LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY
- LIGO -
CALIFORNIA INSTITUTE OF TECHNOLOGY
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Drop Test - COC Carrier and Shipping Case

Craig Conley

Distribution of this draft:

D. Coyne, S. Eliason, A. Lazzarini

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California Institute of Technology
LIGO Project - MS 51-33
Pasadena CA 91125
Phone (818) 395-2129
Fax (818) 304-9834
E-mail: info@ligo.caltech.edu

Massachusetts Institute of Technology
LIGO Project - MS 20B-145
Cambridge, MA 01239
Phone (617) 253-4824
Fax (617) 253-7014
E-mail: info@ligo.mit.edu

WWW: http://www.ligo.caltech.edu/

1 ABSTRACT

The drop test of the shipping case containing the COC carrier and dummy optic was performed at National Technical Systems in Fullerton, CA on 8/30/96. The dummy optic, secured within the COC carrier, was made of aluminum, and exactly the size and shape of a large LIGO optic, but with 27% more mass.

The case was dropped in ten different orientations from a height of 36" onto a concrete floor. The setup consisted of a hinged platform with a stretched bunji cord attached for quick separation from the case at drop-time, a mounted triaxial accelerometer (accel), and electronic monitoring equipment including two oscilloscopes.

The test revealed inadequacy of the shipping case, with the current foam insert design, to shield the carrier from the resulting shock forces. The carrier experienced shock forces of up to approximately 200g. It appears likely that a greater thickness of foam (as well as a larger case) will be deemed necessary. Stress analysis of the COC carrier standoffs will determine whether the standoffs should be thickened and provided with threaded inserts.

2 PROCEDURE RECAP

(See attached NTS Log Sheet, graphs, sketches and photos)

The accel was initially mounted with dental cement to the side of the dummy optic, approximately centered between it's top and bottom, with axes oriented as sketched. After a couple of drops to get the 'feel' and adjust equipment settings, the setup was seen to provide very good control of the drop orientation with no interference from the platform owing to the pre-loaded bunji cord. The drops were executed with good results until the 7th drop, at which time the case and carrier were opened revealing damage to the carrier including completely stripped threads in the mounting screw holes of the hinged standoff, looseness of the other two standoffs at the base, bending of the top plate hold-down screws and locating pins, fracturing of the L-section tefflon base pad at the hinged standoff, buckling of the top face of the cover and a sheared mounting screw to the left handle plate. The accel was broken free from the optic and had left an imprint in the side of the cover. After re-mounting the accel to the cover as sketched with the original axes orientations, the test was resumed with the optic in its non-secure condition in the damaged carrier. The accel was broken loose again on the 8th drop, and re-mounted in approximately the same location for the 9th and 10th drops. The final three drops yielded questionable output results (see table below). Through the course of the test, the case incurred mainly cosmetic damage, and was not rendered unusable.

NOTE: The worst case drop (with this test's carrier/case orientation) would presumably be a front side drop, in which the weaker mounted hinged standoff would take the full impact of the optic. This drop was not executed in this test

APPENDIX 1 PEAK ACCELERATION VALUES

Table 1:

Drop #	Orientation	Peak Acceleration (G)		
		X_p	Y_p	Z_p
1	bottom	-72	-2	-2
2	side, hinge	-78/97	193/-80	106/-115
3	left side, handle	-49/15	-15/8	-75/0
4	bottom left edge	80/-70	197/168	67/-118
5	top left edge	-95/29	-67/67	-50/35
6	top side edge (hinge)	21/3	40/-3	4/-1
7	bottom side edge (latch)	-82/15	-71/49	-27/53
8[a]	top left corner (latch)	-110/80	-70/55	-112/128
9[a]	bottom left corner (latch)	-175/74	197/-60	164/-119
10[b]	top	14/-12	8/-9	6/-8

a. Suspect output traces. Plots decay to non-zero steady state values.
b. Outputs not as expected. Y_p & Z_p values should be near zero.

NTS

GENERAL LOG SHEET

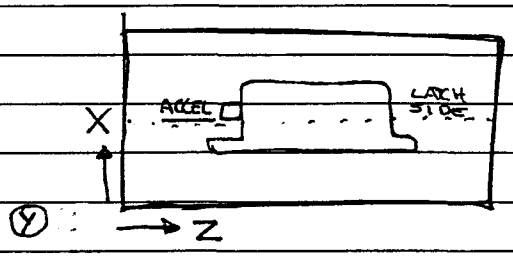
TEST 36" FREE FALL DROP MJO 673-3185

CUSTOMER CALIFORNIA INSTITUTE OF TECH. DATE 8-30-96

TEST ITEM CARGO CONTAINER P/N _____ S/N _____

SPECIFICATION CUSTOMER VERBAL PAR _____

DATE	TIME	LOG ENTRIES	INITIAL
8-30-96	0900	SET UP DROP APPARATUS, ATTACH ACCELEROMETER	
		TO DUMMY MASS, START TEST	
		DROP 1 BOTTOM, COMPLETE	
		2 SIDE (HINGE), COMPLETE	
		3 LEFT SIDE (HANDLE), COMPLETE	
		4 BOTTOM LEFT EDGE, COMPLETE	
		5 TOP LEFT EDGE, COMPLETE	
		6 TOP SIDE EDGE (HINGE), COMPLETE	
		7 BOTTOM SIDE EDGE (LATCH), COMPLETE	
		8 TOP LEFT CORNER (LATCH) COMPLETE	
		9 BOTTOM LEFT CORNER (LATCH) COMPLETE	
		10 TOP, COMPLETE	
8-30-96	1330	TEST COMPLETE	



PAGE 1 OF 1

TEST BY T. Henderson DATE 8-30-96

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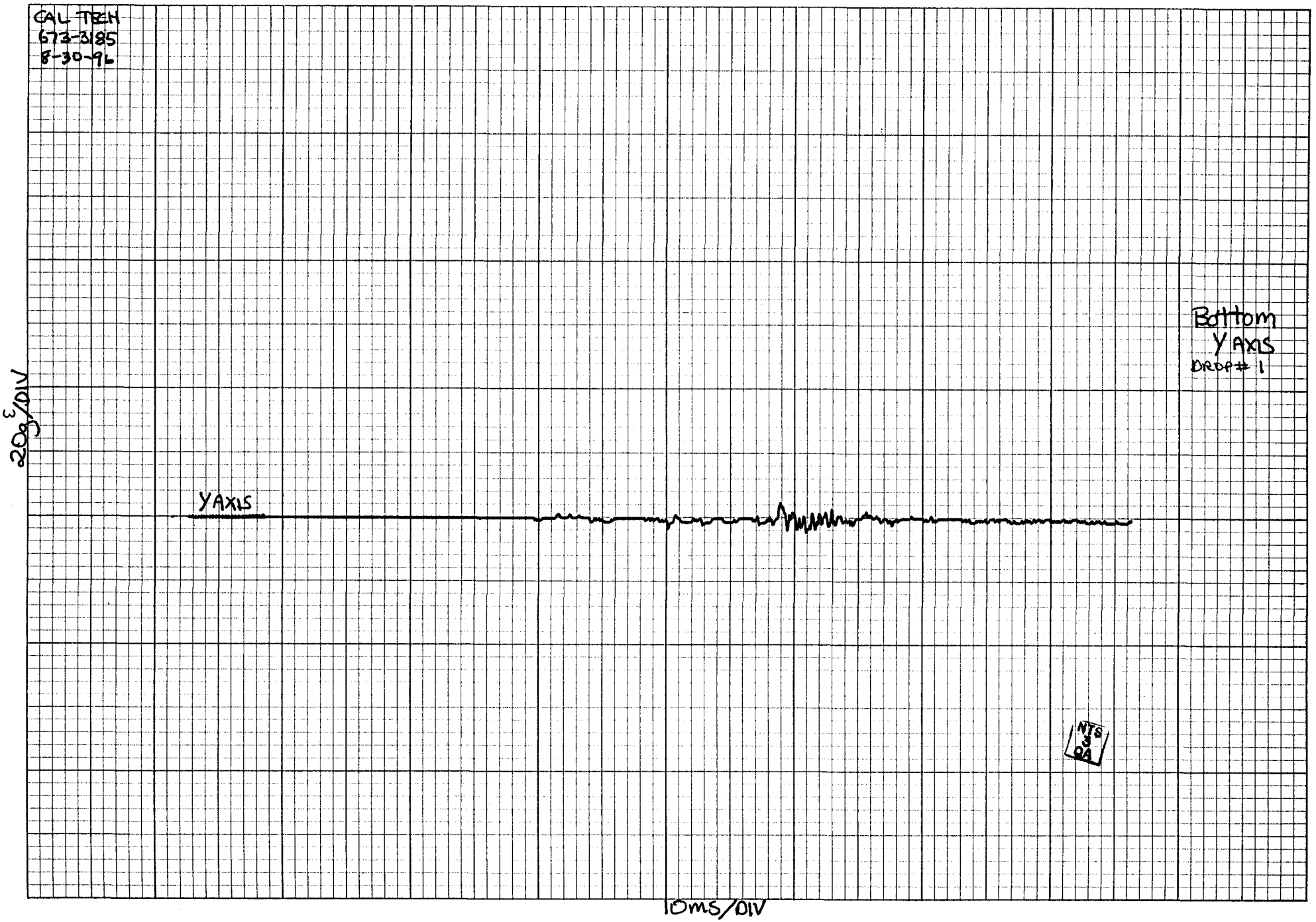

