encapsulation plant consists of a main building which chiefly houses the encapsulation operation including operating and maintenance workshops, electrical power systems, auxiliary systems, changing facilities, offices, staff canteen, laundry, reception and an exhibition for visitors.

4.2 Accommodation area and buildings

The accommodation area is within a fenced enclosure and occupies an area of about 160 × 190 m. The plant is designed to comply with requirements for physical protection against nuclear activity. Vehicle parking is located outside the fence. The plant is made up of one large building, an adjacent garage with workshop and wash hall for vehicles and a store for transport casks and shielded frames. The maximum dimensions of the building are about 105 m long, 80 m wide and 25 m high (excl. ventilation stack), building volume about 160,000 m^3.

4.3 Components of the encapsulation plant

The plant includes a transport air lock, a dispatch hall, a handling cell, a canister handling section, a maintenance section, a power supply section, an auxiliary and service system section, a waste management section and a personnel and visiting section. Facilities also include an adjacent garage and wash hall, and a store for transport casks and shielded frames.

4.3.1 Transport air lock

All incoming and outgoing transports of spent fuel take place via the transport air lock. Transport vehicles can drive into the lock through the gate in the outer wall. The roof of the lock has a sliding door that gives connection to the dispatch hall. In the transport air lock there is a rack for shock absorbers and another rack with bottom adapters for transport casks.

4.3.2 Dispatch hall

The dispatch hall is the largest single space in the plant. Here are handling transport casks for spent fuel, canister transport casks and empty canisters. The main equipment in the hall is a canister control station, a bogie and an air-cushion transporter. A 100-tonne overhead crane is available in the hall. On the same crane console there is also an auxiliary hoist with a maximum capacity of 10 tonnes.

4.3.3 Handling cell

The handling cell (hot cell) is the most complex part of the plant. The cell is secured against earthquakes and is radiation-shielded. All handling in the cell is remote operated, either electrically or by using master slave manipulators. There are two large penetrations in the floor. One constitutes the docking position for transport casks with fuel, the other is the docking position for a copper canister placed in a shielded frame. In the middle of the cell in the floor there is a buffer store for a total of 60 fuel elements, 60 BWR elements or 40 BWR and 20 PWR elements. This buffer store is made up of air-cooled ducts in which the fuel can be stored while waiting for a canister to be docked to the cell. The cell is equipped with an overhead crane for handling fuel elements and transport cask lids.

4.3.4 Transfer corridor

No personnel should spend time in this section of the plant, which is radiation-shielded, other than for maintenance purposes. The canister handling machine constitutes the inward and outward route for both empty and filled copper canisters. The transfer corridor section deals mainly with moving copper canisters in shielded frames on air-cushion transporters. This space houses all the handling stations needed for the sealing of copper canisters, the station for inerting and lifting on of copper lids, the welding station, the nondestructive testing station and the machining station.

4.3.5 Maintenance zone

Maintenance of shielded frames and air-cushion transporters is carried out in a controlled area. Periodic maintenance and service of transport casks for filled copper canisters takes place in a delimited area in the dispatch hall.

4.3.6 Waste management zone

All waste that arises in connection with operation of the plant is divided into different categories. The principal categories are active or inactive waste. Depending on the form of the waste, it is dealt with differently in the plant's waste management zone. In general, solid waste is compressed and liquid contaminated waste is evaporated. The zone contains handling equipment for the filling of various waste vessels which are then transported to Clab where the waste undergoes final processing.

4.3.7 Personnel and visiting zone

Office premises and personnel canteen are provided, together with space for visitors' facilities. The visitors can observe all operations in the dispatch hall via a window from a balcony. The operations at the various canister sealing handling stations are shown with the aid of multimedia.

5 Process and function description

5.1 Encapsulation

Each week four TN17/2 transport casks arrive at the encapsulation plant. The casks are horizontally placed on transport frames. The transport frame is put down into the store to await unloading of the fuel. Only one cask at a time can be handled, and this takes place in the transport air lock. The transport cask's shock absorbers are removed and a bottom adapter is screwed on. Using the main crane, the transport cask is lifted up out of the transport air lock and moved either to the transport cask storage space or to one of the preparation bays in the dispatch hall. In the preparation bay, a ventilation system is connected to ventilate the cask and detect any damaged fuel that may be present. Negative pressure against the environment is maintained to avoid dissemination of airborne activity. The outer lid and ring flange are then dismounted. When the preparations are complete, the cask is moved to a bogie by the main crane. The bogie is moved to a position directly beneath the handling cell. A ventilation system is connected and normal air pressure established in the transport cask. The bogie and cask are now lifted by hydraulic motor up to the floor penetration of the handling cell. Docking is completed by filling a rubber seal with air.

Empty copper canisters arrive at the plant lying in a transport frame which in its turn is placed in transport packaging. Using the main crane, the canister is lifted out of the transport air lock to the control and alignment equipment in the dispatch hall. The canister is checked/examined and fitted with a sleeve and centering equipment.

The copper lid of the canister comes by the same transport as the canister but in separate packaging. The lid is checked in the dispatch hall, after which it is transported to the inerting station.

After quality control, the copper canister is moved into production using the canister handling machine. The canister is placed in a shielded frame which is moved with the aid of air-cushion transporters. The shielded frame is moved to the docking position under the handling cell to which the canister is docked.

At this stage, a filled fuel transport cask and an empty copper canister are docked to the handling cell.

The crane in the handling cell lifts away the floor plug in the penetration to the transport cask and then lowers a protection funnel into position. The inner lid of the transport cask is lifted up and placed in a special rack. The fuel in the transport cask can now be lifted over to a docked copper canister or placed in the buffer store of the handling cell. When the fuel is to be moved to a canister, the steel lid of the insert is first raised by magnets and screw jacks. A guidance and protection plate is then placed over the canister. The fuel element can now be placed in the canister.

Once the canister has been filled with either four PWR elements or twelve BWR elements, the guidance and protection plate is removed and the insert lid is lowered into position. Docking is completed and the shielded frame with the canister is moved to the inerting station.

At the inerting and tightness testing station, the canister is docked from beneath in a similar way as with the handling cell. A robot arm links a connector to the penetration of the steel lid. This connection is first used to vacuum-pump the space inside the insert, which is then filled with argon. Vacuum pumping and argon filling are repeated until the necessary atmospheric quality in the insert has been achieved. The steel lid is tested for tightness. The weld joint surface for the copper lid is then checked.

Having previously been lifted into the station, the copper lid is put in place. At the welding station, the copper canister is docked from beneath in a similar way as with the handling cell. The canister is then sealed using friction stir welding.

Machining and non-destructive weld testing take place in separate stations. A visual inspection is carried out and then the weld joint is tested. Excess material and the weld zone are then machined and final quality control of the weld performed by non-destructive testing. The planned testing methods are X-ray and ultrasound.

Robots are used in the decontamination station to perform smear tests on the outside of the canister to check that it is clean. If decontamination is required, water and remote-controlled brushes are used, after which further smear tests are performed. The external dose rate is also checked before the canister leaves the station.

Canisters are loaded into transport casks by the canister handling machine in a special loading position in the dispatch hall. The canister is lowered into the cask, which is then fitted with a lid. The transport cask, which stands on a bogie, is moved to a platform where the external lid is fitted.

The main crane is used to lift the cask onto a transport frame which is placed in the transport air lock. When the cask is lowered onto the transport frame it is also placed in a horizontal position. Shock absorbers are fitted to the cask, after which a specially-designed terminal vehicle backs in beneath the transport frame and raises it together with the cask. The cask is delivered to the final repository.

If a need should arise to remove non-encapsulated fuel from the encapsulation plant, it may be placed in fuel transport casks and taken back to Clab. In the event of recovery of canisters from the final repository, they must first be opened in the encapsulation plant, after which the fuel can be loaded into fuel transport casks.

5.2 Handling of defective copper canisters

If the weld is rejected during nondestructive testing but contains defects that are considered reparable, the canister is returned to the welding station where it is re-welded. The quality of the weld is then checked again.

When it is not possible to deal with the defect by welding repair, the shielded frame carrying the rejected canister is placed to one side so that normal production is not impeded. Storage spaces for such canisters are available within the plant.

Where appropriate, a defective canister is handled in a special way by cutting open the copper lid in the machining station. After the copper lid has been lifted off, the canister is transported to the handling cell where the inner lid is disconnected and lifted off. The fuel is transferred to the buffer store or a docked transport cask.

The empty canister is moved to the active workshop where the insert is decontaminated and lifted up out of the copper shell. The insert may be reused in a new canister while the copper shell and copper lid are decontaminated and sent for recycling.

The unloaded fuel elements in the handling cell are transferred to a new canister.

At an unloading position in the transport corridor, the canister is lifted by the canister handling machine up from the shielded frame and lowered into the measurement and decontamination station. The sleeve left behind in the shielded frame is lifted (also by the canister handling machine) to a position in the dispatch hall where it is checked and if necessary decontaminated.

5.3 Auxiliary systems, service systems and electrical power systems

Certain systems may be integrated with the final storage facility and the Forsmark plant. The most important systems are floor drainage from controlled areas (system 345), the distribution system for new demineralised water (system 733), the ventilation system for controlled areas (system 742), the compressed air system (system 753) and the gas system for copper canisters (system 756). The most important system group for electricity and power are the ordinary mains (640 system), process network (660 system) and battery backed systems (670 system).

5.4 Control systems

Control systems in the encapsulation plant consist of operating and supervision equipment which is located in the central control room and locally around the plant.

The system consists of a double computer system which has a primary and a secondary computer. The primary computer is normally connected, while the secondary computer is continually updated. In this way, the secondary computer is prepared immediately (automatically or manually) to take over the primary computer function without affecting the operator functions.

The encapsulation plant is monitored and controlled mainly from the central control room. There are work stations in the control room with VDUs and keyboards. The screens show process images of the operated and indicated systems. Equipment in the plant and can be operated and measuring points read from the work stations.

