Reducing Ultra-Clean Transportation Fuel Costs with HyMelt® Hydrogen

Quarterly Report

March 1 – June 30, 2006

July 2006

Work Performed Under Cooperative Agreement No. DE-FC26-02NT41102

For

U.S. Department of Energy
National Energy Technology Laboratory
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By

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DISCLAIMER

ABSTRACT

This report describes activities for the fifteenth quarter of work performed under this agreement. MEFOS, the gasification testing subcontractor, reported to EnviRes that the vendor for the pressure vessel for above atmospheric testing plans to deliver it by October 20, 2006. MEFOS performed a hazardous operation review of pressurized testing.

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1.0 PROJECT OBJECTIVES, SCOPE AND DESCRIPTION OF TASKS

1. Introduction

EnviRes and DOE executed the cooperative agreement for this work on September 19, 2002. This document is the fifteenth quarterly progress report under this agreement. Kvaerner, MEFOS and Siemens Westinghouse will conduct most of the significant tasks in this project through subcontracts with EnviRes.

1.1 Scope of Work

Phase I of the work to be done under this agreement consisted of conducting atmospheric gasification of coal using the HyMelt technology to produce separate hydrogen rich and carbon monoxide rich product streams. In addition smaller quantities of petroleum coke and a low value refinery stream were gasified. Phase II of the work to be done under this agreement, consists of gasification of the above-mentioned feeds at a gasifer pressure of approximately 3 bar. The results of this work will be used to evaluate the technical and economic aspects of producing ultra-clean transportation fuels using the HyMelt technology in existing and proposed refinery configurations.

1.1 Phase I Task Description

Task 1.1 Project Management and Planning

This task includes all project planning; experimental test plans; risk analysis; implementation of a bridge loan and project funding, purchasing, contracting and accounting systems with requisite auditing; and execution of contracts with MEFOS, Kvaerner and Siemens Westinghouse

Task 1.2 Preparation and Shipment of Feedstock Materials

This task consists of procuring 25 tons of coal, 15 tons of petroleum coke and 48 – 55 gal drums of aromatic extract oil; transporting the coke and coal to a pulverizing facility; pulverizing, drying and loading the coke and coal into bags; and shipping the feedstocks to MEFOS in Lulea, Sweden. EnviRes completed this task

Task 1.3 Predictive Modeling of the HyMelt Process

This task consists of generating detailed reactor energy and material balances for each feedstock using the Fact Sage pyrometallurgical thermodynamic modeling program. Kvaerner will perform detailed process simulation using the Aspen Plus process simulator. Kvaerner, MEFOS and EnviRes will evaluate and analyze the results of predictive modeling. This has been completed.

Task 1.4 Combustion Modeling and Analysis

Siemens Westinghouse will perform combustion turbine modeling using fuel gas conditions and compositions provided by task 1.3. Siemens Westinghouse completed this task.

Task 1.5 Design and Fabrication of Pilot Plant Specific Molten Iron Bath Apparatus

MEFOS will design and fabricate all solid feeding systems and oxygen injection systems required by the testing. EnviRes will assist MEFOS in designing the petroleum liquid feed system. MEFOS will design the shell of the high-pressure reactor. MEFOS and EnviRes completed the originally planned injection system for this task. MEFOS and EnviRes designed and fabricated a tuyere for submerged injection. MEFOS and EnviRes designed and fabricated a commercially feasible tuyere for testing in December 2003. We performed the testing as planned.

Task 2.0 Project Testing

Task 2.1 HyMelt Atmospheric Pressure Testing in a Molten Iron Bath

MEFOS designed and fabricated the petroleum liquid feed system. This injection system was tested in a cold flow environment. The injection systems were hot commissioned. Any equipment revisions indicated by cold flow testing and hot commissioning were made. Process performance testing was performed for each feed. MEFOS and EnviRes completed execution of this task.

