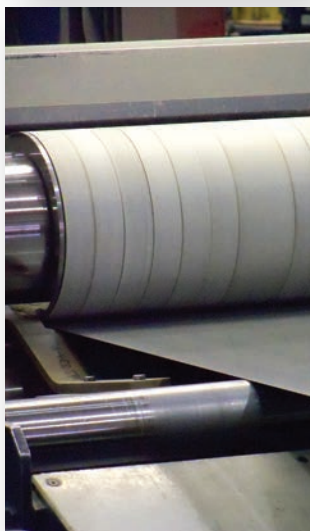
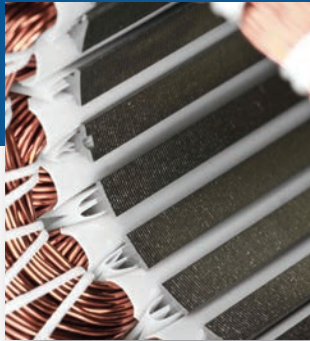


# DI-MAX<sup>®</sup> HF-10

**COLD-ROLLED FULLY PROCESSED  
NON-ORIENTED ELECTRICAL STEEL**



**Aircraft Generators**

**High Speed Motors**

**Traction Motors**

**DI-MAX<sup>®</sup> HF-10** is a fully processed non-oriented electrical steel designed for use in high speed motors, traction motors, aircraft generators and other rotating equipment operating at frequencies above 60 Hz. DI-MAX HF-10 electrical steel is supplied in a nominal thickness of 0.010 in. (0.25 mm).

## Product Description

Composition (Typical)		(WT %)
Silicon	(Si)	2.65
Aluminum	(Al)	0.70

### GUARANTEED MAXIMUM AND TYPICAL MAGNETIC PROPERTIES\*

Release grading is based on as-sheared Epstein test and based on core loss at 1.0 T and 400 Hz in accordance with ASTM A343 (reference data at frequencies above 400 Hz were developed in conformance with ASTM A348). Representative properties using stress relief annealing are shown for reference.

### CORE LOSS

	Typical	Maximum
As-Sheared	14.5 W/kg (6.6 W/lb.)	15.5 W/kg (7.0 W/lb.)
After 830 °C SRA	13.7 W/kg (6.2 W/lb.)	14.5 W/kg (6.6 W/lb.)

### OTHER MAGNETIC PROPERTIES\*

Magnetic Induction at 5000 A/m	1.65 T
Volume Resistivity	54 – 56 $\mu\Omega \cdot \text{cm}$
Saturation Induction	1.99 T

### INSULATIVE COATING

Type ASTM	A976 C-5
Components	Aluminum phosphate, inorganic silicate fillers, acrylic resin
Thickness*	2.5 – 2.8 $\mu\text{m}$ (100 – 110 $\mu\text{in}$ )
Space Factor	Minimum 95.0% Typical 96.5%
Franklin Current	Maximum 0.30 A Typical 0.02 A
Weldability	Good (minimal porosity)

A976 C-5-A type (CARLITE® 3 ANTI-STICK™ Electrical Steel) is available upon request.

### MECHANICAL AND PHYSICAL PROPERTIES

Density	7.65 gm/cm <sup>3</sup>
Yield Strength*	350 MPa (50,000 psi.)
Tensile Strength*	450 MPa (65,000 psi.)
Elongation, % in 2"*	20%
Rockwell Hardness*	B78
Thickness Aim	0.010 in. (0.25 mm)
Tolerance	$\pm 0.00075$ in. ( $\pm 0.02$ mm)
Strip Crown*	0.00020 – 0.00025 in. (0.005 – 0.006 mm.)

Density determination conducted in compliance with ASTM A34. Typical mechanical and physical properties as noted.



