



AEROSPACE INFORMATION REPORT

SOCIETY OF AUTOMOTIVE ENGINEERS, Inc.

485 Lexington Ave., New York, N. Y. 10017

AIR 944

Issued 9-15-66

Revised

PNEUMATIC POWER SUPPLIES FOR STARTING AIRCRAFT

1. PURPOSE - This report is intended to provide a cross section of pneumatic power supplies available for starting aircraft engines. These descriptions are intended for general use by the aircraft and airline industries in design and utilization of modern gas turbine-powered aircraft.
2. SCOPE - The information contained in this report has been simplified to facilitate its use. Specific manufacturers should be contacted for more detailed information. Many of the basic power plants are available in numerous configurations to provide shaft power or electrical power in addition to the pneumatic capability. Vehicles for the ground transportation of the power supplies are also varied to fit specific requirements. The state-of-the-art in small gas turbines has advanced to a point where they are competitive with the more conventional ground power supplies in practically all areas.
3. MANUFACTURERS - The manufacturers listed in this report are included for reference but do not necessarily represent all sources in this field.
4. CLASSIFICATION OF POWER SUPPLIES
 - 4.1 Dynamic - This type of power supply is a true prime mover and can furnish pneumatic power continuously for unlimited periods of time. They are used to support the low-pressure (40 - 70 psia) air turbine starters. Several basic configurations are in use. The majority are either gas turbine bleed, gas turbine-driven compressor, or reciprocating engine-driven compressor.
 - 4.2 Inert or Static - This type of power supply may or may not contain a prime mover, depending on the vehicle configuration. The common feature is stored air compressed to various pressures and expanded to perform the aircraft starting function or recharge pneumatic storage volumes on board the airframe. Units of this type are being used to support the low-pressure (40 - 70 psia) air turbine starters, for impingement starting and the high-pressure fuel air combustion starting systems. Air is stored at pressures up to 5000 psi in steel bottles. In the air turbine starter system, this air is expanded, reheated, and applied directly through control valves to the starter motor. In the combustion starter system, the high-pressure air is transferred from the portable power unit to the airborne storage system at the high pressure. The actual start is performed by use of the airborne bottle system.
5. DISCUSSION - The power unit characteristics drastically affect the engine starts obtained with the system. Uncontrolled pressure variations or pulsations can cause severe mechanical problems in the airborne equipment. The air temperature and pressure maintained during the starter operation determine the torque output and the shape of the starter torque curve as the engine acceleration takes place. Matching of the motor to the air source is necessary in many cases to ensure acceptable performance from the starting system. A detailed analysis of main engine starting characteristics, duct losses (both temperature and pressure), variations of support equipment performance with ambient temperature, and airframe engine limitations must be completed before an accurate prediction of the actual starting system performance can be made. Studies of this type can easily be completed by the various starter manufacturers. It is suggested that problem statements be forwarded to them when the need arises.
6. DETAILED DATA - Appendix 1 contains generalized information on a cross section of available pneumatic power supplies. Performance data given are exclusive of hose losses.
7. SUGGESTED USE - The data contained herein have been verified by individual manufacturers, where possible, and are believed to be accurate insofar as they are represented. The individual manufacturers should be contacted to obtain further data.

PREPARED BY SUBCOMMITTEE AE-6D, TURBINE STARTING SYSTEMS,
OF SAE COMMITTEE AE-6, STARTING SYSTEMS

INDEX OF EQUIPMENT

A. POWER-LIMITED EQUIPMENT

<u>Manufacturer</u>	<u>Model Number</u>	<u>Description</u>	<u>Performance Curves</u>	
		<u>Page</u>	<u>Page</u>	<u>Figure</u>
AiResearch	GTCP-30 Series	3	4, 5	1, 2
	GTCP-36 Series	6	7	3
	GTC-85 Series	8	9	4
	GTCP-85 Series	10	11, 12	5, 6
	GTCP-105 Series	13	14, 15	7, 8
Boeing	502-12B (Trailer)	16	18	9
	502-12B (Truck)	17	18	9
Continental	TC-106	19	20	10
Greer Hydraulics	AC-1-A	22	23	11
	AC-1-B	22	23	11
	AC-1-C	22	23	11
	AC-2-A	24	25	12
	AC-2-B	24	25	12
	AC-2-C	24	25	12
	ACE	21		
	ACSE-2004	26	27	13
Ingersoll-Rand	200 DH 165	28	30	15
	200 GH 165	28	29	14
	200 EH 165	31		

B. CAPACITY LIMITED EQUIPMENT

Avco Corp.	AS-1B	32	33	16
	NPSU-1	34	35	17
	NPSU-1 (Revised)	36	37	18
Wells Mfg. Co.	59A 122	38		

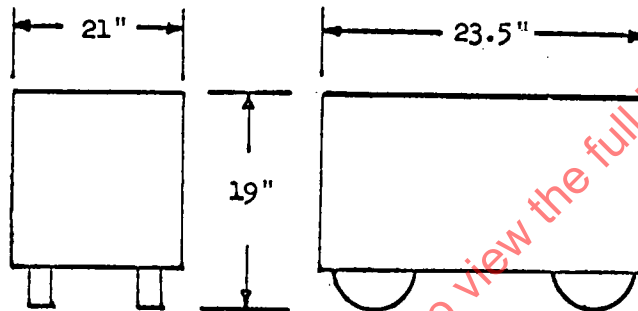
PNEUMATIC STARTER AIR SUPPLY
(Power Limited)

Manufacturer AiResearch Manufacturing Co.

Model Number GTCP-30 Series

Description

- a) type of compressor Single-stage radial outflow
- b) type of prime mover Single-stage radial inflow gas turbine
- c) type of fuel MIL-J-5624, Grades JP-4 and JP-5,
MIL-G-5572
- d) package dimensions and type Aircraft, automotive, etc.



- e) delivery hose; type, length

Rated Output at Compressor Delivery Connection

a) guaranteed performance	60°F, Sea Level Day	
	With zero shaft HP	With 20 shaft HP
Pressure, psig	<u>23.3</u>	26
Air Flow, lb/min	<u>28.5</u>	22
Air Temperature, °F	<u>385</u>	385
Zero Bleed Shaft HP	40	

