BNL-105774-2014-TECH

EP&S No. 61;BNL-105774-2014-IR

Test report of a wire grid electrode in an electrostatic separator

R. A. Loper

April 1973

Collider Accelerator Department

Brookhaven National Laboratory

U.S. Department of Energy

USDOE Office of Science (SC)

DISCLAIMER

Brookhaven National Laboratory
Associated Universities, Inc.
Upton, New York

EP&S Division Technical Report

No. 61

R. Loper

Test Report of a Wire Grid Electrode in an Electrostatic Separator

Background

All of our electrostatic separators have used either all stainless steel electrode systems or a combination of heated glass and stainless steel. The performance of the all steel system has not been as good as the system using glass (1), however steel electrodes do not have the maintenance problems that are associated with heated glass.

It was suggested (2) by W.A. Smith of Rutherford High Energy Laboratory that wire grid electrodes would improve the performance of steel systems and decrease the conditioning time of an operating system.

Test Conditions

A wire grid electrode was designed using a spacing factor (75% open) similar to the Rutherford electrode. Stainless steel wire 3/16" in diameter was used to form the electrode. The outline of the wire electrode was identical to the original steel electrodes.

Calculations showed that the force on the wire for a gradient of 100 KV/cm was .048 pounds per lineal inch or 1.6 lbs. per wire form. This force is insufficient to cause deflection of the 3/16" wire as supported.

The wire electrode was installed in the 2 meter test separator as the positive polarity electrode. A conventional steel electrode was used as the negative electrode.

The separator was conditioned in hard vacuum (2 x 10^{-6} torr) and run in nitrogen or helium at 3 - 5 x 10^{-4} torr.

Test Results

With a 5 cm electrode gap, periods of conditioning and running were carried out over a 3 week period. It was quickly established that this separator configuration was not going to give the performance hoped for (see curves for 2" gap). The following observations were noted:

Conditioning

1. Low current (<30° μA) discharges were the rule.
2. There was usually a visable arc associated with a discharge.
3. The discharges in the gap occurred at random points.
4. The positive electrode (grid) conditioned faster than the negative electrode.
5. Each plate conditioned easily to 200KV.
6. At the higher voltages there was a continuous glow discharge in the gap. The discharge seemed to be located opposite the wire grid supporting assembly.

Gas Operation

1. There was no significant gas effect.
2. The spark rate was high.
3. Although the maximum breakdown voltage at various pressures were repeatable, breakdowns occurred frequently at voltages lower than maximum.

In order to compare the results of our wire grid with those of Rutherford the electrode gap was changed to 10 cm. The test separator was operated over a period of 4 weeks. The pressure voltage curves were determined (see curves for 4" gap). Again several observations were noted:

Conditioning

1. Conditioning was hard and gas conditioning was necessary also.
2. Each plate would condition individually to 220 KV in vacuum and 340 KV in gas.
3. Low gap current surges and discharges were common.

Gas Operation

1. Type of gas was not important.
2. Magnetic field had no appreciable effect.

3. Spark rate was generally high.
4. Operation at 500 KV was possible.
5. A gap voltage of 600 KV was attained after 10 days of operation at 500 KV.

Conclusions

The wire grid electrode at least in the configuration tested was not a success. The test results demonstrated that the performance of the wire grid was no better than the conventional all steel electrode system, and for small gaps, worse. In all cases the glass system is still superior.

Rutherford was able to attain voltages 10% higher with their electrode of the same wire-to-spacing ratio and gap. The significantly shorter conditioning time that they experienced was not demonstrated by our design.

The limitation of the grid electrode system is in the electrode gap. There appears to be a threshold at a gradient of 60 - 75 KV/cm (including the Rutherford results) for any steel system . This threshold is only marginally dependent on the configuration of the electrode system.

The wire grid electrode is operational at 500 KV on a 10 cm gap.