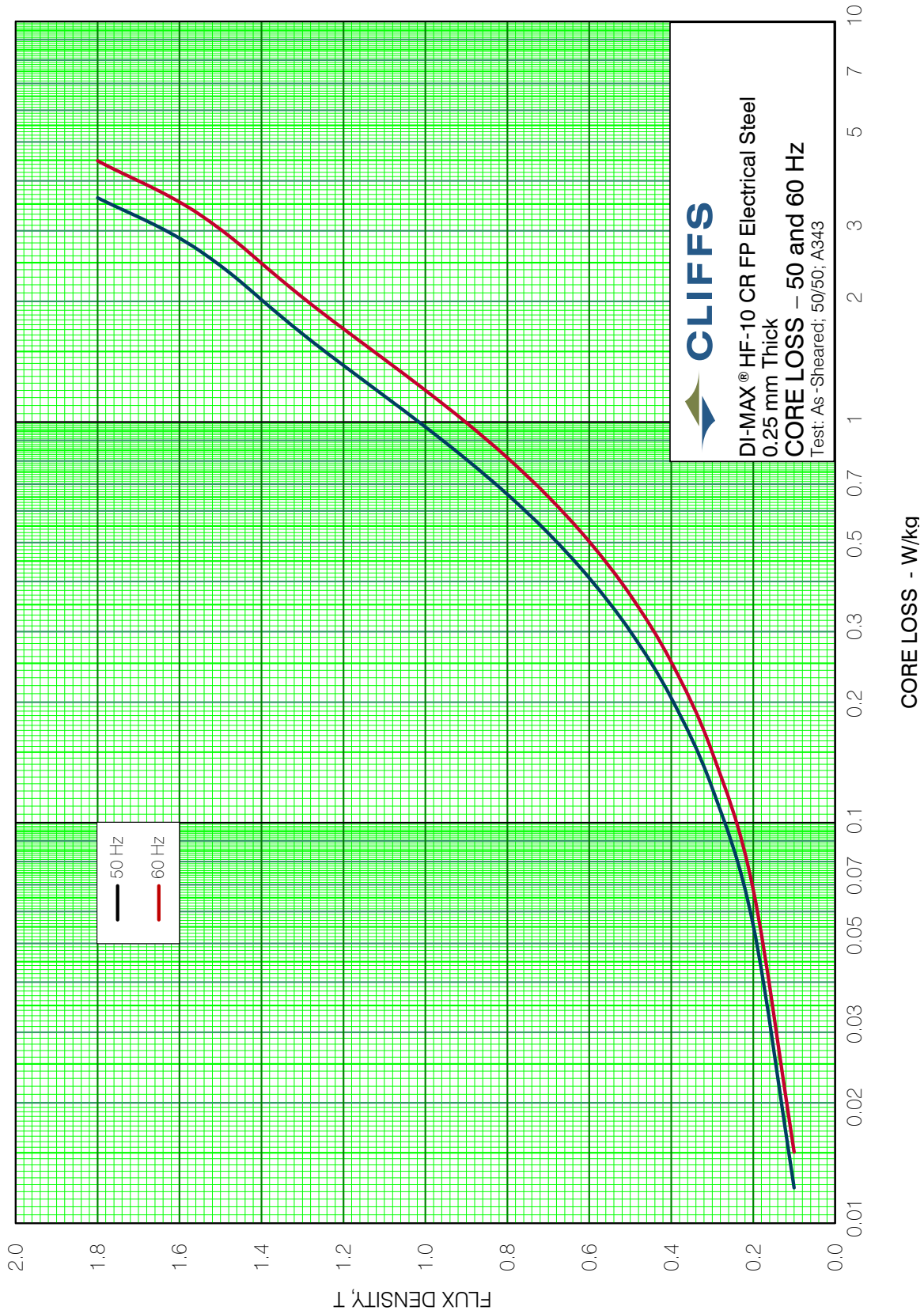
## Core Loss And Exciting Power Tables As-Sheared

