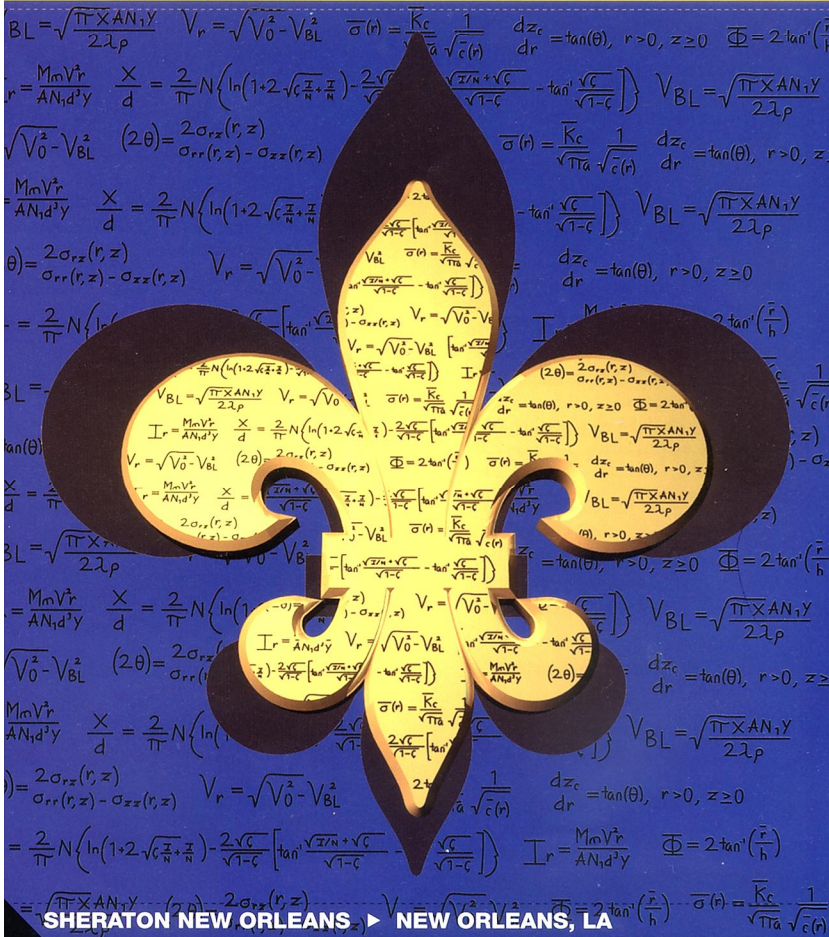


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$$BL = \sqrt{\frac{\pi X AN_1 Y}{2 \lambda p}} \quad V_r = \sqrt{V_0^2 - V_{BL}^2} \quad \sigma(r) = \frac{K_c}{\sqrt{\pi a} \sqrt{c(r)}} \quad \frac{dz_c}{dr} = \tan(\theta), \quad r > 0, \quad z \geq 0 \quad \Phi = 2 \tan^{-1}\left(\frac{r}{h}\right)$$
$$I_r = \frac{M_m V_r}{AN_1 d^2 y} \quad \frac{X}{d} = \frac{2}{\pi} N \left(\ln \left(1 + 2 \sqrt{c \frac{z}{h} + \frac{z^2}{h^2}} \right) - \frac{2 \sqrt{c}}{\sqrt{1-c}} \left[\tan^{-1} \frac{\sqrt{z/N + \sqrt{c}}}{\sqrt{1-c}} - \tan^{-1} \frac{\sqrt{c}}{\sqrt{1-c}} \right] \right) \quad V_{BL} = \sqrt{\frac{\pi X AN_1 Y}{2 \lambda p}}$$
$$\sqrt{V_0^2 - V_{BL}^2} \quad (2\theta) = \frac{2 \sigma_{rz}(r, z)}{\sigma_{rr}(r, z) - \sigma_{zz}(r, z)} \quad \sigma(r) = \frac{K_c}{\sqrt{\pi a} \sqrt{c(r)}} \quad \frac{dz_c}{dr} = \tan(\theta), \quad r > 0, \quad z \geq 0$$
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al

Behind Armour Effects at Shaped Charge Attacks

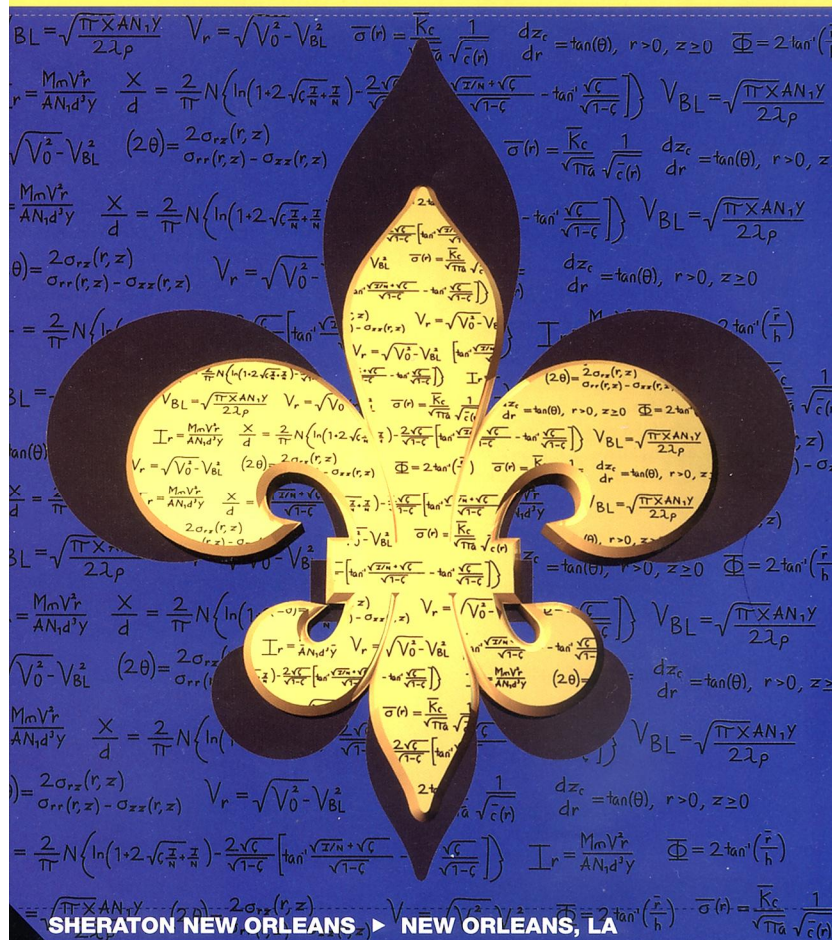
Prof. Dr. M. Held



Schrobenhausen, Germany

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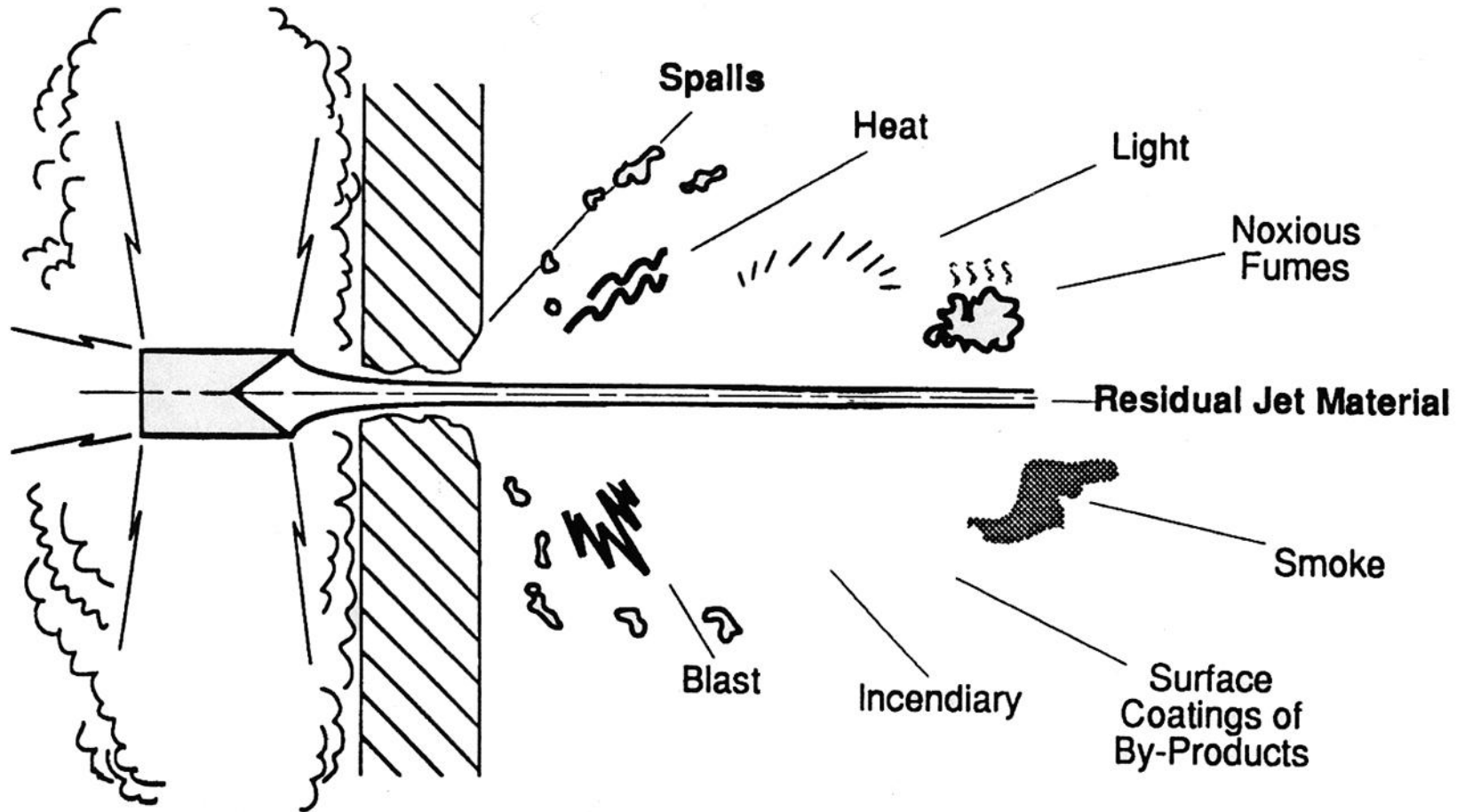


Introduction

ed Charge Effects

Location	Phenomena	Efficiency Carrier	Percentage
Internal	Mechanical	<ul style="list-style-type: none"> • Residual Jet • Fragments 	
	Blast	Pressure history	
	Thermic	Heat	
	Optical	Dazzle Dust	
	Chemical	Gaseous (HE-Products)	
External	Mechanical	<ul style="list-style-type: none"> • Fragments • Blast 	

Armour Effects after Shaped Charge Jets Perforations



Don Kennedy



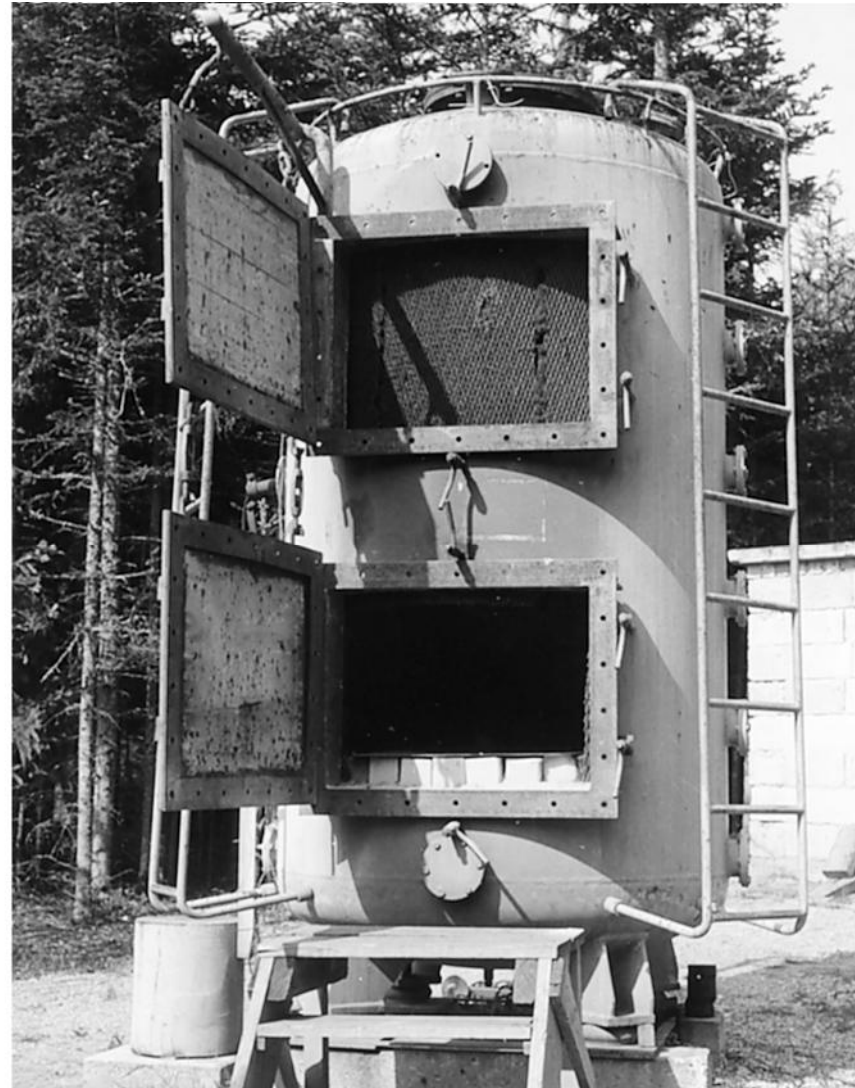
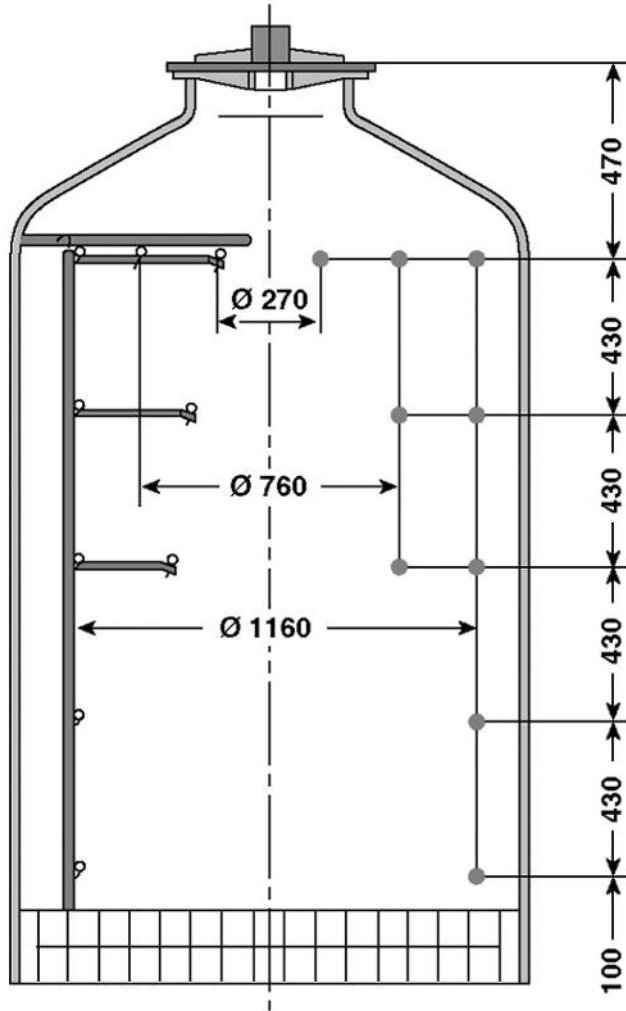
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Diagnostic Vessel

