ASSEMBLY NOTES
MACHINE NO 2

MONTPELLIER

Shrinking sleeve on intensifier cylinder:

Max dia of cylinder = 160·07
Min dia of sleeve = 160·04
} so 0·03 interference

Assembled OK with 200°C heating.

Intensifier oil cylinder 2302

Sent back to Sydney for thread chasing. It then had 0·3 end play.

The i.d. of the cylinder varied from 130·120 to 130·137 as ground.

At 1000 MPa, the diameter stretch is 0·178 mm, so question is whether 0·178 + 0·137 = 0·315 mm is too much for the 2 mm nitrile ring to cope with. At 700 MPa, it is 0·125 + 0·137 = 0·26 mm — probably OK.

Bore re-measured with 3 point micrometer

One end: 130·155 end
130·130 in about 50 mm
~~can't reach middle~~
130·120 in about 50
130·135 other end

10/1/91

Top end 130·168
~ 130·130 50 mm down

female

$PD = D_{measured.}$ + 3.804

with 3mm wire

male $PD = D_{measured}$ − 6.8038

with 4 mm wire

These nuts have been transferred to No 1 vessel.

New nuts made — see later.

No 2 Cylinder

Delivered 30/3/90
Cradle damaged
Vessel seems OK

Top female thread. (Measured before shrinking jacket)
Measured between 3mm wires, dia = 152.25 outer
152.16 inner end.

→ PD = 156.05 outside limits 156.103 – 156.503 for 6H fit.
to 155.96

Bottom female thread 152.39 – 152.43 (oval)
152.37 – 152.43

→ PD = 156.194 – 156.234
156.174 – 156.234
within limits but at least 0.040 out of round

NUTS

Top nut: Dmeas = 162.08
162.08

→ PD = 155.276

Bottom nut: Dmeas = 162.35
162.35

→ PD = 155.546

limits 156.023 } 6g
155.723 }

both outside limits

Bore of No. 2 vessel

at top	64·90
20 mm in from top :	64·925
20 " " bottom :	65·075
at bottom	65·075

Cylinder Minor diameter:

		limits
Top	153·6	153·505
	153·7	– 154·305
Bottom	153·86 – 153·95	
	153·85 – 153·78	

Within limits

Conclusions: Threads in vessel a little tight at top, but within limits at bottom although out of round. Minor diam's within limits

Nuts both outside limits, too small by 0·2 to 0·5 mm at least, preferably 0.4 to 0·7 mm bigger.

Aug 17, 1990

New nuts for No 2 Vessel

Top nut : Measured over 4 wires : 162.92

→ P.D. = 156.12

Crest diam. = 159.74 top
159.66 bottom

Does not fit : PD too big ; vessel thread should be chased out to fit nut.

Bottom nut : Over wires : 162.62

→ P.D. = 155.82

Crest diam = 159.53 parallel.

Just fits — bottom thread of vessel could do with a skim to take out out-of-round & give a free fit. Probably should not be cleaned up altogether.

HARDNESS OF NO 2 VESSEL

(heat-treated by Gow's 23-2-90)

using vacuum furnace 600°C 30 min
800°C 2 hrs
1020°C 3½ hr
nitrogen quench
temper 520°C 3½ hr
" 620 4½ hrs
Measured at 46 HRC

would not have been tempered in vac. furnace

Powanto order TO 101
23-2-90
Invoice R8547139

Info. from Kerry Weight, manager.

Tested on bottom end by Hawker de Havilland 9-7-90:

Three positions gave	393 HB	42 HRC
	406 HB	44
	420 HB	45

However, tests on 1½-2 mm thick slices cut by EDM from about 10 mm from ends gave:

Near bottom end (no 2): 41½, 42½, 41½ HRC
Near top end (no 1): 50, 49, 48½ HRC

Equotip tests from MetLab Mapel give 45 HRC at one end and 51 HRC at the other; 49 HRC half-way along.

Further tests on hardness of vessel 14 Sept 1990

Top end tested by de Havilland 10/9/90 :

Three positions :	505 HB	52 HRC
	514 HB	52 HRC
	514 HB	52 HRC

Also further results (certificate) on the EDM slices :

Near Bottom end : 41·5–42·5 HRC directly

42·5–44·5 " in traverse by $HV_{0.2}$ (micro hardness)

Near Top end : 48·5–50 HRC directly

50·5–53·5 " in traverse.

Thus the hardness is OK at bottom end and about 100 HB too high at the top end.

Based on tempering T = 600°C the diagram on p19 of the ASSAB Tool Steel Handbook suggests that the quenching temperature must have been somewhat over 1100°C at the top end and somewhat below 900°C at the bottom end. Gow's card says it was austenitized at 1020°C, for which the tempering diagram would predict around 47 HRC for a 600°C temper. Alternatively, if the austenitizing temp were uniform, the tempering temperature must have varied from about 550°C at the top to 630°C at the bottom (opposite sense of temp. gradient to that for hardening).

21/9/90

Discussion with Kerry Weight (foreman) and Sean Harrington (manager) at Gow's Heat Treatment suggested that the vessel may have been tempered in a smaller, muffle furnace adjacent to the vacuum furnace (often done to conserve energy unless vacuum furnace tempering is specified) and that this furnace may have been cooler nearer the door. This corroborates the view of Barry Moore (Aseab) that the hardness variation is probably a tempering problem.

INTENSIFIER CYLINDER No 2

Hardness was tested by Hawker de Haviland on 21/9/90 (this cylinder was re-stamped no. 1 on the outer sleeve by me in mistake, not finding the original no 2 , and so it appears as no. 1 on H.dH.'s certificate

The pressure connection end gave

HB 432, 429, 429 , equiv't to HRC 46

and the threaded end gave

HB 388, 390, 390 , equiv't to HRC 42

While 42 ± 2 HRC was the specification, the higher hardness at the top end is acceptable in the intensifier cylinder.

PRESSURE VESSEL No 2 — RETEMPER

According to telephone call to Kevin Sheddon, the vessel was 40 HRC one end and 43 HRC the other after Gow's had re-tempered (they were supposed to do it in the vacuum furnace).