MANUFACTURER: AiResearch

MODEL:GTCP30 Series

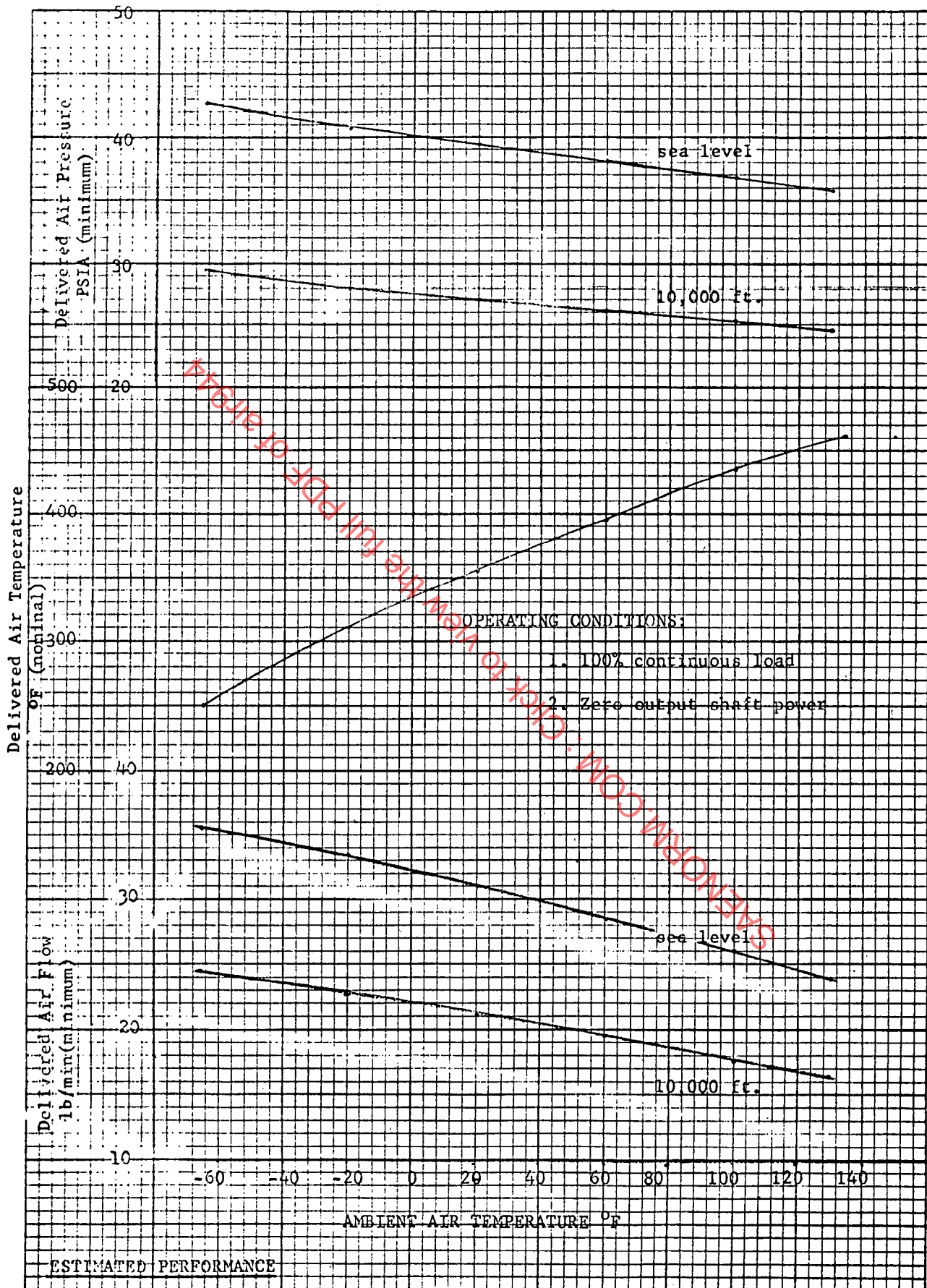


Figure 1

MANUFACTURER: AiResearch

MODEL: GTCP 30 Series

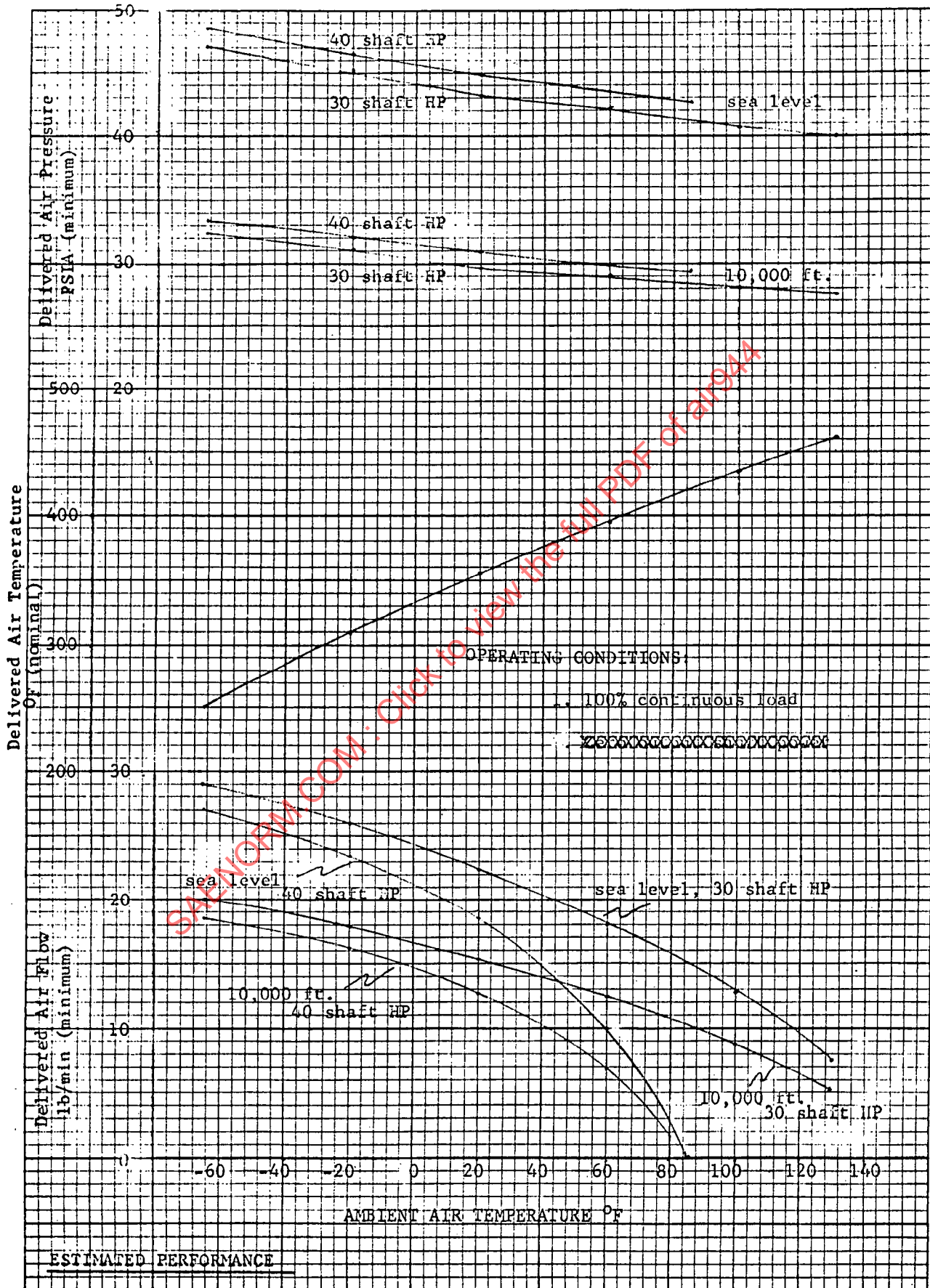


Figure 2

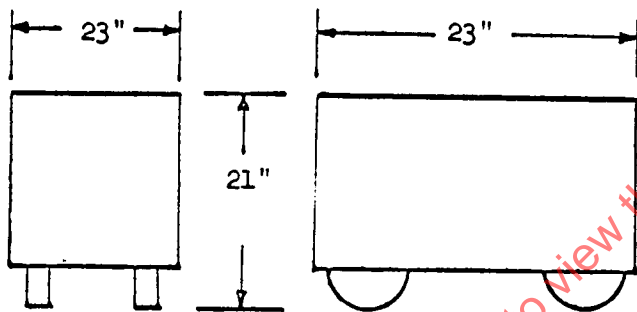
PNEUMATIC STARTER AIR SUPPLY
(Power Limited)

Manufacturer AiResearch Manufacturing Co.

Model Number GTCP-36 Series

Description

- a) type of compressor Single-stage radial outflow 4:1 press. ratio
- b) type of prime mover Single-stage radial inflow gas turbine
- c) type of fuel MIL-J-5624, JP-4 and JP-5, MIL-G-5572
D1655-61T, A, B, A-1
- d) package dimensions and type APU



- e) delivery hose; type, length

Rated Output at Compressor Delivery Connection

- a) guaranteed performance 60°F, Sea Level Day
With 10 shaft HP
- | | |
|---------------------|-------------|
| Pressure, psig | <u>29.7</u> |
| Air Flow, lb/min | <u>60</u> |
| Air Temperature, °F | <u>390</u> |

MANUFACTURER: AiResearch

MODEL: GTCP 36 Series

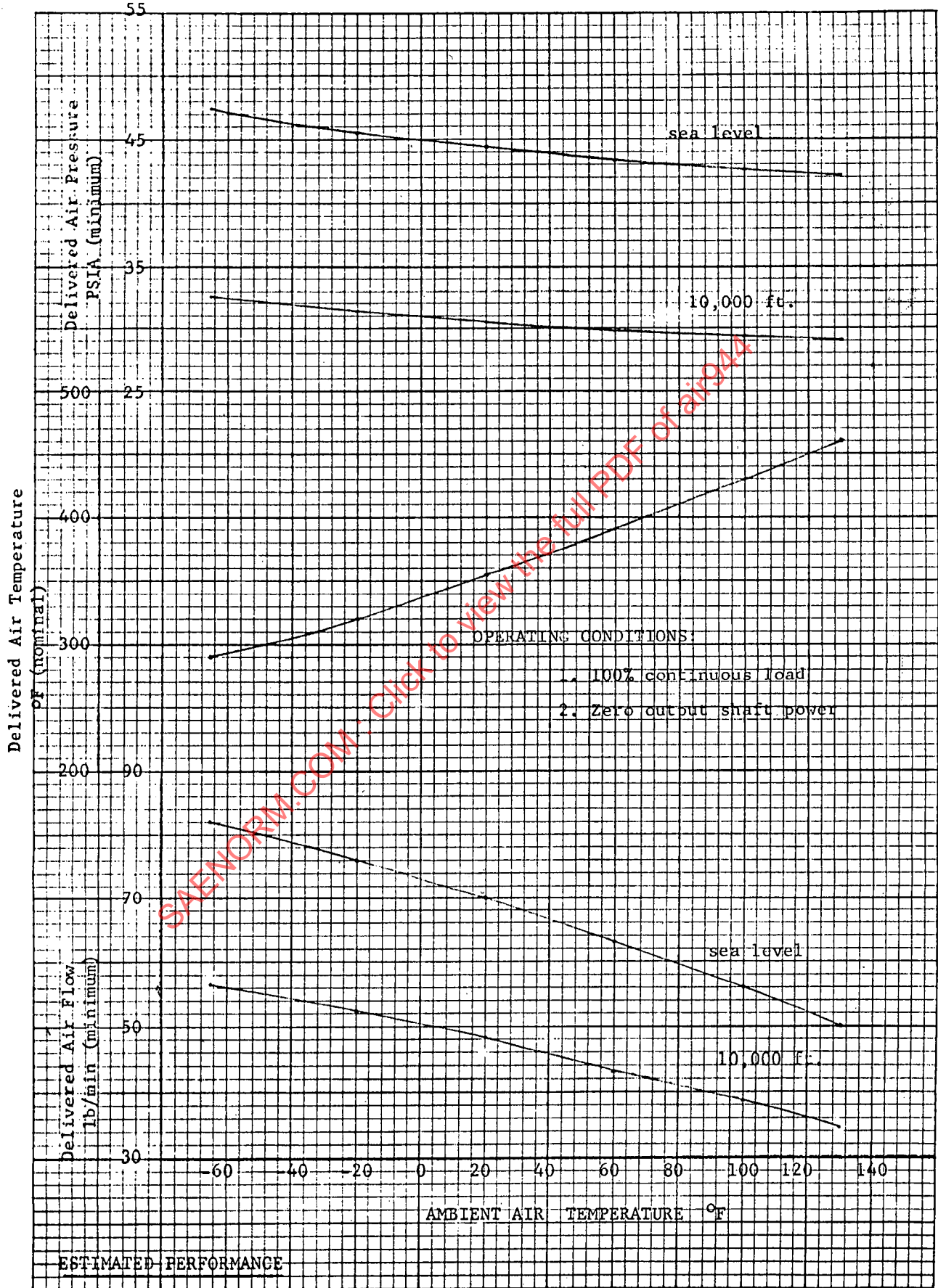


Figure 3

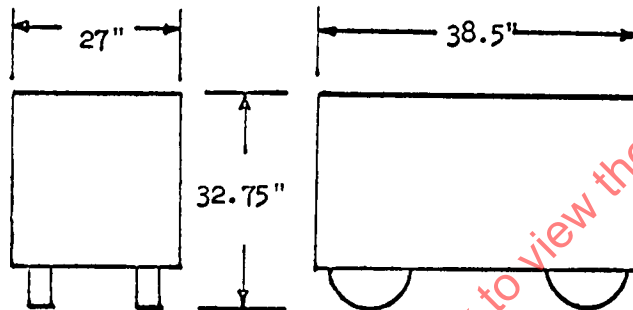
PNEUMATIC STARTER AIR SUPPLY
(Power Limited)

Manufacturer AiResearch Manufacturing Co.