5.5 Waste management

Active waste or contaminated air may occur normally in the following systems. Equipment in the handling cell (system 255), floor drainage from controlled areas (system 345), ventilation systems for controlled areas (system 742), ventilation systems for the buffer store in the handling cell (system 748), ventilation systems for fuel transport casks (system 749).

Active waste that occurs in the encapsulation plant is managed so that it can be transported to Clab, where it receives final treatment. It is assumed that only low and medium active waste will be generated during operation of the plant.

5.5.1 Airborne activity

Airborne activity occurs primarily in the handling cell and the inerting and tightness testing station. Before the air is released from the plant, it must pass through HEPA filters that are incorporated in the ventilation system.

5.5.2 Liquid waste

Liquid active waste is run through a circuit in which solid compounds are accumulated in filters. The solution is heated up a few degrees. The part that is vaporised and separated and condensed out may be returned to the decontamination system. That part of the solution that does not evaporate after a number of cycles is transferred to a 200-litre drum for onward transport to Clab. One 200-litre drum per working day is considered to be maximum production.

5.5.3 Solid waste

Solid operating waste is divided into inactive, low active and medium active waste. Inactive waste is collected in standard containers. Low active waste is handled, treated and packed in the same way as at the nuclear power stations. Medium active waste is packed in standardised concrete moulds. The active waste is then transported to Clab in waste transport containers.

6 Gamma measurement, sorting and drying of fuel at Clab

Fuel reception at the encapsulation plant is to take place under dry conditions, which means that the fuel must be dried before it leaves Clab. To optimise the actual encapsulation work at the plant, the fuel must be sorted on arrival and, if needed, the gamma measurement verification clarified. This too is to take place at Clab before the fuel is transported to the encapsulation plant.

The fuel that is to be encapsulated undergoes several handling stages at Clab before being sent off to the encapsulation plant. The data of every single fuel element is known, but there might be a need of a final verificatory gamma measurement before encapsulation. This is done in the component pool. The fuel element must pass through a number of detectors which meter the fuel. Two sides can be measured at once and measurement takes a total of about ten minutes. The fuel is placed in a storage canister, which is moved to the service pool when it is full. From here, the fuel is lifted over to a fuel transport cask. When the cask is filled, the lid is fitted and it is lifted over to a preparation cell. The water is drained out and a drying system is connected to the cask. Hot air is circulated through the fuel during the night. During the following working day, the dryness in the transport cask is checked, after which the cask is sent to the encapsulation plant. See Appendix 3 "Logistics/time and motion study for fuel management at Clab" and Appendix 4 "Necessary installation modifications at Clab for gamma measurement, sorting and drying of fuel".

7 Transport

Transport aspects are discussed in outline below. There is no amplification of the transport question in this report, since this is being dealt with separately.

7.1 Local transport within the operating area

Within the operating area there is a special transport vehicle for the movement of transport casks lying on transport frames. This type of vehicle is already in use at the nuclear installations.

7.2 Fuel transport

One of the assumptions behind this report is that the same type of fuel transport cask (TN17/2) currently used for fuel transport to Clab will also be used for the transport of fuel from Clab to Forsmark. Since it is assumed that the nuclear power stations will still be in operation, new transport casks must be obtained. On average, four transport casks of fuel will arrive at Forsmark every week.

To reduce the number of transport movements, options for optimising the quantity of fuel that can be transported to the encapsulation plant in each transport cask must be assessed. At an earlier stage of encapsulation plant planning, there were plans to use large transport casks which are available on the market but which are not used in Sweden /PLAN 92 1992/. These accommodate 52 BWR or 19 PWR elements, which may be compared with TN17/2 capacity (17 BWR or 7 PWR elements).

7.3 Copper canister transport

Empty, complete canisters arrive at the encapsulation plant directly from a special canister factory where the copper shell is fitted with a bottom and (like the insert) finally processed, quality-controlled and assembled as a unit. Transport logistics depend on location of canister manufacture amongst other factors, but transport from the factory will probably be by lorry.

The transport cask for filled copper canisters must be radiation-shielded and designed in a way appropriate for its reception at the final repository. Since the encapsulation plant is sited at the final repository, the transport distance will be very short for this type of cask. Transport casks are to be licensed in accordance with the international requirements posed in the IAEA's transport recommendations /Ekendahl and Pettersson 1998/.

8 Personnel requirements

8.1 Clab

Clab shall be used for gamma measurement verification (if necessary) and sorting and drying of spent fuel before it is transported to Forsmark for encapsulation. If five copper canisters are to be prepared per working week, four transport casks each containing seven PWR elements or 17 BWR elements must leave Clab each week. The logistics study shows that this cannot be achieved with an eight-hour working day. Provided that the operation is run in two shifts, there is a good chance of achieving the production target. The personnel requirement at Clab for ordinary encapsulation operations can be specified only roughly at this stage.

Operation (two shifts)	
Technology	1
Handling	4
Transport and maintenance	1
Safeguards	0.25

A total of 6.25 new full-time jobs is needed at Clab for the encapsulation operation.

As the nuclear power stations reach the end of their technical life, the number of fuel transports to Clab will decline. Certain parts of the existing personnel complement will still be needed for the encapsulation operation.

8.2 Encapsulation plant

All operations at the encapsulation plant will be carried out during the daytime.

Operation		*El., instrument and computer maintenance*	
Manager, secretary	2	Manager	1
Shift workers	8	Engineers	2
Technicians/engineers	7	El., inst. and computer technicians	6
Crane operation, transport	5		
Technical support, planning, safeguards	4		

Mech. maintenance		*Rad. protection, chemistry, decontamination*	
Manager	1	Manager	1
Engineers	2	Radiation protection/chemistry	3
Foreman, mechanics	5	Decontamination	3

50 people are required in accordance with the above for operation and maintenance. The number of future appointments in personnel administration, information, construction, storage, purchasing, training, transports, guard duty etc is estimated at 25 full-time jobs, to be coordinated with the operation of the final repository.

9 Mishap analysis

No mishap analysis has been conducted within the framework of this report, since the level is comparable with a preliminary study. However, the analyses carried out during the planning work for the encapsulation plant sited at Clab also apply to a great extent to a plant sited at Forsmark.

10 Conclusions

At an encapsulation plant sited at a possible final repository in Forsmark, all operation would take place during normal working hours (calculated as an eight-hour working day). This requirement is no obstacle. However, the work necessary for encapsulation at Clab must be done in two shifts. The operation requiring most time and personnel at Clab is the verificatory gamma measurement of the fuel if this is needed. The drying also takes a long time but can take place at night and be monitored by Clab's ordinary shift personnel.

In purely technical terms there are good prospects for the construction of an encapsulation plant sited at Forsmark, and this has been confirmed by the two independent companies who have previously examined the proposed technical solution.

The personnel requirement for the daily operation of the encapsulation plant is estimated to be between 70 and 85 full-time jobs.

11 Word and concept definitions

Name	Definition
Cask adapter	The cask adapter is screwed on with twelve screws, using the holes previously used to fix the outer lid of the transport cask.
Lid adapter	The lid adapter is fixed to the lid of the transport cask by eight screws. When the transport cask is moved the lid adapter, and with it the lid, can be locked to the cask adapter.
Bottom adapter	Adapter that is fitted to the bottom of the transport cask after the removal of the shock absorber. The adapter has controls for positioning the transport cask on the bogie.
Bogie	Truck in the dispatch hall for a transport cask with spent fuel.
Handling cell	Radiation-shielded space (hot cell) in which spent fuel is moved from transport cask to copper canister.
Sleeve	The primary function of the sleeve is to act as a hoist for the copper canister throughout the encapsulation process until the canister has been sealed and tested.
Canister handling machine	The canister handling machine consists of a radiation-shielded rotating transport air lock for empty and filled copper canisters between the dispatch hall and the transfer corridor. The machine also includes a lid handler for the canister transport cask.
Transport air lock	Passage for incoming and outgoing transport of transport casks and empty copper canisters. Fitting and removal of shock absorbers and bottom adapters to transport casks takes place here.

12 References

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Appendix 1

System list for the encapsulation plant in Forsmark

1 ACCOMMODATION AREA AND BUILDINGS
11 External installations
113 Roads, open areas, fences
115 Culverts and cable trenches in the ground
117 Lightning arresting equipment

12 Main ground buildings
124 Encapsulation building

14 Other buildings
142 Vehicle workshop and wash hall
144 Entrance security building
148 Handling cell radiation shield doors

18 Penetrations
185 Pipe supports
187 Pipe penetrations
188 Ventilation penetrations

2 EQUIPMENT FOR RECEPTION, HANDLING AND STORAGE
21 Equipment for fuel reception in the encapsulation building
211 Equipment in transport air lock
212 Equipment at storage space for transport casks
213 Transport and handling equipment in the handling hall
215 Equipment in transport cask preparation cell

25 Service and monitoring equipment
255 Handling cell equipment
256 Inerting and tightness testing station equipment
257 Welding station equipment
258 Nondestructive testing station equipment
259 Machining station equipment

26 Transport casks etc
261 Transport casks for fuel
263 Inserts for transport casks
264 Fuel documentation
266 Tools for transport casks
267 Handling equipment for filters and solid waste
269 Transport casks for disposal canisters

27 Disposal containers
278 Disposal canisters

28 Cranes and transport equipment
282 Auxiliary overhead cranes
283 Auxiliary lifting tools
284 Main cranes in encapsulation building
286 Elevators
287 Shielded frames
288 Transporters for shielded frames
289 Tilting equipment and inspection frame

29 Other transport and handling systems
293 Transport and handling equipment for transport casks for disposal canisters
294 Canister handling machine

3 AUXILIARY SYSTEMS
33 Sampling systems
336 System for sampling and analysis

34 Other auxiliary systems
345 Controlled area floor drainage system
347 Laundry equipment

35 Copper canister auxiliary systems
353 Monitoring and decontamination station equipment

37 Systems for treatment of liquid waste
372 Floor drainage water treatment system
375 Water discharge system

4 TRANSPORT SYSTEMS
42 Transport vehicles
421 Terminal vehicles
422 Transport frames

5 CONTROL SYSTEMS
50 Framework for control equipment
506 Network based programmable equipment

51 Common control systems
511 Control panels, tables and desks
512 Software based operator interface
513 Electrical equipment cubicles and cabinets, common cubicles
515 Control cables