with 2.4 m³ Volume





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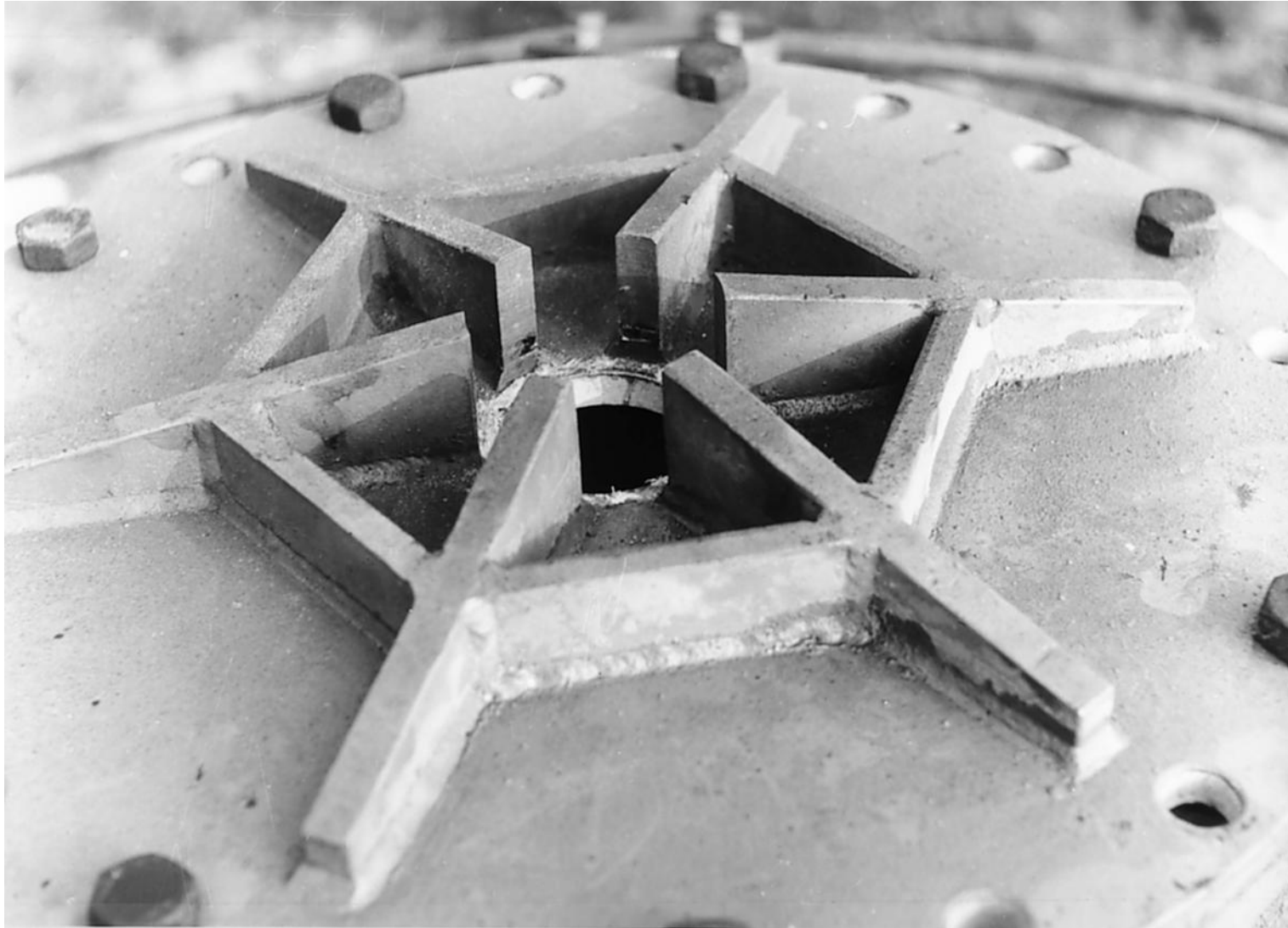


Image on Top



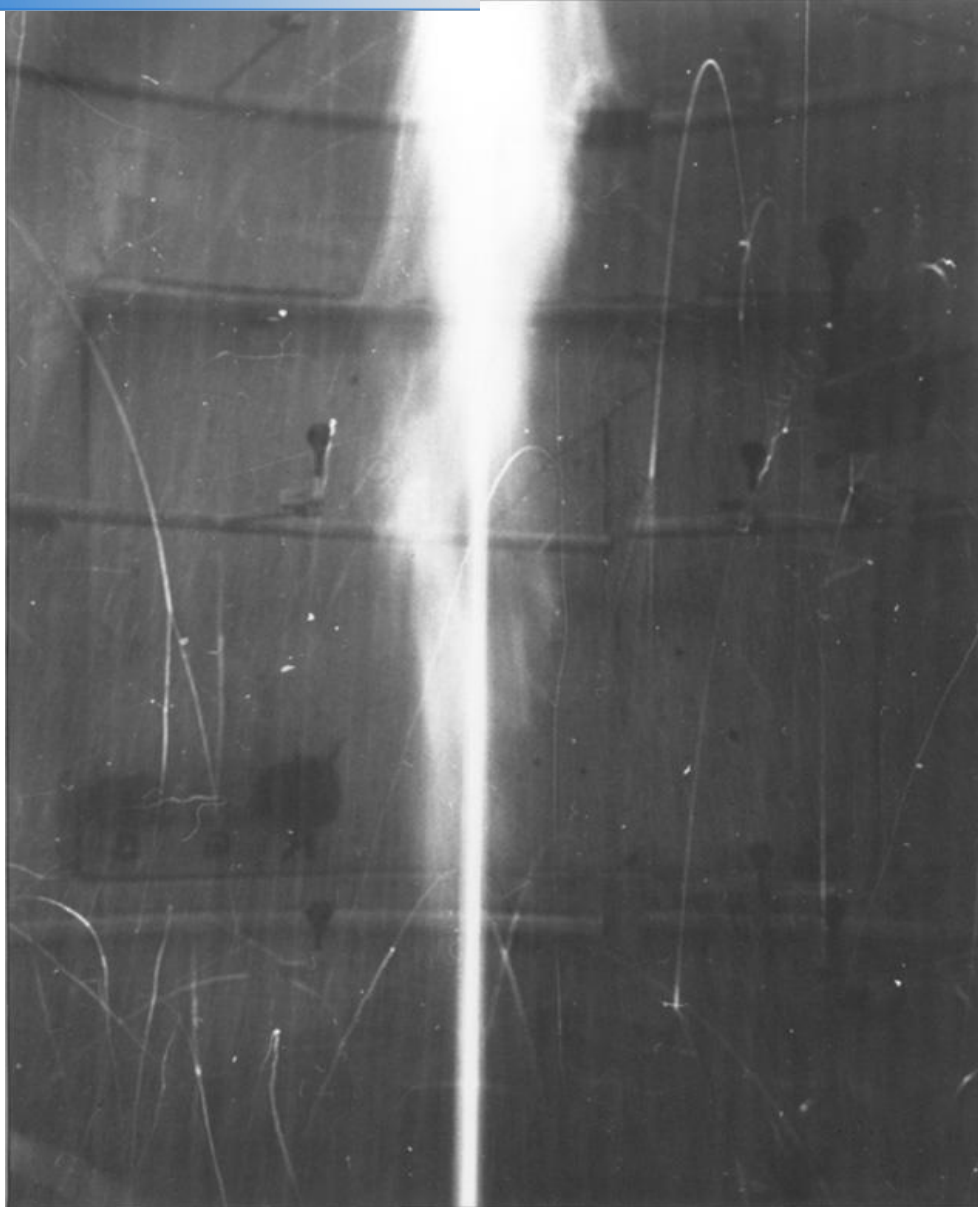


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Pictures



Cobra with Cu liner in
the diagnostic vessel



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ictures





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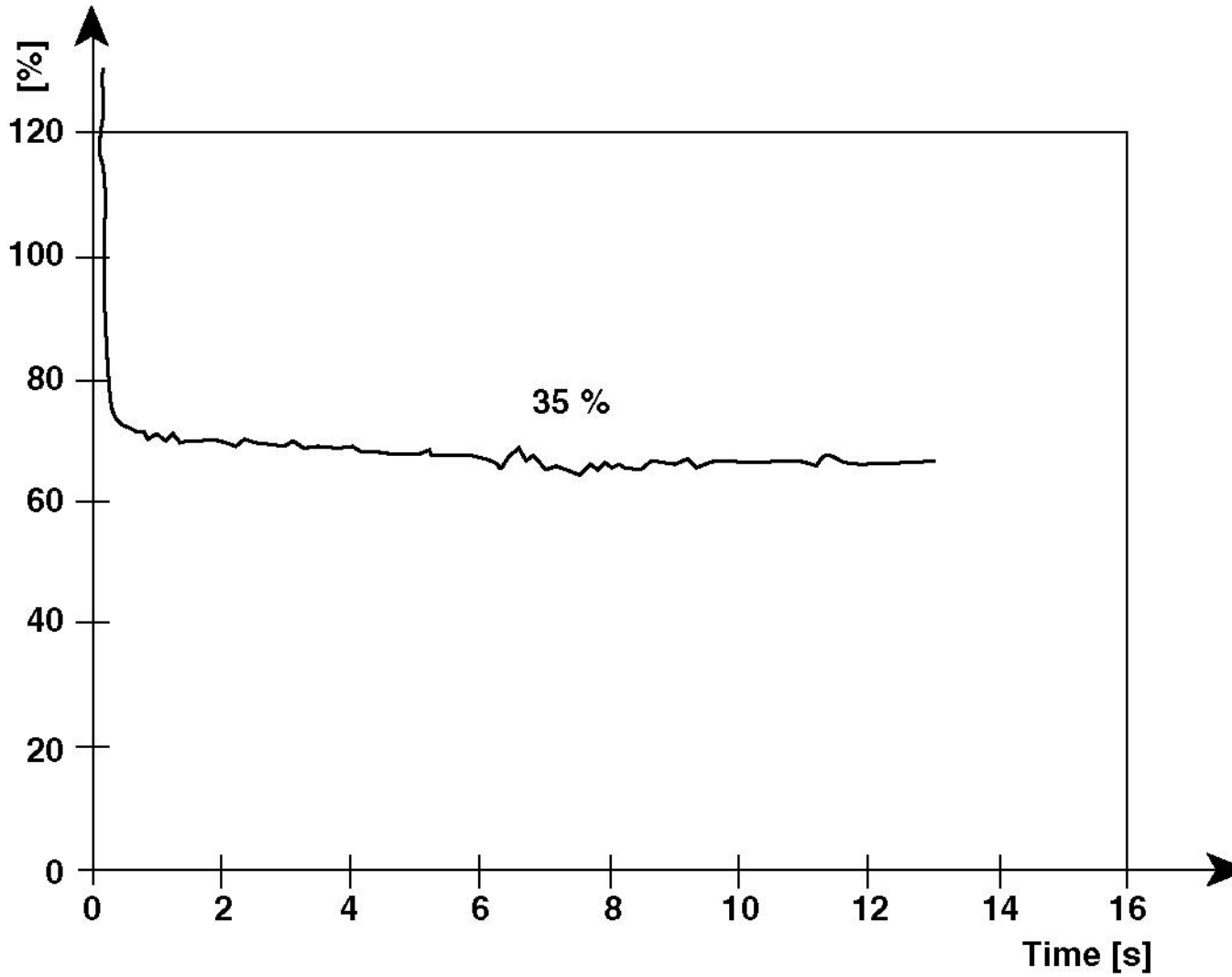
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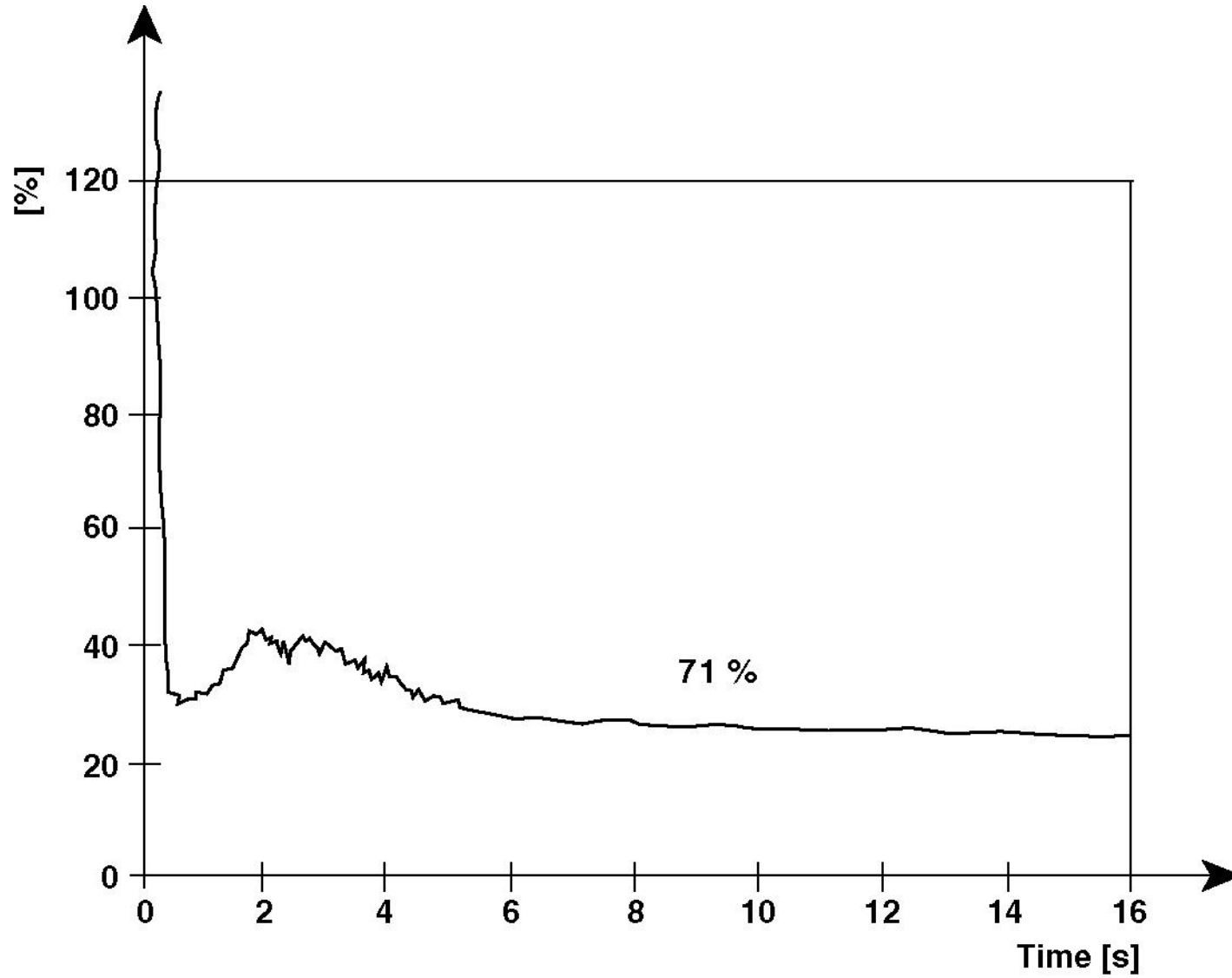
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ictures



EADS
DEFENCE
& SECURITY





with Gaseous Analysis and Piezoelectric Pressure Gauges



Measuring Tank No.