Flux Density (T)	CORE LOSS (W/kg) @ Frequency (Hz) - ASTM A343; ASTM A348; 50/50; As-Sheared										
	50	60	100	200	400	700	1000	1500	2500	5000	10000
0.1	0.0123	0.0151	0.0271	0.0648	0.17	0.396	0.699	1.36	3.23	10.4	32.7
0.2	0.0556	0.0683	0.123	0.289	0.736	1.66	2.86	5.43	12.4	37.5	113.0
0.4	0.205	0.252	0.46	1.09	2.78	6.23	10.6	19.8	43.8	128.0	395.0
0.7	0.528	0.651	1.20	2.91	7.55	17.1	29.4	55.3	125.0	380.0	–
1.0	0.972	1.20	2.22	5.43	14.4	33.4	58.3	112.0	265.0	842.0	–
1.2	1.38	1.71	3.16	7.7	20.4	48.3	85.2	168.0	–	–	–
1.3	1.66	2.05	3.78	9.18	24.3	56.9	101.0	200.0	–	–	–
1.4	2.02	2.49	4.58	11.1	29.0	–	–	–	–	–	–
1.5	2.45	3.03	5.53	13.3	35.0	–	–	–	–	–	–
1.6	2.87	3.54	6.47	15.5	40.1	–	–	–	–	–	–
1.7	3.25	4.00	7.23	17.1	–	–	–	–	–	–	–
EXCITING POWER (VA/kg) @ Frequency (Hz) - ASTM A343; ASTM A348; 50/50; As-Sheared											
0.1	0.0498	0.06	0.101	0.207	0.433	0.809	1.24	2.06	4.09	12.5	36.8
0.2	0.143	0.173	0.294	0.617	1.34	2.62	4.14	7.12	14.7	43.2	126.0
0.4	0.389	0.471	0.811	1.75	3.97	8.07	13.1	23.0	48.4	143.0	432.0
0.7	0.905	1.10	1.90	4.16	9.72	20.4	33.8	61.0	134.0	425.0	–
1.0	1.76	2.13	3.67	7.98	18.6	39.7	66.7	124.0	285.0	965.0	–
1.2	2.94	3.55	6.06	12.9	29.1	61.0	102.0	190.0	–	–	–
1.3	4.31	5.20	8.79	18.3	39.9	81.5	133.0	242.0	–	–	–
1.4	8.32	10.0	16.7	34.1	71.2	–	–	–	–	–	–
1.5	24.2	29.4	49.0	98.6	203.0	–	–	–	–	–	–
1.6	68.2	82.5	137.0	276.0	574.0	–	–	–	–	–	–
1.7	150.0	181.0	301.0	604.0	–	–	–	–	–	–	–

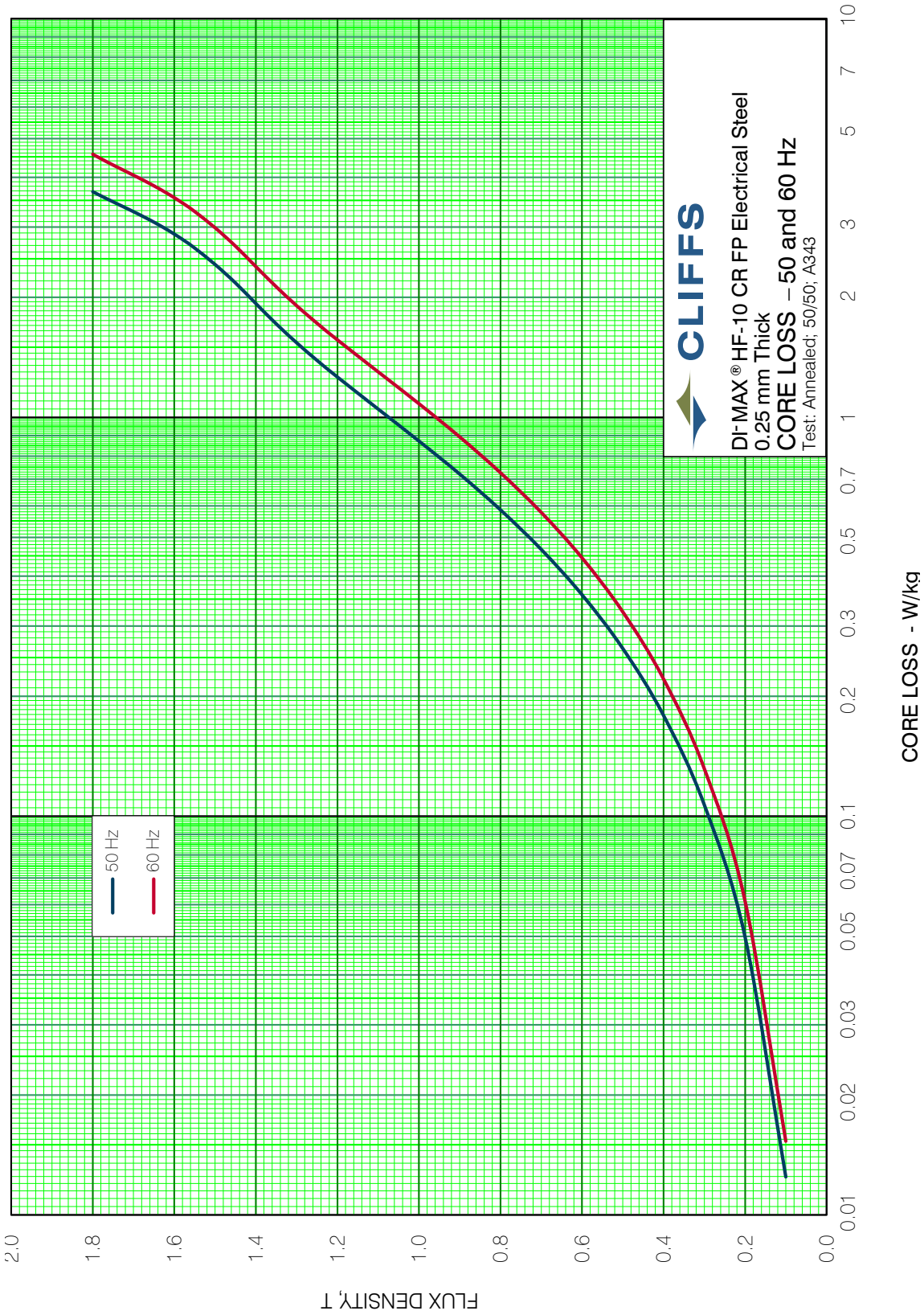
## Core Loss And Exciting Power Tables Stress Relief Annealed