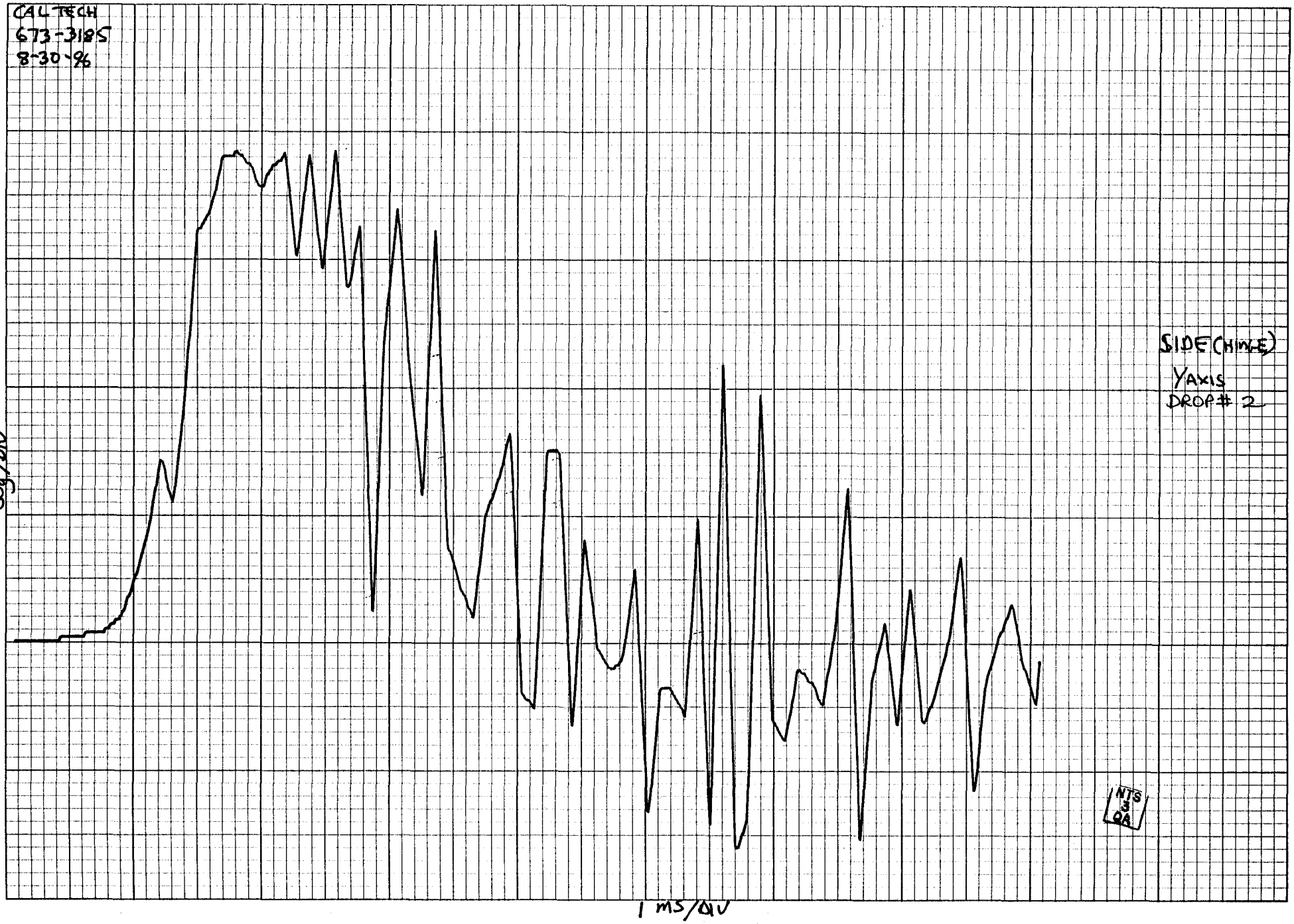

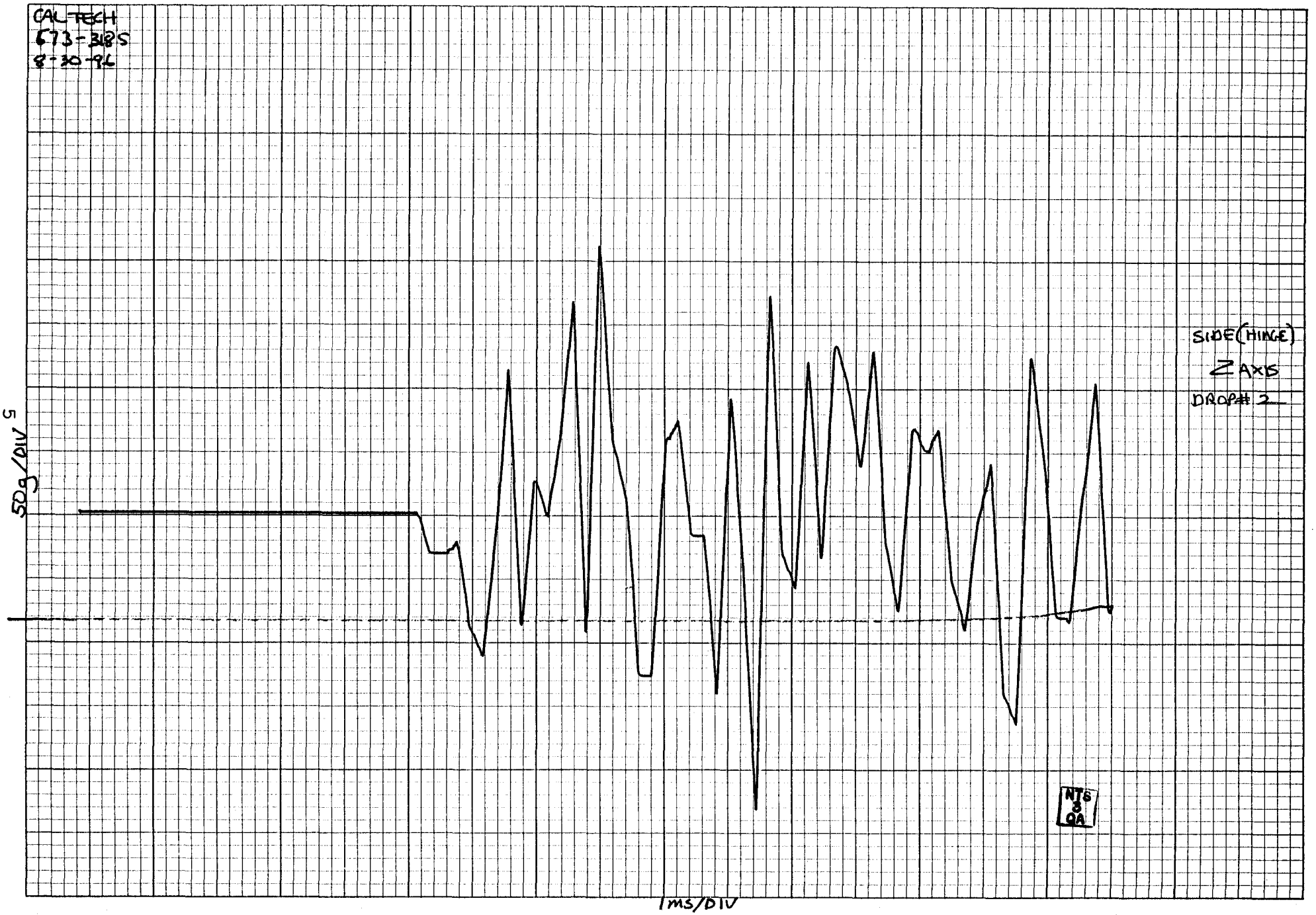

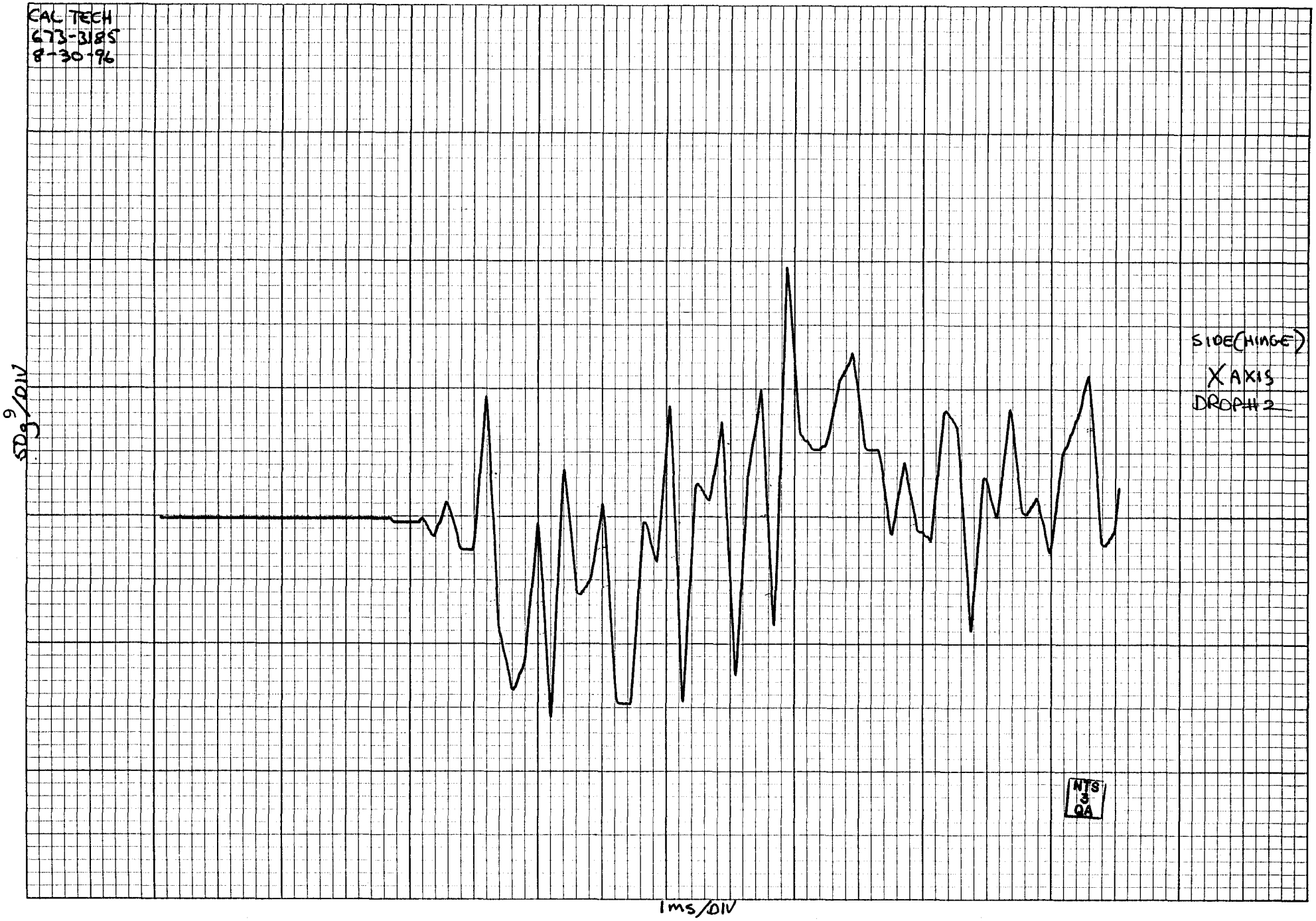

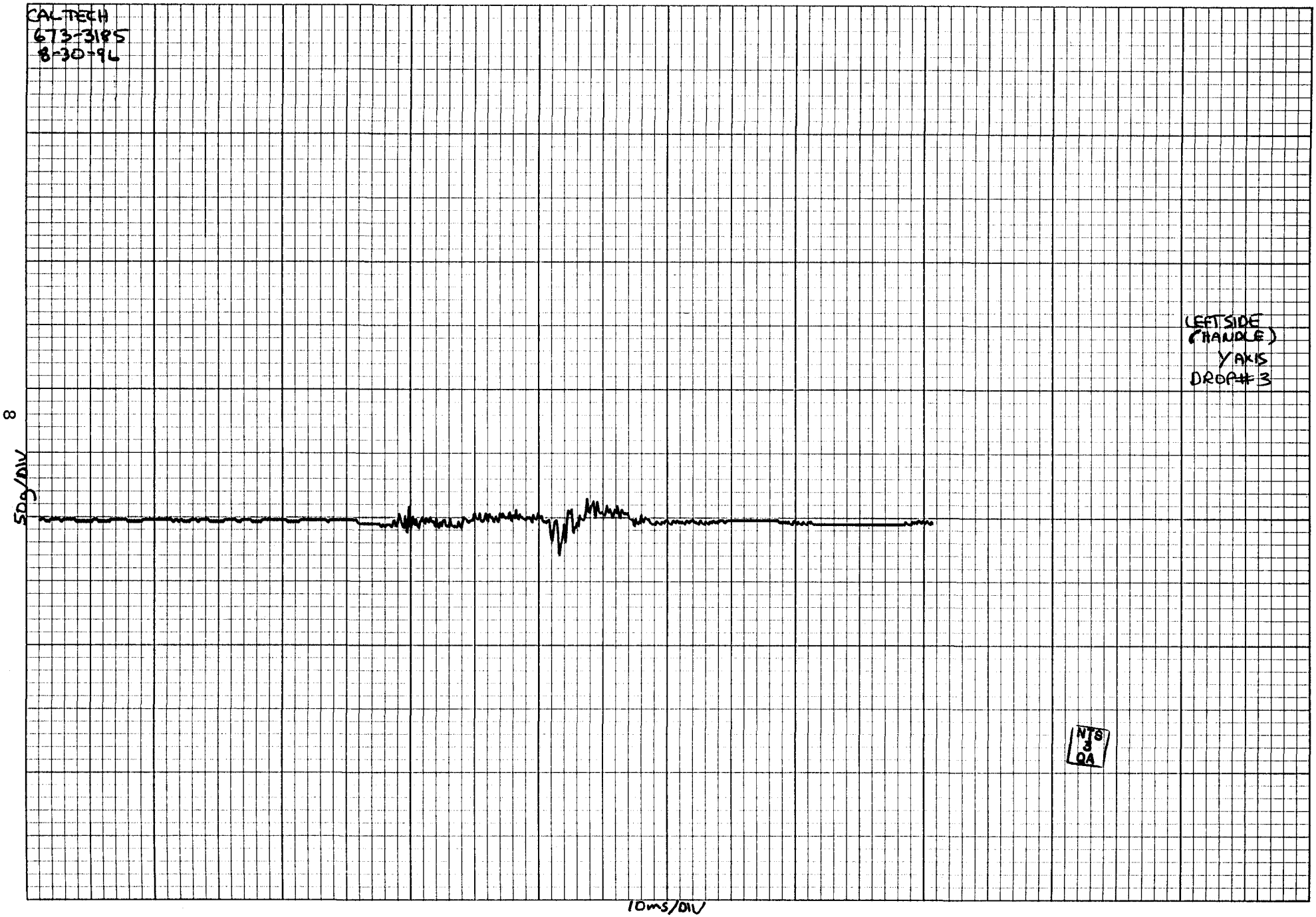

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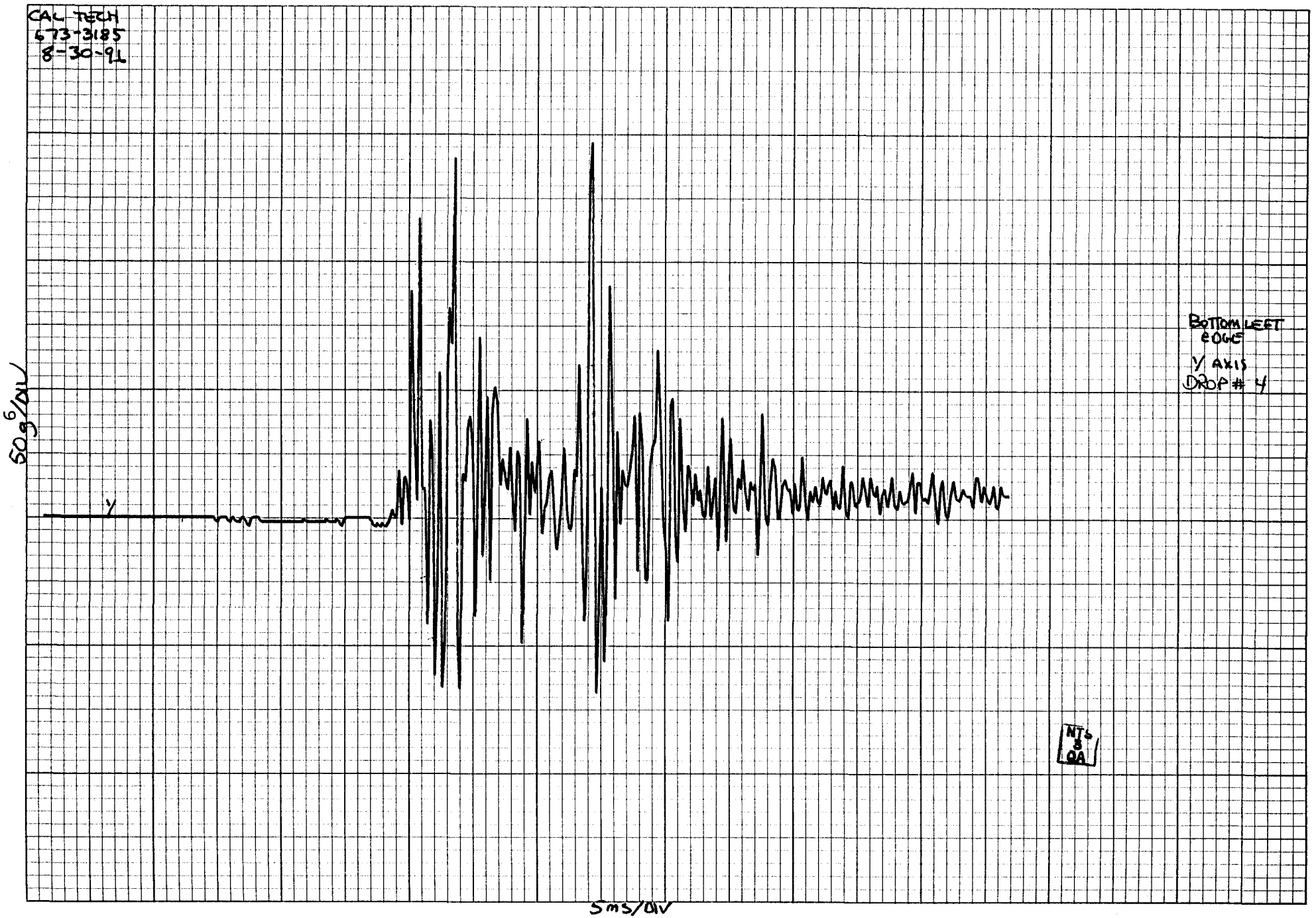
Test Report No. 673-3185



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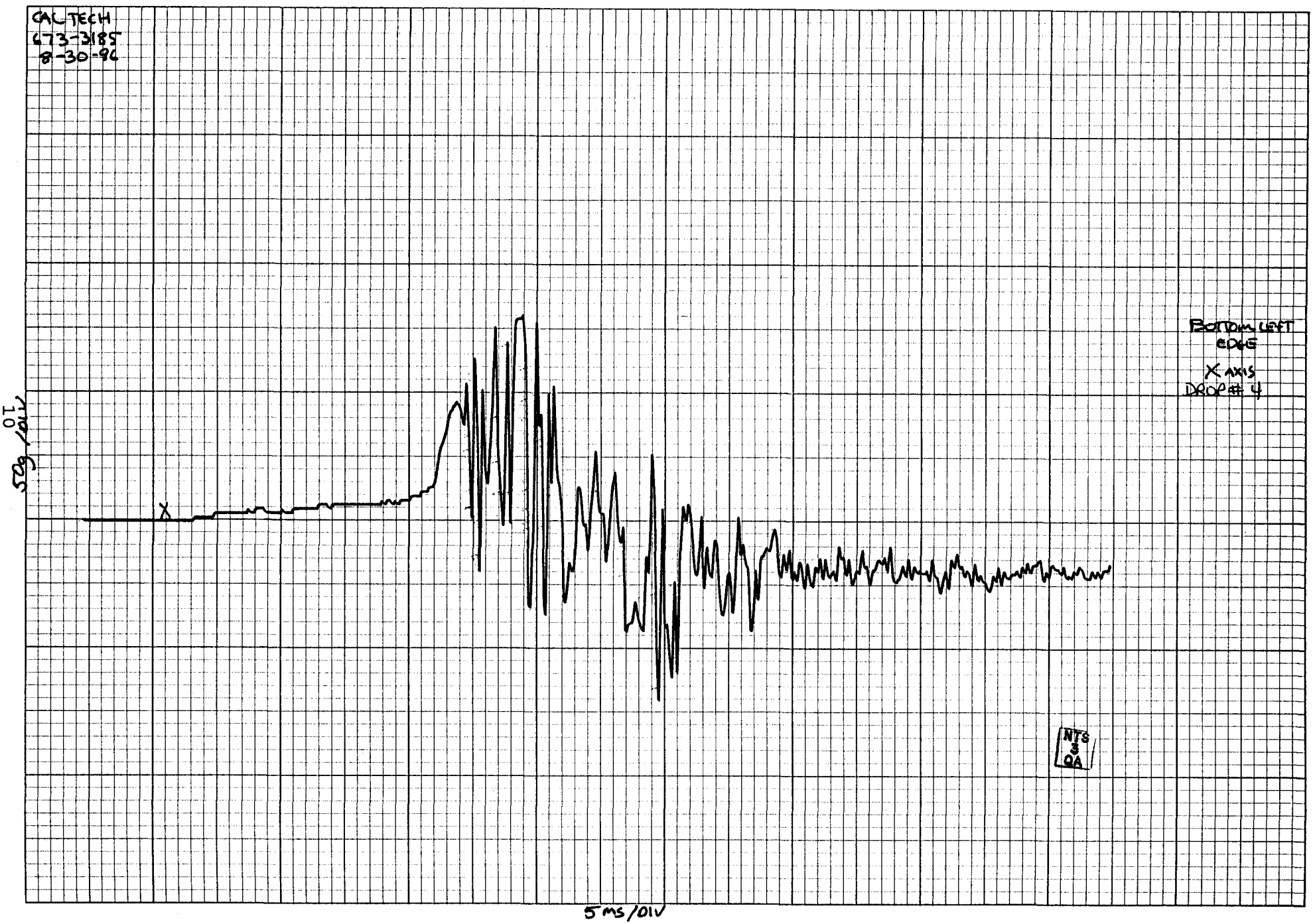