Model Number GTC-85 Series

Description

- a) type of compressor Two-stage radial outflow
- b) type of prime mover Single-stage radial inflow gas turbine
- c) type of fuel MIL-J-5624, Grades JP-3, JP-4, and JP-5
MIL-G-5572, Shell 640 (kerosene)
- d) package dimensions and type Truck, trailer, jeep, and aircraft



- e) delivery hose; type, length

Rated Output at Compressor Delivery Connection

- a) guaranteed performance 60°F, Sea Level Day
- | | |
|---------------------|-------------|
| Pressure, psig | <u>35.5</u> |
| Air Flow, lb/min | <u>150</u> |
| Air Temperature, °F | <u>410</u> |

MANUFACTURER: AiResearch

MODEL: GTC85 Series

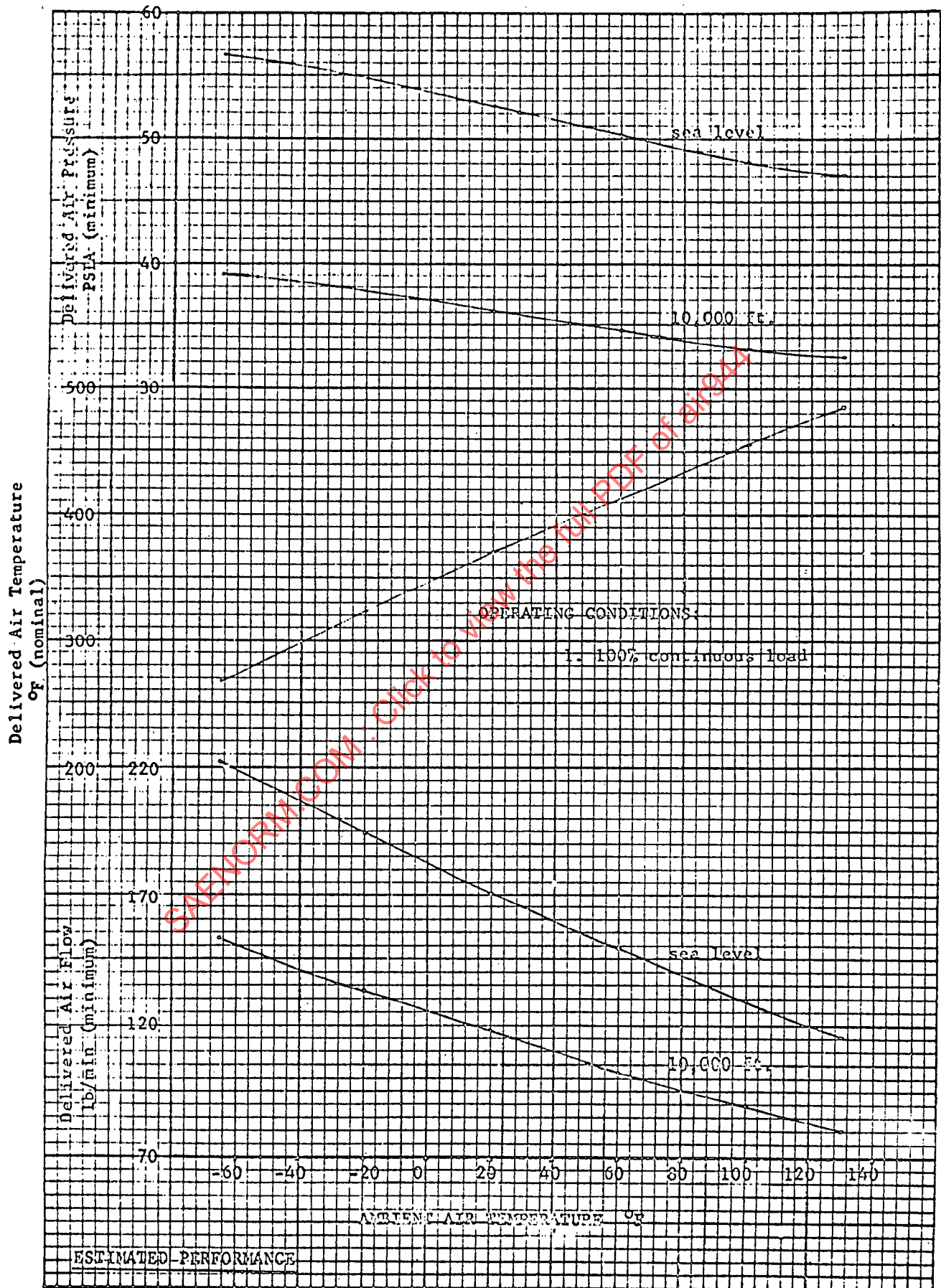


Figure 4

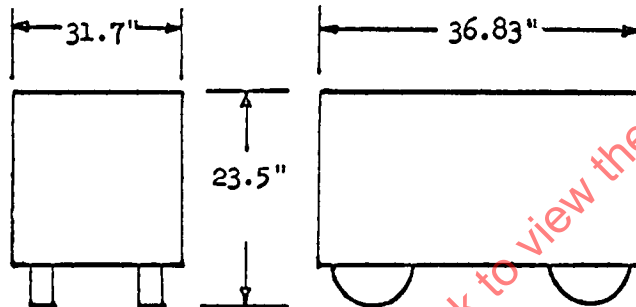
PNEUMATIC STARTER AIR SUPPLY
(Power Limited)

Manufacturer AiResearch Manufacturing Co.

Model Number GTCP-85 Series

Description

- a) type of compressor Two-stage radial outflow
- b) type of prime mover Single-stage radial inflow gas turbine
- c) type of fuel MIL-J-5624, Grades JP-3, JP-4, or JP-5
MIL-G-5572, Shell 640 (kerosene)
- d) package dimensions and type Truck, trailer, jeep, and aircraft



- e) delivery hose; type, length

Rated Output at Compressor Delivery Connection

a) guaranteed performance	60°F, Sea Level Day With zero shaft HP	With 100 shaft HP
Pressure, psig	<u>37.5</u>	42.3
Air Flow, lb/min	<u>144</u>	110
Air Temperature, °F	<u>408</u>	420
Zero Bleed Shaft HP	200	