Acknowledgements

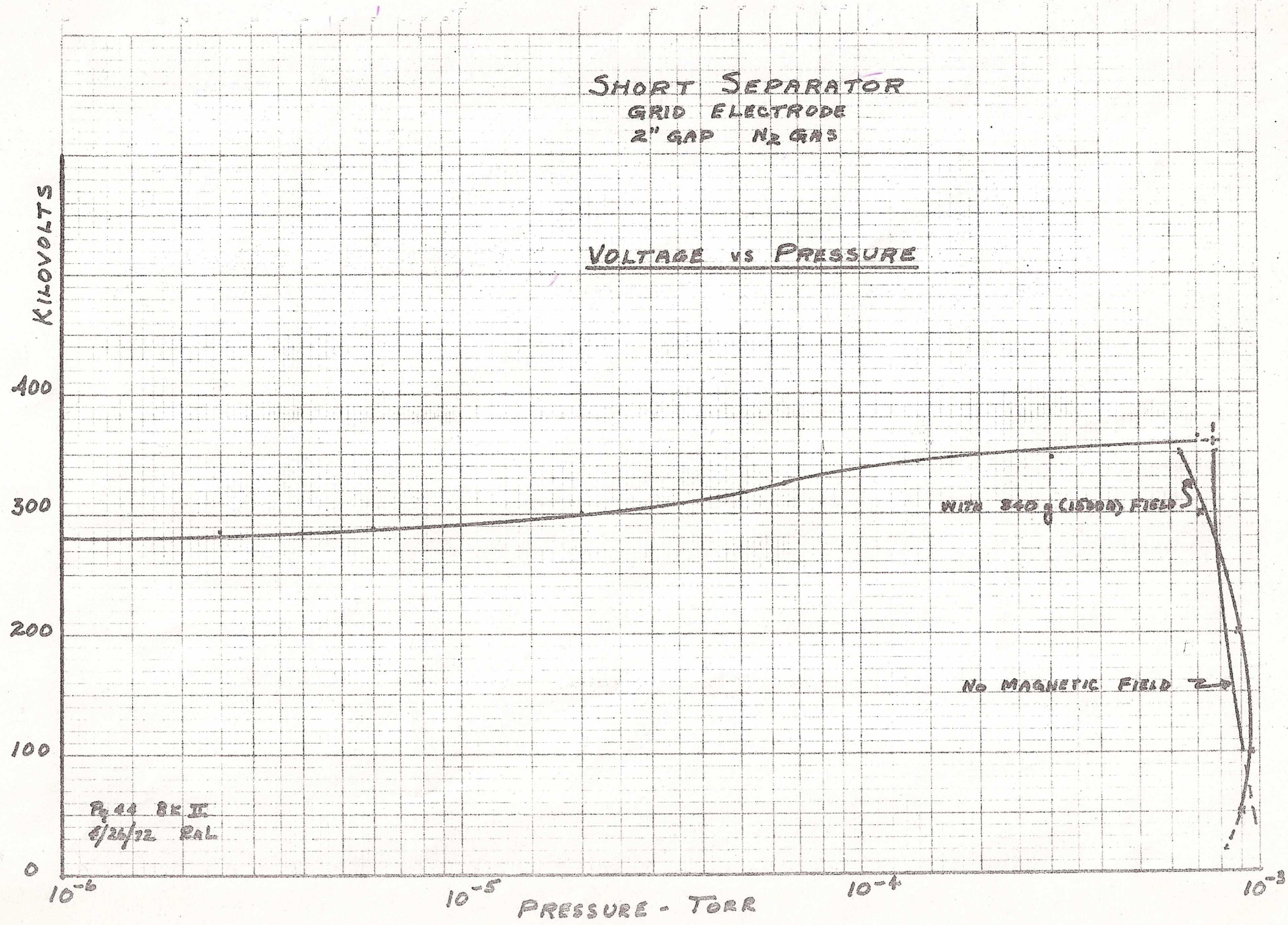
John Walker had the interesting task of designing the wire grid electrode. Ideally the electrode would have no internal supporting structure and yet be rigid enough to support itself with no deflection. Furthermore it had to be able to be assembled and handled for installation. R. Monaghan, L. Zaloga, and L. Potter assembled and installed the electrode.

