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Ambient Temperature & Humidity Correction Factors for Exhaust Emissions from Two Classes of Aircraft Turbine Engines

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**AMBIENT TEMPERATURE AND HUMIDITY CORRECTION FACTORS
FOR EXHAUST EMISSIONS FROM TWO CLASSES
OF AIRCRAFT TURBINE ENGINES**

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FINAL REPORT



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TABLE OF CONTENTS

	Page
INTRODUCTION	1
Purpose	1
Background	1
DISCUSSION	1
Description of Turbine Engines	1
Description of Sample Probes	2
Description of Method	2
RESULTS	5
Magnitude of Correction Factors	18
Emission Variability Reduction for Corrected TF30-P1 and J57-43WB Engine Data Bases	18
SUMMARY OF RESULTS	35
CONCLUSIONS	36
REFERENCES	37
APPENDIXES	
A - TF30-P1, JT8D-11, and J57-43WB Engine Performance with Observed and Corrected Emission Indexes	
B - Emission Indexes and Mathematical Models TF30-P1 and J57-43WB Engines. NO _x Indexes are Corrected for Humidity	
C - Correlation Coefficients Analysis of Variance Values and Coefficients from Regression Analysis	
D - Graphical Solution for K ₃ Humidity Constant for NO _x EI--J57-43WB Engine	

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LIST OF ILLUSTRATIONS

Figure		Page
1	Emission Sample Probes--TF30-P1 Engine	3
2	Emission Sample Probe--J57-43 Engine	4
3	Ambient Temperature Correction Factors for NO _x EI--TF30-P1 Engine	19
4	Ambient Temperature Correction Factors for NO _x EI--J57-43 and JT3D Engines	20
5	Ambient Temperature Correction Factors for NO _x PI--TF30-P1 Engine	21
6	Ambient Temperature Correction Factors for NO _x PI--J57-43 and JT3D Engines	22
7	Ambient Humidity Correction Factors for NO _x EI--TF30-P1 and J57-43 Engines	23
8	Ambient Humidity Correction Factors for NO _x PI--TF30-P1 and J57-43 Engines	24
9	Ambient Temperature Correction Factors for CO EI--TF30-P1 Engine	25
10	Ambient Temperature Correction Factors for CO EI--J57-43 and JT3D Engines	26
11	Ambient Temperature Correction Factors for CO PI--TF30-P1 Engine	27
12	Ambient Temperature Correction Factors for CO PI--J57-43 and JT3D Engines	28
13	Ambient Temperature Correction Factors for THC EI--TF30-P1 Engine	29
14	Ambient Temperature Correction Factors for THC EI--J57-43 and JT3D Engines	30
15	Ambient Temperature Correction Factors for THC PI--TF30-P1 Engine	31
16	Ambient Temperature Correction Factors for THC PI--J57-43 and JT3D Engines	32

LIST OF TABLES

Table		Page
1	Equation (6) Constants - TF30-P1 and J57-43WB Engines	8
2	Ambient Temperature and Humidity Correction Factors for TF30-P1 Turbofan Engine Emissions	12
3	Ambient Temperature and Humidity Correction Factors for JT3D Turbofan Engine Emissions	15
4	Variability Reduction of Corrected TF30-P1 and JT8D Engine Emission Data Base	33
5	Variability Reduction of Corrected J57-43WB Engine Emission Data Base	34

INTRODUCTION

PURPOSE.

The purpose of this report was to establish correction factors for reducing exhaust emissions from two classes of aircraft turbine engines to standard-day temperature and humidity.

BACKGROUND.

The Clean Air Amendments of 1970 (reference 1) specified that the United States Department of Transportation (DOT) and the Federal Aviation Administration (FAA) promulgate regulations enforcing the aircraft engine emission standards established by the Environmental Protection Agency (EPA). Since the emission measurements showed significant variability throughout investigations performed by EPA and industry (reference 2), it was apparent that the variability would have to be quantified.

Since 1971, two major variability problems regarding emission measurements have been identified by industry and government study teams. The first problem involves acquiring a representative emission sample from the exhaust plume. Stratification of emissions in the exhaust plume has been proven by detailed traverse probing and the analysis of profile and contour plots of carbon monoxide (CO), total hydrocarbons (THC), and oxides of nitrogen (NO_x). Studies of the traverse emission plots indicate that the use of fixed probing techniques to provide representative samples is feasible (reference 3).

The second problem area affecting emission measurements involves the effect of changes in ambient weather conditions, particularly temperature and humidity, on emission levels.

Therefore, the FAA was commissioned to conduct an investigation of these variability problems at the National Aviation Facilities Experimental Center (NAFEC), Atlantic City, New Jersey. The results of that portion of the investigation designed to establish the quantitative effects of ambient temperature, humidity, and barometric pressure on the production of turbine engine emissions and to establish correction factors to normalize the ambient weather effects for standard sea level conditions are reported here.

DISCUSSION

DESCRIPTION OF TURBINE ENGINES.

Two aircraft turbine engines were tested, TF30-P1 mixed-flow turbofan engine and J57-43 turbojet engine. A surplus USAF TF30-P1 turbofan engine was selected as a test vehicle because of performance similarities to the commercial JT8D engine. The TF30-P1 turbofan engine was modified by removing the afterburner assembly and installing a fixed-area exhaust nozzle for commercial engine

simulation. The engine incorporates a front fan, having a bypass to engine airflow ratio of approximately 1.09 to 1, which diverts air through an annular duct that forms the outer shell of the engine. The bypass air is mixed with the exhaust gases downstream of the turbine. The pressure ratio across the compressor is 16 to 1. The engine, as modified, provides 11,500 pounds thrust at takeoff power.

A J57-43WB turbojet engine was made available by the USAF for this investigation and was selected because of performance similarities to the commercial JT3D-1 turbofan engine. Parameters of concern were those that influence the generation of emissions, specifically, the air pressure and temperature levels at the inlet to the combustion chambers. The J57-43WB is a turbojet engine featuring a compressor pressure ratio of 12.5 to 1 at high power. The J57-43WB engine, was utilized as a test vehicle to simulate combustion chamber inlet conditions of the JT3D-1 engine.

DESCRIPTION OF SAMPLE PROBES.

Four fixed sample probes were installed through the TF30-P1 tailpipe in proximity to the core-fan duct splitter, as shown in figure 1. Each probe contained three sample orifices (0.030-inch diameter) located to sample only exhaust gases from the core. A random sample pattern was achieved by installing the probes on varying chord angles. These fixed sample probes were utilized to determine the emission levels of the TF30-P1 engine during the ambient factors tests, since various probing techniques at the exhaust nozzle exit were being investigated concurrently.

A fixed, 12-point sample probe in the shape of a square was utilized for the J57-43WB engine. The probe was positioned with the diagonals rotated 22.5° from the vertical and horizontal centerlines as shown in figure 2. The probe was designed to sample at 62 percent of the nozzle radius through 0.03-inch holes located at the midpoint and one-ninth radius on both sides of the midpoint of each side (reference 4). The probe was positioned for acquiring representative emission samples based on traverse results of a JT3D-1 engine with similar combustion chambers and strut configurations. The probe was located 10 inches downstream of the exhaust nozzle to eliminate or minimize probe effects on engine performance.

DESCRIPTION OF METHOD.

When measuring the emissions of turbine aircraft engines under varying atmospheric conditions, there may be no control of inlet air temperature (t_2), specific humidity (H), or pressure (P). Therefore, if the regulations for emissions are to be enforced, the effect of these ambient weather conditions on the emissions must be known quantitatively.

Using the J57-43WB and TF30-P1 engines, exhaust emission measurements were acquired over the range of ambient conditions occurring during the winter, spring, and summer seasons. Emissions of THC, CO, and NO_x were measured over five engine power settings for ambient inlet temperatures of 16° Fahrenheit (F) to 94° F and specific humidity range of 10 to 150 grains of

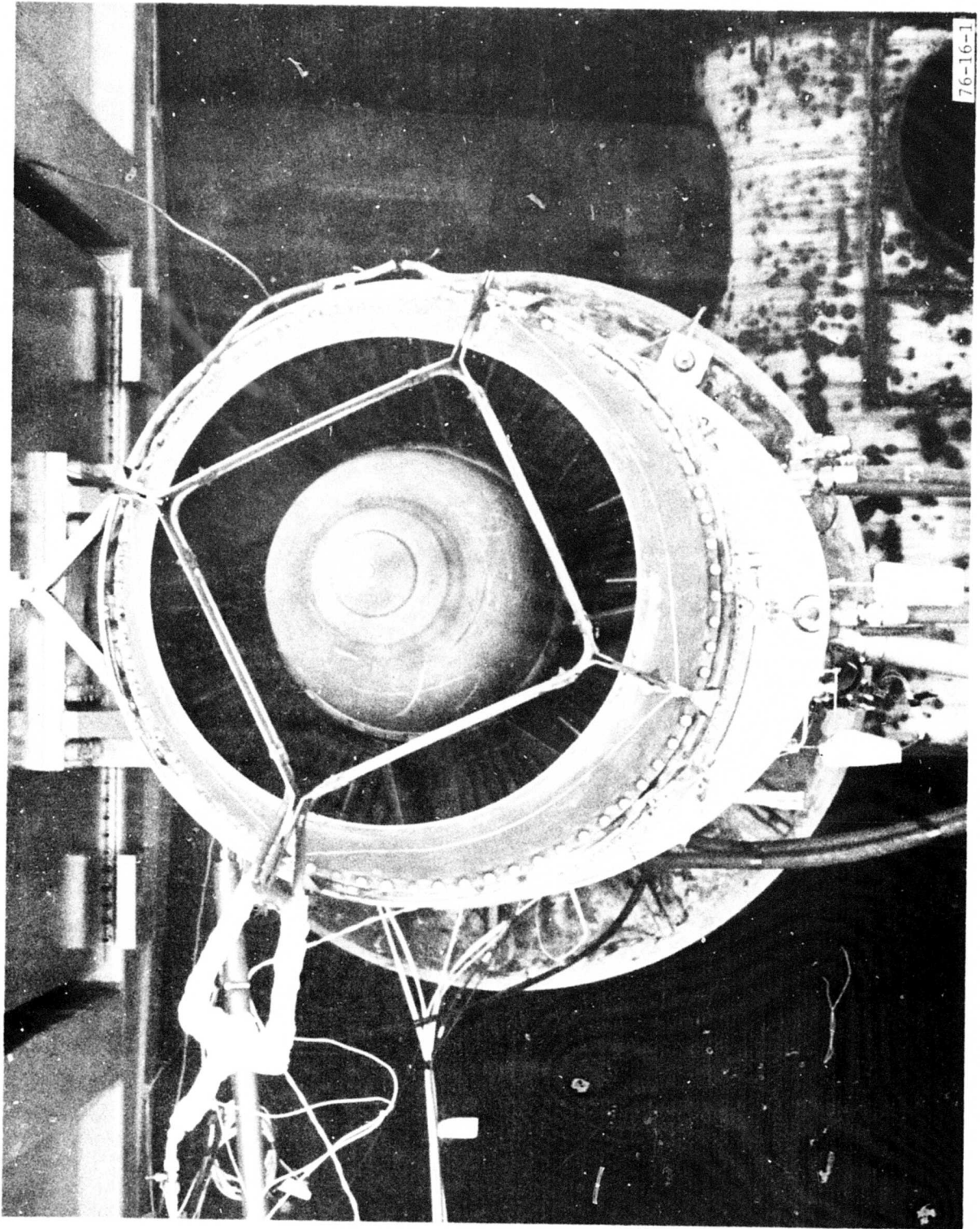


FIGURE 1. EMISSION SAMPLE PROBES--TF30-P1 ENGINE

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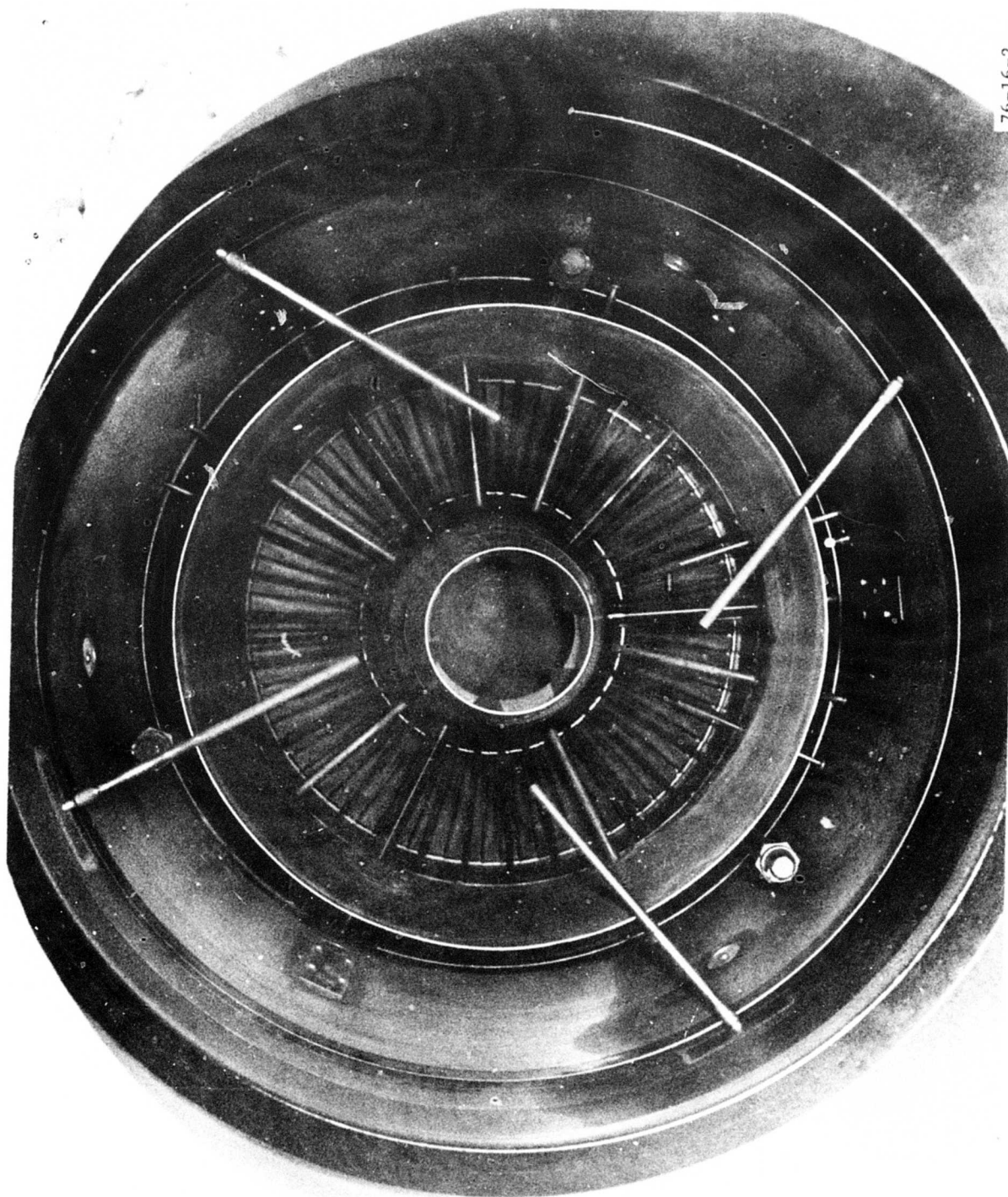


FIGURE 2. EMISSION SAMPLE PROBE--J57-43 ENGINE

water vapor per pound of dry air. Barometric pressure extremes were minimal, being less than 1 inch of mercury.

Mathematical modeling of emission generation in turbine engines (reference 5) has indicated that air pressure (P_3) and temperature (t_3) at the inlet to the combustion chambers are major parameters determining emission levels for a given combustion chamber. The objectives of the test procedures were to maintain a constant value of engine power, while allowing ambient temperature to vary. The primary engine power conditions of idle, approach, cruise, maximum continuous, and takeoff were selected for development of separate correction factors, each at constant P_3 levels. Power settings were held constant throughout the investigation by maintaining a constant engine pressure ratio (EPR), constant corrected thrust, and constant corrected fuel flow. Both engines were operated at identical EPR's at power conditions of approach, cruise, and maximum continuous. This procedure was implemented to determine the effect on the correction factors of the difference in compressor pressure ratio levels between the two engines. Each test period consisted of an up-calibration and a down-calibration procedure through the selected power conditions. Engine stabilization was determined by monitoring the gaseous emission records on continual basis. When stabilization was reached, the variation of the gaseous emissions became random; whereas, during stabilization, the records would show a steadily increasing or decreasing trend with time. The emission measurement systems conformed to the specification of reference 6. The data base included approximately 230 engine performance and emission measurements, for each engine tested (appendix A).

The data collected were analyzed by verifying the existence of meaningful effects, converting the data to its most usable form and then describing the generation of emissions mathematically. To accomplish the analysis, correlation, transformation and multiple regression techniques were utilized to generate the desired constants for the mathematical models. The correction factors were then calculated as the ratio of the mathematical model, solved for standard ambient conditions to the model, which may be solved for actual conditions to calculate the correction factor.

RESULTS

The emission indexes were inspected initially by plotting against the inlet temperature (t_2). These plots are included in appendix B. The emission of CO and THC decreases with increased ambient temperature, while NO_x increases with increased temperature. A linear equation fit was considered as being the simplest way of defining the emissions. However, extrapolation implied zero or negative emissions. As a result, several alternative models were postulated and tested. The models were variations of the general equation for a straight line,

$$y = mx + b \quad (1)$$

Case I

$$EI = mT + b \quad (2)$$

Case II

$$EI = m/T + b \quad (3)$$

Case III

$$\ln EI = m/T + b \quad (4)$$

where EI is emission index

T is absolute temperature (Rankine)

m is the slope

b is the intercept

The transformations of equations 3 and 4 to parabolic-type curves from the straight-line equation, was accomplished by substituting $1/T$ for T and for equation 4, substituting $\ln EI$ for EI . The transformations were used so that straight-line fitting techniques (least squares) could be employed for the fitting of more complex functions. Equation 2 and 3 were utilized in the analysis, but were discarded, appendix C.

In the actual statistical computer output, specific humidity and atmospheric pressure were added, making the model a multiple linear fit, thus making the general equation;

$$y = b + m_1 X_1 + m_2 X_2 + m_3 X_3 + E \quad (5)$$

where y = log emission index

b = intercept

m_1 = coefficient associated with X_1

X_1 = temperature reciprocal $1/T$

m_2 = coefficient associated with X_2

X_2 = specific humidity

m_3 = coefficient associated with X_3

X_3 = barometric pressure

E = error term

The tabulation of the correlations, statistical tests, and regression coefficients for the specific humidity, temperature, and pressure are included in appendix C. The generated statistics were utilized in the following way:

1. The correlation coefficients were tested to determine if a relationship between the emission index and specific measured ambient conditions could exist.

2. Multiple correlation coefficient squared showed the percentage of variability explained by the equation that was generated.

3. The F value was tested to determine if the multiple correlation coefficient squared was more than chance.

4. Regression coefficients, intercept value, and error of estimate were used to generate the equation.

A review of the correlation coefficients shows that for most power settings, barometric pressure does not contribute significantly to the emission index. This could be due to the rather narrow range of ambient pressures over which the tests were run, (less than 1 inch of mercury) and the constant EPR and P₃ requirement of the test procedure. As a result, barometric pressure was discounted as a meaningful factor in the mathematical models to be presented.