52 Computer systems
522 Process computer system

54 Process and handling control
541 Process measurement equipment
542 Process control equipment
543 Process operation system

55 Radiation monitoring
553 Stack radiation monitoring
554 Process system radiation monitoring
555 Radiation monitoring for certain rooms
556 Portable radiation monitors
558 Personnel monitoring system

56 Activity supervision
561 Direct indicating dosimeters

58 Miscellaneous measurement and supervision
584 Seismograph
588 Meteorological measurement equipment

6 ELECTRICAL SYSTEMS
62 High voltage grid connection
620 High voltage grid connection

64 General network
641 General 6.3 kV network
642 6.3 kV network for external power supply
643 General 690 V network
645 400/230 V network for external power supply
646 General 400/230 V network

65 Reserve power equipment
651 Diesel generator system
656 Diesel fuel system

66 Process network
662 Diesel backed process network 660 V
663 Diesel backed process network 400/230 V

67 Battery backed systems
672 110 V DC network
672 24 V DC network
677 400/230 V AC network

68 Electrical power control systems
681 Operating system for electrical power systems
685 Relay protection system
686 Measuring system

69 Cable systems
691 Power cables
692 Cable penetrations
693 Cable trays
694 Internal earthing systems

7 SERVICE SYSTEMS
71 Sea water cooling system
713 Cooling system

72 Secondary cooling systems
723 Closed cooling circuits for general cooling purposes
726 Low temperature cooling system

73 Water treatment and distribution systems
733 Distribution system for new demineralised water

74 Ventilation systems
742 Ventilation system for controlled areas
746 Ventilation system for non-controlled areas
748 Ventilation system for buffer store in handling cell
749 Ventilation system for fuel transport casks

75 Pressurised gas systems
753 Compressed air system
756 Gas system for disposal canisters
758 Other gas systems

76 Fresh water distribution, sewage and drainage systems
761 Tap water distribution system
762 Hot water distribution system
763 Heating system
765 Floor drainage system for uncontrolled areas
766 Sewage water system
768 Groundwater drainage system
769 Roof drainage system

8 MISCELLANEOUS EQUIPMENT
81 Equipment in workshops
811 Equipment in transport cask workshop
812 Equipment in garage
813 Equipment in washing station
814 Equipment in mechanical workshop
815 Equipment in electrical and I&C workshops

82 Miscellaneous equipment
821 Analysis laboratory equipment
825 Special tools and special equipment

83 Lighting and power terminals
831 Indoor lighting system
832 Outdoor lighting system
837 Power terminals

84 Alarm and communication systems
840 Optical fibre transmission
841 Internal telephone and intercom systems
842 National telephone network
843 Alarm system
844 Paging system
845 Public address system
846 Clock system
848 Radio telephone system
849 Internal TV supervision system

86 Fire protection systems
861 Firefighting water system
862 Water sprinkler system
869 Fire alarm system

9 PHYSICAL PROTECTION EQUIPMENT
99 Security systems
990 Supervision and operation
991 Area protection system
992 Passage control system
993 Door locks
994 Physical protection monitoring system
995 Door entrance telephone system
997 Metal detectors

Appendix 2

Process flow chart: fuel route from Clab to final repository

Location	Process	Description
Clab storage section	Fuel transport	Storage canister with fuel element is moved to the fuel hoist and then to the component pool.
Clab component pool	Fuel monitoring	The fuel elements are placed in a storage canister. The fuel elements are lifted out of the canister and metered one at a time.
Clab component pool	Fuel sorting	A storage canister is filled with sorted fuel with a view to optimum decay power for the elements which are to be in the same canister.
Clab service pool	Fuel transfer	The fuel elements are transferred from the storage canister to a fuel transport cask.
Clab preparation cell	Fuel drying	The fuel elements are dried using forced hot air, standing in the fuel transport cask overnight.
Clab	Transport	The transport cask is transported by road and water to the encapsulation plant.
Encapsulation plant	Fuel reception	The transport cask arrives and is placed either in the store or driven into the transport air lock.
Transport air lock	Unloading	The fuel transport cask is driven into the transport air lock. The shock absorbers are removed and bottom adapter fitted.
Preparation bay	Preparation	Ventilation of transport cask. Outer lock and ring flange dismounted.
Transfer corridor	Docking	The transport cask is placed on a bogie. The bogie is raised and the cask docked to the handling cell.
Handling cell	Fuel transfer	The fuel is lifted over from the transport cask to a copper canister that is also docked to the handling cell.
Inerting station	Inerting, tightness testing	Inerting and tightness testing of insert lid. The copper jacket's fusion face is checked and the copper lid put on.
Welding station	Welding	The copper canister is secured in the welding equipment after which the copper lid is welded on using friction stir welding.
OFP station	Nondestructive testing	Ultrasound and X-ray testing of the lid weld.
Machining station	Machining	Machining of fusion face and surplus material.
Measurement and decont. station	Measurement, decontamination	Smear test of outside of copper canister. If necessary, the canister is decontaminated with water and brushes.
Canister handling machine	Copper canister transfer	The finished copper canister is lifted over to a canister transport cask.
Transport air lock	Loading	Shock absorber fitting. The canister transport cask is made ready for transport to the final repository.
Transport air lock	Transport	The transport cask is transported by road and/or rail to the final repository.

Appendix 3

Logistics/time and motion study for fuel management at Clab

Two-shift working hours 07.00–23.00

Place	Operation	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Preparation cell	Dry-filled TC (TN 17/2), leak test		60 min															
Transport air lock	Shock absorbers fitted, outgoing transport			60 min														
Transport air lock	New TC in, shock abs. removed				60 min													
Preparation cell	TC prepared					60 min												
Service pool	TC from preparation cell to service pool					40 min												
Service pool	TC lid removed						45 min											
Service pool	TC filled with 17 BWR													425 min				
Service pool	TC lid fitted														45 min			
Preparation cell	TC from service pool to preparation cell															40 min		
Preparation cell	Drainage, connection of drying equipment																60 min	
Preparation cell	Overnight drying																	480 m.
Preparation cell	Dry-filled TC, leak test		60 min															
Transport air lock	Shock absorbers fitted, outgoing transport			60 min														
Transport air lock	New TC in, shock abs. removed				60 min													
					ETC.													

Component pool — Monitoring, total time/BE 30 min., 17 × 0.5 hrs = 8.5 hrs

Time to measure 17 BWR fuel elements = 8.5 hours

The different colours in the diagram represent the route of individual transport casks (TCs) through CLAB. The times are approximate but in the correct order of size. The example applies to BWR fuel since the handling of this requires more time than PWR fuel. The handling procedures are the same for the different fuel types but the number of BWR elements per transport cask is more than double the number of PWR elements.

Appendix 4

Necessary installation modifications at Clab

General

Encapsulation of fuel will not start before 2017. Traditional handling at Clab (i.e. reception of spent fuel from the nuclear power stations) may have declined by this time, facilitating improved handling logistics at Clab as regards encapsulation operations.

During certain periods, four filled TN17/2 transport casks of spent fuel will arrive at Clab simultaneously. This will occupy the preparation cells for a number of days. It takes 48 hours to empty a transport cask. There are only two operating lines in system 311 (cooling system for transport casks) for the three preparation cells. There are two unloading lines in the pools.

Plant modifications

The existing handling machine for the M03.25 service pool is relatively slow and may therefore need to be upgraded or replaced with a new handling machine.

A new handling machine for handling individual fuel elements must be installed in the M03.29 component pool. Installation of a new handling machine means that the existing 231ZA3 canister (storage canister) handling machine may require partial modification.

The component pool needs an additional six positions for storage canisters (a total of 12 storage canister positions is required). Pool bottom reinforcements exist to some extent. Certain equipment (such as suspension tackle for frameworks and drop protection for 231ZA3) needs to be moved to another pool.

Gamma measurement (fuel monitoring) of the fuel must take place in the component pool. Existing gamma equipment will be replaced with new equipment, to be installed in the middle of the short side of the pool (western side). Monitoring equipment cannot be installed in the service pool because the wall between this pool and the cask pool is already massive on level +107.00. In fact a room is needed on the outside of the water-filled pool where all other monitoring equipment can be accommodated. The existing M02.32 cleaning space will be converted to a measurement equipment room for the new fuel monitoring equipment.