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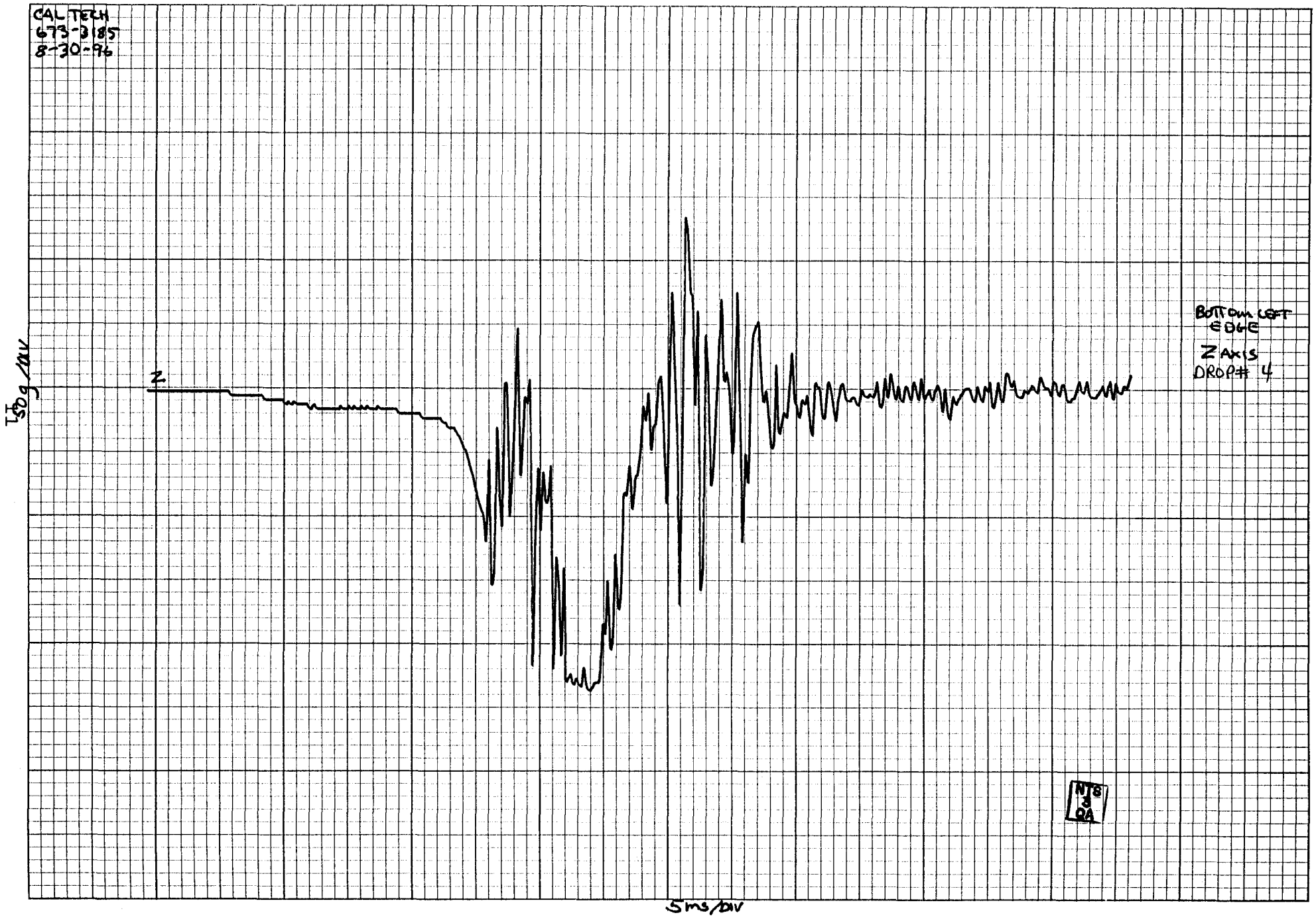

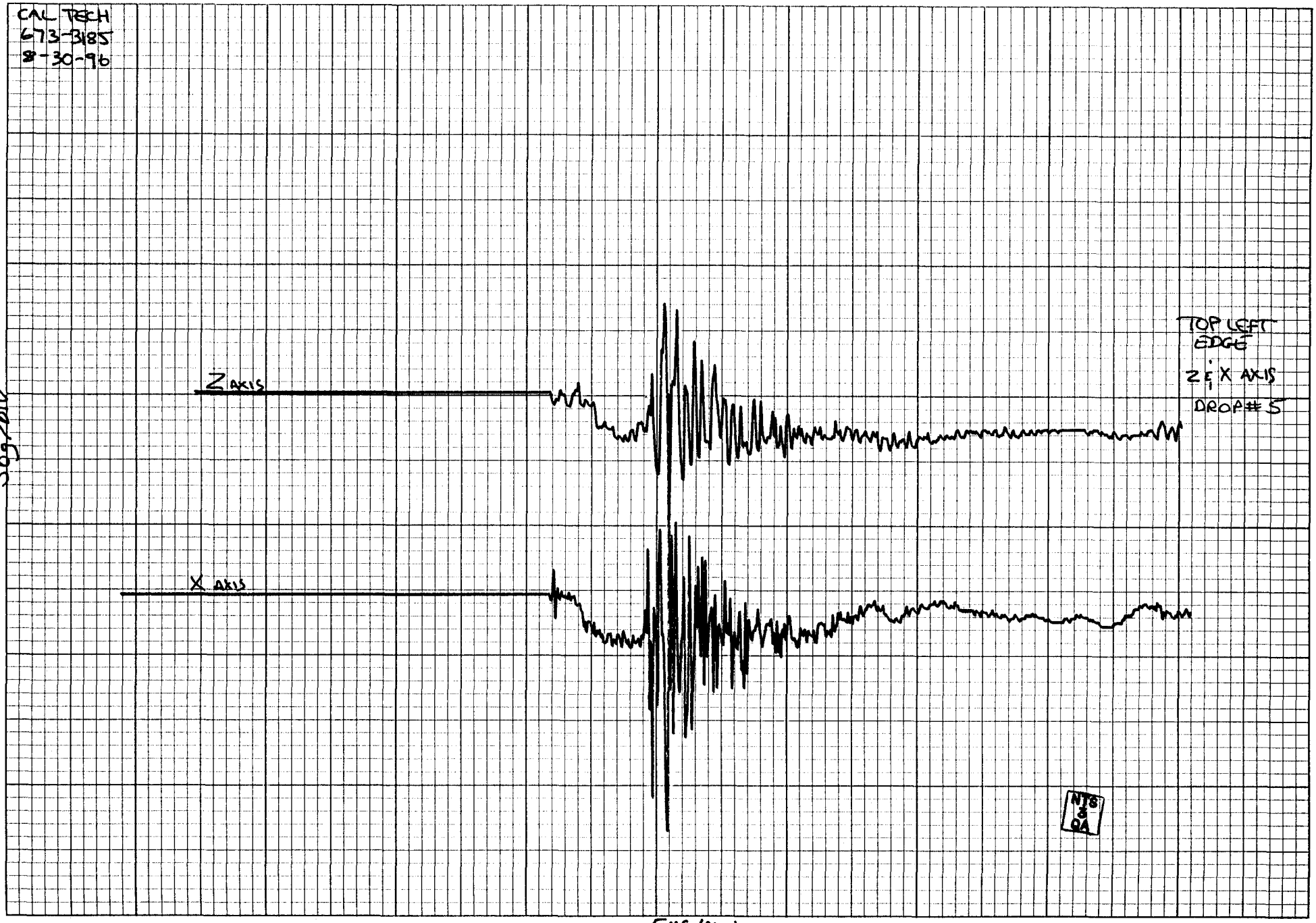

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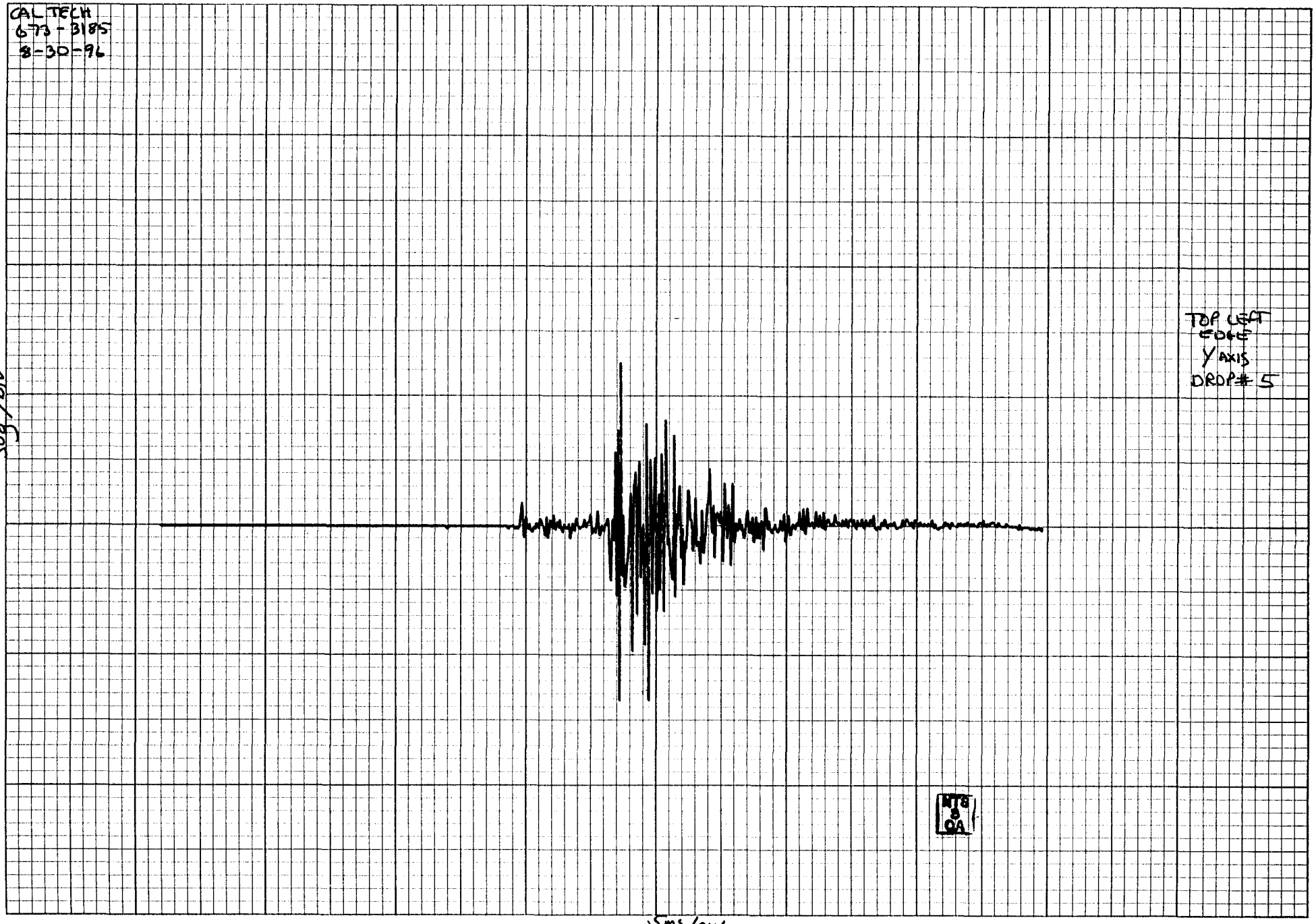

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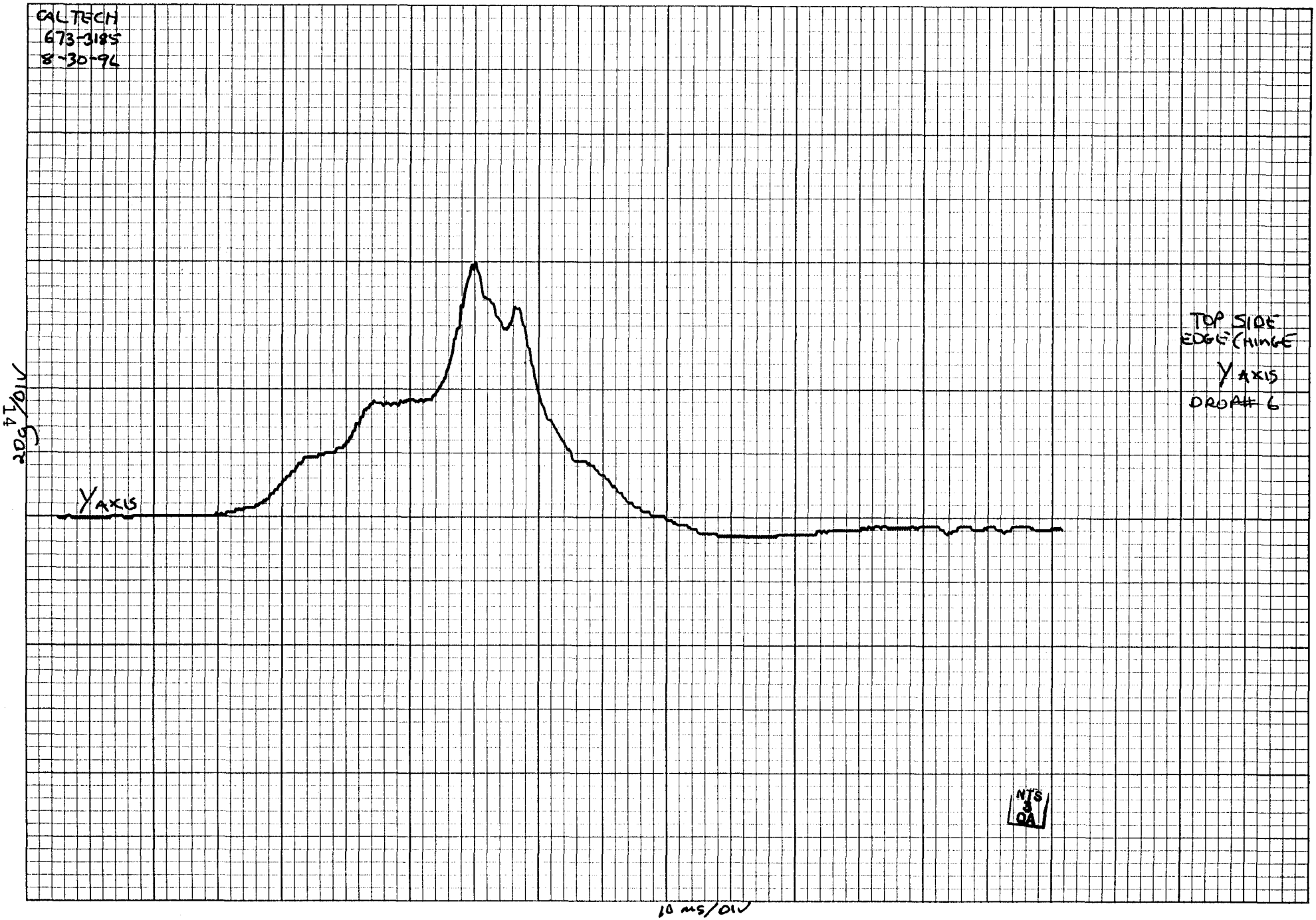

