



## COLDfire Thermal Technologies Pty. Limited

### Copper Electrode Testing Interpretations

**Testing conducted by:** *Constellation Technology Corporation  
7887 Bryan Dairy Road, Suite 100  
Largo, Florida, 33777*

**Test Report Number:** *A00766*

**Date:** *6-30/11/2000*

**Report Analyst:** *Jackson / Busefink*

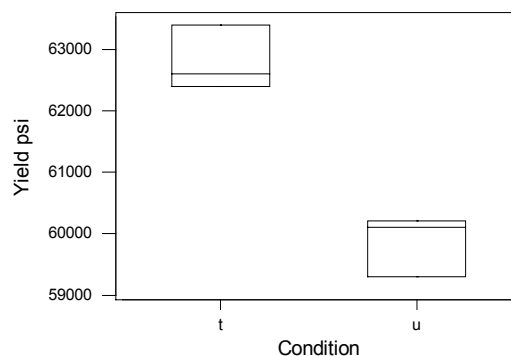
**Testing Method:** *Tensile / Compression / Yield*

#### *Test Protocols*

*Ten samples of copper electrodes, 5 marked as treated and 5 marked as untreated were tested to determine the % ICAS and the tensile / compression strengths. The % ICAS was determined by applying a current source to the electrodes. The tensile and compression testing was performed on a Tinius Olsen LoCap tensile tester, calibrated on 23/6/00 and next due 23/1/0. The testing used a 30,000 pound load cell set on the 12,000 pound range applied at a constant 2,400 pounds per minute. The compression testing was completed using the LoCap tester by applying a 10,000 psi load (3,000 pounds force) to the electrodes and measuring the deflection. The full analytical report is reproduced on page 2 of this summary.*

The most interesting and important property is the increase in Yield strength (not Tensile strength). Yield is practical failure point (permanent distortion), and Tensile, which is measured as the breakage point where the final result is two pieces instead of one.

The most significant result of the testing is the average yield strength increase from 59867psi to 62800psi, an increase of 4.9%. This is a statistically significant difference indicating the reflected increase in wear and use time of the welding electrodes and can be represented pictographically as follows:



The practical application of the test is that it will take a 5% higher clamping force to distort COLDfired weld tips over an untreated weld tip. The significant increase in wear is indicative that once COLDfired, the tip yield strength is moved outside the operational wear window and while only slightly increased strength it delivers substantially increased wear.

The tests referred to within this report are related to high conductivity copper cadmium free electrode. It should be noted that use of an electrode containing a high level of Cadmium has the effect of greatly increasing yield strength without much effect on electrical conductivity but at the cost of occupational health and safety due to the high levels of poison.

**Analytical Test Data**

**CONSTELLATION TECHNOLOGY CORPORATION**

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 An Equal Opportunity Employer



*Analytical Services Laboratory*

**Test Report – A00766**

Company: <u>Thermal Technology Services, Inc.</u>	Contact: <u>Frank Masyada</u>
Address: <u>7500 Ulmerton Road Suite 27</u>	
City/State/Zip: <u>Largo, FL 33771</u>	
Sample description and ID: <u>Copper Electrodes</u>	
Date Received: <u>10/26/00</u>	Date Analyzed: <u>11/6-30/00</u> Date Reported: <u>2/6/01</u>
Test Method: <u>Tensile / Compression / % IACS</u>	Analysts: <u>Jackson/Busefink</u>

**Discussion:**

Ten samples of copper electrodes, 5 marked untreated and 5 treated, were received to determine the % IACS and the tensile/compression strength. The % IACS was determined by applying a current source to the electrodes. The tensile and compression testing was performed on a Tinius Olsen LoCap tensile tester, calibrated 6-23-00 due 6-23-01. The testing used a 30,000 pound load cell set on the 12,000 pound range with the load applied at a constant 2,400 pounds per minute. The compression testing was completed using the LoCap tester by applying a 10,000 psi load (3,000 pounds force) to the electrodes and measuring the deflection.

**Results:**

The results of the tensile testing are given in Table 1.

Sample	Dia (in)	Yield Load (lbs)	Tensile Load (lbs)	Yield Strength (psi)	Tensile Strength (psi)	Reduction of area (%)	Elong (%)
Untreated 1	0.483	10,870	12,260	59,300	66,900	68	22
Untreated 3	0.532	13,360	15,100	60,100	67,900	67	25
Untreated 4	0.542	13,900	15,510	60,200	67,200	65	23
Treated 7	0.511	13,000	14,260	63,400	69,500	65	20
Treated 9	0.492	11,900	13,140	62,600	69,100	64	22
Treated 10	0.532	13,880	15,250	62,400	68,600	68	23

Table 1

The results of the % IACS testing are given in Table 2.

Untreated				
Sample	Volts	Voltage drop	$\Omega$	% IACS
1	9.41	0.000156	0.000016578	82.2
2	9.40	0.000156	0.000016596	82.1
3	9.41	0.000156	0.000016578	82.2
4	9.37	0.000155	0.000016542	82.3
5	9.47	0.000159	0.000016790	81.1
Average				82.0
Treated				
6	9.41	0.00156	0.000016578	82.2
7	9.38	0.000156	0.000016631	81.9
8	9.38	0.000157	0.000016738	81.4
9	9.37	0.000156	0.000016649	81.8
10	9.41	0.000158	0.000016791	81.1
Average				81.8

Table 2

The results of the compression testing are given in Table 3. The diameter of all electrodes measured 0.617 inches. The electrodes operate at 10,000 psi, therefore the test load was determined as 3,000 pounds.

Sample	Diameter (in)	Length (in)	Load (lbs)	Deflection (in)
Untreated 2	0.617	7.000	3,000	0.0200
Untreated 5	0.617	6.600	3,000	0.0176
Treated 6	0.617	7.000	3,000	0.0197
Treated 8	0.617	7.000	3,000	0.0175

Table 3

The tensile results indicate that the Yield strength increased an average of 4.9% and the Tensile strength increased an average of 2.5% after thermal treatment. The % IACS indicated a slight increase after thermal treatment, except for samples 5 & 6. The compression results indicate no difference between the treated and untreated samples.

Comments:

- The uncertainty of the above results was not determined.
- The results only relate to the sample analyzed.
- This report shall not be reproduced except in full, without written approval from the laboratory.

Approved by: Ken Coulter for WES Date: 2-6-01  
 William E. Swartz, Ph.D.  
 Manager, Analytical Services



The above testing is accredited by the American Association for Laboratory Accreditation  
 Mechanical Testing Field - A2LA Certificate # 1171.02 Expires 3/30/2001