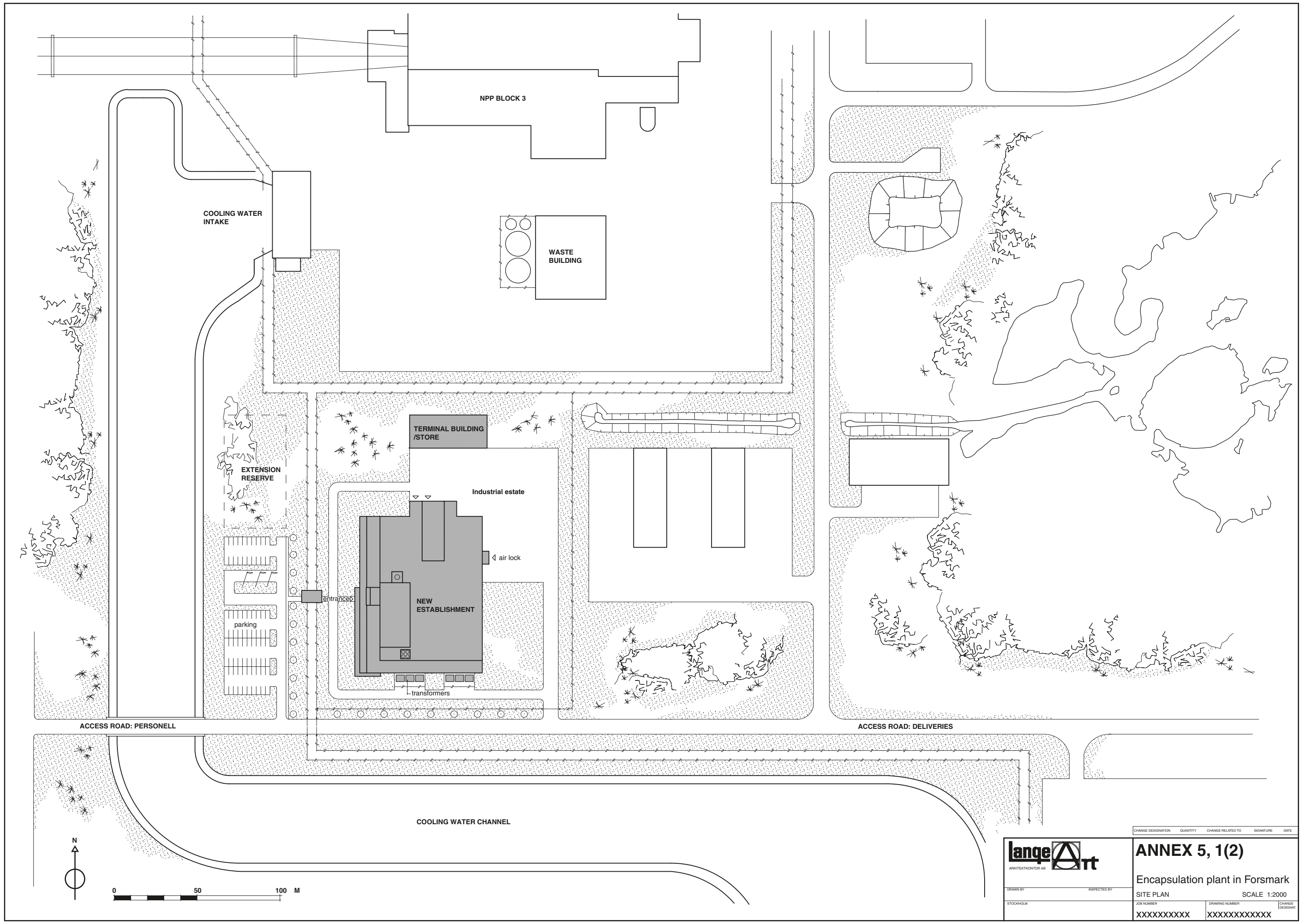
It is proposed that space M01.11 be used for the main components of the drying equipment. M01.11 has a floor area of 8.5 m × 6.5 m and a room height of 4.3 m. At present a ventilation duct passes through the room (dia. 1 m) along the short side above the entry door and further along one of the long sides. New pipes will be laid through the joists to room M02.11, where HEPA filters will be placed. Pipes will be extended through the wall from M02.11 to M02.09 and onward to the M02.16 preparation cell. The preparation cell is used for drying. Other operations at Clab that require preparation cell use take priority.

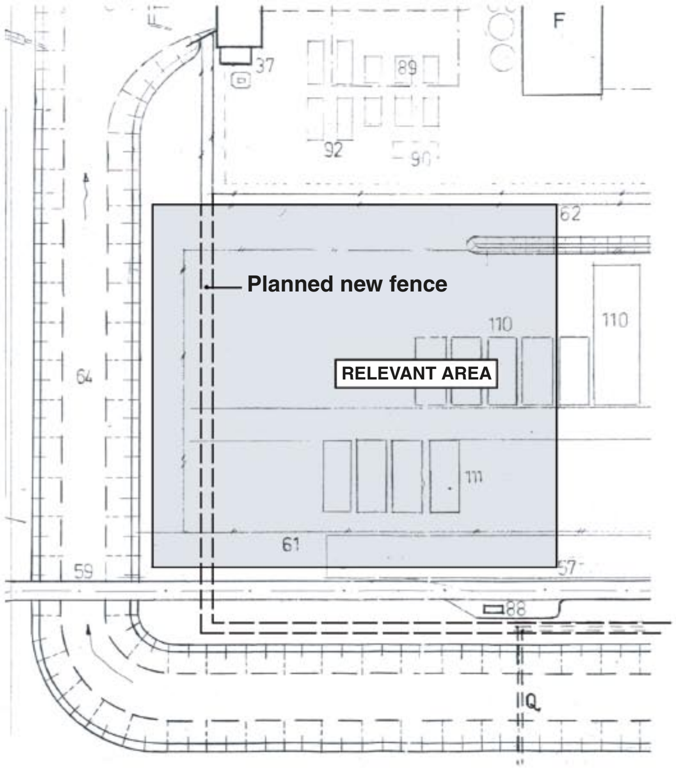
Preparations have been made for a nitrogen system in the plant. The system, which is intended to be used for inerting in the fuel transport casks, requires the addition of gas stores and feed lines.

Equipment must be added to the waste plant for the reception and handling of the radioactive waste from the encapsulation plant.

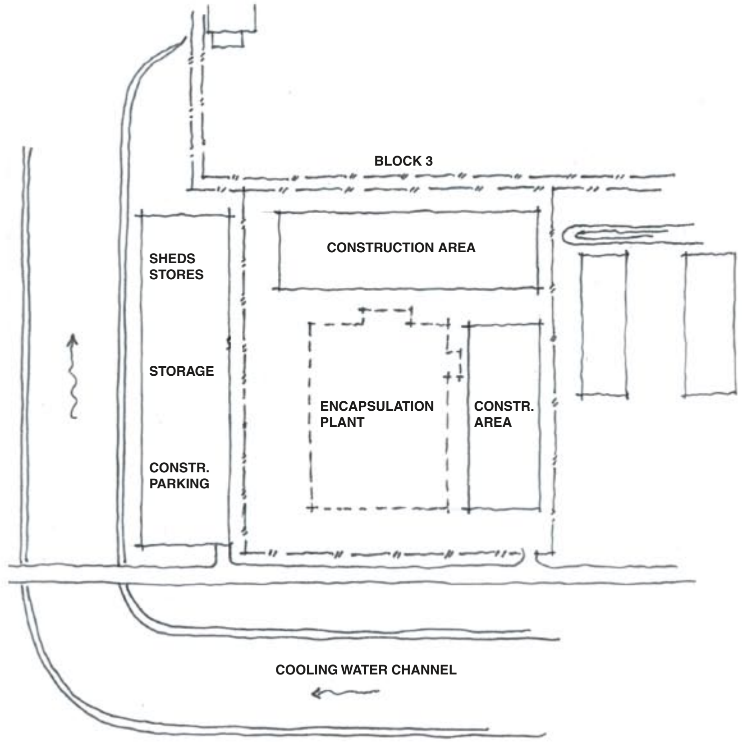
Appendix 5

Site plan





SITE PLAN **AT PRESENT**



SITE PLAN **CONSTRUCTION STAGE**

CHANGE DESIGNATION	QUANTITY	CHANGE RELATED TO	SIGNATURE	DATE

lange Art ARKITEKTKONTOR AB

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STOCKHOLM

ANNEX 5, 2(2)