Although the linear and the inverse temperature correlations showed that definite relationships could exist, they were both aesthetically and scientifically lacking in justification. It was noted empirically that the rate of chemical reaction was a function at the natural logarithm, e, raised to a power varying inversely to the absolute temperature. Therefore, the model of equation 6 was used to characterize the production of CO, THC, and NO_x in engine exhaust emissions. The least-squares curve fit and subsequent transformation results were generalized in the mathematical statement:

$$EI = K_1 \frac{e^{K_2/T}}{e^{K_3 H}} (E \text{ or } \frac{1}{E}) \quad (6)$$

where EI is the emission index, pounds pollutant per 1,000 pounds fuel.

K₁ = equation constant equivalent to intercept of the equation when in logarithmic form

K₂ = constant associated with the temperature

K₃ = constant associated with the humidity

e = base natural logarithms

E = the error term

T = absolute temperature, degrees Rankine

H = specific humidity, grains of water vapor in one pound dry air.

Equations of the same form were developed for the power index, PI, in units of pounds pollutant per 1,000 pounds thrust.

A tabulation of the constants obtained by use of a log transformation in a multiple linear regression program and its subsequent reversion is presented in table 1. These data are a result of one quality check where points that deviated from an earlier fit were removed (i.e., points with large residual errors were eliminated). Reasons for the outliers were sought and found in some cases.

TABLE 1. EQUATION (6) CONSTANTS--TF30-P1 AND J57-43WB ENGINES

POLLUTANT	ENGINE	POWER	K1	K2	K3	FIGURE	SAMPLE SIZE	ERROR
CO EI	TF30	IDLE	5.1570	1256.563	0	B-1	48	1.05
CO EI	TF30	APP.	0.2927	2021.082	0	B-3	37	1.05
CO EI	TF30	CRUISE	0.013281	2855.175	0	-	45	1.07
CO EI	TF30	MAX CONT	0.017659	2542.404	0	-	44	1.04
CO EI	TF30	T.O.	0.052138	1908.304	0	-	20	1.05
CO EI	J57	IDLE	92.4123	- 78.25197	0	B-2	34	1.03
CO EI	J57	APP	0.449323	1861.4501	0	B-4	37	1.07
CO EI	J57	CRUISE	0.00458	3714.9572	0	-	30	1.12
CO EI	J57	MAX CONT	0.000996	4345.10736	0	-	34	1.12
CO EI	J57	T.O.	0.006367	3040.7463	0	-	18	1.20
CO PI	TF30	IDLE	6.3313	1060.613	0	-	45	1.06
CO PI	TF30	APP	0.21112	1928.538	0	-	33	1.07
CO PI	TF30	CRUISE	0.009658	2736.993	0	-	44	1.07
CO PI	TF30	MAX CONT	0.015166	2355.897	0	-	46	1.05
CO PI	TF30	T.O.	0.03643	1839.695	0	-	18	1.04
CO PI	J57	IDLE	3122.4285	-1538.340	0	-	34	1.10
CO PI	J57	APP	0.27401	2114.235	0	-	36	1.07
CO PI	J57	CRUISE	0.00633	3465.1117	0	-	30	1.09
CO PI	J57	MAX CONT	0.00053	4559.685	0	-	29	1.15
CO PI	J57	T.O.	0.005289	3048.5308	0	-	17	1.21
THC EI	TF30	IDLE	0.03624	3063.438	0	B-5	41	1.10
THC EI	TF30	APP	2.57X10 ⁻⁸	9046.7352	0	B-7	37	1.36
THC EI	J57	IDLE	14.023	1147.721	0	B-6	31	1.04
THC EI	J57	APP	0.08685	1810.508	0	B-8	13	1.07
THC EI	J57	CRUISE	25.074	1671.1327	0	-	22	1.34

TABLE 1. EQUATION (6) CONSTANTS--TF30-P1 AND J57-43WB ENGINES (Continued)

POLLUTANT	ENGINE	POWER	K1	K2	K3	FIGURE	SAMPLE SIZE	
							N	ERROR
THC PI	TF30	IDLE	0.02464	3169.4998	0	-	39	1.10
THC PI	TF30	APP	4.97X10 ⁻⁹	9660.748	0	-	39	1.38
THC PI	J57	IDLE	1305.873	-851.5824	0	-	29	1.11
THC PI	J57	APP	0.033016	2314.9414	0	-	11	1.05
THC PI	J57	CRUISE	0.06176	1278.3011	0	-	21	1.32
THC PI	J57	MAX CONT	0.13523	779.3156	0	-	19	1.19
NOx EI	TF30	IDLE	148.518	-2031.98	-.00246	-	44	1.09
NOx EI	TF30	APP	299.144	-2016.97	-.00272	B-9	38	1.05
NOx EI	TF30	CRUISE	685.693	-2127.54	-.00283	B-11	42	1.04
NOx EI	TF30	MAX CONT	428.884	-1794.91	-.00272	B-13	42	1.04
NOx EI	TF30	T.O.	226.83	-1439.07	-.00170	-	20	1.03
NOx EI	J57	IDLE	29.02622	-1136.415	-.0027	-		
NOx EI	J57	APP	220.2439	-1769.837	-.0027	B-10	21	1.05
NOx EI	J57	CRUISE	232.0866	-1604.362	-.0027	B-12	27	1.07
NOx EI	J57	MAX CONT	453.740	-1900.329	-.0027	B-14	26	1.05
NOx EI	J57	T.O.	380.6582	-1690.599	-.0027	B-15	14	1.04
NOx PI	TF30	IDLE	294.931	-2441.26	-.00357		37	1.06
NOx PI	TF30	APP	260.495	-2185.83	-.00348		34	1.07
NOx PI	TF30	CRUISE	454.172	-2201.00	-.00274		41	1.04
NOx PI	TF30	MAX CONT	741.874	2331.48	-.00309		42	1.05
NOx PI	TF30	T.O.	617.405	2152.75	-.00343		20	1.05
NOx PI	J57	IDLE	33737.7	4406.446	-.0032		20	1.17
NOx PI	J57	APP	174.8873	1641.981	-.0032		31	1.06
NOx PI	J57	CRUISE	466.4236	-2023.692	-.0032		26	1.06
NOx PI	J57	MAX CONT	95 62496	-2348.734	-.0032		25	1.05
NOx PI	J57	T.O.	553 0429	-1951.914	-.0032		15	1.06

The utility of these constants is twofold: (1) By using them in the general equation, a prediction equation for the respective power setting is now available; and (2) it provides a method of using ambient T and H to correct EI and PI to standard condition. A review of table 1 suggests that for the TF30-P1 engine the coefficients for humidity tend to approach some constant value over the power settings for NO_x . NO_x EI approaches 0.0027, and NO_x PI approaches 0.0032. The humidity coefficients for the J57-43 engine were developed graphically across engine power, appendix D.

Regression and correlation analysis of the CO measurements from the TF30-P1 engine indicated humidity coefficients (K_3) of approximately -0.0013 for CO EI and -0.0016 for CO PI. Similar analysis of the CO measurements from the J57-43WB engine failed, however, to confirm the existence of humidity correction factors. Ambient temperature dependent models and correction factors with and without humidity were applied to the TF30-P1 data base (appendix A). Ambient temperature correction factors without humidity significantly lowered the standard deviation of the corrected indexes and further lowered the standard deviation of the data base compared with the original factors including humidity at all power conditions except idle. Based on these results, the CO humidity factors for the TF30-P1 engine were eliminated, and the total effects were assigned to ambient temperature.

A review of the error values shows that for CO and NO_x , the equations utilized data that were within 10 percent or less of the respective equation yield. The error values stated are a result of transforming from a logarithmic to a linear scale and are one standard deviation in magnitude. If a normal distribution of data is assumed for the logarithmic state, the limits determined by the error statement contain approximately 68 percent of the data.

Total hydrocarbons measurements from the TF30-P1 engine show larger error terms, especially for the approach settings. The TF30-P1 engine THC correction factors as originally developed were revised as a result of the error of determination. Primarily, the modification involved elimination of the humidity factors, because of questionable correction under high humidity conditions at approach power. The humidity factor was also eliminated at idle power, since the small factor was within the error of determination. Regression analyses were then performed to assign the total effects to the ambient temperature correction. The THC constants presented in table 1 were developed on this basis and are therefore only temperature dependent.

Multiple regression analysis of the CO and THC measurement from the J57-43WB engine indicated that humidity and barometric pressure were not significant. The CO and THC measurements from the J57-43WB engine were analyzed by simple regression analysis, using only ambient temperature as the variable.

A number of commercial turbine engines incorporate fuel controls that regulate idle power to a constant thrust or constant EPR. This feature is accomplished by varying engine rotational speed (RPM) with changes in ambient temperature. The fuel controls of engines such as, the TF30-P1, JT8D, and JT3D-1 engine have this feature. The fuel control of the J57-43WB engine, on the other hand,

regulates idle power to a constant high rotor speed (N_2) and, as a result, varies thrust. Significant differences exist in the mathematical models and correction factors for the two engines at idle power. Correction factors for JT3D engine emissions at idle power were developed from the J57-43WB engine measurements. A data base was established at constant power conditions (EPR), consisting of selected J57-43WB engine emission measurements from low idle for low ambient temperatures and from high idle for high ambient temperatures.

Variability of the NO_x measurements from the J57-43WB engine required the use of graphical methods across power for determination of K_3 humidity constant. The humidity K_3 constants for the J57-43WB engine measurements of NO_x EI and PI levels were related to combustor inlet temperature (t_3) at various humidity levels. The information were then cross plotted against humidity, and K_3 constants were developed by fitting equation 6 to the results. The graphical solution for K_3 is included in appendix D. The NO_x data base for the J57 engine was corrected for humidity, and the ambient temperature effects were determined by simple regression analysis.

The ambient temperature and humidity correction factors for the TF30-PI and JT3D turbine engine emissions are presented in tables 2 and 3. The correction factors are defined as the product of $C_T \times C_H$, temperature correction times humidity correction. C_T and C_H are calculated from the ratio of the mathematical model (equation 6) for the EI or PI at standard conditions of 59° F and zero humidity to the model for the temperature and humidity conditions of the day. The correction factors were calculated for the TF30-PI and J57-43WB engines using the values for the model associated with table 1. Temperature correction coefficients were determined by solving equations 7 and 8.

$$C_T = \frac{K_2/518.69}{K_1 e^{K_2/T}} \quad (7)$$

The intercept constants, K_1 , cancel, and K_2 was determined by correlation and regression analysis. Constant K_4 results from solving for the standard temperature.

$$C_T = \frac{K_4}{K_2/T} e \quad (8)$$

The correction factor for humidity was determined by equations 9 and 10:

$$C_H = \frac{K_1 e^{-K_3(0)}}{K_1 - K_3(H)} \quad (9)$$

The intercept constants cancel and solving for zero humidity, e to the zero power, is one, and K_3 is negative.

$$C_H = e^{-K_3(H)} \quad (10)$$

TABLE 2. AMBIENT TEMPERATURE AND HUMIDITY CORRECTION FACTORS FOR TF30-P1 TURBOFAN ENGINE EMISSIONS

1.0 DEFINITION OF TERMS

- 1.1 C_T : Correction coefficient for variations in ambient temperature from the standard of 59° F.
- 1.2 C_H : Correction coefficient for variations in humidity from the standard of zero.
- 1.3 e : Base natural logarithms
- 1.4 T : Ambient temperature absolute--degrees Rankine - ($t^\circ \text{F} + 459.69$)
- 1.5 H : Ambient specific humidity--grains of water vapor in 1 pound of dry air
- 1.6 EI_C : Emission index corrected ($EI \times C_T \times C_H$), pounds pollutant per 1,000 pounds fuel
- 1.7 PI_C : Power index corrected ($PI \times C_T \times C_H$), pounds pollutant per 1,000 pounds thrust

2.0 IDLE POWER EMISSION INDEX

Figure

- 2.1 C_T : $(NO_x) = 0.01989 e^{2031.98/T}$ 3
- 2.2 C_H : $(NO_x) = e^{0.0027(H)}$ 7
- 2.3 C_T : $(CO) = \frac{11.2747}{e^{1256.56/T}}$ 9
- 2.4 C_T : $(THC) = \frac{367.25}{e^{3063.4/T}}$ 13

3.0 IDLE POWER

POWER INDEX (PI) POWER INDEX

TABLE 2. AMBIENT TEMPERATURE AND HUMIDITY CORRECTION FACTORS FOR
TF30-P1 TURBOFAN ENGINE EMISSIONS (Continued)

	Figure
3.1 $C_T: (NO_x) = 0.009036 e^{2441.26/T}$	5
3.2 $C_H: (NO_x) = e^{0.0032(H)}$	8
3.3 $C_T: (CO) = \frac{7.7275}{e^{1060.61/T}}$	11
3.4 $C_T: (THC) = \frac{450.6}{e^{3169.50/T}}$	15
4.0 APPROACH POWER (EPR 1.31) EMISSION INDEX	
4.1 $C_T: (NO_x) = 0.020474 e^{2016.97/T}$	3
4.2 $C_H: (NO_x) = e^{0.0027(H)}$	7
4.3 $C_T: (CO) = \frac{49.2303}{e^{2021.08/T}}$	9
4.4 $C_T: (THC) = \frac{37559580.0}{e^{9046.70/T}}$	13
5.0 APPROACH POWER (EPR 1.31) POWER INDEX	
5.1 $C_T: (NO_x) = 0.014795 e^{2185.83/T}$	5
5.2 $C_H: (NO_x) = e^{0.0032(H)}$	8
5.3 $C_T: (CO) = \frac{41.18596}{e^{1928.54/T}}$	11
5.4 $C_T: (THC) = \frac{122704000.0}{e^{9660.75/T}}$	15
6.0 CRUISE POWER (EPR 1.76) EMISSION INDEX	
6.1 $C_T: (NO_x) = 0.016544 e^{2127.54/T}$	3
6.2 $C_H: (NO_x) = e^{0.0027(H)}$	5
6.3 $C_T: (CO) = \frac{245.8173}{e^{2855.175/T}}$	9

TABLE 2. AMBIENT TEMPERATURE AND HUMIDITY CORRECTION FACTORS FOR
TF30-P1 TURBOFAN ENGINE EMISSIONS (Continued)

7.0 CRUISE POWER (EPR 1.76) POWER INDEX

7.1	$C_T: (NO_x) = 0.014359 e^{2201.0/T}$	5
7.2	$C_H: (NO_x) = e^{0.0032(H)}$	8
7.3	$C_T: (CO) = \frac{195.7294}{e^{2736.99/T}}$	11

8.0 MAXIMUM CONTINUOUS POWER (EPR 1.905) EMISSION INDEX

8.1	$C_T: (NO_x) = 0.031415 e^{1794.91/T}$	3
8.2	$C_H: (NO_x) = e^{0.0027(H)}$	5
8.3	$C_T: (CO) = \frac{134.502}{e^{2542.40/T}}$	9

9.0 MAXIMUM CONTINUOUS POWER (EPR 1.905) POWER INDEX

9.1	$C_T: (NO_x) = 0.011165 e^{2331.48/T}$	5
9.2	$C_H: (NO_x) = e^{0.0032(H)}$	8
9.3	$C_T: (CO) = \frac{93.8802}{e^{2355.90/T}}$	11

10.0 TAKEOFF POWER (EPR 2.05) EMISSION INDEX

10.1	$C_T: (NO_x) = 0.06238 e^{1439.07/T}$	3
10.2	$C_H: (NO_x) = e^{0.0027(H)}$	7
10.3	$C_T: (CO) = \frac{39.60978}{e^{1908.30/T}}$	9

11.0 TAKEOFF POWER (EPR 2.05) POWER INDEX

11.1	$C_T: (NO_x) = 0.01579 e^{2152.75/T}$	5
11.2	$C_H: (NO_x) = e^{0.0032(H)}$	8
11.3	$C_T: (CO) = \frac{34.70278}{e^{1839.70/T}}$	11

TABLE 3. AMBIENT TEMPERATURE AND HUMIDITY CORRECTION FACTORS
FOR JT3D TURBOFAN ENGINE EMISSIONS

1.0) DEFINITION OF TERMS (See table 2)

2.0 IDLE POWER EMISSION INDEX

	Figure
2.1 $C_T: (NO_x) = 0.12053 e^{1097.47/T}$	4
2.2 $C_H: (NO_x) = e^{0.0027(H)}$	7
2.3 $C_T: (CO) = \frac{1.6841}{e^{270.35/T}}$	10
2.4 $C_T: (THC) = \frac{54.3643}{e^{2072.534/T}}$	14

3.0 IDLE POWER POWER INDEX

3.1 $C_T: (NO_x) = 0.0095737 e^{2411.25/T}$	6
3.2 $C_H: (NO_x) = e^{0.0032(H)}$	8
3.3 $C_T: (CO) = 1.0$	12
3.4 $C_T: (THC) = \frac{54.3643}{e^{2072.534/T}}$	16

4.0 APPROACH POWER (EPR 1.31) EMISSION INDEX

4.1 $C_T: (NO_x) = 0.03297 e^{1769.84/T}$	4
4.2 $C_H: (NO_x) = e^{0.0027(H)}$	7
4.3 $C_T: (CO) = \frac{36.1889}{e^{1861.45/T}}$	10
4.4 $C_T: (THC) = \frac{32.8038}{e^{1810.51/T}}$	14

5.0 APPROACH POWER (EPR 1.31) POWER INDEX

TABLE 3. AMBIENT TEMPERATURE AND HUMIDITY CORRECTION FACTORS
FOR TURBOFAN JT3D ENGINE EMISSIONS (Continued)

	Figure
5.1 $C_T: (NO_x) = 0.04219 e^{1641.98/T}$	6
5.2 $C_H: (NO_x) = e^{0.0032(H)}$	8
5.3 $C_T: (CO) = \frac{58.9155}{e^{2114.23/T}}$	12
5.4 $C_T: (THC) = \frac{86.752}{e^{2314.94/T}}$	16
6.0 CRUISE POWER (EPR 1.76) EMISSION INDEX	
6.1 $C_T: (NO_x) = 0.04536 e^{1604.36/T}$	4
6.2 $C_H: (NO_x) = e^{0.0027(H)}$	7
6.3 $C_T: (CO) = \frac{1289.7346}{e^{3714.957/T}}$	10
6.4 $C_T: (THC) = \frac{25.074}{e^{1671.13/T}}$	14
7.0 CRUISE POWER (EPR 1.76) POWER INDEX	
7.1 $C_T: (NO_x) = 0.02021 e^{2023.69/T}$	6
7.2 $C_H: (NO_x) = e^{0.0032(H)}$	8
7.3 $C_T: (CO) = \frac{796.7222}{e^{3465.11/T}}$	12
7.4 $C_T: (THC) = \frac{11.7574}{e^{1278.30/T}}$	16
8.0 MAXIMUM CONTINUOUS POWER (EPR 1.905) EMISSION INDEX	
8.1 $C_T: (NO_x) = 0.02564 e^{1900.33/T}$	4
8.2 $C_H: (NO_x) = e^{0.0027(H)}$	7
8.3 $C_T: (CO) = \frac{4346.297}{e^{4345.107/T}}$	10

TABLE 3. AMBIENT TEMPERATURE AND HUMIDITY CORRECTION FACTORS
FOR JT3D TURBOFAN ENGINE EMISSIONS (Continued)

9.0 MAXIMUM CONTINUOUS POWER (EPR 1.905) POWER INDEX

	Figure
9.1 $C_T: (NO_x) = 0.01080 e^{2348.73/T}$	6
9.2 $C_H: (NO_x) = e^{0.0032(H)}$	8
9.3 $C_T: (CO) = \frac{6573.235}{e^{4559.68/T}}$	12
9.4 $C_T: (THC) = \frac{4.49277}{e^{779.156/T}}$	16

10.0 TAKE-OFF POWER (EPR 2.30) EMISSION INDEX

10.1 $C_T: (NO_x) = 0.038413 e^{1690.60/T}$	4
10.2 $C_H: (NO_x) = e^{0.0027(H)}$	7
10.3 $C_T: (CO) = \frac{351.522}{e^{3040.746/T}}$	10

11.0 TAKE-OFF POWER (EPR 2.30) POWER INDEX

11.1 $C_T: (NO_x) = 0.02321 e^{1951.91/T}$	6
11.2 $C_H: (NO_x) = e^{0.0032(H)}$	8
11.3 $C_T: (CO) = \frac{356.8673}{e^{3048.53/T}}$	12

MAGNITUDE OF CORRECTION FACTORS.