Task 2.4 Above Atmospheric Pressure Testing in a Molten Metal Bath

Robert H. Wombles and Donald P. Malone of EnviRes met with Nils-Olov Lindfors, Janne Tikka, and Anders Stralberg of MEFOS at the MEFOS office in Lulea, Sweden on June 12 –13, 2006. MEFOS plans to receive the above atmospheric pressure reactor on October 20, 2006. We anticipate the refractory to arrive at approximately the same time. We finalized details for the pressure control system and approved the orders for long lead items such as the graphite ring and stopper.

Preliminary drawings of the above atmospheric reactor, the pressure control equipment and the gas sampling system appear at the end of Appendix I. The first view shows the reactor in its operating position as latches have been released in preparation for tilting. The second view shows the reactor being tilted.

Two weeks after the meeting MEFOS conducted a hazardous operation review of the planned testing. Appendix I contains a copy of this review. We plan to conduct above atmospheric testing in December 2006.

2.0 EXECUTIVE SUMMARY OF WORK DONE DURING THIS REPORTING PERIOD

EnviRes awaits a resolution of the refractory specification issues with MEFOS's vendors. We expect to begin pressure testing in late November or early December of this year.

3.0 Experimental

MEFOS Activities

No experimental activities were conducted by MEFOS during the reporting period.

Kvaerner Activities

Kvaerner performed no experimental activities during the reporting period

Siemens Westinghouse Power Corporation Activities

Siemens Westinghouse performed no experimental activities during the reporting period.

4.0 Results and Discussion

There were no experimental activities during the reporting period.

5.0 Conclusions

There are no conclusions to present

6.0 References

None

7.0 PLAN FOR THE NEXT QUARTER

We will complete all purchase orders for above atmospheric testing. EnviRes and MEFOS will draft an experimental plan for the work scheduled in December.

Appendix I

HYMELT – “Pressurised converter”