Shaped Charge	:	Orig. Cobra
HE - Weight	:	1480 g
Cu liner - Weight	:	250 g
Standoff	:	300 mm
Barrier	:	300 mm

Gaseous Analysis

(Oxygen Absorption in Pyrogallol)

Oxygen before Firing : 20.9 %

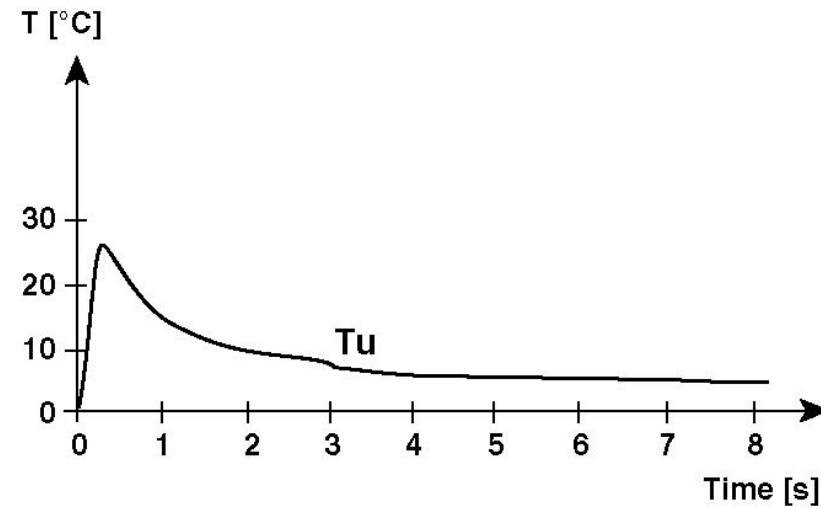
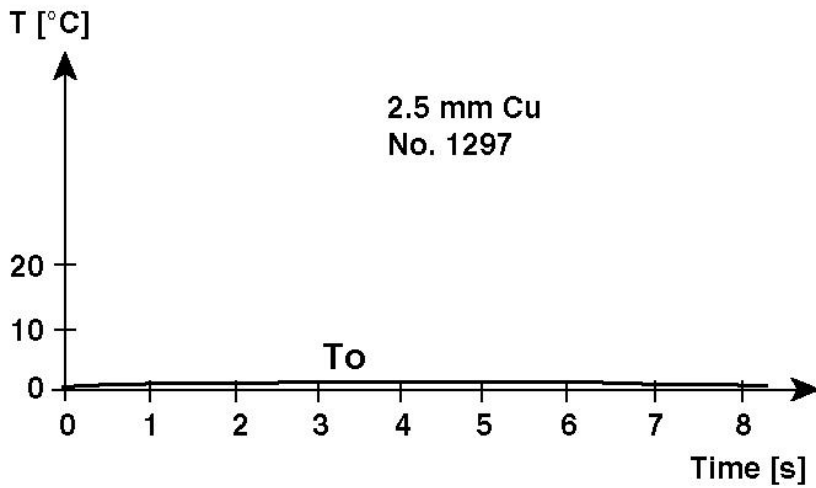
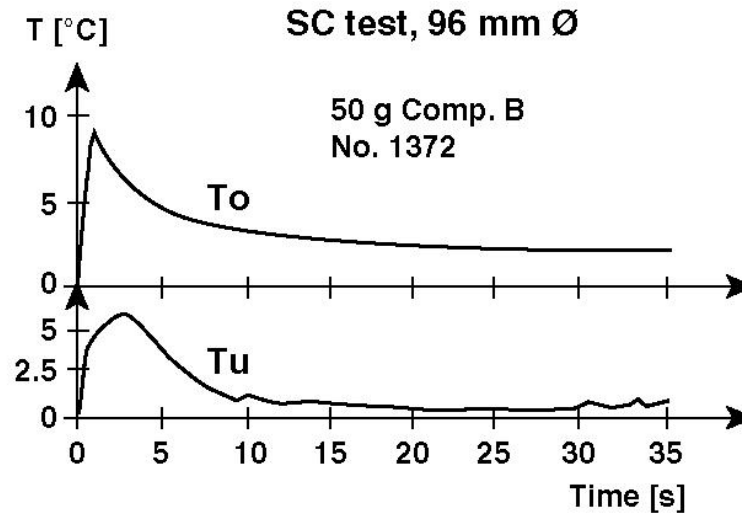
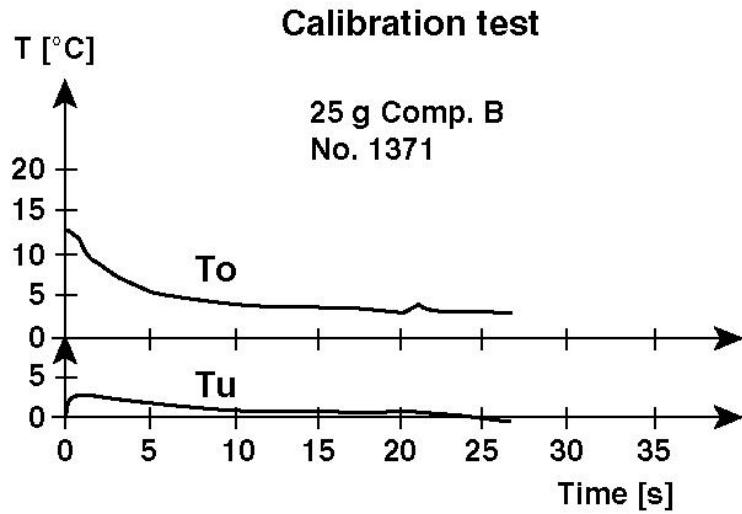
Oxygen after Firing : 20.6 %

Found in Water after 50 Liter Gas:

Iron Fe 0.70 mg

Copper Cu 1.40 mg

Nitropenoxia NO Shows

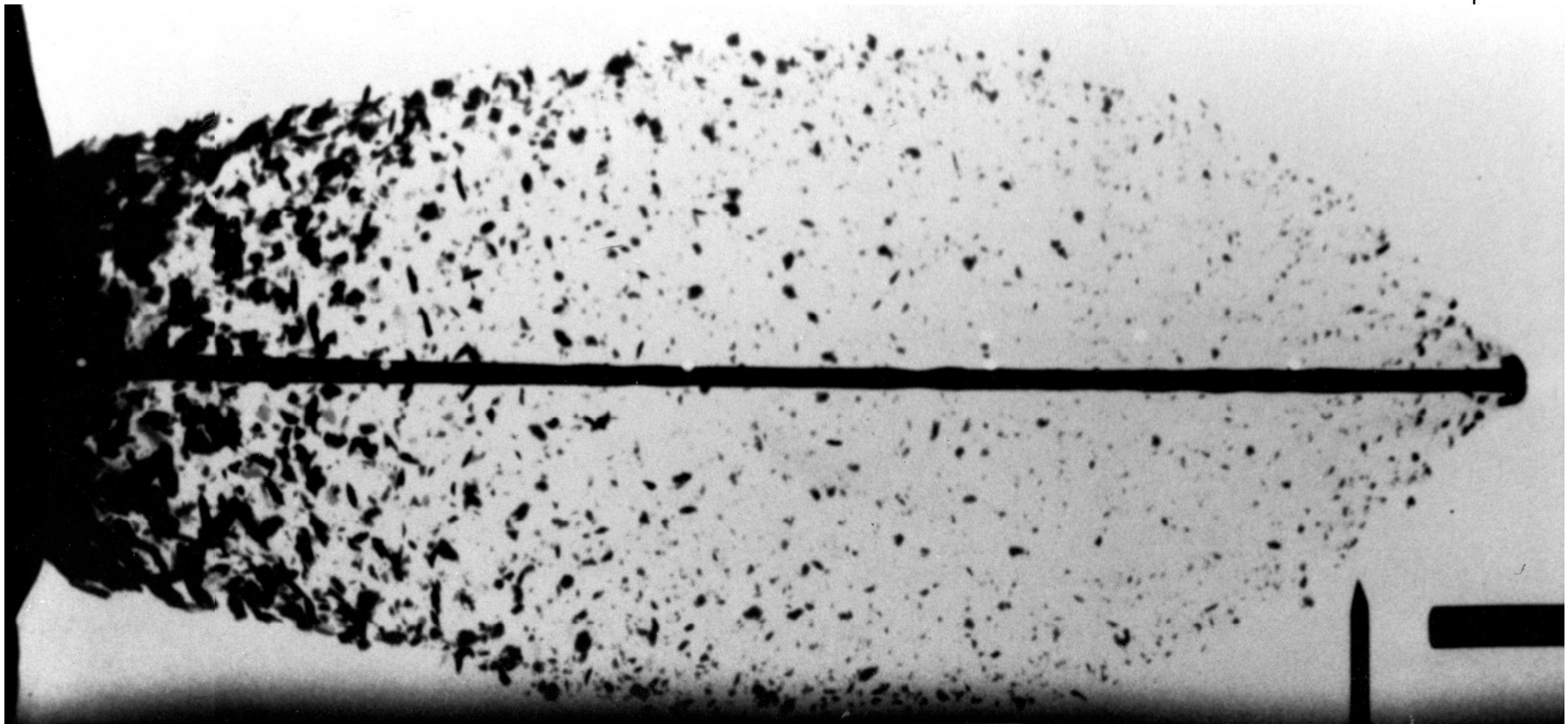




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Spall Fragments



Bottom





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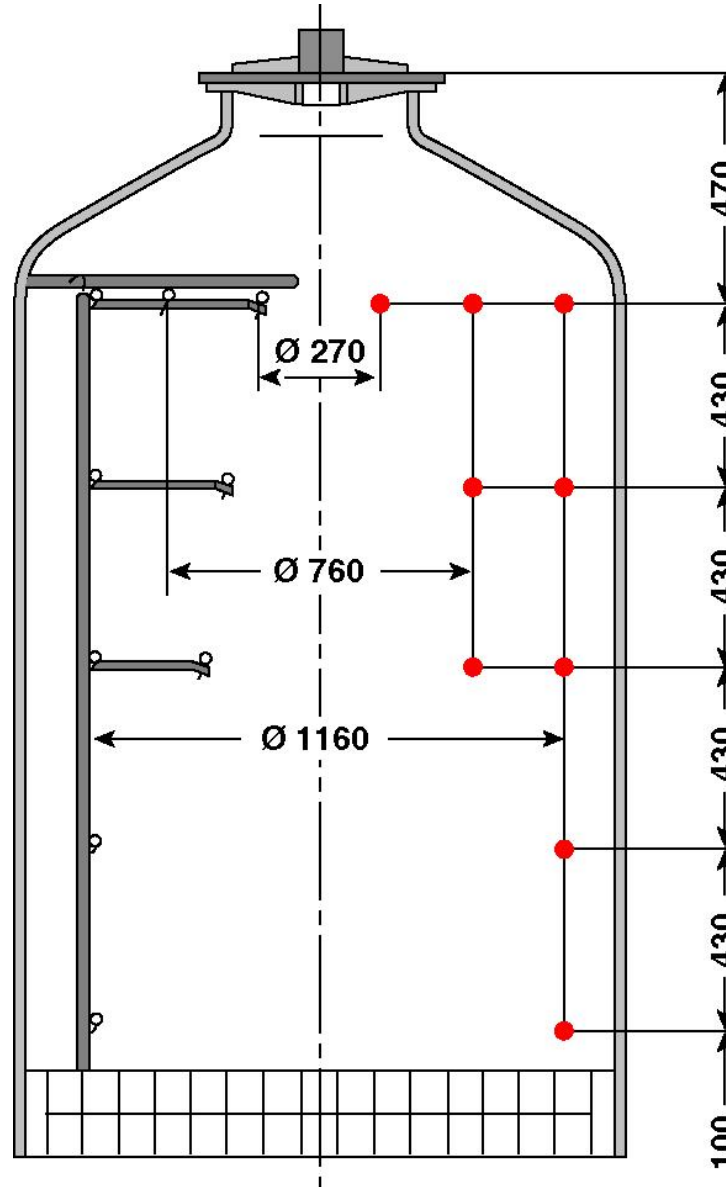


Blast Load Measurements

Gauges

6 pictures
x 9 locations =
= 54 diagnostic points

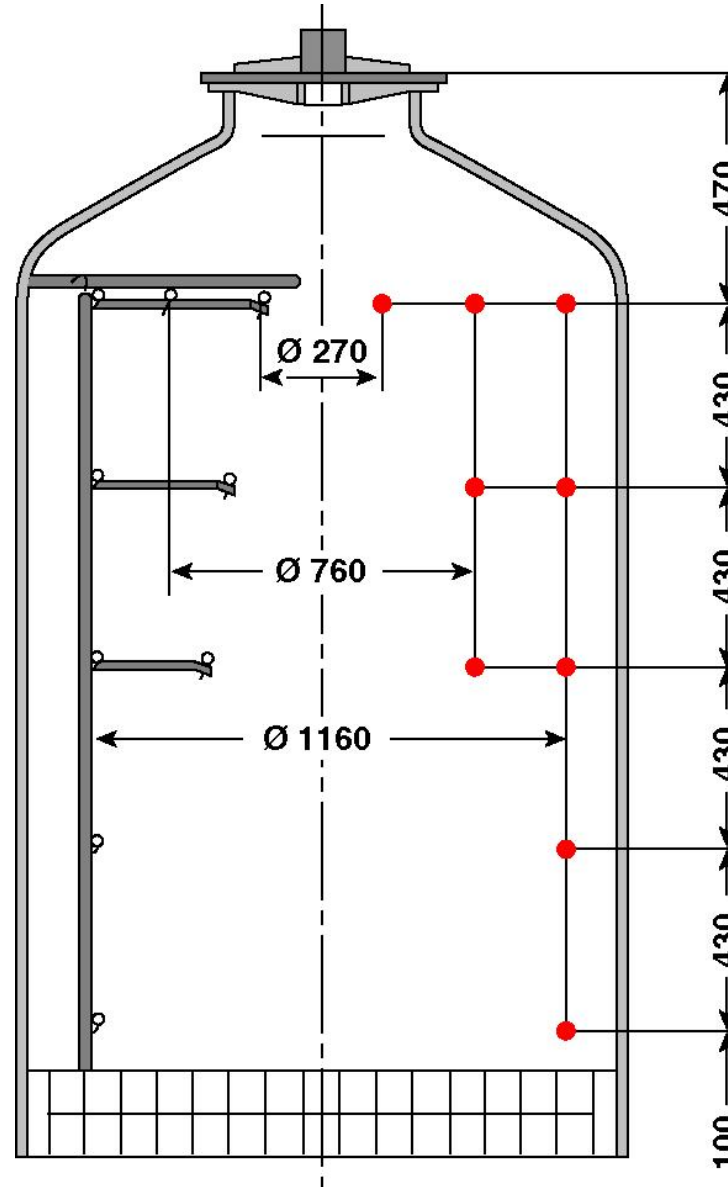
54 dodecahedra
x 11 diaframa =
594 measurements,
distributed over the
radius and height
of the diagnostic vessel