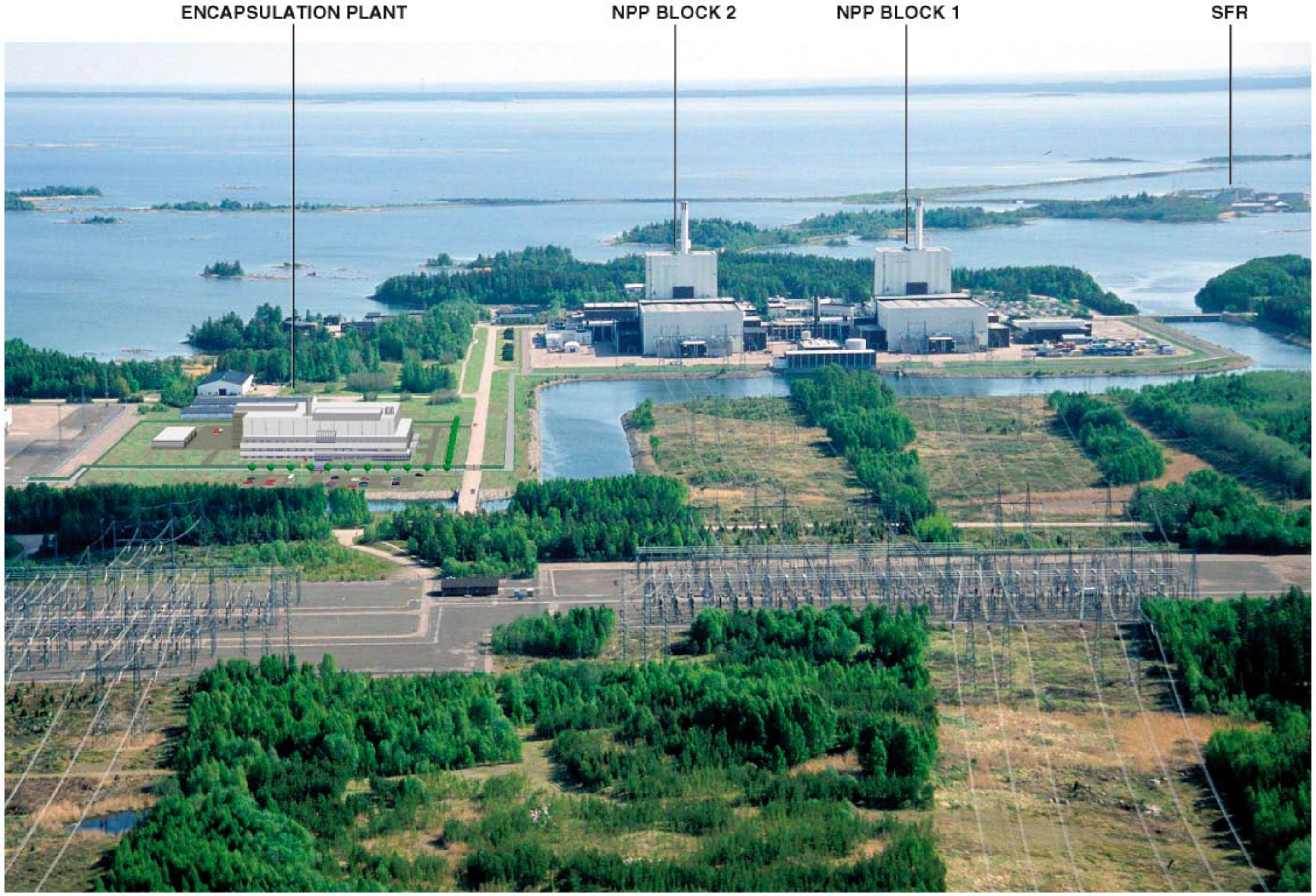
Encapsulation plant in Forsmark

SITE PLAN - at present/ construction stage — SCALE 1:2000

JOB NUMBER	DRAWING NUMBER	CHANGE DESIGNAT.
XXXXXXXXXX	XXXXXXXXXXXX	

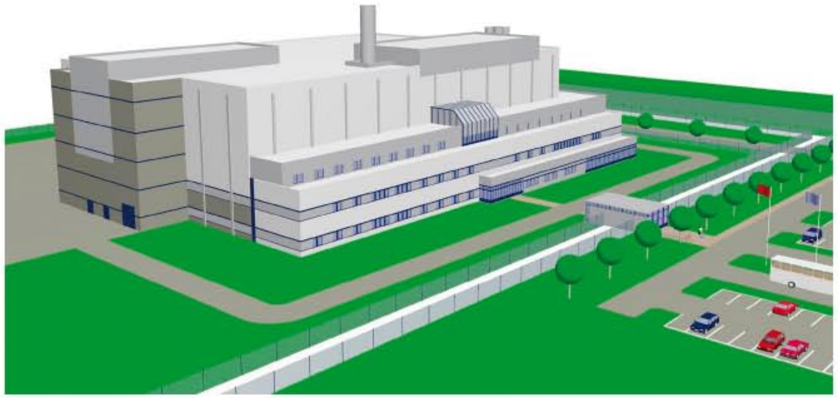
Ground perspective

Aerial perspective



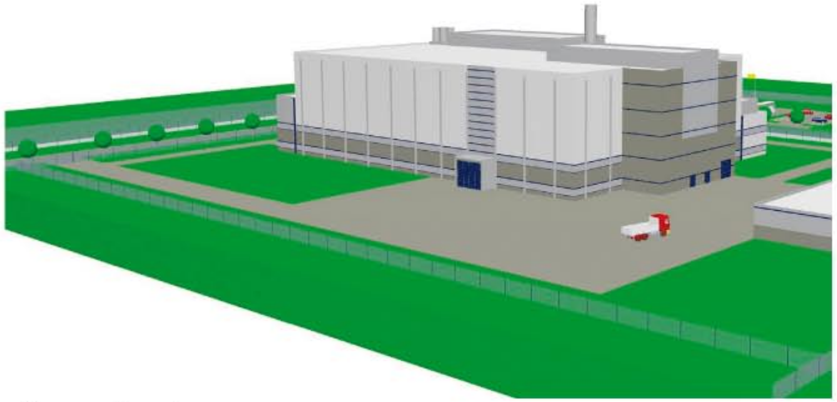
Appendix 8

Installation seen from different directions

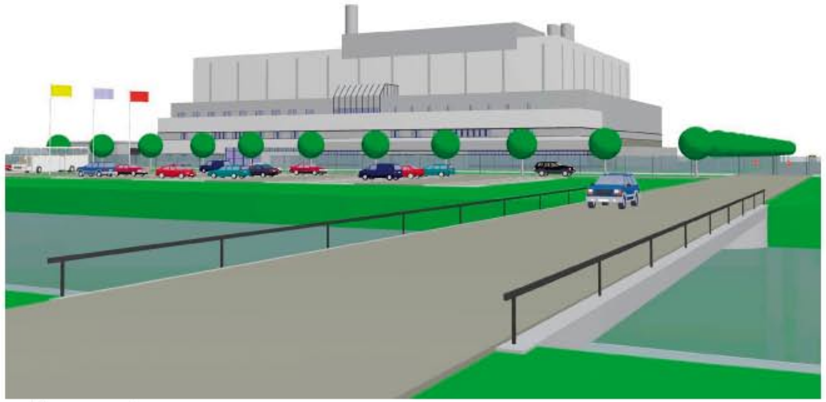


From north-west

From south-west



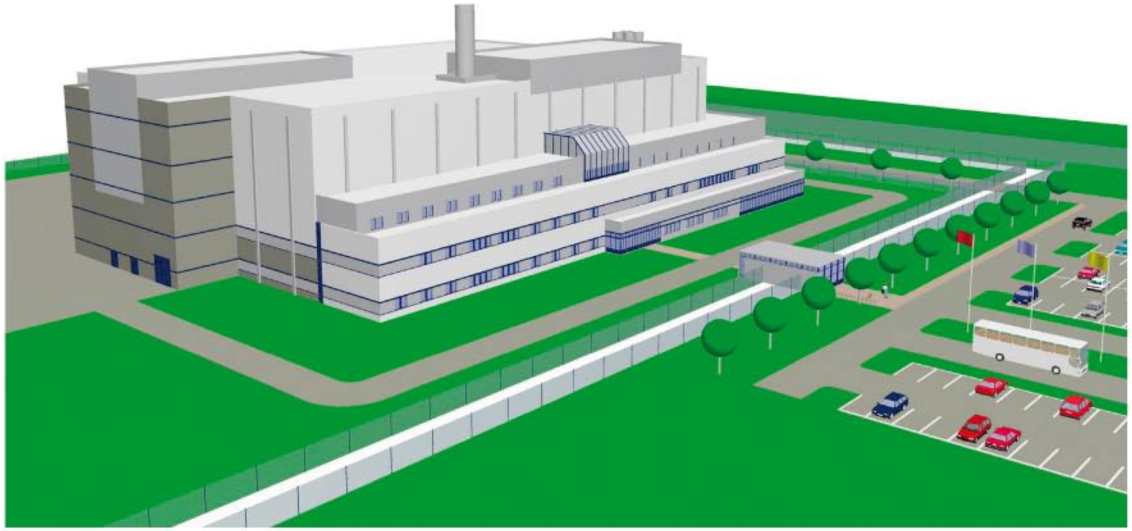
From north-east



From west

Appendix 9

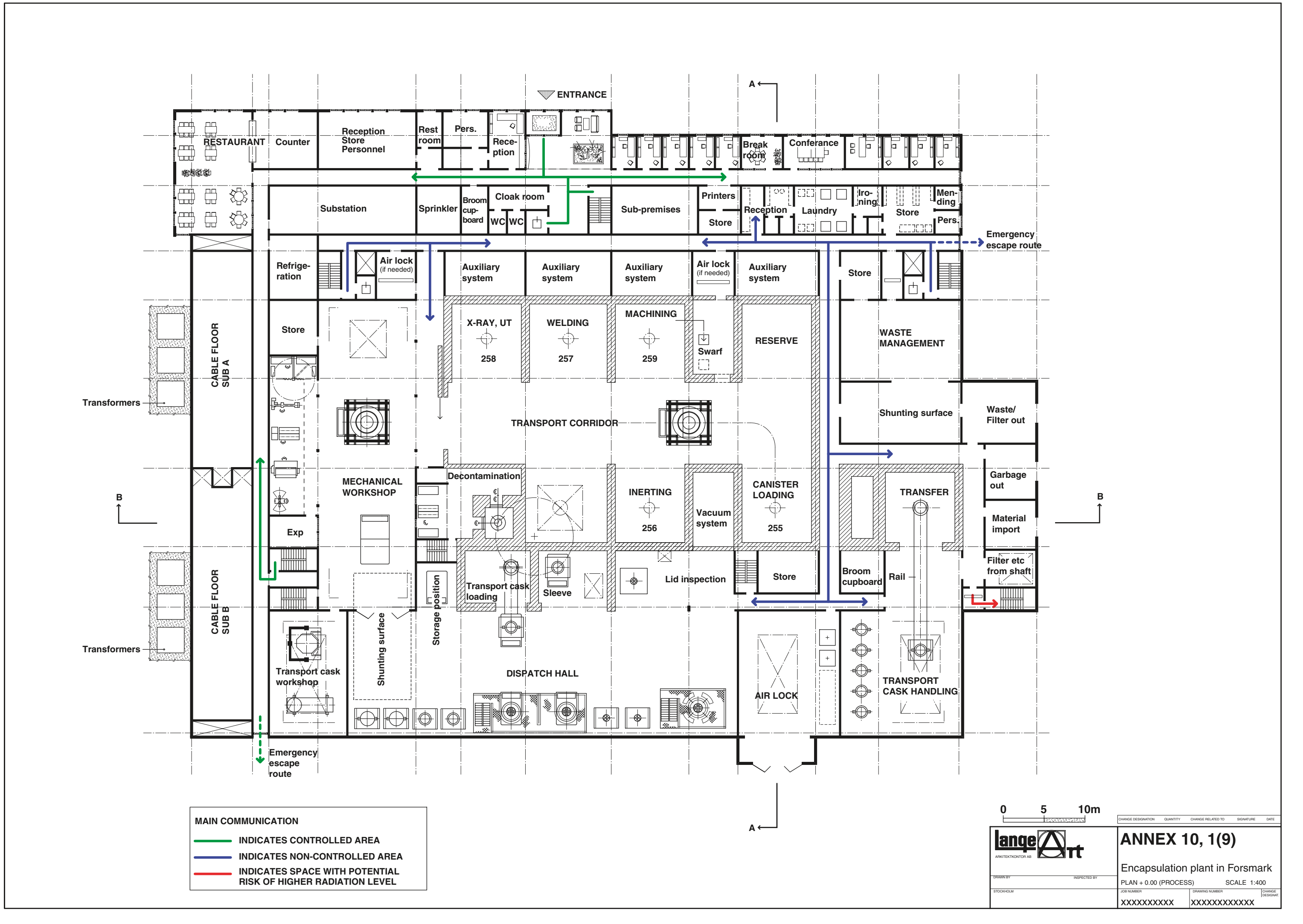
Surfaces and volumes

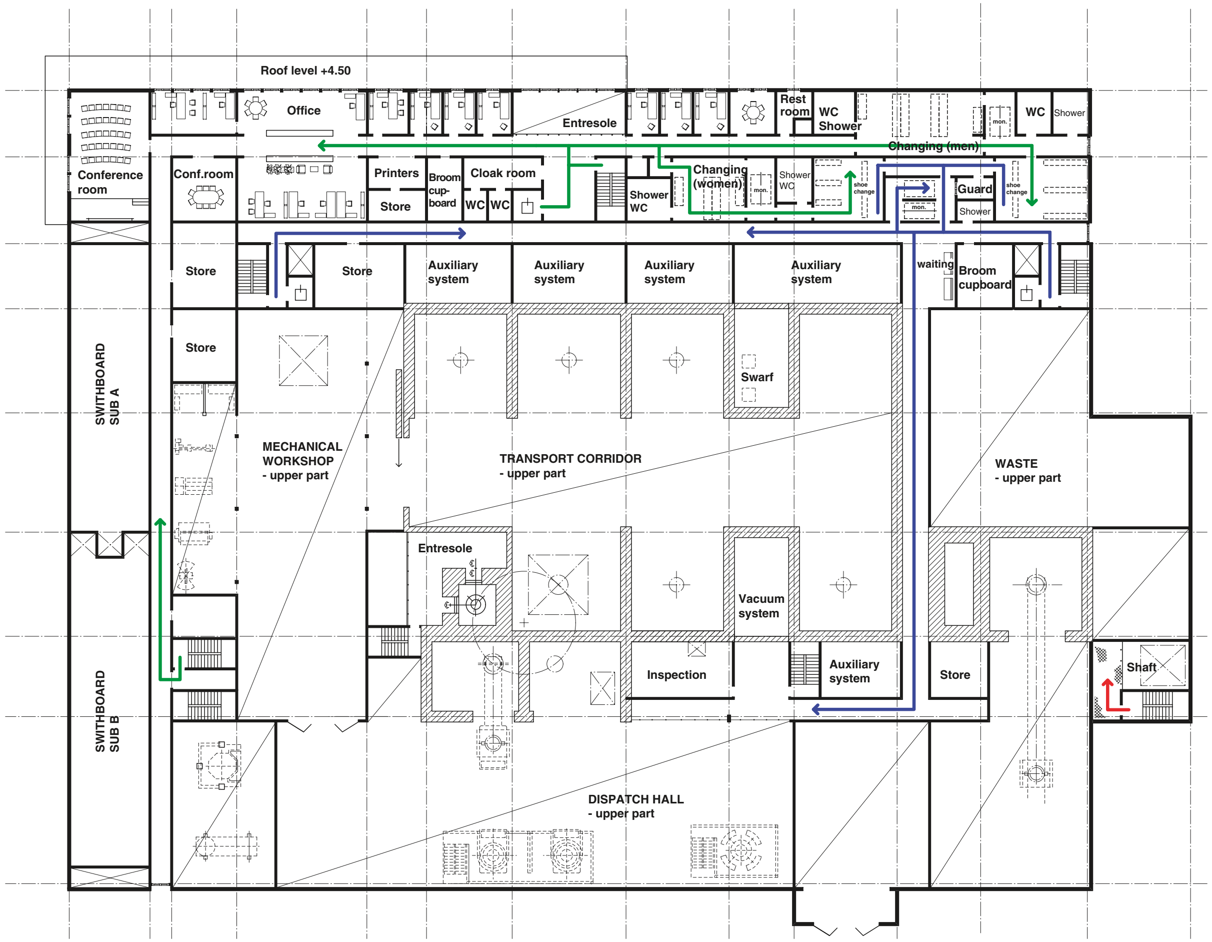