Then I agreed that the vessel be re-ground as follows:

- OD to specified size (230.100 / 230.060)
- seal bore each end — 67.150 / 67.180
- main bore 65.450 / 65.500 with honed finish
- bottom c/bore 145.150 / 145.210
- chase threads to remove distortion

Plugs (top & bottom) to be 67.140 / 67.120
145.100 / 145.060

New furnace & hand all plugs were made.

ID checked in situ from top

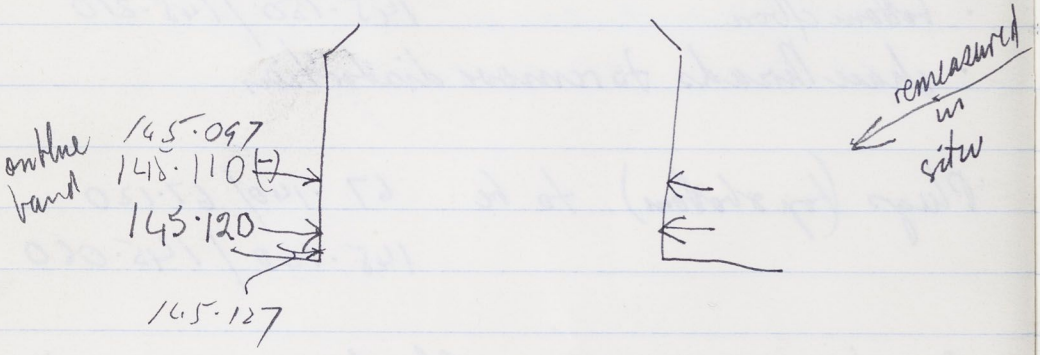
~~65.650~~ (bore honed)

65.650 (micrometer a bit wild; may be a few µm too big

~20 mm below O-ring

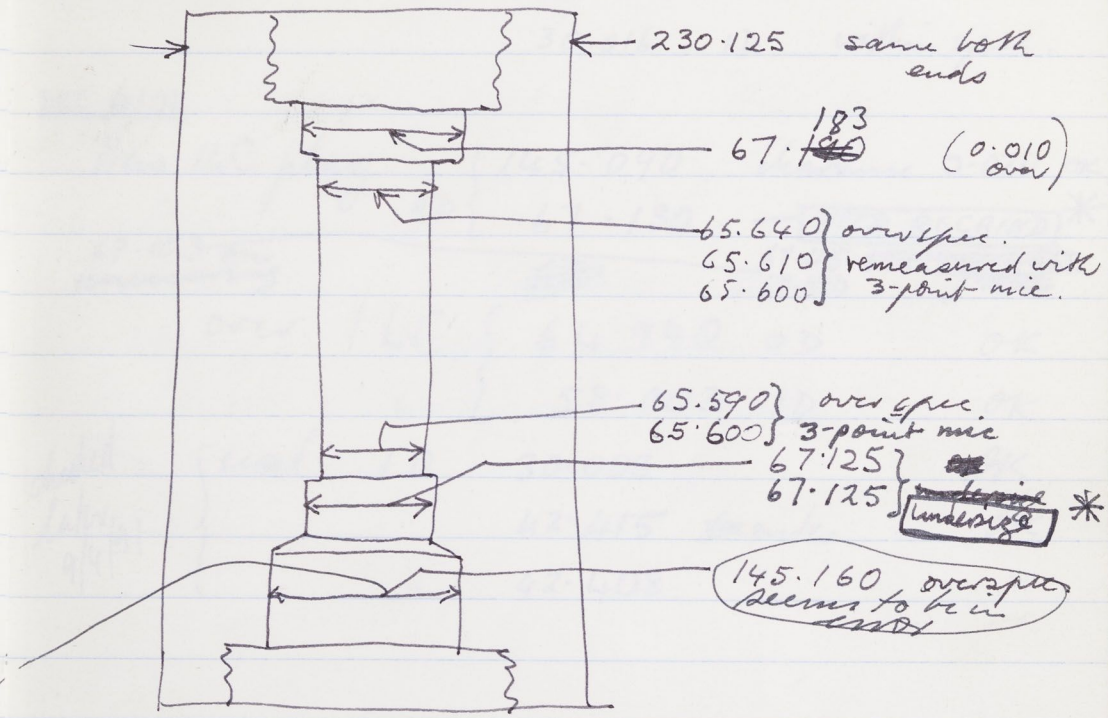
65.582 as far down as can reach

(65 below O-ring groove)



9.1.91

Pressure Vessel dimensions after re-grind:



Vessel threads been chased (a bit of chatter)
Top nut goes in OK : been semi-blacked
Bottom nut " " "
Inner top nut fits OK.

Not been remachined on bottom face * — done by Frank 24/1/91

DRG 3101

New furnace plug : 67·190 O.D.

Clearance in bore = 0·007 — rather small

30·016 I.D within spec.

actually −0·007 ie interference fit.

DRG 4101

New ILC plug : { 145·090 clearance 0·070 OK.
OD { 67·130 — NEED REGRIND *

67·103 on remeasuring ~~66~~ 67·115 ~~67·100~~ 67·090

over ILC { 64·940 OD OK
58·003 ID OK.

checked later 9/4/91 { seal ID 30·008 OK
" 42·415 ~~for~~ outer OK
" 42·408 "

25/1/91

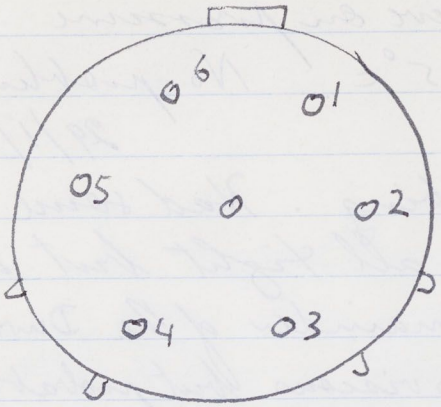
Shrank outer sleeve on pressure vessel, from 225°C. No problem.