The ambient temperature and humidity correction factors for the TF30-P1 and J57-43WB engine emissions were solved for the temperature coefficient (C_T) and then solved for the humidity coefficient (C_H). When solving for C_T the humidity was held constant at zero, and when solving for C_H , the temperature was held constant at the standard of 59° F.

C_T for EI and PI was plotted for each pollutant on composite engine power illustrations for the five power conditions as shown in figures 3, 4, 5, 6, 9, 10, 11, 12, 13, 14, 15, and 16. Similar curves NO_x EI and NO_x PI for C_H are shown in figures 7 and 8. The characteristics and magnitude of the correction factors are apparent.

EMISSION VARIABILITY REDUCTION FOR CORRECTED TF30-P1 AND J57-43WB ENGINE DATA BASES.

The emission measurements from the TF30-P1 and J57-43WB engines were tabulated in appendix A, both uncorrected and corrected for ambient temperature and humidity. The one-standard-deviation variability of these measurements are tabulated in tables 4 and 5. As may be noted, the correction of the measurements produced a significant reduction in variability. Variability reduction of the data base with application of the correction factors was striking. Based on one standard deviation, variability of the THC EI was reduced 41 to 66 percent. Variability of CO EI was lowered 35 to 60 percent, and NO_x EI up to 33 percent.

An existing data base for JT8D-11 engine was included in appendix A and the one-standard-deviation variability was tabulated in table 4. The JT8D engine emission measurements were corrected for ambient temperature and humidity to demonstrate the applicability of the TF30-P1 correction factors. As may be seen in table 4, the reduction in variability of the JT8D-11 engine corrected emission indices is approximately equal in magnitude to the reduction of variability of the TF30-P1 engine emission indexes. Because of this similarity, the factors may be utilized to correct the JT8D engine emissions for ambient temperature and humidity effects.

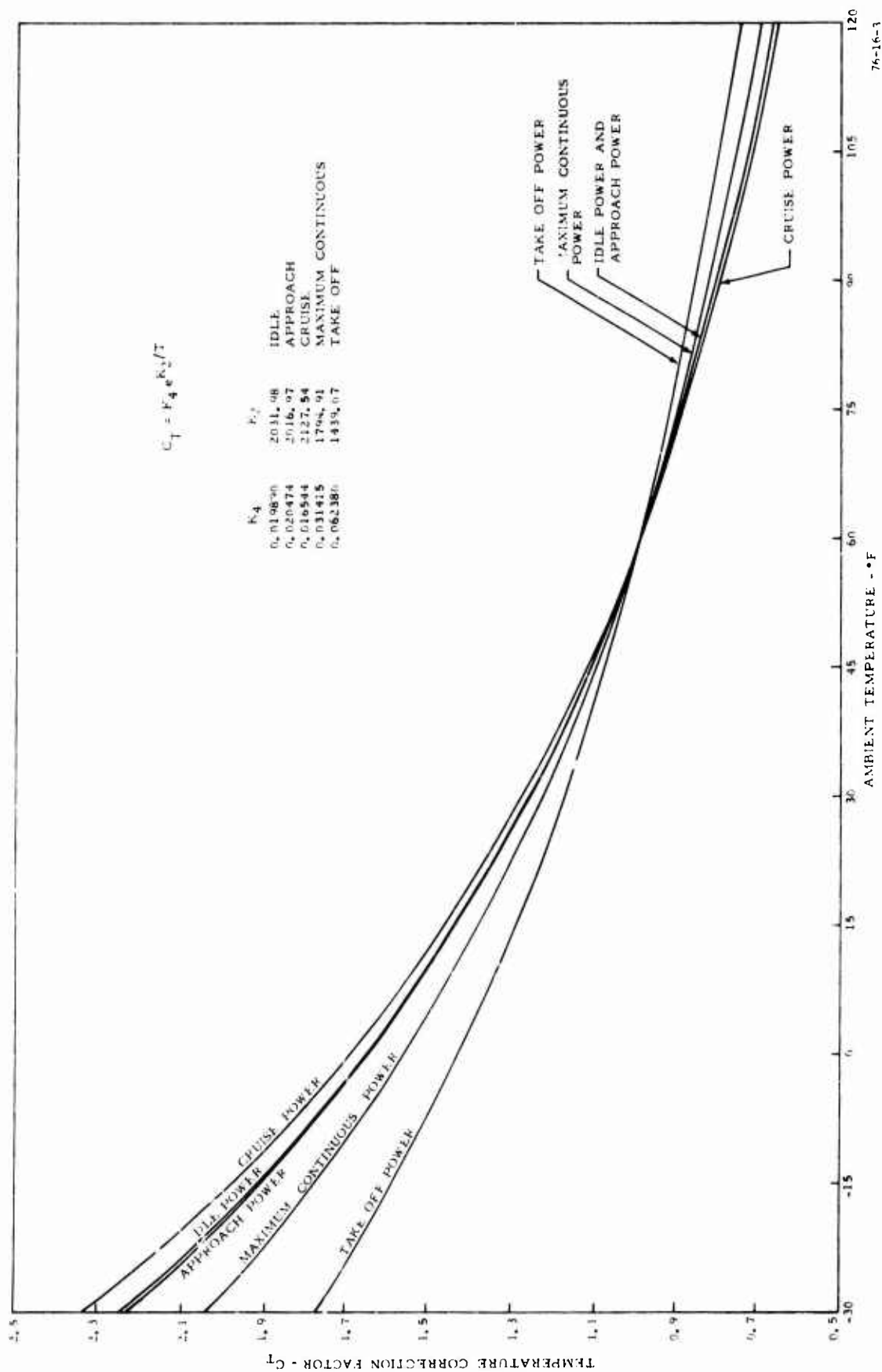


FIGURE 3. AMBIENT TEMPERATURE CORRECTION FACTORS FOR NO_x EI--TF30-P1 ENGINE.



