# JOB REPORT

**Customer:** Petrofac Facilities & Management Ltd

**End User:** Total E&P UK, Shetland Gas Plant

**Location:** Sullom Voe, Shetland, United Kingdom

**Project:** Skid perimeter grouting, skid fill, and pressure injection

**Dates:** 3 May to 7 June 2016

## 1. EXISTING CONDITION

The units in question are high-pressure SPX/Clyde Union 5-cylinder plunger pumps, driven by ABB electric motors of 420 kW, through a David Brown gearbox, operating at 238 rpm. All 3 elements are mounted on a fabricated steel skid, with approximate dimensions of 8.2 x 3.3 x 0.3 m. The units were manufactured and installed in 2015, but have been suffering from vibration issues since start-up, and are in MEG injection service.

1.1 Foundation details remain unknown. API RP 686 recommends a foundation mass which is 5-10 times the machine weight for reciprocating machinery, and the reported weight of all items is approximately 25,000 kg. The foundation mass should therefore be something between 125 and 250 tonnes. A separate rule-of-thumb which we have developed over the years is that each kW of power input/output requires 100 kg of foundation mass for good damping, which would equate to 42 tonnes. In many cases, the foundations for skid mounted machinery are quite small, and it is the skid-fill which provides the bulk of the inertial mass required to give good vibration damping.

1.2 The skid has been set on small soleplates at each anchor bolt, 22 in total, and grouted with an unknown cementitious product. The gap between skid base and foundation top is approximately 60-70 mm. The transfer of energy from the skid into the foundation is presently confined to the small amount of area of the soleplates, and the anchor bolts themselves, details of which remain unknown. The contact between soleplates and skid base is quite bad in many areas, with the soleplate out of plane, and poorly supported by the underlying cement grout.

## 2. REPAIR WORK CARRIED OUT

2.1 A site visit was carried out on 5 April 2016 in an attempt to determine the site restrictions, rules and regulations, etc, but the information available was less than comprehensive. A number of tests of the proposed method and materials were then

required by Petrofac to determine the bonding ability of epoxy grout to clean concrete surfaces, and to scabbled surfaces, which naturally proved to be better.

2.2 We were eventually able to mobilize on 3 May, and site work started immediately on scabbling the concrete surface outside the skid perimeter. The concrete under the skid had been hp water washed, by the on-site contractor, but drying time was excessive, and the Method Statement was changed to air blowing for subsequent skids.

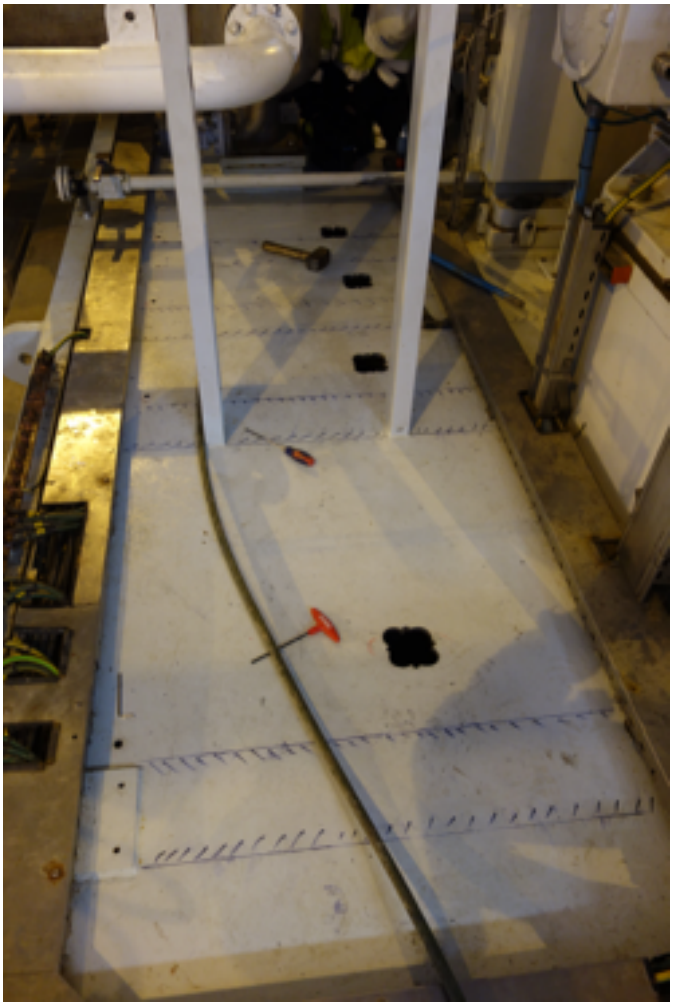
2.3 Inner forms were prepared to contain the epoxy grout. This phase was also adjusted to allow for drilling of the top plate to be completed before work on the concrete.

*The inner forms were cut to size, using a pneumatic jigsaw, and supported against the back of the original grout pads by wire secured to small concrete anchors. Gaps top and bottom were then sealed with epoxy putty.*

2.4 Heavy duty plywood forms were then fabricated, and covered with PE release film, and set in place 100 mm from the skid edge.

2.5 ALPHATEC 800 epoxy grout was mixed and poured to embed the lower flange of the skid, and allowed to cure overnight.

2.6 Cement grout injection holes were cut in the top plate of the skid, using pneumatic magnetic-base drills. 15 mm diameter breather holes were also drilled in the high side of each compartment.