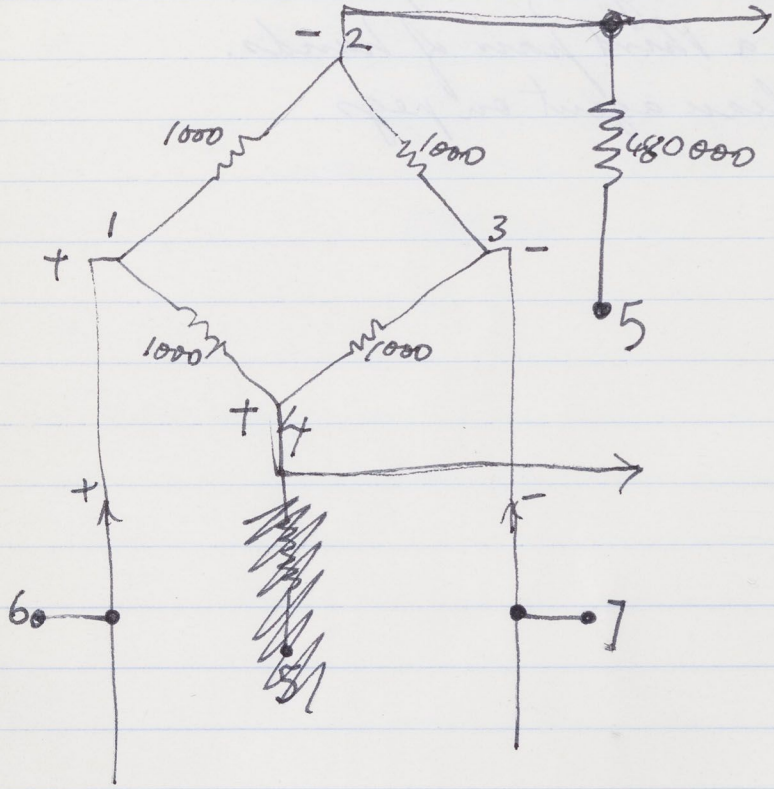
29/1/91

Wound copper tubing. Had some difficulties getting all tight but not too bad. Used remainder of the Duralco 132 cement. Pretty viscous but probably necessary for staying in place.

Could use a third pair of hands.

Also put release agent on pegs.


6
1
5
2
0
4
3


2
1000
1000
480000
1
3
5
1000
1000
4
6
7

Top Pressure Gauge

Labelled ASCO INSTRUMENTS

PR 851 7000 bars 129

Resistances measured with Wheatstone bridge (leads 0·08 Ω)

	Ω		Ω
1 – 3	1004	2 – 3	753
– 2	753	– 4	1004
– 4	753	– 5	480000
– 5	470,000	– 6	752
– 6	0·090	– 7	752
– 7	1004		
3 – 4	~~753~~ ~~0·080~~	4 – 5	470 000
– 5	470 000	– 6	753
– 6	1004	– 7	753
– 7	0·080		
5 – 6	470 000	6 – 7	1004
– 7	470 000		

0.496
11.254
11.750

$V_{in}0 = 0.496$
$V_{in}1 = 11.750$
$V_{out}0 = 0$
$V_{out}1 = 700$

700 MPa = 11.254 mV
20 = 0.322 mV
} to change $V_{in}0 \rightarrow$ ~~0.174~~ 0.818
$V_{in}1 =$ ~~11.258~~ 12.072

↓

see 9.3-91

Original dia — see off
9/9/91

6-3-91

First pressurization

Set gauge as at left.

Went up to 22·8 PV, 47 MPa on Heise.

Left over night.

Next morning 22·2 45·2

Changed excitation from 5V to 10V; PV now reading ~64. Came back to zero = 20·0

Reset config as at left. 9/3/91

PV	Heise		
~~10·0~~	~~10·5~~	Put in new valves & solenoid air valve	
~~47~~	~~44~~	Protais	intensif in & out
9·7	11·0	.	
97·0	102·0	.	
200·9	209·2	190	
303·9	315·0	300	
403·9	416·0	402	
497	513	500	intensifier leak
dropped back			
340·5	350·0	330	11.34

slow leak. Released

0·1 ~-20 D later back to +10

D = 65·6^{35} ~~00~~ down 20 mm

65·~~508~~ 580

ie no significant stretch at this stage.

Re-zeroed Heise

	PV		Heise		Protais
Zero:	0.0		0		0
Bottle	9.6		10.0		
Primed	98.8		102.7		94
	205.4		211.0		196
	310.9	9.0	319.9		307
	407.6	10.3	417.3		402
	502.0		514.0		504

Moderate leak; not in p.V. when valved off; not showing in bubbler ~~of~~ intensifier:

~~413.0~~ 404.0		Δ=7.0 413.0		395
304.4	7.3	311.7		296
206.1		211.0		204
108.7		111.0		105
55.9		55.7		48
0.3		−1.0		0
0.1		0.0		0 next morning

From graphical plot the Heise gauge reads ~~1.026~~ 1.058 times the PV gauge, ie have to increase the scale of PV by factor ~~1.026~~ 1.058, ie 11.254 mV → ~~11.547~~ 11.908

ie $V_{in}0$ = ~~0.796~~ 0.818

$V_{in}1$ = ~~11.843~~ 12.365

reset after ~~Calib~~ test to 730 kPa

JEE 16/3/91

Calibration

9-3-91

From a graphical plot of PV vs Heise, the Heise gauge reads 1.026, times the PV, ie have to increase PV readings by factor 1.026, so instead of FS being 11.254 mV, need to set FS = 11.254 / 1.026 = 10.968 mV (presumably 10 V excitation is a bit low)

$\therefore V_{in}0 = 0.818$ $V_{out}0 = 0$

$V_{in}1 = 11.786$ $V_{out}1 = 700$

Pumped up

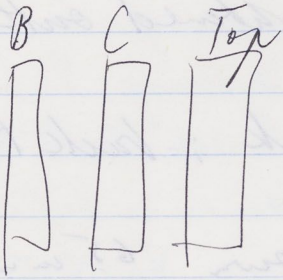
PV	Heise	Protais	
202.8	203.2	186	½ hr wait
298.4	298.2	282	1 hr "
393.2	391.0	376	¾ hr. v. slow leak
509	507	498	~½ min
502.6	501		1½ min
498.7	497.0		2½ "
393.2	391.3	382	½ hr
295.2	295.2	285	"
204.9	204.8	197	

