

The European Spallation Source Active Cells Facility – Challenges in Construction – HOTLAB 2018

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The Active Cells Facility (ACF) at the European Spallation Source ERIC (ESS) is currently being built in Lund, Sweden. The facility will be a process facility with the main function of processing activated and contaminated metallic waste originating from the neutron spallation process enabling research at ESS. Sub-functions of the ACF are segregation and size reduction of metallic waste, interim storage, receiving and shipping of waste as well as protecting workers from the hazardous environment.

The ACF internal dimensions will be around 30 meters long, 12 meters wide and 15 meters in height and a special feature of the facility is the windowless design, forcing the in-cell viewing system and control system to be highly integrated with the operations of the facility. The baseline throughput of waste is calculated to be around 170 tons/5 year cycle and the most activated components reaching levels up to $3e+09$ μ Sv/hour. The ACF static barrier structures is built with high density concrete and the wall thickness is 1.3 meter. The ACF is currently being built as part of the construction of the ESS target station building and at time of writing, the concrete works for the ACF is about half way done.

This paper will concentrate on the challenges of the interfaces between the cast in items enabling the installation of the internal stainless steel liner and other mechanical waste process systems and the civil construction of the ACF superstructure.

Civil construction interface challenges

The civil construction of the ACF (and ESS as a whole), is performed under a contract with a large construction company as well as a range of civil engineering companies providing the detailed design and solutions for the superstructures of the buildings. Based on best available techniques as well as cost and schedule limitations, the construction methods are not always suited for high tolerances and other specific requirements necessary for the ACF cast in items.

In total, there are about 3500 items that will be casted into the concrete, for example; liner beams, confinement penetrations, anchor plates, media penetrations and electrical conduits. All of which have their own requirements on tolerances and unique features. The subparagraphs below are highlighting some of the main challenges that the machine/construction project interfaces has experienced so far.

Mechanical versus civil construction tolerances

Casting in items manufactured in accordance with mechanical tolerances with the expectation that alignment, fitting and interfaces to the later installed machinery in the cell will be in accordance with these mechanical tolerance is not expected to work. Regardless of how well these structures are

aligned pre-casting of concrete, the formworks as well as the casting process including a lot of vibration and hydraulic pressure will have an impact on the positions of the cast in items.

ESS has currently deployed a number of mitigations to handle this, one being the use of an internal steel frame in the walls (see Figure P1, middle picture) that, for most of the components, will separate the interface between re-bars and the cast in items. The components are structurally fastened to the steel frame and very fine pre-cast tolerances can be achieved, however, the post-cast tolerances are in some areas observed to be close to the maximum allowable.

Other ways of dealing with tolerances is for example to cast the floor slabs in more than one sequence, the first casting is to nominal level -200 mm allowing floor embedment items to be installed by drilling anchors into the concrete, then pour the final concrete layer up to nominal level of the floor.

The ACF will be clad with stainless steel plates, to accommodate these an over dimension of the casted in liner beams, which the plates will be welded to, was chosen. This allows for deviations in construction and the stainless steel plate dimensions.

Re-bar design and casting sequences

The amount of re-bars used for the ACF is about 500 kg/m³, which is about the double amount of re-bars used when building a concrete bridge for example. This as well as how the concrete construction is segmented in the walls (height and length of one single casting sequence) are limiting the way the cast in items can be designed as well as placed. Nominally, anchor plates for example have to be designed with a centre-to-centre distance between the anchor bolts of multiples of 150 mm to accommodate the positions of the re-bars.

No cast in item can be placed longitudinal along a casting joint, which also have forced the design to change in concurrence with progress of the detailed design of the civil works (see Figure P1 right picture).

Uneven concrete surfaces

For both walls and floors, the ideal result from the concrete surfaces, to be able to install the stainless steel liner plates, would be for the surfaces to be completely flush with the liner beams, confinement penetrations and anchor plates. This has, despite the use of spring loaded rods to establish a high pressure between liner beams and concrete form works, been proven difficult. The main reason for this is that the formwork is somewhat flexible (some millimetres) as well as that in between the formworks sections, there are normal wood that when wet, swells differently than the formworks (see Figure P1 right picture).

This has led to that the walls so far have had to be grinded down (only on the hot side of the wall), to be able to fasten the stainless steel liner plates to the liner beams. If the gap is too large, it would not allow the 2 mm thick liner plates to get in contact with the liner beams and welding them together would not have been possible (the way it is designed).

Installation of cast in item in tight spaces

In many positions, the cast in items location and size are either difficult for the civil works to manage (see Figure P2 – left picture), or the installation of the cast in items are very difficult due to tight spaces (often due to that re-bar installation has already been done). This requires either good interaction between mechanical and civil construction to minimize surprises on site, or that as large items as possible are pre-manufactured prior to installation (this can also save time on site). One example is the large pre-manufactured storage pits, see Figure P2 – right picture, that were transported to site and lifted directly into the ACF prior to casting.

