

SUMMARY OF ACOL BENDING CHAMBER  
PRE-STRESSING TESTS (PROTOTYPE)

- 1) As briefly exposed in annex 1, ACOL bending magnet vacuum chambers must be squeezed in a prestressed state in the magnet gap at the assembly stage, to provide enough clearance for the beam.
- 2) To test the feasibility of forming the chamber as described in annex 1, a prototype chamber 1.5 m long with transverse dimensions approaching the BHW's one (width 380 mm, plate thickness 4 mm, 316 LN) has been built.
- 3) The chamber has been pressurized to 1.9 bars (relative) with dry nitrogen in order to achieve a state of deformation which compensates for the initial deflection under vacuum (see figure 1).
- 4) Assymetry of loading and high level of stresses (cf annex 2) lead to different plastic - hard worked - zones for the two load cases (internal or external pressure). This gives residual stresses and one consequence is the new plastic deformation under vacuum after it has been pressurized. (cf figure 1).
- 5) Figures 1 and 2 also show that subsequent to the forming, numerous cycling between atmospheric pressure and vacuum does not stabilize the chamber. One probable reason lies in the fact that the loading is highly non linear with the deformation (particularly around the flat state), and that it increases as the plastic deformation proceeds.
- 6) In order to stabilize the chamber, check the security margin as far as externally applied pressure, and following fruitful discussions with M. Bona (TIS ref.1), the chamber has been subjected to external pressures of 1.2 and 1.5 bars in the Lep vacuum group overpressure test tank. Results are given on figures 3-4-5, showing no catastrophic failure, and good stability of the chamber after numerous cycling.
- 7) Finally the chamber has been subjected to a destructive internal pressure test using the TIS water facility (M.T'Hart). One end plate weld failure stopped the spectacular deformation test at 17 bars (gauge). This gives an idea of the margin of security available during the forming procedure.
- 8) According to the described test, the feasibility of pre-stressing the ACOL bending magnet vacuum chambers has been proven. Stabilization of the chamber will be obtained either by a slightly higher forming pressure, or by means of a 1.2 bar external pressure test.

A. Poncet

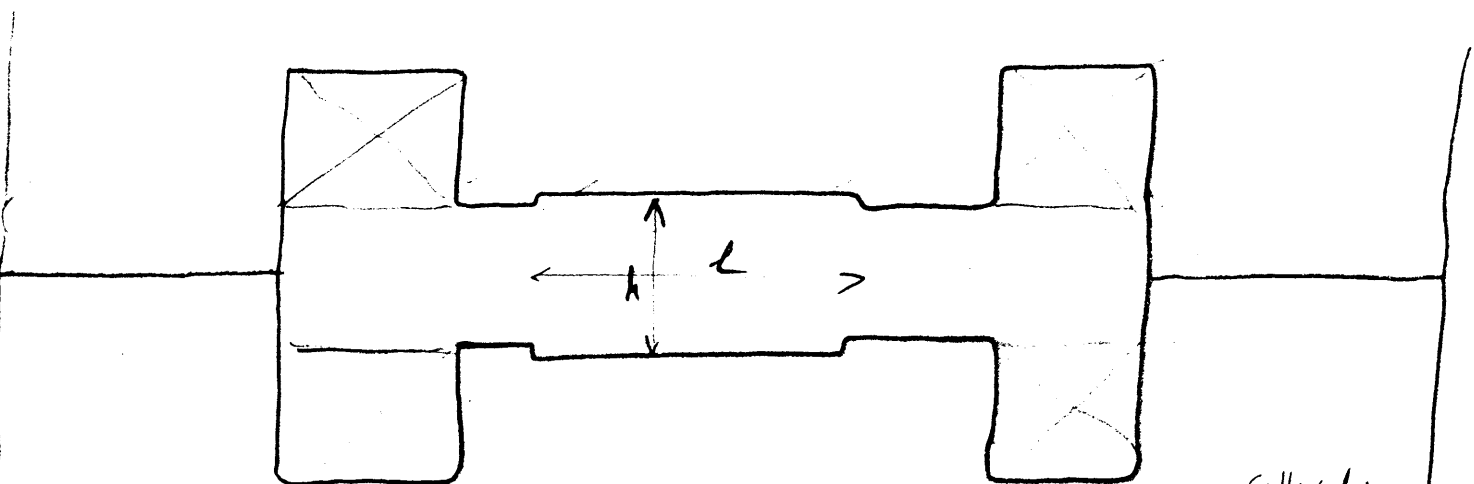
ANNEX 1

27/6/84

A. Foucault

ACOL bending magnet  
vacuum chamber

ACOL  $\rightarrow$  2 types of window frame bending magnet  $\left\{ \begin{array}{l} \text{BHW} \\ \text{BHN} \end{array} \right.$

