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6 MN Force Calibration Machine

Hydraulic Amplification Upgrades

Section B: Purging & Repair of Hydraulic Circuit

Technical Specification

Project Reference: FL2018-P001

Table of Contents

1 Project Background

1.1 The Metrology Institute

The National Metrology Institute of South Africa (NMISA) is responsible for maintaining the S.I. units and to develop primary scientific standards of physical quantities for South Africa. The NMISA maintains and compares those standards with other national standards to ensure global measurement equivalence. It must also provide reference analysis in the case of a measurement dispute. The NMISA also maintains and develops primary methods for chemical analysis for the purposes of certifying chemical, electromagnetic and physical references.

1.2 Force Calibration Services

The NMISA Force Laboratory is responsible for the international traceability of force measurement in South Africa. To this end, the institute maintains and operates a hydraulically amplified, Deadweight Force Calibration Machine. The machine itself is over 40 years old and its hydraulics are in need of modernization.

2 Machine Description

2.1 Current equipment

The machine is comprised of two inter-dependent sections; a deadweight lifting section (which has recently been renovated) and a hydraulic section consisting of three hydraulic presses.

The *Deadweight Section* consists of the following major components and ancillaries:

- Deadweight Lift Motor: 4.0 kW (380 VAC/3-phase), 11.0 A Servo Motor
- Platform Motor: 160 W (230 VAC), 3.0 A Servo Motor
- 2x Electro-magnetic brakes
- Hydrostatic bearing motor: 0.5 kW (240 VAC)
- Tare beam motor: 160 W (230 VDC), 3.4 A Servo Motor

The *Hydraulic Section* is driven by a *hydraulic power pack* (**HPU**) with the following motors:

- 3.8 kW (380 VAC)
- 7.5 kW (380 VAC)
- 2x 0.37 kW (380 VAC)
- 3x 1.1 kW (380 VAC)

The HPU is to be replaced with a new and modern model of similar or lower power demands. The said HPU replacement must be a self-contained unit with its own control panel that will communicate with the existing machine control panel.

2.2 Force Traceability Process

The existing *Deadweight Section* generates force by means of a stack of calibrated stainless-steel mass pieces. The applied force pulls upon the deadweight cradle, which in turn applies this force (F_0) upon the deadweight loading piston.

A balancing pressure (P_0) is thus developed within the deadweight loading piston. This balancing pressure is then transferred to the piston cylinder in each of the three force presses. Each piston cylinder has a specific cross-sectional area; it is in this way that the deadweight force is amplified to 200 kN (F_1), 1000 kN (F_2) and 6000 kN (F_3) of applied force respectively.

The transmission ratios are as follows:

- *200* kN *force Standard Machine (F_0 to F_1) – 1:5*
- *1000* kN *force Standard Machine (F_0 to F_2) – 1:25*
- *6000* kN *force Standard Machine (F_0 to F_3) – 1:150*

For these ratios to be achieved and for the traceability chain to remain unbroken, the balancing pressure (P_0) needs to be exactly equal to the piston cylinder pressure (P_1; P_2; P_3) respectively. This process is illustrated in *Figure 1* in the appendix below.

The accuracy to which these pressures can be balanced has a major bearing on the uncertainty of measurement of the force amplification. To this end, it is required of the HPU to both generate and maintain the needed pressure in the deadweight loading piston and the respective piston cylinders to high accuracy and precision. Force calibrations are taken at each force interval. Each force value must be generated and maintained stable for 30 seconds.

	Pressure Range (MPa)		Stability Range
Force (kN)	**Min**	**Max**	**kPa**
200	2	25.5	6
1000	1.9	25.4	12
6000	2.2	29.1	21

The piston cylinders of each of the three force presses are positioned on three column frames. Each loading frame connects to the respective pistons by means of a spherical hydrostatic bearing. Thus, axial support is provided with minimum friction and misalignment.

The vertical position of the piston is supported by means of eight horizontal hydrostatic bearings; four at the upper and four at the lower end of the piston cylinder. This ensures that the gap between cylinder and piston is kept as small as possible without the rotation of the piston being hampered.

These hydrostatic bearings are to be independently pressurized by the HPU. The pressure feed will need to be modulated and monitored continuously. A spike in this pressure would indicate that the nozzles of the bearing feed jets are blocked. The HPU's control system would need to flag an alarm and initiate pressure safety protocols. This process for each piston cylinder is illustrated in *Figure 2* in the appendix below.

The force calibration cycle requires multiple iterations of force generation (and by extension, pressure generation) to specific values. As a result of each calibration run, the viscosity of the hydraulic fluid fluctuates as a result of the inherent temperature fluctuation. Consequently, the temperature of the hydraulic fluid needs to be maintained within acceptable limits.

The existing Hydraulic Power Pack (***HPU***) has fallen into disrepair and needs to be upgraded or replaced.

3 Proposal Requirements: Purging & Repair of Hydraulic Circuit (Piping, Feed Nozzles, Mechanical Seals etc.)

Due to the machines age and subsequent breakdown over the years, some refurbishment of the hydraulic equipment is required. The refurbishments will include (but not limited to) the following:

- *Purging of all hydraulic piping*
- *Purging of the overhead sump*
- *Inspection and pressure testing of piping*
- *Inspection and pressure testing of the overhead sump*
- *Repair or replacement of any piping sections with leaks and/or hairline cracks*
- *Inspection of all hydrostatic bearings*
- *Repair/replacement of all hydraulic jet nozzles feeding each cylinder (current nozzles are Solex 040 & 060 Series jets)*
- *Inspection and repair/replacement of all mechanical seals*
- *Inspection and repair/replacement of all pressure safety devices*

All repairs and refurbishments are to be conducted according the applicable SANS Code (Pressurized Equipment, Welding codes etc.) and best practice. Further details can be discussed during the site visit.