FIGURE 4. AMBIENT TEMPERATURE CORRECTION FACTORS FOR NO_x EI--J57-43 AND JT3D ENGINES

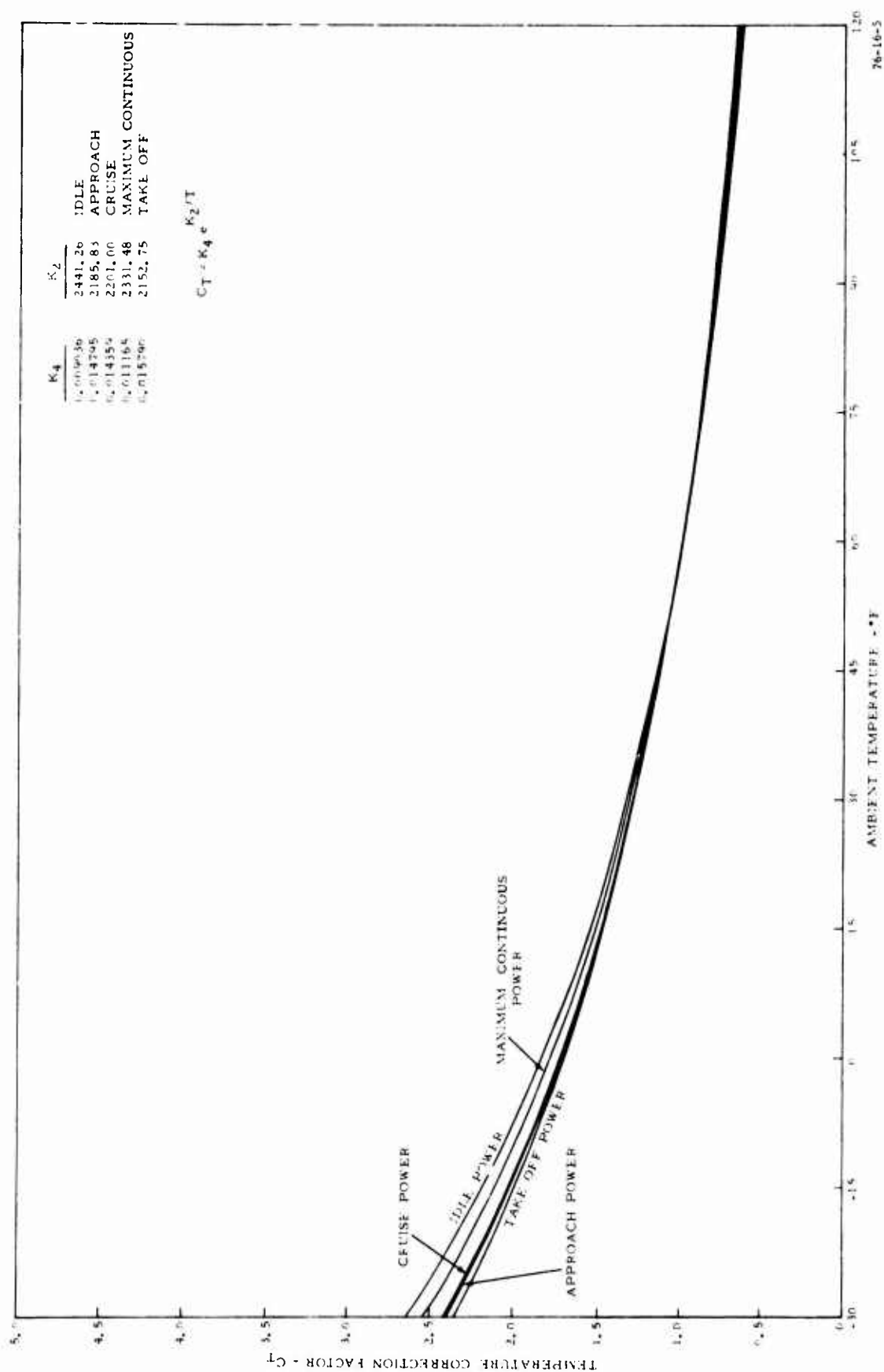


FIGURE 5. AMBIENT TEMPERATURE CORRECTION FACTORS FOR NO_x PI--TF30-P1 ENGINE

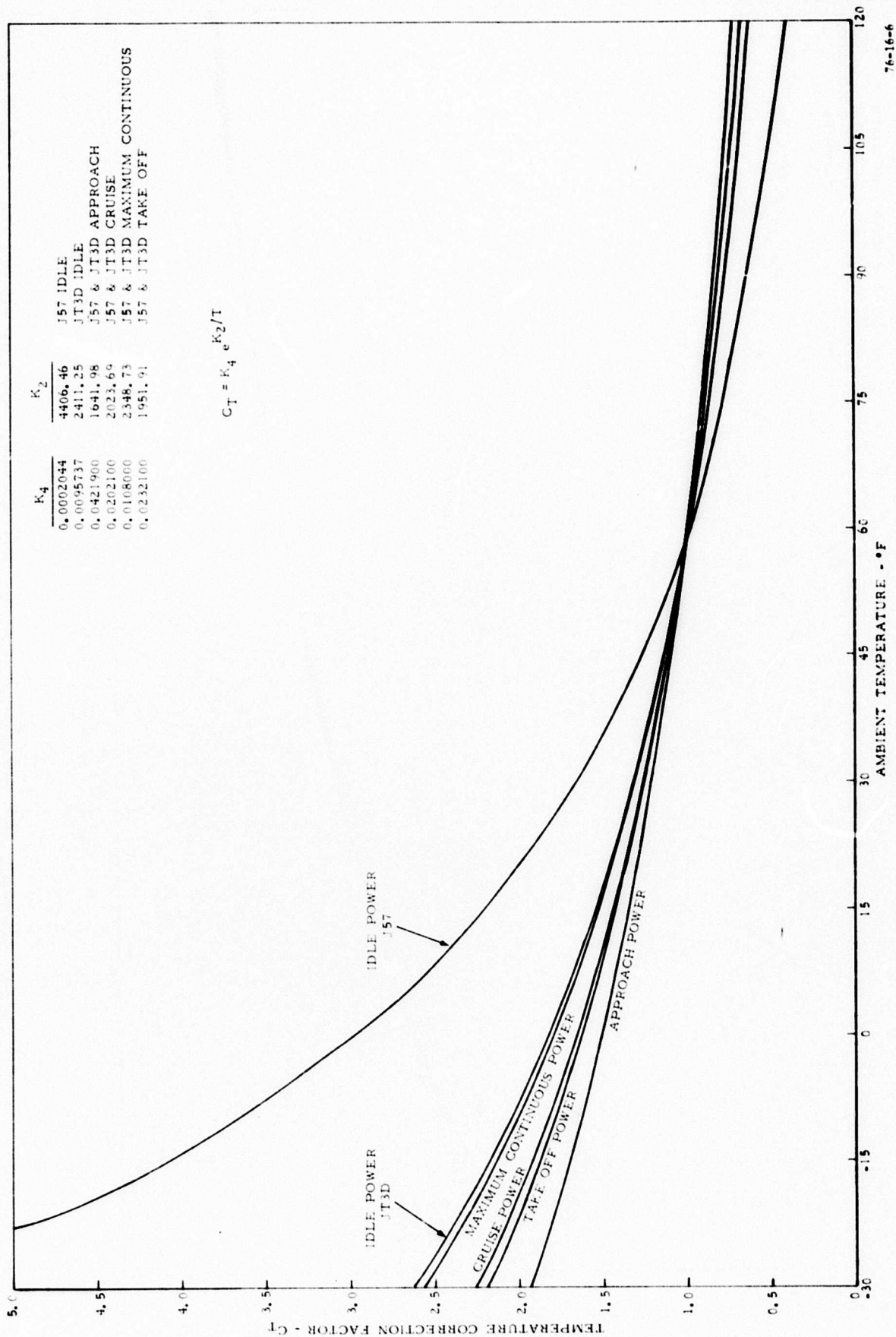


FIGURE 6. AMBIENT TEMPERATURE CORRECTION FACTORS FOR NO_x PI--J57-43 AND JT3D ENGINES

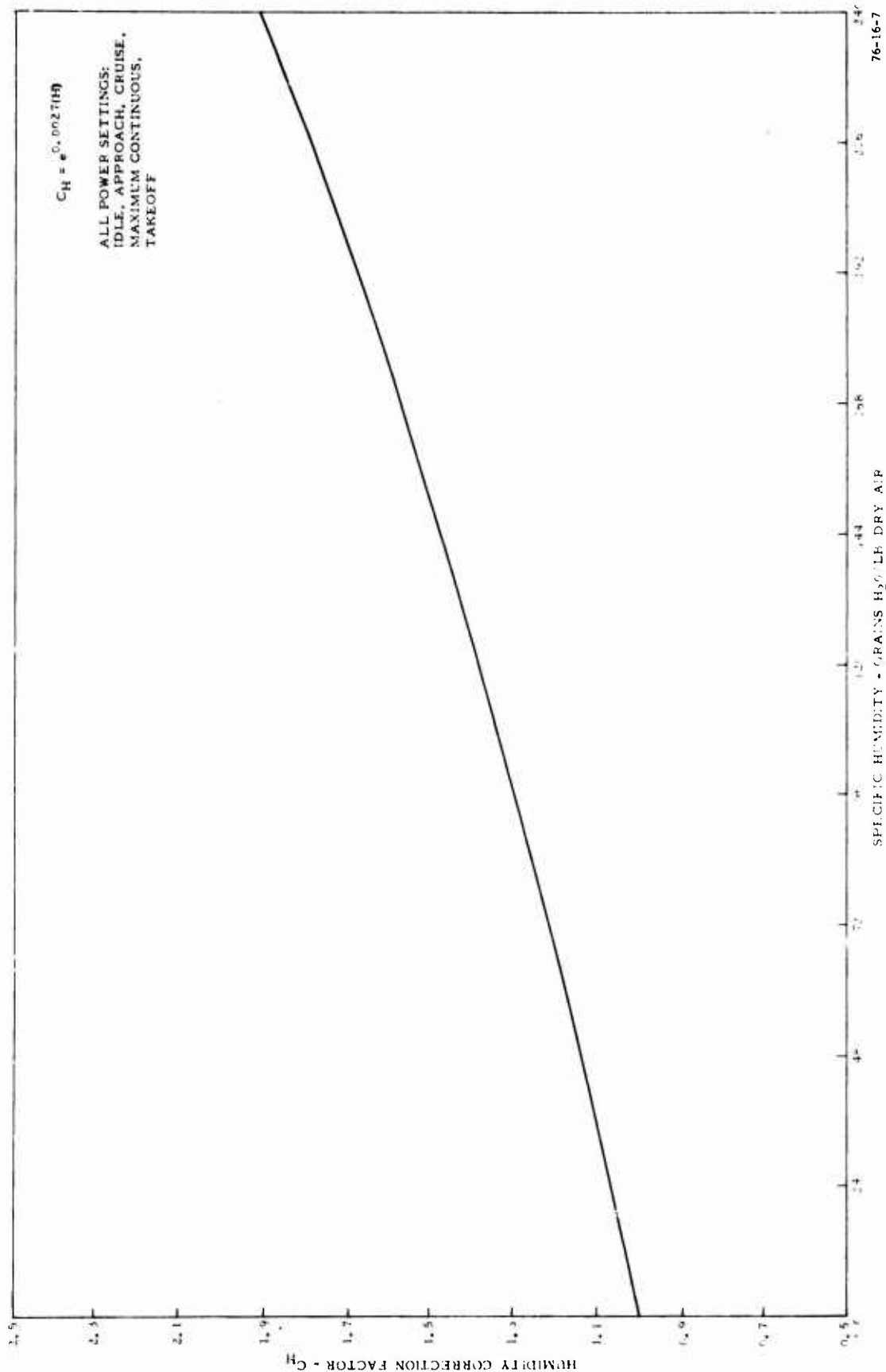


FIGURE 7. AMBIENT HUMIDITY CORRECTION FACTORS FOR NO_x EI--TF30-P1 AND J57-43 ENGINES

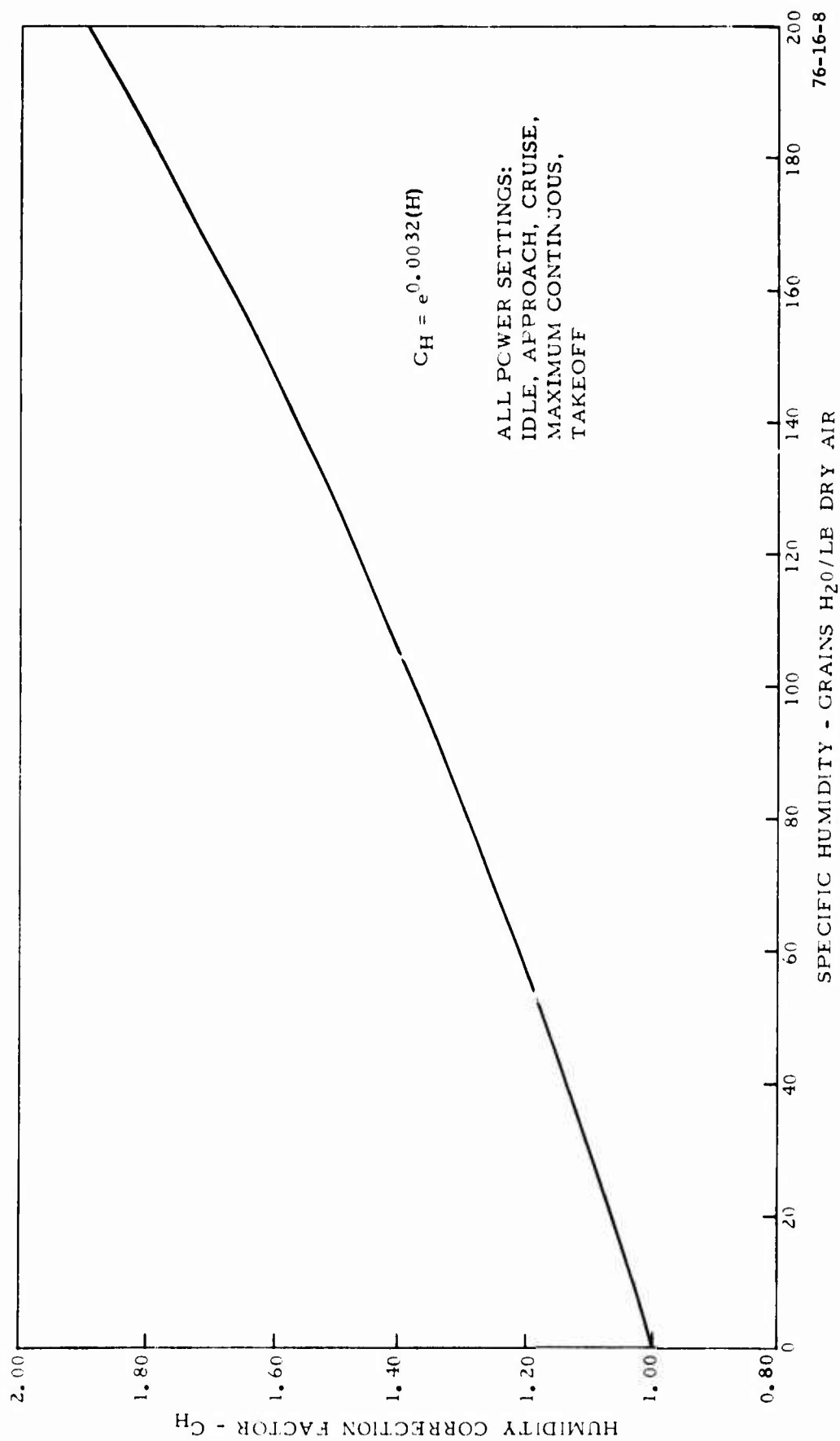


FIGURE 8. AMBIENT HUMIDITY CORRECTION FACTORS FOR NO_X PI--TF30-P1 AND J57-43 ENGINES

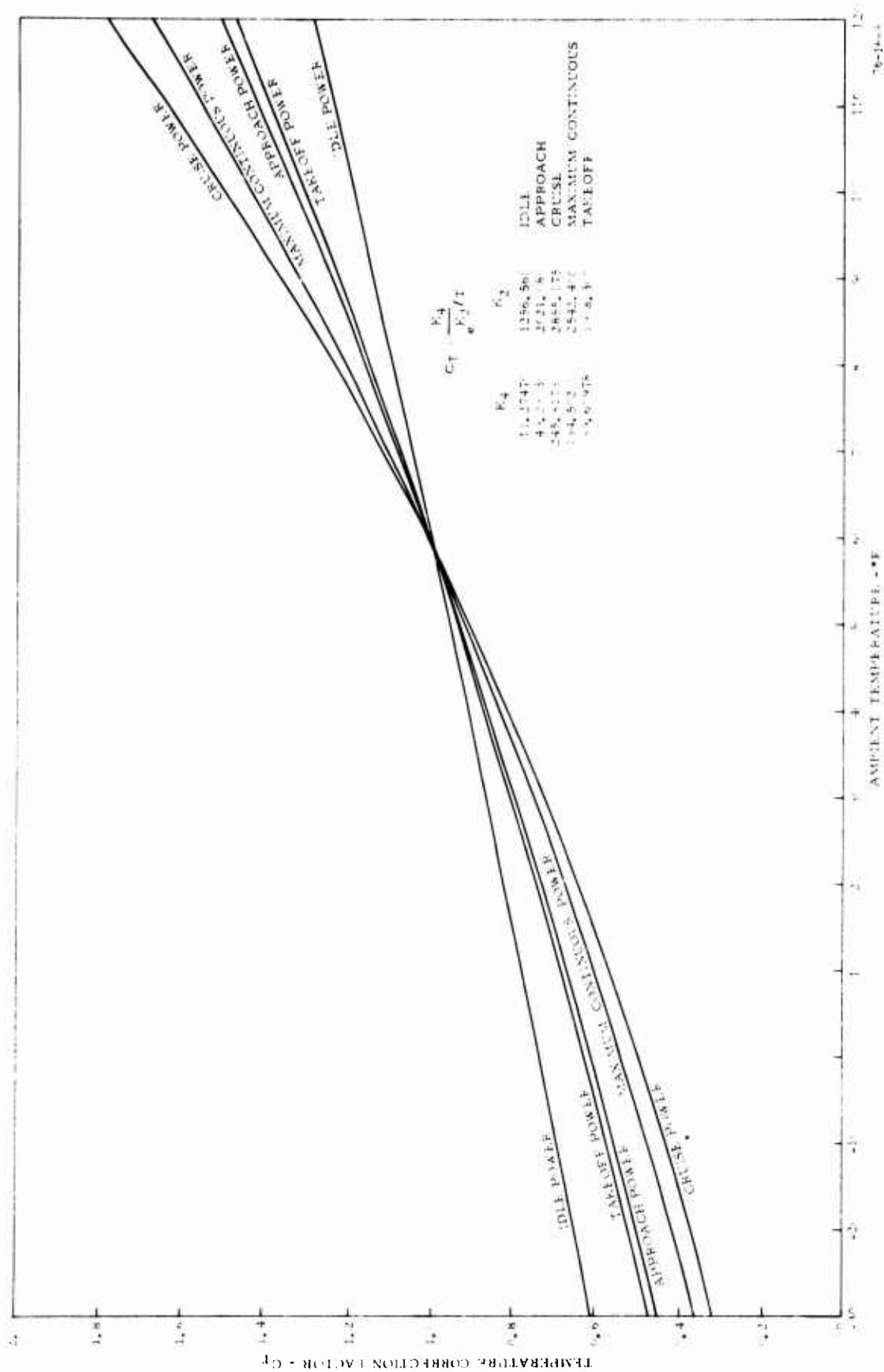


FIGURE 9. AMBIENT TEMPERATURE CORRECTION FACTORS FOR CO EI--TF30-P1 ENGINE

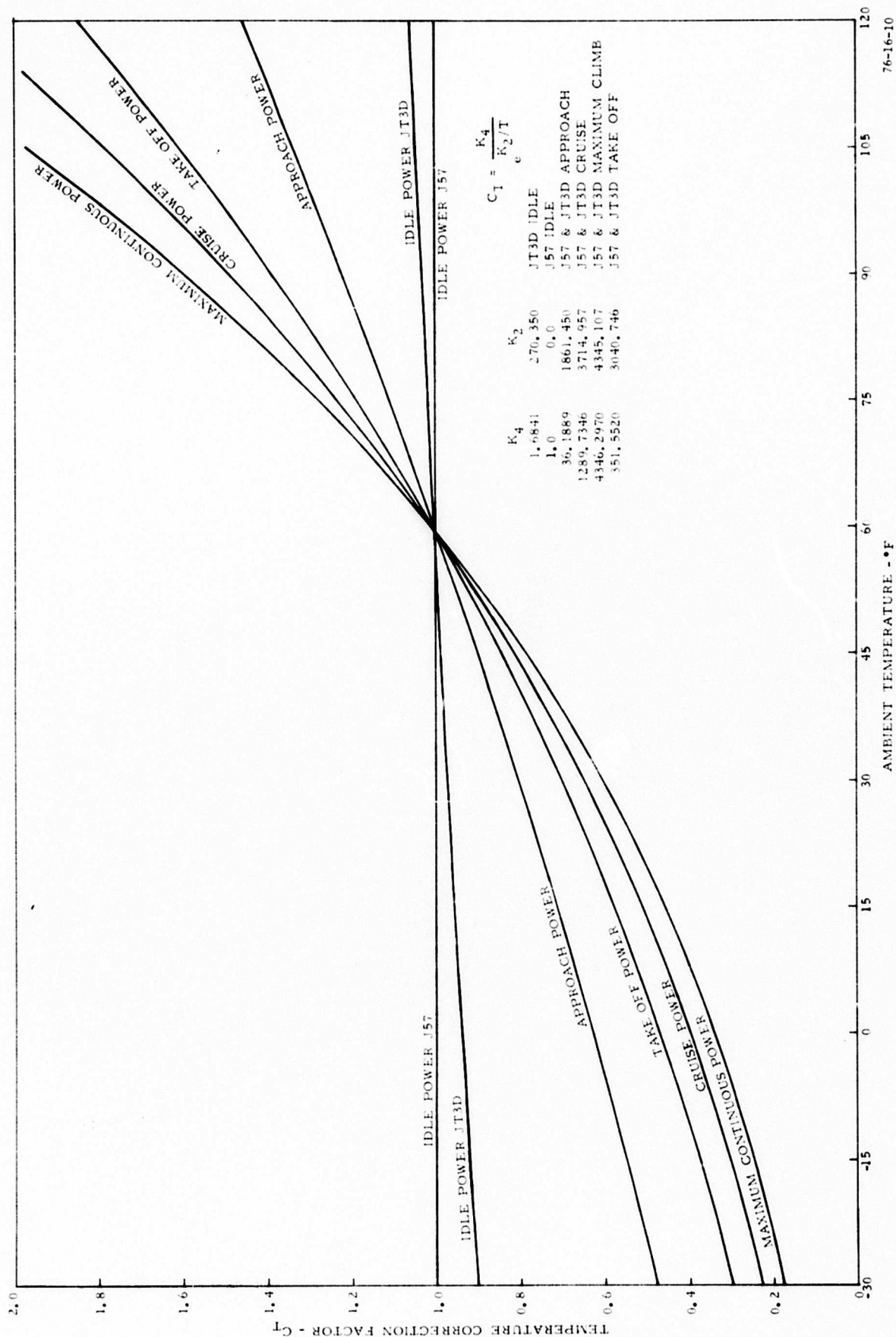
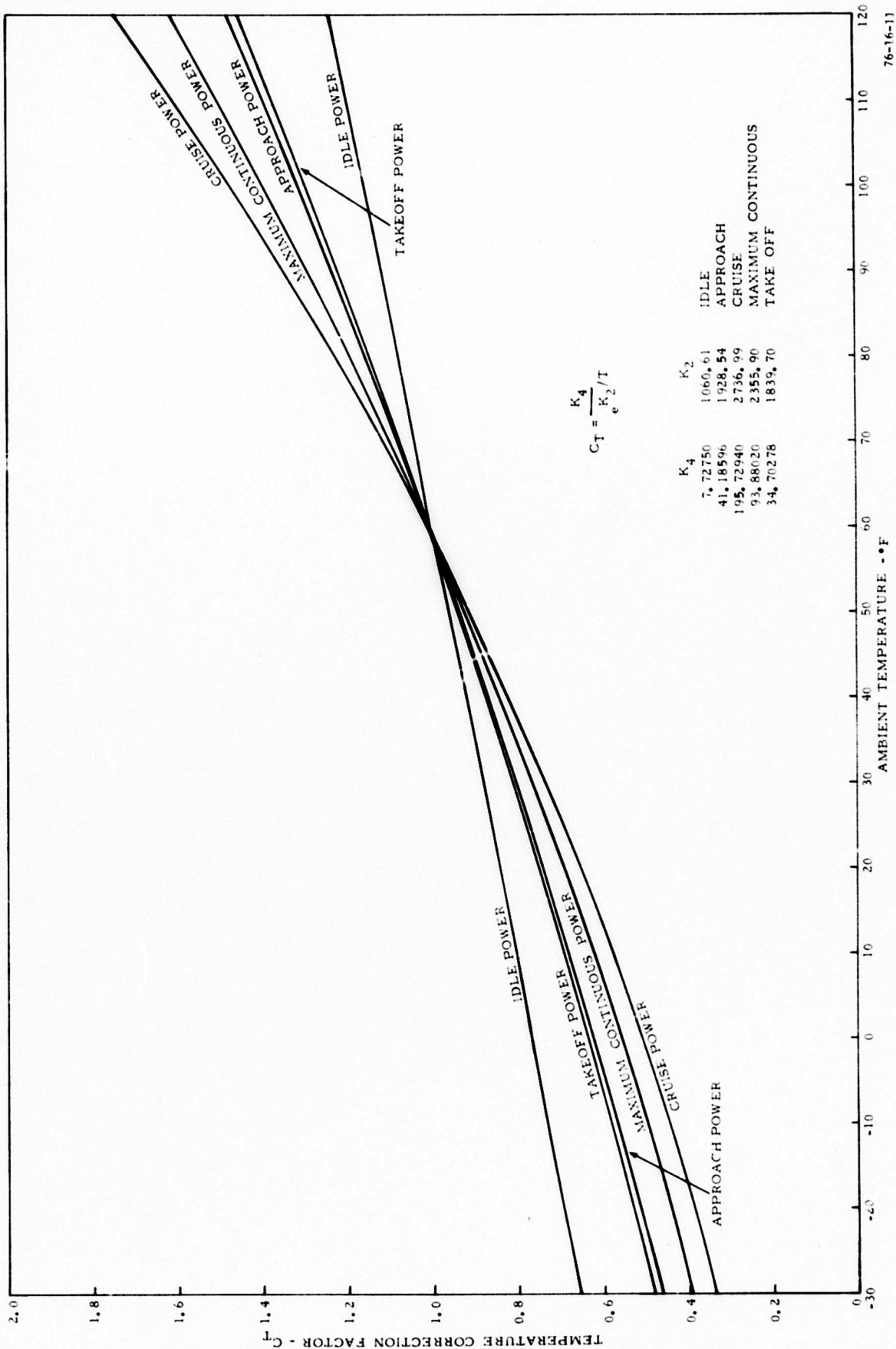