Hazardous Event / Situation

Time and Place: 26 June 2006 13:00 – 16:00 and
29 June 13.00 – 15:30 MEFOS

Attending: Nils Edberg, Chairman

Christer Larsson

Stig-Anders Granbom

Anders Strålberg

Lars-Åke Ekervhen

Thomas Olsson

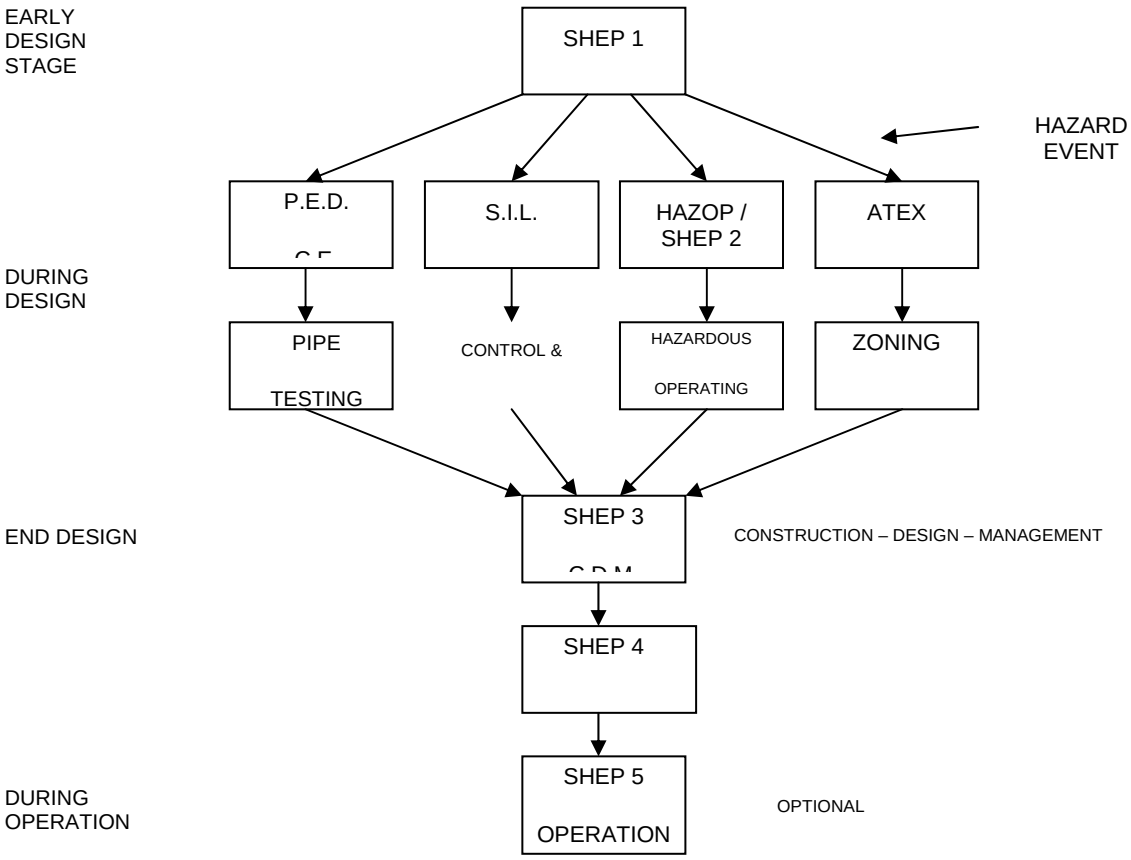
Nils-Olov Lindfors

Janne Tikka

Per Hellberg, secretary

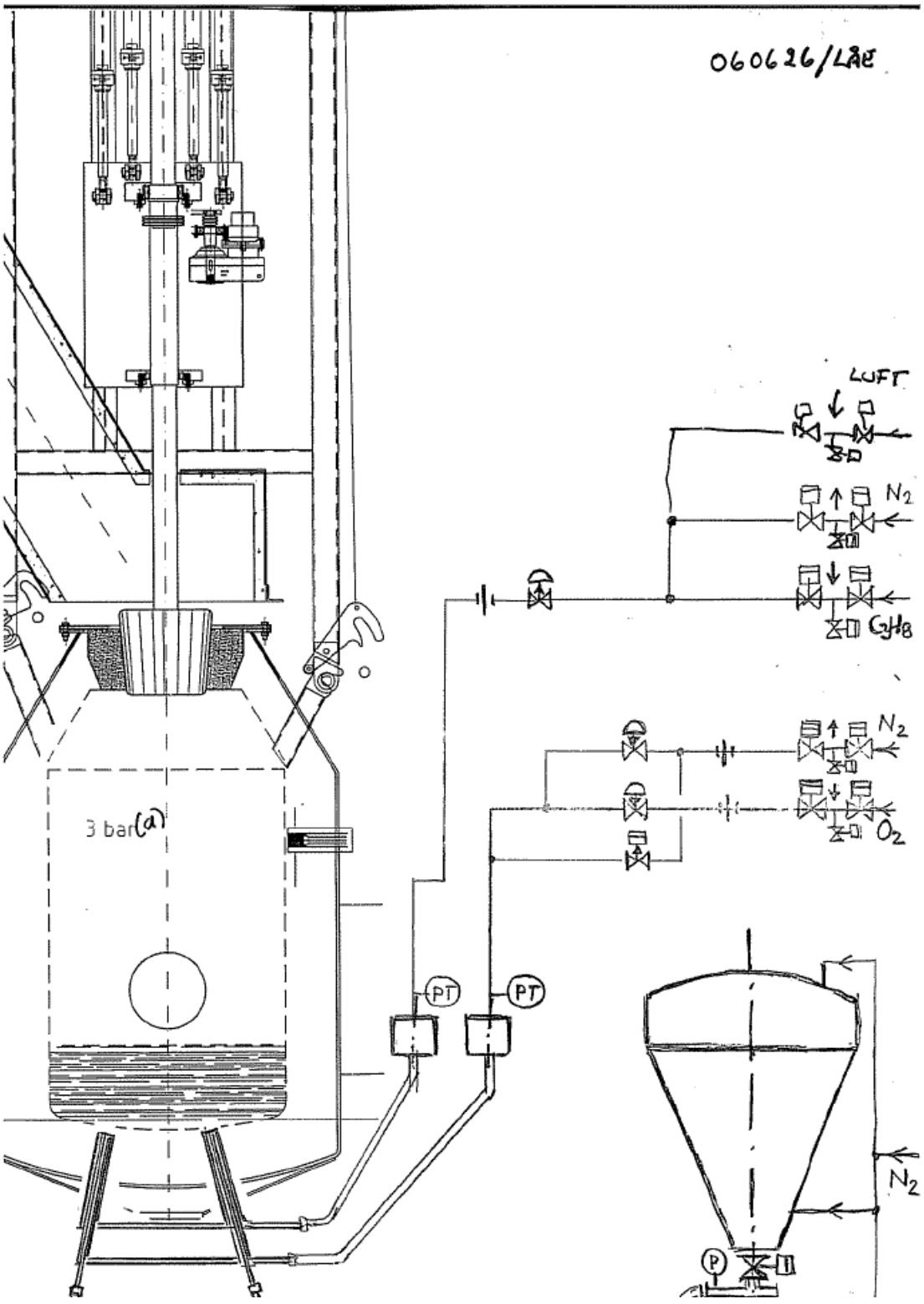
Introduction

A Hazardous event study has been performed within the project “HYMELT”. The study was done according to the following process steps.



Plant description

An overview of the plant is shown below.



The universal converter is used and the converter is pressurised during a certain process step. The pressure in the furnace is controlled by a “plug”.

The process steps are roughly as follow:

- Preheating with propane, using the nozzles in the bottom of the converter
- The hot metal is melted in the EAF
- The melted metal is put in to the converter. The hot metal has a high carbon content
- Blowing of the hot metal, reduce the carbon content of the metal.
- Carbonisation step with pressurized converter

The following remarks on the plant and process steps have been done during the meeting:

- The gas analyse inside the converter in very important. The gas analyse inside the converter can also be compared with the gas analyse in the off gas system.
- The insulation bricks are made of carbon magnesite.
- The plug is rotating, to ensure that the plug is not getting stuck.
- The vessel and the plug unit is linked together to prevent oscillations during blowing.
- Water cooling has to be installed in the plug lance, off gas hood and flange on top of the vessel.
- The assumed coal rate during carbonisation is about 10 - 12 kg /min. This gives the smallest gap between the plug and vessel, which is about 1 mm.
- The media to the converter is divided into tree cases (se plant overview)
  Inert: Nitrogen, Nitrogen
  Carbonisation: Coal, Air (Nitrogen)
  Blowing: Propane, Oxygen
- The propane pressure is limited to max 4.5 bar.
- No temperature measurement or metal sampling during trails only when the vessel is tilted.
- Pressure measurement is done in two cases, in the mantle and by measuring the pressure on the plug.

Hazardous Event / Situation

The Hazard study 1 is enclosed below. The following remarks have been done on the Hazard study during the meeting:

- Frozen slag in the top part of the converter.

