Materials Magic
Hitachi Metals

Metglas®, Inc.

Amorphous Alloys for Transformer Cores

Metglas® Amorphous Transformer cores are manufactured from low loss **Metglas® 2605SA1** and **Metglas® 2605HB1M** transformer core alloys. These low loss, high permeability alloys have excellent performance for single and three phase commercial, industrial and distribution transformer applications.

1. Alloys and the specification

Alloy		2605SA1	2605HB1M
Induction at 60 Hz and 80 A/m* (T)		≥1.35	≥1.50
Core Loss* (W/kg)	at 60 Hz and 1.3 T	≤0.17	≤0.17
	at 60 Hz and 1.4 T	≤0.20	≤0.20
Exciting Apparent Power* at 60 Hz and 1.4 T (VA/kg)		≤1.10	≤0.50

* These numbers in the above table are measured according to ASTM A 932/A 932 M - 01.

2. General Properties and Characteristics

Electromagnetic

Alloy	Saturation Induction (T)	Electrical Resistivity (μΩm)	Magnetostriction ($x10^{-6}$)	Curie Temperature (°C)
2605SA1	1.56	1.3	27	395
2605HB1M	1.63	1.2	27	364

The numbers in the above table are not guaranteed

Physical

Alloy	Density (g/cm^3)	Crystallization Temperature (°C)	Tensile Strength (N/mm^2)	Young's Modulus (GPa)	Vickers Hardness Hv-50 g load	Thermal Expansion Coefficient ($x10^{-6}$/°C)
						30 - 300°C
2605SA1	7.18	510	2,000	110	900	7.6
2605HB1M	7.33	489	2,100	120	900	4.3

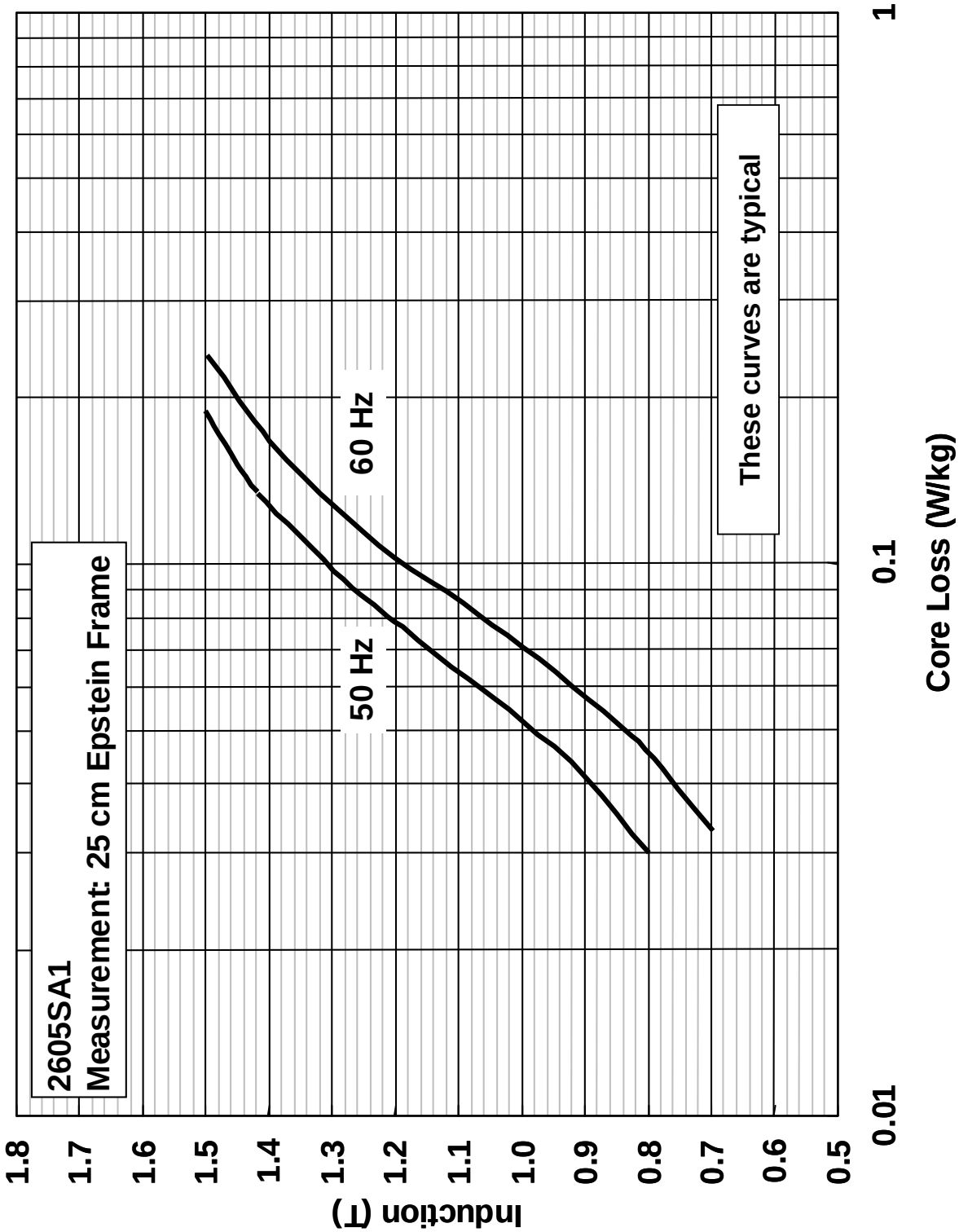
The numbers in the above table are not guaranteed

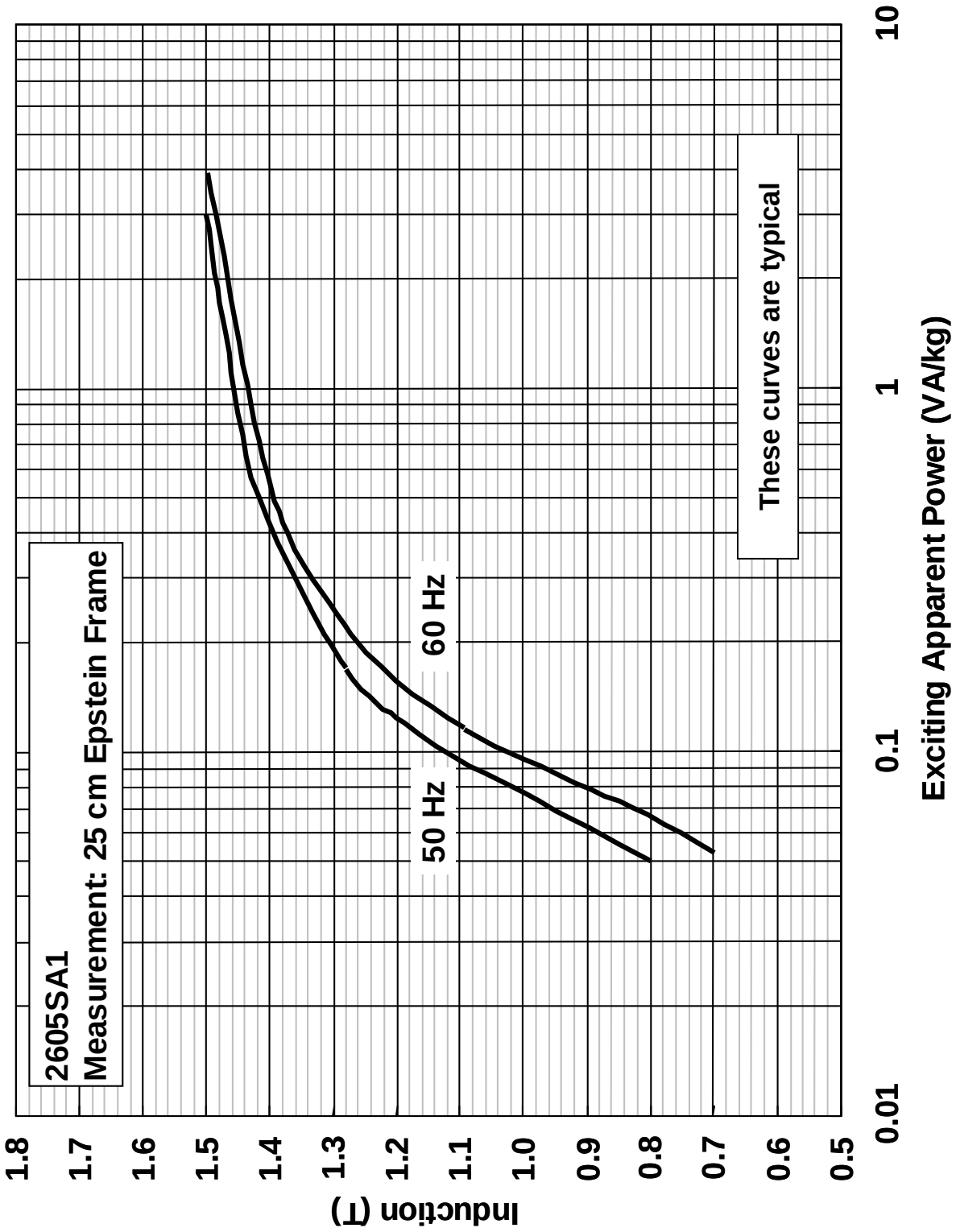
3. Ribbon Dimensions and Lamination Factor

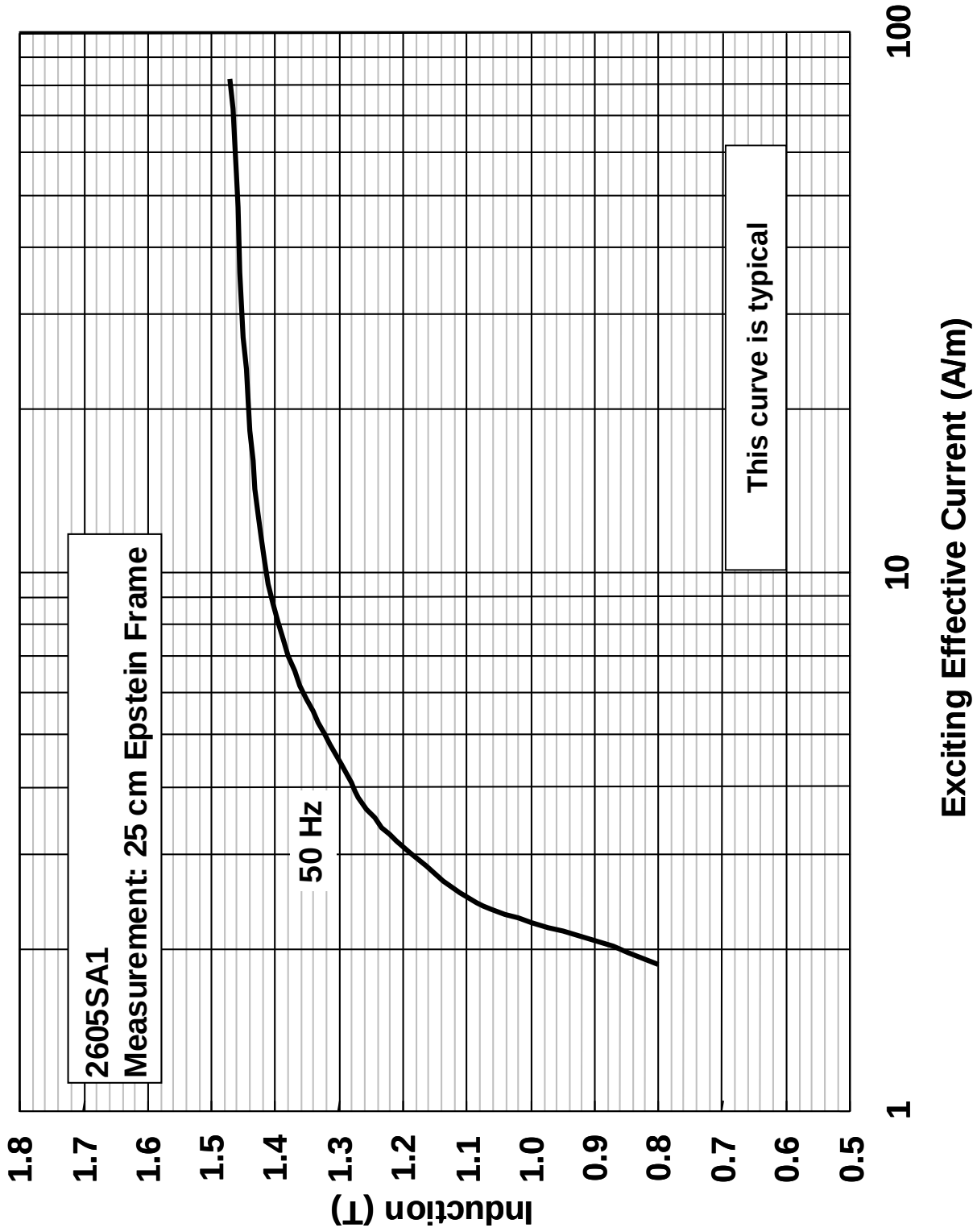
Alloy	Thickness (μm)	Standard Available Widths (mm)			Lamination Factor (%)
2605SA1	25 ± 4	142.2 ± 1.0	170.2 ± 1.1	213.4 ± 1.4	≥84
2605HB1M					