FIGURE 10. AMBIENT TEMPERATURE CORRECTION FACTORS FOR CO EI--J57 AND JT3D ENGINES



76-16-11

FIGURE 11. AMBIENT TEMPERATURE CORRECTION FACTORS FOR CO PI--TF30-P1 ENGINE

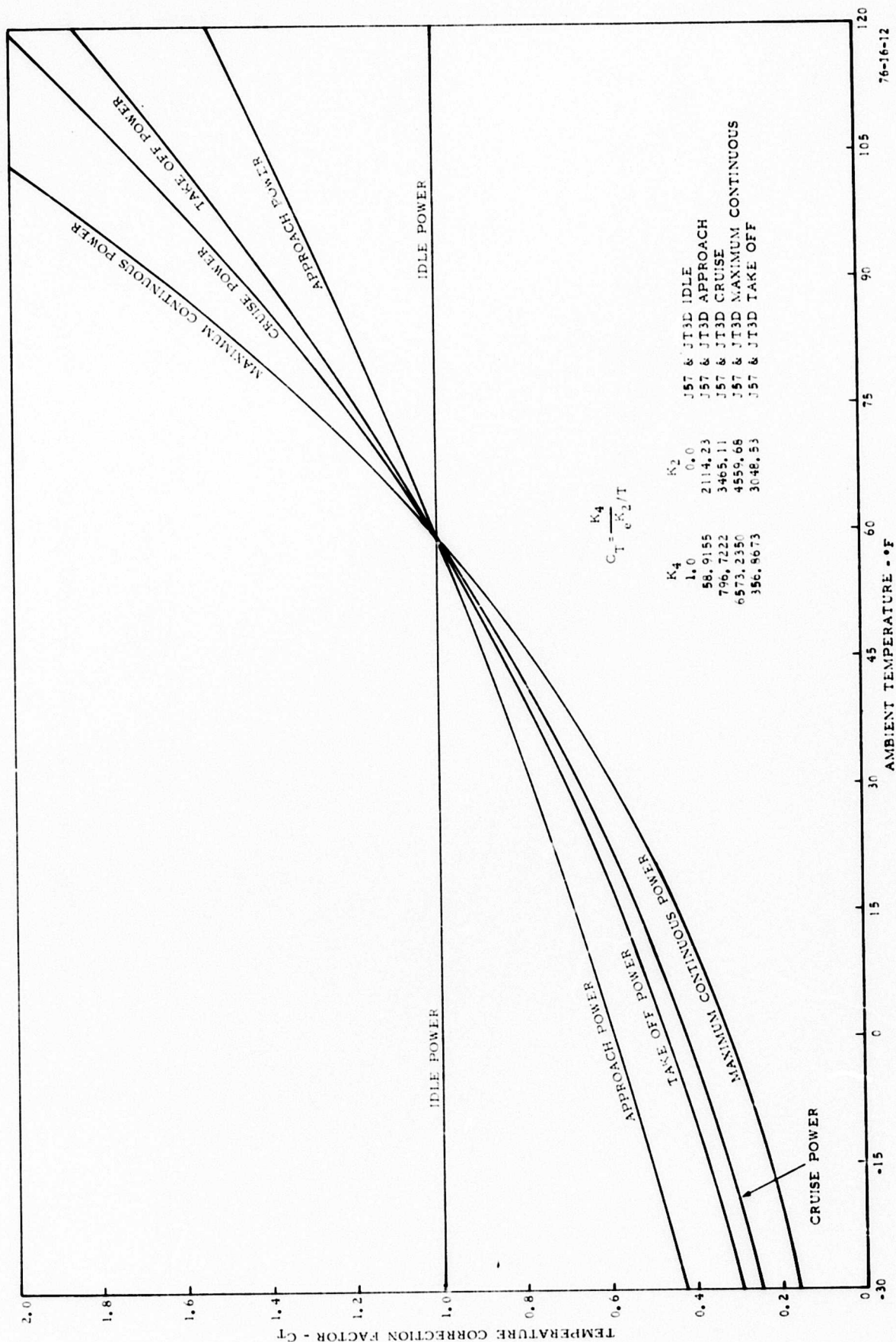


FIGURE 12. AMBIENT TEMPERATURE CORRECTION FACTORS FOR CO PI--J57-43 AND JT3D ENGINES

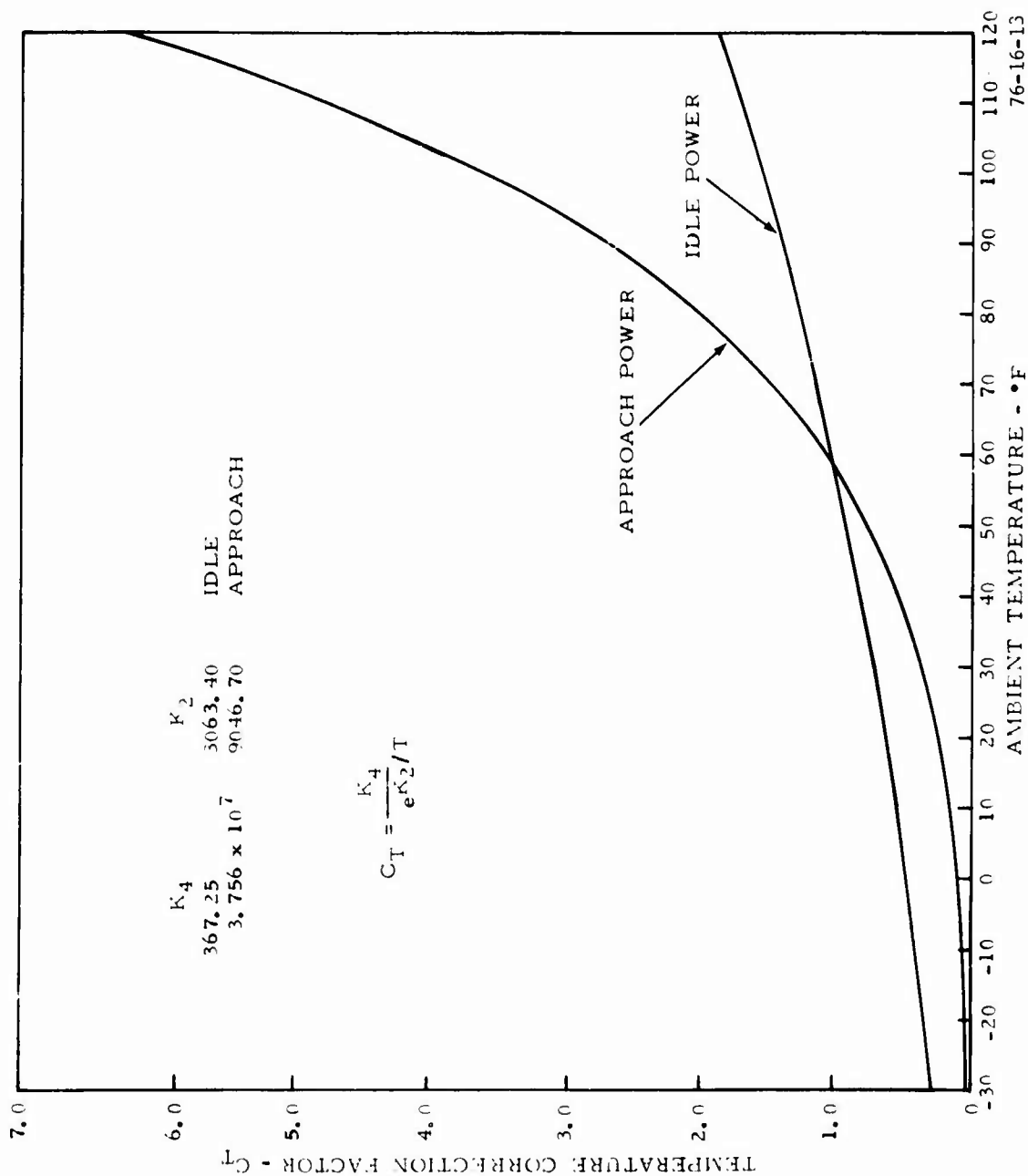


FIGURE 13. AMBIENT TEMPERATURE CORRECTION FACTORS FOR THC EI-TF30-P1 ENGINE

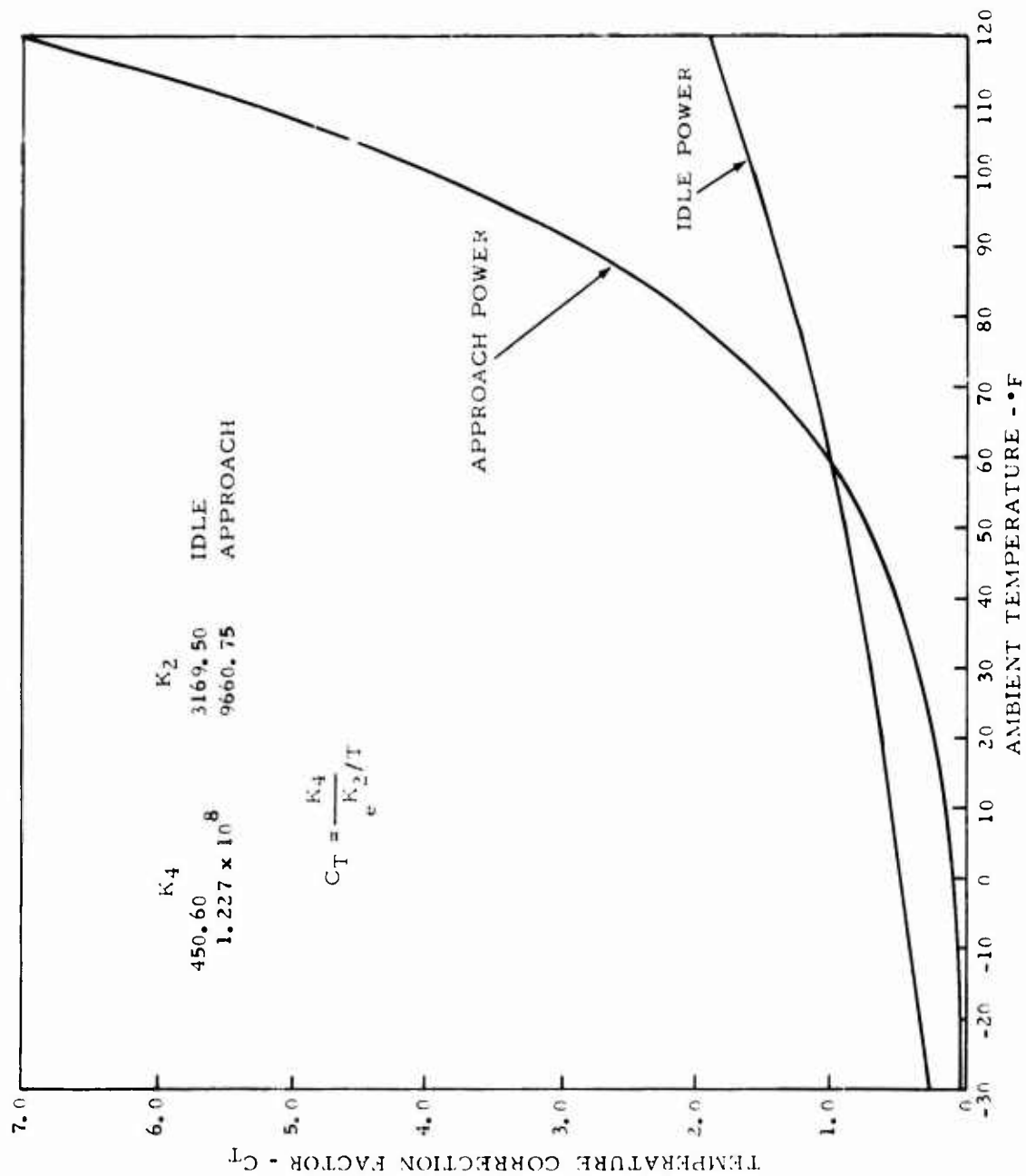
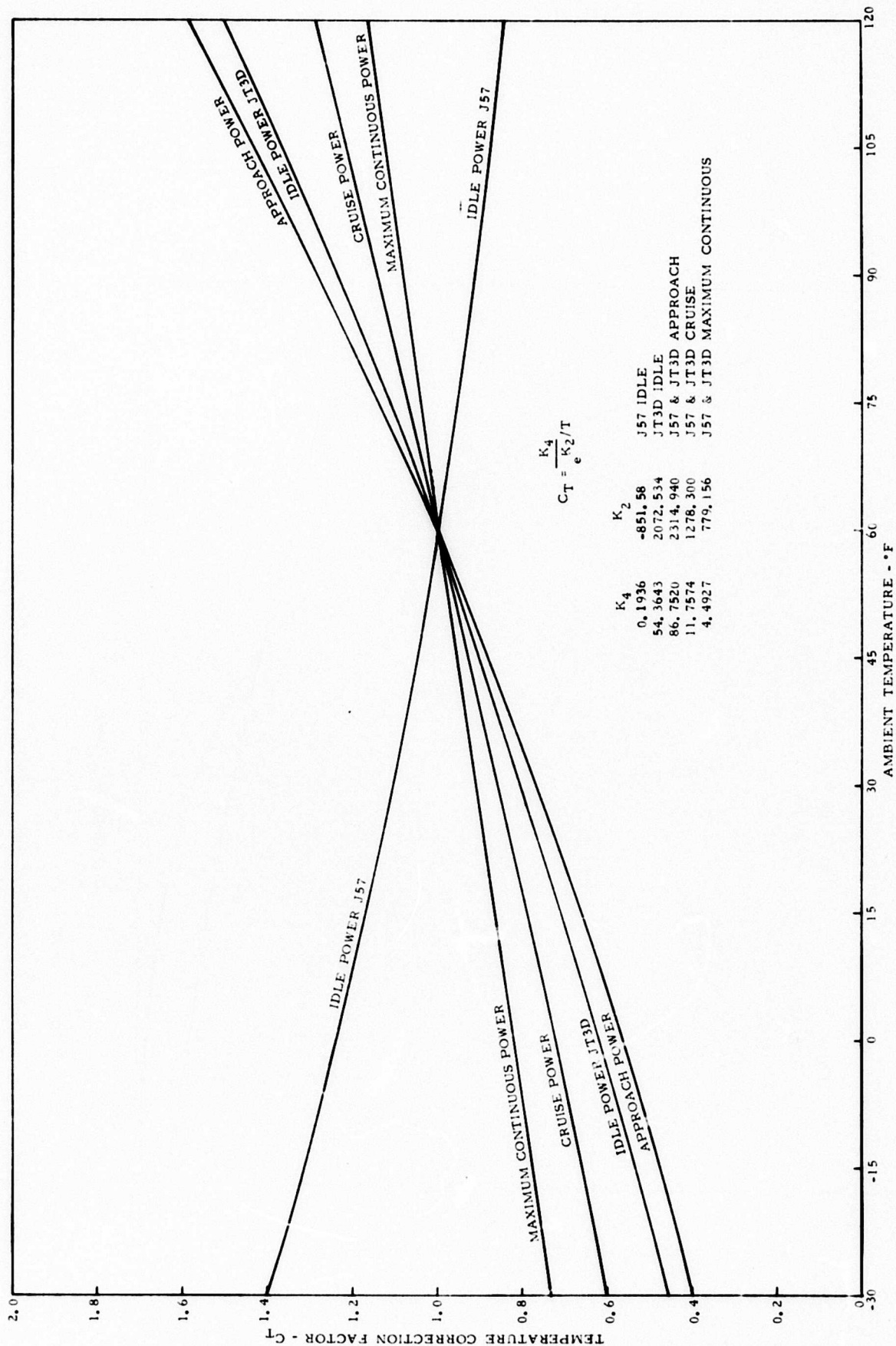


FIGURE 15. AMBIENT TEMPERATURE CORRECTION FACTORS FOR THE PI--TF30-P1 ENGINE

76-16-16



76-16-15

FIGURE 16. AMBIENT TEMPERATURE CORRECTION FACTORS FOR THE PI--J57-43 AND JT3D ENGINES

TABLE 4. VARIABILITY REDUCTION OF CORRECTED TF30-P1 AND
JT8D ENGINE EMISSION DATA BASES

Emission	TF30-P1 ENGINE			JT8D-11 ENGINE		
	Uncorrected EI One Standard Deviation	Corrected EI One Standard Deviation	Corrected EI Reduction (Percent)	Uncorrected EI One Standard Deviation	Corrected EI One Standard Deviation	Corrected EI Reduction (Percent)
CO IDLE	6.14	3.66	(40%)	3.73	2.40	(36%)
THC IDLE	3.97	1.51	(66%)	2.31	1.08	(53%)
NO _x IDLE	0.37	0.34	(8%)	0.17	0.128	(25%)
CO APP	2.54	1.66	(35%)	1.31	0.59	(55%)
THC APP	1.24	0.48	(61%)	0.24	0.14	(42%)
NO _x APP	0.49	0.37	(24%)	0.53	0.42	(21%)
CO CRUISE	0.67	0.45	(22%)			
NO _x CRUISE	1.14	1.14	(0%)			
CO MC	0.56	0.179	(68%)	0.20	0.19	(5%)
NO _x MC	0.98	0.66	(33%)	0.40	0.26	(35%)
CO T.O.	0.30	0.16	(45%)	0.20	0.18	(10%)
NO _x T.O.	1.12	1.01	(10%)	0.72	0.89	

TABLE 5. VARIABILITY REDUCTION OF CORRECTED J57-43WB
ENGINE EMISSION DATA BASE

<u>Emission</u>	<u>Uncorrected EI One Standard Deviation</u>	<u>Corrected EI One Standard Deviation</u>	<u>Corrected EI Reduction (Percent)</u>
CO IDLE	-	-	-
THC IDLE	15.14	8.74	(42%)
NO _x IDLE	0.30	0.25	(17%)
CO APP	3.04	1.18	(61%)
THC APP	1.14	0.67	(41%)
NO _x APP	0.34	0.26	(23%)
CO CRUISE	2.11	0.76	(64%)
NO _x CRUISE	0.71	0.72	(0)
CO MC	1.85	0.66	(64%)
NO _x MC	0.68	0.50	(26%)
CO TO	0.72	0.40	(44%)
NO _x TO	0.81	0.58	(28%)

SUMMARY OF RESULTS

Exhaust emission measurements were acquired from two aircraft turbine engines (J57-43WB and TF30-P1) to establish correction factors for normalizing ambient temperature, humidity, and barometric pressure effects on the generation of emissions. The mixed-flow TF30-P1 engine was modified to incorporate a fixed-area exhaust nozzle to simulate the physical characteristics and the performance of the commercial JT8D engine. A J57-43WB turbine engine was utilized as the test vehicle to simulate the physical characteristics and performance of the commercial JT3D-1 aircraft engine. Testing was conducted to take advantage of the ambient weather conditions occurring naturally during the winter through summer seasons.

The emission indexes were analyzed for ambient weather effects by postulating mathematical models that were thought likely to characterize production of emissions. The models were then evaluated by performing correlation, transformation, and multiple regression analyses. Models postulated and discarded included linear and inverse mathematical relationships. Since physical chemistry describes the behavior of chemical reaction rates logarithmically as inversely proportional to the absolute temperature, it was this equation that was utilized to characterize the production of gaseous emissions. The model was evaluated, and the equation constants were determined by a log transformation in a multiple linear regression and correlation analysis program. The correction coefficients were then determined from the ratio of the model for standard conditions, to the model for actual condition.

The measurements indicated that the factors for ambient temperature and humidity provide significant and adequate correction of emissions. Although barometric pressure may have a significant theoretical effect on emissions, the range of pressures available within the data base was only 3 percent, and the test procedures compensated for variations. Ambient temperature and humidity correction coefficients were established for each of five engine power conditions: idle, approach, cruise, maximum continuous, and takeoff for two classes of aircraft turbine engines. Separate factors were established for the various power conditions, each at constant pressure at the inlet to the combustion chambers.

The significant magnitude of the correction coefficients is striking. At an ambient temperature of zero, coefficients go as low as 0.10, and at a temperature of 100° F, the coefficients are as high as 2.40. The extremes in correction were required for the THC indexes.

The correction coefficients were evaluated by applying them to the TF30-P1 and J57-43WB engine emission data bases. The reduction in measurement variability was significant. An existing JT8D-11 engine emission data base was corrected using the TF30-P1 factors. The reduction of JT8D-11 engine emission measurement variability as corrected was of approximately equal in magnitude to that of the TF30 data base from which the factors were established. The TF30-P1

emission correction coefficients were therefore considered applicable for correction of JT8D engine emissions. A suitable data base was unavailable for testing the JT3D-1 engine correction factors developed from the J57-43WB engine emission measurements, but since the geometric and performance conditions of the J57-43WB combustion chambers were similar to combustor conditions of the JT3D engine emissions, the correction factors were considered applicable for correction of JT3D engine emissions.

CONCLUSIONS

1. The mathematical models developed to describe the emission characteristics as a function of ambient temperature and humidity of two classes of turbine engines exhibit good correlation of data when applied.
2. The correction coefficients established for the TF30 engine were considered applicable for correction of JT8D engine emissions.
3. Fuel control characteristics (control to constant thrust or constant speed) can influence emission output at idle power, and thus correction factors for the specific conditions must be developed.
4. The correction factors developed for the J57-43WB engine and modified at idle power were considered applicable for correction of JT3D engine emissions.
5. Ambient temperature is the dominant variable affecting the production of emissions. Humidity had significant secondary effects on the generation of nitrogen oxides.
6. Ambient temperature and humidity effects on the production of emissions are considered to have been a major source of variability in past investigations.

REFERENCES

1. Clean Air Amendments of 1970, Public Law 91-604, 91st Congress, H.R. 17255, December 31, 1970.
2. McAdams, H. T., Analysis of Aircraft Exhaust Emission Measurements Statistics, EPA Technical Report NA 5007-K-2.
3. Slusher, G. R., Analytical Study of Mixed-Flow JT8D Exhaust Emission Measurements for Fixed Probe Requirements, FAA Technical Report FAA-RD-76-140.
4. Klueg, Eugene P. and Slusher, G. R., Exhaust Emission Probe Investigation of a Mixed Flow Turbofan Engine, Technical Paper Presented before October 1974 Meeting, Instrument Society of America, New York, New York.
5. Sarli, V. J., Eiler, D. C., Marshall, R. L., Effects of Operating Variables on Gaseous Emissions, Technical Paper Presented before October, 1975 Meeting of Air Pollution Control Association Specialty Conference on Air Pollution Measurement Accuracy as in Relation to Regulation Compliance. New Orleans, Louisiana.
6. Control of Air Pollution from Aircraft and Aircraft Engines, Federal Register, Volume 38, Number 136, Part II, 17 July 1973.

APPENDIX A

TF30-P1, JT8D-11, AND J57-43WB ENGINE PERFORMANCE
WITH OBSERVED AND CORRECTED EMISSION INDEXES

APPENDIX A

LIST OF TABLES

Table		Page
A-1	TF30-P1 Engine Performance with Observed and Corrected Emission Indexes at Idle Power	A-2
A-2	TF30-P1 Engine Performance with Observed and Corrected Emission Indexes at Approach Power	A-4
A-3	TF30-P1 Engine Performance with Observed and Corrected Emission Indexes at Cruise Power	A-6
A-4	TF30-P1 Engine Performance with Observed and Corrected Emission Indexes at Maximum Continuous Power	A-8
A-5	TF30-P1 Engine Performance with Observed and Corrected Emission Indexes at Takeoff Power	A-11
A-6	JT8D-11 Engine Performance with Observed and Corrected Emission Indexes at Idle Power	A-13
A-7	JT8D-11 Engine Performance with Observed and Corrected Emission Indexes at Approach Power	A-14
A-8	JT8D-11 Engine Performance with Observed and Corrected Emission Indexes at Maximum Continuous Power	A-15
A-9	JT8D-11 Engine Performance with Observed and Corrected Emission Indexes at Takeoff Power	A-16
A-10	J57-43 Engine Performance with Observed and Corrected Emission Indexes at Idle Power	A-17
A-11	J57-43 Engine Performance with Observed and Corrected Emission Indexes at Approach Power	A-19
A-12	J57-43 Engine Performance with Observed and Corrected Emission Indexes at Cruise Power	A-21
A-13	J57-43 Engine Performance with Observed and Corrected Emission Indexes at Maximum Continuous Power	A-23
A-14	J57-43 Engine Performance with Observed and Corrected Emission Indexes at Maximum Continuous Power	A-25

APPENDIX A

TF30-P1, JT8D-11, AND J57-43WB ENGINE PERFORMANCE WITH OBSERVED AND CORRECTED EMISSION INDEXES

Engine performance and emission measurements for the TF30-P1, JT8D-11, and J57-43WB engines at each of five power conditions are tabulated in tables A-1 through A-14. Compressor inlet temperature, humidity, and barometric pressure are included to provide a data base for possible future correlation analysis. The calculated emission indexes, EI and PI are tabulated. The emission index is also corrected using the technique developed in this report.