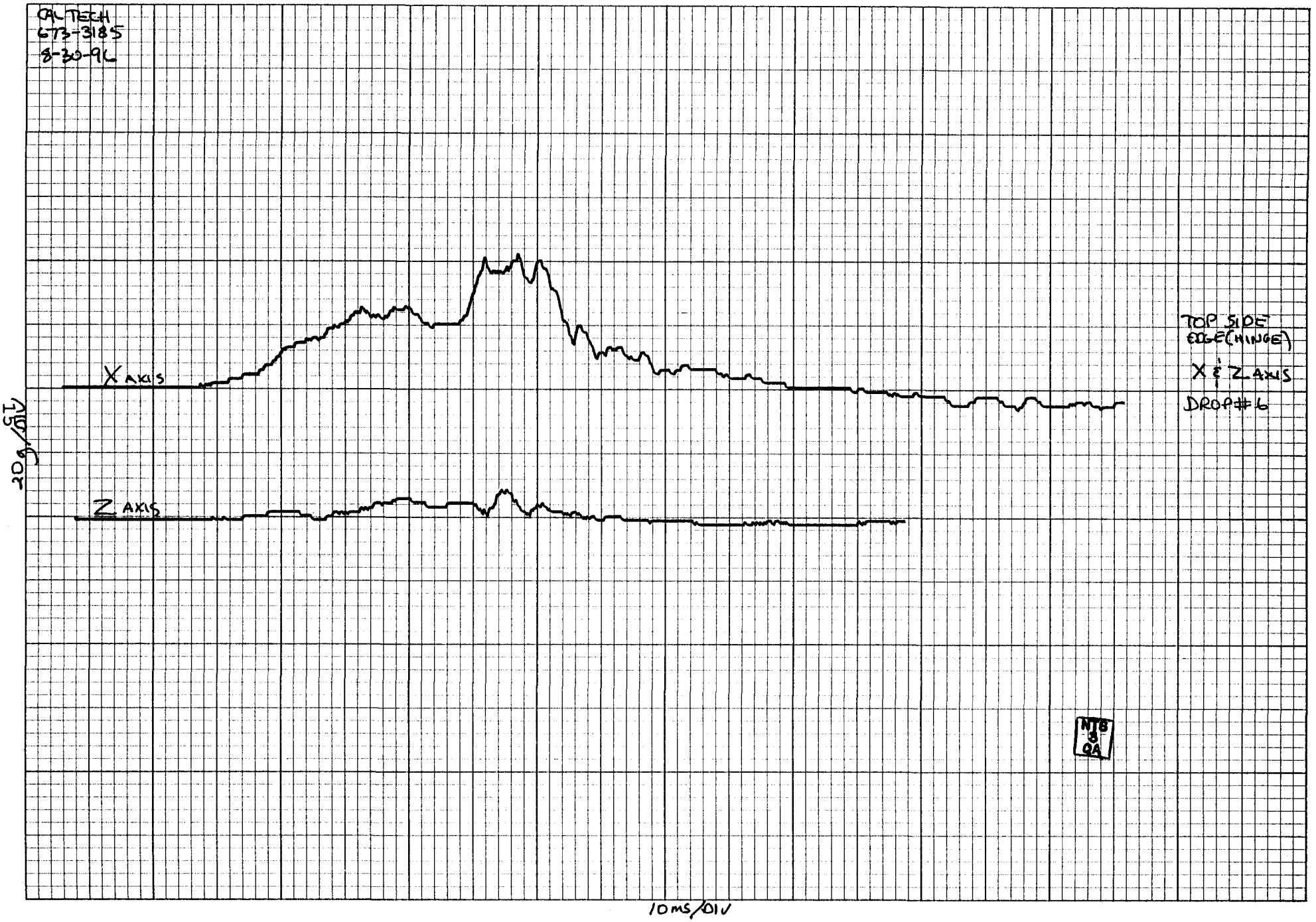

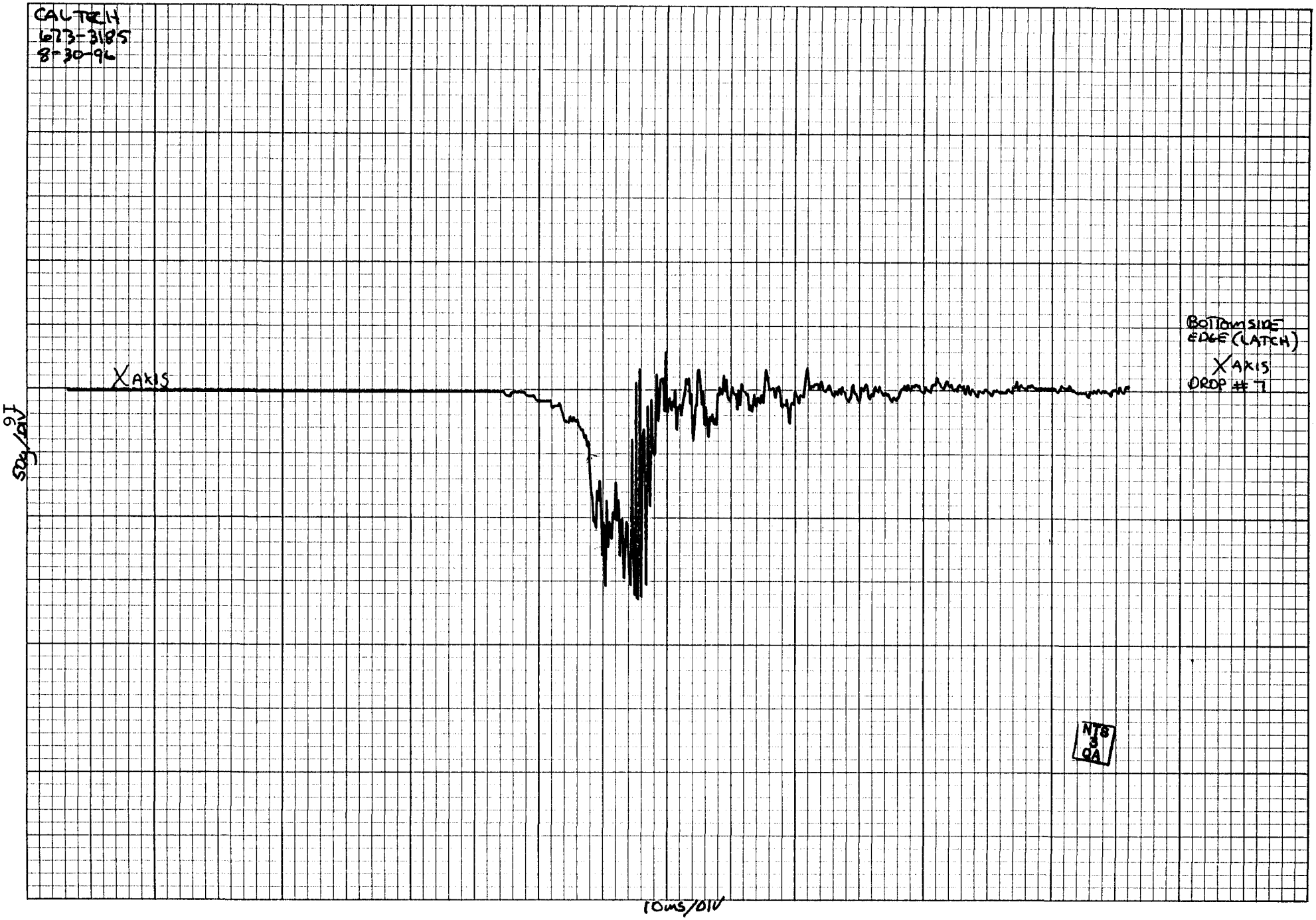

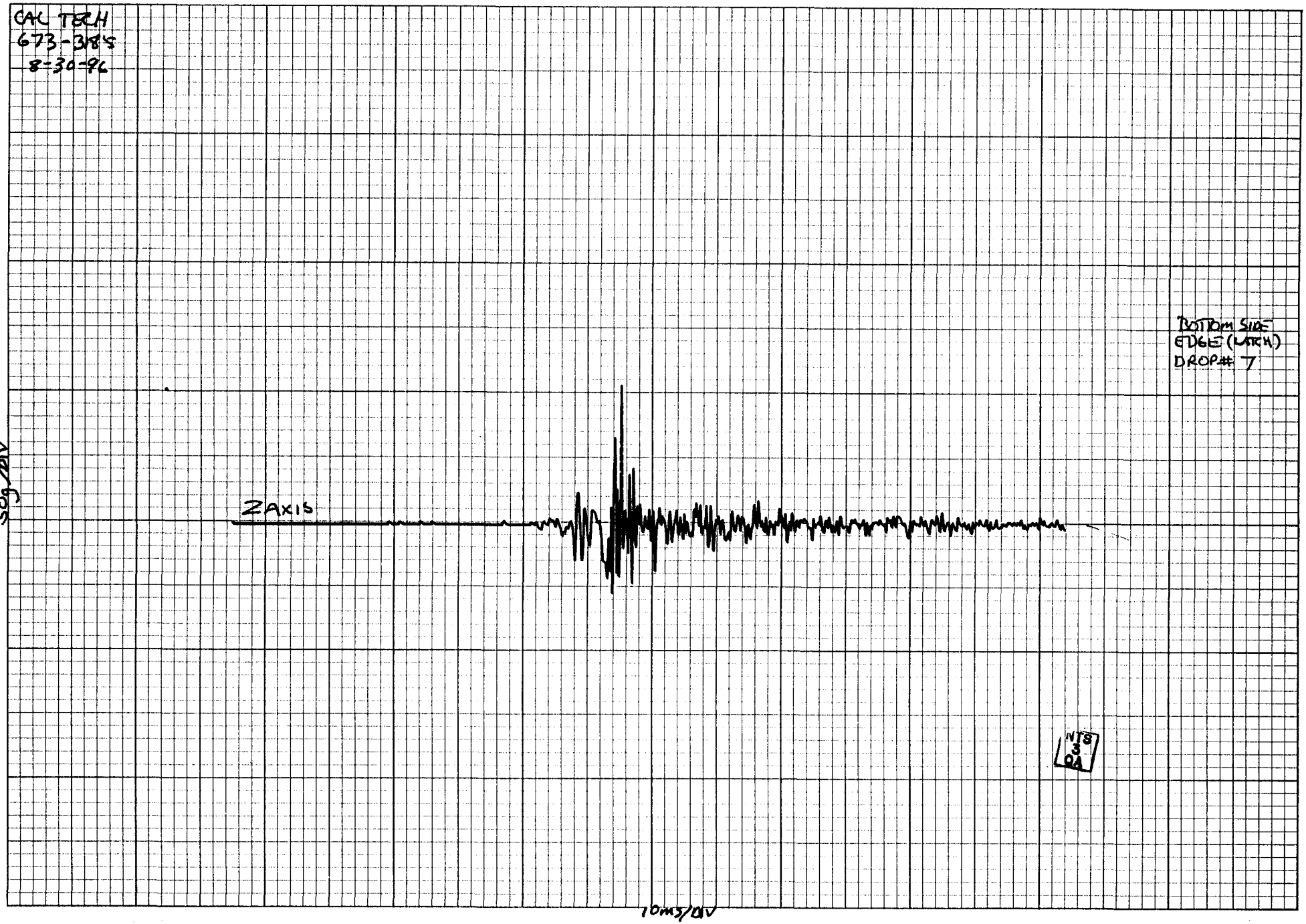

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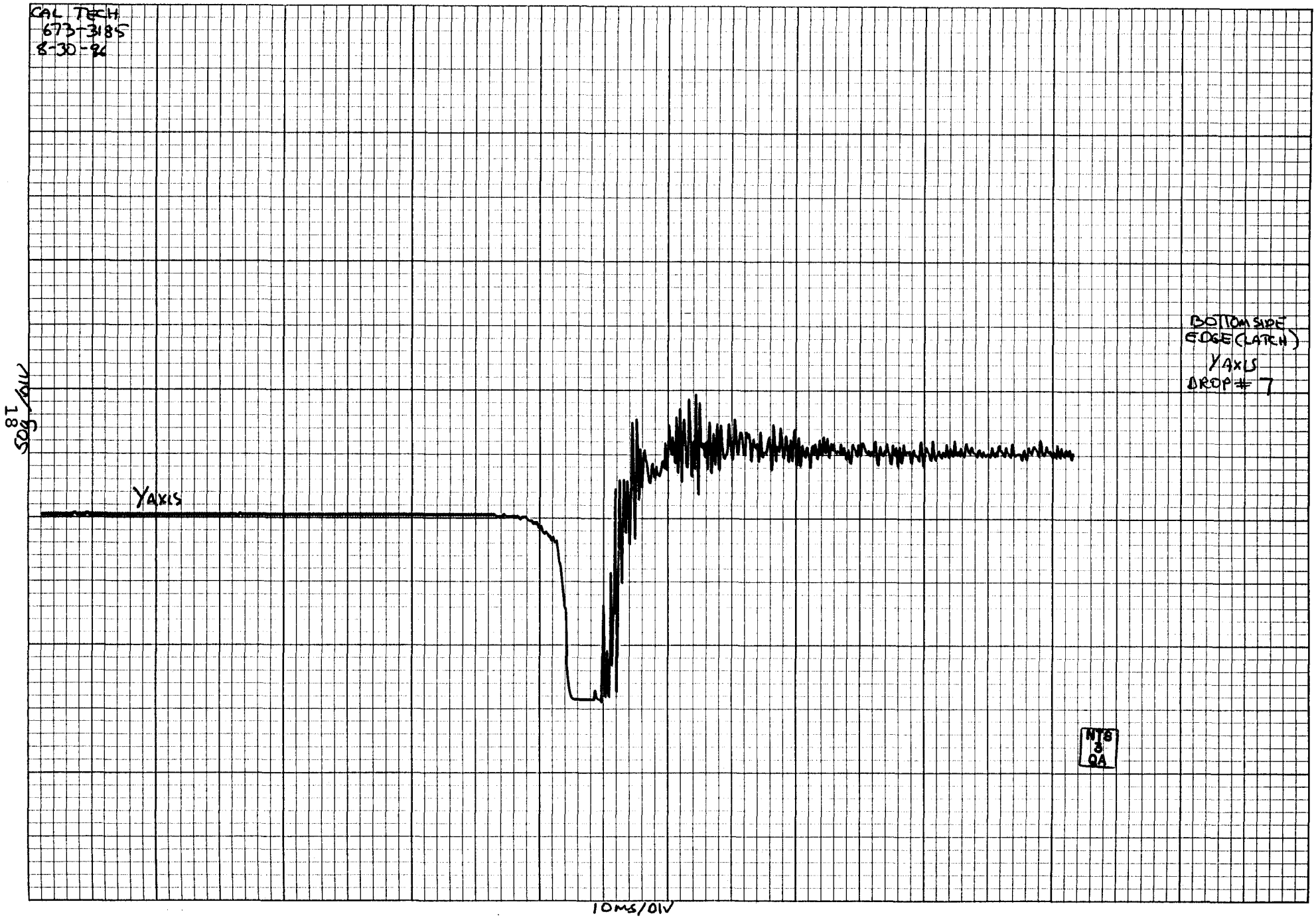

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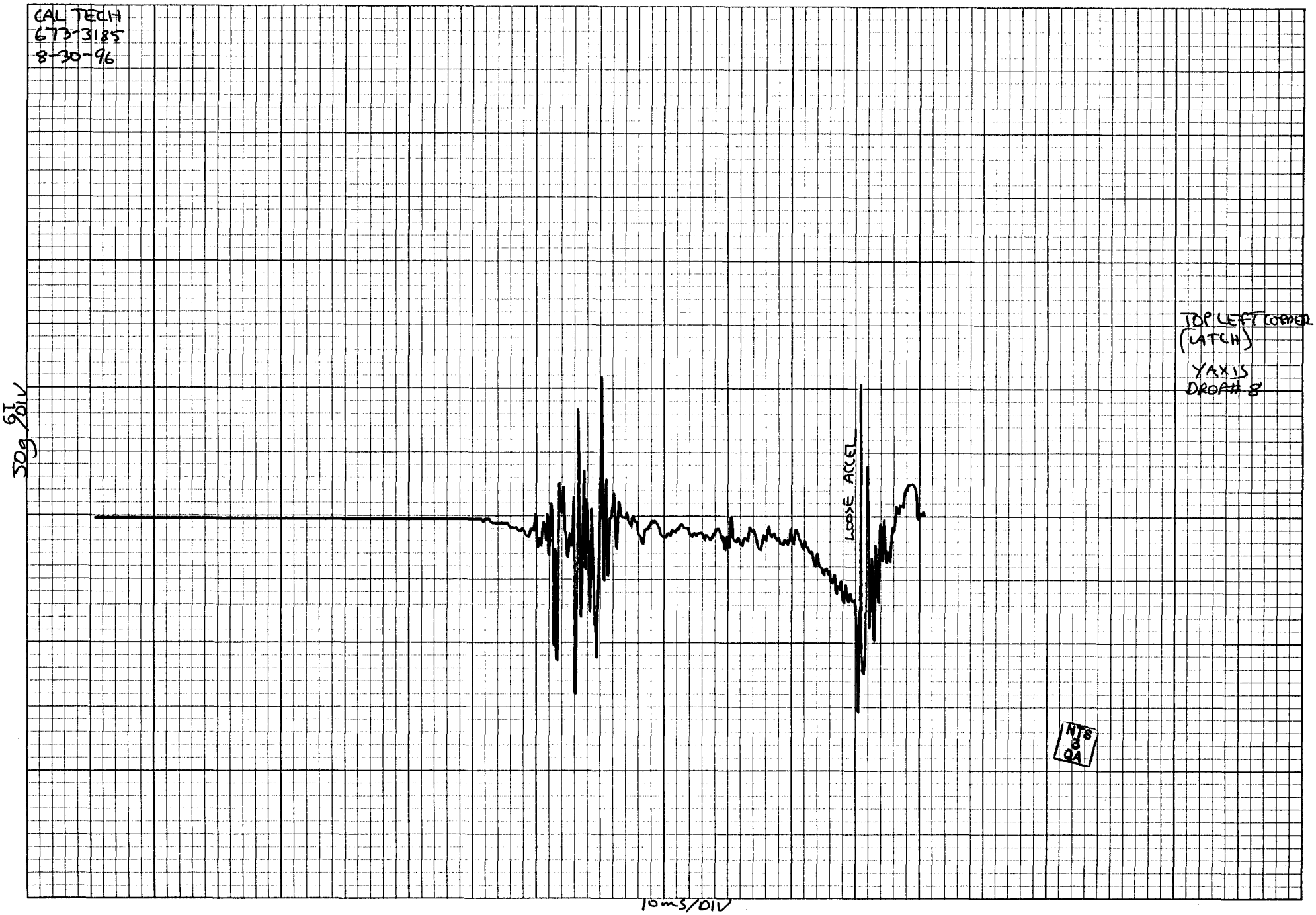