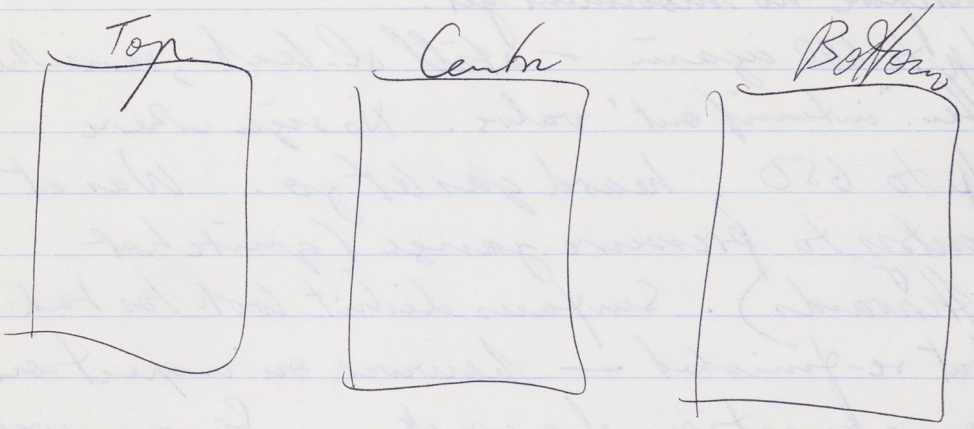
11/3/91

Took off Heise gauge for higher pressure tests.
Bottle pressure 9 MPa.
Up to 540, leak; tightened outlet from "intens. in" valve.
Up to 600 - still some leak; back to zero
Can't see where leak is.

I.D. = 65.580 down 65 mm
= 65.640 " 20 "

Therefore no movement yet.
Up to 600 again - still sl. leak, somewhere after "intens. out" valve. No sign where
Up to 650, heard gasket go. Was at entry to pressure gauge (quite hot afterwards). Surfaces didn't look too bad but re-finished — however on inspection some question of a crack. So removed Top gauge, plugged & then pumped up ~~by~~ by viewing Protais oil gauge. Got to 640 bar on Protais, probably 650 MPa but leaking as fast as pumping.
Closing "intens. out" gland showed up leak rate. Plumbing leak - tightened.
Another cycle: 660 MPa. This time leak at entrance to intensifier


B
C
Top


Top
Centre
Bottom

13/3/91

Tightened intensifier connection.
Put gauge back in.
Up to 684, leak. — two cone seals
Up to ~~7##~~713 — cone seal
Up to 724 —
Up to 732 — holding reasonably.

ID = 65.580	down 65 mm	ie no measurable stretch
= 65.645	" 20 mm	

Pressure zero now shifted to 2.8

14/3/91

Went to put in new (2A) furnace plug & found it to be oversize. So changed to no 3 plug (Frank had original 2 at home).
Bottle pressure : 8.4 − 2.8 = 5.6
Pumped to ~80 MPa.
Tried furnace — shorted at top & bottom leads, seems to be at the brass rods. Blew top fuse. Earlier had to swap leads into fuse holders to set get top & bottom connected to correct meters.

15/3/91

Frank reorganized feed thro' with heat shrink on stems to avoid shorting (most of the leads had shorted).

Pumped up again — leak at top plug ~~at~~; dropped pressure — stopped at 16
pumped — leak started at 41 again
Repeated exactly on next cycle.
Finally spec jacket leak appeared so abandoned test.
Turned out that I had forgotten to put the inner sleeve in, so top jacket seal O-ring was beginning to be cooked. The leak was probably at the join of PSZ & Al_2O_3 due to no chamfer on the PSZ.

16/3/91

Resetting zero of pressure gauge:

Previous setting was $V_{in}0 = 0.818$ } 700 MPa
$V_{in}1 = 11.786$ } = 10.968 mV

which after the 730 MPa test gave a zero of 2.8 MPa

2.8 MPa equiv to $\frac{2.8}{700} \times 10.968 = 0.044$ mV, so added this to both above readings, now being

$V_{in}0 = 0.862$
$V_{out}0 = 11.830$ } 700 MPa ≡ 10.968 mV.

(1)

(3) Same furnace as for machined. Ramping 30°/min

0	243		235
1	416	(1/2) 529	373
2	628	649	554
3	752		656
4	857		705
5	896		721
6	924		727
7	932		729
8	952		732
9	~~991~~ 1007		730
10	1018 – 30 / 1040		696 / 719
11	1044	1013	675
12	989		630
13	891		574
14	770		500
15	590		395
16	~~394~~		275
17	278		168
18	155		114
19	112		84
20	95		

18/3/91

Put new jacket on calib ~~###~~ pistons, after chamfering PSZ a little.

Have to be very careful of mitre ring when re-inserting — needs the O-ring compressing washer reduced a bit ~~on~~ at top jacket seal so as to reduce gap between nut & piston.

Pumped up from 4 MPa gas — a bit slow.

Profile ① left & self-tune.

Control Point ⑤ = 500 0·56/0·20/1·00

Power varying too much to measure

Changed to control on ⑥, SP 550, 0·56/0·2/1·00

Started profile ② but soon abandoned p/c spec. leak. Pressure ~ 280 MPa

There is also still a top plug leak.

Sprang a spec leak so abandoned.

Same problem as before — put more chamfer on PSZ piece.

Pumped up again. Changed furnace settings to 0·4/0·2/1·00 & SP to 450

Follows ramp at about 75% power (9·5, 5 & 12·5 A in T C & B resp.)

Pumped to 280 MPa (at ~300°C).