MANUFACTURER: AiResearch

MODEL: GTCP85 Series

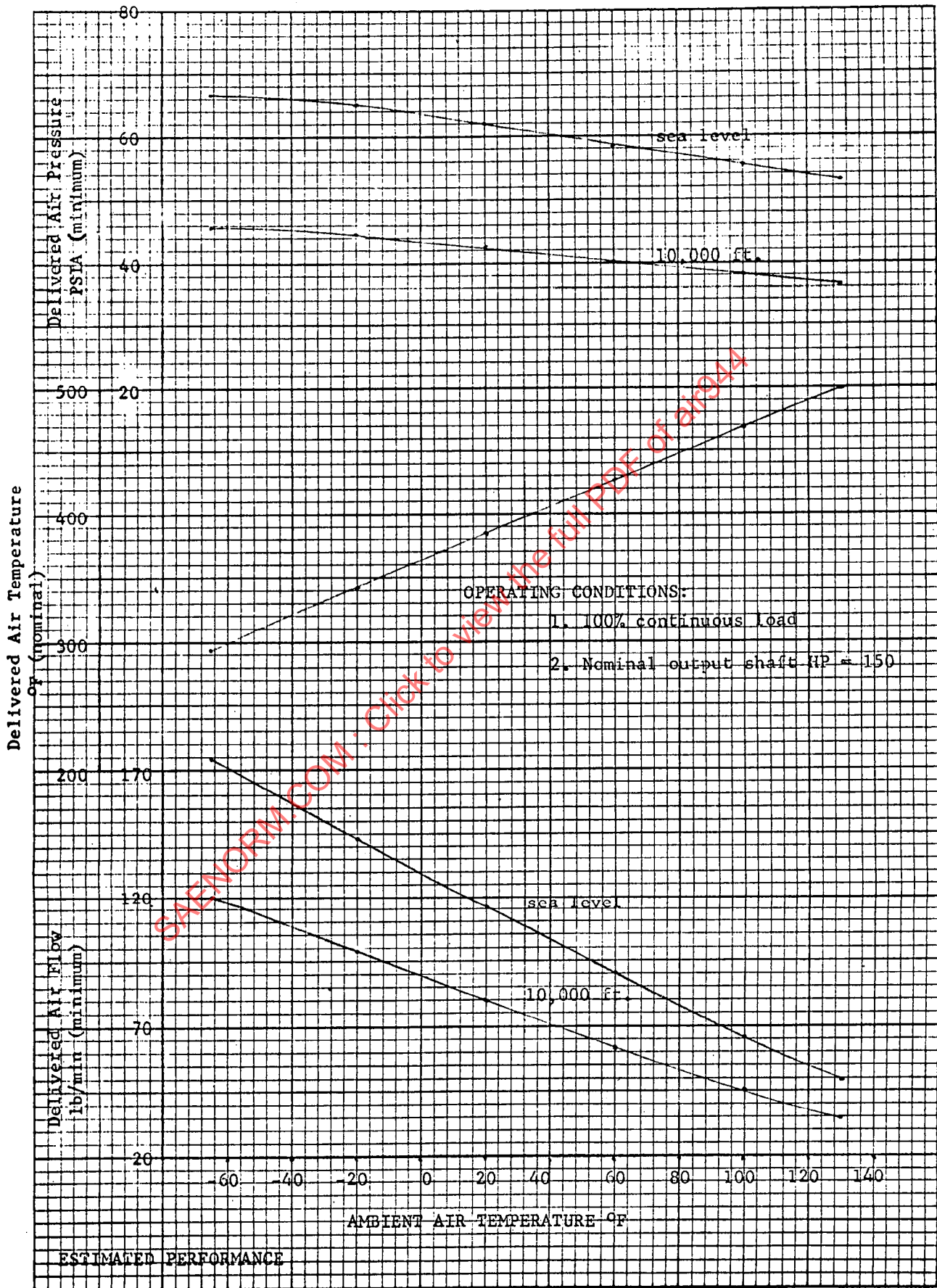


Figure 5

MANUFACTURER: AiResearch

MODEL: GTCP85 Series

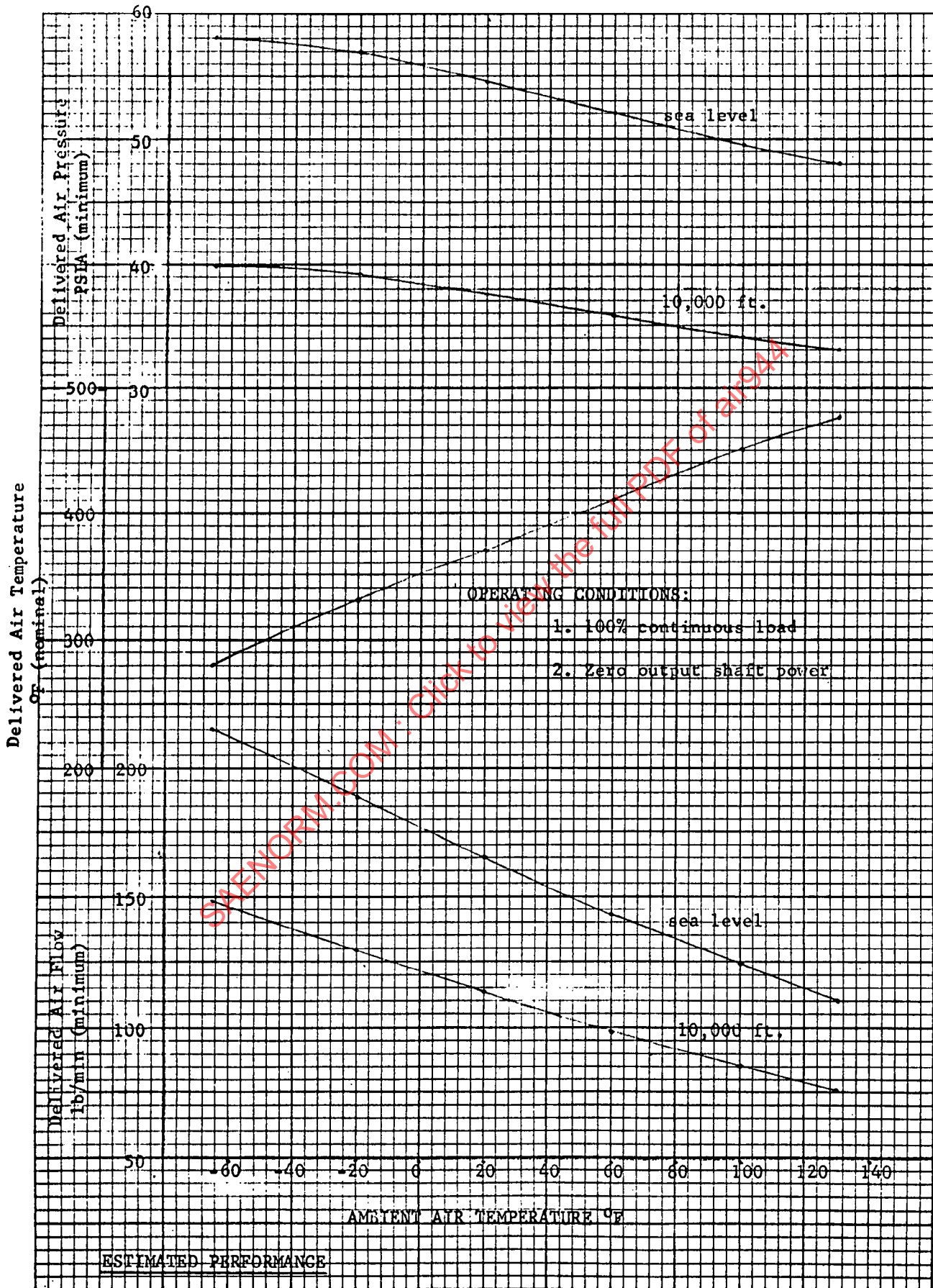


Figure 6

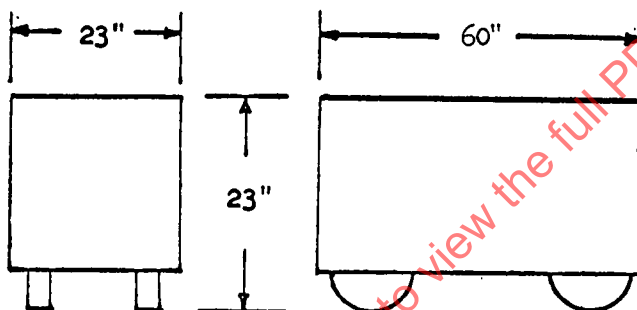
PNEUMATIC STARTER AIR SUPPLY
(Power Limited)

Manufacturer AiResearch Manufacturing Co.

Model Number GTCP-105 Series

Description

- a) type of compressor Two-stage radial outflow
- b) type of prime mover Two-stage gas turbine
- c) type of fuel MIL-J-5624, Grades JP-3, JP-4, and JP-5
MIL-G-5572
- d) package dimensions and type Truck, trailer, ship pod, stationary



- e) delivery hose; type, length

Rated Output at Compressor Delivery Connection

a) guaranteed performance	60°F, Sea Level Day		
	With zero shaft HP		With 55 shaft HP
Pressure, psig	62	38	65
Air Flow, lb/min	210	123	188
Air Temperature, °F	515	365	521
Pressure Ratio	5.0	3.6	