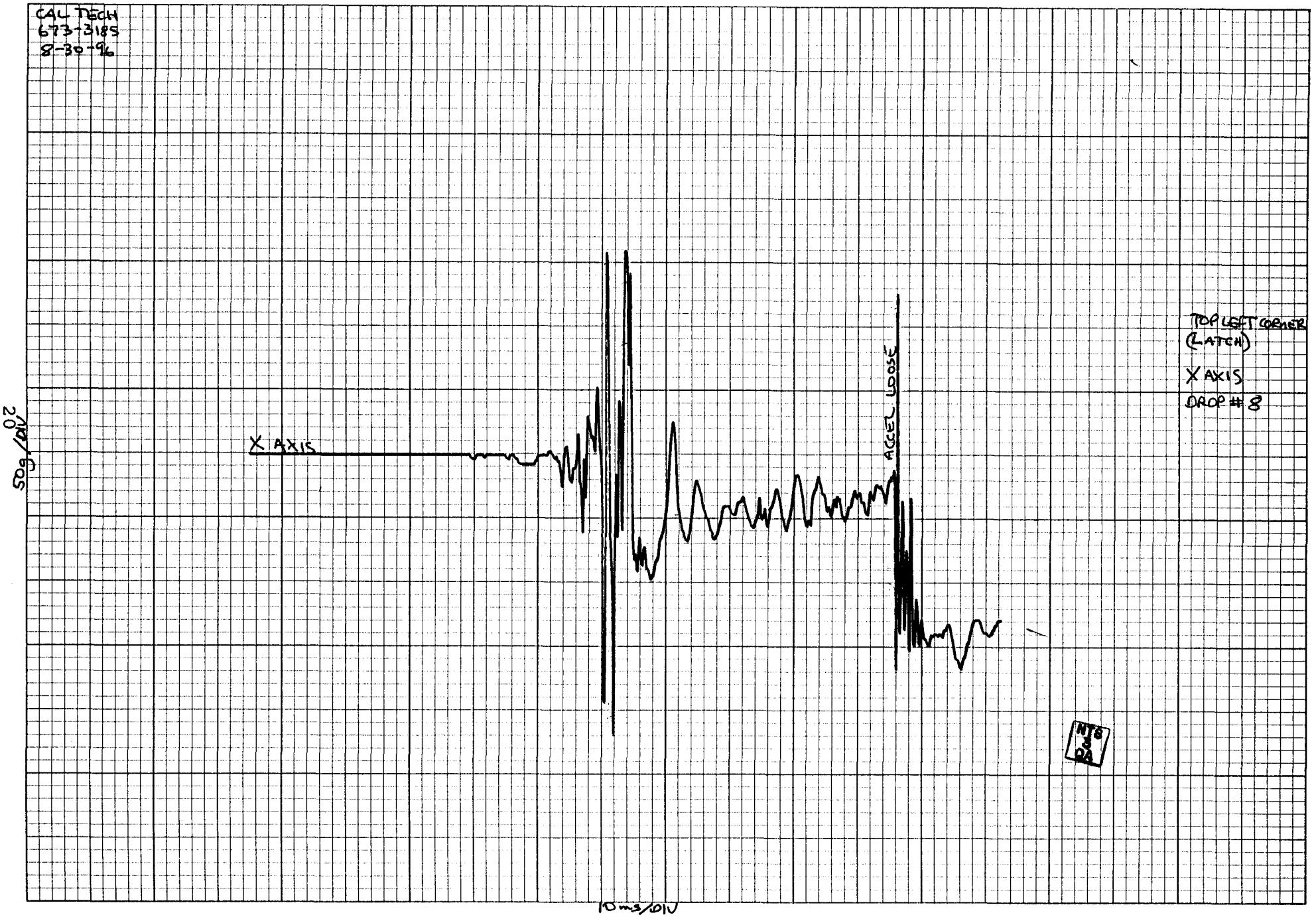

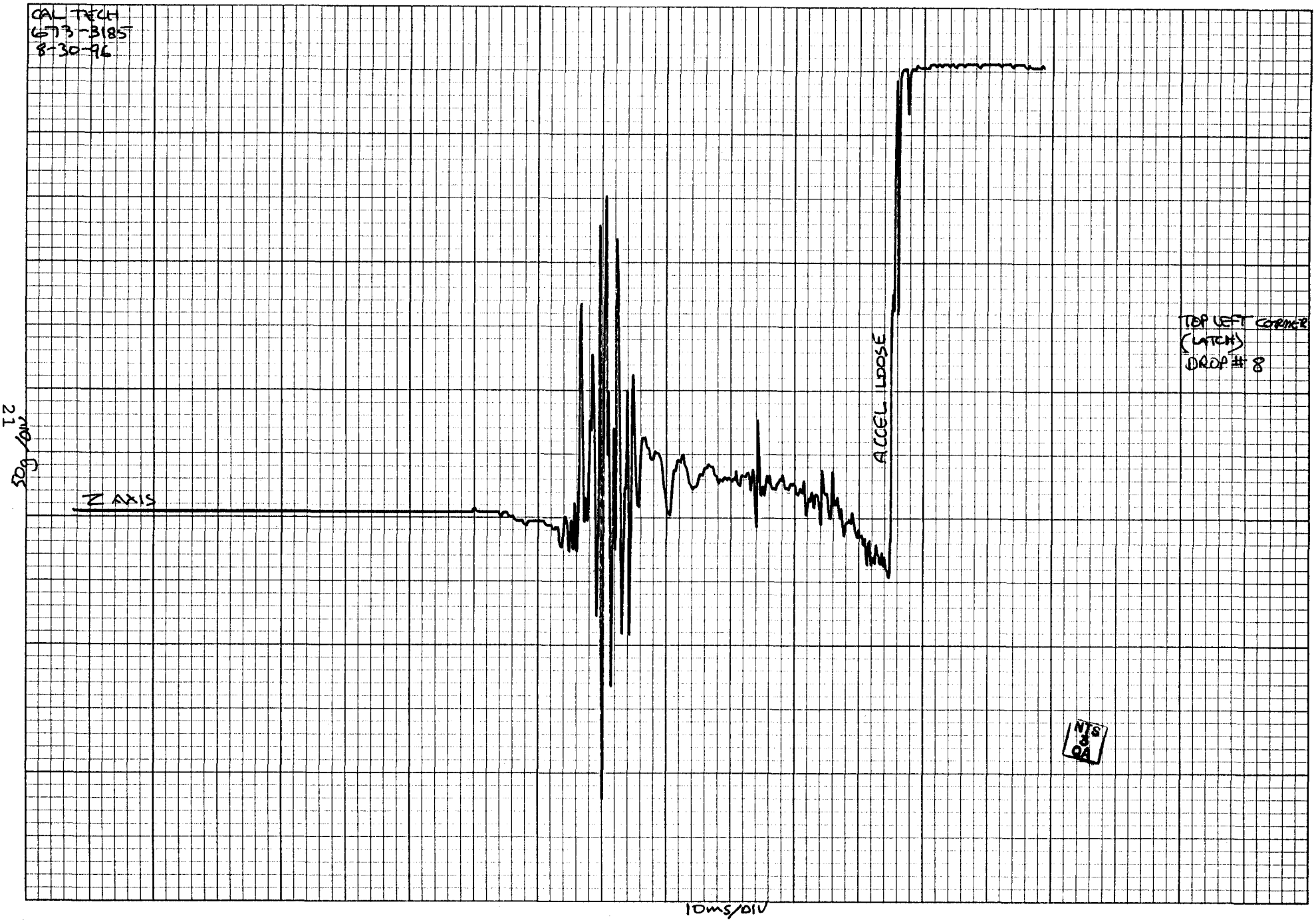

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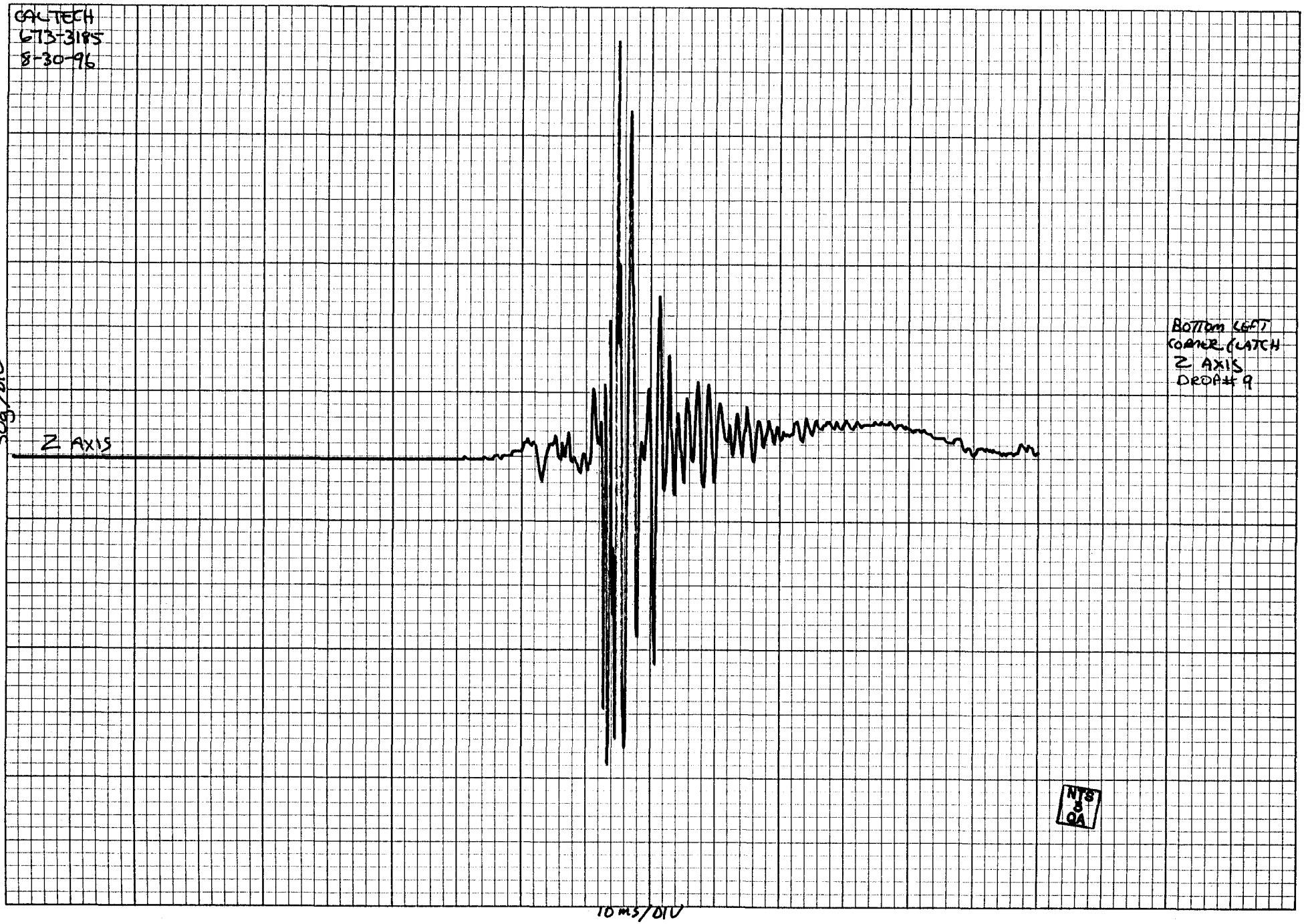