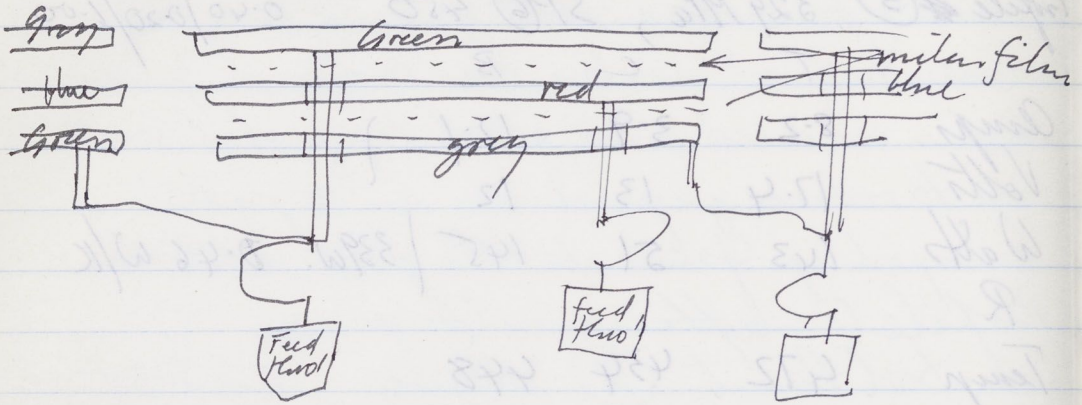
At 315 MPa, bubbles started at no 2.
No bubbles at no 3 so far.

Profile ~~#~~ (3) 329 MPa, SP (6) 450 0·40/0·20/1·00

	T	C	B	
Amps	8·2	3·9	12·1	
Volts	17·4	13	12	
Watts	143	51	145	339W. 0·46 W/K
R				
Temp	472	434	448	

20/3/91

Put in mild steel specimen length 17·5, with internal load cell and thermocouple without capac. plates. Steel pistons. 26 ~~Position~~ Ran at 200 MPa ~ 250°C
Tried to deform — seemed to deform only a few mm up to 50 kN (t), ie very strong.
Took out — sl barrelling


Grey
blue
green
Green
red
grey
mylar film
blue
Feed Fluid
Feed Fluid
green
red
grey
grey
blue
green
(167)
138
green
140
(169)
measured without body earthed
— with in brackets
red
blue
146
(172)
145½
(175)
142
(172)
grey
133
(157)
dl less sensitive

29-3-91

Internal Load Cell

Set up similarly to that in No 1 machine except that the connections to the plates were all brought out downwards thro' holes in the lower plates & the connections made more directly to the feed throughs. An extra layer of teflon insulation (1.1 ϕ) was put over the leads down the stem, which fitted into 1 mm wide grooves.

First measurements on diagram opposite. Red plate needs to be raised a little. After readjust,

Red-green = 170

Red-grey = 170

So need to lower blue plate v. slightly. Readjust to

Blue-green = 170(-)

Blue-grey = 169

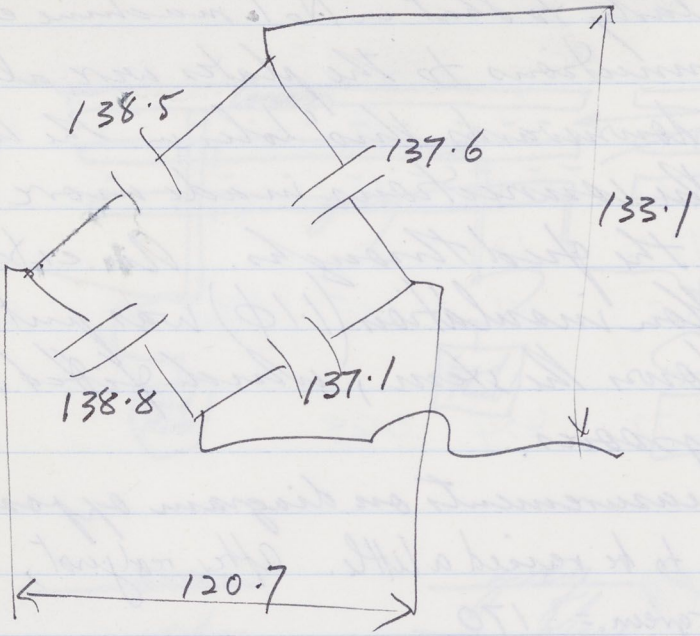
Should be OK now

Green-grey = 170

Red-blue = 156 ← suggestive of some sort of minor short or leakage.

Readjusted later — see over.

This time the lead from preamp to front panel was taken through a copper



HAl 1	~~50.0~~ ~~10.0~~	acts on doors
LAl 1	1.0	
Hys 1	2.0	
Hi r 1	nonlatch	
HAl 2	50.0 → 100	acts on pump
LAl 2	240.1	
Hys 2	2.0	
Hi r 2	nonlatch	

conduit for more shielding, & was terminated at the meter, to which the power for the preamp was also brought. Meter reading now ~~[illegible]~~ very steady.

Capacity readings now as at left

Set zero on meter — it seems to vary a bit from one loading to another, by about 0.1 kN; seems a bit too much to be friction on the assembly piston. Need to check with specimen removed.

Loaded up to 6 MPa on oil pressure gauge (area of jack = 0.00344 m^2, so 1 MPa → 3.44 kN/MPa). Set Calif roughly at this.

ILC zero at zero p fairly close to 0.0

On applying bottle pressure (15 MPa) zero of ILC went up to 4.16, settled down to 4.02, p = 16.5

Pumped to	55.0		ILC 11.70	
	101	100	21.29	20.93
¼ hr on	99.5		20.67	
so	97.0		20.09	
	96.6		20.01	

100 MPa

Needs 2.8 MPa = 9.6 kN to overcome friction

at 100 MPa pressure

35 kN reading at 8.0 MPa

− 20 − 2.8

15 kN signal 5.2 MPa ≈ 17.9, say 18 → ~18 kN load.

Release oil pressure, reading = 31.8

− 20.0 zero

11.8 kN residual friction

200 MPa

Pumped up:

201	MPa	33.[illegible]	
199		33.33	40°C
201		33.34	
200		32.71	29°C

Friction about 5.2 MPa = 18 kN

zero now ~ 31.48, 199.5 MPa

contact 16.47 mm, pumped to 10 MPa 44.0

= 5.2 fr. − 31.5

4.8 MPa

= 16.5 kN 12.5 kN reading

release oil pressure, reading 44.3

31.5

12.8 kN

residual friction

300 MPa near end of stroke (started about 1/4 stroke)

300 MPa

	301	30.85	35°
	300	30.80	
	301	30.75	33°
¾ hr	298	30.47	29°

Friction nearly 8 MPa = 27 kN up
6½ MPa = 22 kN down

LC zero moves around a bit with piston movement

	POS	17.0	30.72
		16.7	29.63
		16.5	29.63
contact around here →		(16.35)	33.88
12 MPa		(16.23)	45.0
			−30.0
			15.0 kN

friction 6

6 MPa ≡ 20.6 kN

Reliant pressure.