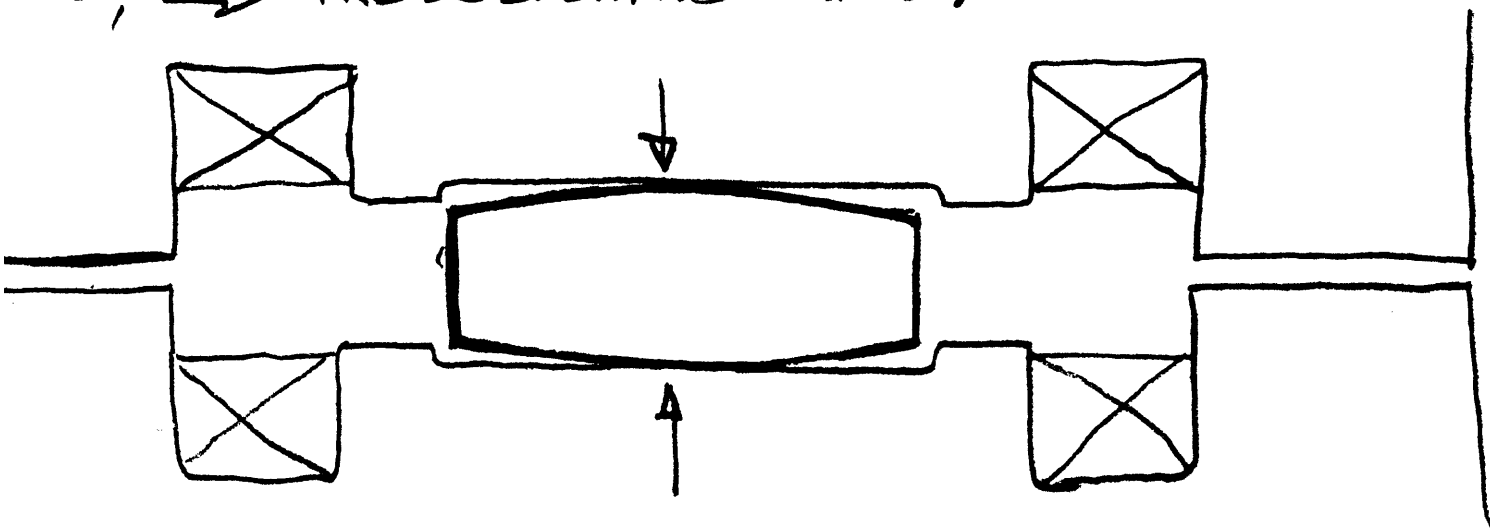


(mm)

	$h$	$l$	worse beam height	(allowed) Max chamber wall thickness + deflection (no clearance)
BHW	114	420	100	$\rightarrow 7$ <span style="border: 1px solid black; border-radius: 50%; padding: 2px;">9</span>
BHN	114	260	106	$\rightarrow 4$ <span style="border: 1px solid black; border-radius: 50%; padding: 2px;">6</span>

WITHOUT PRESTRESS,  
ONE CANNOT DO MUCH BETTER THAN

So,  $\Rightarrow$  PRE-DEFORMED SHAPE:



# SEQUENCE OF OPERATIONS

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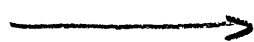
ANNEX 1:

## ACOL bending chamber

- 16 BHN 260 x 114 mm chambers  
(8) BHW 420 x 114 mm chambers  
(STRAIGHT ~ 2 m LONG)

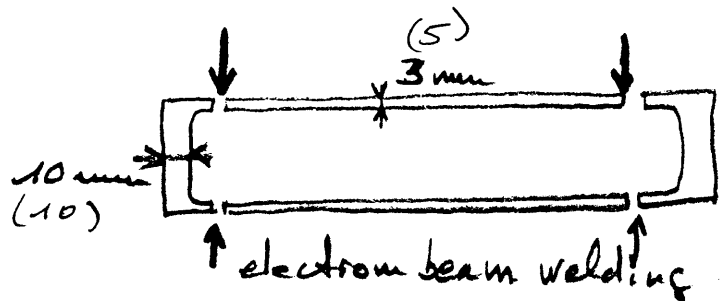
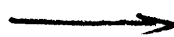
### SEQUENCE OF MANUFACTURE AND INSTALLATION

Steel

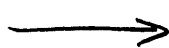


316LN

BHN  
(BHW)



Vacuum firing



950 °C 2 hrs -  
(Standard)

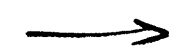
(Leak testing)  
plastic pre form



+ 2.5 bars (g) dry  
Nitrogen

(Leak testing)

chamber's mounting



squeezed in magnets  
at factory

Magnetic measurements



inside chambers

chamber connections:

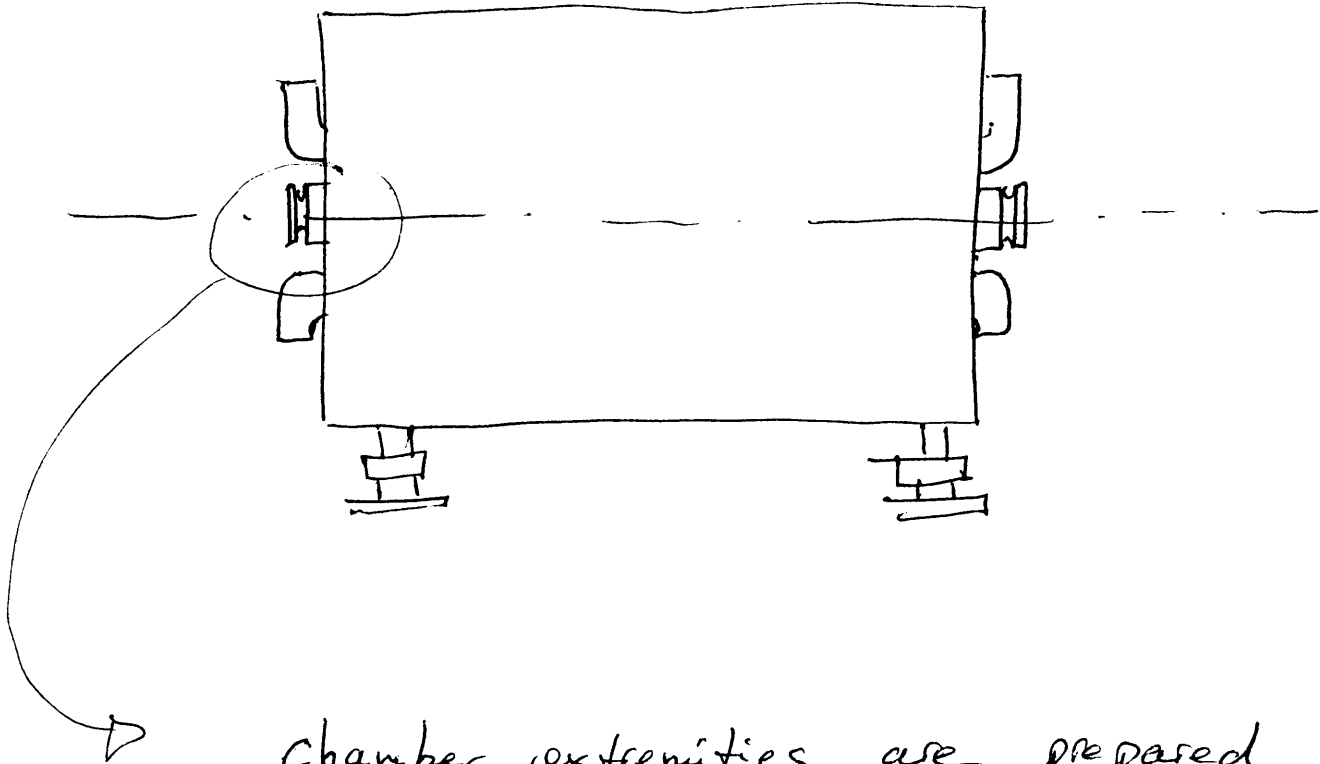


welded to plate  
transition piece -

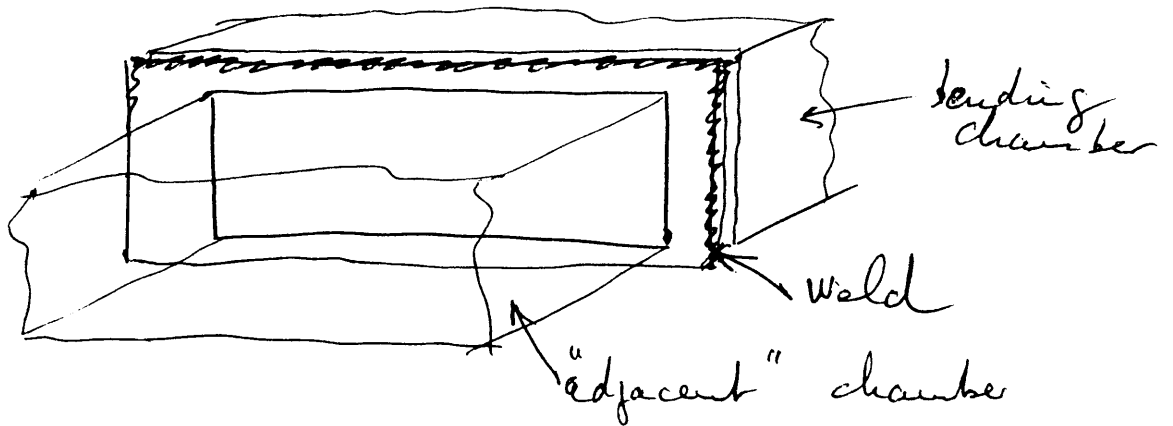
ANNEX 1:

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CHAMBERS MOUNTED IN MAGNETS:



Chamber extremities are prepared for welding of transition plate to adjacent chamber