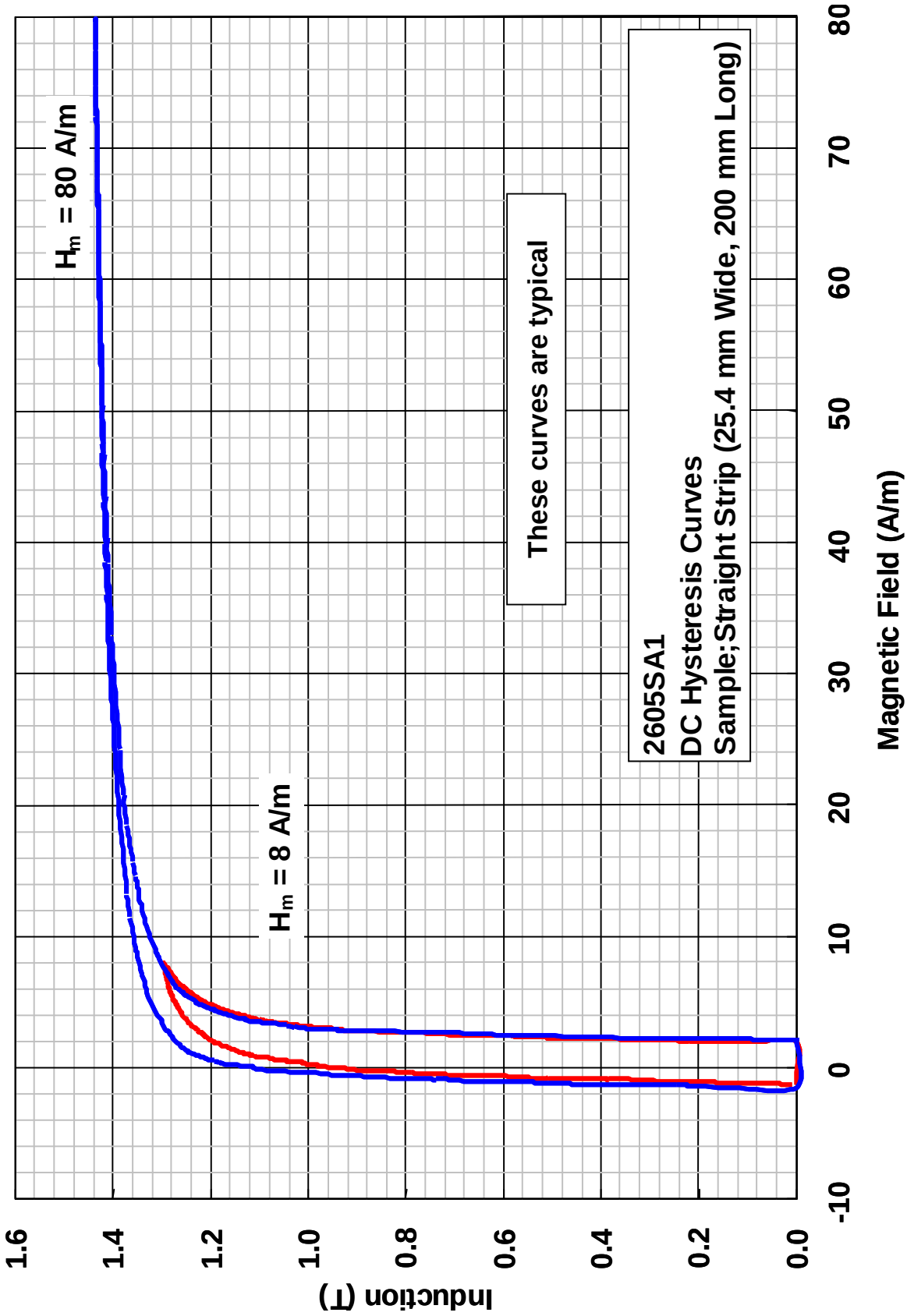
4. Typical Magnetic Properties

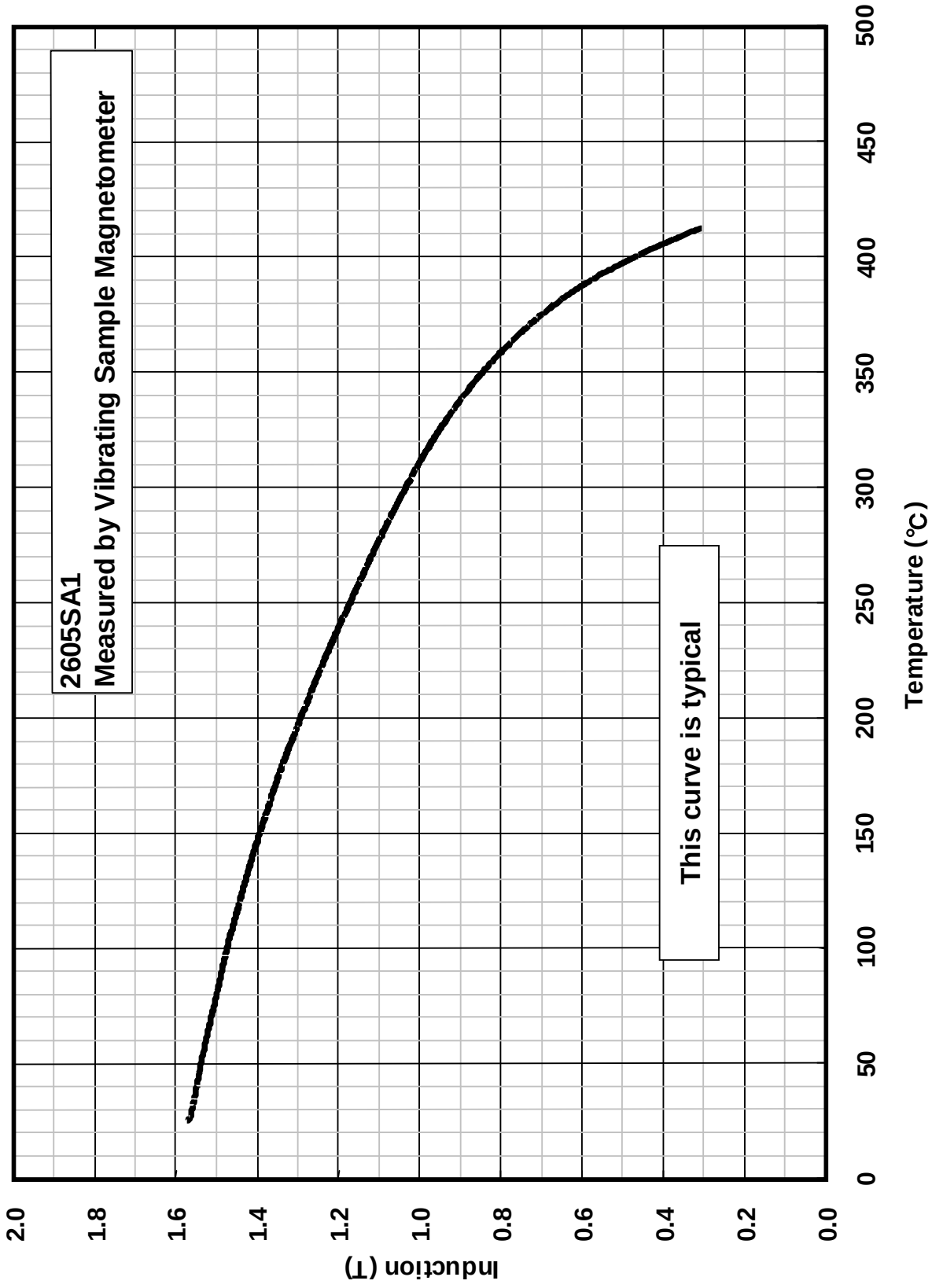
In the following pages some examples of the properties on 2605SA1 and 2605HB1M transformer core alloys are shown. AC magnetic properties were measured by 25 cm Epstein test frame method.
DC hysteresis curves were measured by a Single Strip Test method. The samples were 25.4 mm wide and 200 mm long. The heat treatment of the samples were performed at 370°C for 2 hours for 2605SA1 alloy and at 340 °C for 2 hours for 2605HB1M alloy in a magnetic field of 2400 A/m directed along the long axis of the ribbon to release stress and induce the magnetic anisotropy along the long axis of the ribbon. These properties are not guaranteed.

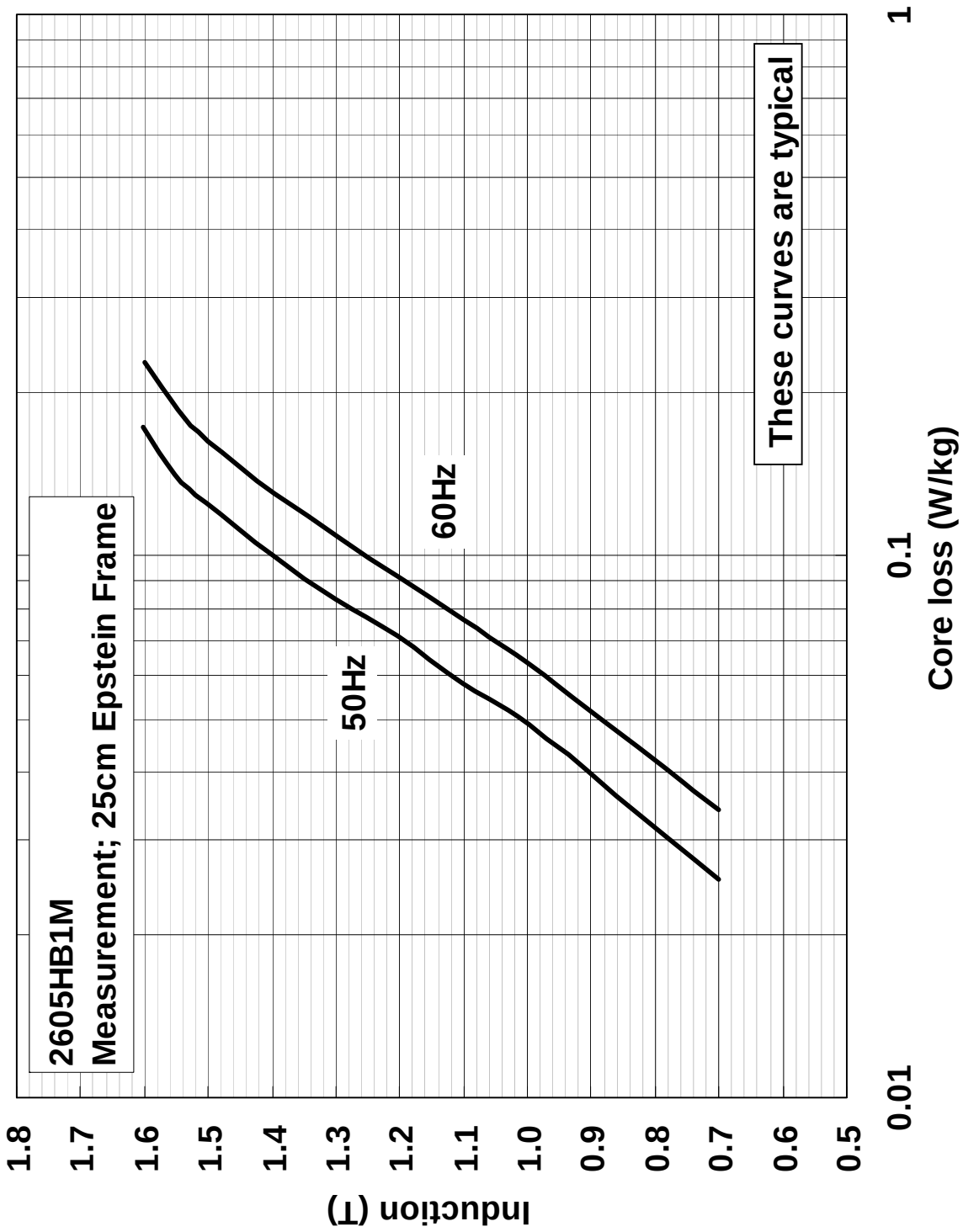

2605SA1
Measurement: 25 cm Epstein Frame
60 Hz
50 Hz
These curves are typical
Induction (T)
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
Core Loss (W/kg)
1
0.1
0.01