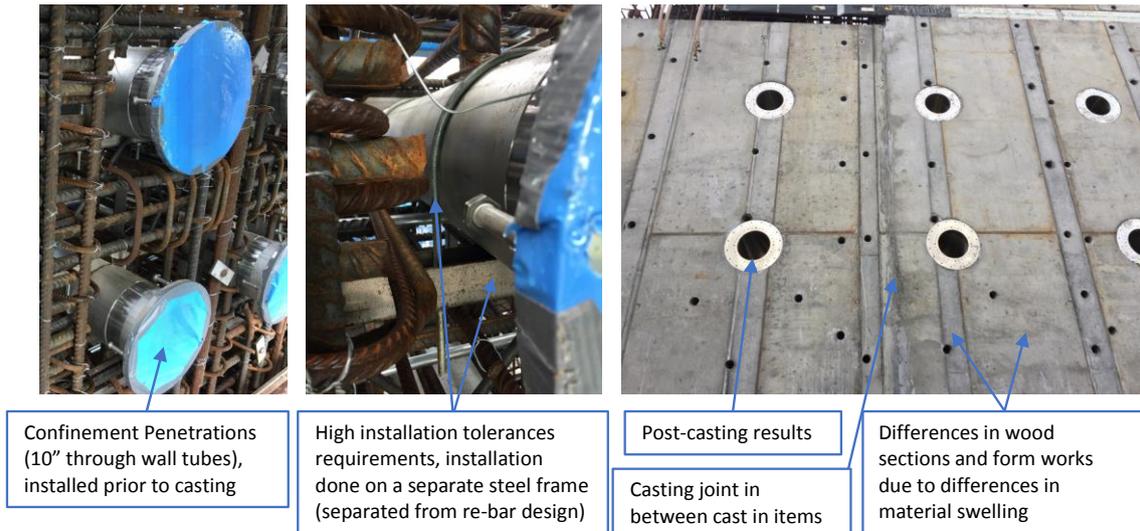


Figure P1: Confinement penetrations, pre- and post-concrete casting¹

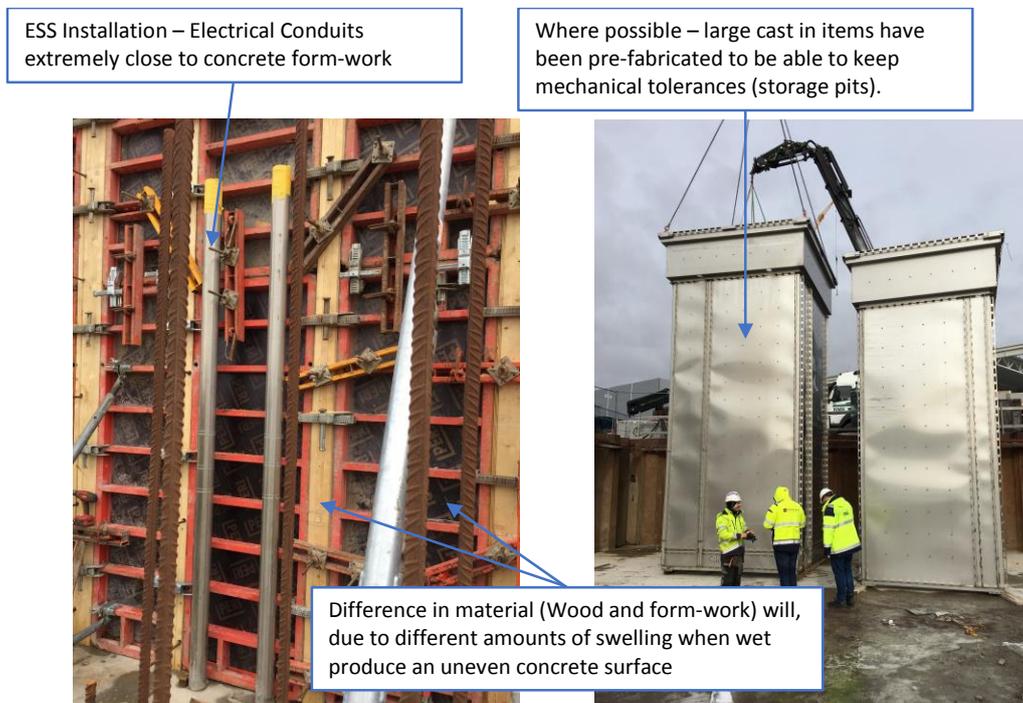


Figure P2: Challenges and solutions of some of the interfaces with the civil works of the ACF¹.

¹ Pictures from site taken by Magnus Göhran, ESS.