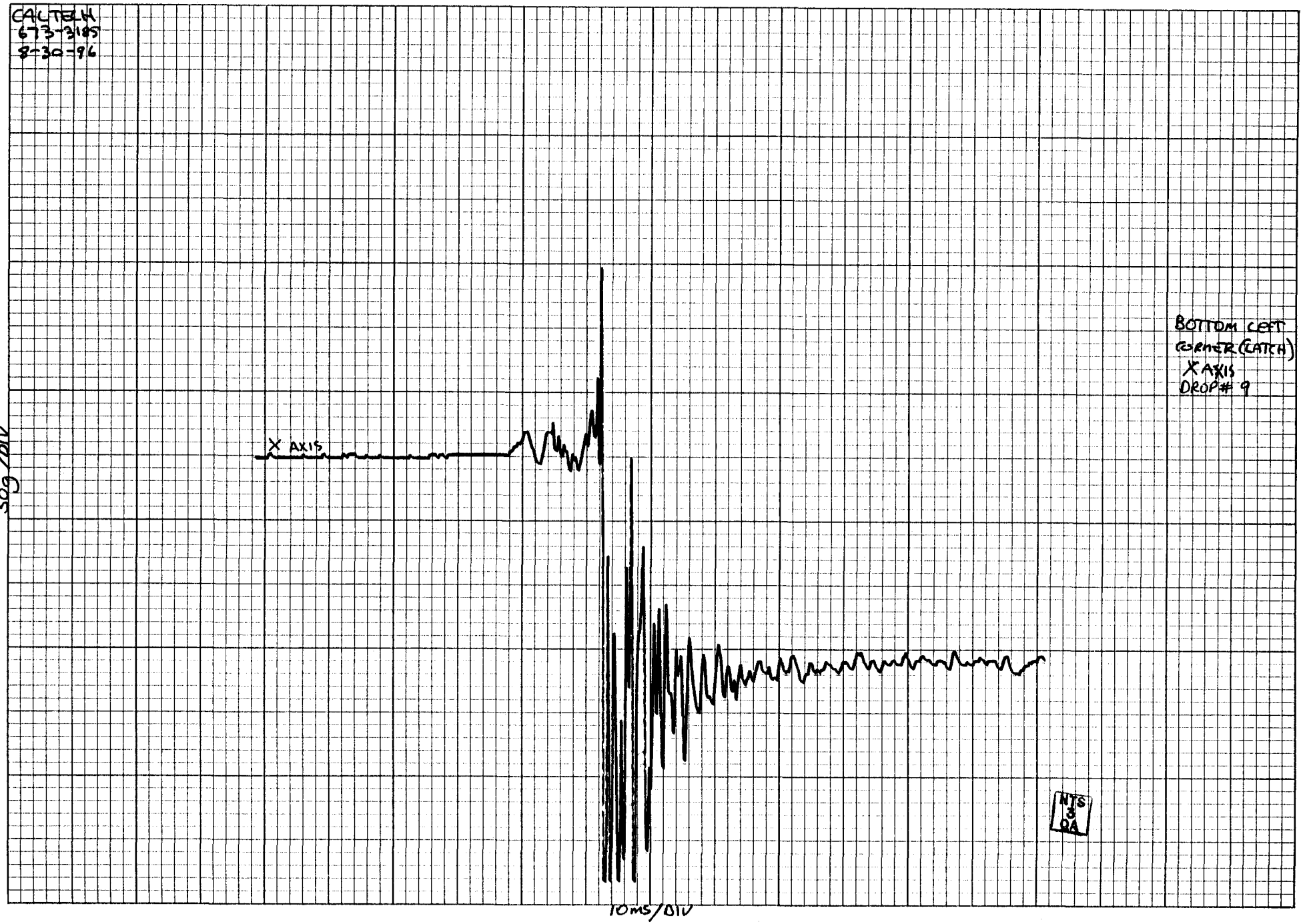

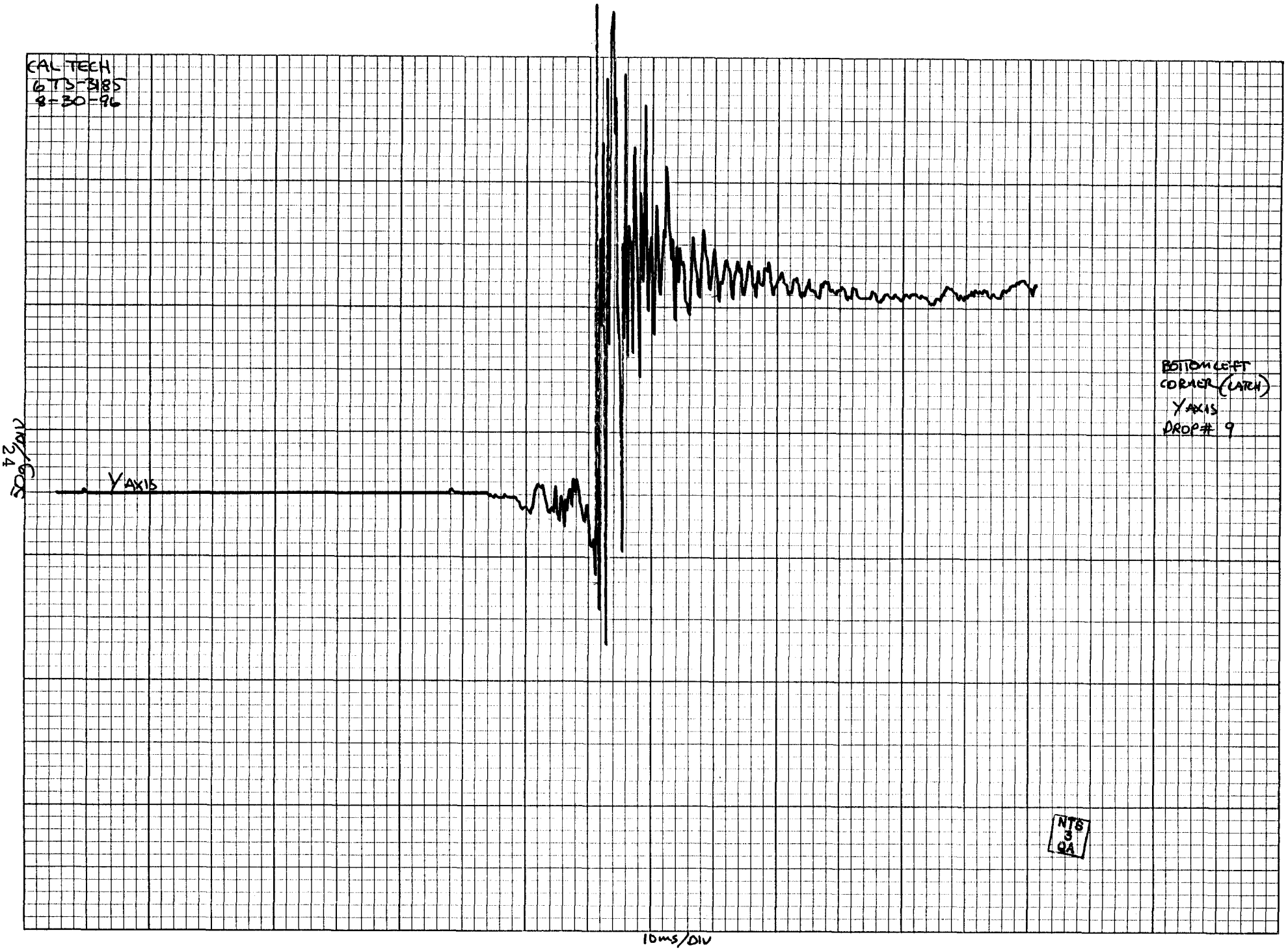

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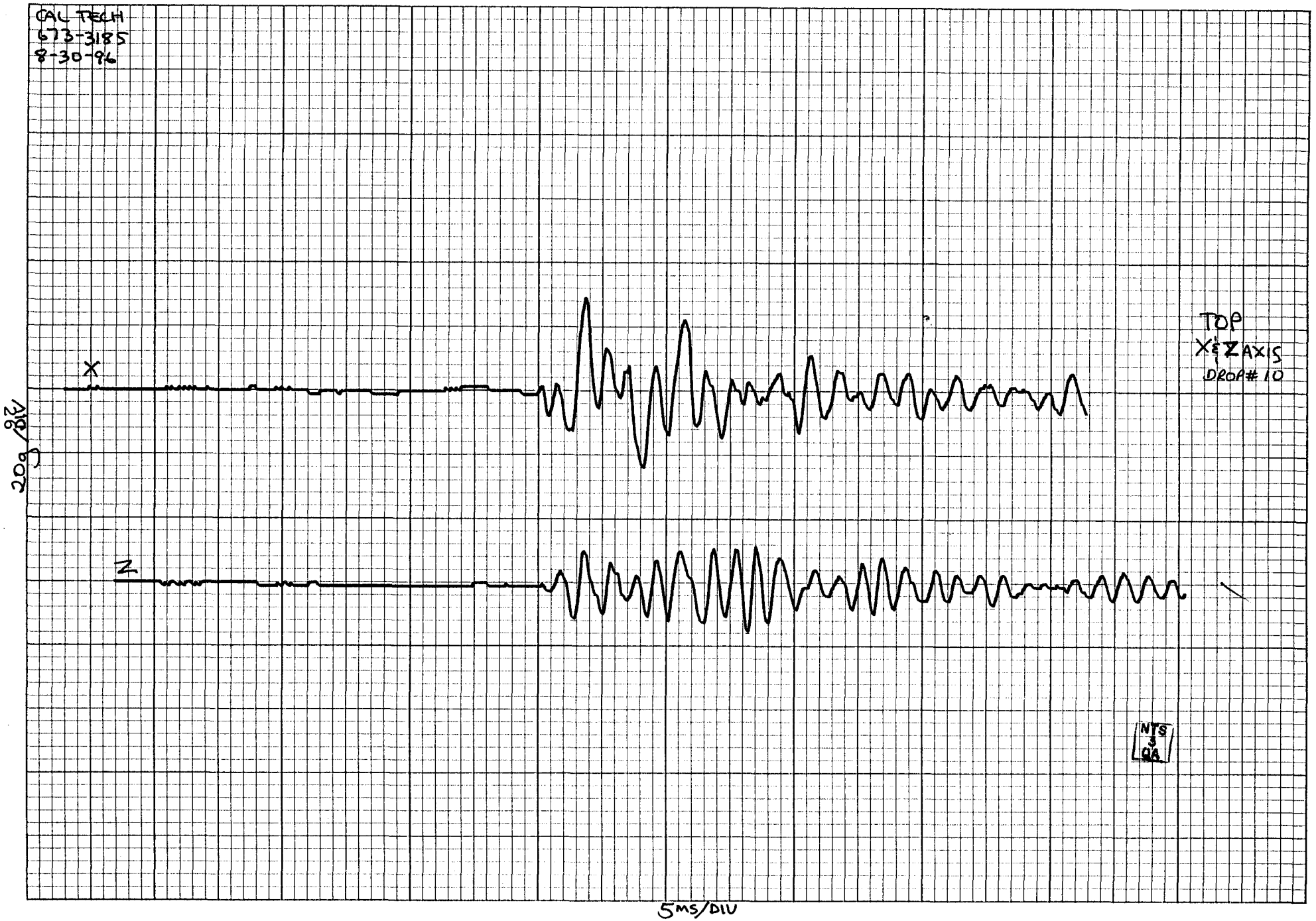
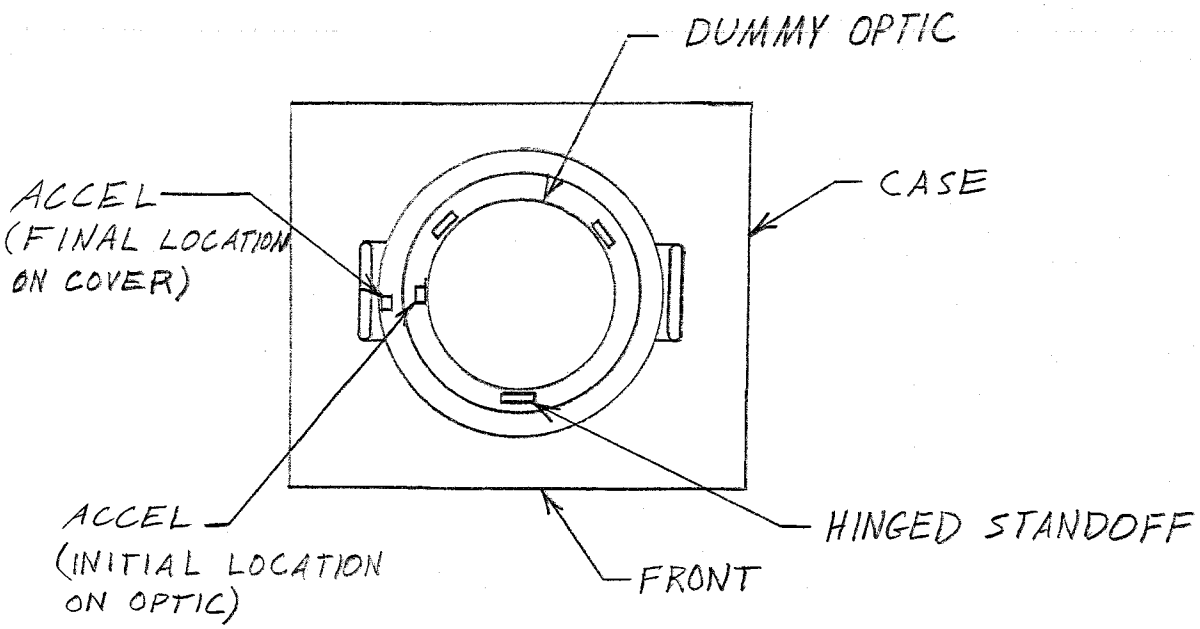


Test Report No. 673-3185

NTS

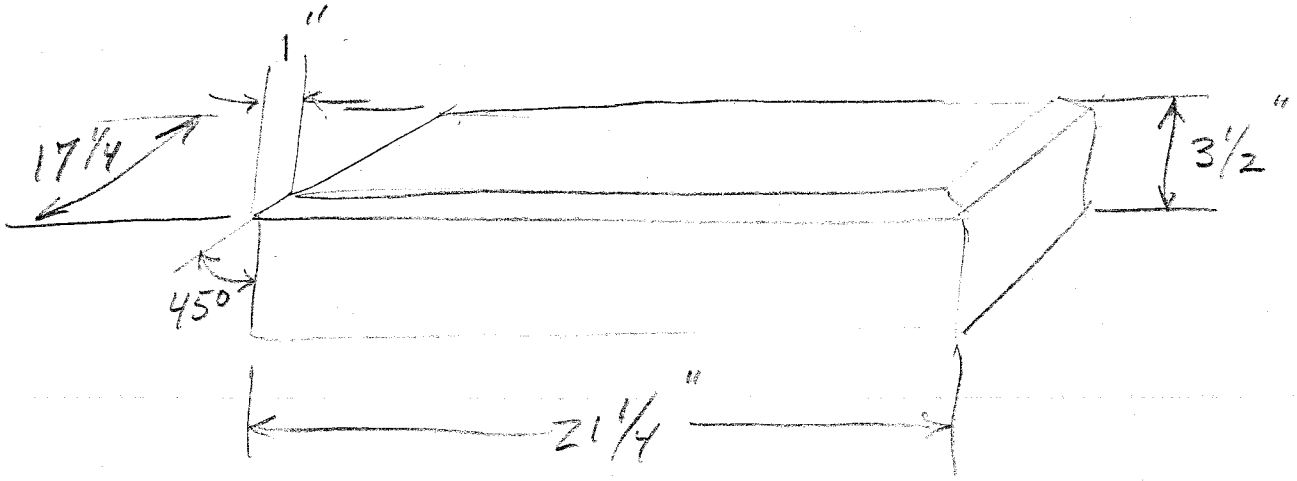
EQUIPMENT LIST

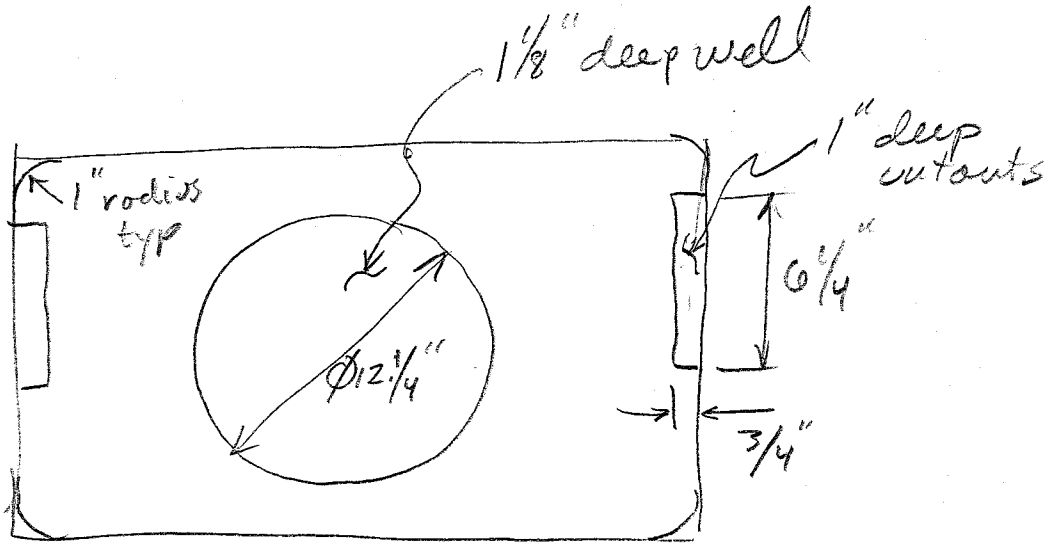
Description	Apparatus	Calibration
SHOCK	Kikusui Digital Oscilloscope, Model 5020A, ± 3%, NTS Control No. D-4863-F	6 Months Due 12-6-96
	Kistler Digital Oscilloscope, Model 5020A, NTS Control No. MET-4225-F	6 Months Due 9-8-96
	Kistler Dual Mode Amplifier, Model 5004, NTS Control No. MET-4230-F	6 Months Due 1-15-97
	Kistler Dual Mode Amplifier, Model 5004, NTS Control No. MET-4232-F	6 Months Due 1-15-97
	Kistler Dual Mode Amplifier, Model 5004, NTS Control No. MET-4231-F	6 Months Due 1-2-97
	PCB Accelerometer (Tri-Axial), Model 356A07, NTS Control No. D-5006-F	6 Months Due 2-16-97
	Western Graphtec X-Y Plotter, Model WX1200E, NTS Control No. D-4807-F	6 Months Due 12-7-96