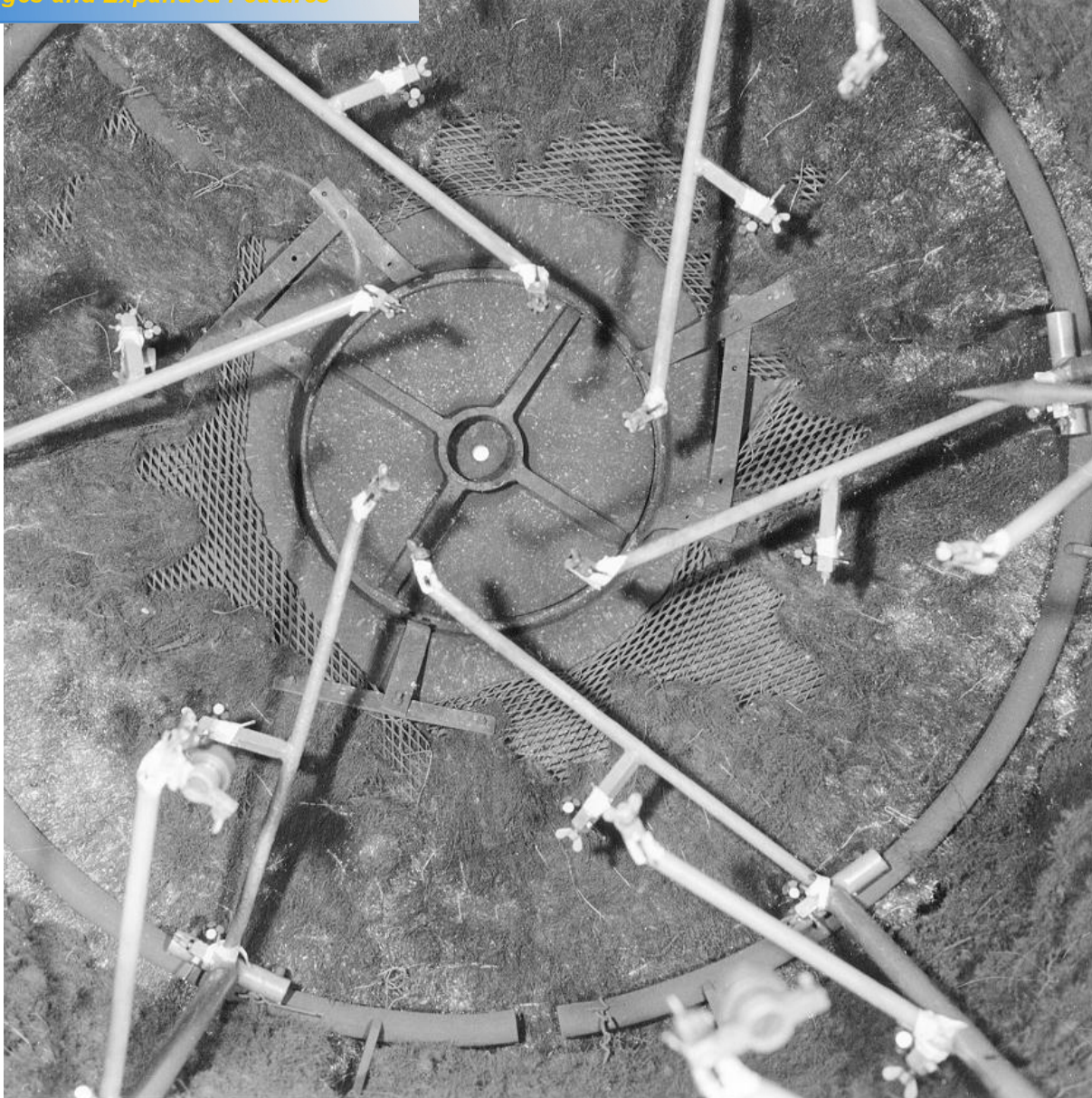
Gauges

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radius and height
of the diagnostic vessel