Flux Density (T)	CORE LOSS (W/kg) @ Frequency (Hz) - ASTM A343; ASTM A348; 50/50; SRA										
	50	60	100	200	400	700	1000	1500	2500	5000	10000
0.1	0.0125	0.0153	0.0279	0.0671	0.177	0.415	0.73	1.41	3.32	10.6	33.5
0.2	0.0498	0.0613	0.112	0.269	0.703	1.62	2.82	5.38	12.3	37.9	115.0
0.4	0.179	0.221	0.409	0.994	2.60	5.96	10.3	19.4	43.0	128.0	398.0
0.7	0.467	0.578	1.09	2.69	7.14	16.5	28.4	53.3	121.0	382.0	–
1.0	0.873	1.08	2.04	5.09	13.7	32.3	56.7	109.0	254.0	843.0	–
1.2	1.26	1.57	2.94	7.30	19.8	47.3	84.1	164.0	–	–	–
1.3	1.54	1.91	3.58	8.83	23.7	56.7	102.0	200.0	–	–	–
1.4	1.93	2.39	4.46	10.9	29.0	–	–	–	–	–	–
1.5	2.42	2.99	5.57	13.5	35.7	–	–	–	–	–	–
1.6	2.88	3.56	6.67	16.0	41.3	–	–	–	–	–	–
1.7	3.28	4.05	7.47	17.7	–	–	–	–	–	–	–
EXCITING POWER (VA/kg) @ Frequency (Hz) - ASTM A343; ASTM A348; 50/50; SRA											
0.1	0.0413	0.0498	0.0848	0.176	0.377	0.72	0.98	1.98	4.17	12.2	36.9
0.2	0.118	0.143	0.246	0.522	1.17	2.34	3.43	6.76	14.5	42.2	125.0
0.4	0.322	0.39	0.682	1.50	3.49	7.35	11.5	22.2	47.8	140.0	429.0
0.7	0.745	0.907	1.60	3.59	8.65	18.7	30.4	59.4	132.0	416.0	–
1.0	1.43	1.74	3.05	6.82	16.6	36.5	60.6	121.0	284.0	956.0	–
1.2	2.37	2.87	4.95	10.8	25.5	55.6	91.3	186.0	444	–	–
1.3	3.49	4.24	7.23	15.4	34.8	73.0	116.0	236.0	559	–	–
1.4	7.36	8.94	15.2	31.1	66.1	–	–	–	–	–	–
1.5	25.6	31.0	54.0	109.0	226.0	–	–	–	–	–	–
1.6	73.4	88.8	153.0	307.0	636.0	–	–	–	–	–	–
1.7	158.0	191.0	326.0	654.0	–	–	–	–	–	–	–