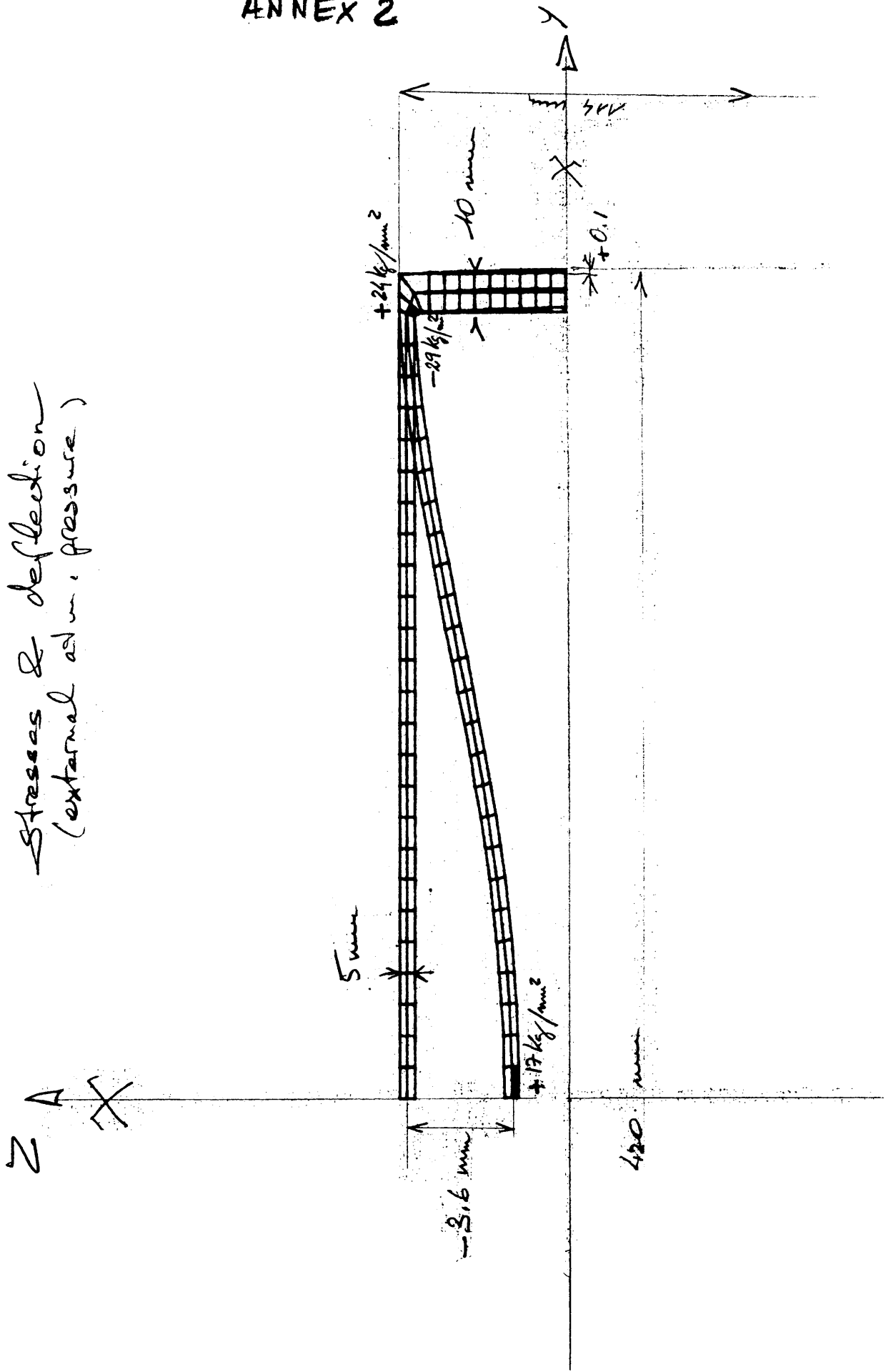


Annexes : stresses and deflections in bending chambers.

# ANNEX 2

ACOL BAW CHAMBER

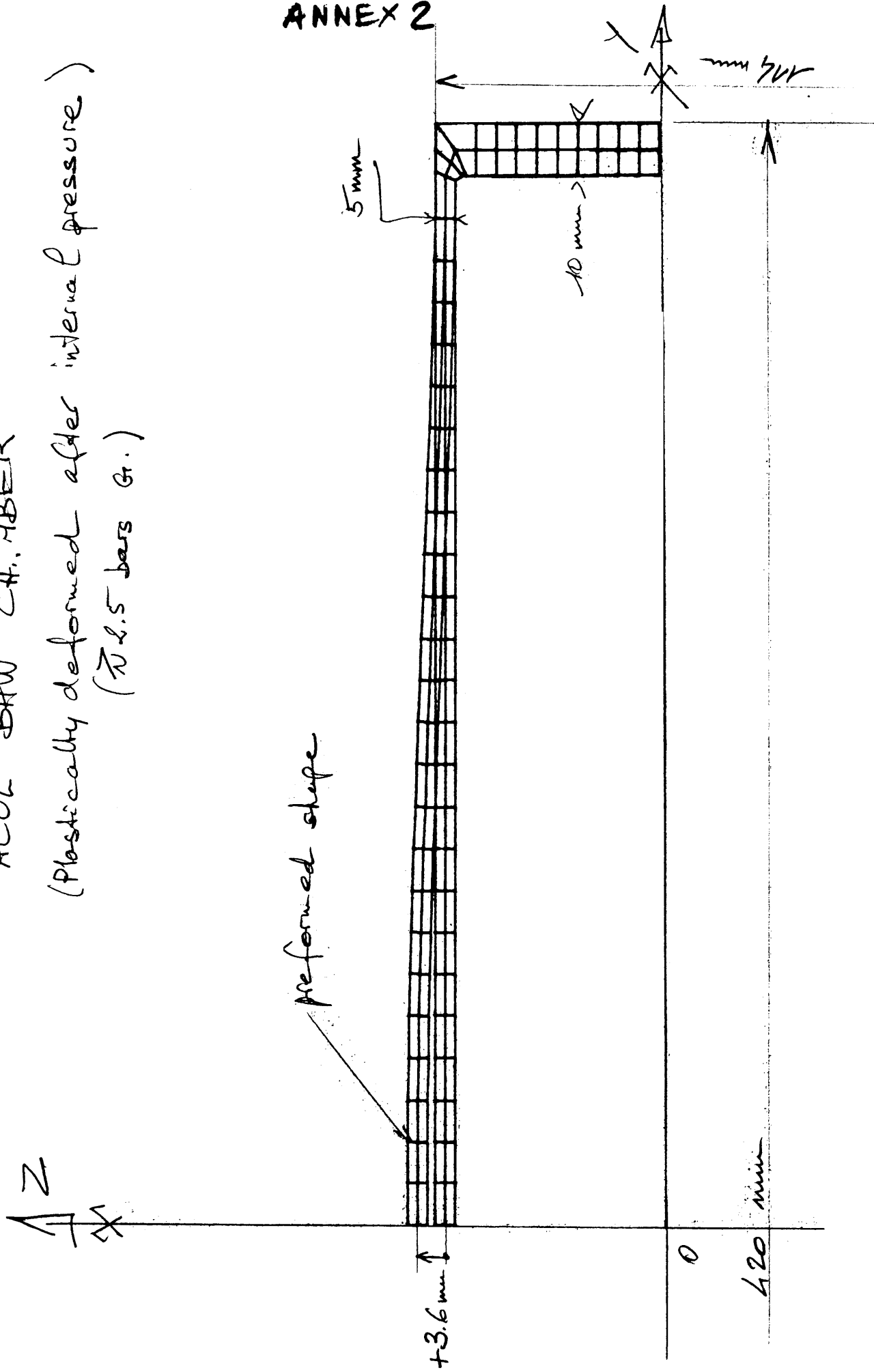
Stresses & deflection  
(external atm. pressure)



ACOL BHW CH. HBER

(Plastically deformed after internal pressure)  
( $\bar{\sigma}$  2.5 bars Gr.)