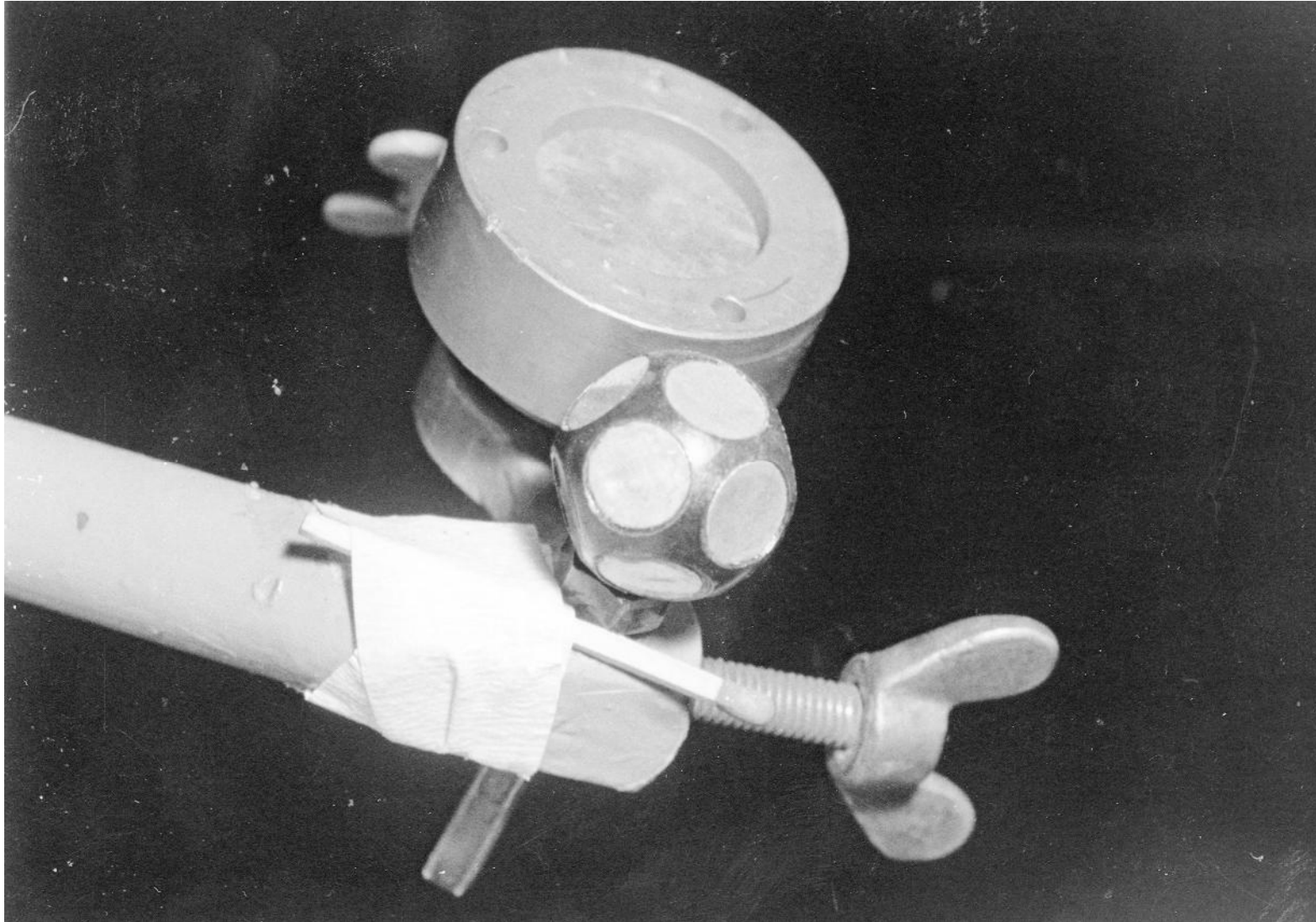
o of diagnostic vessel



Fictitures

Expanded metal mesh

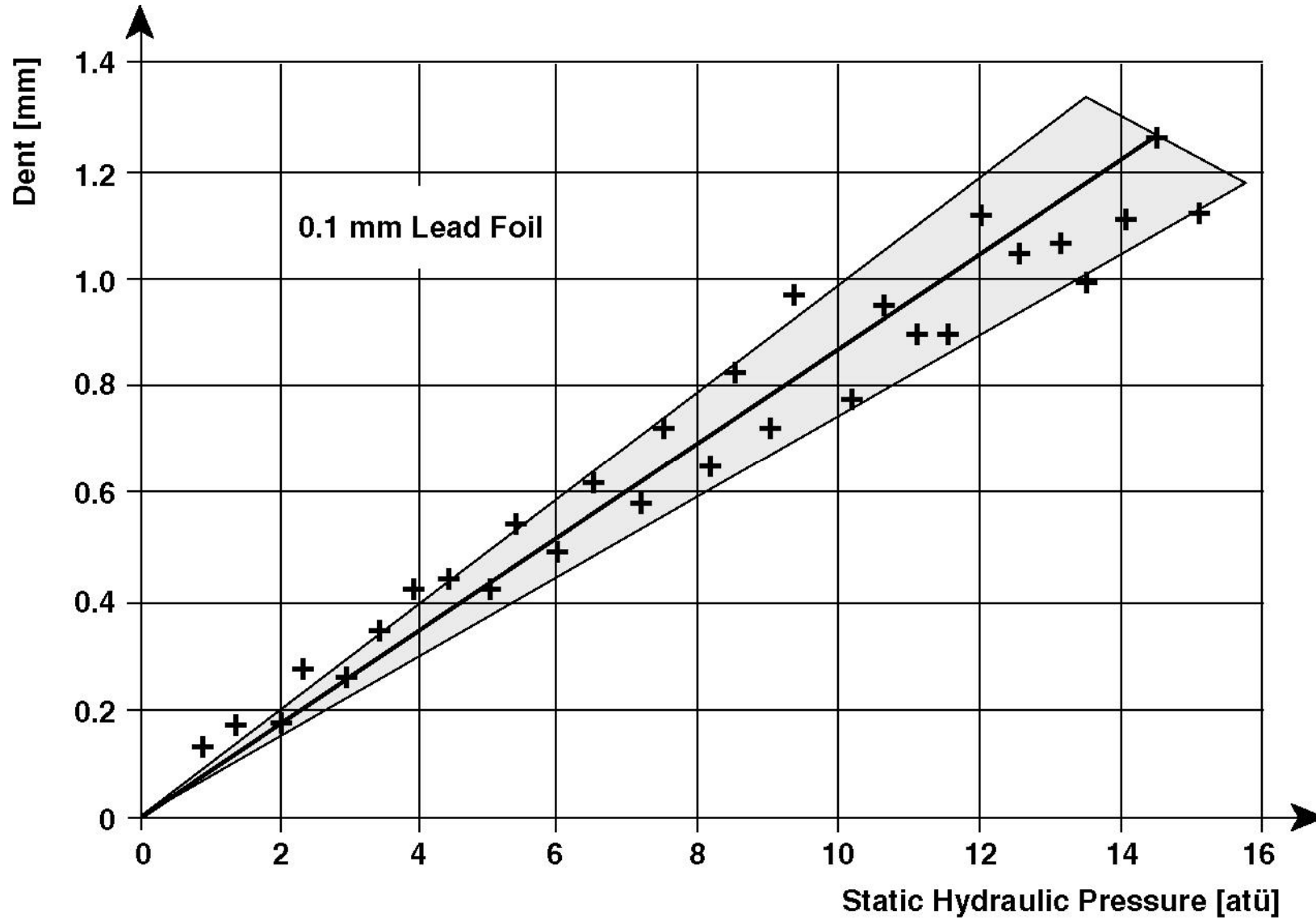
Caeder, Matches



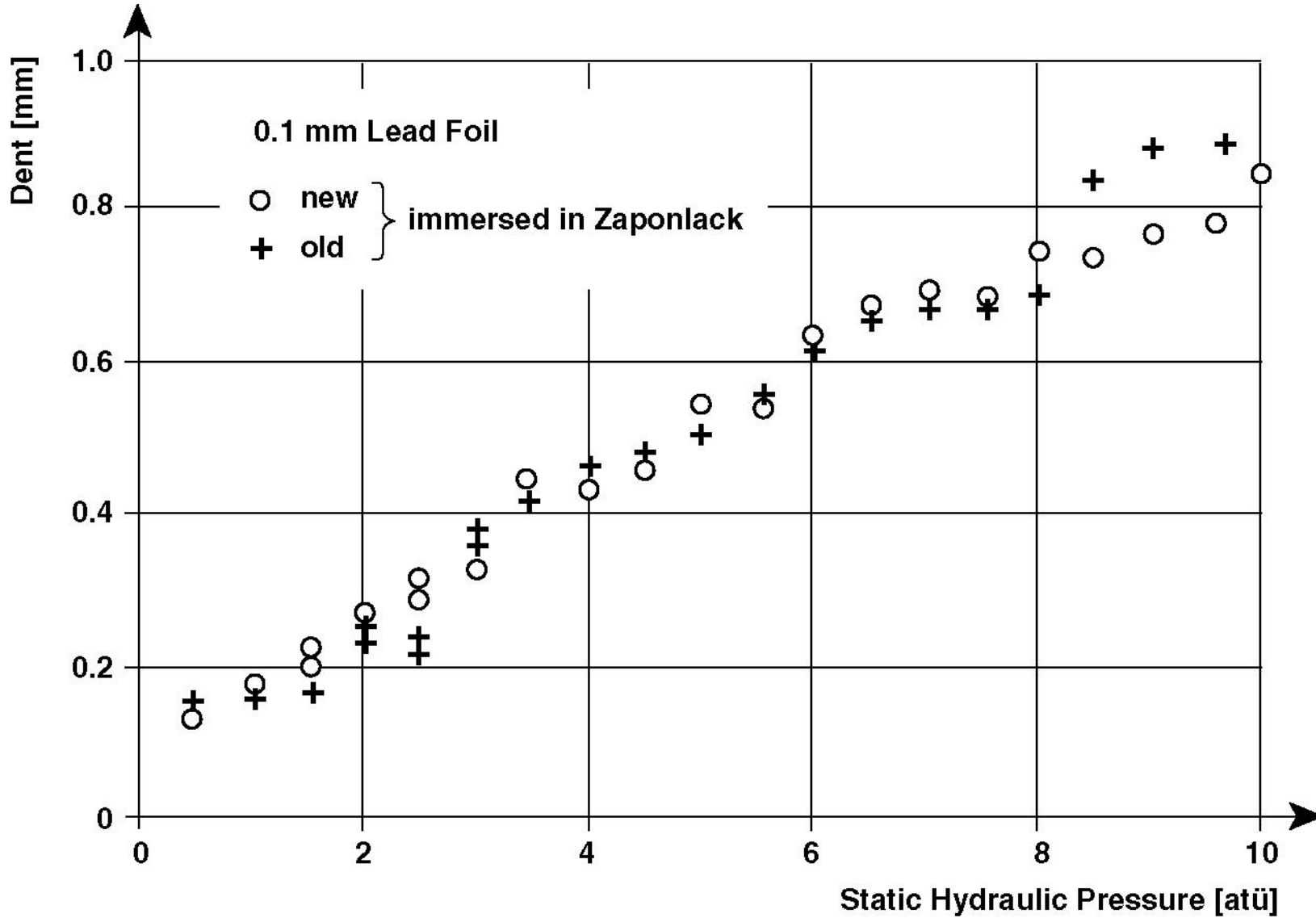
körper“

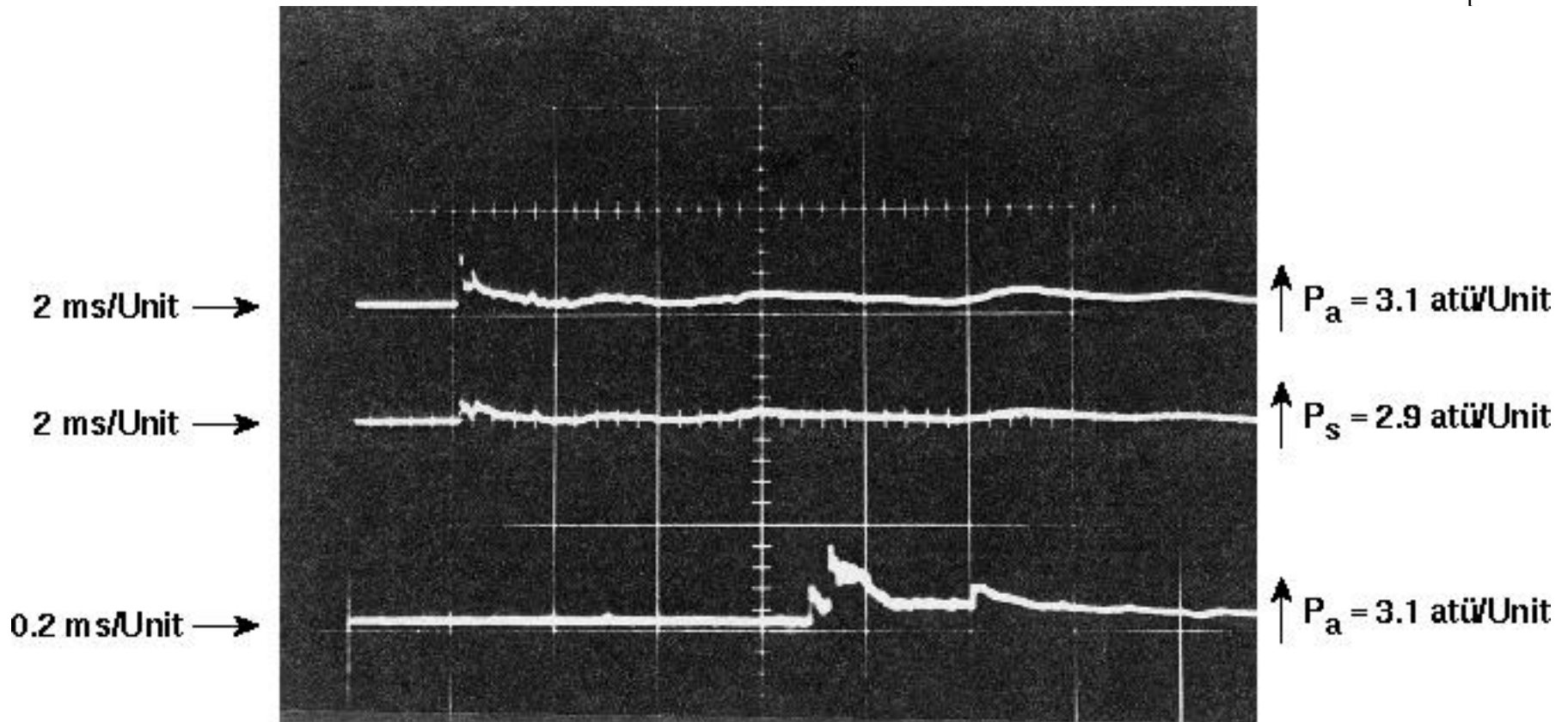


Measuring Device



Measuring Device

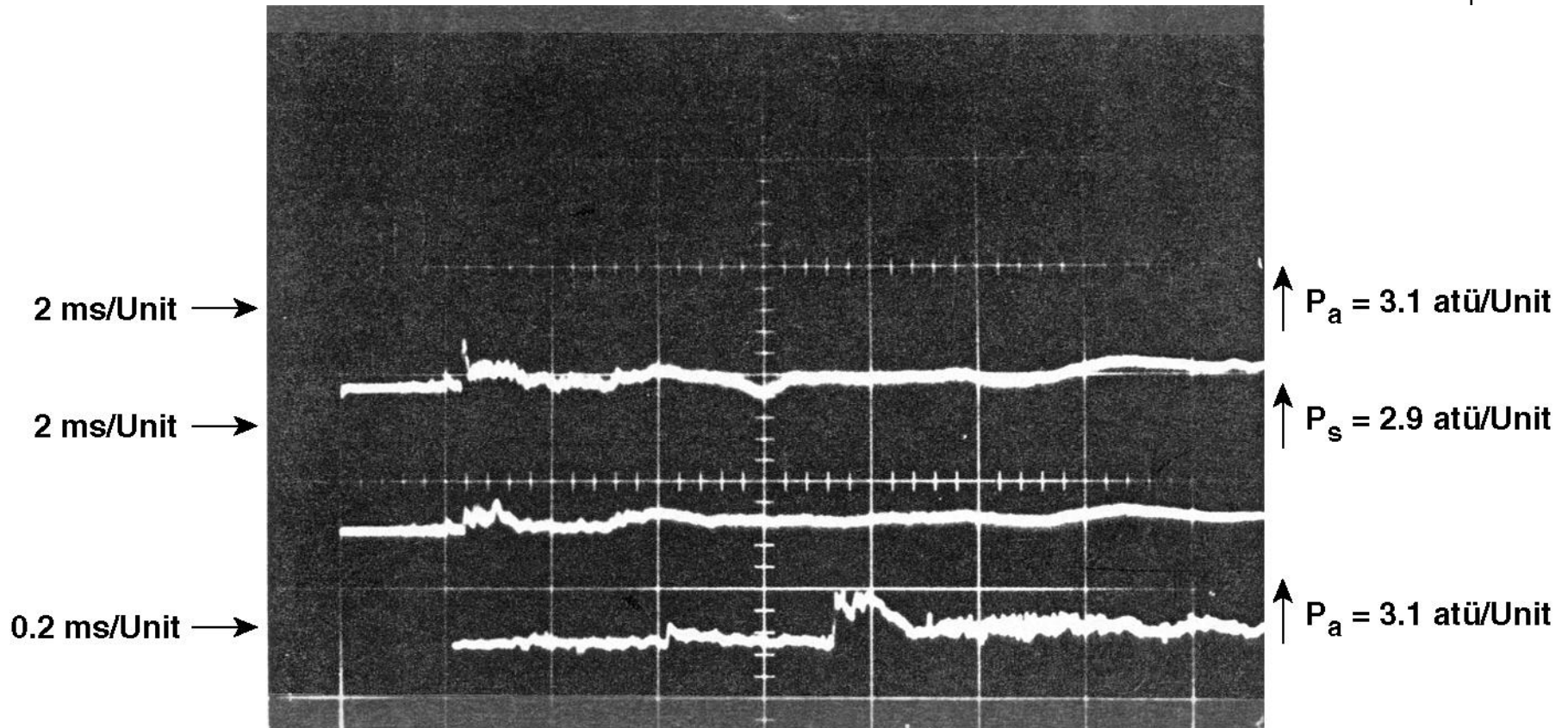




$$P_R = 2.2 \text{ atü}$$

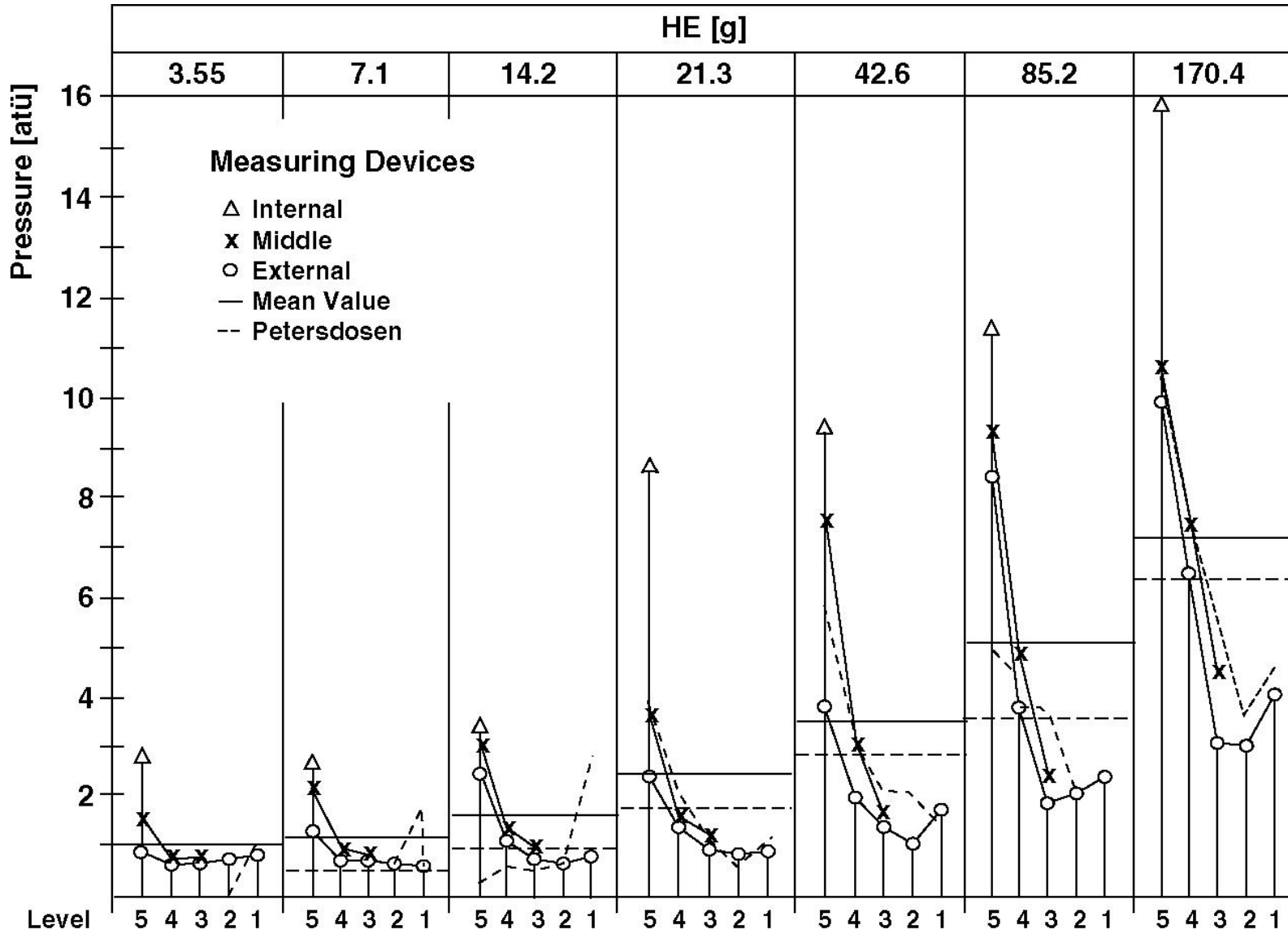
$$P_S = 0.6 \text{ atü}$$

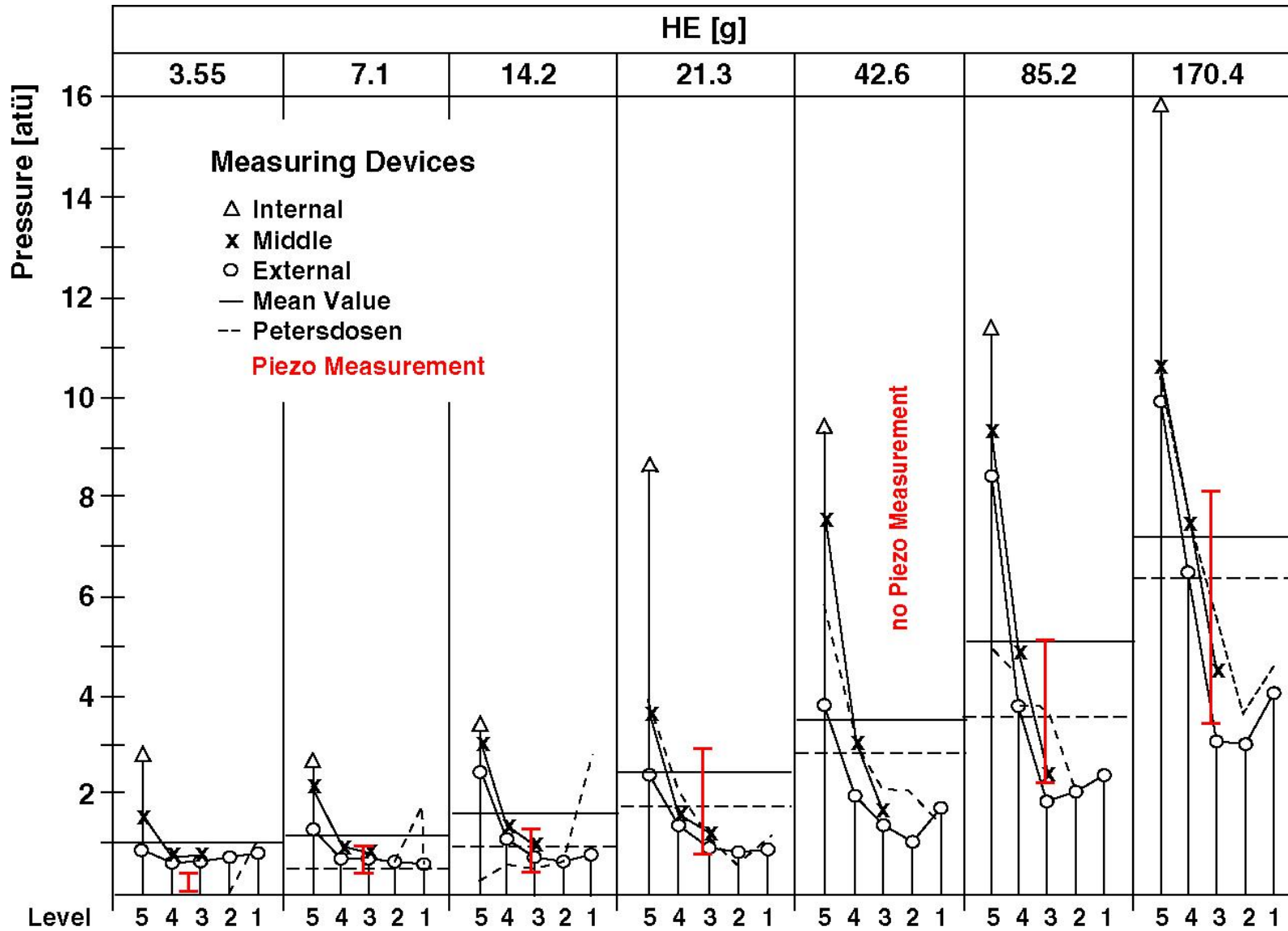
00 mm Barrier