MANUFACTURER: AiResearch

MODEL: GTCF105 Series

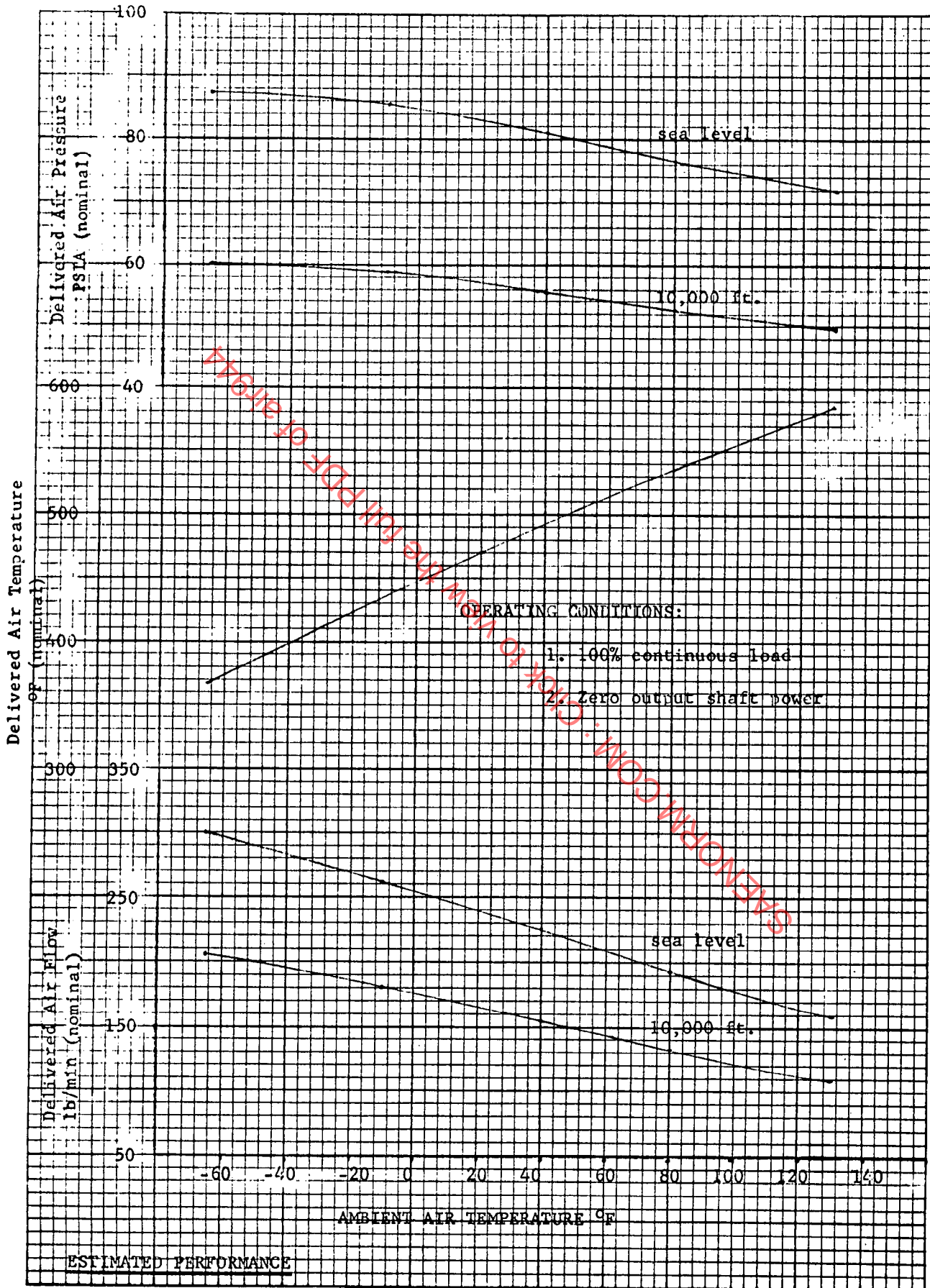


Figure 7

MANUFACTURER: AiResearch

MODEL: GTCP105 Series

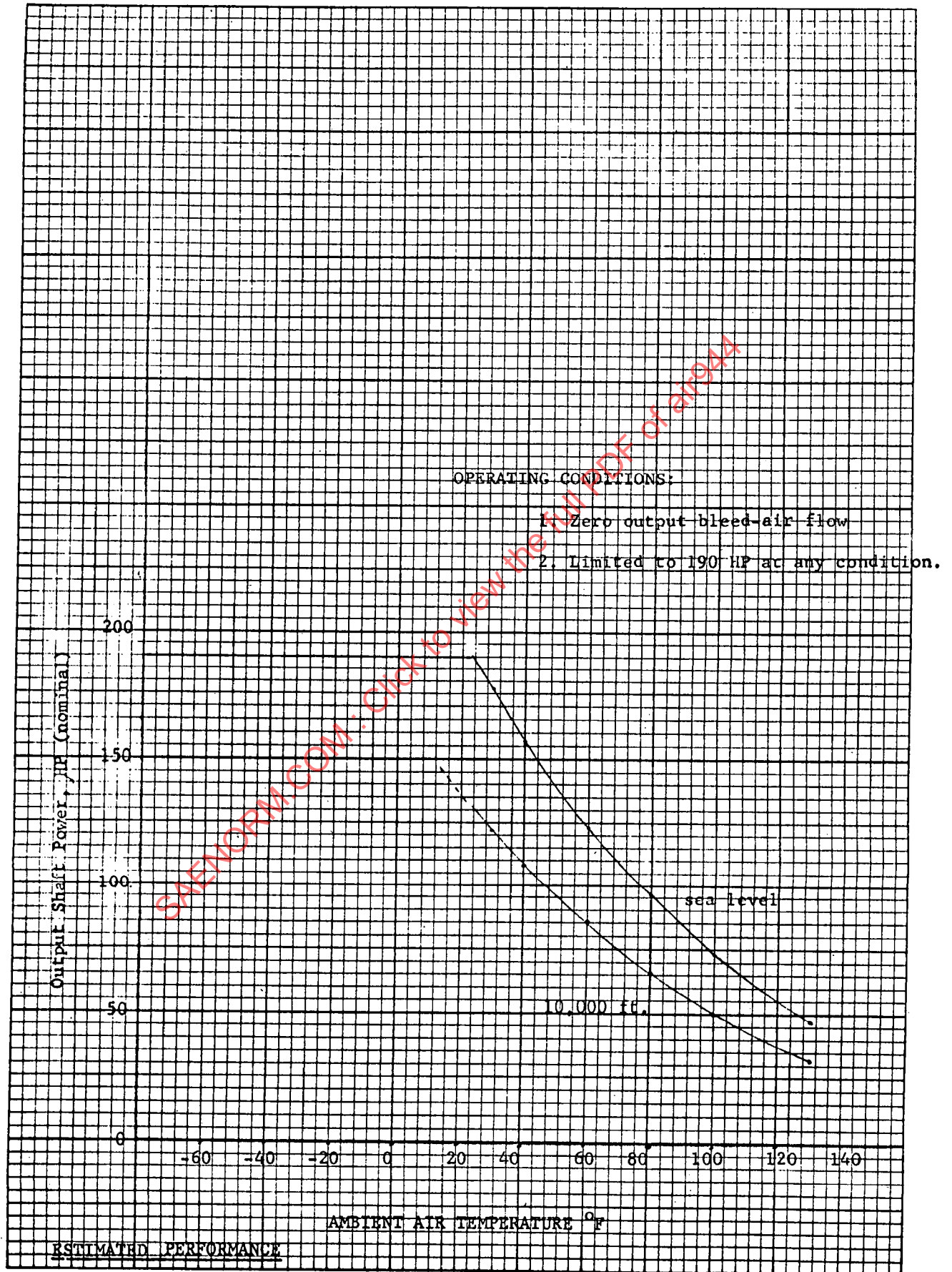


Figure 8

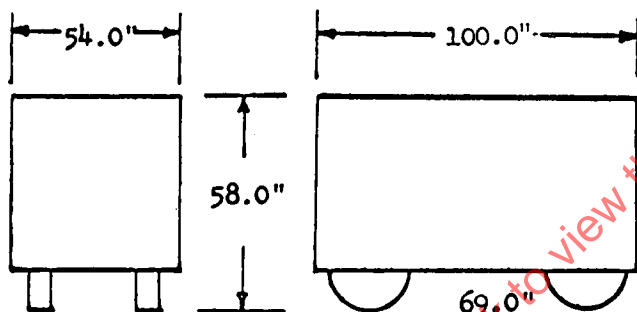
PNEUMATIC STARTER AIR SUPPLY
(Power Limited)

Manufacturer The Boeing Company, Turbine Division

Model Number 502-12B Trailer-Mounted Installation

Description Gas Turbine-Driven Air Compressor--Split Shaft Turbine

- a) type of compressor Single-stage centrifugal
- b) type of prime mover Gas turbine
- c) type of fuel Multifuel--kerosene, JP fuels, diesel
- d) package dimensions and type _____



- e) delivery hose; type, length 3.5" I.D. dacron and glass reinforced W/#7223 silicone tube with outer rubber scuff jacket - operating temperature range from -65°F to +600°F - available in 20- or 30-foot lengths.

Rated Output at Compressor Delivery Connection

- a) guaranteed performance 60°F, Sea Level Day
- | | |
|---------------------|--------------|
| Pressure, psig | <u>37.3</u> |
| Air Flow, lb/min | <u>118</u> |
| Air Temperature, °F | <u>420°F</u> |

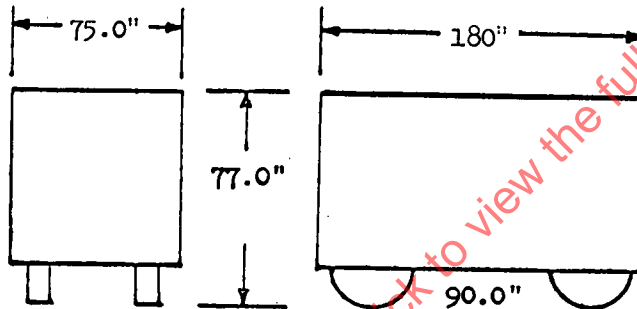
PNEUMATIC STARTER AIR SUPPLY
(Power Limited)

Manufacturer The Boeing Company, Turbine Division

Model Number 502-12B Turbo Starter (Econoline Van)

Description Gas Turbine-Driven Air Compressor--Split Shaft Turbine

- a) type of compressor Single-stage centrifugal
- b) type of prime mover Gas turbine
- c) type of fuel Multifuel--kerosene, JP fuels, diesel
- d) package dimensions and type _____



- e) delivery hose; type, length 3.5" I.D. dacron and glass reinforced W/#7223 silicone tube with outer rubber scuff jacket - operating temperature range from -65°F to +600°F - available in 20- or 30-foot lengths.

Rated Output at Compressor Delivery Connection

- a) guaranteed performance 60°F, Sea Level Day
- | | |
|---------------------|--------------|
| Pressure, psig | <u>37.3</u> |
| Air Flow, lb/min | <u>118</u> |
| Air Temperature, °F | <u>420°F</u> |

MANUFACTURER: BOEING TURBINE DIV. MODEL NO. 502-12B

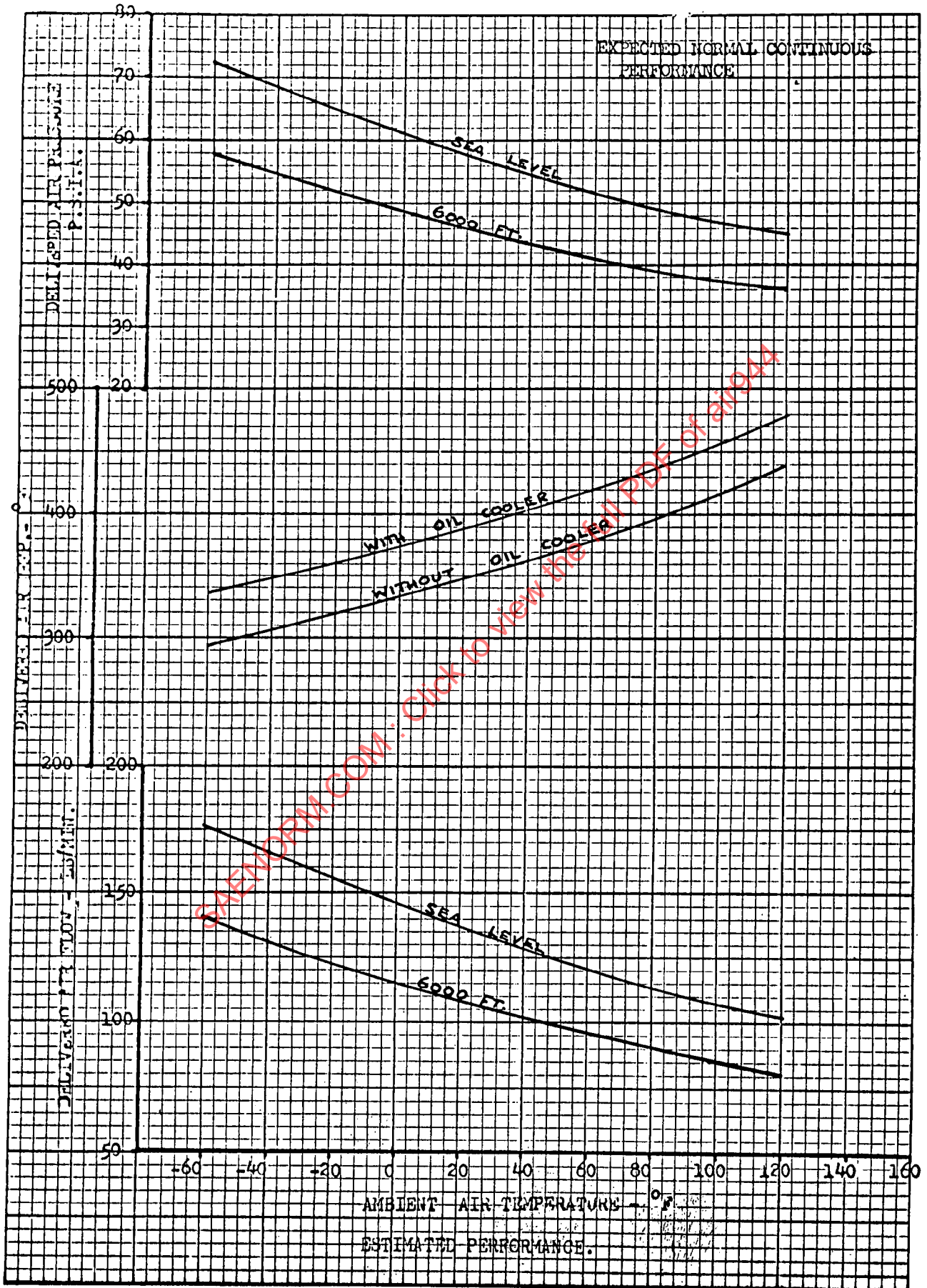


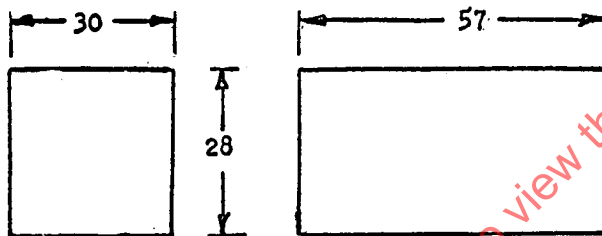
Figure 9

PNEUMATIC STARTER AIR SUPPLY
(Power Limited)

Manufacturer Continental Aviation and Engineering Corporation
Model Number TC106

Description (Turbocompressor)

- | | |
|--------------------------------|--|
| a) type of compressor | <u>Single-stage Centrifugal</u> |
| b) type of turbine | <u>2-stage axial</u> |
| c) type of fuel | <u>MIL-J-5624, JP-4 and JP-5; MIL-G-5572</u> |
| d) package dimensions and type | <u>4-wheel trailer mounted, complete with fuel tanks, controls, hose storage, etc.</u> |



Note

Also available W/O trailer chassis for customer installation. Dimensions shown are pod only.