2.7 Sikagrout 212 cement-based grout was mixed and pumped into place using a Utiform V2 mixer/pump combination unit, through 35 mm ID hoses. The first pump failed on 9 May when 75% of the material had been placed. A repair was effected at a local workshop, and a replacement pump ordered from the rental company in Glasgow. The replacement pump took quite some time to reach site, so the remaining material for the B skid was pumped using the repaired machine. Skids C and A were filled using the newer pump.

2.8 After the cement grout had cured overnight, holes were drilled through the grout in 5 places, to a depth of approximately 650, and 600 mm lengths of reinforcing bar placed into the holes with copper tubing attached.

2.9 The top of each hole, and the top of each cement injection hole was sealed with ALPHATEC 800 epoxy grout, which cured well overnight, thanks to the remaining heat of hydration in the cement grout.

2.10 Breather holes were tapped to allow installation of 3/8" NPT grease nipples.

2.11 ALPHATEC 342 liquid grout was mixed and pumped into each each injection point in turn, using a Larius Nova 60:1 pneumatic plunger pump, and pressures of up to 400 bar, to ensure good bonding between the cement grout and the foundation, and between grout and skid.

2.12 After the injected material had cured overnight, the skid top was sounded to identify any remaining voids, and some additional resin injection done by hand pump.

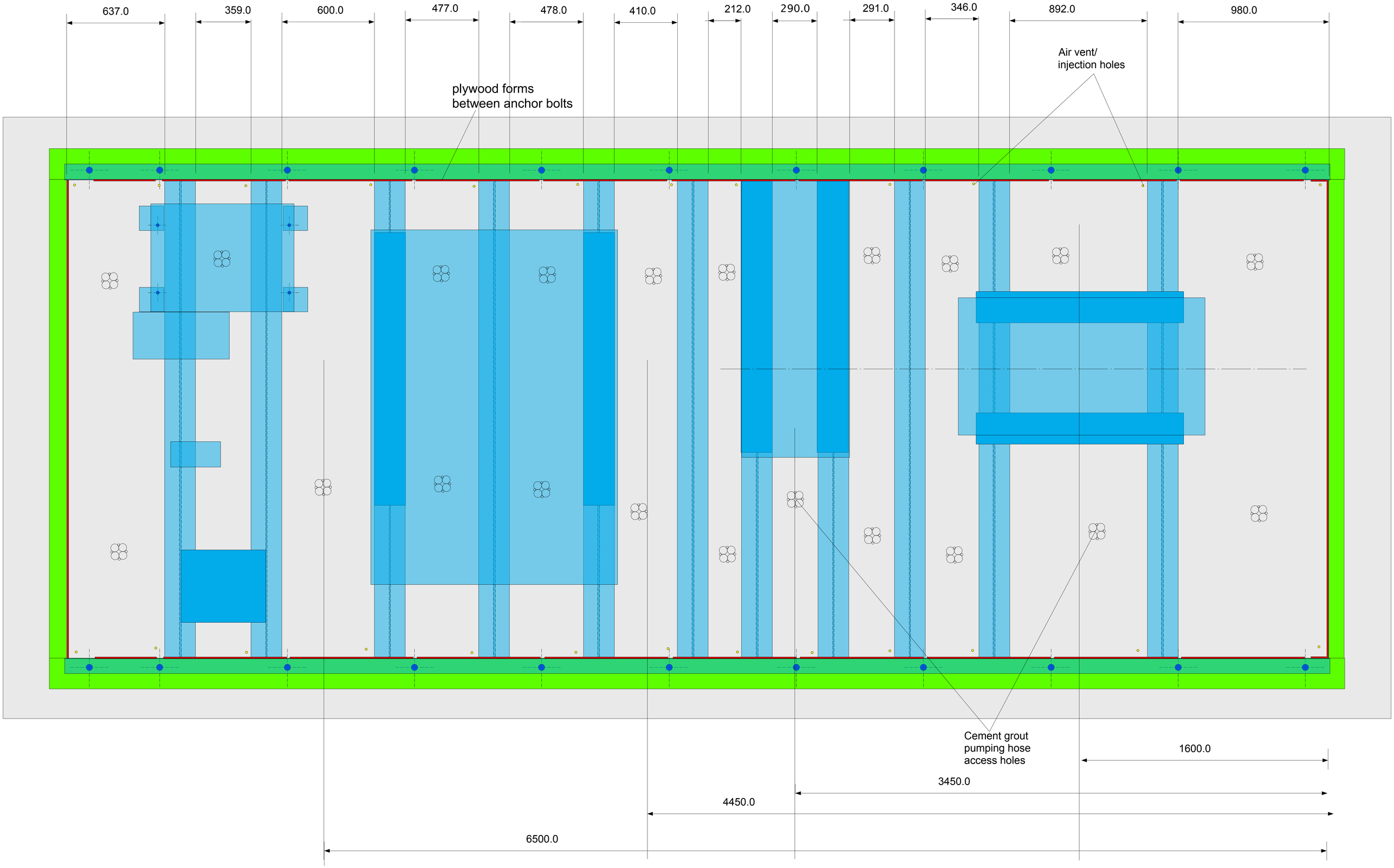
A total of 1880 bags of Sikagrout 212 was injected into the three skids, 608 bags on skid B, 627 on skid C, and 645 on skid A. Each bag contains 25 kg of premixed cementitious grout, and is mixed with 3 litres of water, so the total weight installed is 52,640 kg, or approximately 17,540 kg per skid.

The resin injection complemented the cement injection, with around 320 litres used on the B skid, and 155 and 165 litres respectively on skids C and A.

on behalf of
ALPHATEC ENGINEERING (EUROPE) LTD

Giles Goldsbro,
Technical Director

Date: 16 June 2016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Air vent/
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Cement grout
pumping hose
access holes
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