45.7
30.0

15.7 kN friction

16.5	30.67
16.7	30.65
17.0	30.64
17.5	30.69
17.0	29.56
16.7	29.54
16.5	29.54

Friction consistently ~6 MPa ≡ 21 kN

16·7 30·57

17·0 30·57

17·5 30·63

Seems to be a drag of ± 0·5 kN on the load cell — due to specimen assembly being eccentric ??

Switched on FURNACE SP 300, ramp 30, control on T/C ⑥

TC⑥ = 200 P = 336 TC② = 63

ILC = 30·43 POS = 17·50

TC⑥ = 250 P = 349 TC② = 86 ILC = 30·30

300 364 113 30·13

overshot 5-6°C

½hr: 300 390 371 29·55

Took ~ 9 MPa to move → 31 kN

7½ to keep moving → 26 kN

Load zero = 28·25 moving up

44·5 at 14·0 MPa

= 48·1 kN

28 25·8 zero

16·2 kN ↔ 22·3 kN

ie 16 kN registered for 22 kN actual

Friction back = 6·8/7 MPa = 23 kN

T/C ② went on up to 378°C. Bottom current 12A

Was ~6 kN in no (1) & (3) –
5.5 kN later in (2)

0.030 MIN
on 42.4 ϕ

Furnace off.

When EC (2) ~ 100°C, dropped pressure from

~340, ICC ≈ 29.9

150 MPa ~ 28.5

100 " ~ 19.1

50 " 9.0

15 " 2.0

Summary of friction

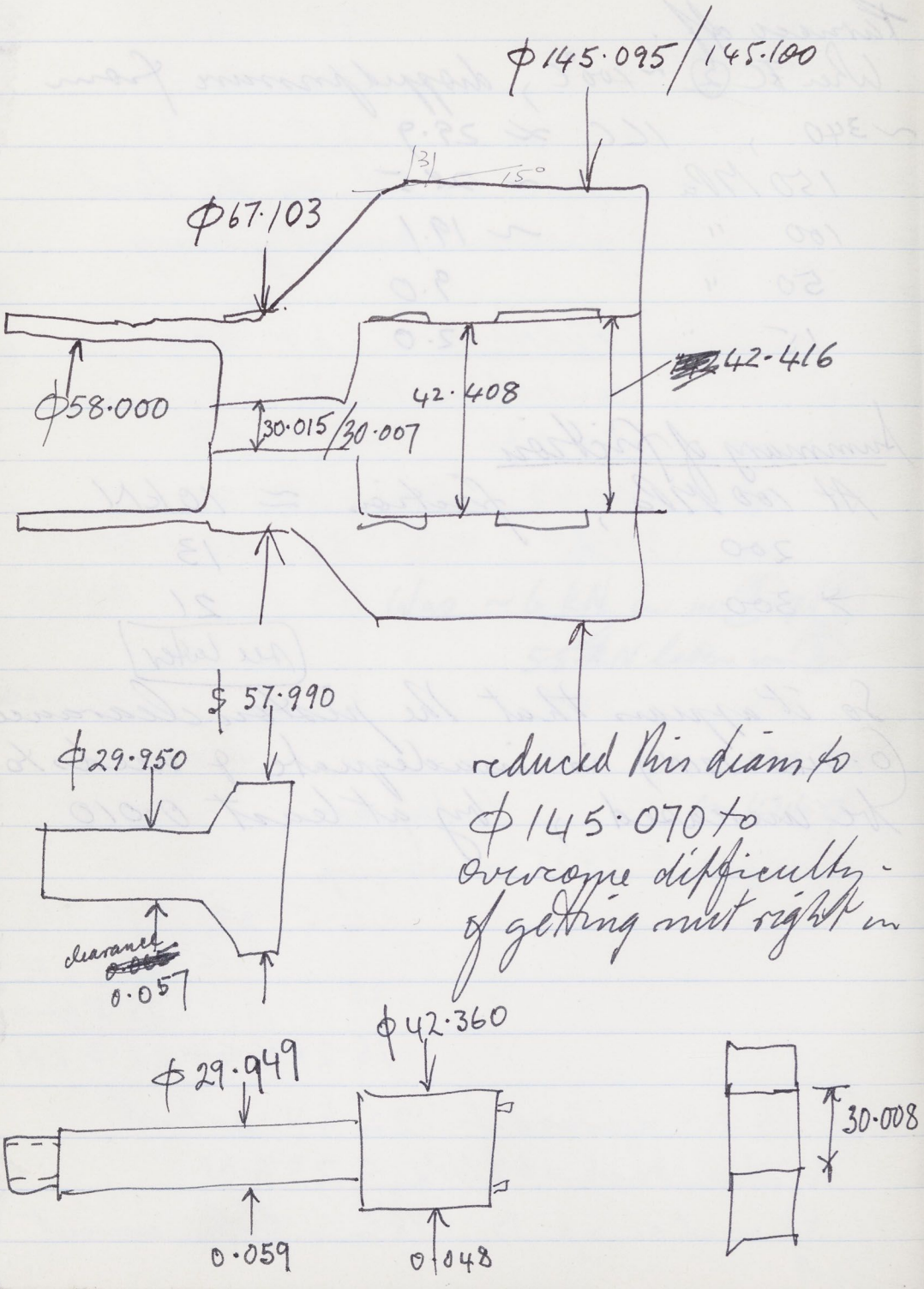
At 100 MPa, friction ≈ 10 kN

200 13

→ 300 21

(see later)

So it appears that the piston clearance (0.040 MIN) is inadequate & needs to be increased, by at least 0.010


ϕ145.095/145.100
31
15°
ϕ67.103
ϕ58.000
30.015/30.007
42.408
42.416
$ 57.990
ϕ29.950
clearance
0.057
reduced this diam to
ϕ145.070 to
overcome difficulty
of getting unit right on
ϕ42.360
ϕ29.949
0.059
0.048
30.008

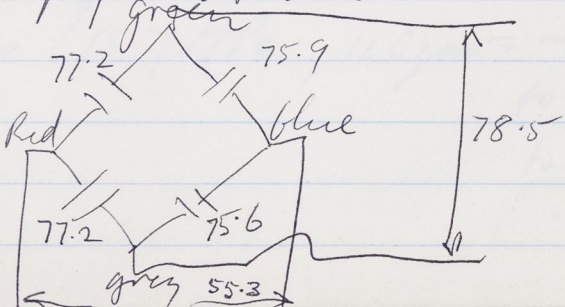
9-4-91

Dismantled bottom plug

Plug does not go right in — short by ~2mm. Appears that the R3 on the pressure vessel is too large, so a 15° x 3 mm taper was machined on the OD of the plug ~~4103~~ 4101 at the edge of the 45° taper.