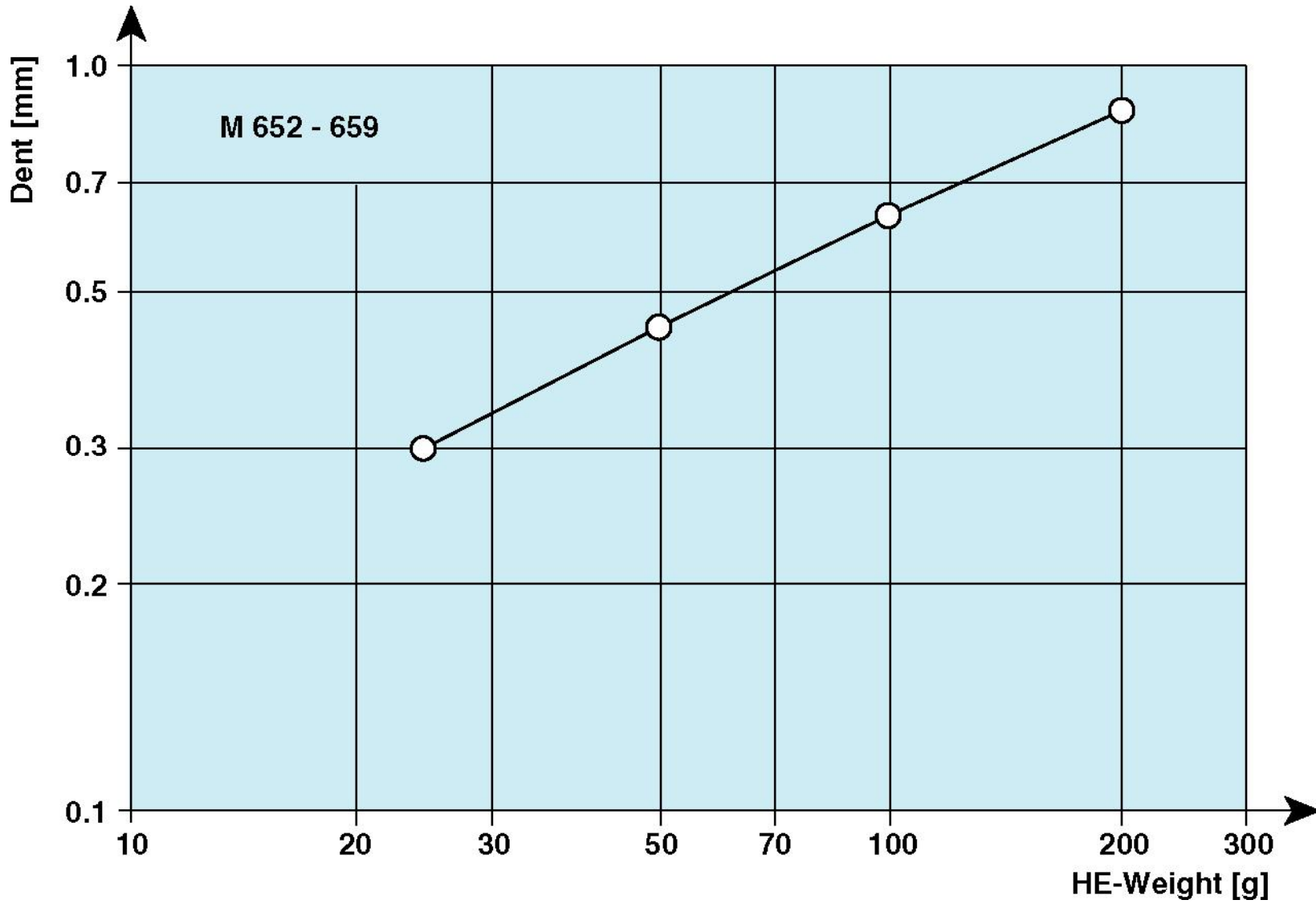


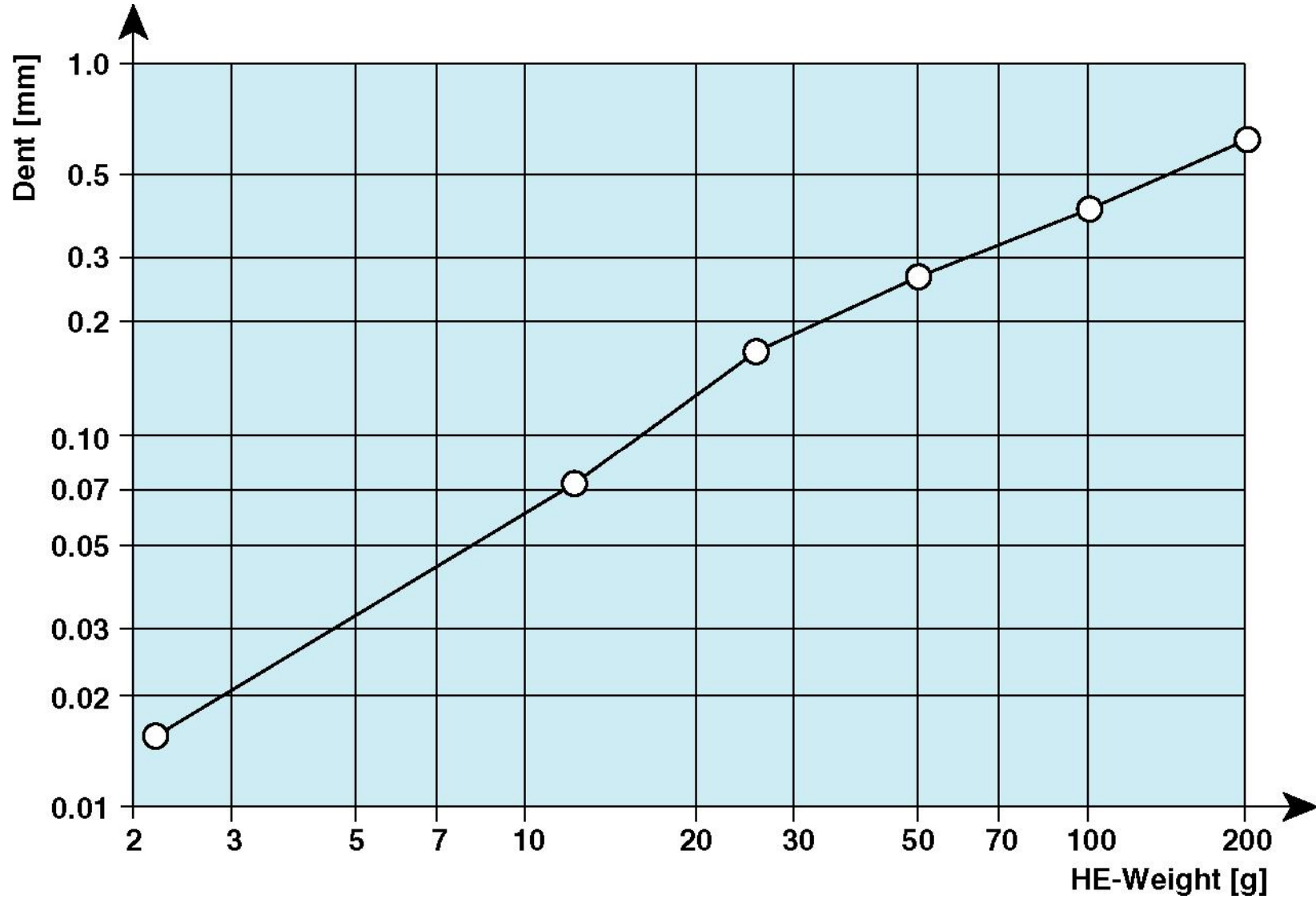
$$P_R = 1.6 \text{ atü}$$

$$P_S = 0.9 \text{ atü}$$







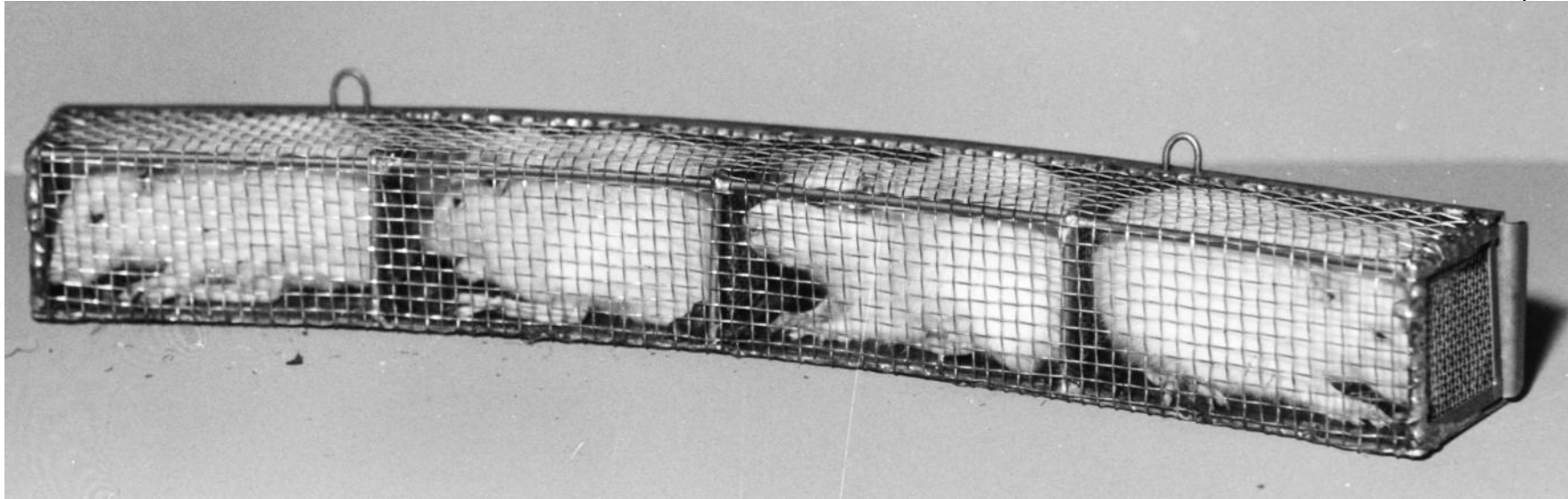




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Albino Rats

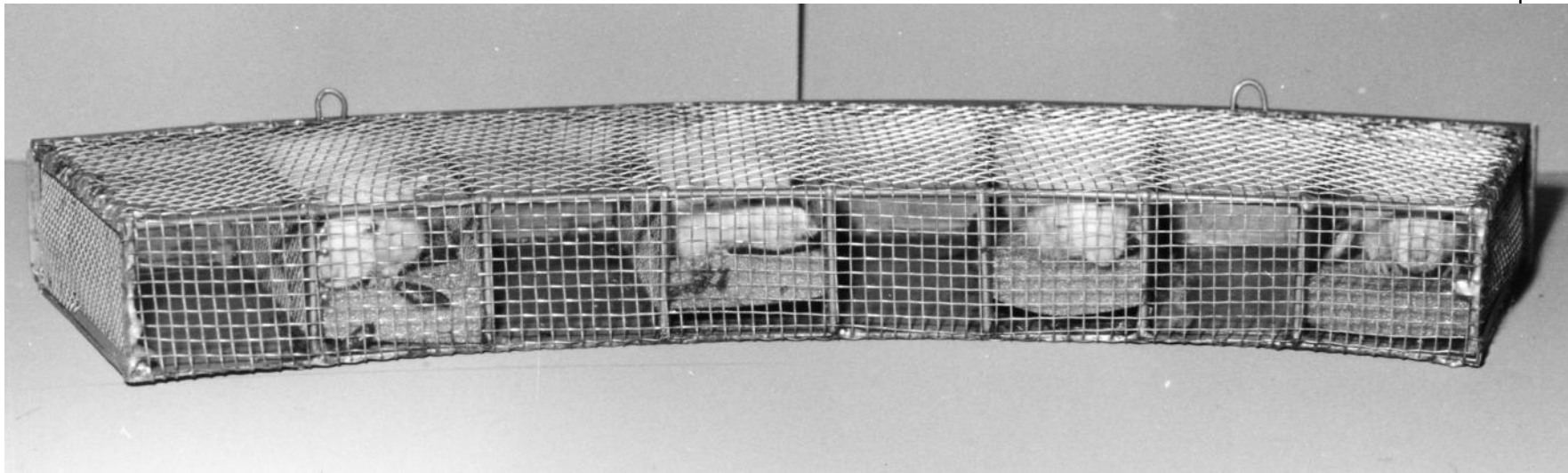




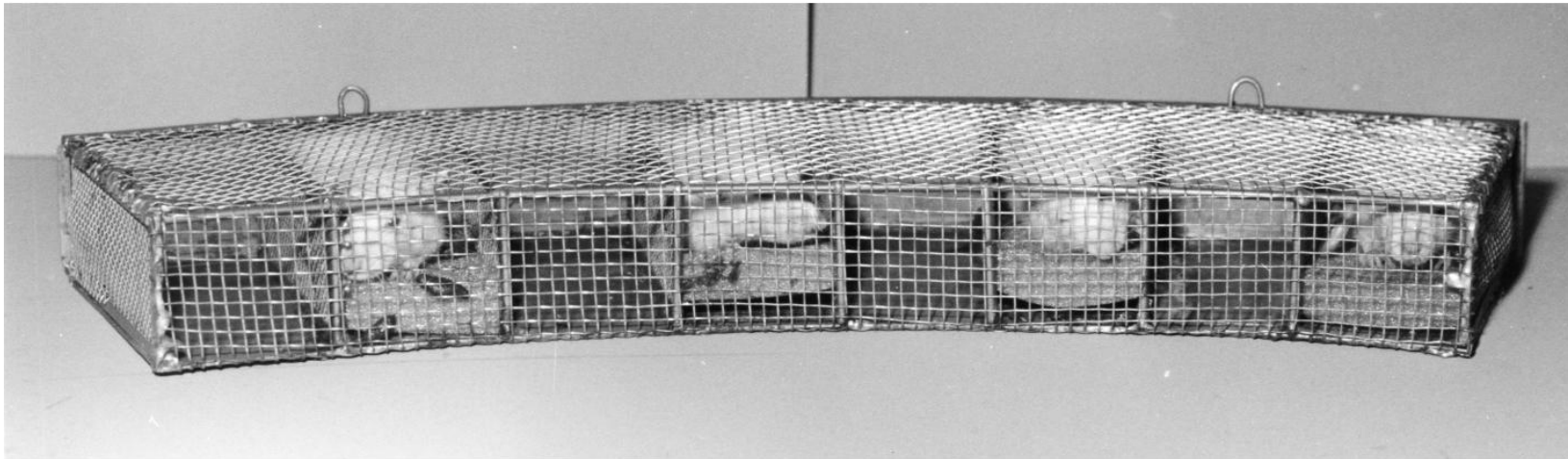
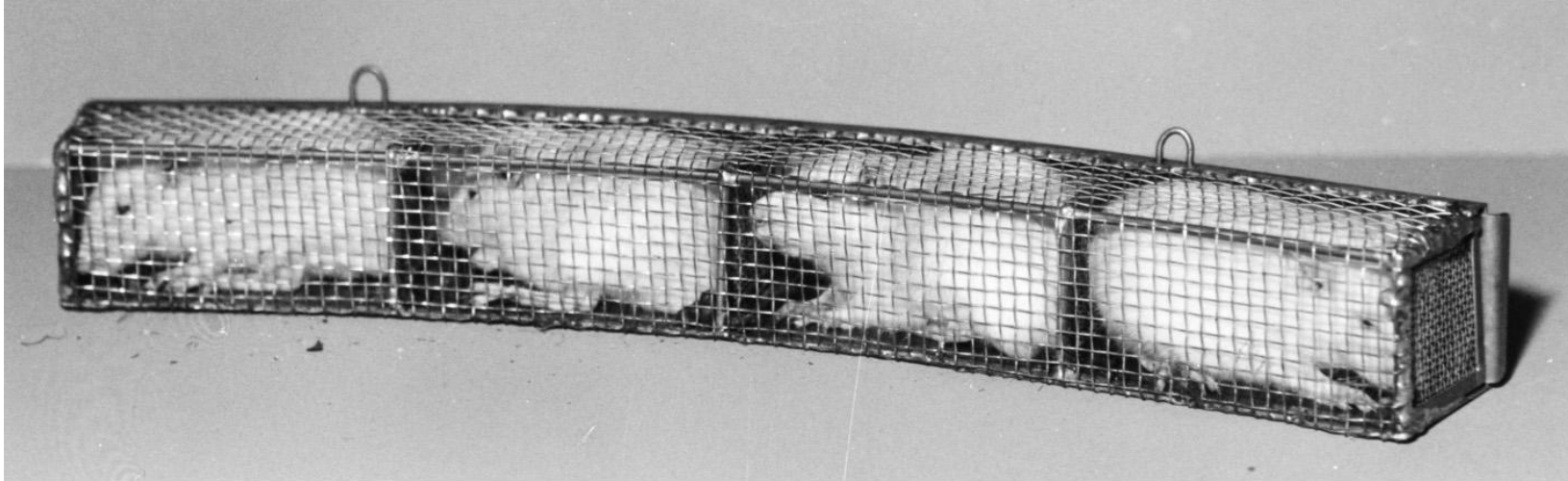
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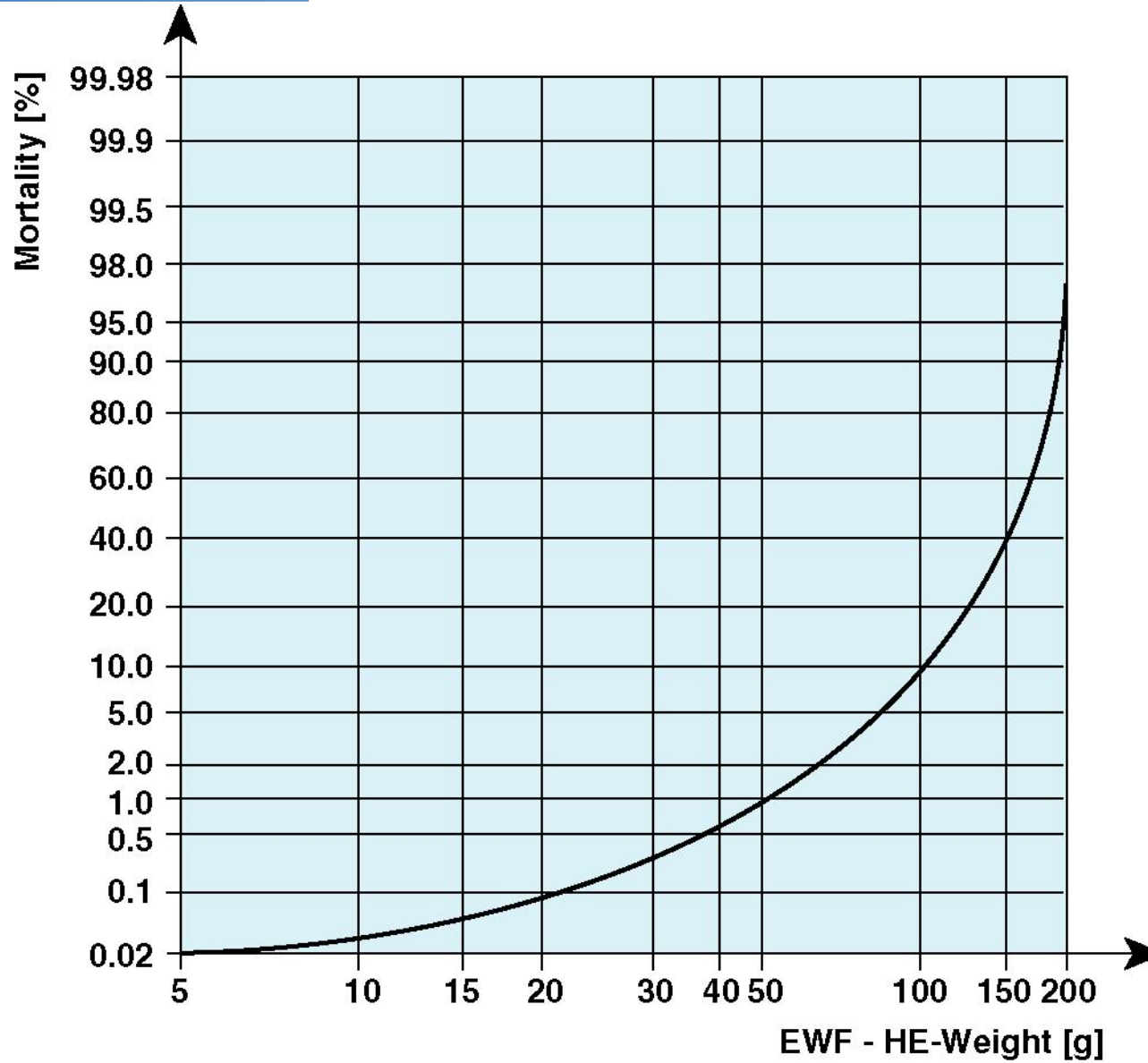
binoculars Rats