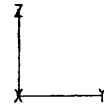
ANNEX 2



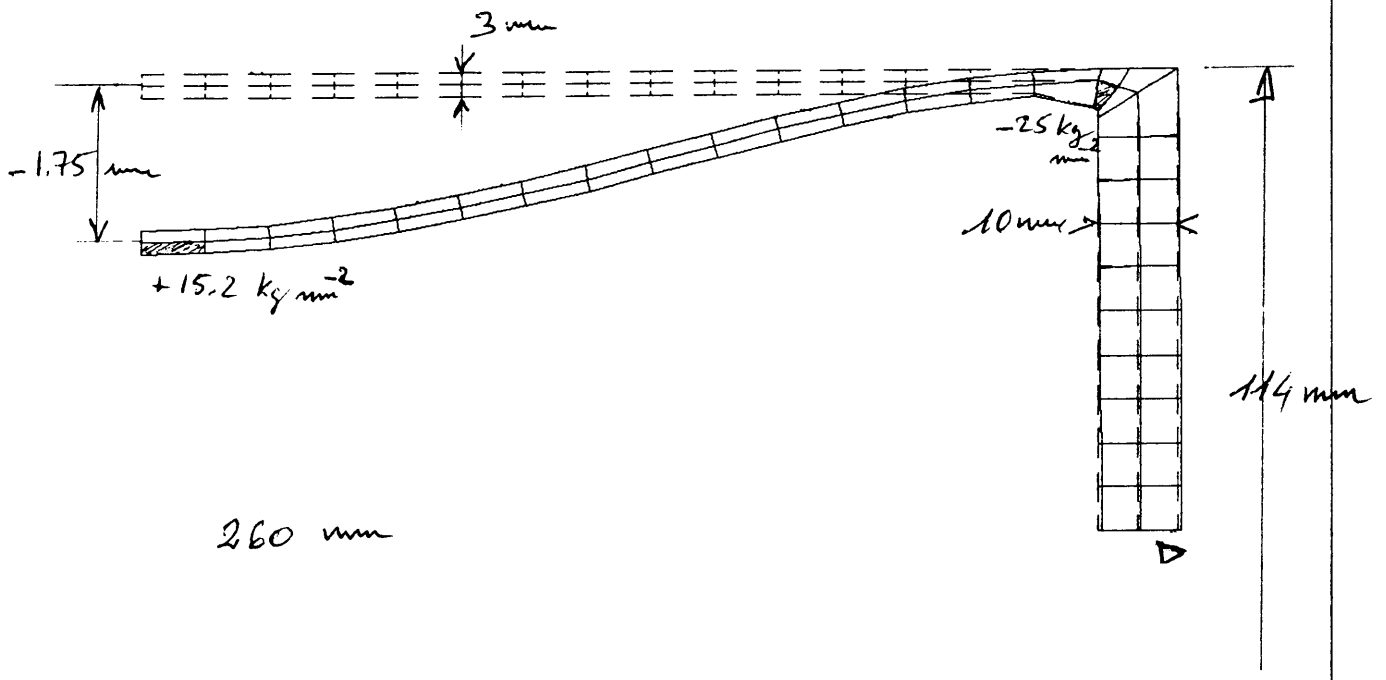
# ANNEX 2

TEST \*\*\*\*\*  
STATIC LOAD CASE 1

IAXIS= 3 ALPHA=0.00 BETA= 0.00  
DEFLECTION SCALE FACTOR= 11.121



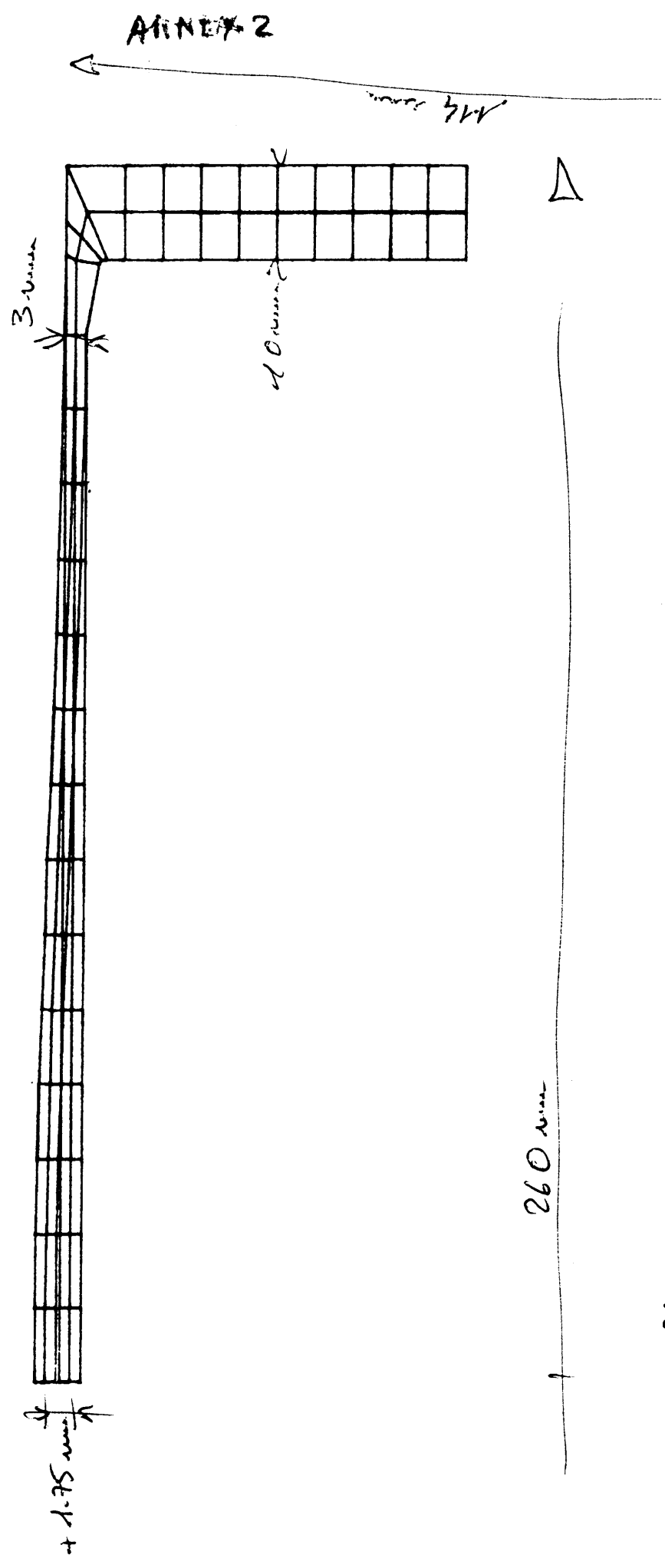
ACOL BHN chamber  
Stresses & deflection  
(external atm pressure)