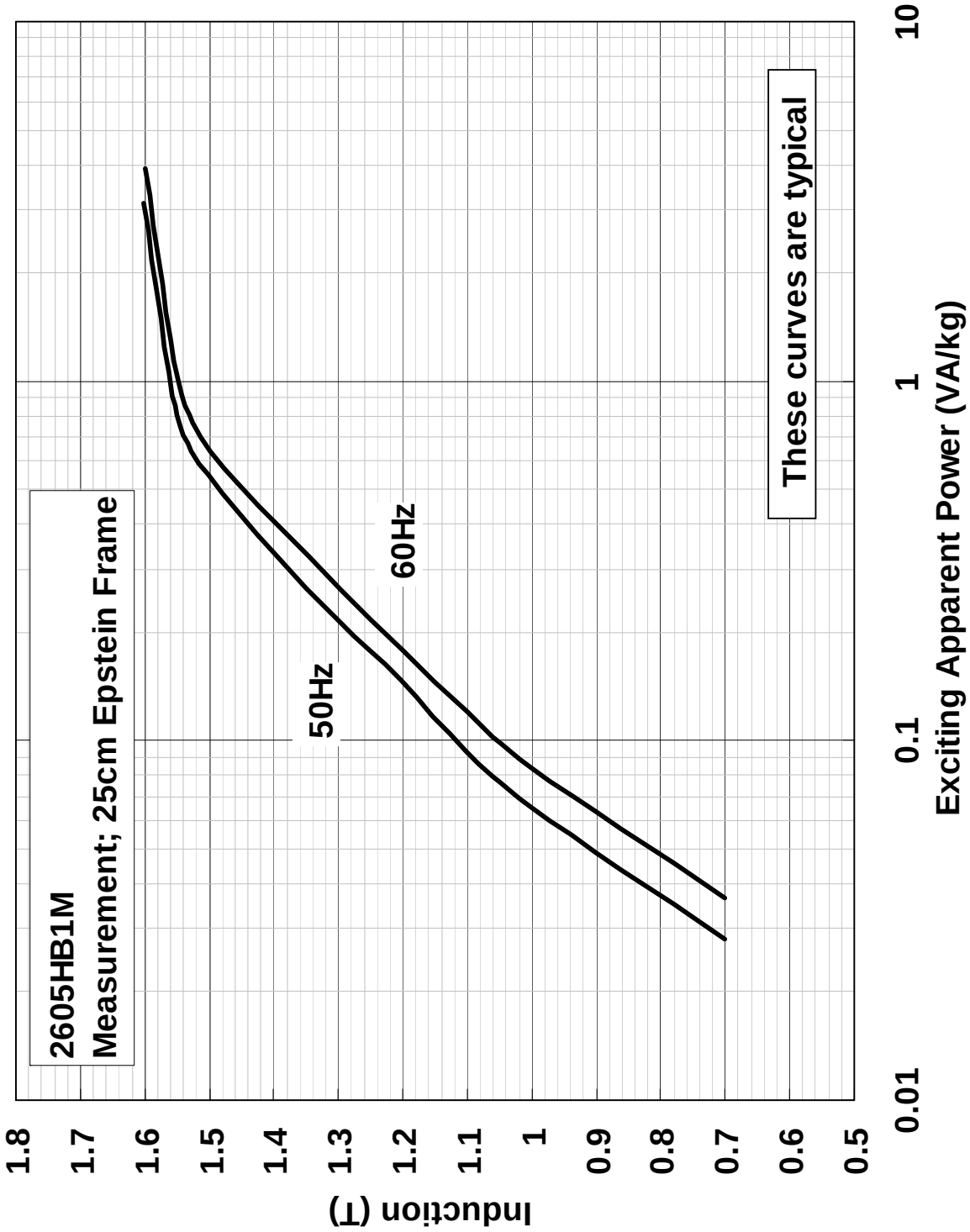

2605SA1
Measurement: 25 cm Epstein Frame
60 Hz
50 Hz
These curves are typical
Induction (T)
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
Exciting Apparent Power (VA/kg)
0.01
0.1
1
10

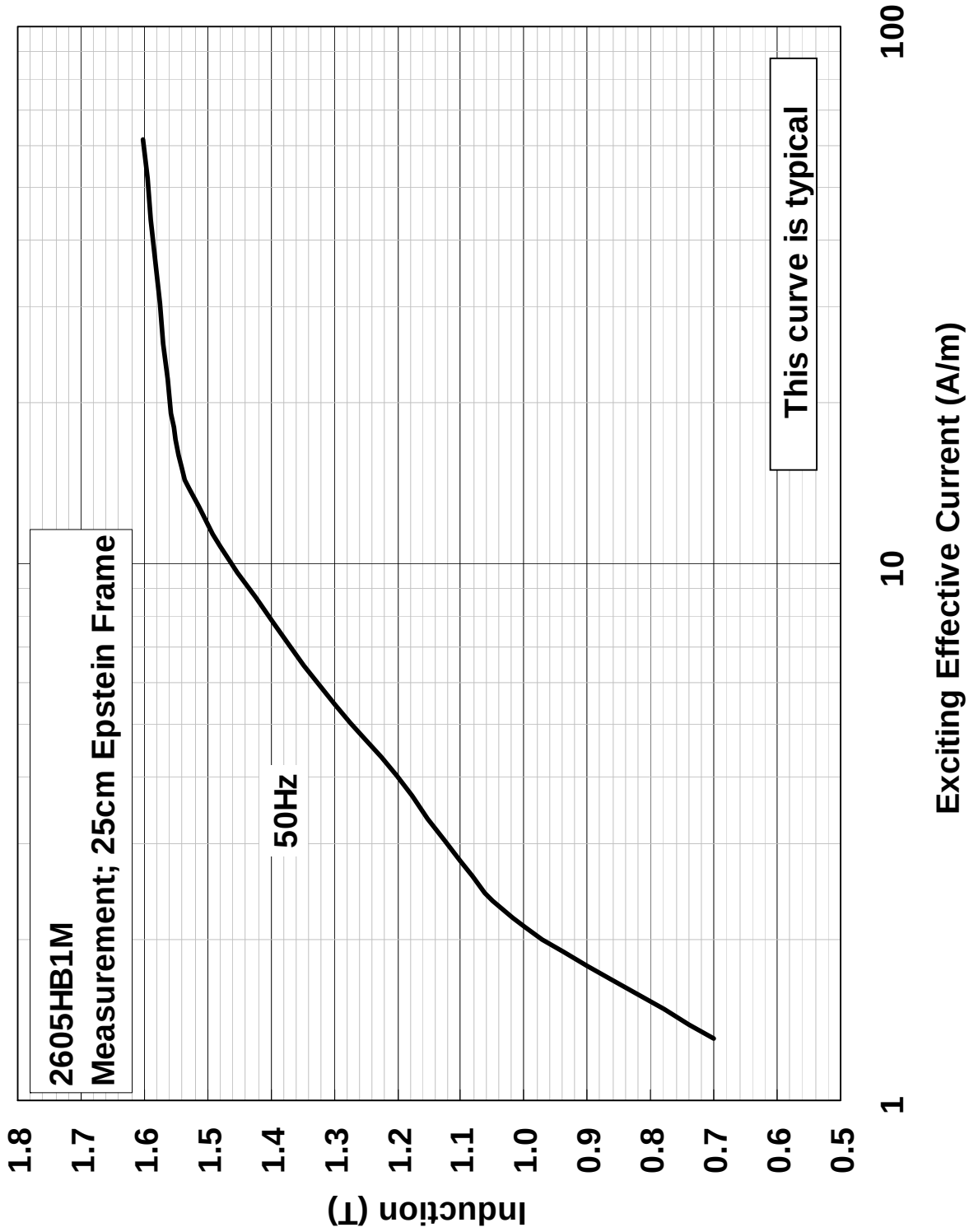

2605SA1
Measurement: 25 cm Epstein Frame
50 Hz
This curve is typical
Induction (T)
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
Exciting Effective Current (A/m)
1
10
100

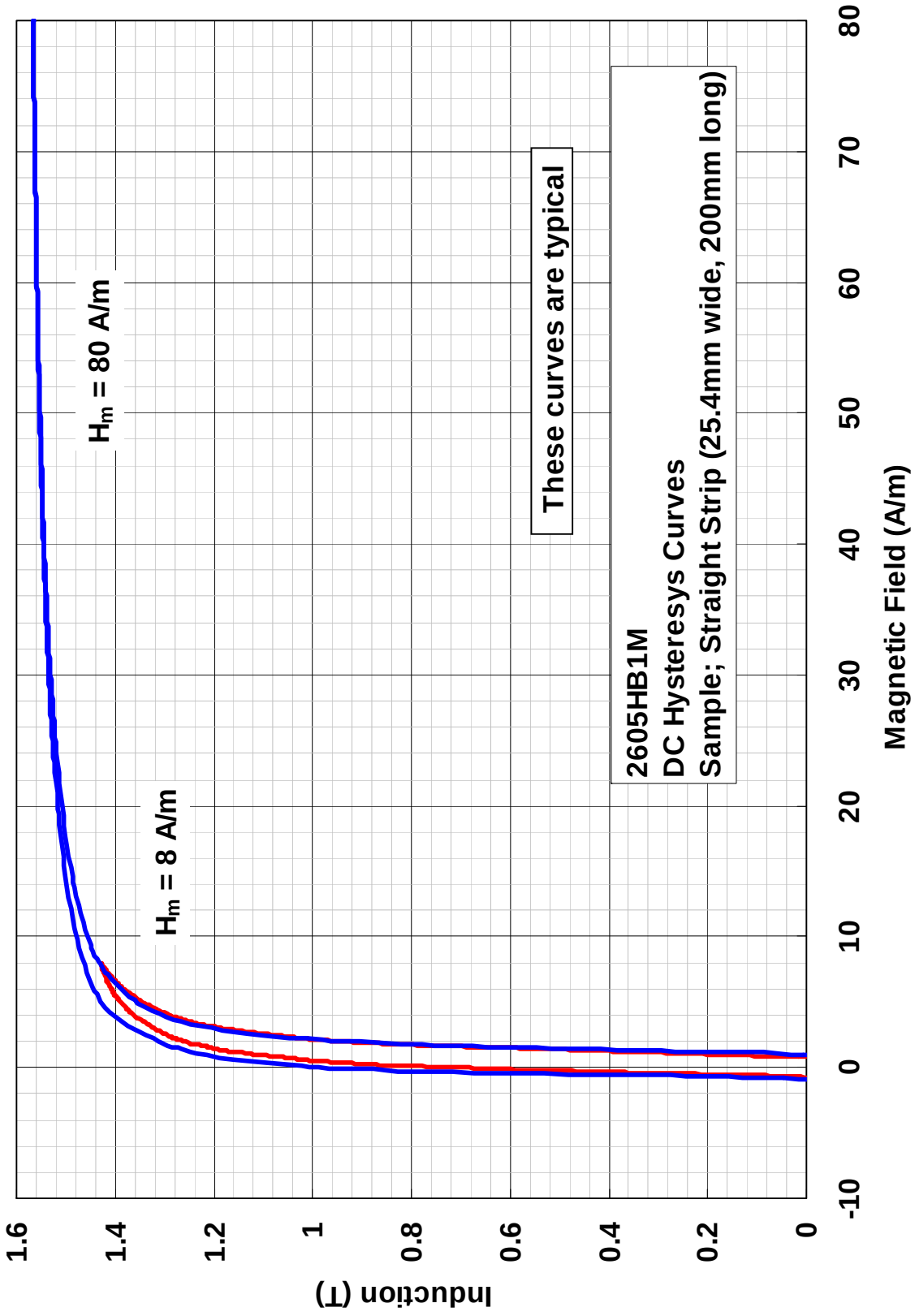

2605SA1
DC Hysteresis Curves
Sample;Straight Strip (25.4 mm Wide, 200 mm Long)
These curves are typical
H_m = 80 A/m
H_m = 8 A/m
Induction (T)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Magnetic Field (A/m)
80
70
60
50
40
30
20
10
0
-10