TABLE A-1. F130-F1 ENGINE PERFORMANCE WITH OBSERVED AND CORRECTED EMISSION INDEXES AT IDLE POWER

RUN NO.	U. V. L. IN DRY AIR	H ₂ GRAINS PER LB. OF DRY AIR	P BAR IN. A	EPG	AIR FLOW LBS./SEC	FUEL FLOW LBS./HR	THRUST LBS	U ₁ OF	CRP. IND. RATIO	CO. E.	HR. E.	NO. X L.	CO. P.	HR. P.	NO. X P.	F/A CARBON BALANCE	F/A MEASURED	CO. E. CORP.	HR. E. CORP.	NO. X E. CORP.
21	17	10.72	30.44	1.076	72.7	833.8	945.2	165	2.562	70.66	29.76	1.96	62.33	26.25	1.72	.00901	.00319	57.08	17.69	2.85
24	35	15.61	30.44	1.082	77.5	897	1095	180	2.710	63.35	19.87	2.417	51.90	16.28	1.98	.00928	.00322	56.33	14.92	3.05
30	37	26.89	30.24	1.083	77.8	914.2		230	2.688	64.73	19.42	2.47	31.08	9.32	1.19	.00906	.00326	58.14	14.95	3.16
34	65	74.02	29.88	1.080	77.6	975.9	1066	250	2.675	53.38	11.62	2.19	48.86	10.64	2.00	.00952	.00349	54.88	12.43	2.56
39	40	20.59	29.92	1.082	78.8	896.4	1093	230	2.706	60.11	16.15	1.95	49.30	13.25	1.60	.00903	.00316	54.82	12.90	2.39
47	38	18.79	29.86	1.084	80.7	888	1085	217	2.709	66.67	13.90	2.48	54.57	11.38	2.03	.00904	.00306	60.19		3.08
53	31	10.72	29.98	1.087	80.7	907.5	1110	193	2.701	68.04	18.23	2.46	55.63	14.90	2.01	.00910	.00312	59.26	13.01	3.17
56	36	23.57	29.93	1.080	79.0	892.4	1154	215	2.706	61.27	16.98	1.75	47.38	13.13	1.36	.00908	.00314	54.76	12.91	2.24
62	38	21.54	29.65	1.084		882.5	1112	197	2.687	64.58	16.03	2.64	51.25	12.73	2.10	-		57.31	12.49	3.30
64	58	25.74	30.36	1.073	73.3	903.6	977.9	230	2.517	64.70	13.86	2.65	59.78	12.61	2.45	.00807	.00342	64.40	13.70	2.86
72	59	28.08	30.32		76.0	894.9	1050	240	2.618	62.02	14.90	2.88	52.86	12.70	2.46	.00945	.00327	62.02	14.90	3.11
73	76	74.02	29.87	1.079	77.5	902.1	1036	280	2.642	53.09	10.84	3.11	46.23	9.44	2.71	.00928	.00323	57.33	13.67	3.35
80	69	74.02	29.81	1.081	79.2	914.7	1089	265	2.646	61.48	13.1	1.40	51.64	11.01	2.86	.00895	.00321	64.36	14.66	3.86
81	52	33.27	29.81	1.082	78.1	897.5	1098	-	2.578	-	13.03	-	-	-	-	.00319	-	-	12.02	-
89	52	33.27	29.84	1.084	77.2	894.3	1097	-	2.678	-	15.07	-	-	-	-	.00322	-	-	13.90	-
90	55	22.54	30.09	1.083	77.7	882.6	1078	-	2.664	58.07	13.83	4.23	47.54	11.32	1.83	.00934	.00316	56.99	13.21	2.44
98	52	22.54	30.08	1.083	78.8	885.8	1068	235	2.665	60.82	15.03	2.69	50.44	12.47	2.23	.00892	.00312	58.84	13.86	3.02
99	74	74.02	29.90	1.075	77.5	893.8	1014	270	2.607	52.96	12.61	2.38	46.68	11.12	2.10	.01011	.00320	56.69	14.88	2.60
107	71	76.67	29.86	1.082	77.5	886	995.4	265	2.643	53.60	10.72	3.14	47.71	9.54	2.79	.00970	.00318	56.62	12.25	3.53
108	72	64.17	30.00	1.080	75	888.1	1043	262	2.672	55.77	12.88	2.56	47.49	10.96	2.18	.00937	.00329	59.17	14.88	2.69
116	69	66.53	29.92	1.084	77.5	887.1	1045	250	2.674	59.22	14.10	2.56	50.27	11.97	2.17	.00940	.00319	62.00	15.76	2.84
117	84	88.10	29.84	1.077	76.6	884.8	1017	287	2.678	52.47	10.91	2.86	45.65	9.49	2.49	.00953	.00321	58.65	14.31	3.03
125	83	97.63	29.80	1.077	77.9	885.9	1019	280	2.647	53.05	8.51	2.64	46.12	7.40	2.29	.00787	.00316	59.05	11.05	2.89
126	77	85.11	29.85	1.080	78.6	890	1016	280	2.677	54.29	10.89	2.52	47.56	9.54	2.21	-	.00315	58.89	12.19	2.78
134	81	64.17	29.80	1.081	77.4	880.4	1007	275	2.646	52.08	8.73	2.71	45.54	7.63	2.38	.0100	.00316	57.48	11.10	2.75
135	70	49.51	30.00	1.085	79.5	896	1061	252	2.702	53.32	10.77	2.97	45.03	9.09	2.50	.00918	.00313	56.07	12.17	3.13
142	70	47.66	29.98	1.084	79.1	892.2	1042	250	2.670	59.09	11.05	2.90	50.59	9.46	2.48	.00941	.00313	62.14	12.49	3.04

TABLE 1. 15-90-PI ENGINE PERFORMANCE WITH OBSERVED AND CORRECTED EMISSION INDEXES AT IDLE POWER (Continued)

RUN NO.	15-90-PI	GRAINS PER HOUR	P BAR IN HG	BAR IN HG	AIR FLOW LBS/HR	FUEL FLOW LBS/HR	THROTTLE LBS	U ₃ OF	COMP PRESS RATIO	CO FI	HC FI	NO _x FI	F/A CARBON BALANCE	F/A MEASURED	CO FI CORR	HC FI CORR	NO _x FI CORR	
143	70	68.95	30.14	1.082	-	876.8	1038	262	2.664	56.84	13.10	2.71	.00947		59.77	14.81	3.01	
151	70	66.53	30.09	1.083	78.8	896.8	1058	260	2.697	75.82	9.80	3.70	.00734	.00316		11.08	4.08	
152	74	74.02	30.22	1.080	78.6	891.3	1054	272	2.690	55.17	11.73	2.89	.00944	.00315	59.06	13.85	3.16	
160	74	71.45	30.20	1.083	78.9	889.8	1055	270	2.691	56.95	11.01	2.88	.00945	.00313	60.96	13.00	3.13	
161	78	74.02	30.13	1.080	79	890.7	1057	272	2.695	54.09	11.50	2.67	.00952	.00313	58.93	14.17	2.84	
169	78	71.45	30.11	1.080	78.3	886.9	1048	270	2.696	54.23	8.56	2.84	.00960	.00315	59.08	10.54	3.00	
170	90	151.09	29.73	1.081	77.9	879	1032	290	2.650	45.64	10.52	2.36		.00313	52.32	14.68	2.85	
178	90	127.86	29.72	1.081	74.9	860.9	1002	280	2.618	46.69	10.70	-	.01003		53.53	14.93	-	
188	70	88.10	29.83	1.082	78.0	975.9	1043	250	2.645	56.20	11.64	2.78	.00922	.00312	59.10	13.16	3.25	
190	76	88.10	29.83	1.084	77.3	875.5	1038	255	2.678	54.28	-	2.60	.00985	.00315	58.62	14.61	2.91	
191	78	59.67	30.10	1.080	79	881.7	1058	272	2.663	61.36	11.86	3.36						
199	78	57.52	30.07	1.080	77	879.5	1039	265	2.665	67.77	11.36	3.08	.00833	.00310	66.85	14.00	3.44	
200	78	79.40	30.08	1.077	78.9	881.4	1059	270	2.664	52.66	10.10	3.13	.00921	.00310	57.37	12.69	3.38	
208	77	74.02	30.06	1.082	79.0	893.9	1060	265	2.699	54.46	-	2.82	.00965	.00314	59.07	-	3.02	
209	85	115.62	29.87	1.079	79.7	883.7	1067	265	2.676	55.01	9.42	2.67	.00961	.00308	61.75	12.47	3.03	
217	85	108.09	29.84	1.081	65.9	877.4	1069	250	2.644	52.52	9.24	2.75	.00962	.00370	58.96	12.25	3.05	
218	68	74.02	29.98	1.080	79.5	882.8	1068	240	2.704	52.94	10.25	2.74	.00965	.00309	55.17	11.35	3.13	
226	66	82.21	29.98	1.080	79.0	883.6	1063	245	2.670	58.58	11.55	2.98	.00915	.00311	60.50	12.49	3.53	
227	90.5	101.01	29.94	1.080	78.3	879.1	1012	270	2.636	50.30	8.45	2.92	.00933	.00312	57.78	11.85	3.06	
235	91	104.49	29.94	1.080	78	885.5	1034	270	2.672	48.46	7.51	2.71	.01005	.00315	55.79	10.58	2.86	
236	91	127.86	29.88	1.074	77.9	875.1	1016	270	2.608	48.80	8.45	2.56	.01003	.00312	56.18	11.41	2.88	
244	91	123.65	29.86	1.080	78.5	884.3	1037	270	2.643	47.04	7.53	2.91	.00991	.00313	54.15	10.61	3.24	
245	90	136.70	29.73	1.081	77.4	874.8	1022	275	2.617	48.02	8.97	-	.01000	.00314	55.05	12.52		
253	91	132.21	29.70	1.084	78.9	887.7	1074	-	2.652	48.42	8.41	-	.00977	.00317	55.74	11.85		
X	-	-	-	-	-	-	-	-	-	55.60	12.24	2.71	-	-	-	-	13.13	3.04
S	-	-	-	-	-	-	-	-	-	6.14	3.97	.369	-	-	-	-	1.51	3.42

TABLE A-2. IF30-P1 ENGINE PERFORMANCE WITH OBSERVED AFD CORRECTED EMISSION INDEXES AT APPROACH POWER

RUN NO.	U ₂ °F	H ₂ O VIB DRY AIR	P _{BAR} IN HG A	FPR	AIR FLOW LBS/SEC	FULL FLOW LBS/HR	INDUST LBS	U ₂ °F	COIL PRESS RATIO	CO EFF	HC EFF	NO _x EFF	F/A CARBON BALANCE	F/A WASTEWATER	CO EFF CORR	THK EFF CORR	NO _x EFF CORR
22	18	12.34	30.44	1.320	143	2266	3879	368	6.274	19.41	-	4.35	11.34	2.90	2.54	1.75	6.22
23	23	14.21	30.44	1.320	143.3	2275	3889	369	6.307	18.93	2.80	5.05	11.08	1.64	2.95	.61	6.94
29	36	26.89	30.24	1.309	141.1	2211	3806	420	6.209	17.86	2.34	4.63	10.37	1.36	2.69	1.04	5.90
31	37	26.89	30.24	1.312	142.4	2256	3826	425	6.275	17.14	3.28	4.77	10.11	1.93	2.82	1.51	6.03
35	65	74.02	29.87	1.312	143.1		3763	460	6.287	12.84	2.17	4.83	11.14	1.88	4.19	2.11	5.59
40	40	20.59	29.89	1.317	143.3	2270	3855	425	6.297	16.35	1.95	4.29	9.63	1.14	2.53	.80	5.21
46	38	18.79	29.86	1.319	146.7	2241	3861	415	6.272	15.19	1.37	4.66	8.81	.79	2.70	.52	5.72
54	31	10.72	29.98	1.314	144.4	2204	3742	400	6.167	18.26	2.07	4.71	10.76	1.22	2.78	.76	5.95
63	38	21.54	29.80	1.315	150	2217	3823	415	6.221	18.19	1.75	5.16	10.55	1.01	2.99	.67	6.38
65	58	25.74	30.34	1.311	145.9	-	3893	455	6.308	14.63	.92	5.59	11.47	.72	4.38	.89	5.98
71	58	28.08	30.32	1.318	141.1	-	3859	443	6.281	13.95	.62	5.60	11.00	.49	4.41	.60	6.03
74	75	74.02	29.86	1.311	145.7	-	3769	495	6.212	12.96	1.22	5.68	10.85	1.02	4.75	2.05	6.11
79	70	71.45	29.82	1.310	142.2	-	3775	480	6.082	13.25	.95	5.95	11.12	.78	5.00	1.33	6.59
82	52	33.27	29.82	1.313	144.5	2387	3794	-	6.182	-	-	-	-	.00459	-	-	-
88	52	33.27	29.84	1.309	143.7	2386	3791	-	6.178	-	-	-	-	.00461	-	-	-
91	53	22.54	30.08	1.314	144.8	2205	3785	445	6.170	15.79	1.90	5.30	9.20	1.11	3.09	1.55	5.83
97	51	22.54	30.08	1.317		2239	3844	435	6.251	16.43	1.50	4.74	9.58	.88	2.76	1.14	5.30
100	72	74.02	29.89	1.319	145.0	-	3741	480	6.201	11.75	1.32	4.66	9.64	1.08	3.82	2.02	5.12
106	72	76.07	29.86	1.326	146.3	-	3767	480	6.276	12.34	.58	5.84	10.21	.48	4.83	.89	6.47
109	74	64.17	29.94	1.325	146.5	2251	3756	470	6.194	13.72	.89	5.53	8.22	.53	3.31	1.45	5.84
115	70	66.53	29.92	1.329	146.9	2237	3757	510	6.230	13.72	1.04	5.39	8.17	.62	3.21	1.49	5.89
118	84	88.10	29.82	1.336	147.1	2330	3824	508	6.384	12.65	.60	5.71	7.71	.36	3.48	1.34	6.00
124	84	96.35	29.80	1.317	142.8	2322	3828	508	6.389	12.17	.48	5.29	7.38	.30	3.21	1.07	5.65
127	80	85.11	29.84	1.333	150	2312	3834	495	6.412	12.49	.45	5.70	7.52	.27	3.43	.88	6.10
133	81	71.45	29.80	1.330	148.5	2325	3846	500	6.388	11.99	.36	5.47	7.25	.22	3.30	.73	5.61
136	69	47.66	29.98	1.328	149.6	2314	3841	468	6.356	13.76	.90	5.91	8.29	.54	3.56	1.25	6.18
141	69	47.66	29.98	1.331	149.4	2311	3841	455	6.422	13.76	.60	5.91	8.28	.36	3.56	.83	6.18

TABLE A-2. TF30-P1 ENGINE PERFORMANCE WITH OBSERVED AND CORRECTED EMISSION INDEXES AT APPROXIMATE POWER (Continued)

RUN NO.	U ₂ %	H ₂ O V LB DRY AIR	P _{bar} IN HG A	APR FLOW LBS/SEC	FULL FLOW LBS/HR	THROST LBS	U ₂ %	COMP PRESS RATIO	CO L ₁	FOR L ₁	NO L ₁ X	CO P ₁	HC P ₁	NO _X P ₁	F/A CARBON BALANCE	F/A MEASURED	CO L ₁ CORR	THC L ₁ CORR	NO _X L ₁ CORR	
144	69.5	68.95	30.10	1.327	2306	3837	478	6.433	13.1	.75	5.61	8.30	.45	3.37	.01117	.00426	14.92	.85	6.19	
150	70	66.53	30.09	1.327	2291	3839	473	6.436	12.47	.53	5.75	7.44	.31	3.43	.01117	.00425	13.52	.76	6.28	
153	74	74.02	30.21	1.327	2304	3845	490	6.449	12.87	.59	5.78	7.71	.35	3.47	.01138	.00424	14.36	.96	6.26	
159	74	71.45	30.20	1.329	2314	3876	490	6.450	12.22	.52	5.78	7.29	.31	3.45	.01138	.00427	13.63	.83	6.22	
162	78	74.02	30.13	1.313	2269	3834	484	6.261	12.31	.85	5.27	7.16	.49	3.06	.01189	.00415	14.13	1.57	5.55	
168	78	74.02	30.11	1.313	2248	3836	475	6.332	11.37	.36	5.65	6.66	.21	3.01	.01165	.00420	13.05	.66	5.95	
171	92	151.09	29.73	1.324	2265	3892	510	6.366	16.34	.14	5.08	9.51	.08	2.96	.01202	.00424	20.63	.32	5.99	
177	90	136.70	29.72	1.322	2261	3892	510	6.334	16.04	-	4.97	9.31	-	2.90	.01229	.00422	19.98	-	5.72	
189	74	88.10	29.83	1.315	2236	3773	460	6.182	14.50	.66	5.10	8.59	.39	3.02	.01149	.00425	16.18	1.08	5.74	
192	77	61.49	30.10	1.317	2237	3837	485	6.301	15.07	.97	6.48	8.79	.56	3.78	.01040	.00423	17.17	1.74	6.66	
198	78	57.52	30.08	1.317	2209	3841	472	6.239	13.63	.48	6.25	7.84	.28	3.59	.01040	.00417	15.64	.89	6.30	
201	77	76.67	30.08	1.312	2203	3842	-	6.205	12.84	.15	5.77	7.38	.09	3.32	.01128	.00418	14.63	.27	6.17	
207	77	74.02	30.06	1.347	2446	-	505	-	10.45	.07	-	6.04	.04	-	.01173	.00440	11.91	1.25	-	
210	84	115.62	29.86	1.348	2433	-	500	-	9.17	.28	5.72	5.28	.16	3.29	.01208	.00438	10.97	.62	6.47	
216	85	111.79	29.84	1.355	2481	-	490	-	9.46	.42	5.71	5.43	.24	3.34	.01209	-	11.39	.54	6.35	
219	68	74.02	29.98	1.315	2245	3854	445	6.290	14.35	1.19	4.71	8.36	.70	2.74	.01126	.00422	15.34	1.60	5.33	
225	66.5	85.11	29.97	1.318	2228	3858	445	6.360	14.30	.45	5.34	8.26	.26	3.09	.01127	.00414	15.12	.58	6.29	
228	90	97.63	29.96	1.318	2277	3858	500	6.292	10.81	.57	6.00	6.38	.34	3.54	.01177	.00428	13.47	1.52	6.21	
234	90	104.49	29.94	1.322	2279	3862	-	6.331	10.96	.28	5.68	4	4	-	.01216	.00428	13.65	.75	5.99	
237	91	127.86	29.88	1.319	2262	3361	490	6.307	10.96	.36	5.50	6.42	.21	3.22	.01182	.00424	13.75	.99	6.13	
243	91	123.65	29.86	1.323	2293	3894	485	6.378	10.88	.21	5.73	6.37	.12	3.36	.01192	.00425	13.64	.58	6.32	
246	90	136.70	29.72	1.321	2278	3882	495	6.335	11.14	.71	5.31	6.54	.41	3.11	.01190	.00426	13.88	1.90	6.11	
252	90	136.70	29.71	1.321	2296	3895	480	6.338	10.75	.35	5.21	6.34	.21	3.07	.01203	.00430	13.39	.94	5.99	
X	-	-	-	-	-	-	-	-	13.70	1.08	5.41	-	-	-	-	-	-	14.47	1.06	6.02
S	-	-	-	-	-	-	-	-	2.54	1.24	.492	-	-	-	-	-	-	1.66	.48	.373