The ϕ58 guide surface for the ILC piston is strongly marked as if it were a bit tight, but it is hard to imagine that this could generate 25 kN of friction. However, it does appear, from extrusion of the O-ring, that the ILC is not seating properly & therefore there will be compressive force on the threads & under pressure, tending to increase the OD! Relieved ILC support (4103 (12)) so that ILC seats properly. Re-assembled.

Rechecked ILC by measuring with Escort meter on pins at amplifier attach socket:



contact
19.3

11/4/91

Preamp connection changed so now excitation on green-grey.

~~Trimming cap: not far off centre~~ ~~just adj~~ neg one end

Newport meter zeroed for zero input

Reading 0.26 with ILC attached but no power on

Power on, reading = 13.80, about half that with excitation on red-blue

Readjusted diff capac. so that zero reading is 0.06 — this seemed to be with a bit of load; pumped down, reading now 0.36.

Pumping up, zero = ~~0~~ −0.22

down −0.23

Contacted; force off; zero −0.17

zero down = −0.14

zero up = −0.18

Before gas, zero = −0.22 POS: ~~19.56~~ 20.13

pressure zero 0.3

Bottle gas: 15.7 MPa, ILC zero = ~~0~~ −0.5, drifting to −1.05

to −1.12

11/4/91

Gas	LLC	POS	Pump oil pressure
52.5 MPa	−3.18	20.14	
	−3.21 } 18.48		MPa
	+15.27 }		6 ≡ 20.6 kN
	−3.18		

fric

Friction below gauge level.

100 MPa	~ −3.4 first	19.96	
102.2	→ −4.13 } 17.33		
	+13.20 }		6 MPa → 20.6 kN
	1.84 residual		−3 / 17.6
	ie 5.9 kN ~~friction~~ double friction		
	~ 3 kN friction (0.9 MPa — does not register)		
	zero −4.04		

200 MPa −4.96 seemed to settle down quicker

Total Friction 2 MPa ≡ 7 kN

9.53 14.5 kN 6 kN − 2 = 4 ≡ 13.7 kN

22.5 (27.5 kN) 10 − 2 = 8 ≡ (27.5)

~~zero~~ 4.47 residual

≃ 9.4 kN double fr = 4.7 kN friction

zero −4.81

There seem to be transient temp effects in the LC gyro after pumping

300 MPa

immediate zero = −5·33

after 5 mins −5·43

(went thro'. d higher values)

−5·37

−12·9 ≡ (18·2) kN

−27·6 ≡ 33·0 kN

release pressure → 5·68

ie ~ 11 kN double friction

~ 5·5 kN friction

zero −5·26

−5·28

Friction at first ~5 MPa ≡ 17 falling to ~3 MPa or 2·5 ≡ 10 kN

8 MPa − 2·5 = 5·5 = (18·9 kN)

12 MPa − 2·5 = 9·5 ≡ 32·6 kN

400 MPa

immediate zero = −5·62

5 mins −5·73

½ hr −5·68

−5·72

9·4 15·1 kN 8 MPa − 4 = 13·7 kN

24·2 29·9 kN 12 − 4 = 27·5

release pressure → 8·1 dropping to 7·5 & further

= 13 kN double fr

6·5 kN friction

zero −5·63

Friction down 4 MPa = 14 kN

Pumping 3½ MPa = 12 kN

26·6 ≡ 32·2 kN Up to 12 MPa again
− 3½ friction ≡ 12 kN
8½ ≡ 29 kN

clean oil → 4·8
double friction 10
friction = 5 kN

Sprung a leak ~ 460 MPa
Dropped to 99 MPa ILC zero ~ −3·8
after ¼ hr ~~10·24~~ 101·7 MPa ILC zero −3·86

Released gas to zero pressure
ILC zero = −0·25
↓
P gauge zero 0·5
after ~15 mins. −0·04
→ wandering around a bit 0·3/0·7
~~Friction up ≈ 3·8 MPa ≡ 13 kN~~

Hold pressure
well at 4000

11/4/91

Dismantled Enerpac pump & cleaned it out for more reliable running.

Tightened up 700 MPa rupture disc.

ILC load zero −0.004 to −0.008 depending on exact pumping/loading prehistory

Pressure zero around 0.3, varying ± 0.1 MPa.

Bottle pressure 15 MPa

ELC zero −1.15

400 MPa

immediate zero −5.92

after ~½ hr −5.79

Friction up ~3.8 MPa ≡ 13 kN

zero 5.73

10.86 7.8 MPa − 3.8 = 4.0

≡ 16.6 kN ≡ 13.7 kN

26.3 12 MPa − 3.8 = 8.2 MPa

+5.7

= 32 kN ≡ 28 kN

Release pressure → ~4.5 kN

≡ 10 kN double friction, dropping back

≡ 5 kN friction

Pumped back

zero = −5.69, −5.70

Intensifier occasionally spraying up a leak near 500°; dropping back, came up OK.

500 MPa

zno soon after reaching p : -6.06
after few mins -6.01
after dropping book in oil -5.96
friction up ~4.2 MPa = 14.4 kN
zno -5.92

15.3
+5.9
= 21.2 kN

10.0 MPa
- 4.2
5.8 MPa = 20 MPa

Release pressure — back to ~9 kN
= 14.9 double friction
= 7.5 kN friction

Recharged intensifier

Got to 600 MPa but leak at no 3.