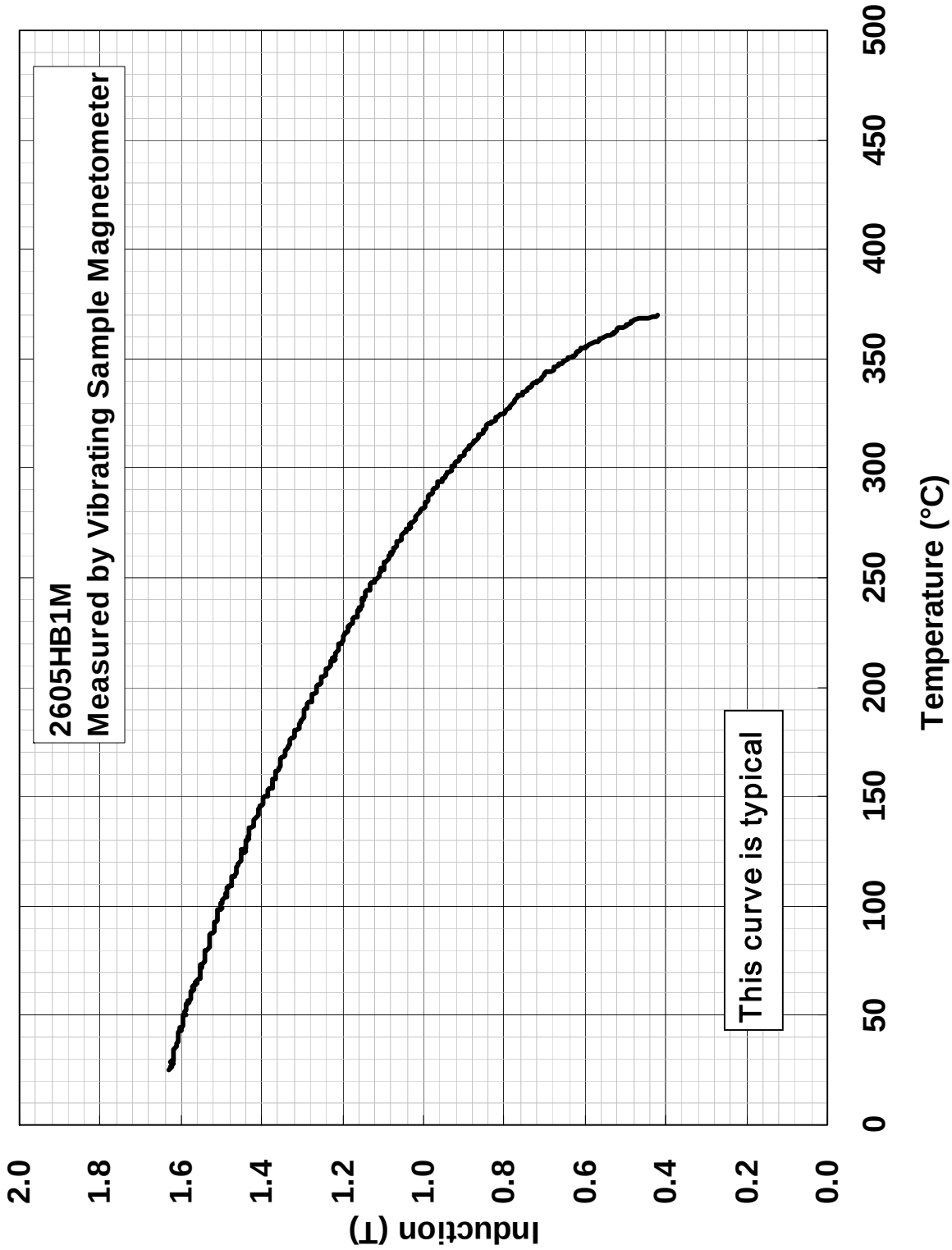

2605SA1
Measured by Vibrating Sample Magnetometer
This curve is typical
Induction (T)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Temperature (°C)
0
50
100
150
200
250
300
350
400
450
500


2605HB1M
Measurement; 25cm Epstein Frame
These curves are typical
60Hz
50Hz
Induction (T)
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
Core loss (W/kg)
1
0.1
0.01


2605HB1M
Measurement; 25cm Epstein Frame
These curves are typical
60Hz
50Hz
Induction (T)
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
Exciting Apparent Power (VA/kg)
0.01
0.1
1
10

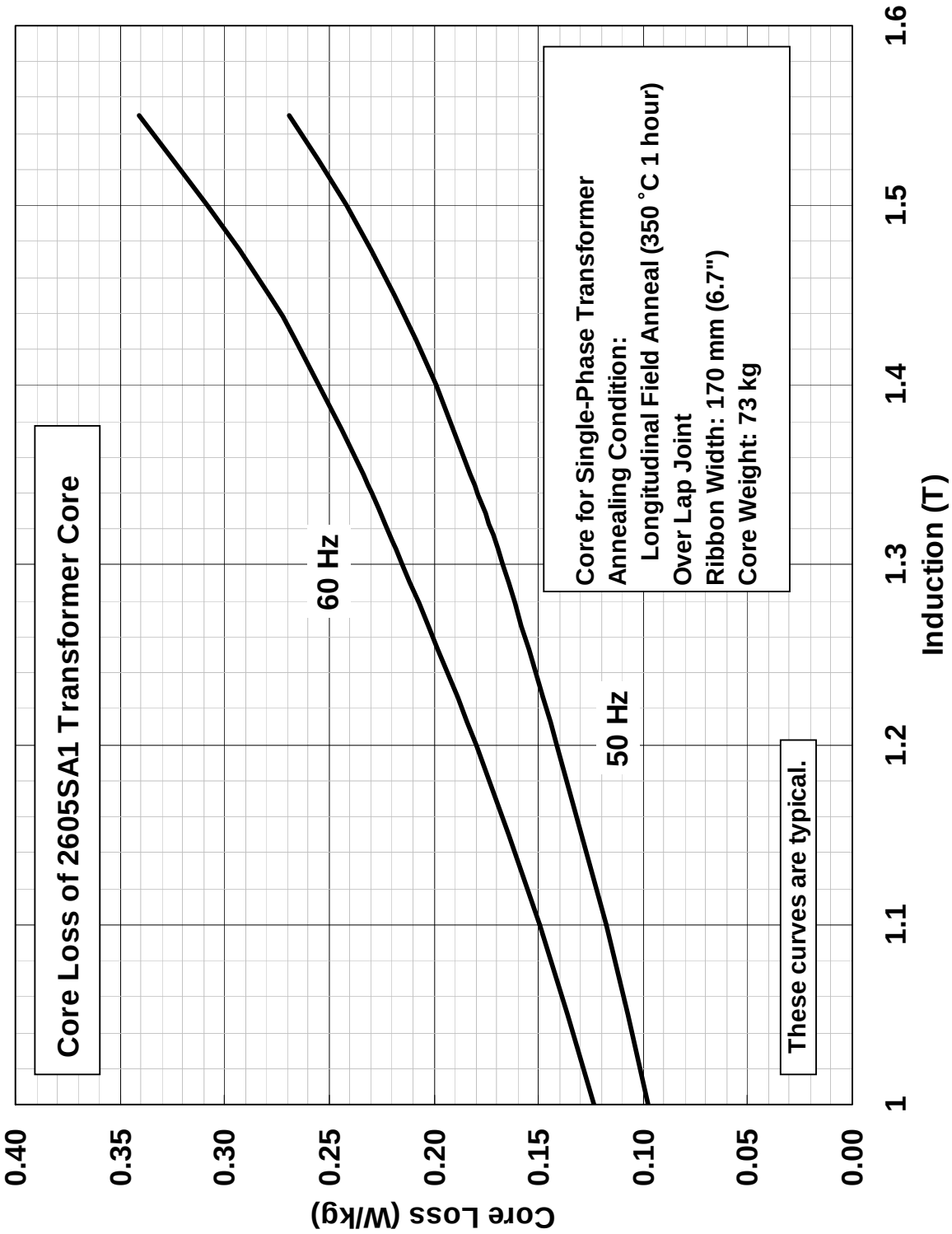

2605HB1M
Measurement; 25cm Epstein Frame
50Hz
This curve is typical
Induction (T)
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
Exciting Effective Current (A/m)
1
10
100

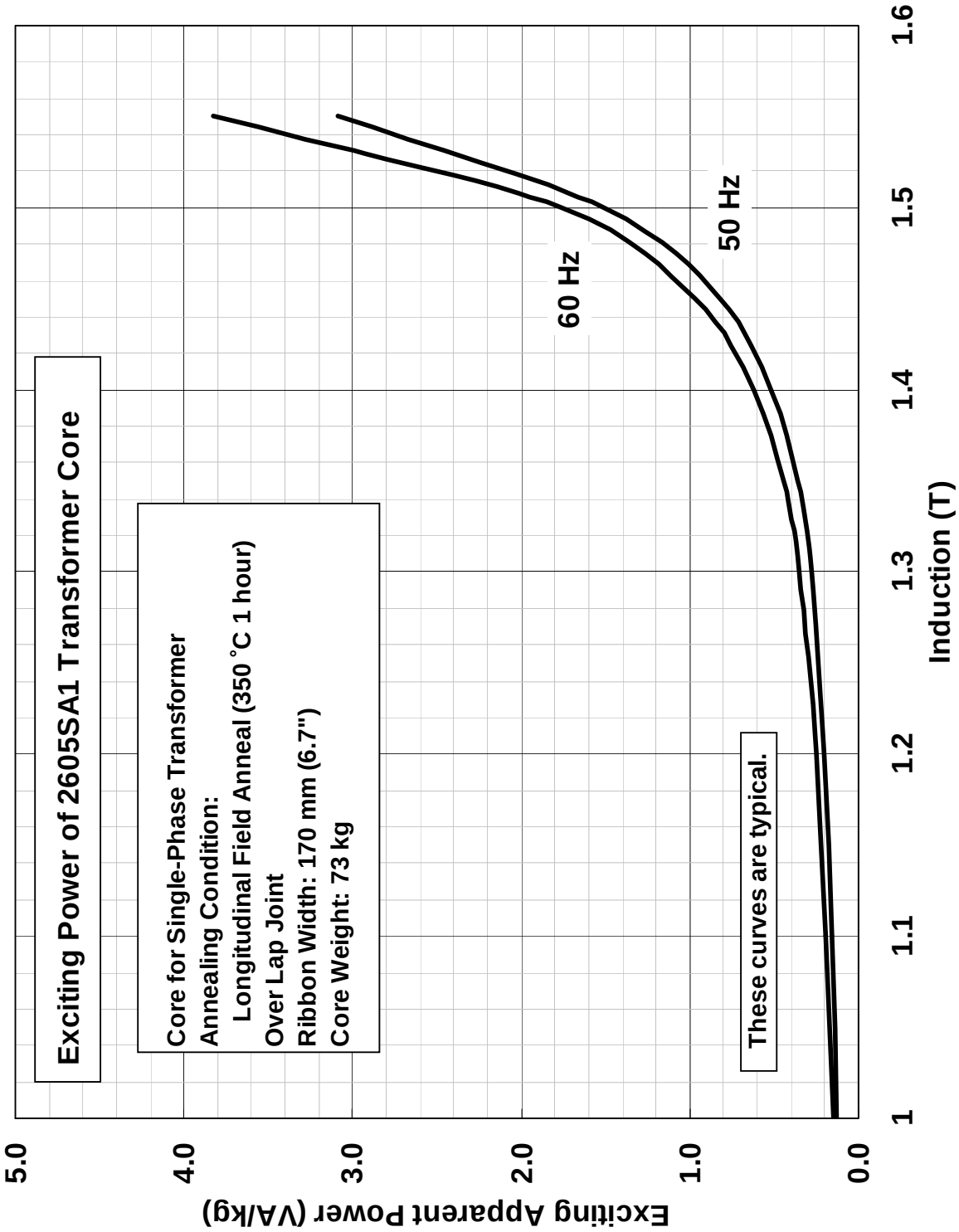

2605HB1M
DC Hysteresys Curves
Sample; Straight Strip (25.4mm wide, 200mm long)
These curves are typical
H_m = 80 A/m
H_m = 8 A/m
Induction (T)
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Magnetic Field (A/m)
80
70
60
50
40
30
20
10
0
-10