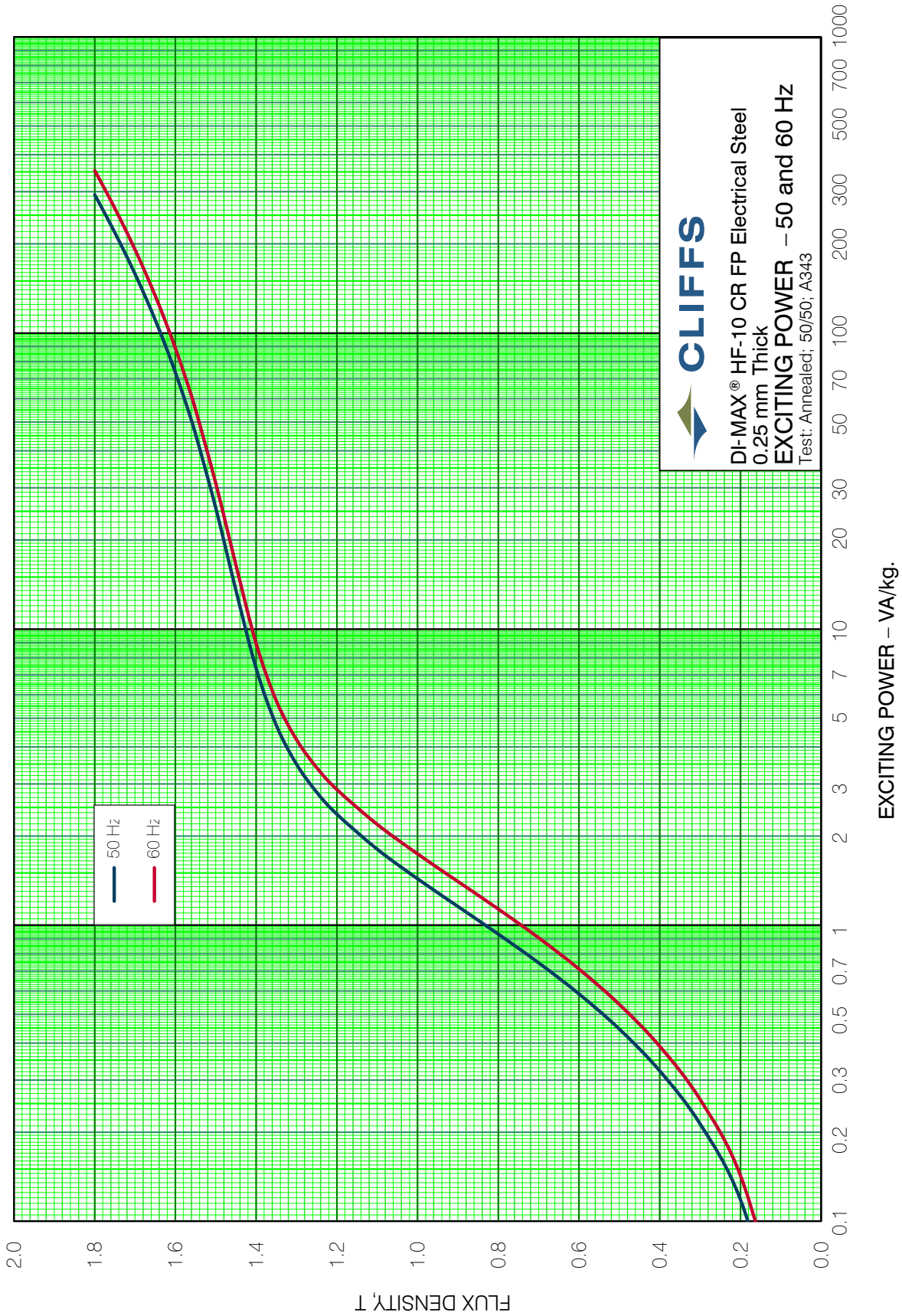
## Core Loss Curve – As-Sheared