Note:

- *Any deviations from the above scope should be explicitly stated. A succinct description of the deviation and the reasons thereof should also be included.*

4 Additional Information and Documentation

4.1 Technical documentation

Kindly refer to the accompanying documents:

- *Equipment flow chart.*
- *Photographs of the machine*
- *Existing EC&I equipment (list can be obtained during the site visit)*
- *GA & P&ID Drawings of Hydraulic Presses (can be viewed during the site visit)*

4.2 Lab Environment

The following site conditions shall be taken into consideration in the design of the equipment:

- Altitude above sea level: approximately 1330 m above sea level
- Ambient Temperature: 19-22 °C
- Ambient Relative Humidity: 35-55 %
- The application is in a manned indoor laboratory.
- Available Power supply:
    - single phase 230 VAC
    - three phase 400 VAC
    - 100 A current supply

4.3 Proposal Documents & Requirements

4.3.1 Site Visit

It is highly recommended that a site visit be organised with the NMISA Force laboratory staff in order to better ascertain the HPU requirements and installation conditions. Bidders are to request a site visit by email at their earliest convenience. Kindly refer to the bid document for further details.

4.3.2 Schedule of Previous Works

The supplier shall demonstrate prior competence in similar applications. A schedule of previous works is to be attached to the supplier's submission. Each reference should include the following:

- *Brief description of reference*
- *Value of reference work*
- *Location of reference work*
- *Contact details of reference (or to be readily available upon request by the NMISA)*

4.3.3 Completion of works

The supplier shall successfully demonstrate the following to the Engineer prior to the commissioning and acceptance of the Works:

- *Equipment operation.*
- *Achievement of the specified performance requirements*
- *Control system operation (where applicable)*
- *Operation of all safety devices*

4.3.4 Guarantees

The supplier shall indemnify the NMISA against any factory defect or deficiency of workmanship. The supplier is to provide a defect guarantee or warranty for the supplied equipment.

A claim shall be lodged with the supplier for defects in the material, equipment or workmanship that render the Hydraulic Power Pack incapable of performing adequately to the specified performance expectations during the guarantee period. The supplier shall, as soon as possible after receipt of the claim, take the necessary steps to enact repairs or replacements as necessary. This is subject to the goods having been treated with reasonable care, in accordance with the supplier's operating manual.

4.3.5 Safety Requirements

The supplier, their goods and their craftmanship, shall comply with accepted industry safety regulations (e.g. the OHS Act No. 85 of 1993; Amendment Act No 181 of 1993; OHS Act 2009 Amendment: Pressure Equipment Regulation; OHS Act No. 85 of 1993: Driven Machinery Regulations etc.) and associated regulations. The supplier shall provide a comprehensive health and safety plan upon supply and/or commissioning of the equipment. All works are to be in accordance to *SABS ISO 9001:2015*

4.3.6 Additional requirements

Kindly refer to the NMISA procurement requirements, terms and conditions as stipulated in the Bid Document (*ToR document*) and the NMISA SCM tender documentation and/or the specified location on the NMISA online repository.