10/2/84

# ACOL BWN Chamber

(Plastically preformed after internal pressure)

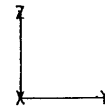




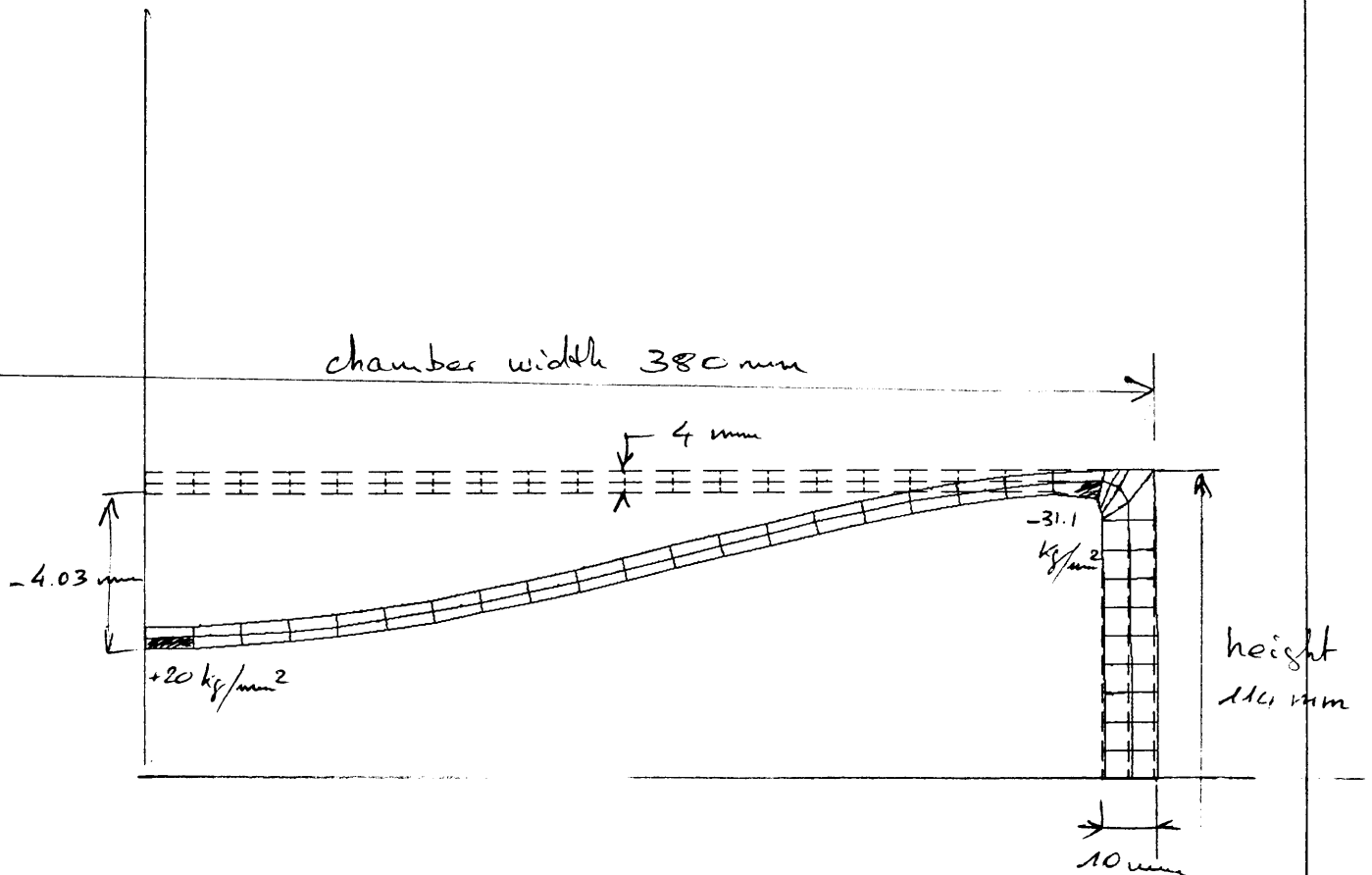
ANALYSIS 2

TEST \*\*\*\*\*  
STATIC LOAD CASE 1

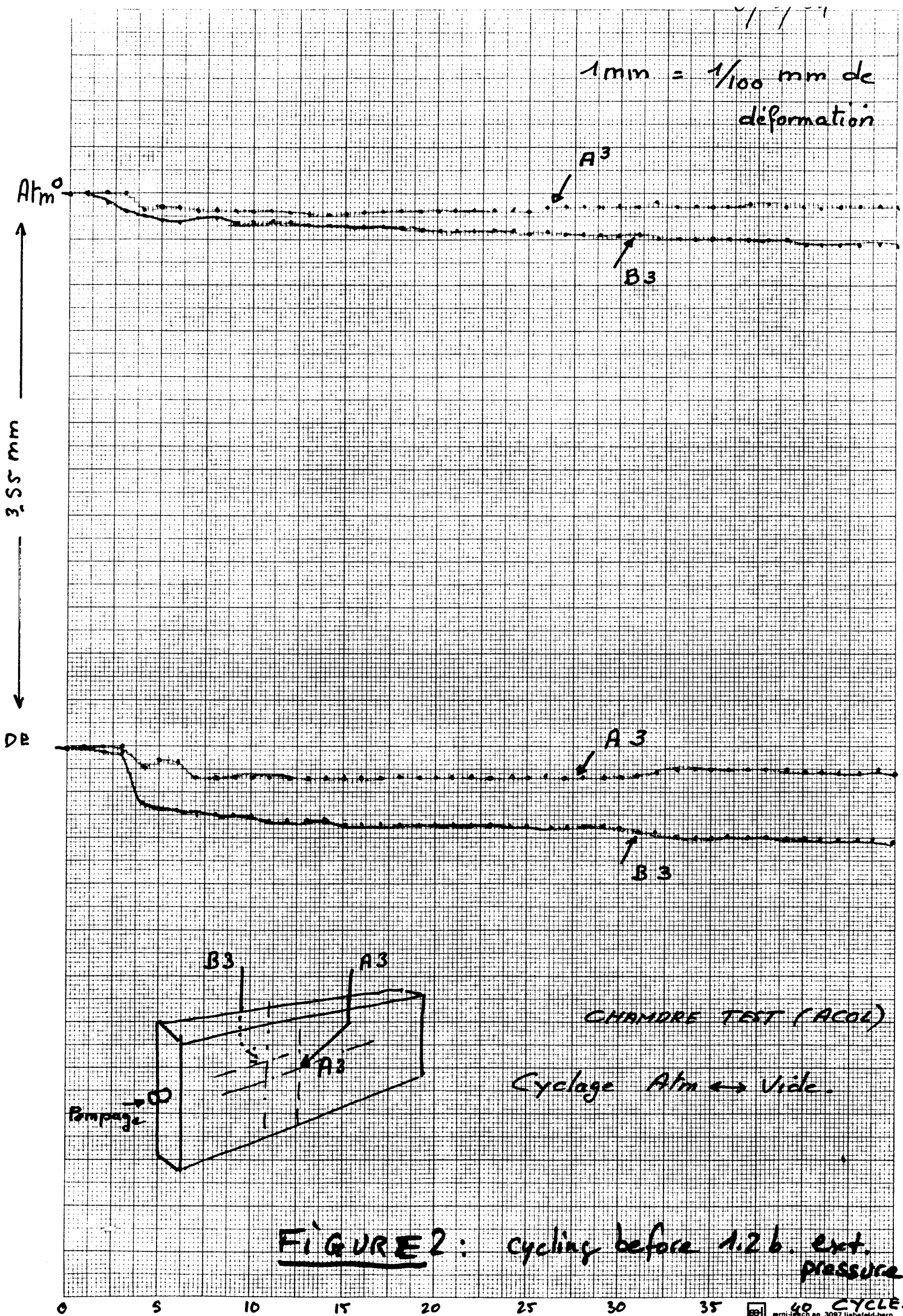
IAXIS= 3 ALPHA= 0.00 BETA= 0.00  
DEFLECTION SCALE FACTOR= 7.0262