TABLE A-3. TF30-P1 ENGINE PERFORMANCE WITH OBSERVED AND CORRECTED EMISSION INDEXES AT CRUISE POWER

REN NO.	U, °F	H ₂ O V L B DRY AIR	P Bar IN Hg A	AIR FLOW LBS/SEC	FUEL FLOW LBS/HR	THRUST LBS	U of F	CORR PRESS RATIO	CO LI	HC LI	NO LI A	CO PI	TH PI	ROX PI A	F/A CARBON BALANCE	F/A MEASURED	CO PI CORR	NOX EI CORR
28	34	26.89	30.24	199.3	4799	8239	570	11.15	4.13	.95	8.61	2.41	.55	5.01	.01421	.00669	3.13	11.40
32	62	71.45	29.91	200.3	4794	8231	640	11.13	3.23	.56	9.41	1.88	.32	5.47	.01507	.00663	3.33	11.14
33	64	71.45	29.88	201.6	4887	8412	637	11.30	3.04	.78	9.52	1.77	.55	5.53	.1707	.00673	3.20	11.10
41	39	20.59	29.85	199.8	4674	8140	592	10.99	4.06	.95	8.71	2.33	.54	5.07	.01423	.00650	3.26	10.85
45	38	18.79	29.87	198	4690	8154	590	12.86	3.97	.35	8.99	2.28	.20	5.17	.01432	.00658	3.15	11.24
48	28	10.72	29.98	198.4	4641	8165	550	10.99	4.94	.38	8.48	2.81	.22	4.82	.01328	.00650	3.48	11.32
52	28	10.72	29.98	198.4	4661	8165	555	11.02	4.32	.36	8.46	2.47	.20	4.83	.01407	.00653	3.04	11.50
59	6	22.54	29.55	210.1	4625	8161	570	11.05	4.16	.37	9.07	2.36	.21	5.14	.01266	.00612	3.22	11.66
66	58	25.74	30.34	200.0	4667	8162	615	11.04	3.61	.25	10.97	2.06	.14	6.27	.01365	.00648	3.57	11.85
70	57	28.08	30.32	200.3	4704	8190	615	10.99	3.12	.10	9.25	.79	.06	5.31	.01605	.00652	3.05	10.14
75	75	71.45	29.84	201.2	4737	8279	685	11.12	2.85	.56	10.66	1.63	.32	6.10	.01511	.00654	3.36	11.43
77	75	71.45	29.82	201.5	4739	8282	675	11.02	2.83	.79	10.61	1.62	.45	6.07	.01488	.00653	3.34	11.38
83	51	33.27	29.82	201.6	4702	8196	-	11.06	-	-	-	-	-	-	-	.00648	-	-
87	51	33.27	29.84	201.7	4696	8201	-	11.09	-	-	-	-	-	-	-	.00647	-	-
92	54	22.54	30.08	205.0	4703	8199	620	10.97	3.42	.56	9.70	1.96	.32	5.57	.01496	.00637	3.24	10.73
96	52	22.54	30.08	198.9	4684	8206	630	11.13	3.48	.59	10.00	1.98	.34	5.71	.01417	.00654	3.23	11.24
101	73	74.02	29.88	202.1	4843	8242	670	11.10	3.29	.53	9.62	1.97	.32	5.77	.01598	.00679	3.80	10.55
105	71	76.67	29.87	201.6	4911	8190	670	11.35	2.93	.11	10.98	1.76	.07	6.58	.01468	.00677	3.32	12.31
110	74	68.95	29.94	207.9	4964	8329	660	11.39	2.80	.16	10.47	1.67	.10	6.24	.01539	.00663	3.27	11.24
114	71	68.95	29.92	204.1	4951	8338	680	11.40	2.99	.90	10.08	1.77	.53	5.98	.01568	.00674	3.39	11.06
119	82	84.10	29.82	205.9	5012	8236	683	11.40	2.74	.22	10.2	1.67	.13	6.40	.01532	.00676	3.46	11.21
123	83	94.35	29.80	209.6	5092	8222	700	11.7	2.47	.05	11.48	1.57	.03	6.49	.01616	.00675	3.15	11.28
128	80	85.11	29.84	213	5043	8333	690	11.66	2.40	.05	0.43	1.46	.03	6.36	.01592	.00663	2.97	11.19
132	81	71.45	29.80	208.9	5130	8345	705	11.68	2.42	.10	10.43	1.49	.06	8.40	.01625	.00682	3.03	10.70
140	69	47.66	29.98	208.8	5080	8361	650	11.75	2.98	.11	10.94	1.81	.07	6.65	.01547	.00676	3.31	11.51
145	70	68.95	30.10	209.2	4782	7949	696	11.26	3.08	.17	9.96	1.85	.10	5.99	.01489	.00635	3.45	11.02
149	70	66.53	30.10	206.1	4732	7950	650	11.23	2.90	.11	10.09	1.75	.07	6.07	.01517	.00645	3.25	11.09

TABLE A-3. TF10-P1 ENGINE PERFORMANCE WITH OBSERVED AND CORRECTED EMISSION INDEXES AT CRUISE POWER (Cont Inued)

RUN NO.	W _{GR} GRAINS H ₂ O VP LB DRY AIR	P _{BAR} IN Hg A	EPR	AIR FLOW LBS/SEC	FUEL FLOW LBS/HK	THRUST LBS	U ₁ FT SEC	COMP PRESS RATIO	CO FI	THC FI	NO _x PPM	F/ CARBON BALANCE	F/A MEASURED	CO FI CORR	NO _x PPM CORR
154	74	76.67	30.21	1.745	209.4	4762	670	11.26	3.01	.23	10.28	1.81	.00832	3.51	11.37
158	74	71.45	30.20	1.747	204.6	4793	658	11.27	2.96	.23	10.50	1.79	.00621	3.46	11.35
163	77	74.02	30.13	1.761	209.5	4741	655	11.77	2.80	.16	10.07	1.60	.00629	3.37	10.71
167	78	74.02	30.12	1.762	206.5	4779	660	11.29	2.64	-	10.25	1.54	.00643	3.26	10.83
172	90	141.34	29.72	1.752	207.4	4786	705	11.19	4.21	-	-	2.42	.00641	5.74	-
176	90	136.70	29.72	1.755	205.1	4785	690	11.19	2.43	-	9.42	1.40	.00648	3.31	10.81
181	83	79.40	29.75	1.756	208.6	4805	662	11.22	2.62	-	10.29	1.51	.00640	3.34	10.63
185	84	79.40	29.74	1.759	206.6	4825	655	11.20	2.62	-	10.29	1.51	.00649	3.37	10.56
193	78	61.89	30.09	1.746	204	4744	660	11.17	3.29	.19	12.45	1.88	.00634	4.00	12.73
197	78	61.89	30.38	1.750	196	4748	660	11.24	3.14	.12	11.62	1.80	.00673	3.81	11.88
202	77	76.67	30.08	1.747	209.6	4813	668	11.34	2.65	.11	10.23	1.53	.00638	3.19	10.96
204	77	74.02	30.06	1.735	203.2	4722	670	11.12	2.46	-	9.96	1.42	.00647	2.96	10.60
211	85	115.62	29.86	1.740	208.7	4765	650	11.22	2.15	.16	9.25	1.24	.00634	2.80	10.39
215	85	111.79	29.85	-	204.3	4756	650	11.22	2.36	.16	10.28	1.36	.00647	3.1	11.43
220	66	74.02	29.98	1.746	208.3	4783	670	11.25	2.84	.17	9.78	1.62	.00638	3.06	11.31
224	68	85.11	29.97	1.750	206.9	4764	640	11.29	3.90	-	9.63	2.22	.00640	4.28	11.30
229	90	97.63	29.96	1.750	208.4	4840	590	11.26	2.21	.16	10.86	1.28	.00645	3.01	11.21
233	90	104.49	29.95	1.763	206.8	4926	660	11.42	2.38	.10	10.36	-	.00662	3.25	10.90
238	92	127.86	29.88	1.748	209.1	4822	670	11.28	2.30	.11	10.56	1.34	.00641	3.20	11.67
242	90	123.65	29.86	1.745	204.5	4856	665	11.25	2.28	.05	10.47	1.34	.00656	3.11	11.60
247	90	136.70	29.72	1.756	209.4	4868	680	11.30	2.32	.21	10.01	1.34	.00646	3.16	11.49
251	90	136.70	29.71	1.759	204	4920	670	11.34	2.29	.10	9.78	1.33	.0064	3.12	11.22
X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE A-4. TF 40-P1 ENGINE PERFORMANCE WITH OBSERVED AND CORRECTED EMISSION INDEXES AT MAXIMUM CONTINUOUS POWER

RUN NO.	U ₁ °F	H ₂ O VP TB IN	P _{BAR} IN	P _{BAR} IN	AIR FLOW LBS/SEA	FUEL FLOW LBS/HR	THROTTLE LBS	U ₂ °F	COMP PRESS RATIO	CO FI	HR FI	NO _x FI	CO FI	THC FI	NO _x FI	F/A CARBON BALANCE	F/A MEASURED	CO FI CORR	NO _x FI CORR
27	34	25.74	30.24	1.926	213.9	5867	9978	645	12.99	2.89	1.32	10.80	1.70	.77	6.35	.01537	.00762	2.25	13.80
36	66	76.02	29.87	1.914	217.9	5637	9860	690	12.87	2.45	1.11	11.05	1.35	.61	6.09	.0161	.00763	2.62	12.89
38	68	76.67	29.86	1.918	215.3	5937	9970	700	12.88	2.17	1.31	11.05	1.29	.78	6.58	.01679	.00766	2.36	12.81
42	38	19.67	29.86	1.913	215.9	5801	9836	644	12.86	2.92	.65	10.87	1.72	.38	6.41	.01557	.00746	2.37	13.27
44	38	19.67	29.87	1.910	215.2	5812	9842	640	12.86	2.88	.43	10.71	1.70	.25	6.33	.01580	.00750	2.37	13.07
49	28	10.72	29.98	1.909	215.5	5762	9845	600	12.81	3.24	.22	9.88	1.90	.13	5.78	.01551	.00743	2.37	12.57
51	28	10.72	29.98	1.902	213.1	5707	9744	600	12.77	3.10	.32	10.33	1.82	.19	6.05	.01568	.00744	2.27	13.25
57	34	22.54	29.94	1.911	219	5747	9859	625	12.84	3.08	.67	10.78	1.80	.39	6.24	.01565	.00749	2.40	13.64
58	35	22.54	29.95	1.910	225.9	5741	9881	620	12.85	2.99	.45	11.16	1.74	.26	6.49	.01486	.00706	2.30	14.03
60	36	21.54	29.65	1.912	222.5	5746	9874	630	12.87	2.88	.33	10.73	1.67	.19	6.25	.01547	.00716	2.29	13.35
61	36	21.54	29.65	1.914	222.6	5713	9877	630	12.84	3.18	.22	11.25	1.84	.13	6.51	.01547	.00713	2.53	14.00
67	58	25.08	30.34	1.904	216.9	5748	9804	715	12.73	2.64	.11	12.87	1.55	.07	7.55	.01502	.00736	2.62	13.98
69	58	25.08	30.32	1.904	214.7	5720	977	685	12.70	2.56	.10	11.93	1.50	.06	6.99	.01623	.00740	2.54	12.96
78	72	71.45	29.82	1.905	216.5	5741	9825	725	12.79	2.26	.54	12.32	1.32	.31	7.20	.01570	.00737	2.55	13.73
84	51	33.27	29.83	1.909	217.6	5742	9817	-	12.82	-	-	-	-	-	-	.00733	-	-	-
86	51	33.27	29.83	1.908	216.3	5761	9814	-	12.82	-	-	-	-	-	-	.00740	-	-	-
93	51	22.54	30.08	1.901	215.4	5697	9777	660	12.75	2.65	.77	11.85	1.54	.45	6.90	.01538	.00731	2.45	13.30
95	52	22.54	30.08	1.904	217.9	5719	9780	665	12.72	2.52	.64	11.78	1.48	.38	6.89	.01575	.00729	2.36	13.13
102	72	74.02	29.88	1.958	213.5	5984	9605	715	12.87	2.13	.39	11.80	1.33	.25	7.35	.01711	.00779	2.40	13.24
104	72	76.67	29.87	1.958	213.7	5777	9554	710	12.84	2.29	.31	12.36	1.38	.19	7.47	.01632	.00751	2.58	13.97
111	73	68.95	29.94	1.989	216.2	6105	9833	715	13.18	2.13	.15	12.07	1.32	.10	7.49	.01712	.00784	2.42	13.78
113	72	68.95	29.93	1.987	218.2	6087	9843	705	13.15	2.09	.05	11.85	1.29	.03	7.33	.01744	.00775	2.36	13.12
120	83	94.35	29.81	1.994	218.4	6195	9885	744	13.17	1.95	.10	12.3	1.22	.06	7.74	.01766	.00788	2.42	14.09
122	84	94.35	29.80	1.998	217.1	6192	9871	750	13.17	1.95	.05	12.17	1.22	.03	7.60	.01766	.00792	2.44	13.82
129	80	71.45	29.83	1.960	223.5	6185	9806	735	13.43	1.68	.05	12.24	1.06	.03	7.75	.01775	.00769	2.03	13.03
131	81	71.45	29.82	1.967	224.7	6215	9854	750	13.51	1.71	.05	12.37	1.08	.03	7.80	.01802	.00768	2.09	13.03
137	69	47.66	29.98	1.971	225.5	6257	9873	705	13.50	2.16	.20	13.35	1.37	.13	8.46	.01693	.00771	2.37	14.22

TABLE A-4. TF 40-PI ENGINE PERFORMANCE WITH OBSERVED AND CORRECTED EMISSION INDEXES AT MAXIMUM CONTINUOUS POWER (CONTINUED)

RUN NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	443	444	445	446	447	448	449	450	451	452	453	454	455	456	457	458	459	460	461	462	463	464	465	466	467	468	469	470	471	472	473	474	475	476	477	478	479	480	481	482	483	484	485	486	487	488	489	490	491	492	493	494	495	496	497	498	499	500	501	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520	521	522	523	524	525	526	527	528	529	530	531	532	533	534	535	536	537	538	539	540	541	542	543	544	545	546	547	548	549	550	551	552	553	554	555	556	557	558	559	560	561	562	563	564	565	566	567	568	569	570	571	572	573	574	575	576	577	578	579	580	581	582	583	584	585	586	587	588	589	590	591	592	593	594	595	596	597	598	599	600	601	602	603	604	605	606	607	608	609	610	611	612	613	614	615	616	617	618	619	620	621	622	623	624	625	626	627	628	629	630	631	632	633	634	635	636	637	638	639	640	641	642	643	644	645	646	647	648	649	650	651	652	653	654	655	656	657	658	659	660	661	662	663	664	665	666	667	668	669	670	671	672	673	674	675	676	677	678	679	680	681	682	683	684	685	686	687	688	689	690	691	692	693	694	695	696	697	698	699	700	701	702	703	704	705	706	707	708	709	710	711	712	713	714	715	716	717	718	719	720	721	722	723	724	725	726	727	728	729	730	731	732	733	734	735	736	737	738	739	740	741	742	743	744	745	746	747	748	749	750	751	752	753	754	755	756	757	758	759	760	761	762	763	764	765	766	767	768	769	770	771	772	773	774	775	776	777	778	779	780	781	782	783	784	785	786	787	788	789	790	791	792	793	794	795	796	797	798	799	800	801	802	803	804	805	806	807	808	809	810	811	812	813	814	815	816	817	818	819	820	821	822	823	824	825	826	827	828	829	830	831	832	833	834	835	836	837	838	839	840	841	842	843	844	845	846	847	848	849	850	851	852	853	854	855	856	857	858	859	860	861	862	863	864	865	866	867	868	869	870	871	872	873	874	875	876	877	878	879	880	881	882	883	884	885	886	887	888	889	890	891	892	893	894	895	896	897	898	899	900	901	902	903	904	905	906	907	908	909	910	911	912	913	914	915	916	917	918	919	920	921	922	923	924	925	926	927	928	929	930	931	932	933	934	935	936	937	938	939	940	941	942	943	944	945	946	947	948	949	950	951	952	953	954	955	956	957	958	959	960	961	962	963	964	965	966	967	968	969	970	971	972	973	974	975	976	977	978	979	980	981	982	983	984	985	986	987	988	989	990	991	992	993	994	995	996	997	998	999	1000
139	70	47.66	29.98	1.972	225.3	6228	9876	706	13.54	2.22	.20	13.82	1.64	.12	8.72	.01693	F/A MEASURED	CO CORR	CO EL	14.63																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
146	70	66.53	30.10	1.917	220.7	5854	9428	705	13.05	2.20	.10	12.45	1.37	.06	7.73	.01658	.00737	2.44	13.55																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
148	70	66.53	30.10	1.917	220.8	5872	9428	705	13.01	2.20	.10	12.16	1.37	.06	7.57	.01658	.00739	2.44	13.55																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
155	74	76.67	30.20	1.917	221.4	5867	9449	726	13.07	2.13	.16	12.92	1.32	.10	8.02	.01623	.00736	2.44	14.42																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
157	74	71.45	30.21	1.917	220.1	5878	9448	728	13.07	2.03	.20	12.47	1.26	.13	7.76	.01657	.00742	2.33	13.72																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
164	77.5	76.67	30.12	1.909	222.7	5880	9924	720	13.00	2.06	.10	12.22	1.22	.06	7.24	.0171e	.00733	2.44	13.34																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
166	77.5	76.67	30.12	1.909	220.2	5871	9927	710	13.04	2.06	.05	12.50	1.22	.03	7.39	.01718	.00741	2.44	13.35																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
173	90	161.34	29.72	1.919	216.6	5831	9925	750	12.86	1.89	-	9.93	1.11	-	5.01	.01756	.00758	2.49	11.97																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
175	90	136.70	29.72	1.919	219.0	5846	9924	745	12.8	1.83	-	10.28	1.08	-	6.06	.01807	.00742	2.41	12.23																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
182	83	79.40	29.75	1.918	218.7	5806	9874	710	12.92	1.88	-	12.10	1.11	-	7.11	.01735	.00737	2.34	12.87																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
184	84	79.40	29.75	1.919	218.3	5827	9881	710	12.86	1.96	-	11.94	1.16	-	7.04	.01758	.00741	2.46	12.62																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
194	78	61.89	30.08	1.917	203	5821	9939	715	12.95	2.51	.28	14.55	1.47	.16	8.52	.0145e	.00797	2.98	15.22																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
196	78	61.89	30.08	1.921	220	5800	9939	712	13.02	2.42	.11	14.15	1.41	.06	8.26	.01495	.00732	2.88	14.80																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
203	77	76.67	30.07	1.914	221.3	5846	9960	-	13.08	1.76	.10	12.54	1.03	.06	7.36	.01673	.00734	2.07	13.74																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
205	77	74.02	30.06	1.976	220.5	5852	9957	715	12.91	1.76	-	12.30	1.04	-	7.23	.01673	.00737	2.07	13.38																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
212	83	115.62	29.85	1.905	219.9	5825	9179	710	12.92	1.76	.50	11.80	1.10	.31	7.33	.01703	.00736	2.19	13.84																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
214	84	111.79	29.85	1.908	220.2	5837	9931	705	12.85	1.80	.14	11.48	1.15	.08	6.75	.01795	.00736	2.25	13.24																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
221	65	74.02	29.98	1.912	222.4	5878	9988	690	13.11	-	.05	11.35	1.76	.03	6.68	.01652	.00734	-	13.33																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
223	67	74.02	29.97	1.915	222.9	5900	9990	690	13.05	-	.10	11.26	2.59	.06	6.65	.01685	.00735	-	13.05																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
230	90	104.49	29.95	1.919	221.4	5955	9981	730	13.05	1.58	.10	12.64	.94	.06	7.54	.01757	.00747	2.08	13.79																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
232	90	104.49	29.95	1.923	223.6	5996	10003	-	13.12	1.73	.09	12.59	41.71	2.22	302.7	.01830	.00745	2.28	13.74																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
239	91	123.65	29.87	1.918	220.6	5958	10014	725	12.99	1.82	.05	12.48	1.07	.02	7.31	.01748	.00750	2.42	14.25																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
241	91	123.65	29.86	1.929	223	5971	10056	720	13.16	1.75	.05	12.39	1.02	.03	7.26	.01793	.00744	2.33	14.15																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
248	91	136.70	29.72	1.932	221.1	6027	10100	720	13.17	1.78																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														

TABLE A-4.