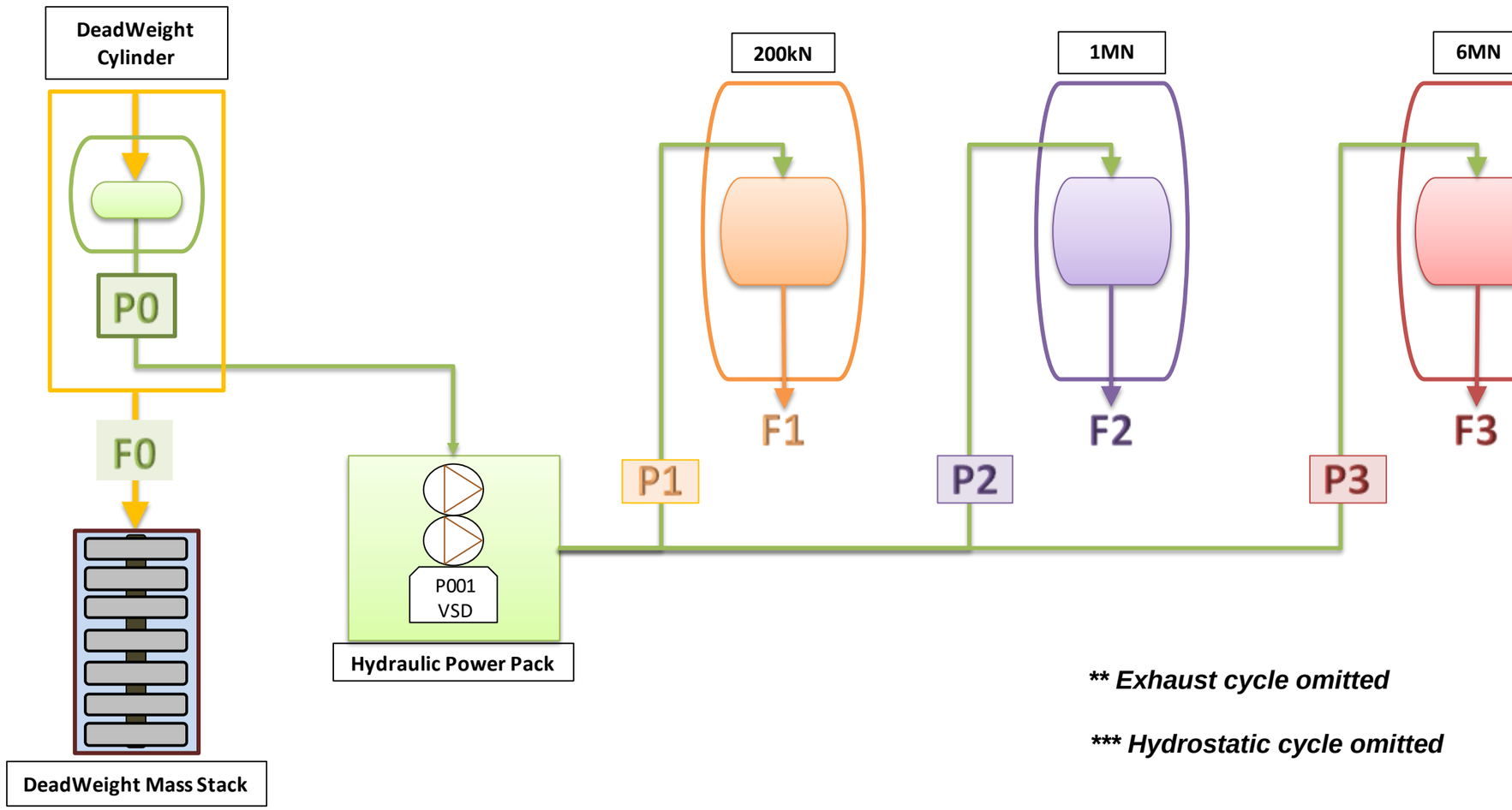
5 Appendix

5.1 Process Flow Diagrams

PROCESS FLOW DIAGRAM

Department: Force & Torque
Client: Force & Torque
Project Number: FL2018-P001

Section: Force & Torque
Date: Thursday, 12 March 2020
Revision: A



Comments: Hydraulic Amplification Force Machine : Hydraulic Transfer of Deadweight Force

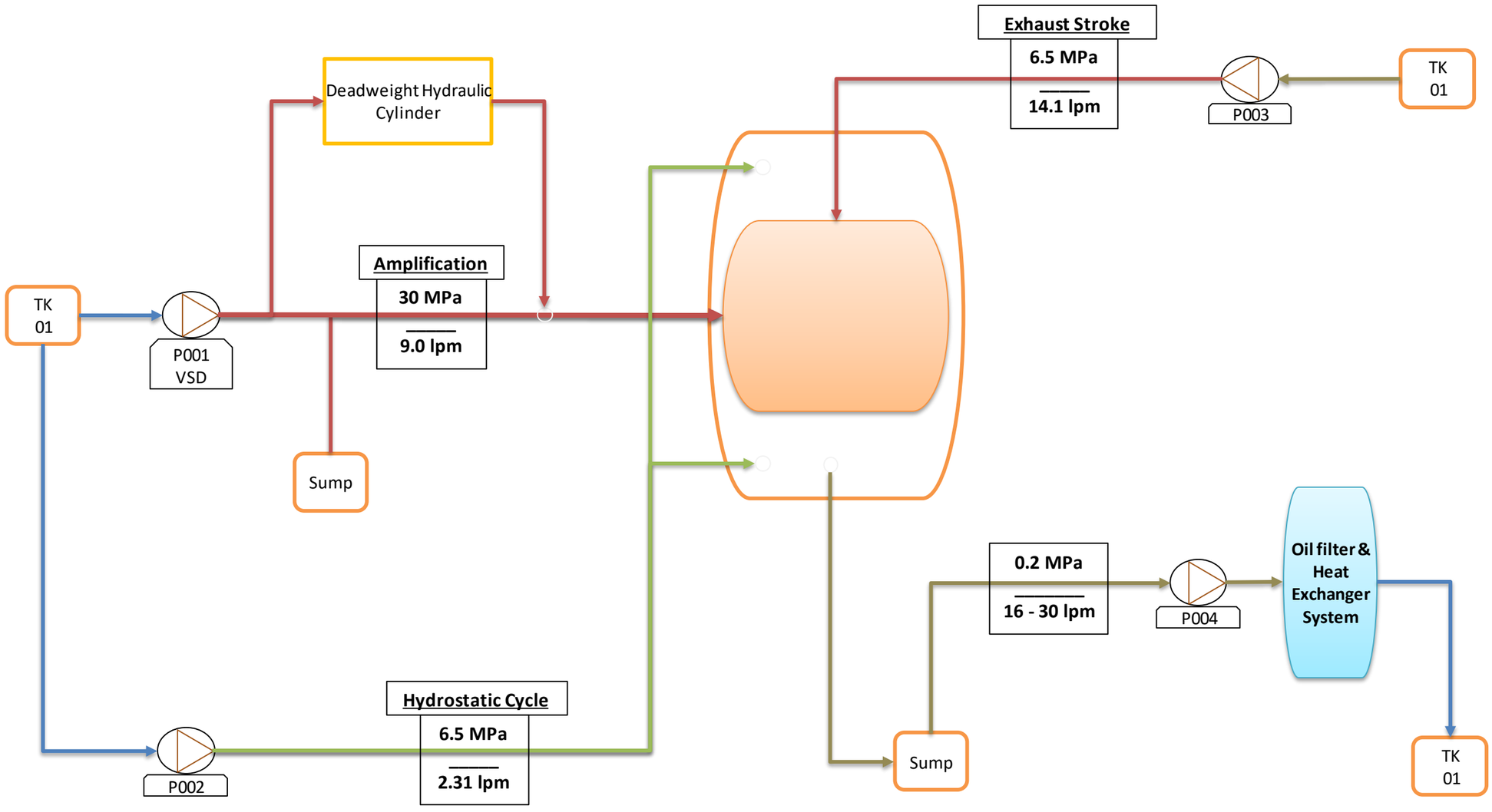
	Name	Date	Rev	Issued for:
Designed:	Mbuso Sibisi	Wednesday, 25 March 2020		RFQ
Checked:				
Approved:				