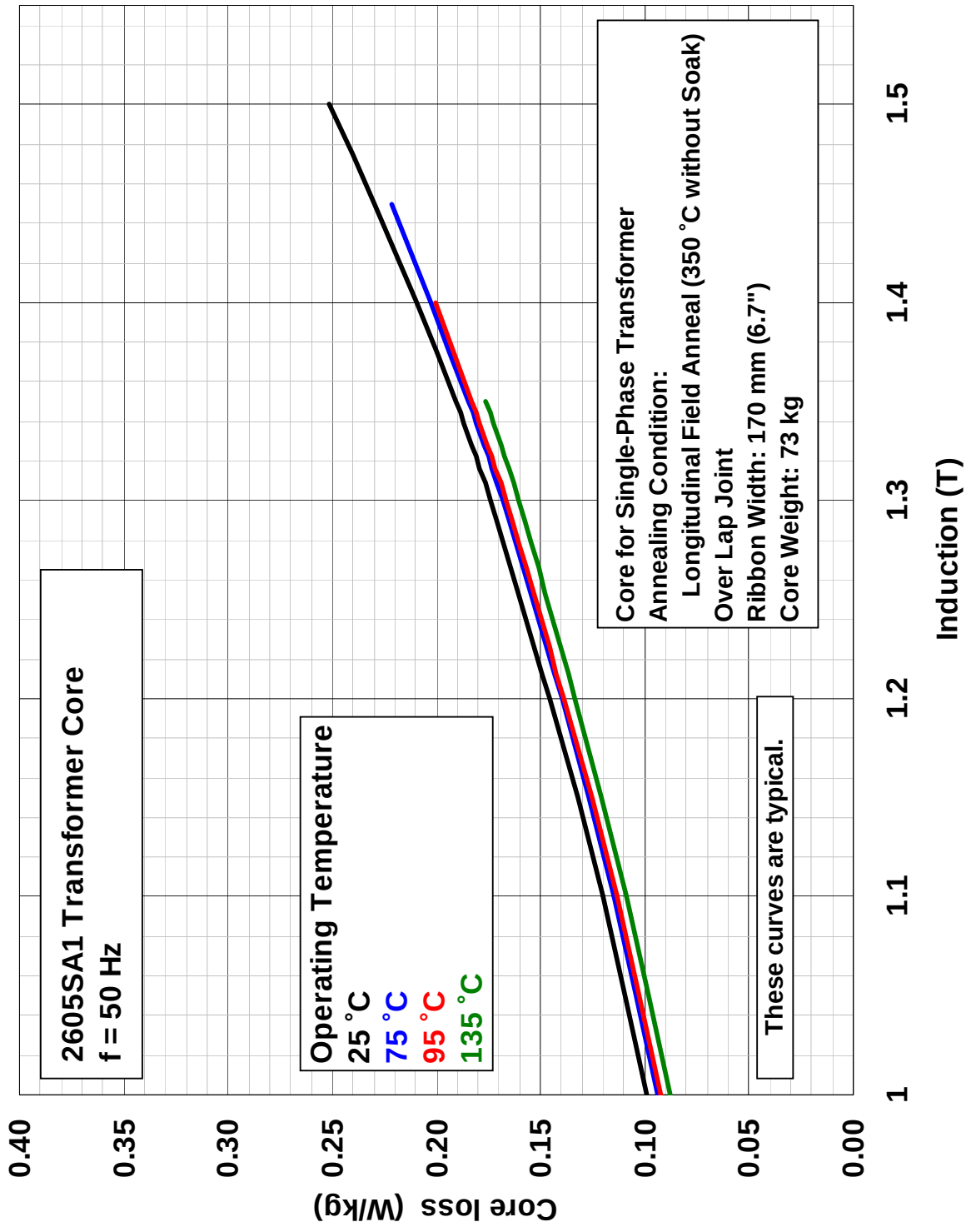

2605HB1M
Measured by Vibrating Sample Magnetometer
This curve is typical
Induction (T)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Temperature (°C)
0
50
100
150
200
250
300
350
400
450
500

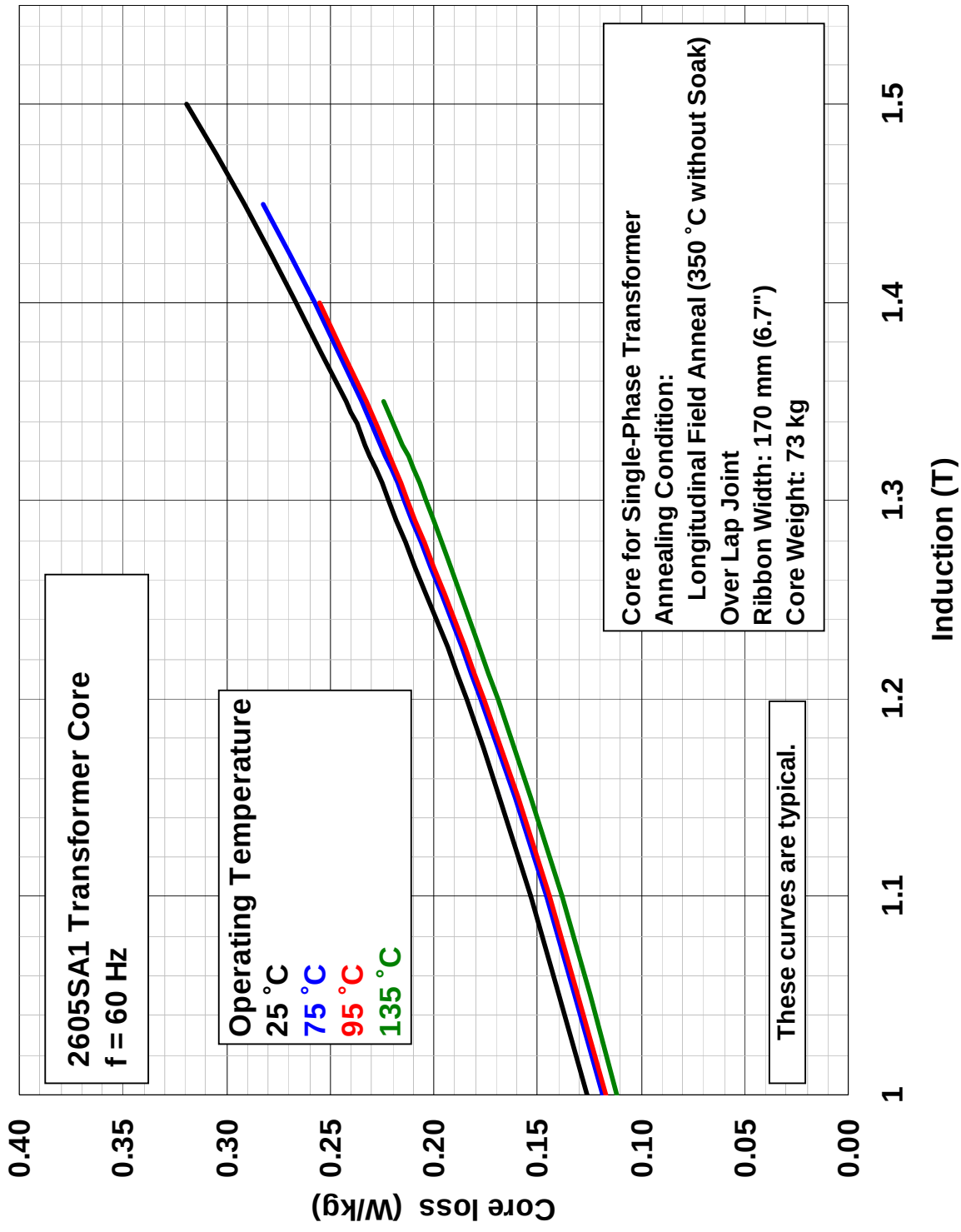
5. Typical Magnetic Properties of Transformer core

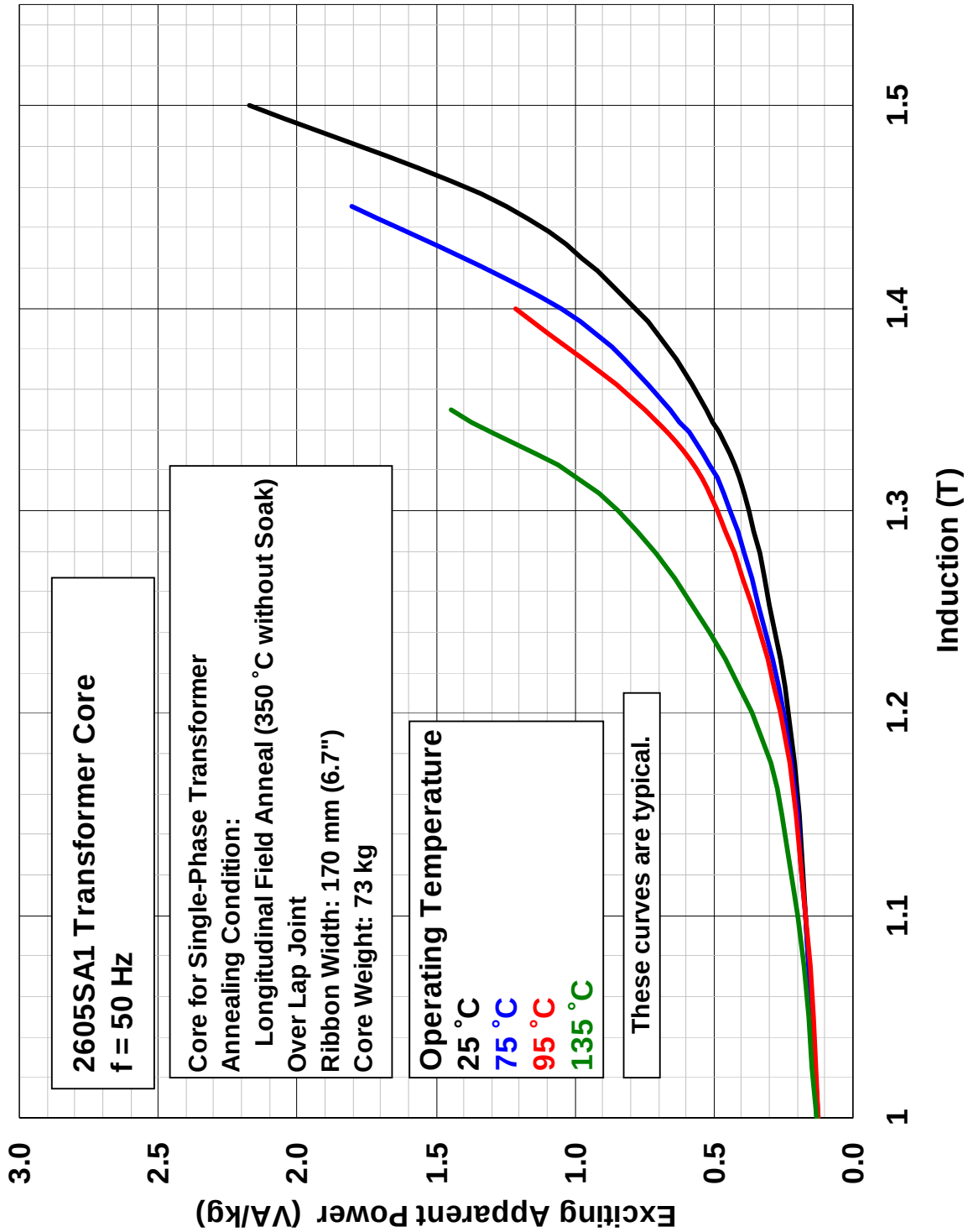
Some examples of the properties on 2605SA1 and 2605HB1M transformer cores are shown. They were annealed at 350°C for 1 hour for 2605SA1 core and at 320 °C for 1 hour for 2605HB1M core. These properties are not guaranteed.