TEST CHAMBER  
STRESSES & deflections





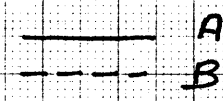


# TEST CHAMBRE A COL (Déformation)

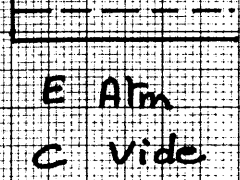
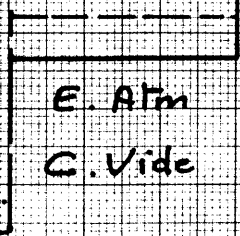
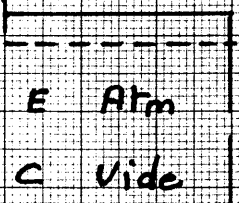
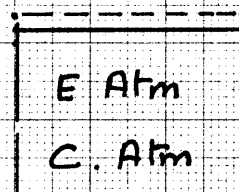
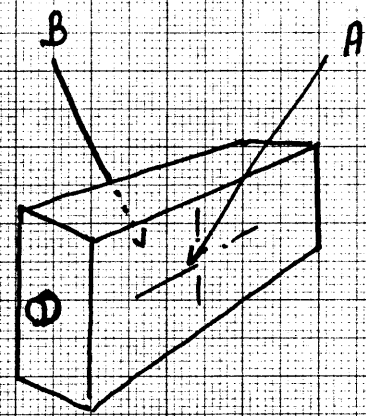
mm