Figure 1 - Pressure Transfer Diagram

PROCESS FLOW DIAGRAM

Department: Force & Torque
Client: Force & Torque
Project Number: FL2018-P001

Section: Force & Torque
Date: Thursday, 12 March 2020
Revision: A



Comments:	Hydraulic Amplification Force Machine: Hydraulic Circuit – 6MN Force Press (All pressure values are nominal values during operation)		**Name**	**Date**	**Rev**	**Issued for:**
		Designed:	Mbuso Sibisi	Thursday, 12 March 2020		RFQ
		Checked:				
		Approved:				

Figure 2 - 6 MN Hydraulic Press PFD

5.2 Machine Photographs

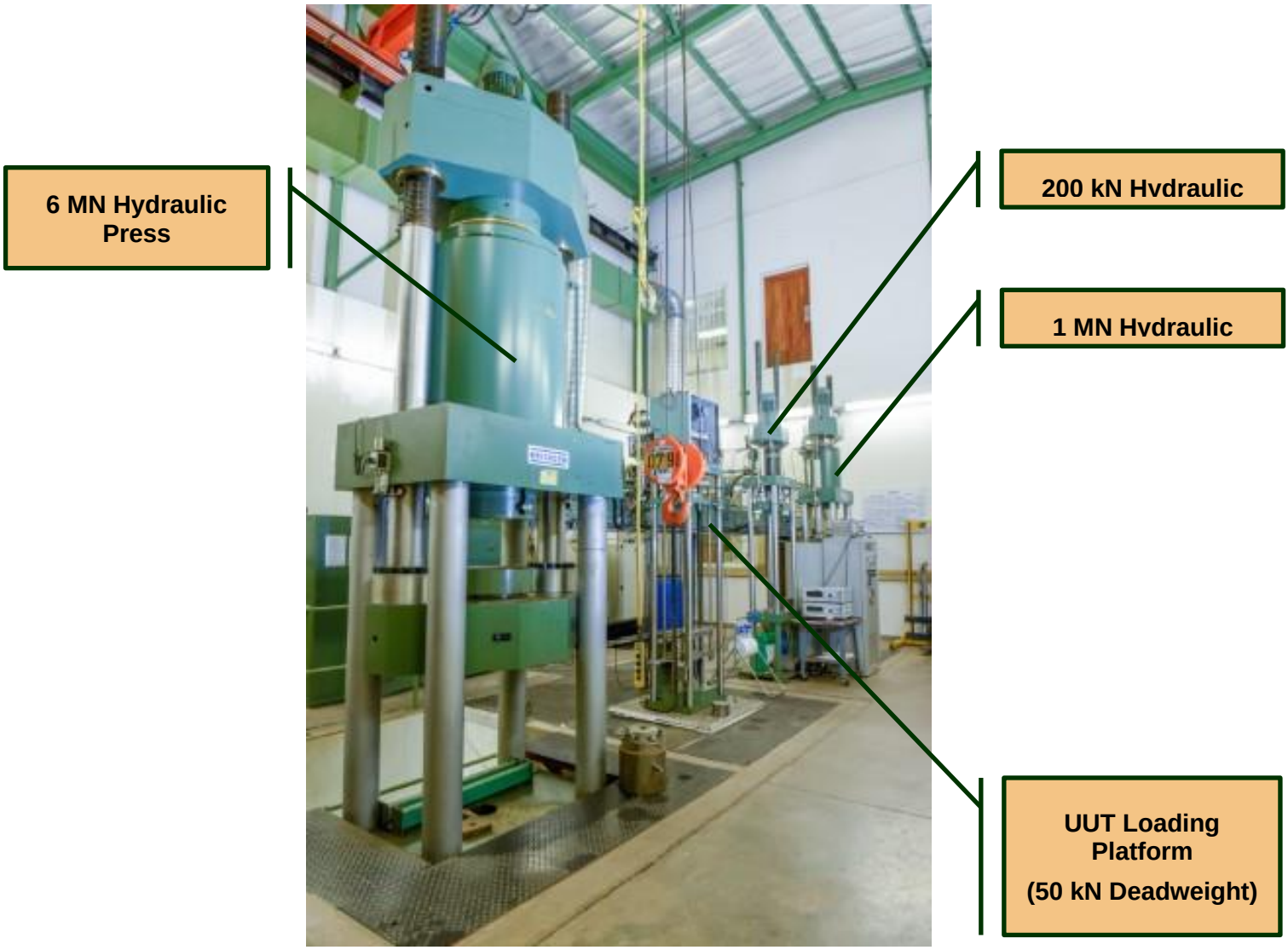


Figure 3 – Hydraulic Presses

Figure 4 – Force Presses

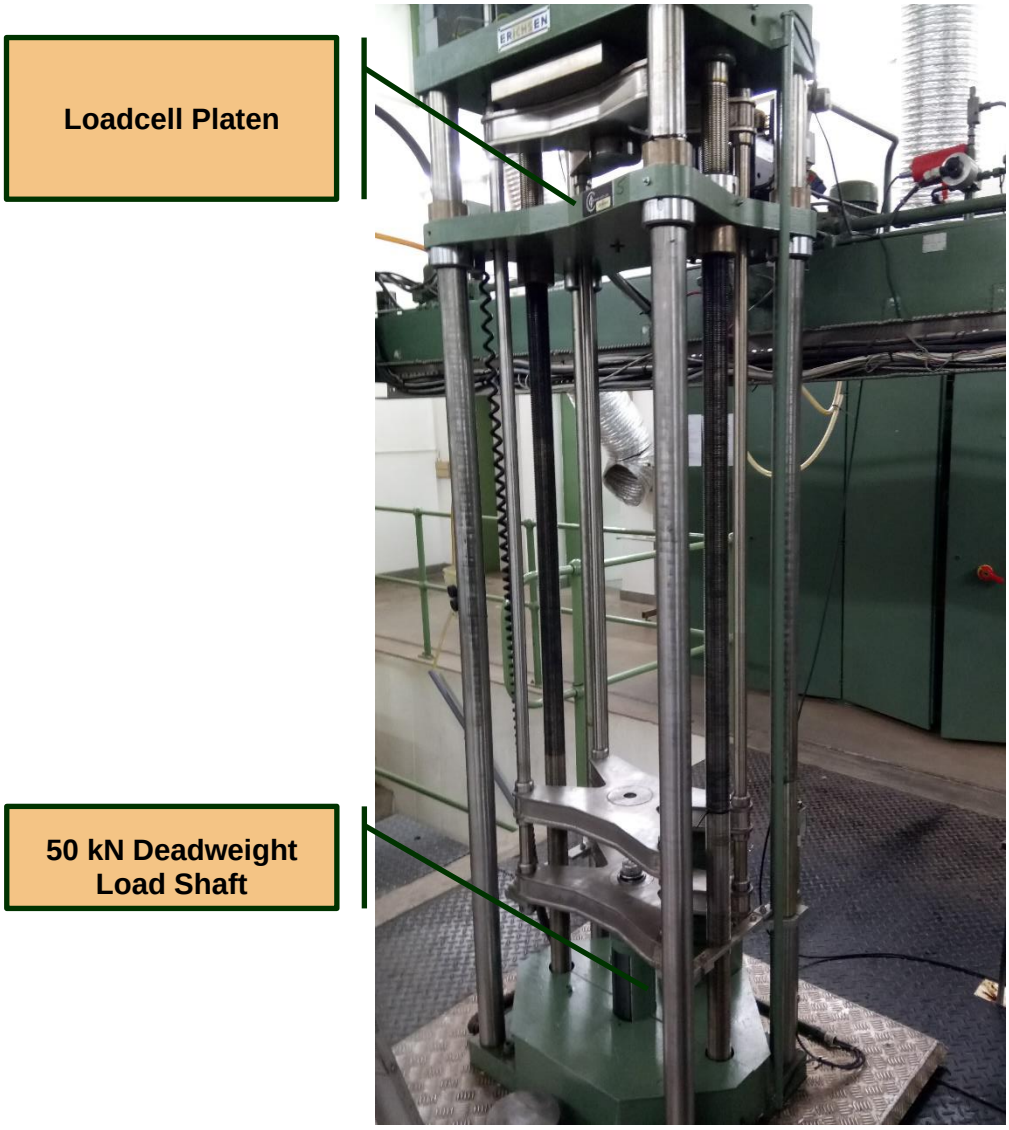


Figure 5 - UUT Loading Platform

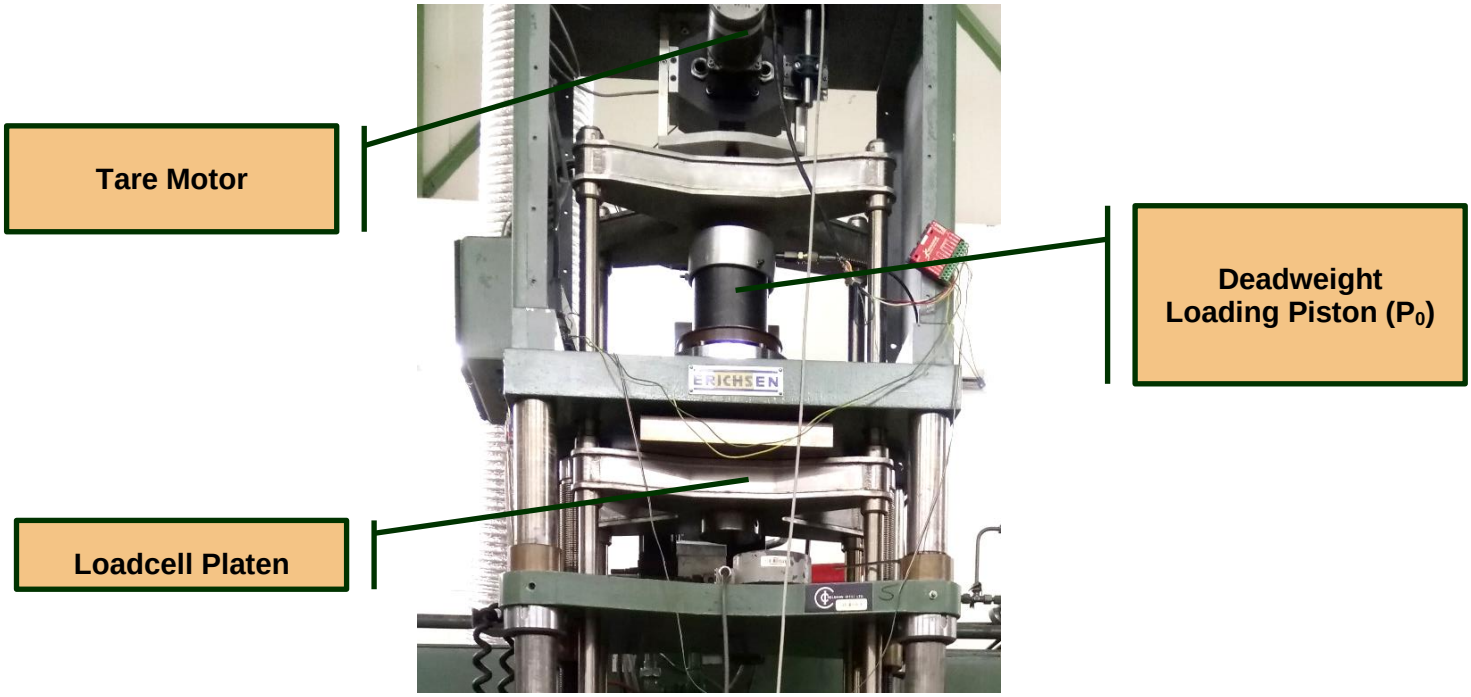