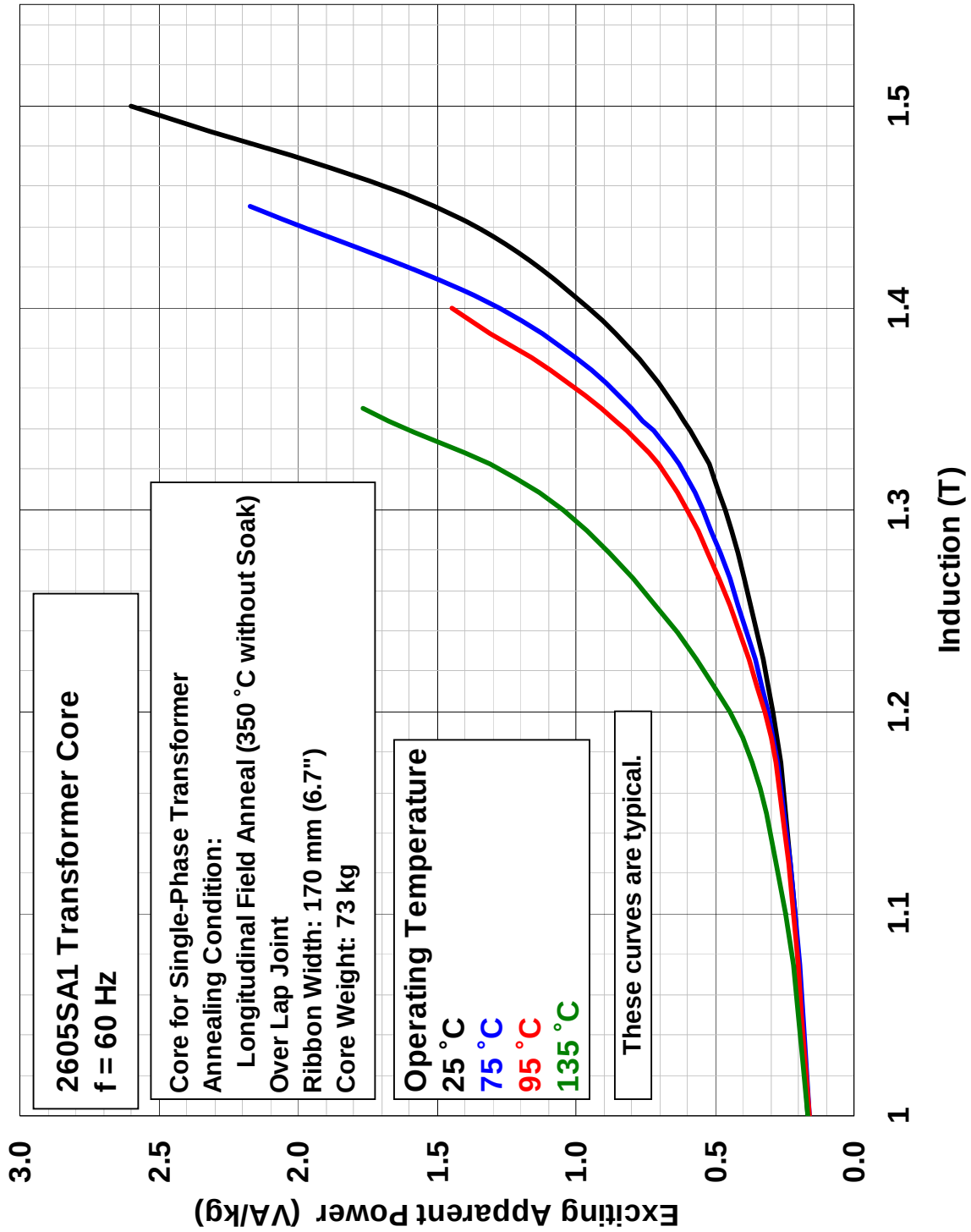


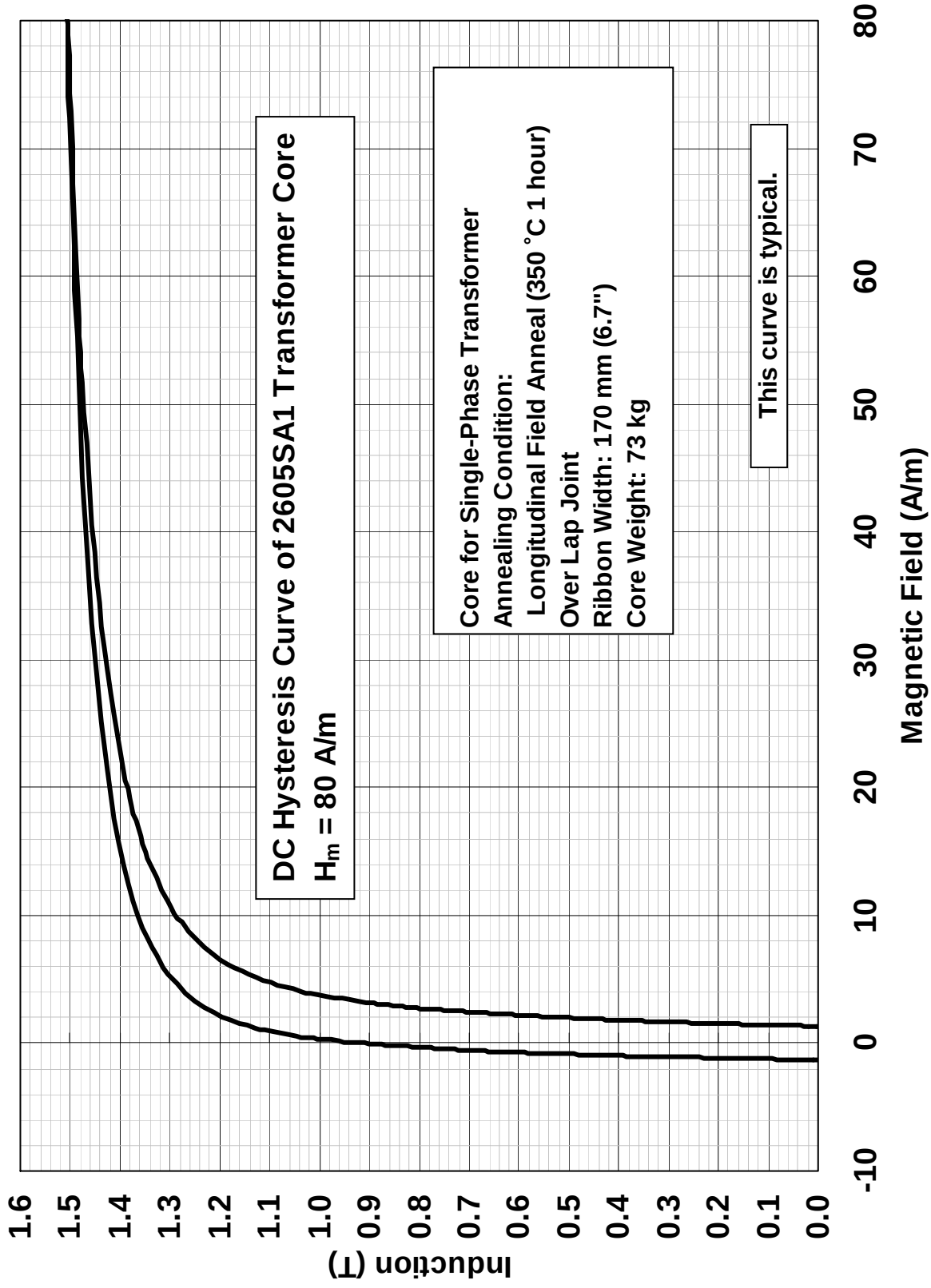

Exciting Power of 2605SA1 Transformer Core
Core for Single-Phase Transformer
Annealing Condition:
Longitudinal Field Anneal (350 °C 1 hour)
Over Lap Joint
Ribbon Width: 170 mm (6.7")
Core Weight: 73 kg
60 Hz
50 Hz
These curves are typical.
Exciting Apparent Power (VA/kg)
5.0
4.0
3.0
2.0
1.0
0.0
1
1.1
1.2
1.3
1.4
1.5
1.6
Induction (T)

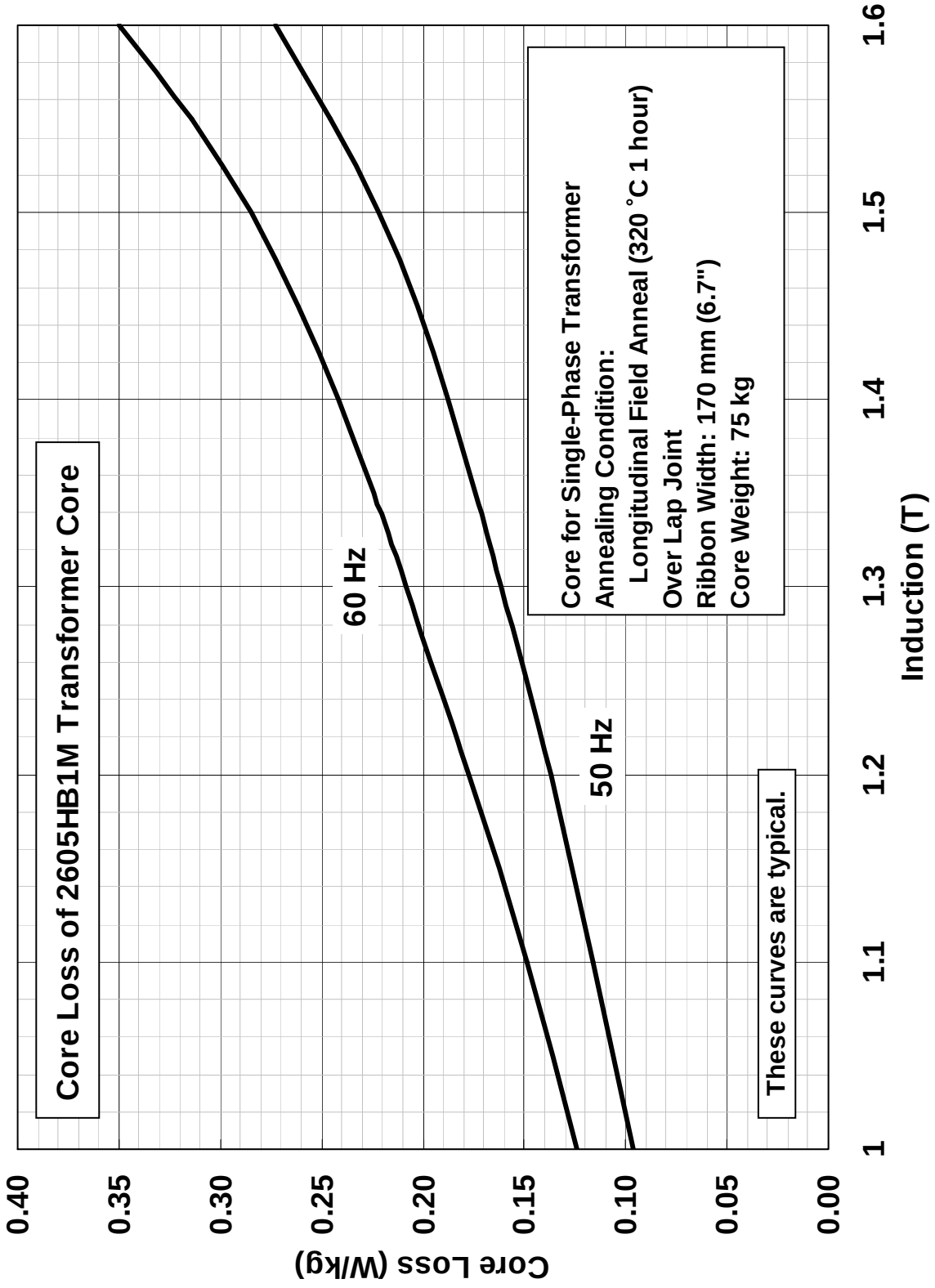

2605SA1 Transformer Core
f = 50 Hz
Operating Temperature
25 °C
75 °C
95 °C
135 °C
Core for Single-Phase Transformer
Annealing Condition:
Longitudinal Field Anneal (350 °C without Soak)
Over Lap Joint
Ribbon Width: 170 mm (6.7")
Core Weight: 73 kg
These curves are typical.
Core loss (W/kg)
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
1
1.1
1.2
1.3
1.4
1.5
Induction (T)

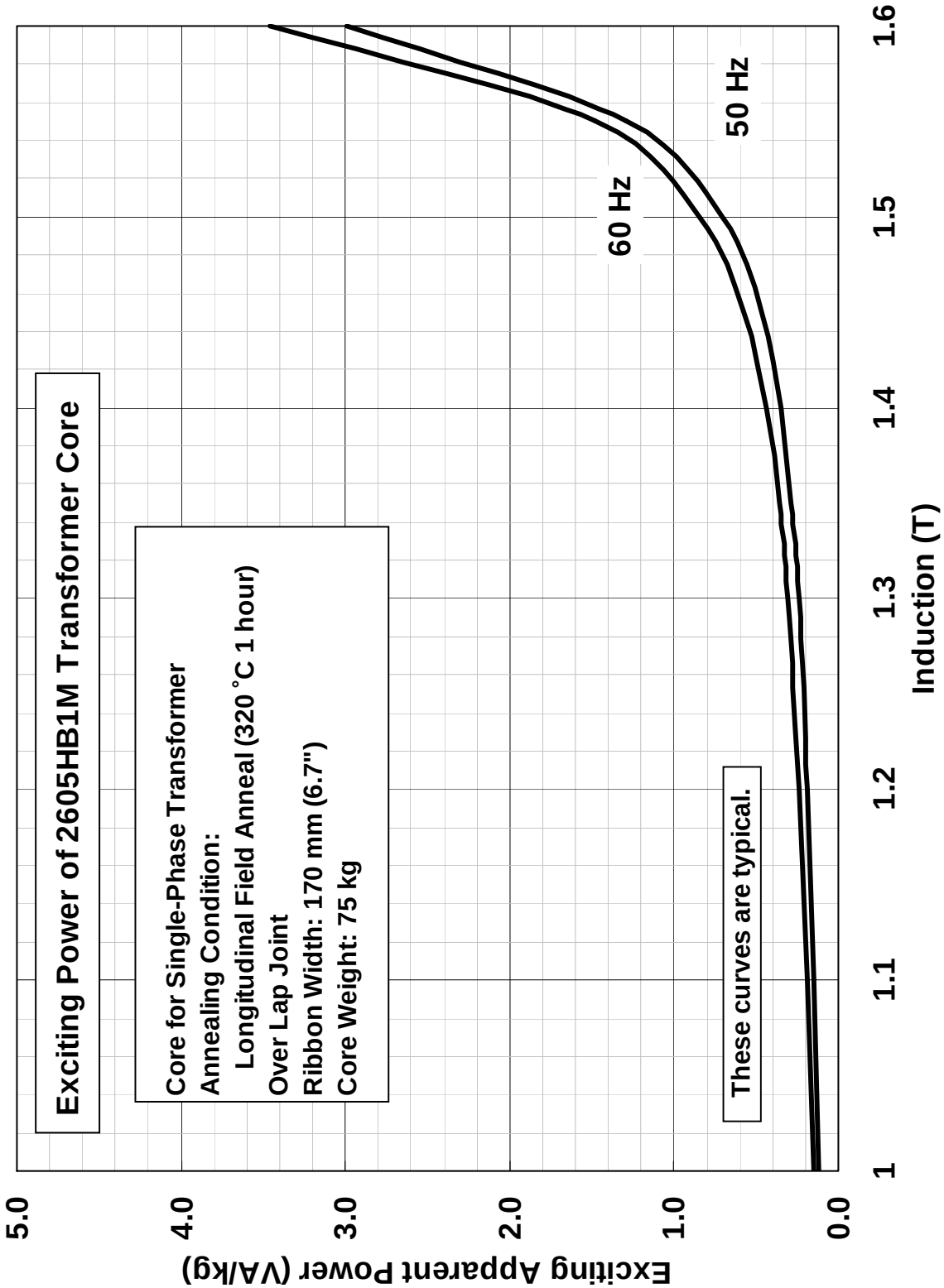

2605SA1 Transformer Core
f = 60 Hz
Operating Temperature
25 °C
75 °C
95 °C
135 °C
Core for Single-Phase Transformer
Annealing Condition:
Longitudinal Field Anneal (350 °C without Soak)
Over Lap Joint
Ribbon Width: 170 mm (6.7")
Core Weight: 73 kg
These curves are typical.
Core loss (W/kg)
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
1
1.1
1.2
1.3
1.4
1.5
Induction (T)