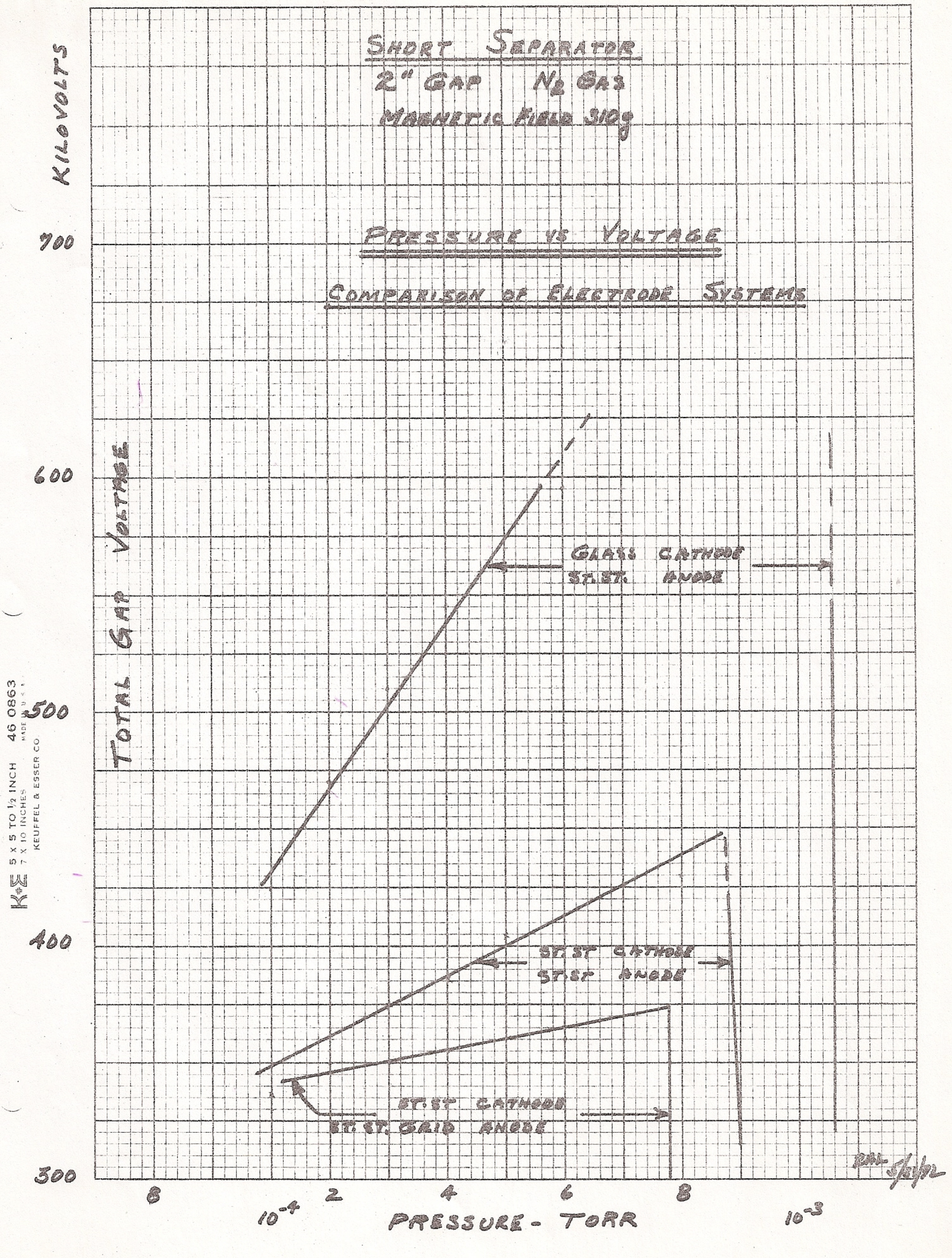
References