Figure 6 - Taring System

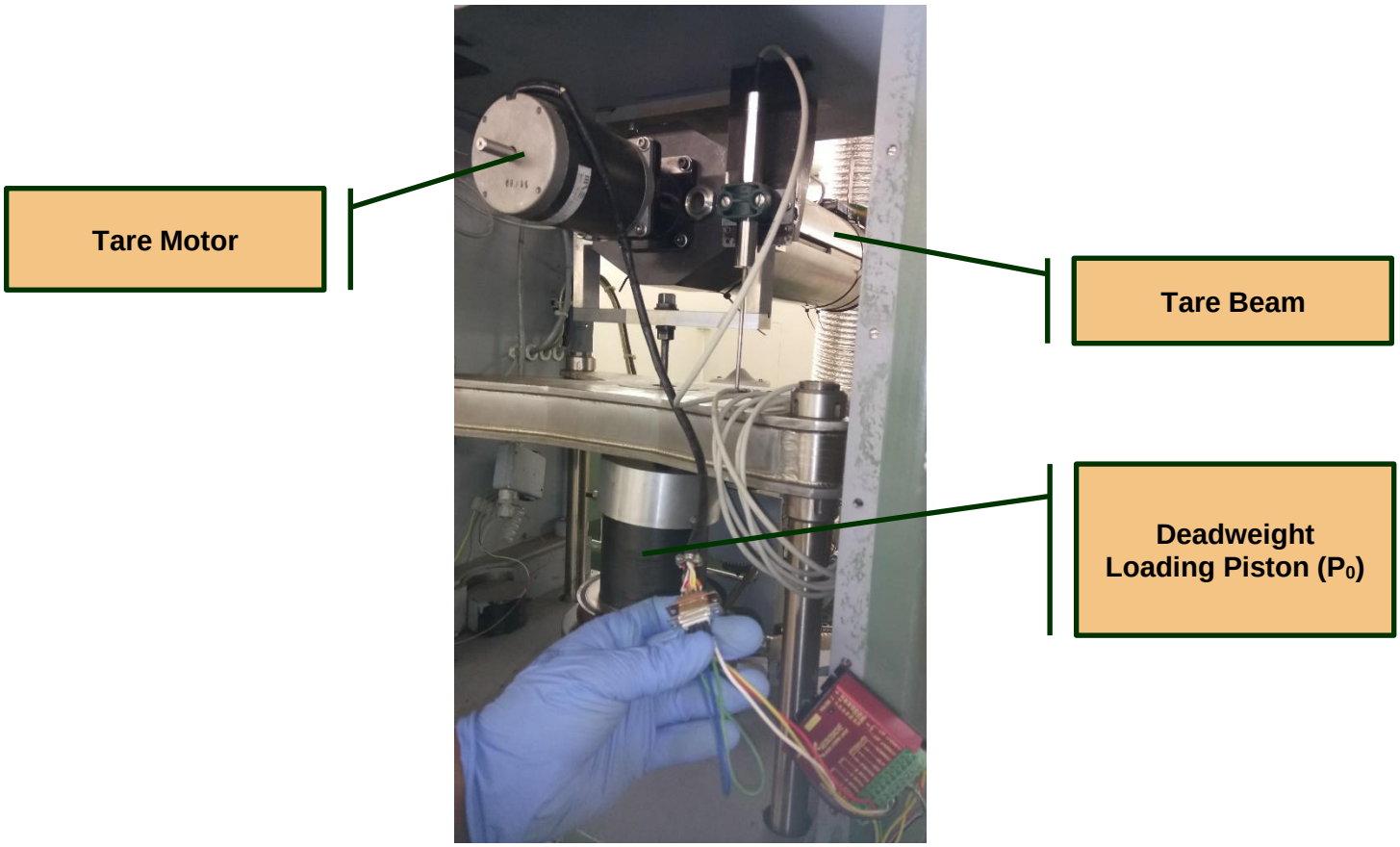


Figure 7 - Tare Beam

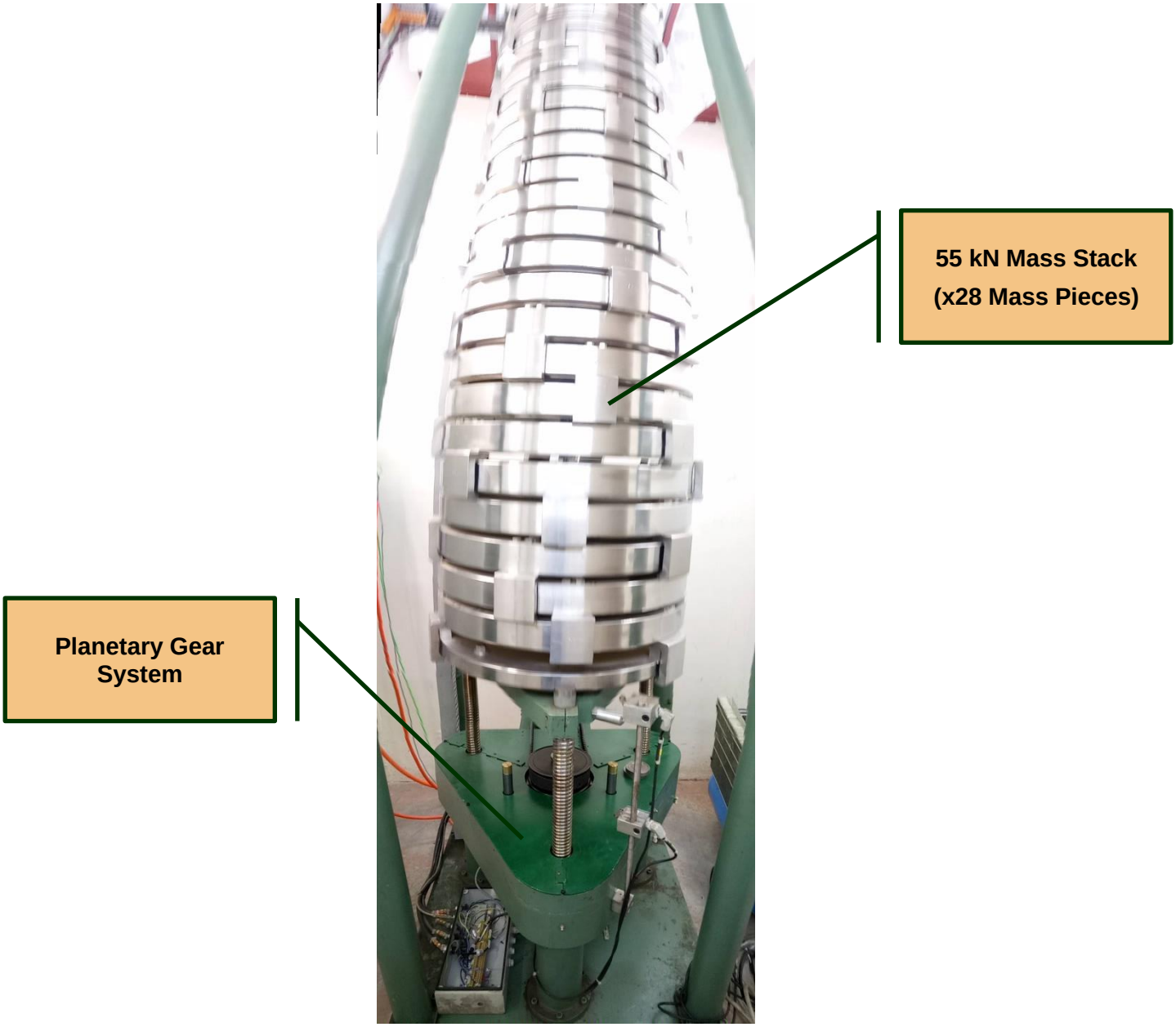


Figure 8 - Mass Piece Section

Figure 9 - 1MN Force Press

Figure 10 - Existing HPU valve block & instruments