- A cut through of the vessel. The vessel is constructed for a maximum temperature of 400 C, the normal temperature is assumed to be about 300 C.
- The vessel is painted with paint that changes colour depending of the surface temperature.
- If the pressure quickly rises in the vessel the plug is removed and nitrogen is injected in the converter, this should be done using automatic process.
- If the plug can not be removed from the vessel, an additional gas evacuation from the vessel must be constructed. Only use the nozzles to evacuate the pressure in the vessel is not enough.
- To increase the temperature in the top of the converter an air nozzle can be installed and used it when the vessel is not pressurised.
- Problems during filling and tapping are discussed, no decision are made.
- The support for the plug lance has to be heat protected.
- Due to the support for the plug lance the converter can not be tilted in both directions.
- Preheating of the converter is done by using the nozzles in the bottom.
- The major insurance financial is to low.
- We have two coal powder vessels is designed from 12 bar and 7 bar.
- When exchange sealing in the converter a working platform has to be designed and when exchanging the plug or reparation work at the off gas hood the whole support has to be removed and placed on the floor. A separate support for the hood has to be constructed.
- A new design of fixing the converter and plug lance support were discussed.
- A safety switch was discussed when working high up near the carne.
- When the power is cut-off nitrogen is injected with a pressure of 10 bar, a reduction of the pressure has to be installed.
- If electivity fails (dip) the plug automatic go up, this has to be done by using mechanics.

Per Hellberg

	HAZARD STUDY 1			
	Author: Per Hellberg	Title:	Meeting Date: 2006-06-26	
	Drawing Title:	Drawing No.	Revision	Meeting No:

Team Members (name and role)			
Christer Larsson	Lars-Åke Ekervhen	Janne Tikka	
Nils Edberg	Thomas Olsson		
Stig-Anders Granbom	Nils-Olov Lindfors		
Anders Strålberg	Per Hellberg		

Hazardous Event or Situation	Caused by	Consequences Immediate / Ultimate	Prevented or Corrected by	Emergency Measures / Mitigation	Action Required	Action By	Action No
External Fire	Hydraulic Oil	Loss of equipment Risk for life	Equipment construction	Fire Hose	Investigation		1
External Fire	Propane leakage	Loss of equipment Risk for life	Propane detection system in the slag pit	Fire Hose			2

External Fire	Coal powder leakage	Loss of equipment Risk for life	Protection shield (Splitter)	Fire Hose	Investigate remote control of the injection system		3
External Fire	Handling liquid metal	Loss of equipment Risk for life		Fire Hose			4
External Fire	Hot combustible gases	Loss of equipment Risk for life		Fire Hose			5
External Fire	Unexpected gas release of combustible gases	Loss of equipment Risk for life		Fire Hose			6

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Stig-Anders Granbom	Nils-Olov Lindfors		
Anders Strålberg	Per Hellberg		

Hazardous Event or Situation	Caused by	Consequences Immediate / Ultimate	Prevented or Corrected by	Emergency Measures / Mitigation	Action Required	Action By	Action No
Internal Fire/explosion	Unexpected gas release of combustible gases into the off gas system	Loss of equipment Risk for life		Fire Hose	Investigation		7
Internal Explosion	Water cooling leakages in the “Plug lance”	Loss of equipment Risk for life	– Measurement of cooling water flow (in/out) – Measurement of cooling water Temperature				8

Internal Explosion	Water cooling leakages in the flange on the top of the converter	Loss of equipment Risk for life	– Measurement of cooling water flow (in/out) – Measurement of cooling water Temperature				9
Internal Explosion	Water cooling leakages in the off gas hood	Loss of equipment Risk for life	– Measurement of cooling water flow (in/out) – Measurement of cooling water Temperature				10
Internal Explosion	Unable to remove the plug in the converter	Loss of equipment Risk for life			Investigation		11

SAFETY HEALTH AND ENVIRONMENTAL PROTECTION REVIEWS

	HAZARD STUDY 1			
	Author: Per Hellberg	Title:	Meeting Date: 2006-06-26	
	Drawing Title:	Drawing No.	Revision	Meeting No:

Team Members (name and role)			
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Nils Edberg	Thomas Olsson		
Stig-Anders Granbom	Nils-Olov Lindfors		