- Land needed including fence: 160 x 190 = 3,040 m^2
- Max. extension: North - South 105 m; East - West 77 m
- Surface build on: 7,220 m^2
- Total volume: 158,760 m^3

Appendix 10

Plant layout





MAIN COMMUNICATION

- INDICATES CONTROLLED AREA
- INDICATES NON-CONTROLLED AREA
- INDICATES SPACE WITH POTENTIAL RISK OF HIGHER RADIATION LEVEL

0 5 10m

lange Art
ARKITEKTKONTOR AB

CHANGE DESIGNATION	QUANTITY	CHANGE RELATED TO	SIGNATURE	DATE

ANNEX 10, 2(9)

Encapsulation plant in Forsmark

PLAN + 4.50 (PERSONELL CONTROL) SCALE 1:400

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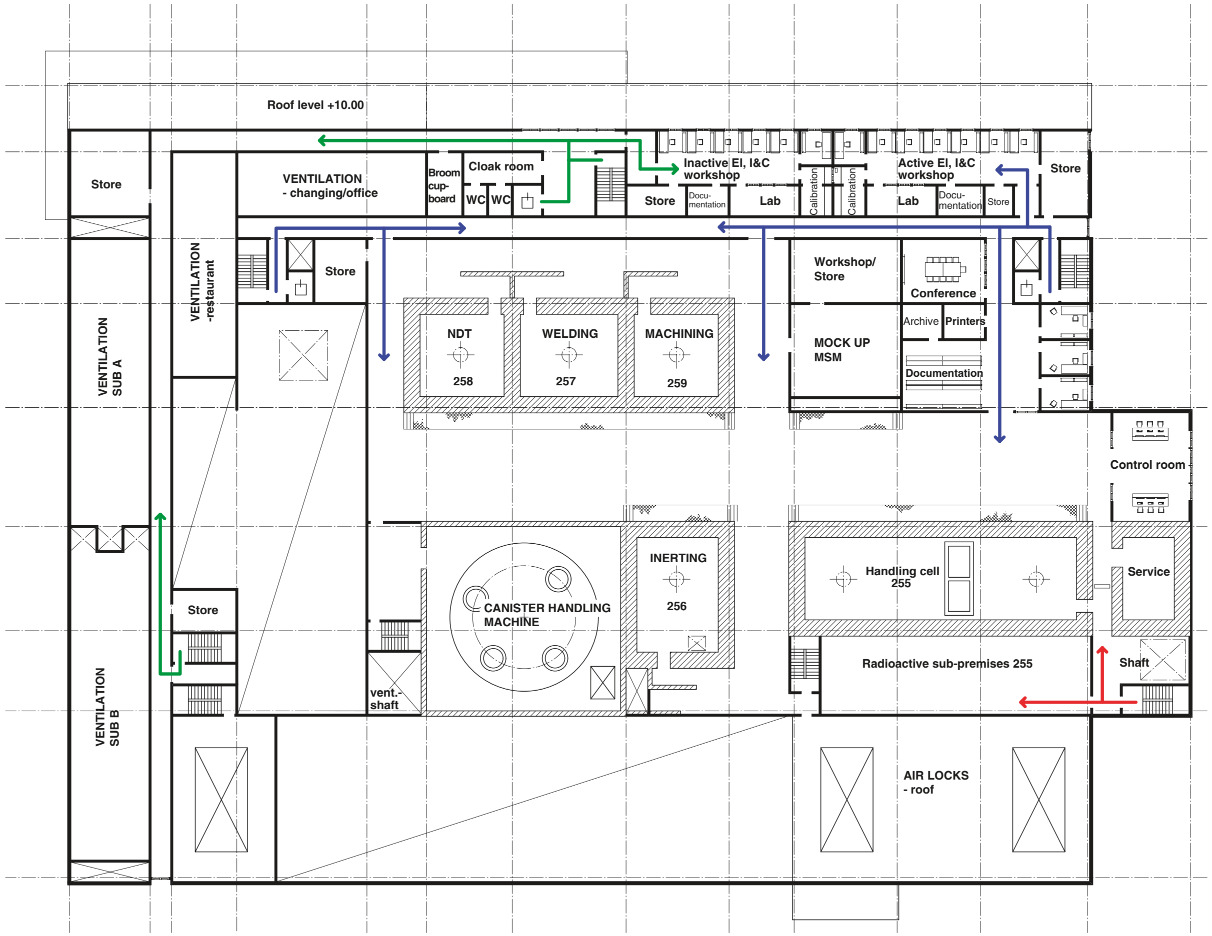
JOB NUMBER	DRAWING NUMBER	CHANGE DESIGNAT.
XXXXXXXXXX	XXXXXXXXXXXX	