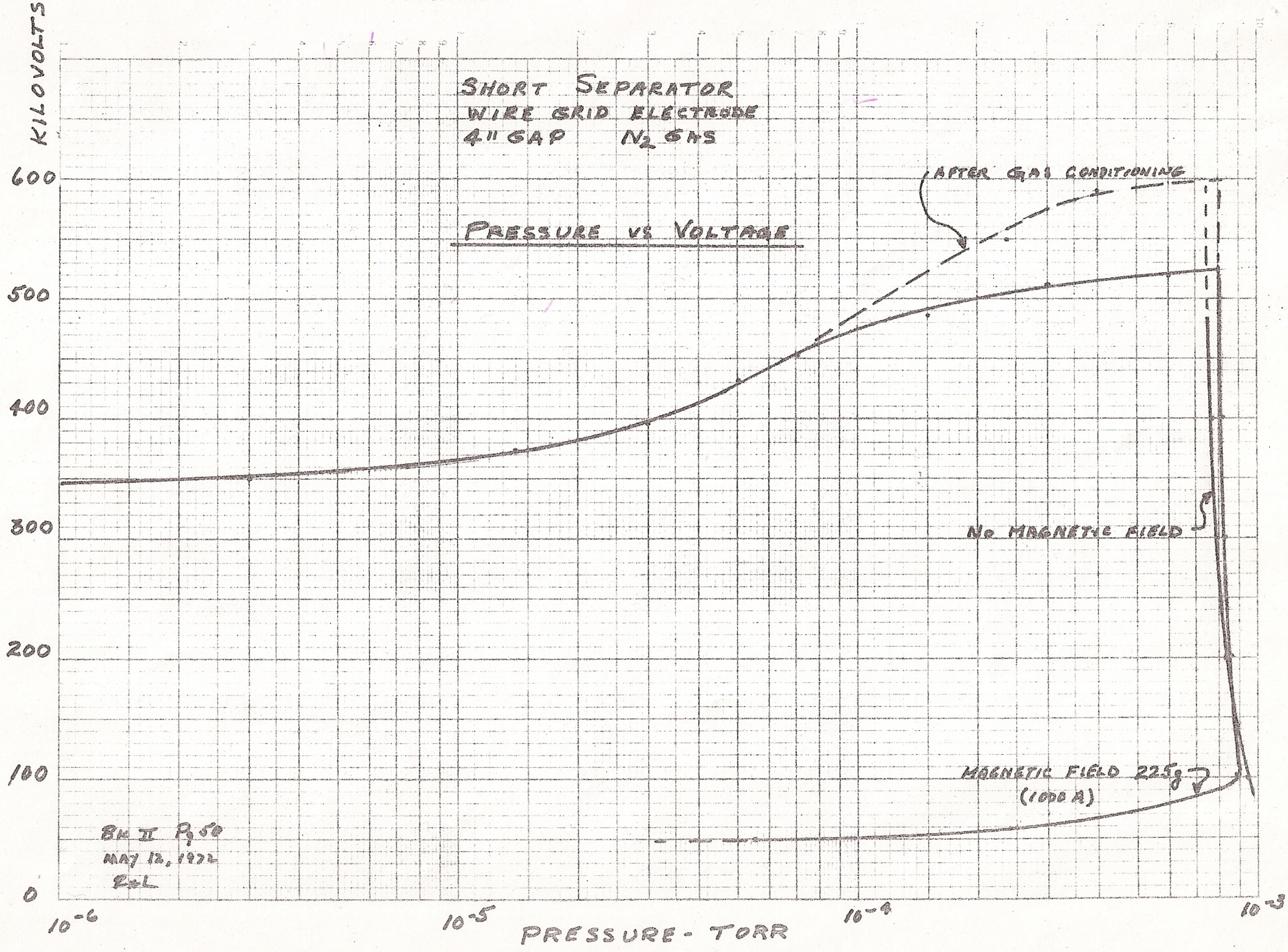
(1) R.A. Loper. EP&S Technical Note NO. 21