Anders Strålberg	Per Hellberg		

Hazardous Event or Situation	Caused by	Consequences Immediate / Ultimate	Prevented or Corrected by	Emergency Measures / Mitigation	Action Required	Action By	Action No
Internal Explosion	High pressure in the converter due to frozen slag in converter top	Loss of equipment Risk for life	– Plug removal (fast) – Nozzles in the converter bottom		– Splitter protection – Pressure measurements in the converter		12
Confined Explosion	Coal powder or propane	Loss of equipment Risk for life	– Propane detection system in the slag pit		Investigation		13
Unconfined Explosion							
Acute harmful/ Noxious exposure	CO gas leakage	Risk for life	– CO detection system in the building – Personal CO detectors				14
Chronic harmful/ Noxious exposure	Coal powder	Toxic					15

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Anders Strålberg	Per Hellberg		

Hazardous Event or Situation	**Caused by**	**Consequences Immediate / Ultimate**	**Prevented or Corrected by**	**Emergency Measures / Mitigation**	**Action Required**	**Action By**	**Action No**
Chronic harmful/ Noxious exposure	CO in the off gas system cleaning water	Toxic			Investigation		16
Environmental pollution							
Violent release of energy	Leakage in the hydraulic oil system				Investigation		17

Noise	Hot gases from the pressure control system	– Working environment – Personal damage	Personal safety equipment		– No working near the furnace during pressurised converter – Camera		18
Visual impact							

SAFETY HEALTH AND ENVIRONMENTAL PROTECTION REVIEWS

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Hazardous Event or Situation	**Caused by**	**Consequences Immediate /**	**Prevented or Corrected by**	**Emergency Measures /**	**Action Required**	**Action By**	**Action No**

		Ultimate		Mitigation			
Major Financial effects							
Moving objects	Tilting of the converter	Injuries			Investigation		19
Moving objects	Fixation of the support of the plug lance	Injuries			Investigation		20
Moving objects	Plug lance, up-down , twist	Injuries			Investigation		21
Moving objects	Transport of material in and out of the converter, Tractor, Truck, Crane	Injuries			Investigation		22
Moving objects	Transport of material in and out of the converter, Tractor, Truck, Crane	Injuries			Investigation		23
Trapping Hazards							
Ergonomics	Change of nozzles in the bottom converter	Injuries			Construction of a working platform		24

SAFETY HEALTH AND ENVIRONMENTAL PROTECTION REVIEWS

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Hazardous Event or Situation	Caused by	Consequences Immediate / Ultimate	Prevented or Corrected by	Emergency Measures / Mitigation	Action Required	Action By	Action No
Cutting hazards							
Hot surfaces	The Converter mantle	Injuries			Investigation		25
Hot surfaces	Change of plug and flange on top of converter	Injuries			Heat protection, radiation shield		26
Electrical hazards	Static electricity, Coal powder, propane	Risk of lift			Investigation		27
Loss of operator interface	Plug always removed	Loss of equipment Risk for life			Investigation		28
Loss of operator interface	The converter is inert using nitrogen	Loss of equipment Risk for life			Investigation, Rebuild the nitrogen supply system		29
Loss of critical functions	Pressure measurements in the converter	Loss of equipment Risk for life			Investigation		30
Loss of critical functions	Low pressure in the media system, nitrogen is injected	Loss of equipment			Investigation		31