TOP VIEW

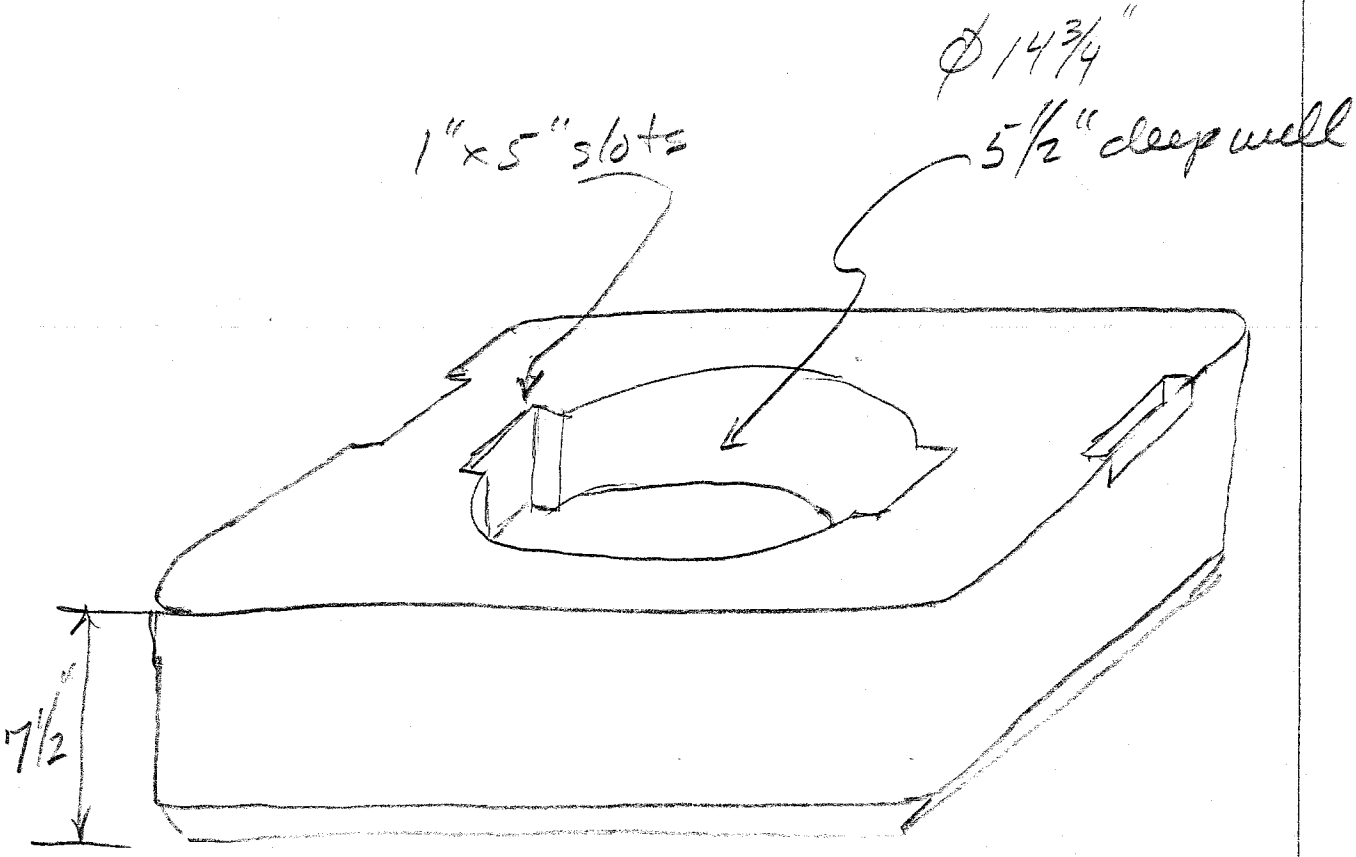
FOAM INSERTS





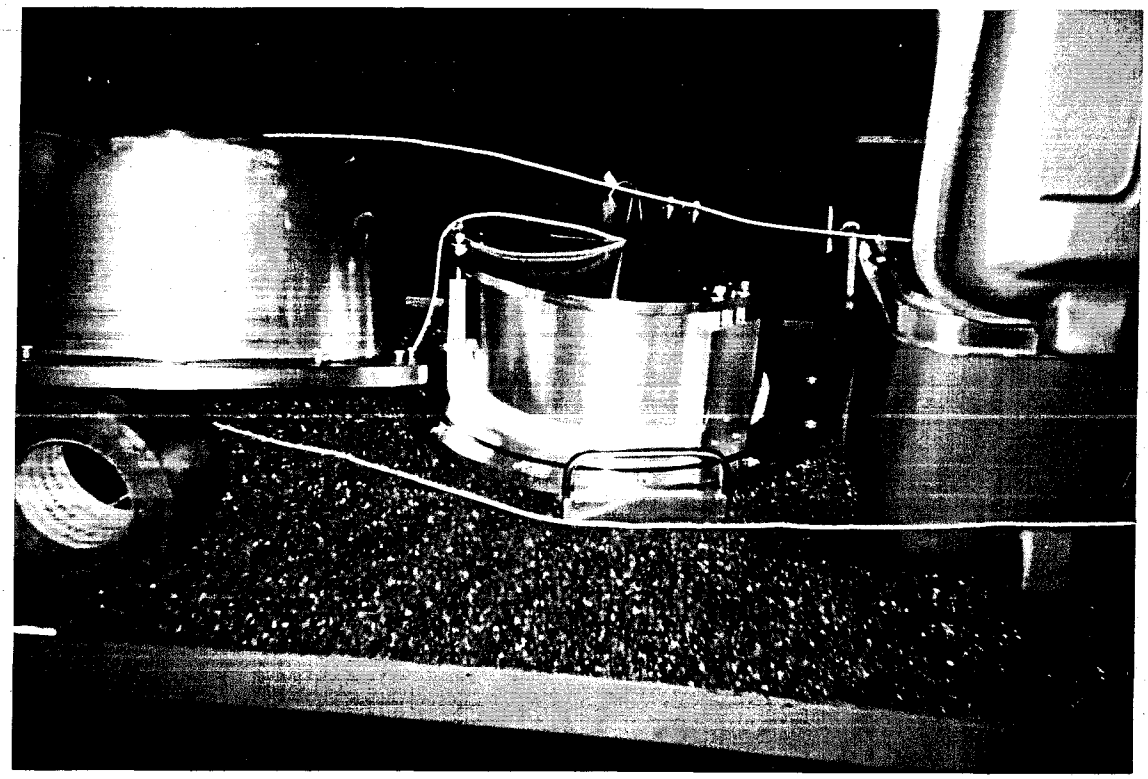
Circular cutout has ¼" diametrical play around carrier top cover

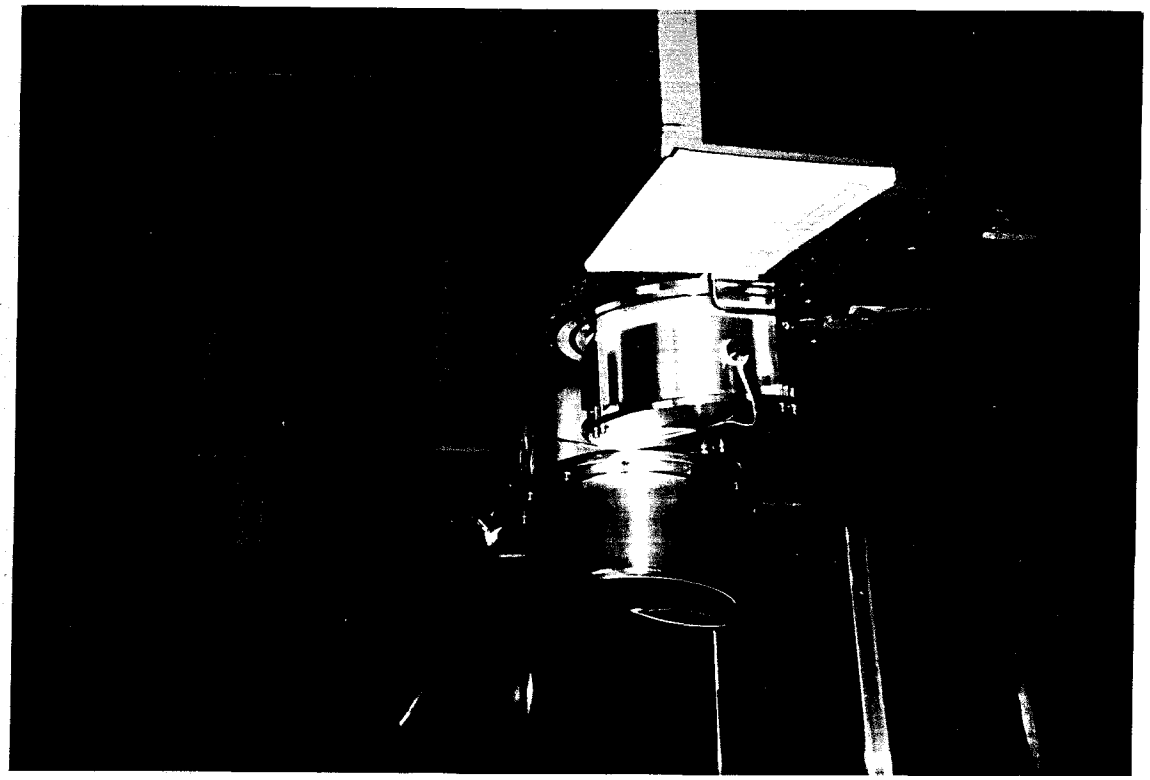
foam insert top

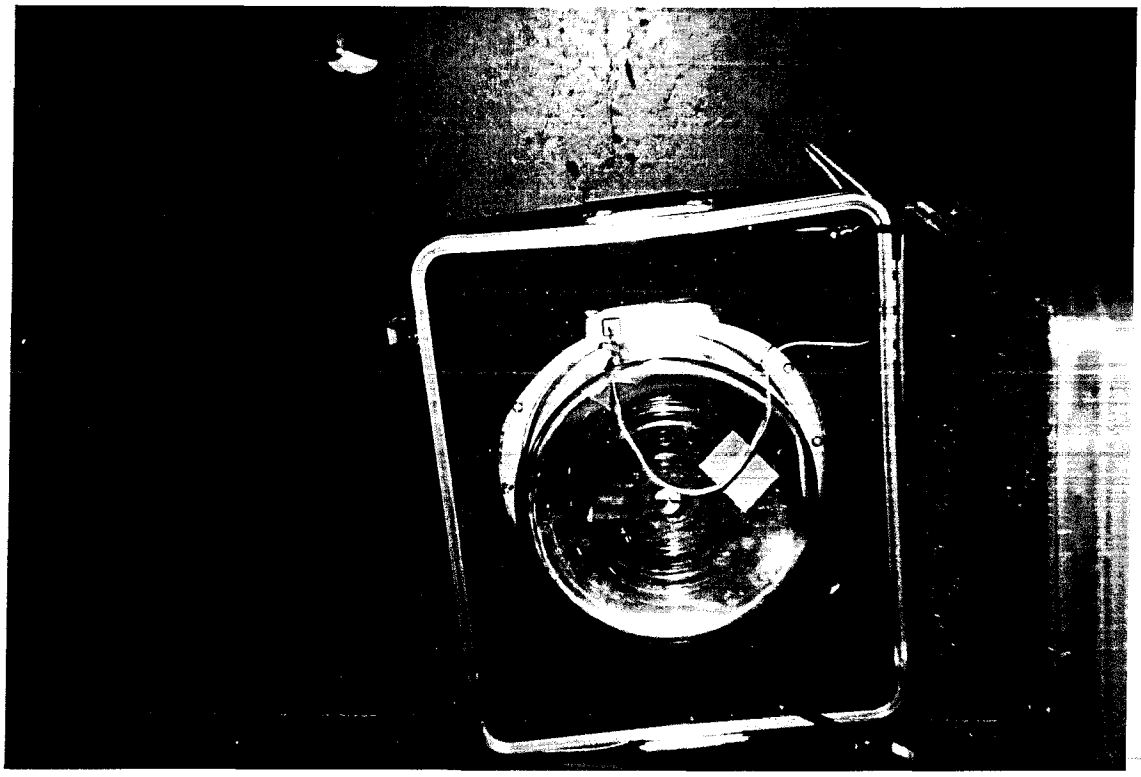


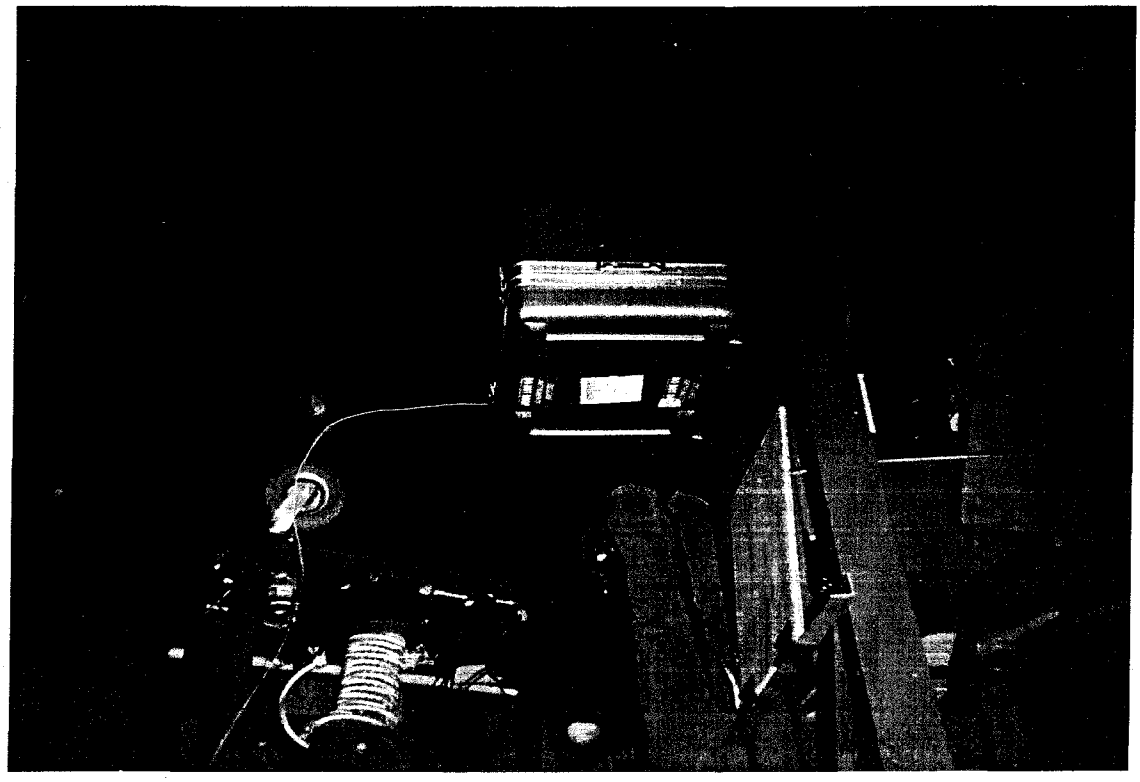
Circular cutout has < 1/8" diametrical play around the base of the carrier cover, but ≈ 1 1/2" radial play around the top of the carrier cover)

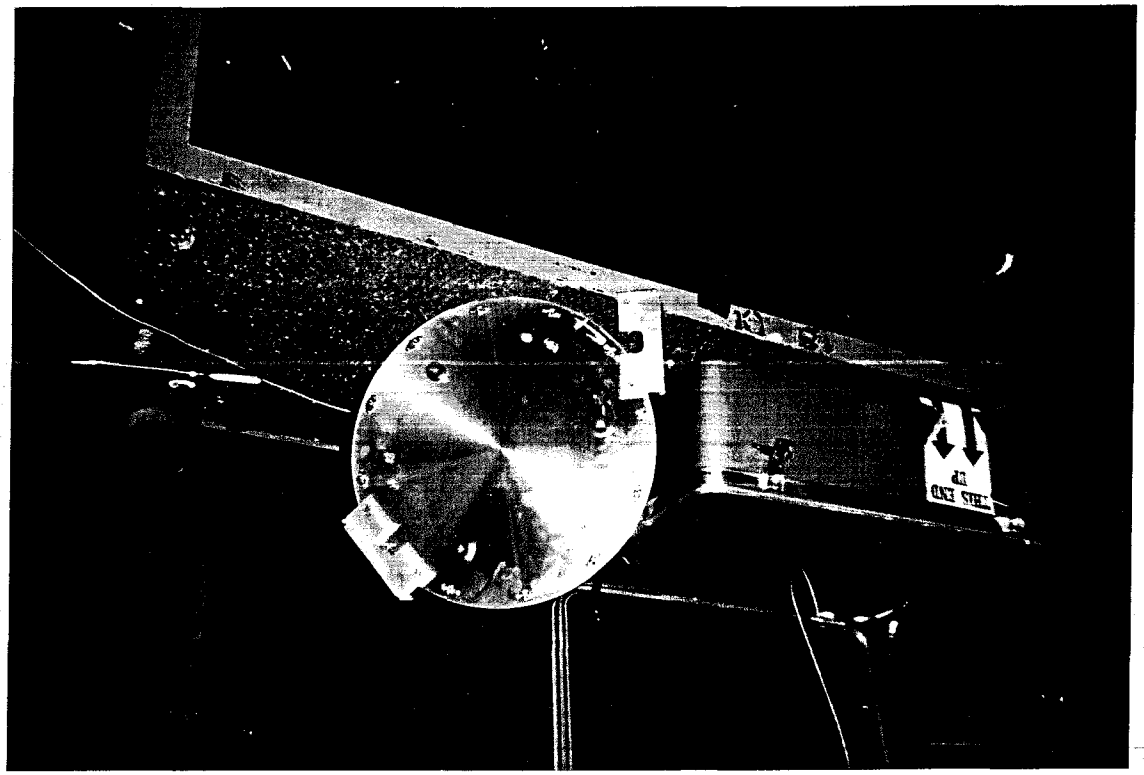
foam insert bottom







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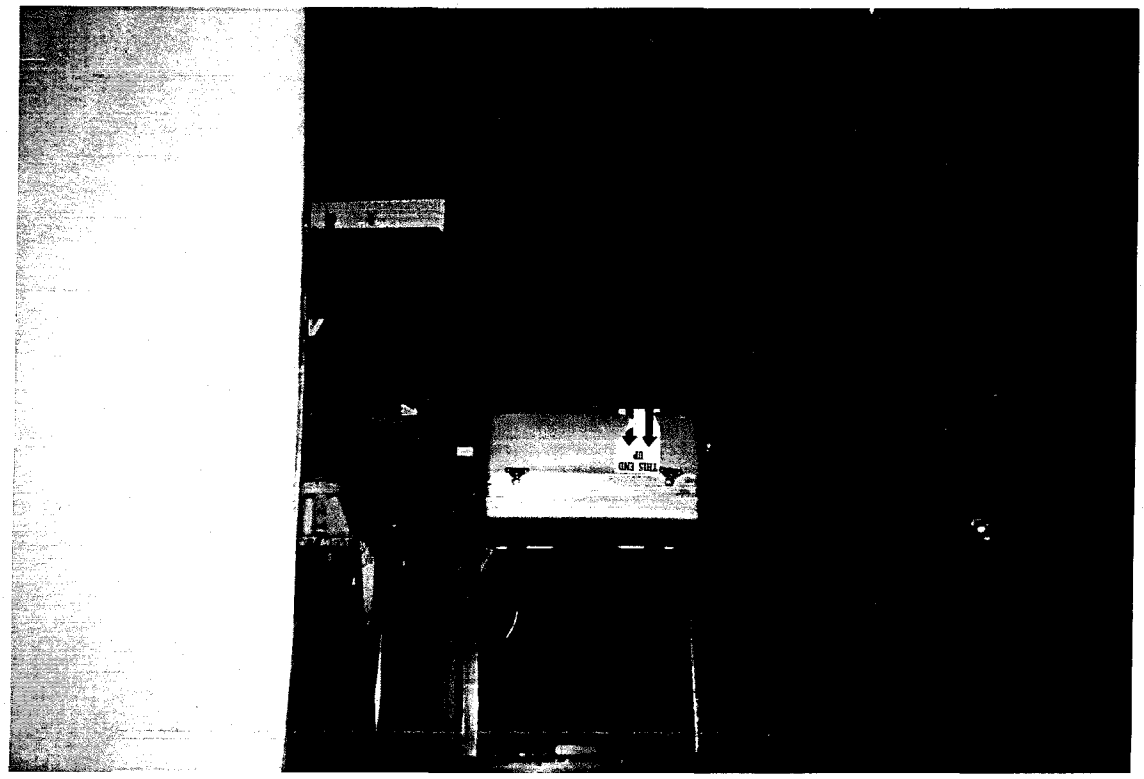