MAIN COMMUNICATION

- INDICATES CONTROLLED AREA
- INDICATES NON-CONTROLLED AREA
- INDICATES SPACE WITH POTENTIAL RISK OF HIGHER RADIATION LEVEL

lange Art ARKITEKTKONTOR AB

STOCKHOLM

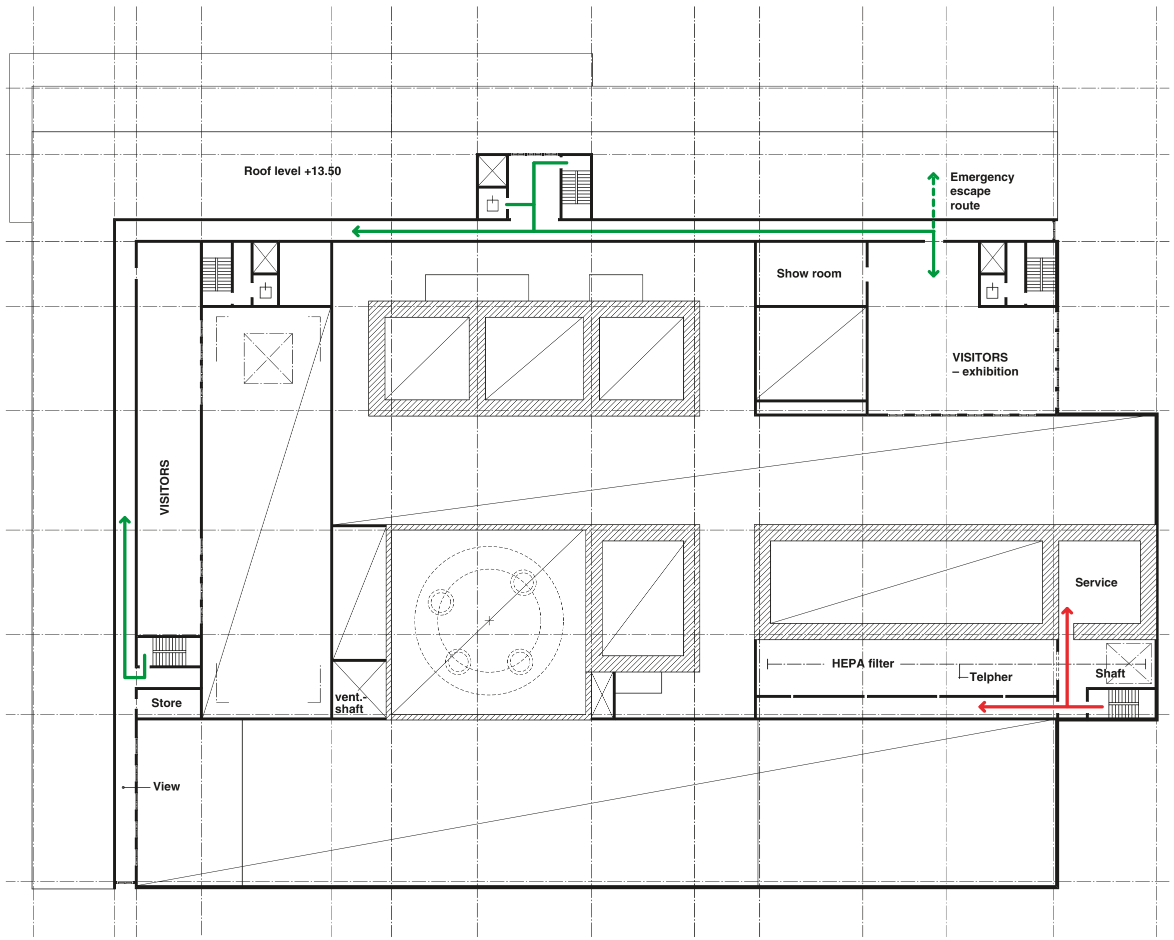
ANNEX 10, 3(9)

Encapsulation plant in Forsmark

PLAN + 10.00 (CELLS) SCALE 1:400

JOB NUMBER XXXXXXXXXX

DRAWING NUMBER XXXXXXXXXXXX



MAIN COMMUNICATION

- INDICATES CONTROLLED AREA
- INDICATES NON-CONTROLLED AREA
- INDICATES SPACE WITH POTENTIAL RISK OF HIGHER RADIATION LEVEL

0 5 10m

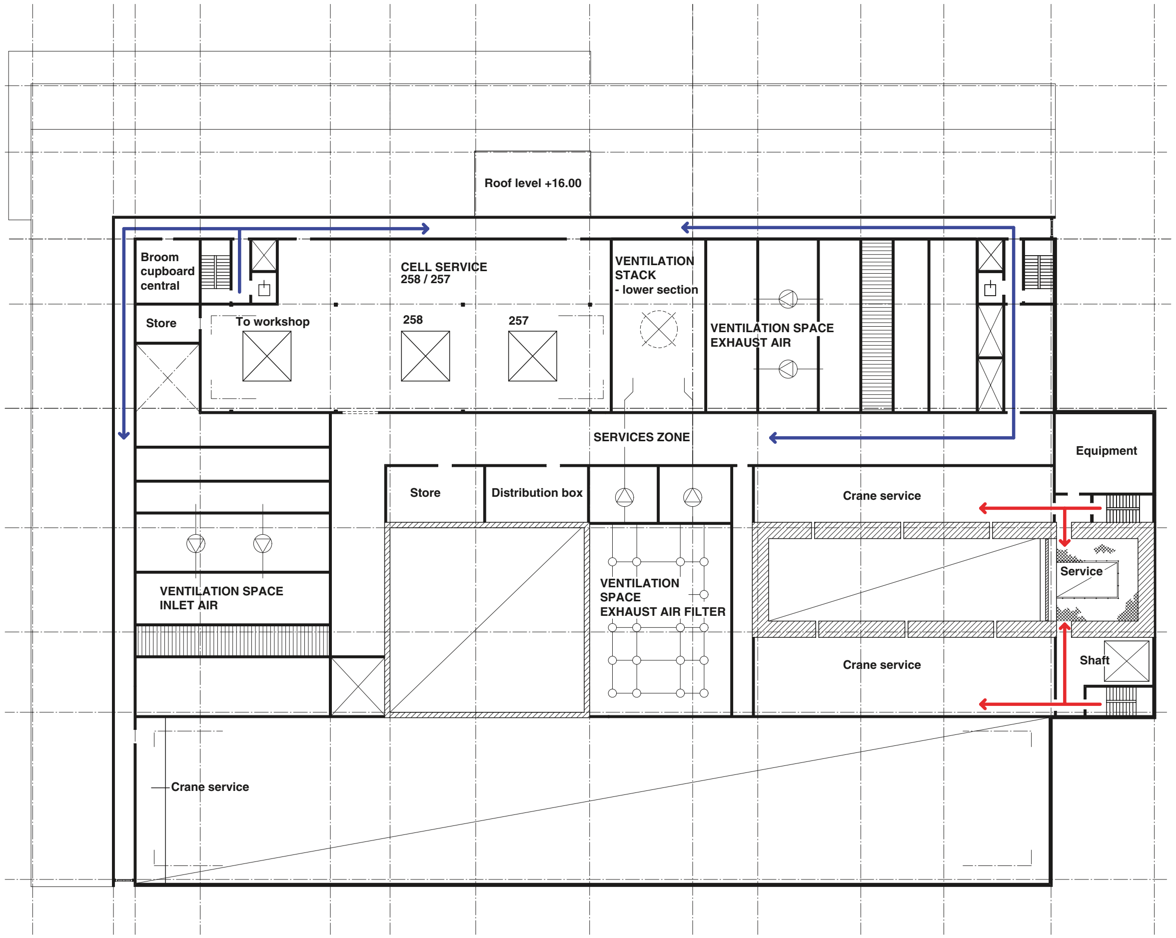
lange Art ARKITEKTKONTOR AB

ANNEX 10, 4(9)

Encapsulation plant in Forsmark

PLAN + 13.50 (VISITORS) SCALE 1:400

XXXXXXXXXX XXXXXXXXXXXX



MAIN COMMUNICATION

- INDICATES CONTROLLED AREA
- INDICATES NON-CONTROLLED AREA
- INDICATES SPACE WITH POTENTIAL RISK OF HIGHER RADIATION LEVEL

0 5 10m

Lange Art ARKITEKTKONTOR AB

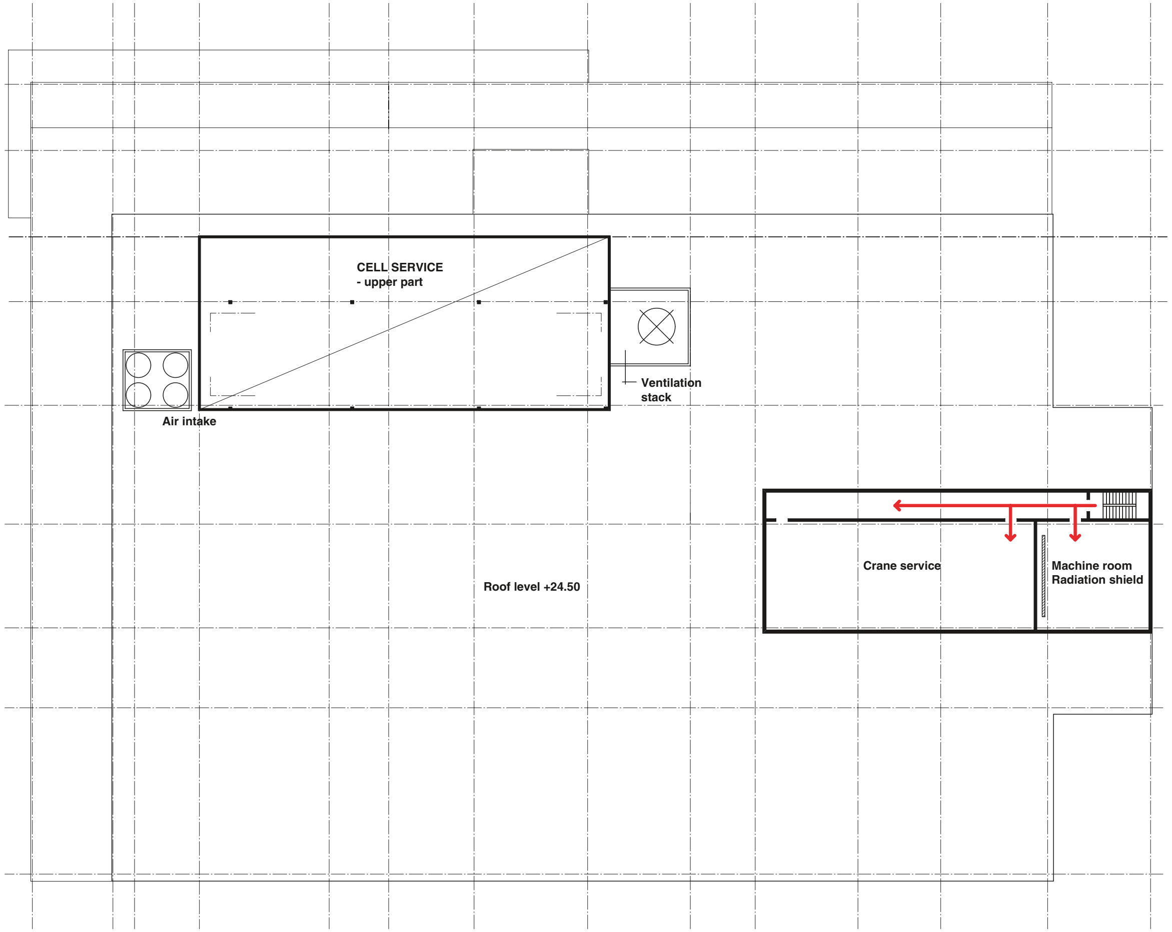
STOCKHOLM

ANNEX 10, 5(9)