SAFETY HEALTH AND ENVIRONMENTAL PROTECTION REVIEWS

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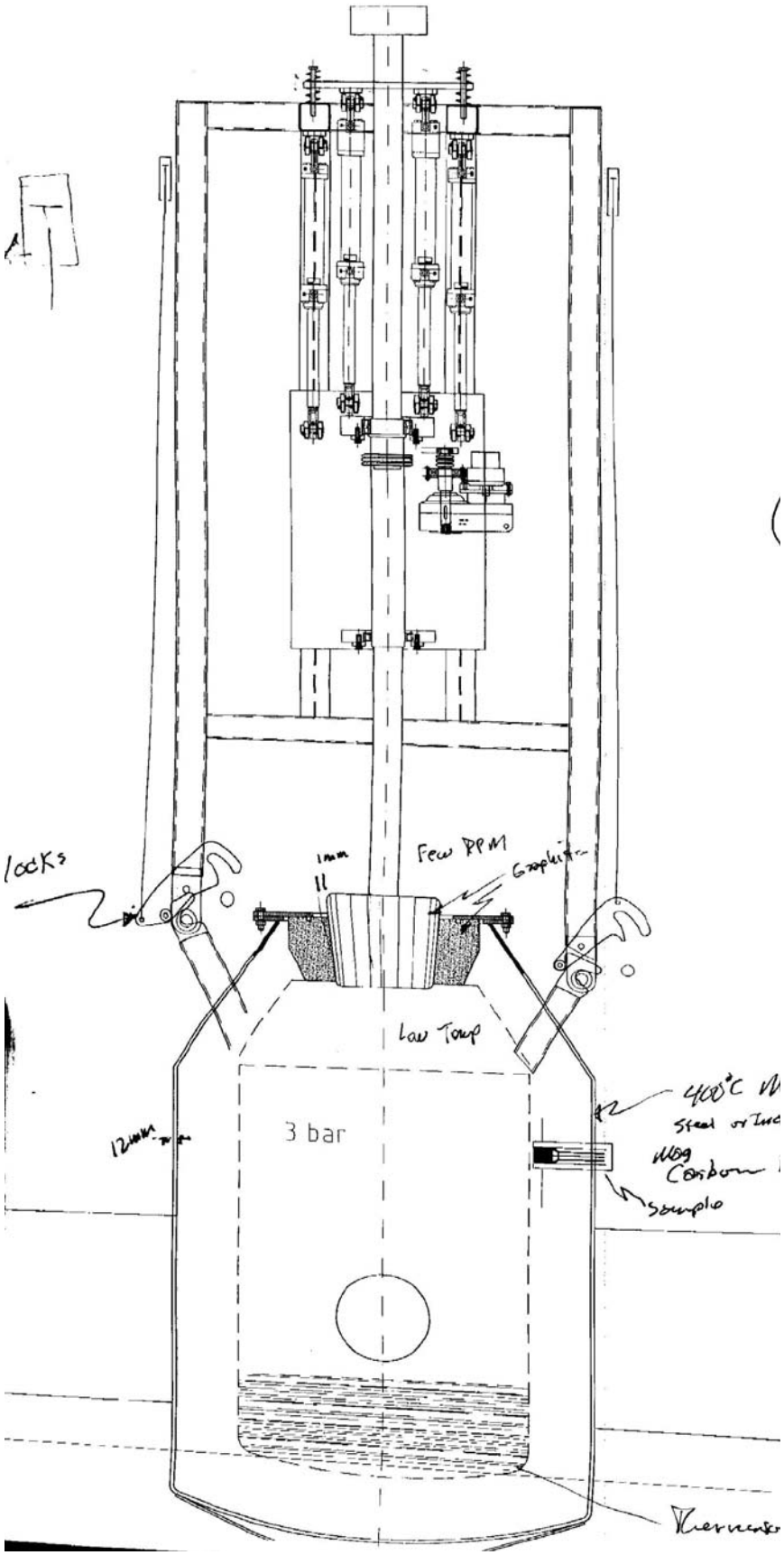
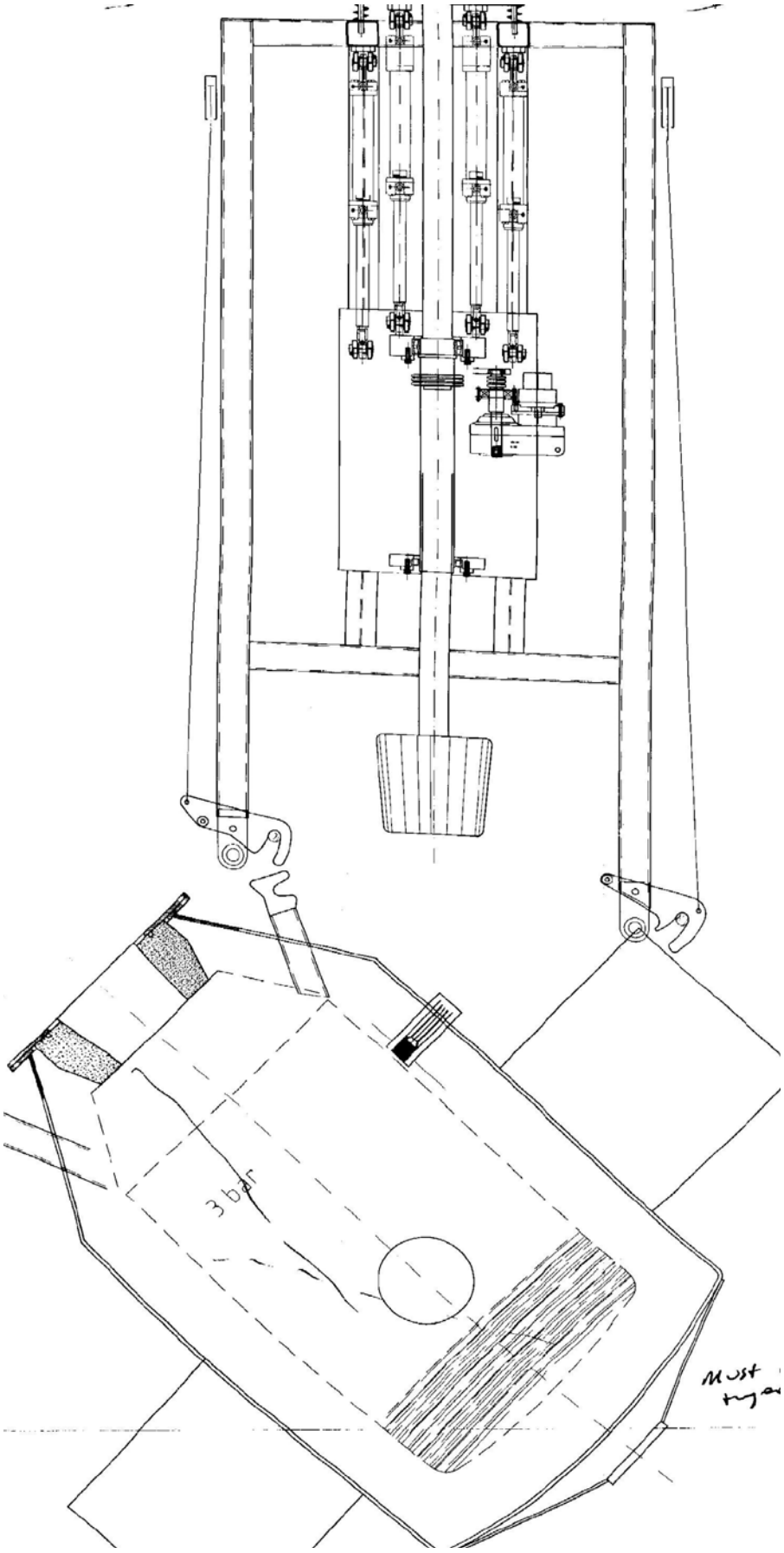
Anders Strålberg	Per Hellberg		

Hazardous Event or Situation	Caused by	Consequences Immediate / Ultimate	Prevented or Corrected by	Emergency Measures / Mitigation	Action Required	Action By	Action No
Loss of critical functions	Loss of pressure measurement in the off gas system	Loss of equipment			Investigation		32
Loss of non critical functions	Data logging	Loss of test data			Investigation		33
Loss of non	Researcher interface	Loss of test data			Investigation		34

critical functions							


locks
1mm
Few PPM
Graphite
Low Temp
3 bar
400°C
Steel or Inc
Sample


3 bar