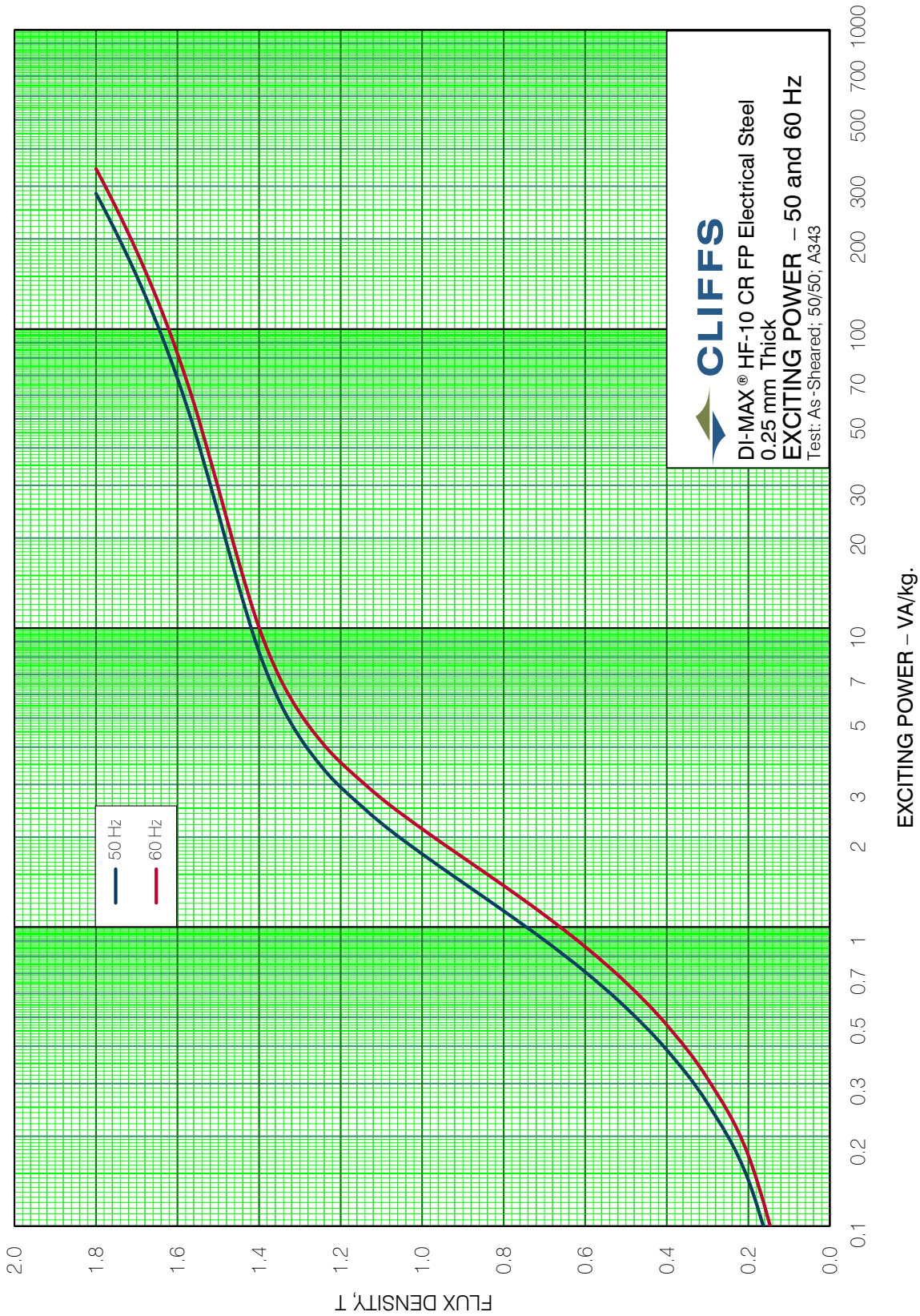
## Core Loss Curve – Stress Relief Annealed