binoculars Rats



Rats 200g



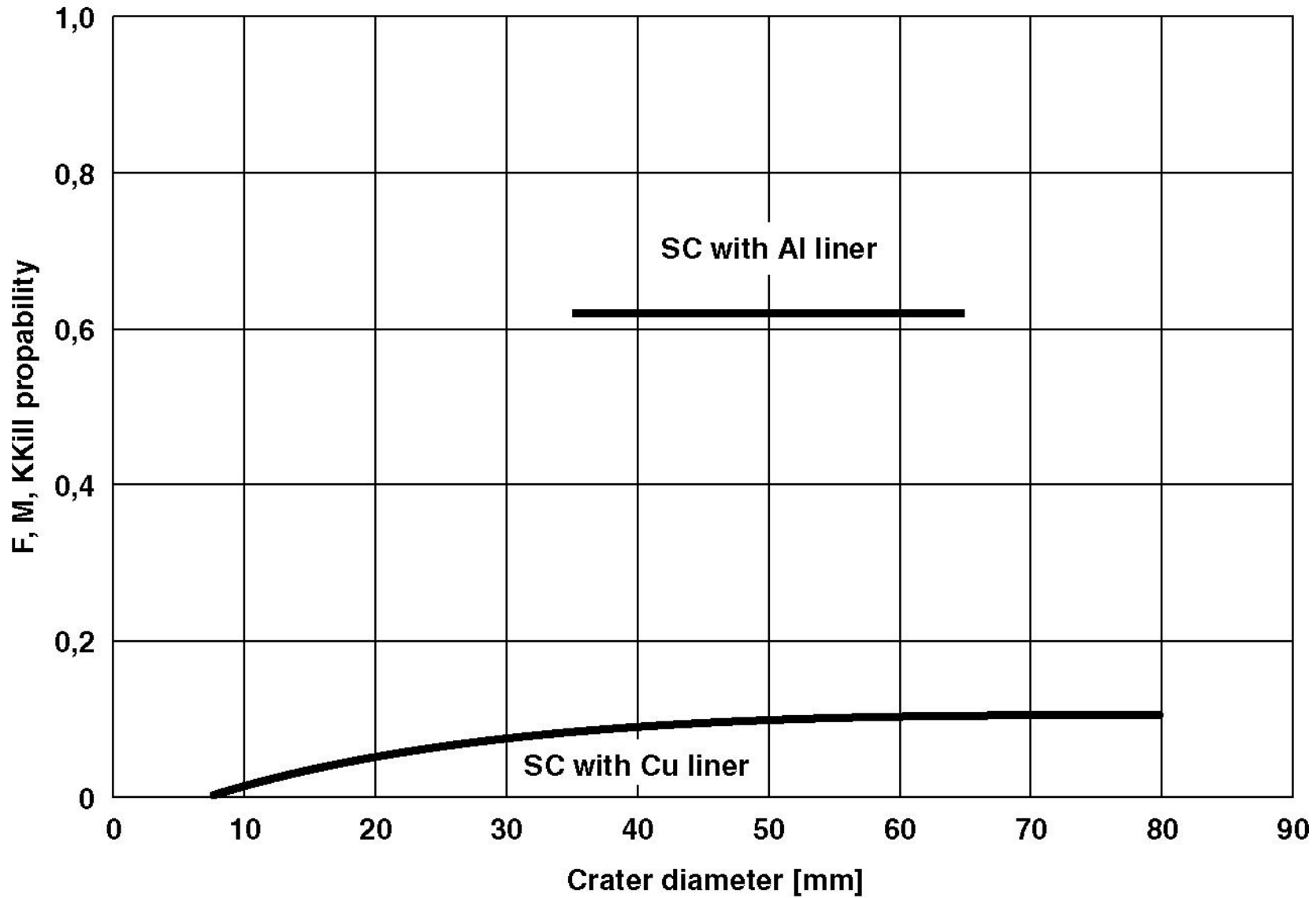


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Incendiary Effects





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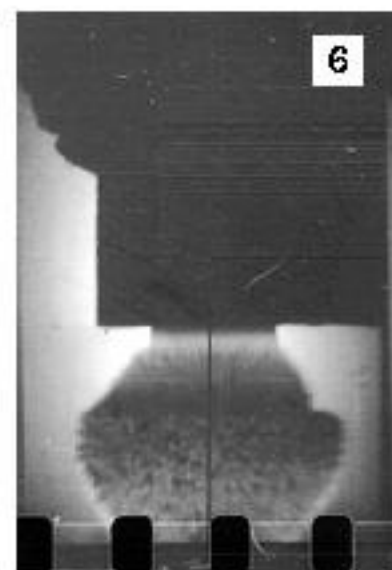
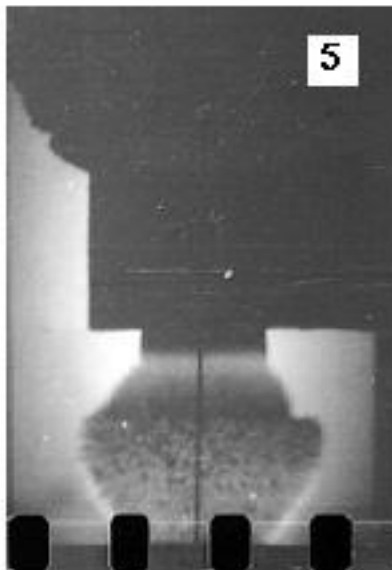
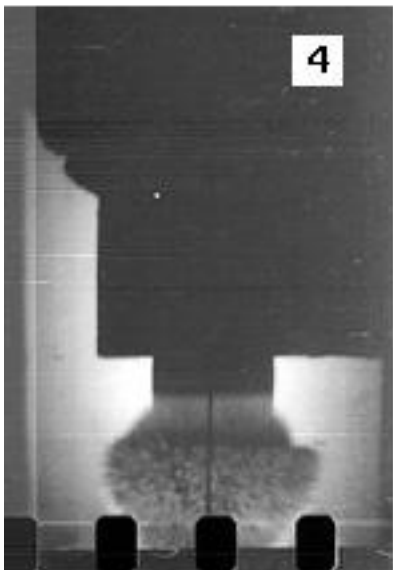
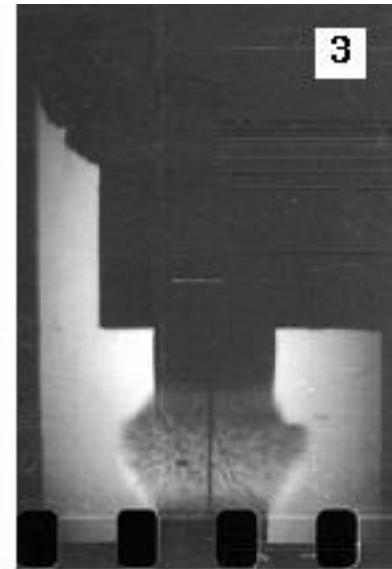
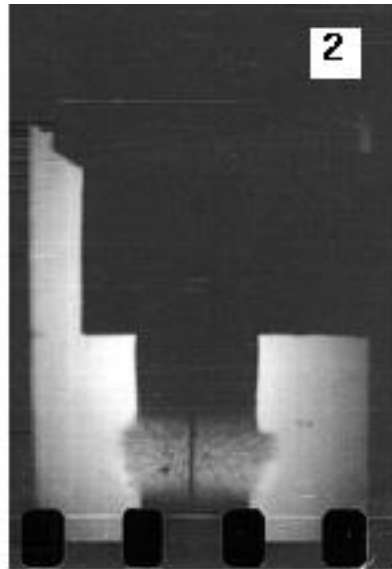
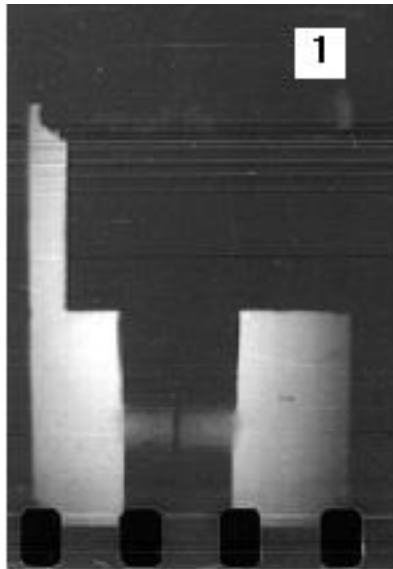


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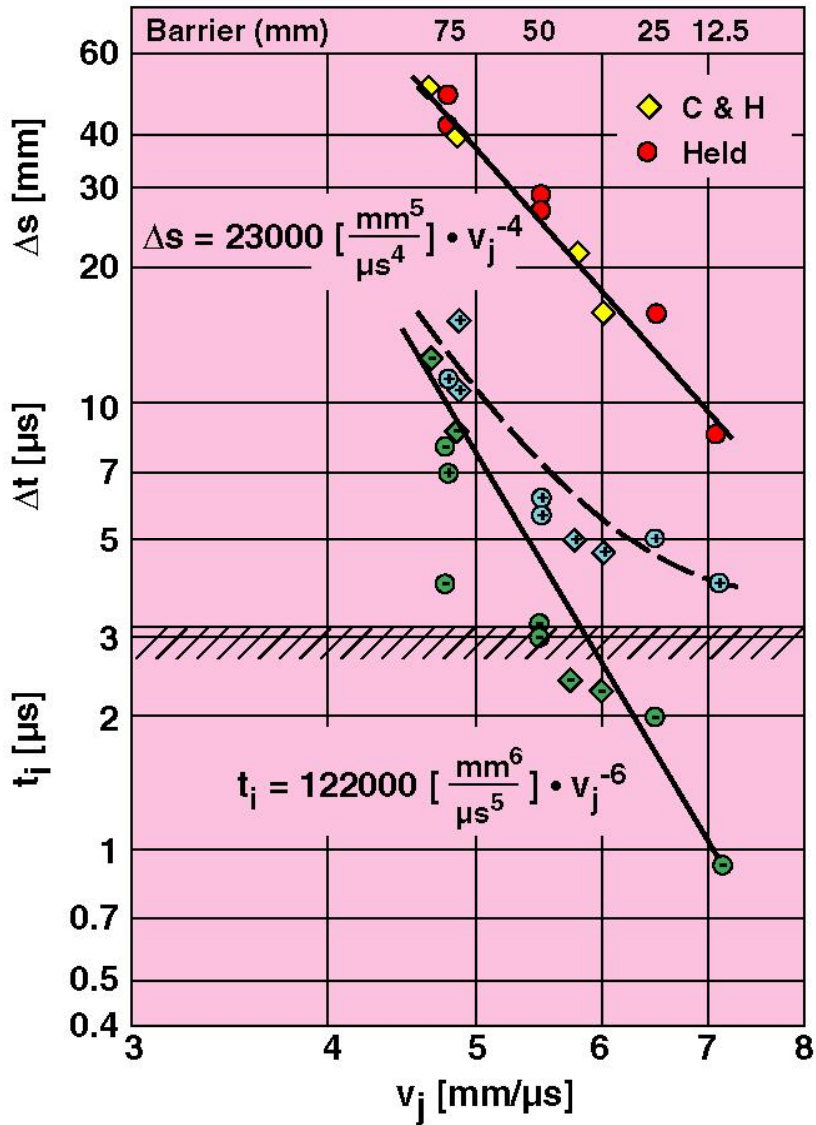
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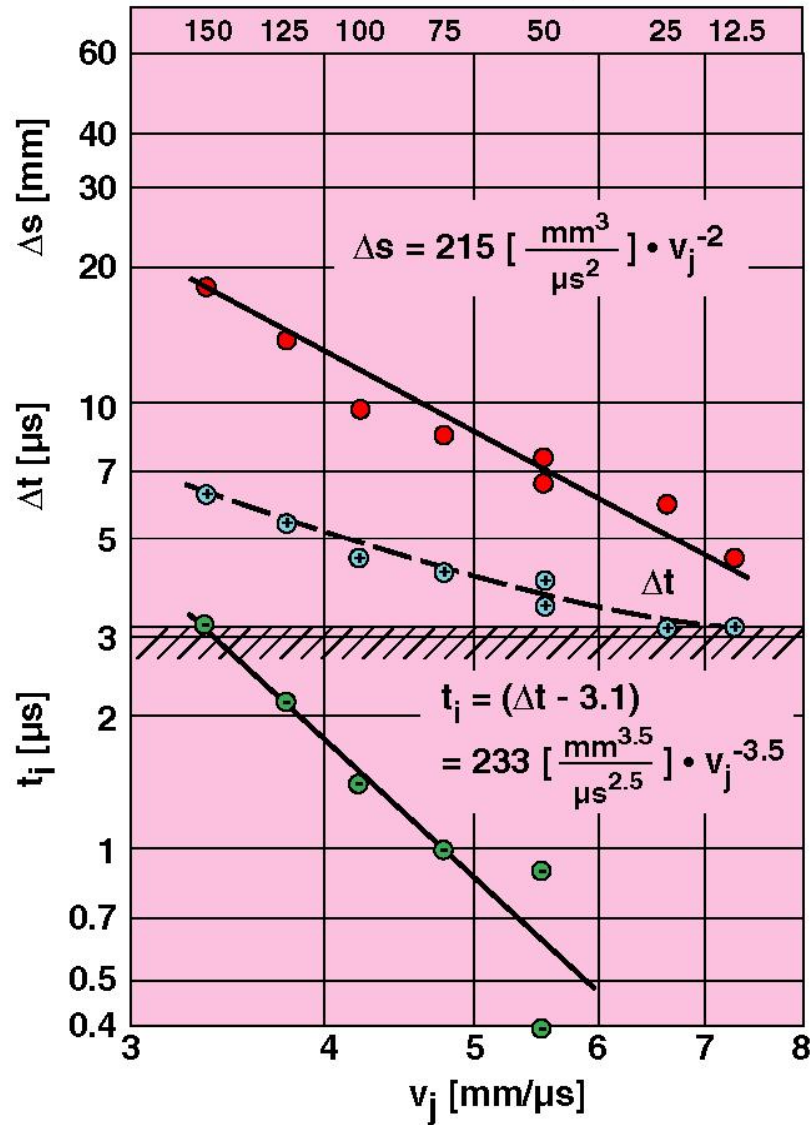
Ignition & Initiation Effects