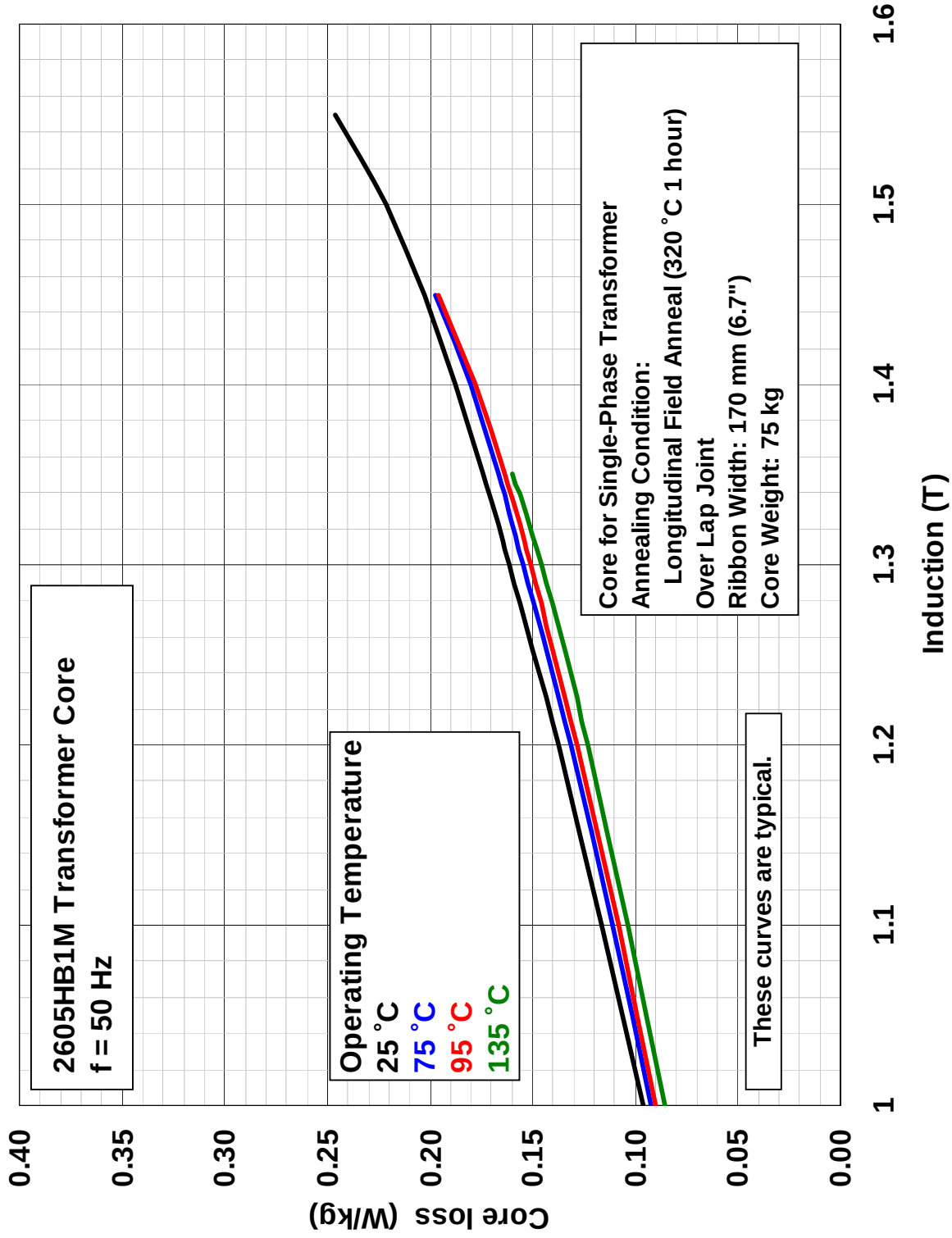

2605SA1 Transformer Core
f = 50 Hz
Core for Single-Phase Transformer
Annealing Condition:
Longitudinal Field Anneal (350 °C without Soak)
Over Lap Joint
Ribbon Width: 170 mm (6.7")
Core Weight: 73 kg
Operating Temperature
25 °C
75 °C
95 °C
135 °C
These curves are typical.
Exciting Apparent Power (VA/kg)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1
1.1
1.2
1.3
1.4
1.5
Induction (T)

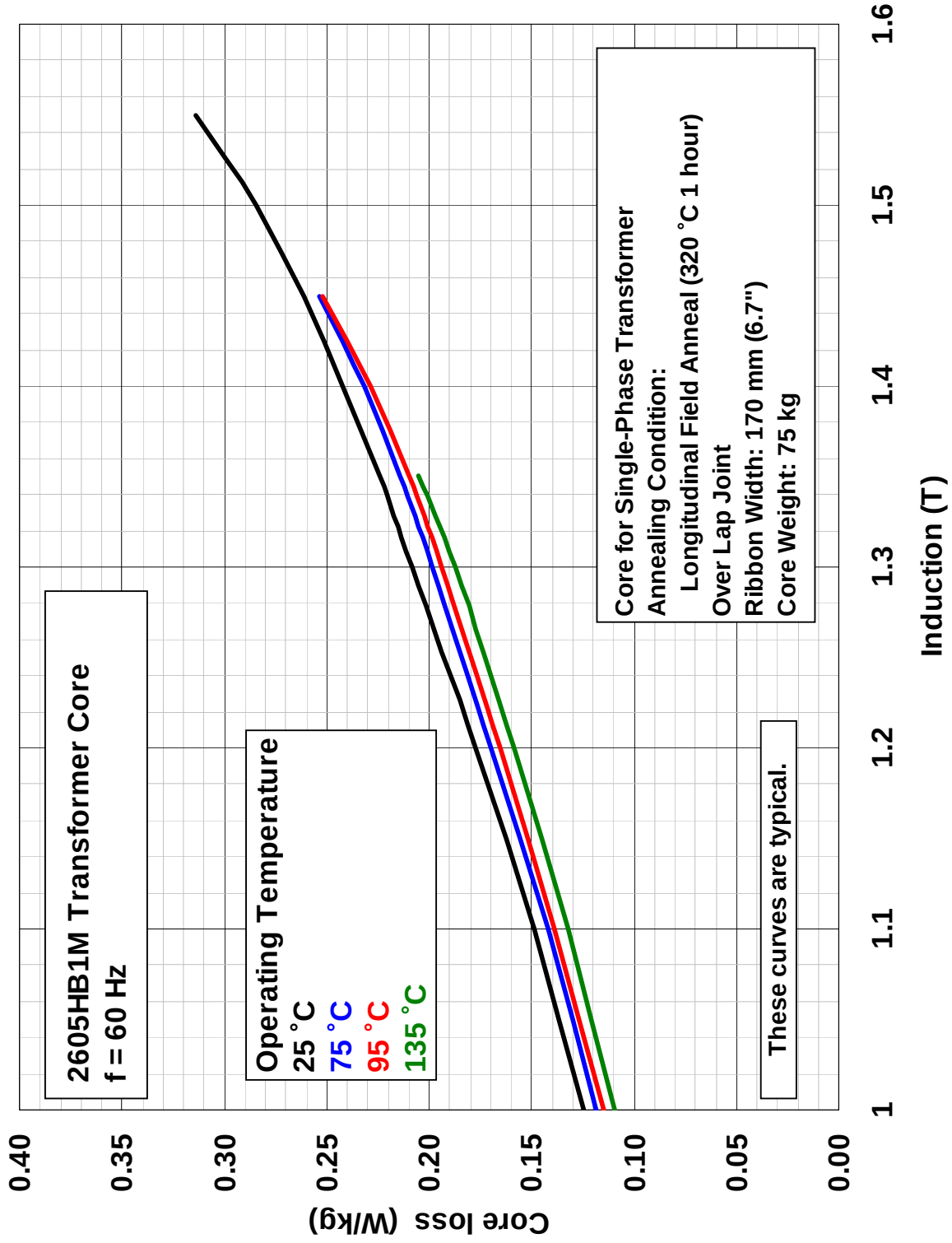

2605SA1 Transformer Core
f = 60 Hz
Core for Single-Phase Transformer
Annealing Condition:
Longitudinal Field Anneal (350 °C without Soak)
Over Lap Joint
Ribbon Width: 170 mm (6.7")
Core Weight: 73 kg
Operating Temperature
25 °C
75 °C
95 °C
135 °C
These curves are typical.
Exciting Apparent Power (VA/kg)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Induction (T)
1
1.1
1.2
1.3
1.4
1.5

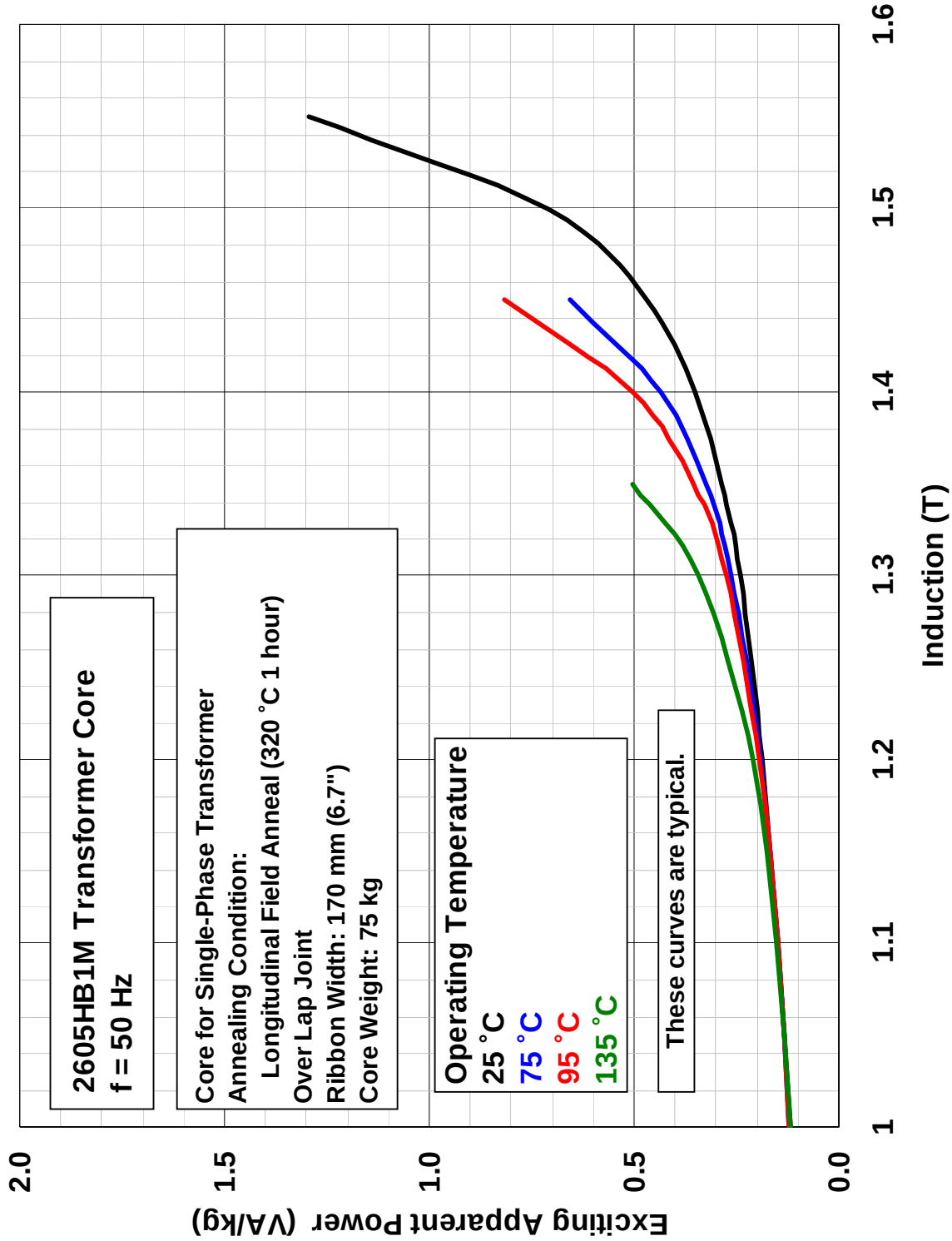

DC Hysteresis Curve of 2605SA1 Transformer Core
H_m = 80 A/m
Core for Single-Phase Transformer
Annealing Condition:
Longitudinal Field Anneal (350 °C 1 hour)
Over Lap Joint
Ribbon Width: 170 mm (6.7")
Core Weight: 73 kg
This curve is typical.
Induction (T)
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Magnetic Field (A/m)
-10
0
10
20
30
40
50
60
70
80