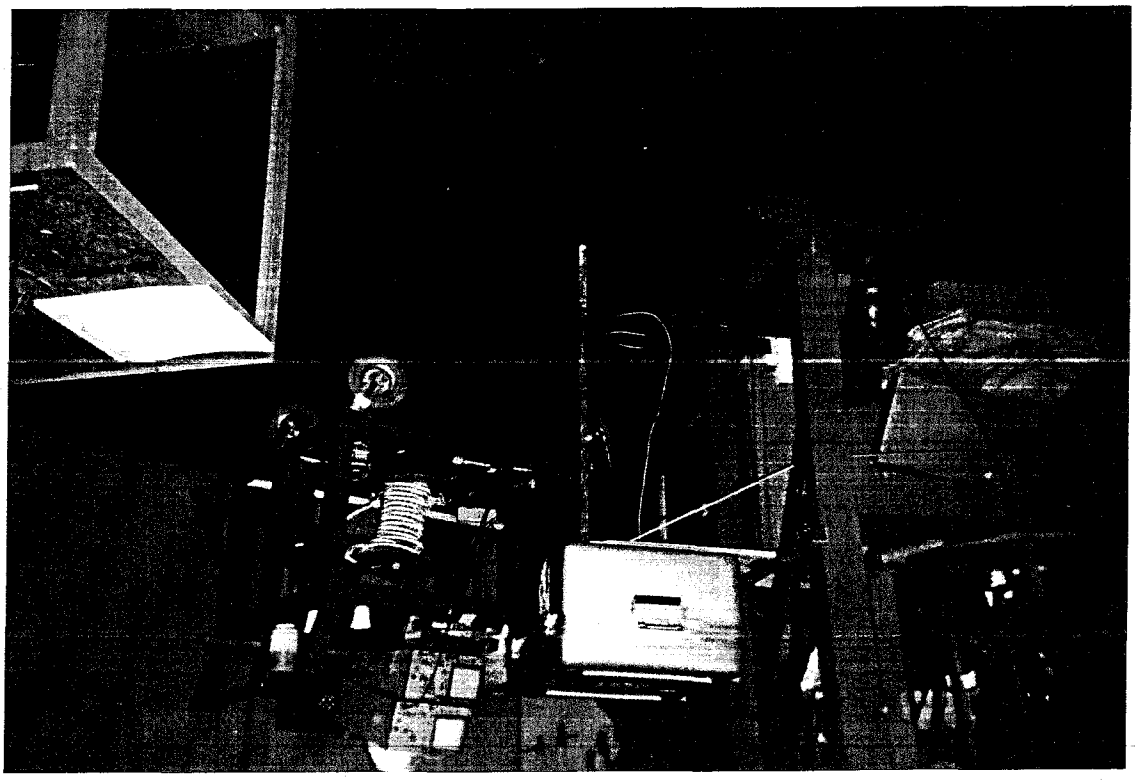

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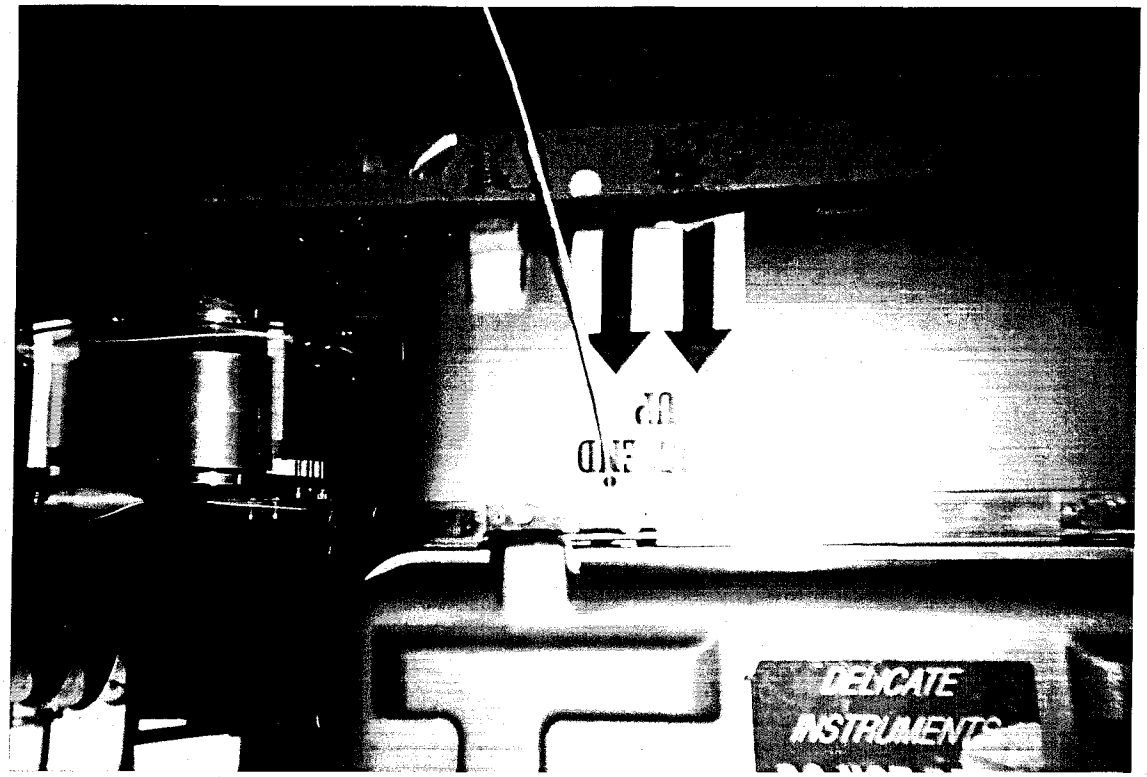
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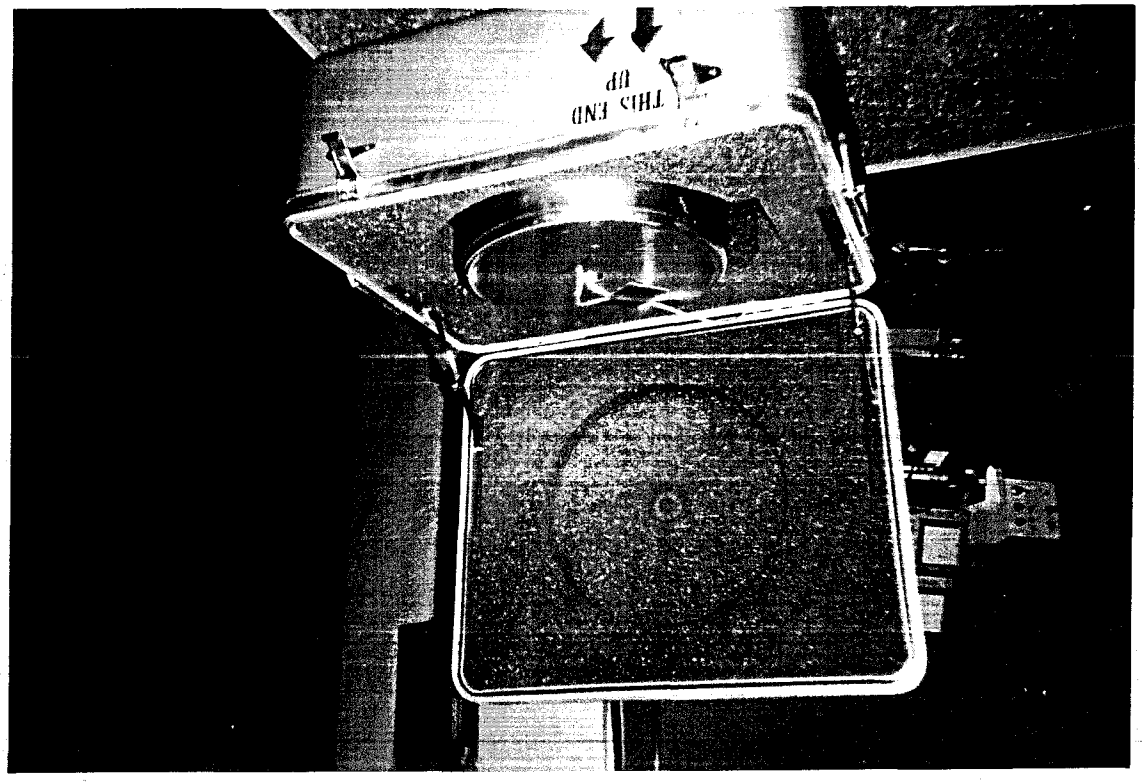
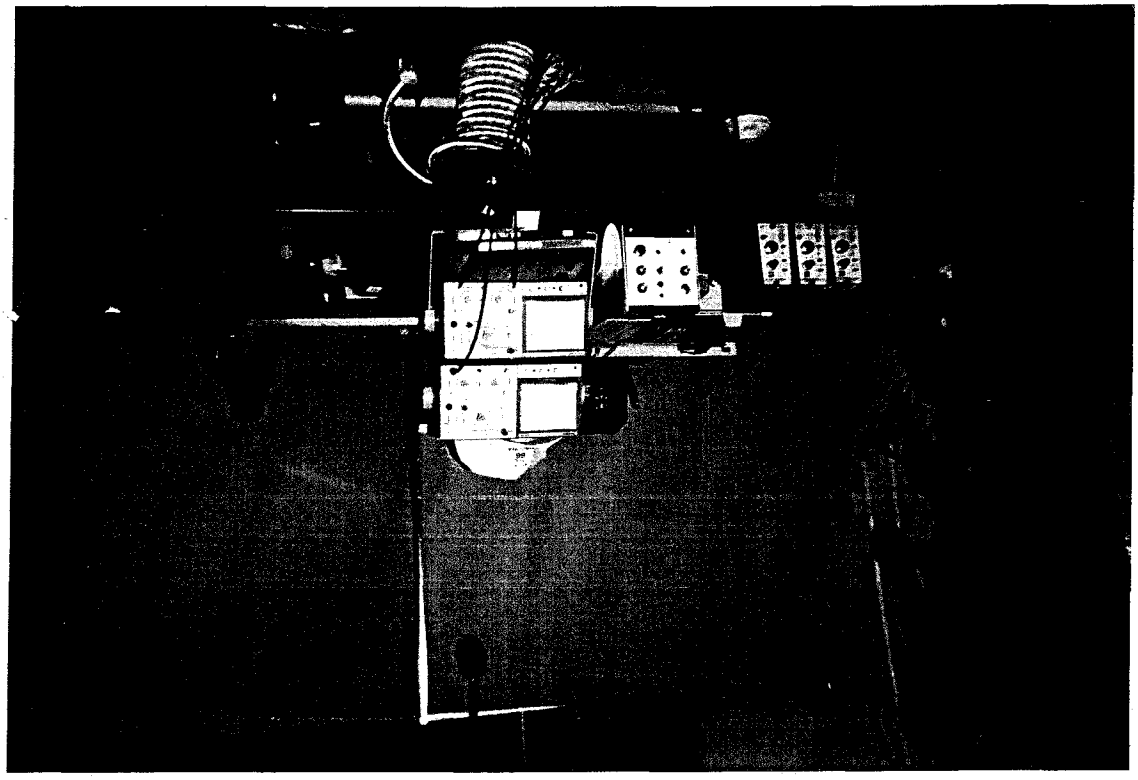
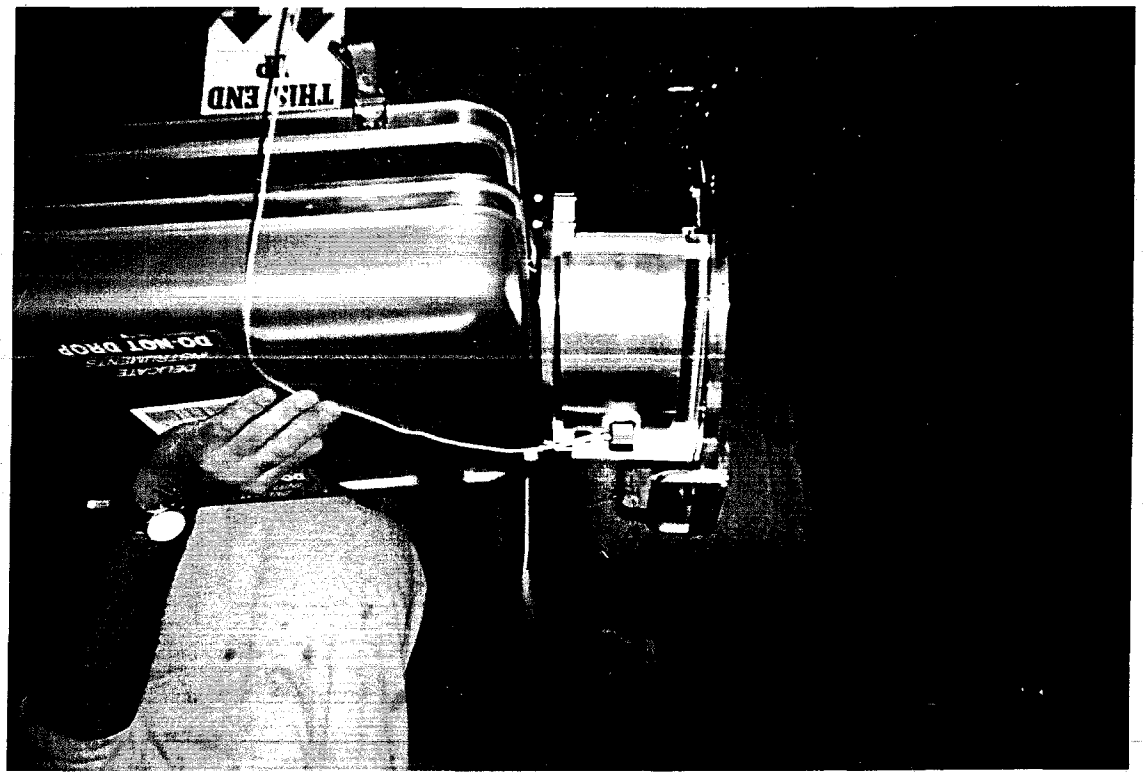
INSTRUMENTS


THIS END
UP




THIS END UP
DO NOT DROP