- e) delivery hose; type, length

Rated Output at Compressor Delivery Connection

- a) guaranteed performance 60° F, Sea Level Day
- | | |
|---------------------|-------------|
| Pressure, psig | <u>50.5</u> |
| Air Flow, lb/min. | <u>126</u> |
| Air Temperature, °F | <u>430</u> |

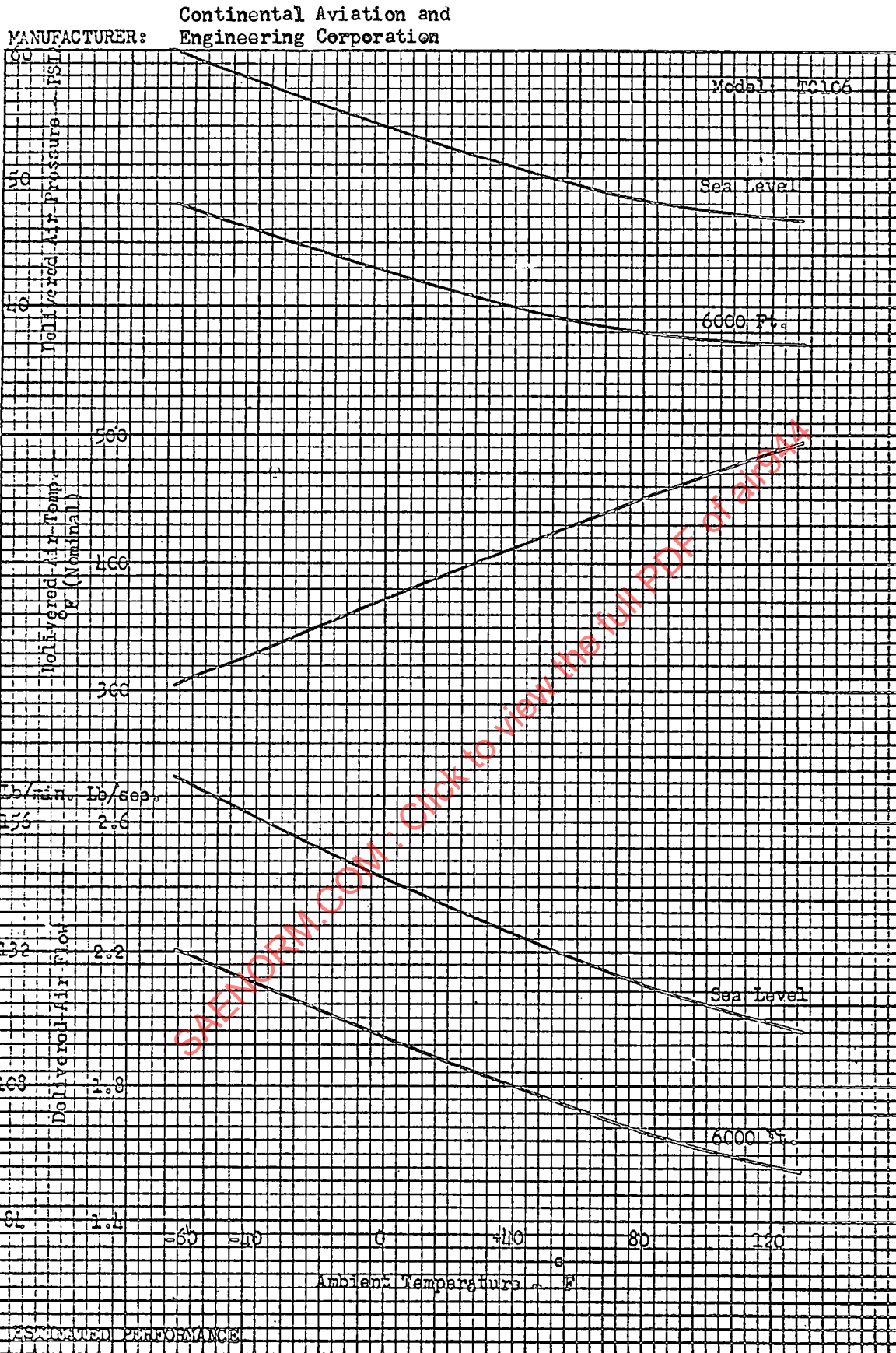


Figure 10

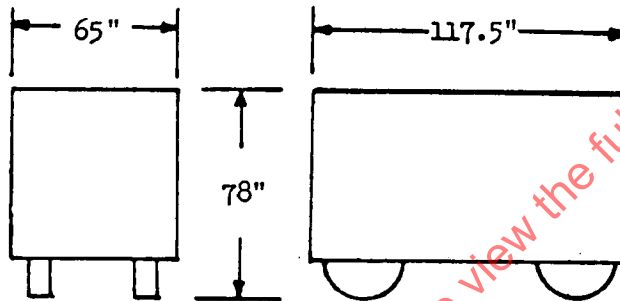
PNEUMATIC STARTER AIR SUPPLY
(Power Limited)

Manufacturer Greer Hydraulics, Inc.

Model Number ACE

Description

- a) type of compressor Rotary screw type (Atlas Copco)
- b) type of prime mover Electric motor
- c) type of fuel Electric power
- d) package dimensions and type Stationary package



- e) delivery hose; type, length Data not available.

Rated Output at Compressor Delivery Connection

- a) maximum performance 60°F, Sea Level Day
- | | |
|---------------------|-------------|
| Pressure, psig | <u>38.3</u> |
| Air Flow, lb/min | <u>115</u> |
| Air Temperature, °F | <u>365</u> |

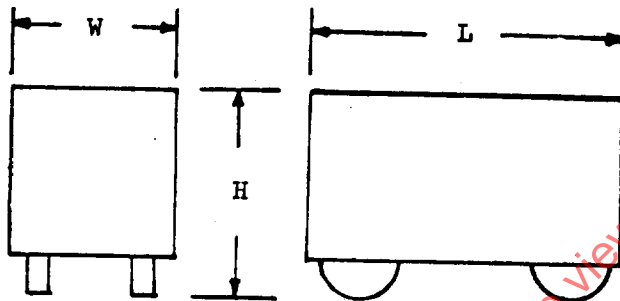
PNEUMATIC STARTER AIR SUPPLY
(Power Limited)

Manufacturer Greer Hydraulics, Inc.

Model Number AC-1-A, AC-1-B, AC-1-C

Description

- a) type of compressor Rotary screw type (Atlas Copco)
- b) type of prime mover Gasoline engine (Ford)
- c) type of fuel Gasoline
- d) package dimensions and type See Table Below



Model	AC-1-A	AC-1-B	AC-1-C
Type of Mount	Skid	Trailer	Truck
L	120"	126"	227"
W	65"	70"	76"
H	50"	65"	73"

- e) delivery hose; type, length

Data not available.

1 Dimensions vary with choice of vehicle.

Rated Output at Compressor Delivery Connection

- a) maximum performance 60°F, Sea Level Day

Pressure, psig 38.3

Air Flow, lb/min 115

Air Temperature, °F 365

MANUFACTURER: GREER HYDRAULICS

MODEL NO. AC-1-A, B, C

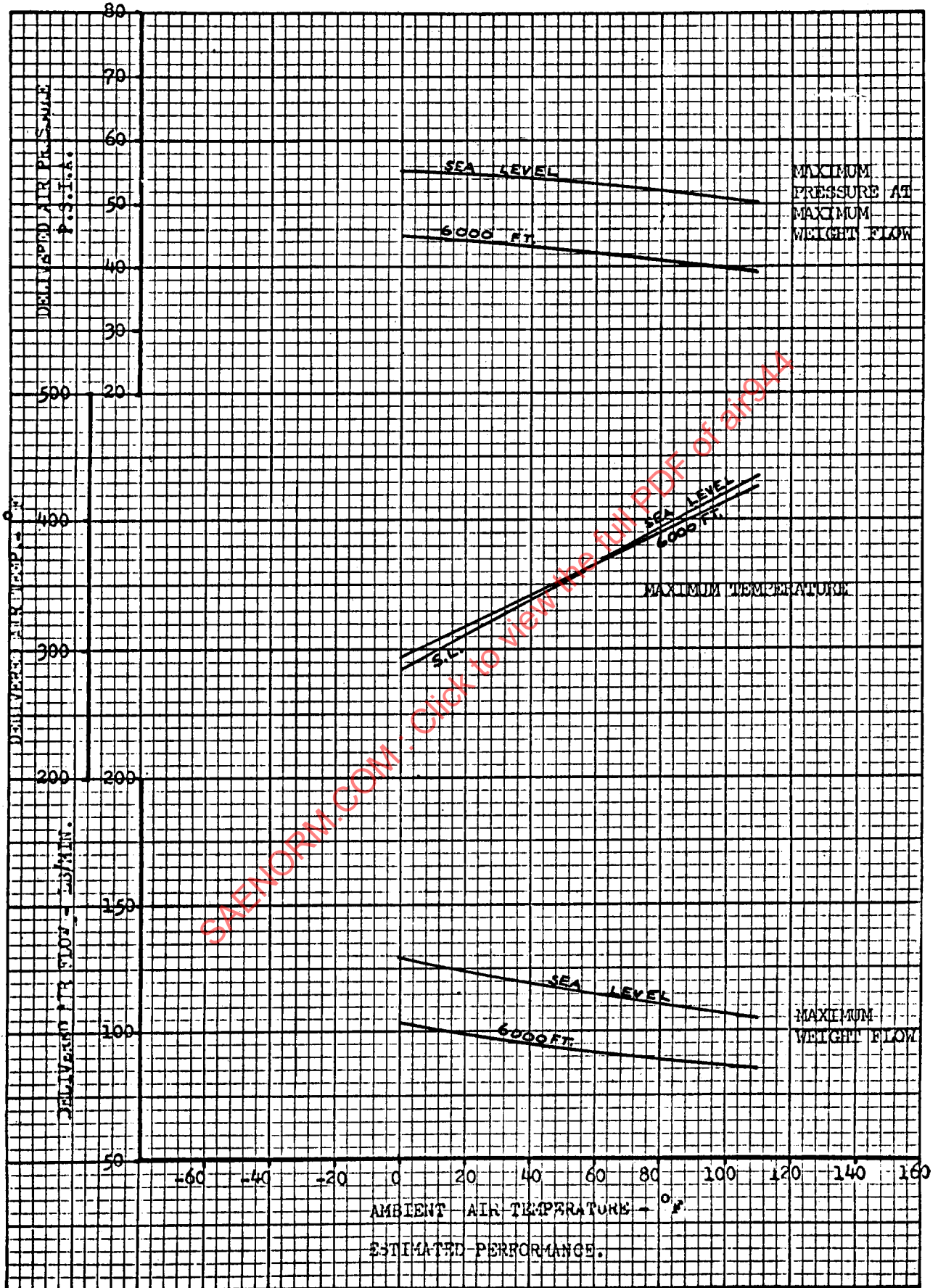


Figure 11

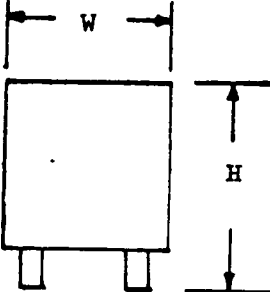
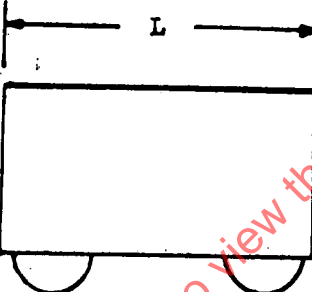
PNEUMATIC STARTER AIR SUPPLY
(Power Limited)

Manufacturer Greer Hydraulics, Inc.