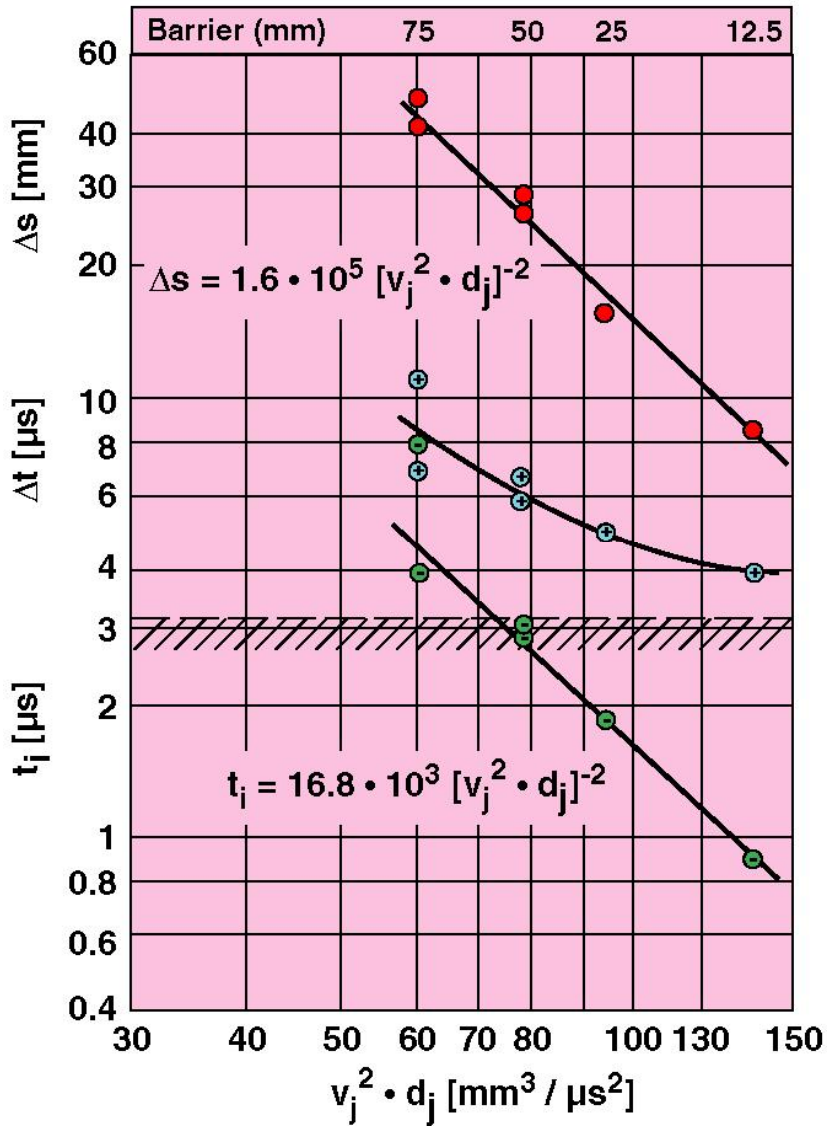
HE in Contact



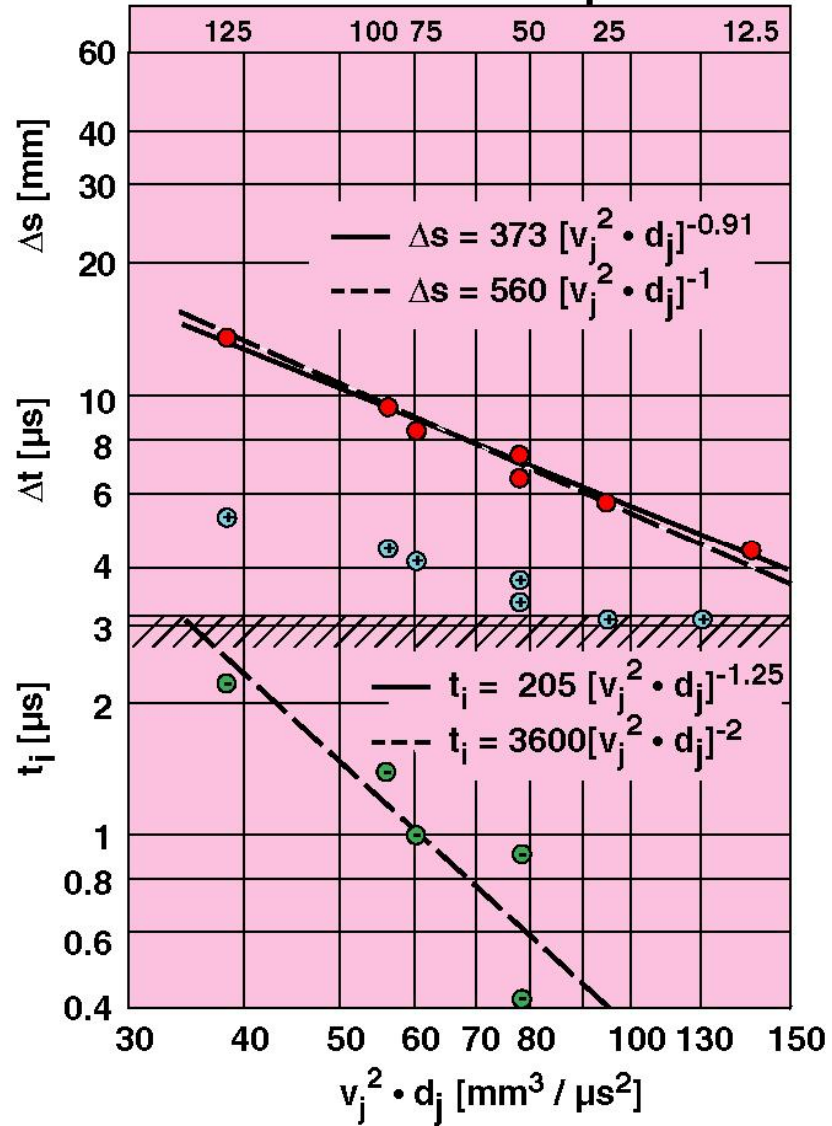
HE in Air Gap

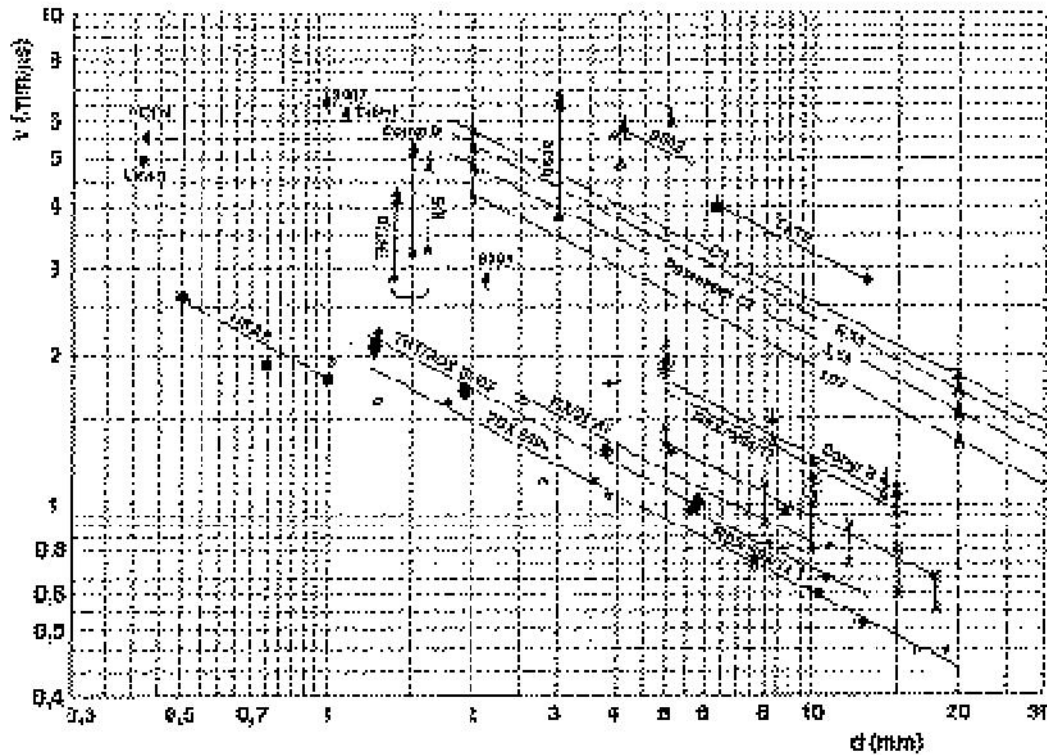


HE in Contact



HE in Air Gap





Type of HE	v^2d ($\text{mm}^3/\mu\text{s}^2$)	Sign in Figure
HNAB	3	■
PBX 9404	4	●
RDX/Wax 88/12	5	●
TNT/RDX 15/65	6	◆
PETN (1.77)	13	▲
Comp. B	16	▲
H6	16.5	▲
Detasheet C3	36 - 53	▲
PBX 9407	40	▲
Tetryl	44	▲
C4	64	▲
TATB	108	■
PBX 9502	128	▲

△ □ ○ - no Initiation ▲ ■ ● - Initiation

The above diagram of the threshold impact velocities as functions of the diameters of the shaped charge jet (▲), projectile (●), flyer foil (■) and from FEM-calculations (x) for different high explosive charges gives a clear indication of the validity of the v^2d -criterion.

M. Held 9th Symposium (int.) on Detonation 1416 - 1426 + 1432 - 1440, 1989

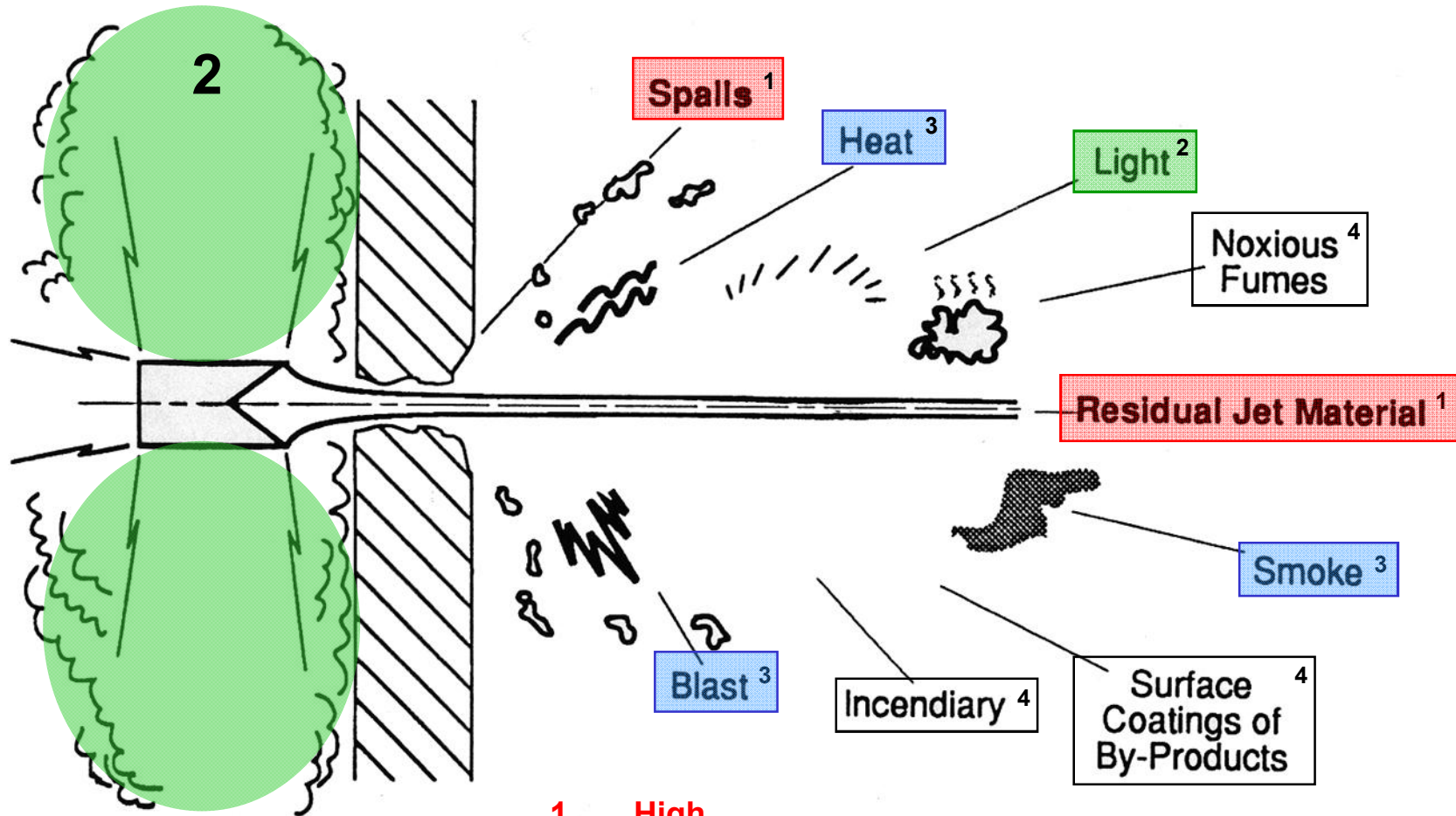
Reactions of Propellants and High Explosives

v^2d or u^2d criterion gives the ignition and initiation threshold values at shaped charge jet impacts

Less sensitive explosives are now not available against shaped charge jet loads

Take no explosives in the crew compartment, if you want to increase the survivability of the crew

Shaped Charge Jets Perforations and Armour Effects after



- 1 High
- 2 Media
- 3 Minor
- 4 nothing