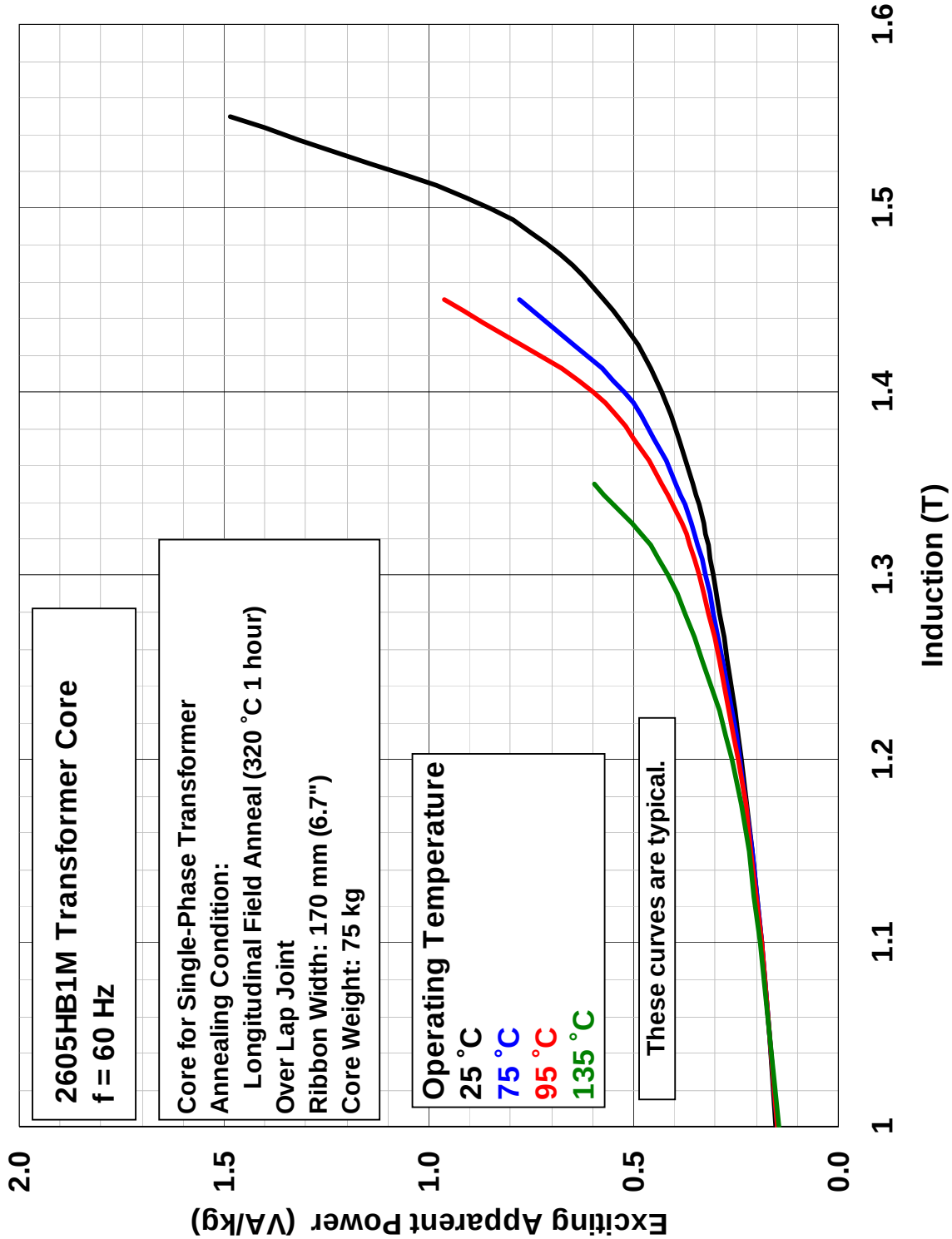

Core Loss of 2605HB1M Transformer Core
Core for Single-Phase Transformer
Annealing Condition:
Longitudinal Field Anneal (320 °C 1 hour)
Over Lap Joint
Ribbon Width: 170 mm (6.7")
Core Weight: 75 kg
60 Hz
50 Hz
These curves are typical.
Core Loss (W/kg)
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Induction (T)
1
1.1
1.2
1.3
1.4
1.5
1.6

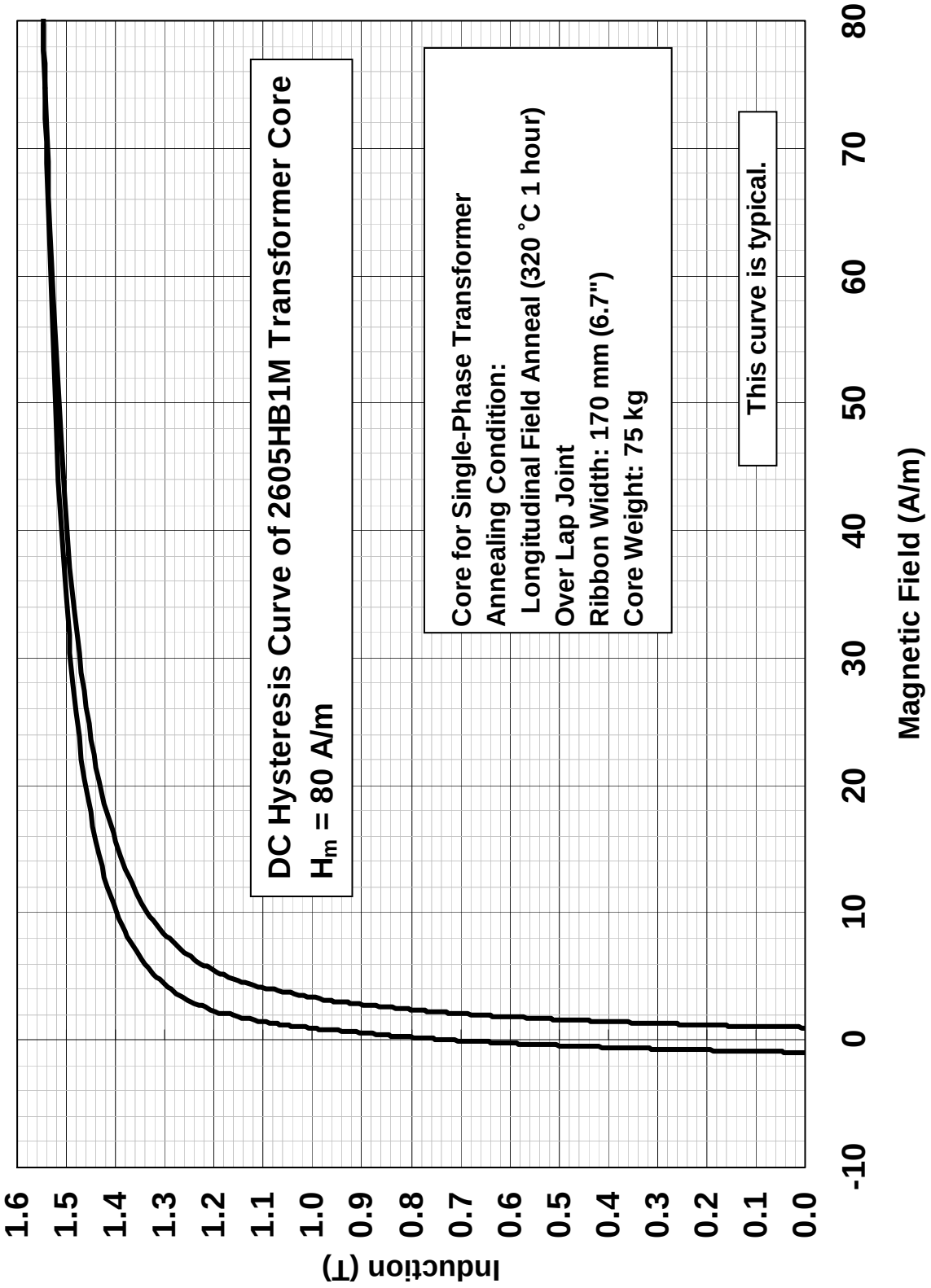

Exciting Power of 2605HB1M Transformer Core
Core for Single-Phase Transformer
Annealing Condition:
Longitudinal Field Anneal (320 °C 1 hour)
Over Lap Joint
Ribbon Width: 170 mm (6.7")
Core Weight: 75 kg
These curves are typical.
60 Hz
50 Hz
Exciting Apparent Power (VA/kg)
5.0
4.0
3.0
2.0
1.0
0.0
1
1.1
1.2
1.3
1.4
1.5
1.6
Induction (T)


2605HB1M Transformer Core
f = 50 Hz
Operating Temperature
25 °C
75 °C
95 °C
135 °C
Core for Single-Phase Transformer
Annealing Condition:
Longitudinal Field Anneal (320 °C 1 hour)
Over Lap Joint
Ribbon Width: 170 mm (6.7")
Core Weight: 75 kg
These curves are typical.
Core loss (W/kg)
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Induction (T)
1
1.1
1.2
1.3
1.4
1.5
1.6


2605HB1M Transformer Core
f = 60 Hz
Operating Temperature
25 °C
75 °C
95 °C
135 °C
Core for Single-Phase Transformer
Annealing Condition:
Longitudinal Field Anneal (320 °C 1 hour)
Over Lap Joint
Ribbon Width: 170 mm (6.7")
Core Weight: 75 kg
These curves are typical.
Core loss (W/kg)
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Induction (T)
1
1.1
1.2
1.3
1.4
1.5
1.6


2605HB1M Transformer Core
f = 50 Hz
Core for Single-Phase Transformer
Annealing Condition:
Longitudinal Field Anneal (320 °C 1 hour)
Over Lap Joint
Ribbon Width: 170 mm (6.7")
Core Weight: 75 kg
Operating Temperature
25 °C
75 °C
95 °C
135 °C
These curves are typical.
Exciting Apparent Power (VA/kg)
2.0
1.5
1.0
0.5
0.0
1
1.1
1.2
1.3
1.4
1.5
1.6
Induction (T)


2605HB1M Transformer Core
f = 60 Hz
Core for Single-Phase Transformer
Annealing Condition:
Longitudinal Field Anneal (320 °C 1 hour)
Over Lap Joint
Ribbon Width: 170 mm (6.7")
Core Weight: 75 kg
Operating Temperature
25 °C
75 °C
95 °C
135 °C
These curves are typical.
Exciting Apparent Power (VA/kg)
2.0
1.5
1.0
0.5
0.0
1
1.1
1.2
1.3
1.4
1.5
1.6
Induction (T)


DC Hysteresis Curve of 2605HB1M Transformer Core
H_m = 80 A/m
Core for Single-Phase Transformer
Annealing Condition:
Longitudinal Field Anneal (320 °C 1 hour)
Over Lap Joint
Ribbon Width: 170 mm (6.7")
Core Weight: 75 kg
This curve is typical.
Induction (T)
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Magnetic Field (A/m)
-10
0
10
20
30
40
50
60
70
80