Model Number AC-2-A, AC-2-B, AC-2-C

Description

- a) type of compressor Rotary screw type (Atlas Copco)
- b) type of prime mover Diesel Engine (Cummins)
- c) type of fuel Diesel
- d) package dimensions and type See Table Below

		Model	AC-2-A	AC-2-B	AC-2-C
		Type of Model	Skid	Trailer	Truck
		L	135"	145"	235"
		W	65"	70"	70"
		H	50"	65"	77"

- e) delivery hose; type, length

Data not available.

Rated Output at Compressor Delivery Connection

- a) maximum performance 60°F, Sea Level Day
- Pressure, psig 39.3
- Air Flow, lb/min 143
- Air Temperature, °F 380

MANUFACTURER: GREER HYDRAULICS MODEL NO. AC-2-A, B, C

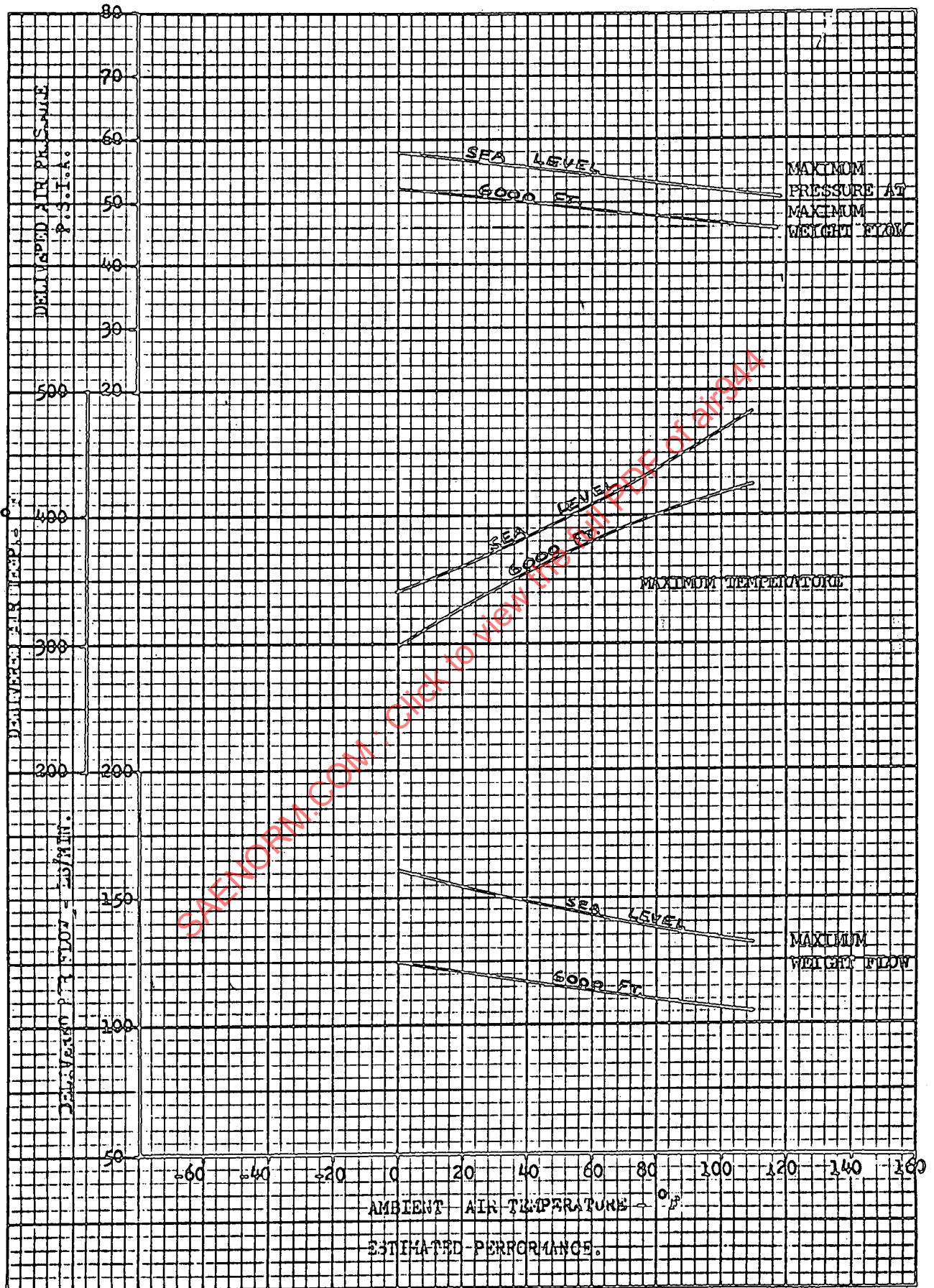


Figure 12

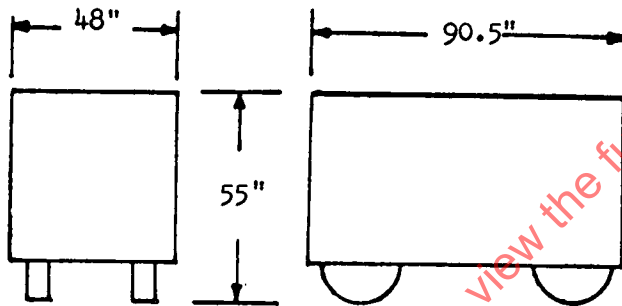
PNEUMATIC STARTER AIR SUPPLY
(Power Limited)

Manufacturer Greer Hydraulics, Inc.

Model Number ACSE-2004

Description*

- | | |
|--------------------------------|---|
| a) type of compressor | Rotary screw type, water cooled, pressure ratio 3.4:1 (Atlas Copco) |
| b) type of prime mover | Electric motor, 250 HP @ 3600 RPM, 480V, 3 Phase, 60 Cycle |
| c) type of fuel | Electric power |
| d) package dimensions and type | Stationary package* |



- e) delivery hose; type, length Data not available.

Rated Output at Compressor Delivery Connection

- | | |
|---------------------------|---------------------|
| a) guaranteed performance | 60°F, Sea Level Day |
| Pressure, psig | <u>35 - 40</u> |
| Air Flow, lb/min | <u>125</u> |
| Air Temperature, °F | <u>340</u> |

*This stationary unit is used in connection with a "hydrant" system with up to 10 outlets, each equipped with a control panel for remote control operation.