E: Atm  
C: Atm

E - Enceinte  
C - chambre a vide



La chambre a vide est mise en place dans une enceinte en surpression

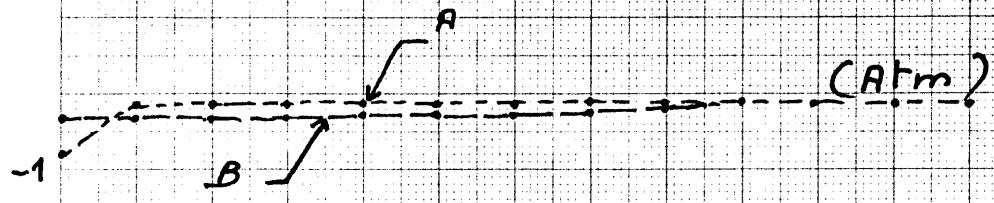


E +200Gr  
C Vide

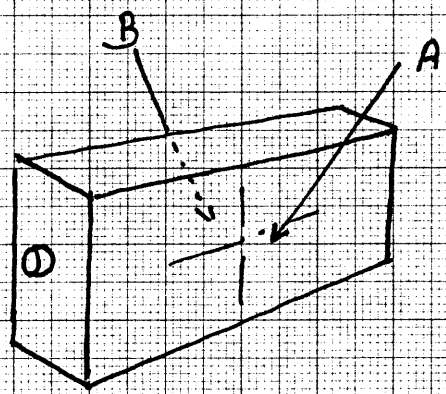
mm

### TEST CHAMBRE ACOL

Cyclage atm ↔ vide après Test  
à 1,2 Bar



13 cyclages de l'atm  
à 2 5 mbar.



-3

-4

-5

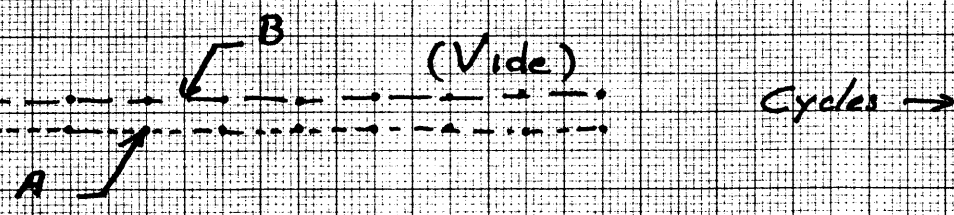


FIGURE 4: cycling after 1.2 b. 8/08/84 B.G  
external pressure

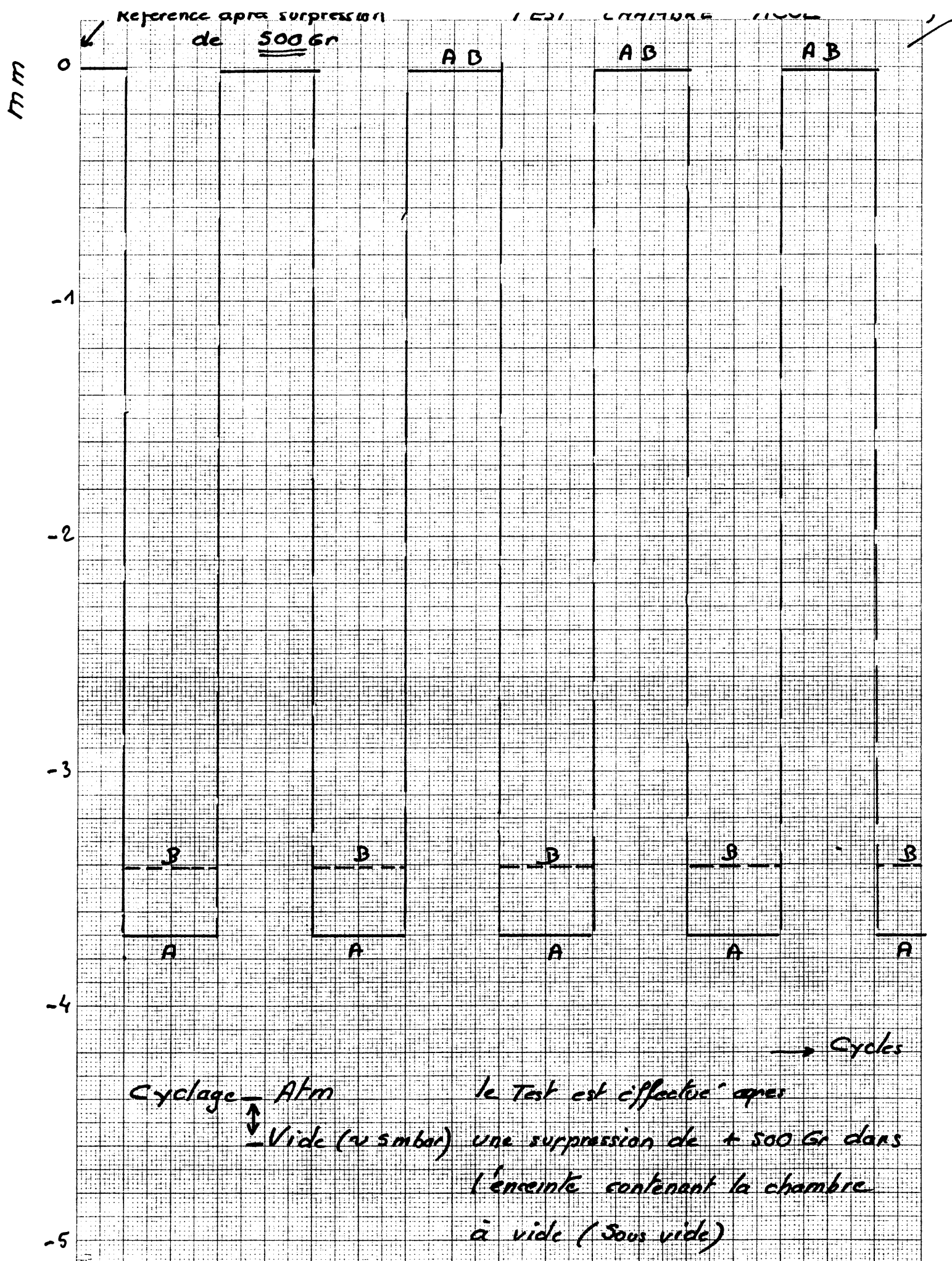


Figure 5: cycling after external 1.5b. 2/08/84 B.G