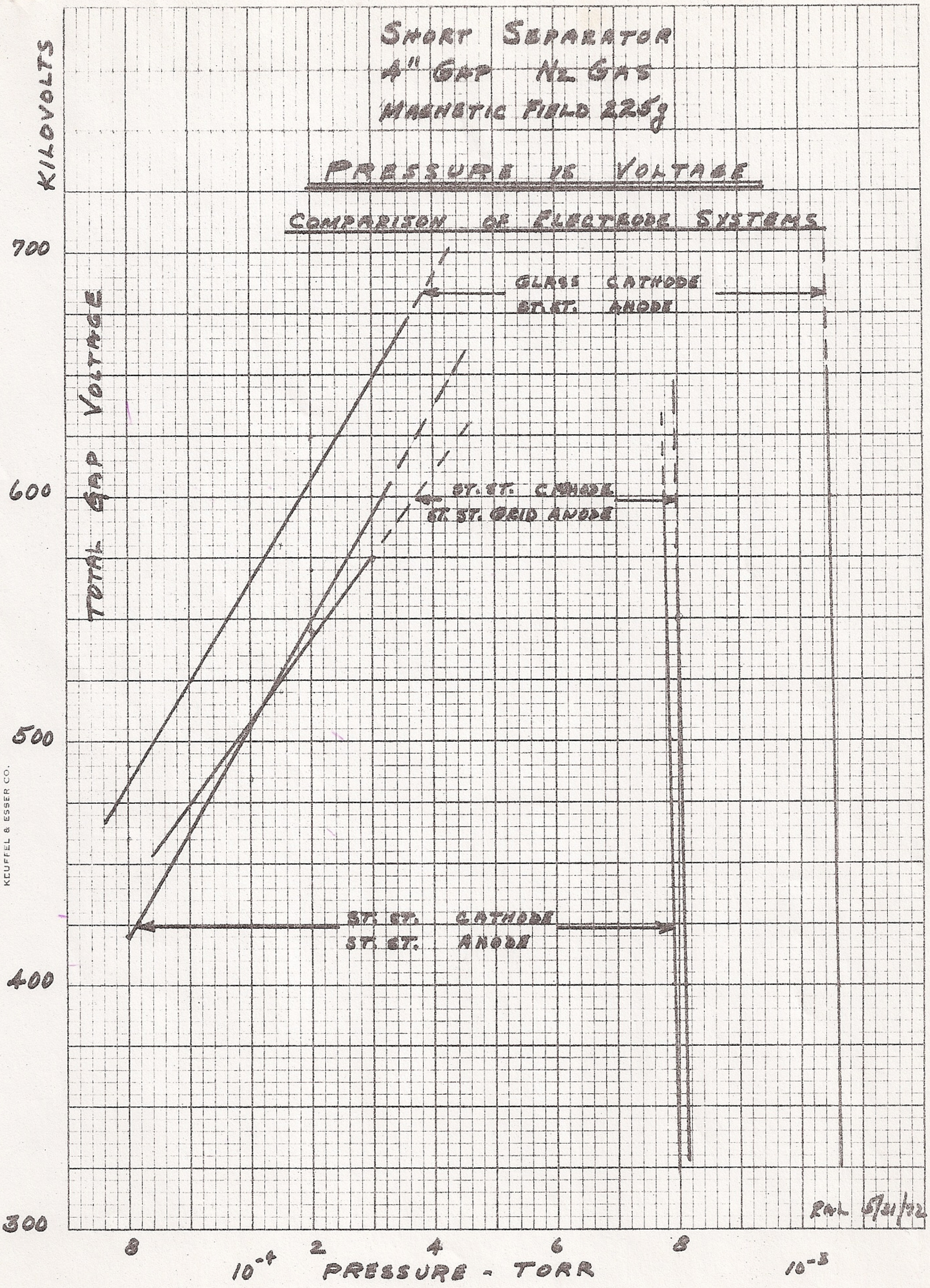
(2) W.A. Smith. Proc. IV Symposium on Discharges and Electrical Insulation in Vacuum. Pgs. 185 - 189

Distribution: B1 (Limited)


SHORT SEPARATOR
GRID ELECTRODE
2" GAP N_2 GAS
VOLTAGE vs PRESSURE
KILOVOLTS
400
300
200
100
0
10^{-6}
10^{-5}
10^{-4}
10^{-3}
PRESSURE - TORR
WITH 340 g (1500A) FIELD
NO MAGNETIC FIELD
Pg 44 BK II
8/26/72 RaL


SHORT SEPARATOR
2" GAP N2 GAS
MAGNETIC FIELD 310g
PRESSURE VS VOLTAGE
COMPARISON OF ELECTRODE SYSTEMS
KILOVOLTS
TOTAL GAP VOLTAGE
700
600
500
400
300
GLASS CATHODE
ST. ST. ANODE
ST. ST CATHODE
ST. ST ANODE
ST. ST CATHODE
ST. ST. GRID ANODE
8
2
4
6
8
10-4
10-3
PRESSURE - TORR
K&E 5 X 5 TO 1/2 INCH 46 0863
7 X 10 INCHES MADE IN U.S.A.
KEUFFEL & ESSER CO.


SHORT SEPARATOR
WIRE GRID ELECTRODE
4" GAP N₂ GAS
PRESSURE vs VOLTAGE
KILOVOLTS
600
500
400
300
200
100
0
10⁻⁶
10⁻⁵
10⁻⁴
10⁻³
PRESSURE - TORR
AFTER GAS CONDITIONING
NO MAGNETIC FIELD
MAGNETIC FIELD 225g
(1000 A)
BK II Pg 50
MAY 12, 1972
R&L


SHORT SEPARATOR
4" GAP N2 GAS
MAGNETIC FIELD 225g
PRESSURE vs VOLTAGE
COMPARISON OF ELECTRODE SYSTEMS
KILOVOLTS
TOTAL GAP VOLTAGE
700
600
500
400
300
GLASS CATHODE
ST. ST. ANODE
ST. ST. CATHODE
ST. ST. GRID ANODE
ST. ST. CATHODE
ST. ST. ANODE
8
2
4
6
8
10-4
10-3
PRESSURE - TORR
RAL 6/21/72