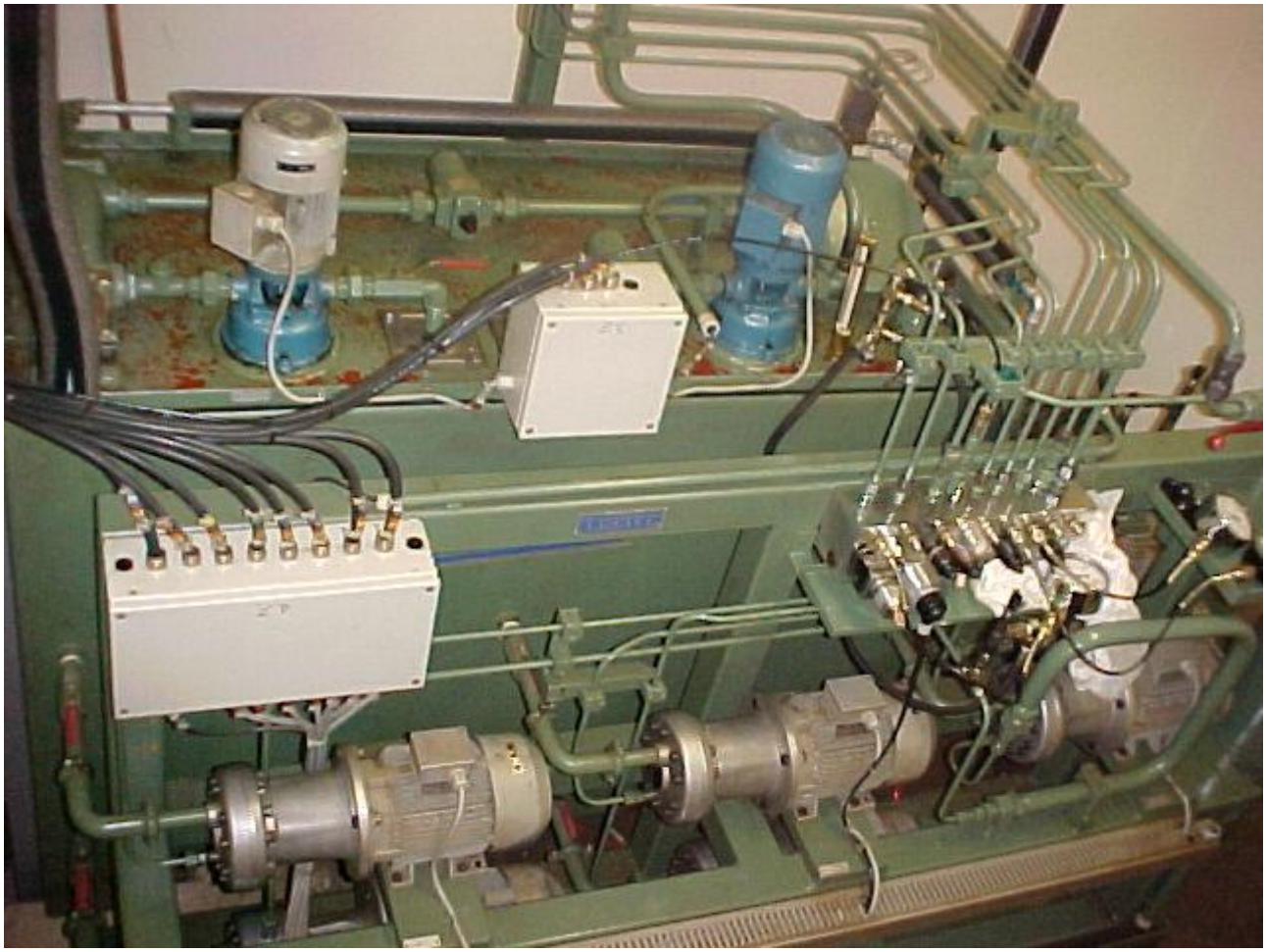


Figure 11 – Existing Hydraulic Power Pack

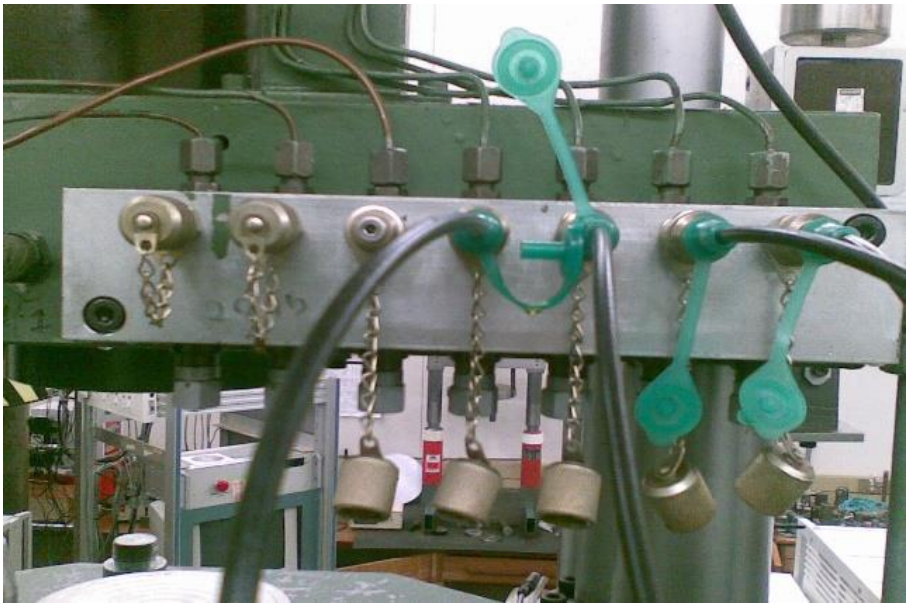


Figure 12 - hydrostatic bearing feed valve (1MN)

Figure 13 - hydrostatic bearing feed valve (200 kN)