572 MPa 1CC 2/10 — 6·64

15.9 12 MPa

~~dros~~

release of oil p → 14·66

Double friction ~10kN

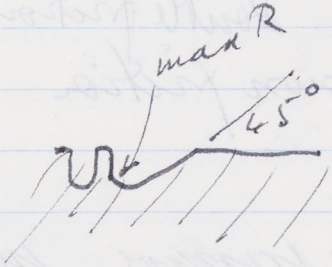
Down friction ~ 5 MPa

≡ 17 kN

On dropping pressure, no 3 leak stopped at 505 MPa.

Fill oil tank to red dot
— this is where intensif was left.

Con cracked at bottom of bottom winding, dirty (overlap join clean) <



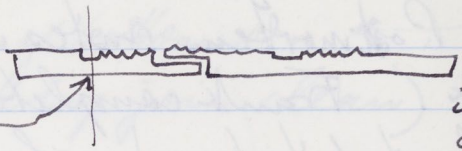
30/3/92

Furnace no. 001 returned for re-furbishing.

Postmortem notes in SERVO RIG NOTES book. Frank completed furnace & took to Amtech today for shipping. Details
- retained upper part of core & windings; replaced lower part of core (this was early two-part core design) put in new lower core with winding, after modifying the grooves to have a 45° champfer & better radius at bottom
- relieved the SS upper core at top to reduce chance of sticking
- extra Al_2O_3 paper layer over core, not up gap, to compensate for some shrinking of insulation which was re-used
- same upper & middle windings
- cleaned Az tubes on Tk ends
- it assembled OK all connections OK
- MS inner tube in place at bottom

Furnace 005 returned Feb 1993
after accident to specimen.

Core smashed.
Earlier break



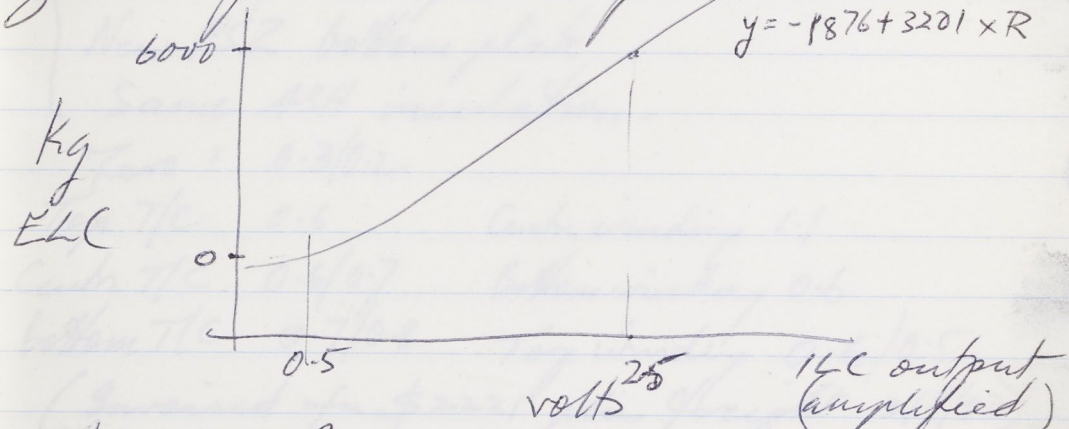
Lot of C on bottom winding

Needs: new core : Bundigo if T > 1000°C
or Coors
insulation OK – question of
changing to SALI
bottom Macor – several breaks.

Refurbished & sent back 29/3/93 with:
1) new Coors core & new PSZ upper core, rewound
2) one new thermocouple
3) new bottom Macor piece

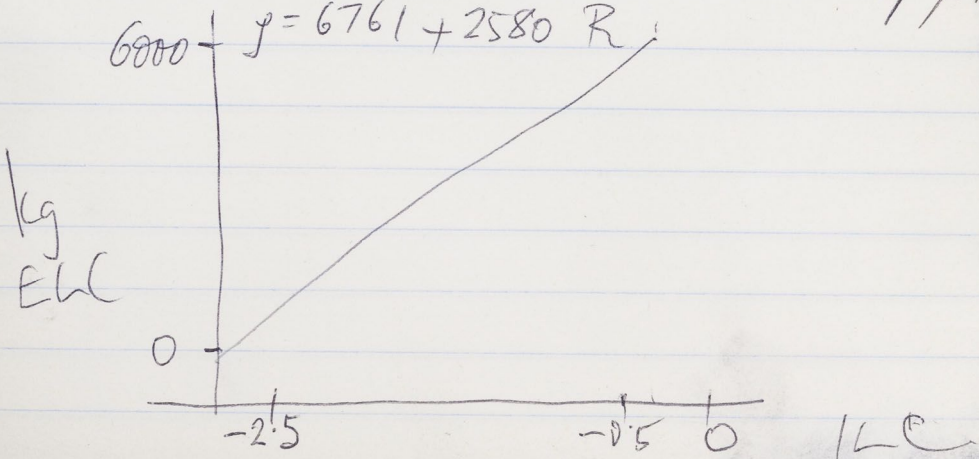
Montpellier 30/4/93

Test on re-wired load cell, now ½ bridge with two strain gauges as other half bridge, & trimming to give approx zero output at atmos. pressure



At 66 MPa, zero has moved to −2·6V (ie equiv to −60 kN). Previously it moved to ~ +6V or thereabouts (about same load but opposite).

Now tried above calib at 66 MPa conf. pr.



Some hiccup at ~0.6V (maybe wires)
Plot gives increased sensitivity at higher pressure (unless this is due to friction?)

Furnace 005 Returned 30/7/93 after blowout, for repair.

- New core (Bendigo)
- 3 new T/C complete
- New PSZ bottom plate
- Same ASH insulation.

Zero : 0·3/0·2

Top T/C	0·6	Centre winding	1·1
Centre T/C	0·6/0·7	Bottom winding	0·6
Bottom T/C	0·7/0·8	Top winding	0·6/0·5

(Invoiced for $2221 plus freight 3/8/93).

THE REMAINING PAGES

IN THIS NOTEBOOK

ARE BLANK