MANUFACTURER: GREER HYDRAULICS

MODEL NO. ACSE-2004

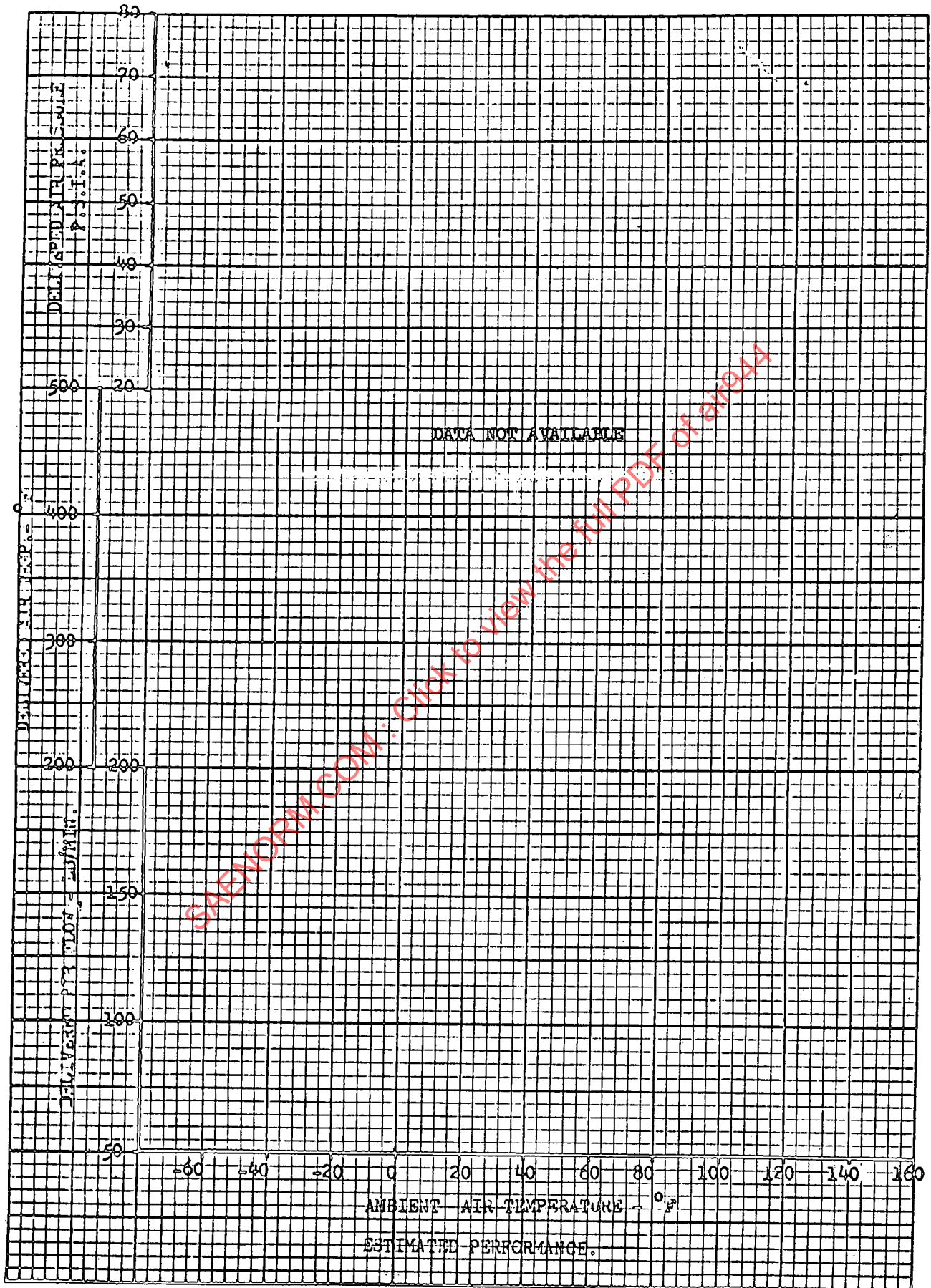


Figure 13

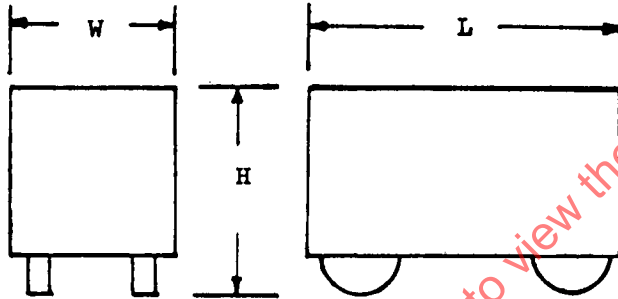
PNEUMATIC STARTER AIR SUPPLY
(Power Limited)

Manufacturer Ingersoll-Rand Company

Model Number 200DH165 or Model 200GH165

Description

- a) type of compressor Rotary positive displacement helical lobe screw type compressor
- b) type of prime mover Gasoline engine or diesel engine
- c) type of fuel 90 Octane gasoline or diesel fuel/aviation kerosene
- d) package dimensions and type Truck-mounted diesel engine drive
Model 200DH165 L 238" W 83" H 89"



- e) delivery hose; type, length H. K. Porter PN-51173 or equal - 30-ft. length

Rated Output at Compressor Delivery Connection

- a) guaranteed performance 60°F, Sea Level Day
- Pressure, psig 42
- Air Flow, lb/min 120
- Air Temperature, °F 400

MANUFACTURER: INGERSOLL-RAID

MODEL NO. 200GH 165 Gasoline driven

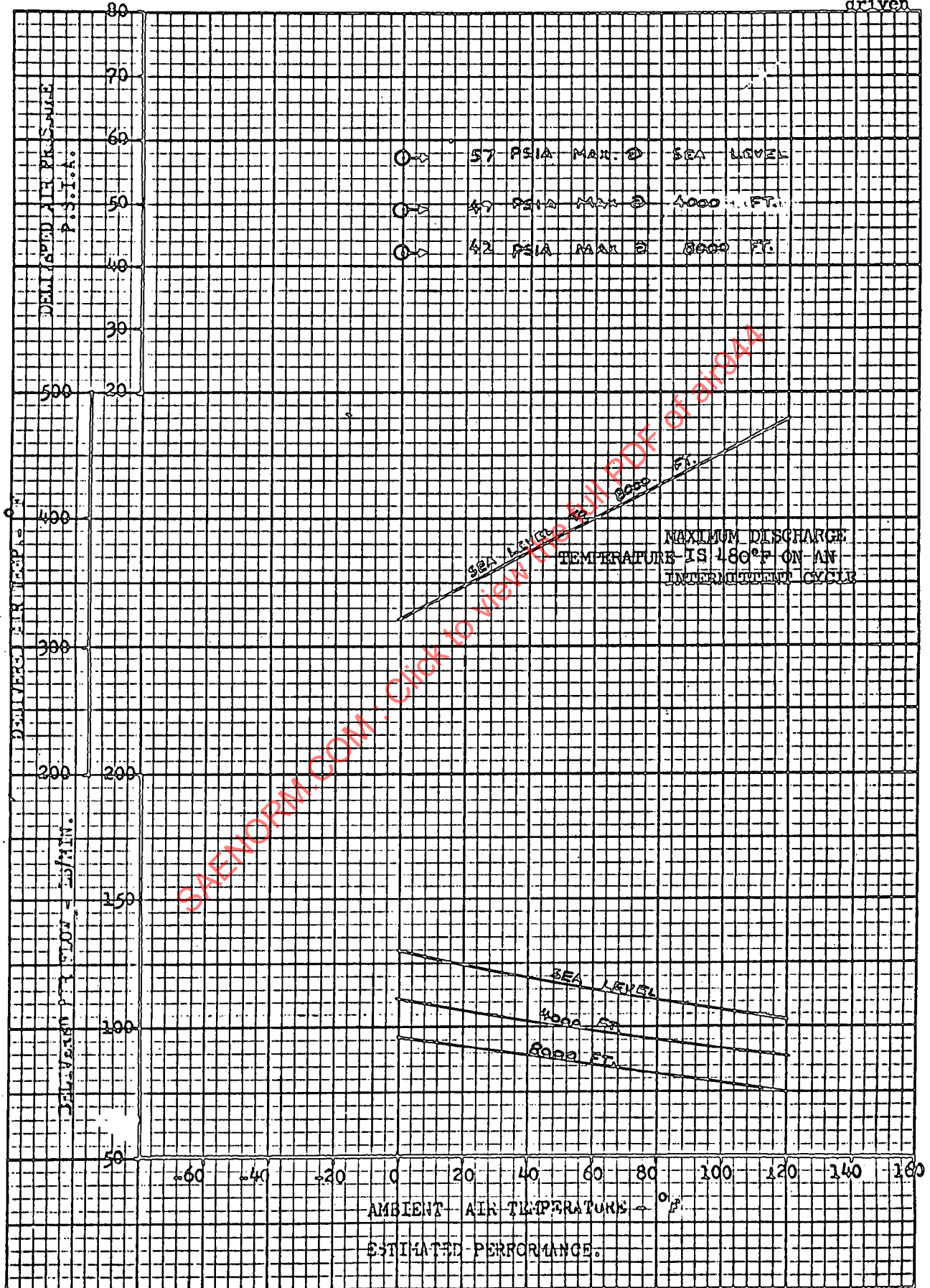


Figure 14

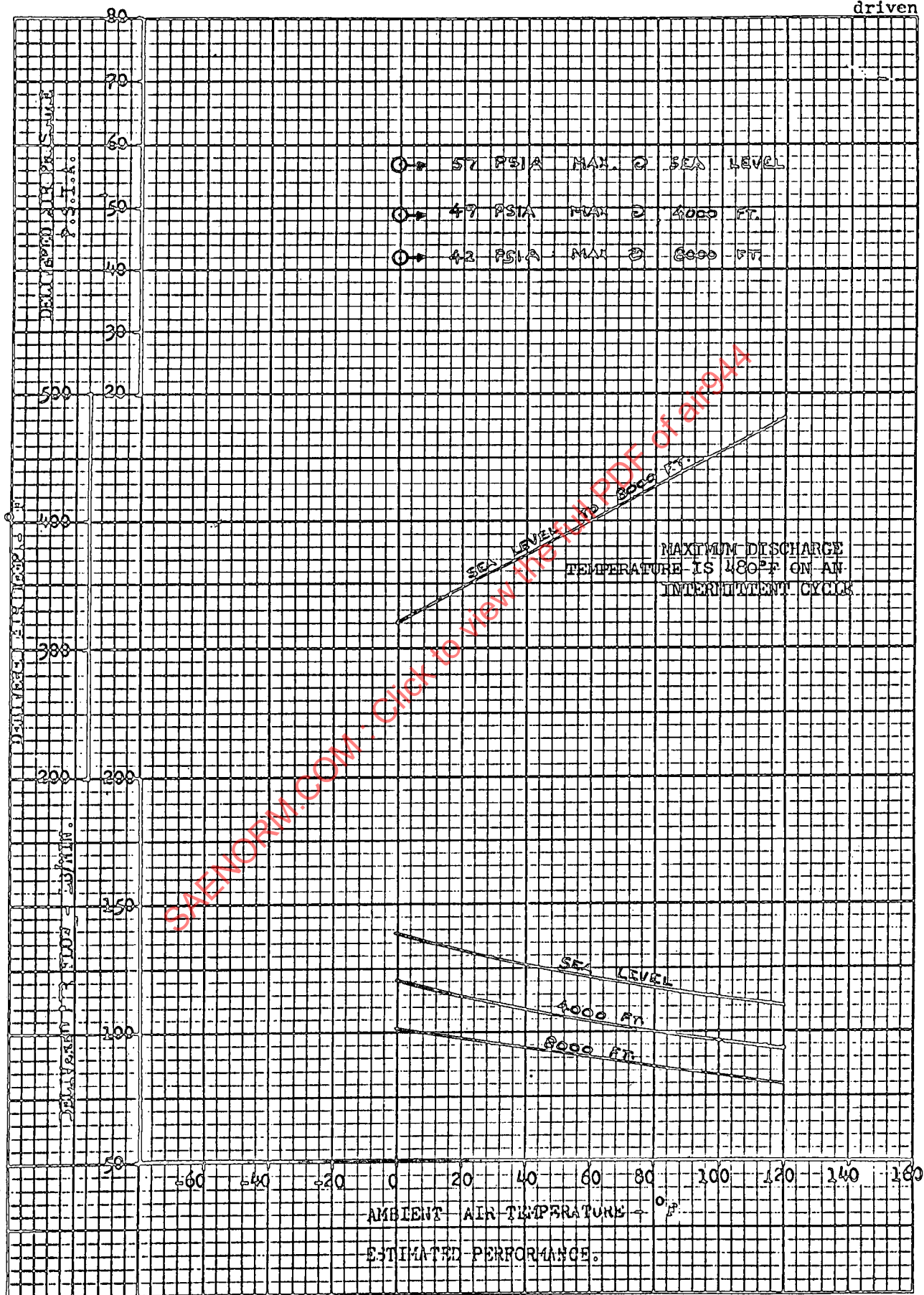


Figure 15