## Exciting Power Curve – As-Sheared

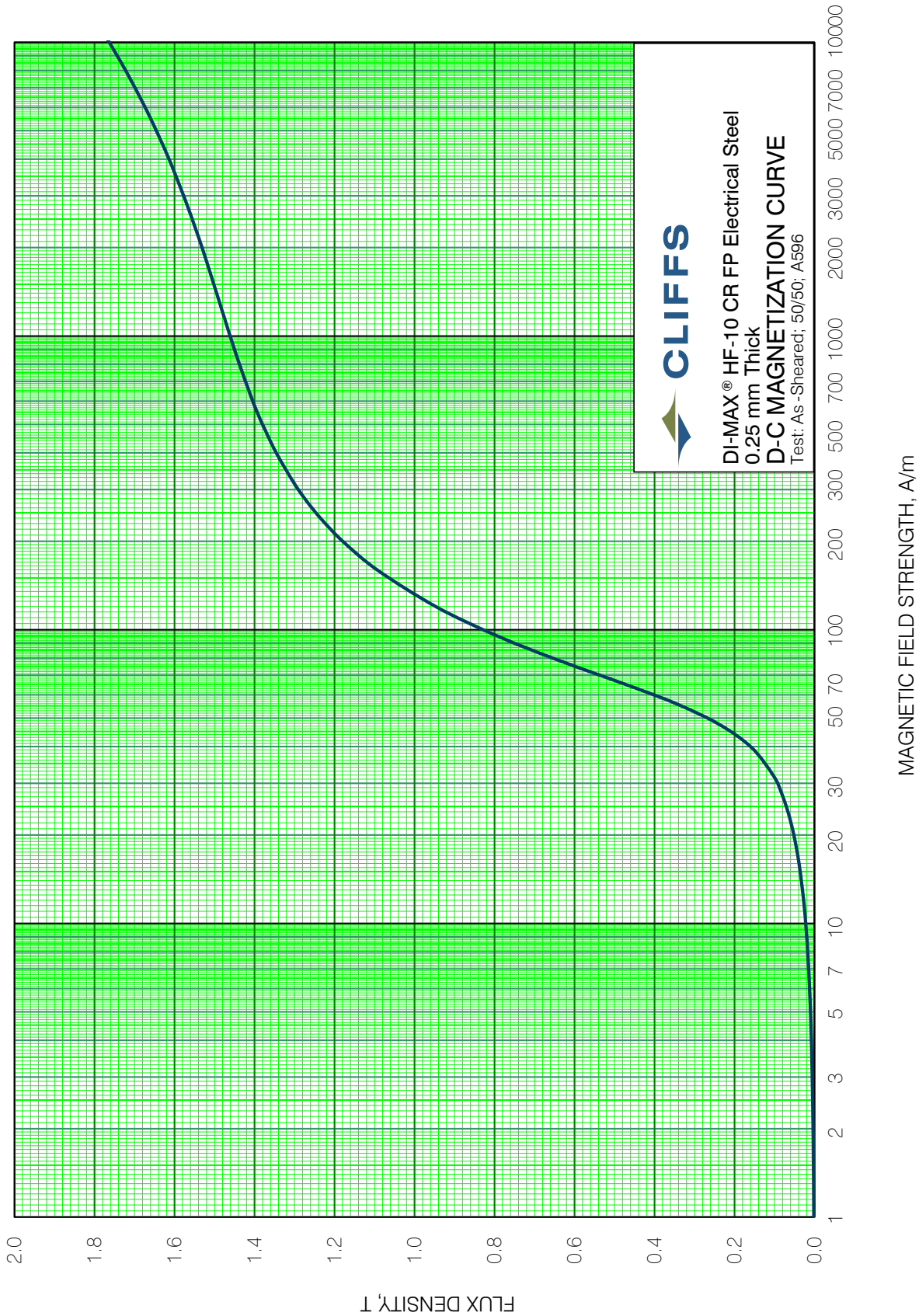


# Exciting Power Curve – Stress Relief Annealed

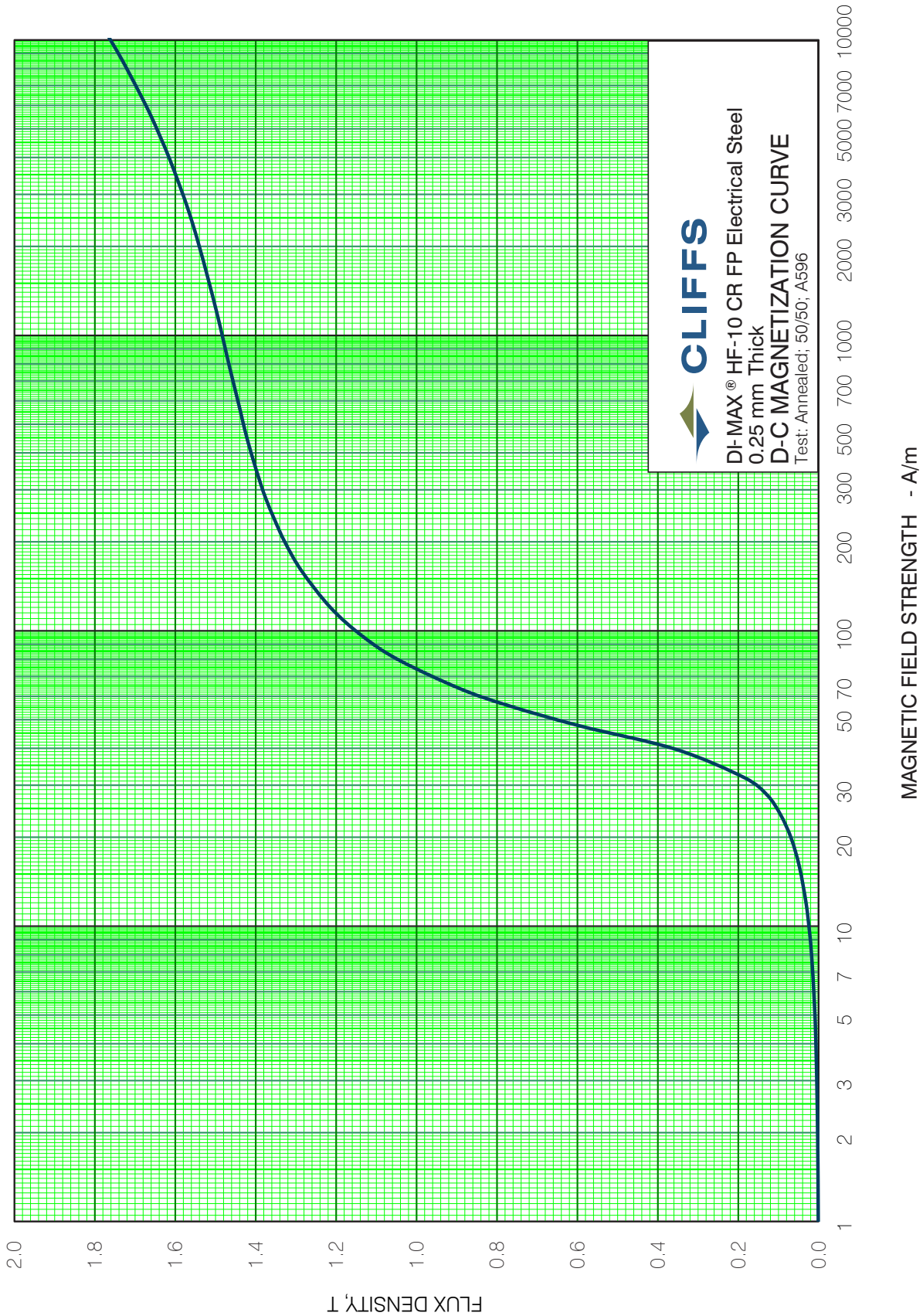




# D-C Magnetization Curve – As-Sheared



# D-C Magnetization Curve Stress Relief Annealed





DI-MAX<sup>®</sup> HF-10

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## About Cleveland-Cliffs Inc.

Cleveland-Cliffs is the largest flat-rolled steel producer in North America. Founded in 1847 as a mine operator, Cliffs also is the largest manufacturer of iron ore pellets in North America. The Company is vertically integrated from mined raw materials and direct reduced iron to primary steelmaking and downstream finishing, stamping, tooling, and tubing. The Company serves a diverse range of markets due to its comprehensive offering of flat-rolled steel products and is the largest steel supplier to the automotive industry in North America. Headquartered in Cleveland, Ohio, Cleveland-Cliffs employs approximately 25,000 people across its mining, steel and downstream manufacturing operations in the United States and Canada.



### **CLEVELAND-CLIFFS INC.**

200 Public Square  
Suite 3300  
Cleveland, OH 44114-2315  
844.STEEL99 | 844.783.3599  
clevelandcliffs.com

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