Encapsulation plant in Forsmark

PLAN + 18.00 (SERVICE/VENT:) SCALE 1:400

XXXXXXXXXX XXXXXXXXXXXX



MAIN COMMUNICATION

- INDICATES CONTROLLED AREA
- INDICATES NON-CONTROLLED AREA
- INDICATES SPACE WITH POTENTIAL RISK OF HIGHER RADIATION LEVEL

0 5 10m

CHANGE DESIGNATION | QUANTITY | CHANGE RELATED TO | SIGNATURE | DATE

lange Art ARKITEKTKONTOR AB

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STOCKHOLM

ANNEX 10, 6(9)

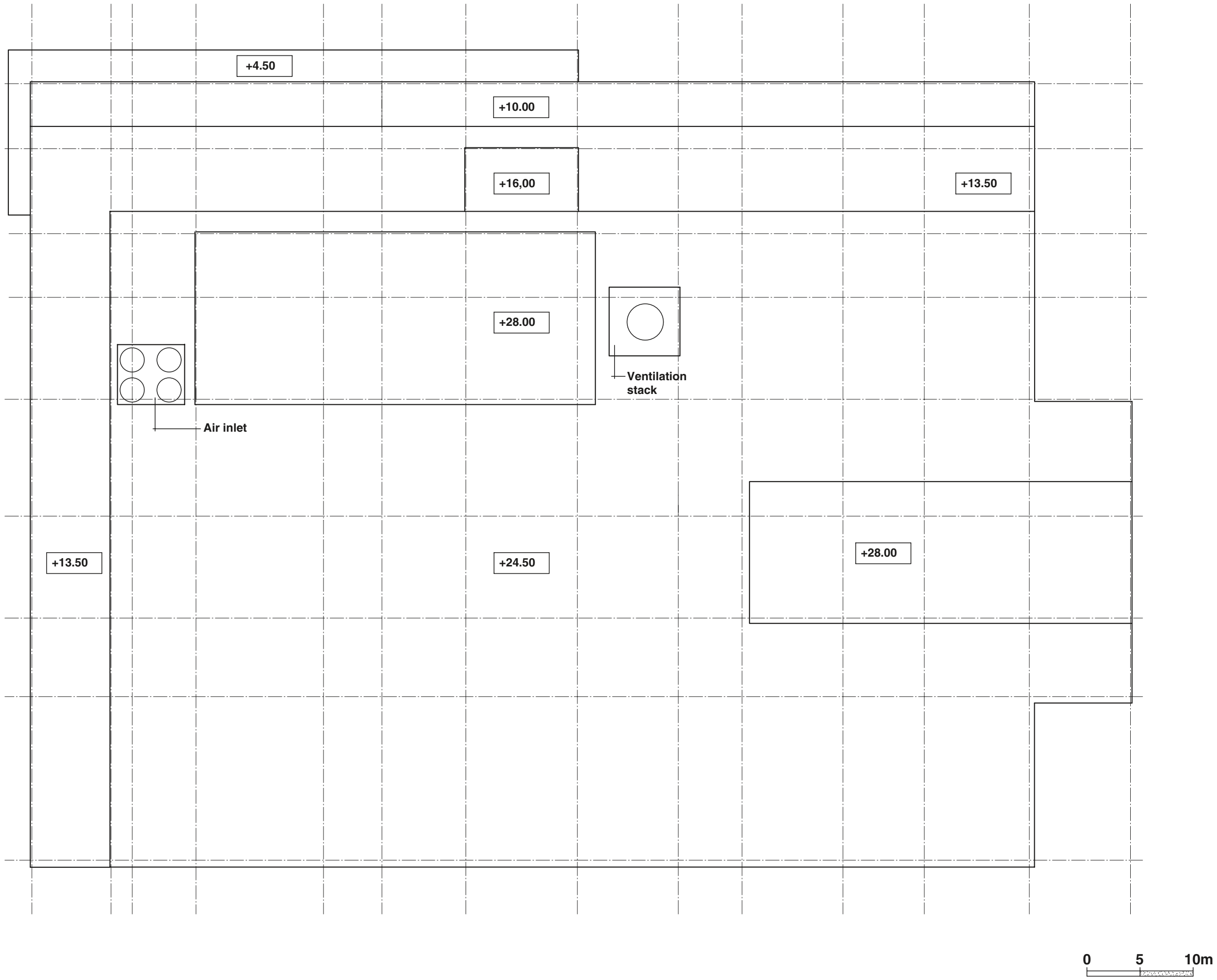
Encapsulation plant in Forsmark

PLAN + 24.50 (ROOF) SCALE 1:400

JOB NUMBER: XXXXXXXXXX

DRAWING NUMBER: XXXXXXXXXXXX

CHANGE DESIGNAT.



CHANGE DESIGNATION	QUANTITY	CHANGE RELATED TO	SIGNATURE	DATE

Lange Art ARKITEKTKONTOR AB

ANNEX 10, 7(9)

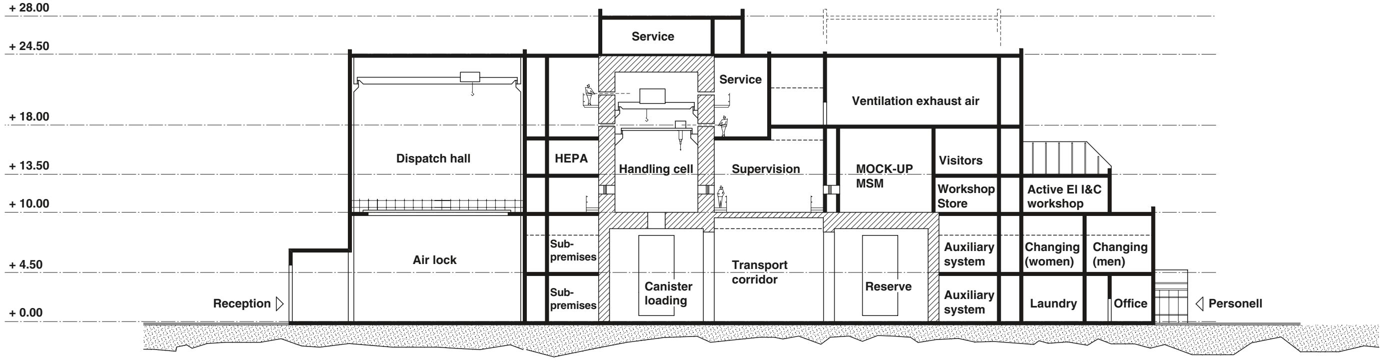
Encapsulation plant in Forsmark

ROOF LEVEL SCALE 1:400

DRAWN BY INSPECTED BY

STOCKHOLM

JOB NUMBER	DRAWING NUMBER	CHANGE DESIGNAT.
XXXXXXXXXX	XXXXXXXXXXXX	



SECTION A-A
(2 crane tracks in handling cell)

0 5 10m

CHANGE DESIGNATION | QUANTITY | CHANGE RELATED TO | SIGNATURE | DATE

LangeArt ARKITEKTKONTOR AB

DRAWN BY | INSPECTED BY

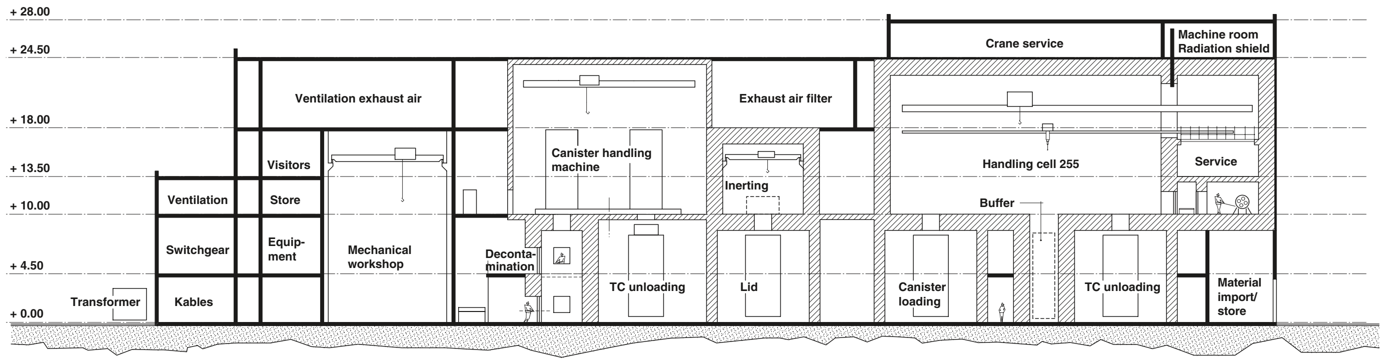
STOCKHOLM

ANNEX 10, 8(9)

Encapsulation plant in Forsmark

SECTION A–A | SCALE 1:400

JOB NUMBER: XXXXXXXXXX | DRAWING NUMBER: XXXXXXXXXXXX | CHANGE DESIGNAT.



SECTION B-B
(2 crane tracks in handling cell)

0 5 10m

CHANGE DESIGNATION QUANTITY CHANGE RELATED TO SIGNATURE DATE

lange Art
ARKITEKTKONTOR AB

DRAWN BY INSPECTED BY

STOCKHOLM

ANNEX 10, 9(9)

Encapsulation plant in Forsmark

SECTION B–B SCALE 1:400

JOB NUMBER DRAWING NUMBER CHANGE DESIGNAT.

XXXXXXXXXX XXXXXXXXXXXX

Appendix 11

Handling cell layout