A-10

TABLE A-5. TF 90-PI ENGINE PERFORMANCE WITH OBSERVED AND CORRECTED EMISSION INDEXES AT TAKEOFF POWER

RUN NO.	H ₂ GRAINS LBS/450 VP LBS VP DRY AIR	P _{bar} IN Hg A	LEAK LBS/SEA	FUEL FLOW LBS/HR	THRUST LBS	C _L %	COEF PRESS RATIO	CO FI	THR FI	WOT FI	CO FI	THR FI	WOT FI	F/A CARBON BALANCE	F/A PLASTERED	CO FI CORR	WOT FI CORR
26	35	25.74	2.041	224.8	6767	690	14.20	2.54	1.16	11.91	1.54	.71	7.23	.01597	.00836	2.12	14.59
37	67	76.67	2.051	225.5	6869	740	14.16	2.28	1.21	13.22	1.40	.74	8.11	.01679	.00846	2.41	15.59
43	38	19.67	2.049	226	6724	688	14.29	2.48	.40	11.84	1.50	.24	7.15	.01677	.00826	2.12	14.04
50	27	10.72	2.051	226.4	6707	645	14.26	2.42	.30	11.81	1.46	.18	7.12	.01681	.00823	1.90	14.59
68	58	28.08	2.029	228.0	6713	710	14.13	2.30	.21	14.88	1.38	.13	8.94	.01604	.00818	2.28	16.74
76	75	71.45	2.028	227.3	6701	780	14.09	1.98	.47	13.54	1.19	.28	8.16	.01789	.00819	2.21	15.11
85	51	33.27	2.048	228.6	6669	11130	14.25	-	-	-	-	-	-	-	.00810	-	-
94	51	22.54	2.050	229.1	6707	705	14.30	2.12	.49	12.56	1.28	.29	7.55	.01736	.00813	2.00	13.94
101	72	74.02	2.049	220.4	6580	745	13.72	1.87	.38	12.89	1.20	.24	8.23	.01793	.00829	2.05	14.69
112	72	68.95	2.115	226.1	6927	10921	14.41	1.83	.14	13.47	1.19	.09	8.55	.01835	.00831	2.06	15.16
121	84	94.35	2.109	226.8	7019	10865	14.36	1.83	.09	13.90	2.84	.14	21.52	.01920	.00860	2.17	15.78
130	82	71.45	2.069	233.5	6986	790	14.60	1.47	.04	13.47	.95	.03	8.70	.01898	.00831	1.72	14.52
138	69	47.66	2.097	236.2	7169	11051	14.96	1.81	.17	14.64	1.17	.11	9.50	.01968	.00843	1.94	15.80
147	70	66.53	2.035	234.3	6888	10452	14.23	1.87	.10	13.88	1.20	.06	8.88	.01745	.00793	2.02	15.68
156	74	76.67	2.025	231.4	6710	10416	14.18	1.87	.14	13.19	1.21	.09	9.14	.01741	.00805	2.07	16.14
165	77.5	76.67	2.027	231	6690	11053	14.29	1.80	.05	13.63	1.09	.03	8.25	.01814	.00804	2.05	15.24
174	90	141.34	2.043	227.8	6685	11115	14.23	1.63	-	12.64	.98	-	7.60	.01854	.00815	2.01	15.83
183	84	79.40	2.050	229.6	6742	11097	14.12	1.70	-	13.46	.90	-	7.36	.01808	.00816	2.01	15.12
195	78	61.89	2.032	233	6607	11009	14.06	2.13	.11	16.87	1.28	.06	10.13	.01541	.00788	2.43	18.07
204	77	74.02	2.018	229	6606	10980	14.15	1.55	.09	13.30	.93	.05	8.00	.01901	.00801	1.75	14.80
213	84	111.79	2.065	232.8	6947	11378	14.49	1.65	.19	14.85	1.01	.11	9.07	.01795	.00829	1.95	17.68

TABLE A-2. TF 30-P1 ENGINE PERFORMANCE WITH OBSERVED AND CORRECTED EMISSION INDEXES AT TAKEOFF POWER (Continued)

[illegible]

TABLE A-6. F100-11 ENGINE PERFORMANCE WITH OBSERVED AND CORRECTED EMISSION INDEXES AT IDLE POWER

REN NO.	H ₂ O VP LB IN DRY AIR	F Bat IN Hg A	LPK	AIR FLOW LBS/SEC	FUEL FLOW LBS/HR	THRUST LBS	T ₃ OF	CORR PRESS RATIO	CO L1	THR L1	NOX L1	CO L1	F/A CARBON BALANCE	F/A MEASURED	CO L1 CORR	THR ET CORR	NOX ET CORR
1	55	20	30.56	1.041	—	987	743	145	1.297	43.19	—	57.38	—	.00743	—	42.39	—
2	70	64	30.065	1.042	—	983	762	170	1.302	41.85	9.53	53.98	—	.00798	—	44.01	10.84
3	67	64	30.06	1.042	—	991	818	175	1.336	38.01	7.94	46.05	—	.00788	—	39.44	8.68
4	67	58	30.025	1.042	—	1037	865	180	1.370	36.04	7.39	43.20	—	.00787	—	37.39	8.08
7	55	30	29.98	1.042	—	982	753	200	1.312	43.67	11.05	56.95	—	.00795	—	42.86	10.55
12	43	15	30.46	1.041	69	983	755	185	1.312	50.42	13.83	65.64	—	.00755	.00396	46.68	11.46
23	45	14	30.00	1.041	90	980	923	205	1.411	45.84	11.42	48.68	—	.00732	.00302	42.86	9.69
24	55	31	30.08	1.041	81	998	804	210	1.306	41.18	10.49	51.12	—	.00779	.00342	40.41	10.40
25	55	31	30.08	1.041	80	982	804	210	1.299	41.14	10.46	50.25	—	.00768	.00341	40.37	9.99
30	55	36	30.14	1.033	85	955	763	200	1.305	45.99	—	57.57	—	.00776	.00312	45.13	—
31	45	27	30.30	1.033	74	986	774	200	—	46.01	—	58.61	—	.00753	.00370	43.02	—
40	48	25	30.28	1.024	80	983	869	—	—	45.89	—	53.13	—	.00741	.00341	43.54	—
41	40	25	29.81	1.042	76	983	979	180	—	47.28	14.01	47.47	—	.00754	.00359	43.12	11.19
46	30	15	30.06	1.042	85	1012	981	180	—	47.31	—	48.80	—	—	331	40.99	—
52	42	12	30.16	1.033	82	991	782	200	—	40.98	—	51.94	—	—	.0036	37.75	—
57	50	30	29.84	1.028	94	1068	755	215	—	—	13.13	—	—	.00316	—	—	11.83
59	33	8	30.14	1.040	79	1020	974	180	—	47.18	13.68	49.40	—	.00712	.00359	41.52	10.02
60	33	8	30.14	1.040	79	1022	1055	180	—	48.93	—	47.40	—	.00955	.00359	43.06	—
61	33	8	30.14	1.040	77	1021	1103	180	—	47.15	14.50	43.64	—	.00712	.00368	41.49	10.62
94	35	7	29.45	1.059	92	980	850	180	—	43.92	12.41	50.64	—	.00732	.00296	39.05	9.32
X	—	—	—	—	—	—	—	—	—	44.31	11.56	—	—	—	—	41.85	10.21
S	—	—	—	—	—	—	—	—	—	3.71	2.31	.166	—	—	—	2.40	1.08

TABLE A-11. J57-43 ENGINE PERFORMANCE WITH OBSERVED AND CORRECTED EMISSION INDEXES AT APPROACH POWER (Continued)

[illegible]

TABLE A-12. J57-A3 ENGINE PERFORMANCE WITH OBSERVED AND CORRECTED
EMISSION INDEXES AT CRUISE POWER

RUN NO.	t ₂ OF	H ₂ O V LBS DRY AIR	P Bar IN Hg A	EPR	AIR FLOW LBS/SEC	FUEL FLOW LBS/HR	THRUST LBS	t ₃ OF	COMP PRESS RATIO	CO EI	THC EI	NO _x EI	CO PI	THC PI	NO _x PI	F/A CARBON BALANCE	CO EI CORR	THC EI CORR	NO _x EI CORR	CO PI CORR	THC PI CORR	NO _x CORR
5	24	11.238	30.11	1.771	133	4656	—	520	—	9.57	—	—	—	—	—	.008660	5.70	—	—	—	—	
14	43	17.131	29.90	1.753	132.2	4651	5590	100	7.73	8.22	—	8.34	6.84	—	6.94	.008835	6.54	—	9.64	5.55	—	8.30
24	39	20.590	30.02	1.773	134.0	4743	5617	560	7.87	8.03	.66	8.33	6.78	.39	7.04	.009040	6.03	.40	9.97	5.19	.35	8.79
35	18	13.560	30.03	1.773	133.5	4750	5604	520	7.86	9.69	1.49	7.47	8.21	1.26	6.33	.008861	5.24	1.13	10.10	4.63	1.02	9.24
46	28	10.233	29.96	1.761	133.2	4647	5617	520	7.81	8.99	—	8.10	7.44	14.01	6.70	.008778	5.70	—	10.14	4.87	11.98	8.87
57	43	14.893	30.13	1.767	133.8	4788	5645	560	7.86	9.27	1.49	9.25	7.56	1.26	7.84	.009066	7.38	1.34	10.63	6.35	1.10	9.32
67	37	21.545	30.22	1.778	134.5	4782	5800	560	7.92	8.27	1.43	9.67	6.81	1.18	7.98	.008837	6.02	1.24	11.75	5.07	.06	10.16
78	57.5	57.518	29.85	1.777	134.5	4789	5815	590	7.90	6.35	1.20	9.73	5.23	.99	8.02	.009171	6.22	1.19	11.47	5.13	.98	9.75
89	79	127.863	29.94	1.759	134.5	4635	5636	620	7.85	4.84	1.50	8.35	3.96	1.23	6.86	.009860	6.31	1.69	10.51	5.10	1.32	8.94
100	80	119.573	29.76	1.770	136.7	5029	5372	640	7.79	4.91	1.06	8.45	4.20	.91	7.24	.010198	6.49	1.20	10.35	5.47	1.00	9.10
110	69.5	71.446	29.81	1.772	140.0	5027	5675	615	5.25	5.04	1.33	9.55	4.47	1.18	8.46	.010313	5.81	1.42	10.89	5.10	1.24	9.84
121	65	91.178	29.77	1.749	139.6	4903	5663	600	7.72	5.94	1.05	9.53	5.14	.91	8.23	.009945	6.45	1.09	11.77	5.55	.94	10.56
132	73	108.086	29.52	1.759	139.2	4943	5715	622	7.85	4.94	.77	9.21	4.27	.61	7.96	.010330	5.96	.77	11.37	5.09	.65	10.15
143	67.5	71.446	29.99	1.761	133.2	4715	5519	600	7.84	6.17	1.02	8.84	5.27	.87	7.55	.009668	6.93	1.07	10.23	5.87	.91	8.91
154	74	74.018	30.20	1.762	133.6	4715	5711	610	7.82	4.53	1.07	9.73	3.74	.88	8.03	.009761	5.54	1.17	10.89	4.51	.94	9.12
167	85	141.343	30.03	1.760	133.0	4666	5683	630	7.77	4.88	2.88	—	4.01	2.36	—	.009736	6.87	3.35	—	5.52	2.65	—
178	90	36.703	29.98	1.761	133.0	4711	5690	637	7.77	4.59	3.82	—	3.80	3.16	—	.009901	6.87	4.58	—	5.54	3.63	—
195	88	111.795	29.80	1.755	139.2	4923	5569	—	7.75	2.88	.62	—	2.54	.55	—	.010528	4.21	.74	—	3.62	.63	—
206	86	91.178	29.91	1.760	139.2	4922	5648	—	7.86	3.24	.26	—	2.83	.23	—	.010797	4.62	.30	3.94	.26	—	—
187	89	132.212	30.13	1.764	143.2	4974	5763	650	7.84	3.71	3.12	—	2.20	2.69	—	.010946	5.49	3.72	4.61	3.08	—	—

TABLE A-13. J57-43 ENGINE PERFORMANCE WITH OBSERVED AND CORRECTED EMISSION INDEXES AT MAXIMUM CONTINUOUS POWER

RUN NO.	Wt. GRAINS H ₂ O V LB DRY AIR	U _{bat} IN DEG A	AIR FLOW LBS/SEC	FUEL FLOW LBS/HK	THRUST LBS	TS OF	COMP PRESS RATIO	CO I I	TH I I	NO _x I I	I/A CALIBN BALANCE	CO FT CORR	NO _x LI CORR	CO FT CORR	THC FT CORR	NO _x FT CORR
6	26	11.238	30.11	1.907	142.7	5384	—	7.80	10.79	—	.009250	4.41	—	—	—	—
15	43	16.352	29.91	1.913	143.5	5455	6641	6.13	—	7.94	.009461	4.70	11.35	3.80	—	9.17
25	40	18.790	30.02	1.913	143.3	5454	6524	5.81	.21	7.76	.009670	4.23	11.24	3.48	.16	9.21
36	20	14.211	30.04	1.913	142.3	5345	6474	7.90	.72	6.58	.009481	4.00	11.16	3.19	.52	9.51
47	28	10.723	29.97	1.895	142.0	5333	6434	7.63	1.06	7.39	.009383	4.48	11.58	3.61	.79	9.85
58	43	16.493	30.13	1.896	142.4	5381	6450	6.78	.98	8.40	.009690	5.19	11.78	4.26	.78	9.70
68	37.5	21.545	30.22	1.907	143.2	5430	6600	5.75	.71	8.46	.009560	4.00	12.77	3.23	.54	10.29
79	58	57.518	29.86	1.905	142.7	5447	6595	4.64	.75	8.28	.010121	4.57	11.80	3.77	.61	8.35
90	79	127.863	29.93	1.883	140.9	5322	6408	3.91	1.42	—	.010393	5.34	11.54	4.50	1.25	—
101	80	119.573	29.76	1.904	150.8	5779	6381	3.38	.80	8.77	.010844	4.68	11.59	4.31	.76	7.35
111	70	65.341	29.81	1.913	148.5	5747	6611	3.64	.90	—	.011434	4.33	—	3.78	.80	—
122	65	91.178	29.76	1.914	150.8	5747	6704	3.62	.65	7.99	.011251	3.96	11.43	3.44	.57	7.59
133	74	108.086	29.52	1.895	149.8	5867	6504	3.47	.78	8.56	.010984	4.39	11.46	4.01	.73	7.54
144	68	76.667	29.99	1.901	142.4	5457	6601	—	.75	8.50	.010714	—	11.89	—	.64	7.97
155	74	68.950	30.20	1.901	142.4	5460	6603	2.72	.62	8.43	.010630	3.44	11.09	2.88	.53	7.42
168	85	136.703	30.03	1.910	142.5	5448	6653	3.45	1.65	—	.010590	5.15	—	4.31	1.45	—
179	90	136.703	29.98	1.905	148.3	5723	6592	2.51	2.39	—	.011438	4.03	—	3.58	2.25	—
196	88	111.795	29.80	1.907	148.5	5817	6638	1.46	.56	—	.011753	2.28	—	2.04	.53	—
207	84	94.354	29.91	1.910	148.6	5741	6521	2.92	.23	7.09	.012036	4.29	—	3.85	.21	—
17	45	16.352	29.91	1.903	142.3	5385	6559	6.27	—	6.62	.009249	4.97	—	4.04	—	—
27	43	18.790	30.03	1.910	142.3	5399	6484	5.82	.21	7.75	.009670	4.46	11.01	3.76	.16	8.95
38	27.5	14.211	30.04	1.913	142.5	5341	6409	8.09	.60	6.87	.009267	4.29	11.30	3.46	.45	9.68
49	28	10.223	29.97	1.901	142.2	5345	6474	6.80	.61	7.43	.009483	3.99	11.68	3.21	.45	9.91
60	43	15.607	30.13	1.900	142.3	5404	6440	5.69	.66	8.46	.009680	4.36	11.82	3.61	.53	9.77
70	39	20.590	30.20	1.904	143.2	5435	6616	5.67	.56	8.57	.009451	4.05	12.77	3.27	.36	10.28
81	59	61.889	29.86	1.905	142.6	5420	—	4.69	.65	—	.010000	4.69	12.29	—	—	—
92	79	127.863	29.92	1.880	149.2	5559	6390	3.42	.71	8.02	.010934	4.67	11.37	4.11	.66	—

TABLE A-13.

A-24

TABLE A-14. J57-43 ENGINE PERFORMANCE WITH OBSERVED AND CORRECTED EMISSION INDEXES AT TAKEOFF POWER

RUN NO.	THC OF	H. GRAINS H ₂ O V LBS DRT AIR	P Bar IN Hg A	AIR FLOW LBS/SEC	FUEL FLOW LBS/HR	THRUST LBS	THC OF	CORP PRESS RATIO	CO EI	THC EI	NO EI	CU PI	THC PI	NO ^X PI	F/A CARBON BALANCE	CO EI	NO ^X EI	CO PI	NO ^X PI
7	27	11.778	30.11	2.299	163.5	7402	-	620	-	3.27	2.94	-	-	-	.011365	2.22	-	-	-
16	44	16.352	29.91	2.311	164.2	7573	-	10.42	3.11	-	12.62	2.61	-	10.57	.011437	2.61	14.53	2.19	11.82
26	42	18.790	30.03	2.296	163.5	7512	8894	640	10.36	2.91	-	2.46	-	10.23	.011544	2.39	14.23	2.02	11.62
37	20	14.211	30.35	2.314	156.2	7565	8951	600	10.44	3.66	.24	10.22	3.09	8.64	.011564	2.27	13.84	1.92	11.73
48	28	10.723	29.97	2.309	164.0	7543	8959	620	10.41	-	.36	11.43	.30	9.63	.011476	-	14.47	-	12.23
59	42	15.607	30.13	2.298	163.6	7532	8869	640	10.38	2.64	.38	12.88	2.24	10.93	.011904	2.16	15.00	1.84	12.42
69	38	21.545	30.21	2.308	164.4	7617	9100	640	10.41	2.53	.39	-	2.12	.33	.011654	1.98	-	1.65	-
80	58	59.672	29.86	2.303	165.0	7622	8990	675	10.38	2.46	.30	13.14	2.08	11.14	.012367	2.43	15.53	2.06	11.22
91	79	127.863	29.93	2.301	163.5	7587	8995	710	10.38	2.24	.66	12.52	1.89	10.56	.012649	2.78	15.67	2.35	9.18
102	80	119.573	29.76	2.143	-	7652	9033	715	10.45	2.04	.74	12.25	1.73	10.37	.012436	2.56	-	2.17	8.96
112	70.5	65.341	29.81	2.306	163.5	7649	9007	695	10.40	2.11	.67	-	1.79	.57	.012951	2.40	14.90	2.03	-
123	65.5	91.178	29.76	2.301	164.3	7599	9102	690	10.42	2.14	.55	12.29	1.79	10.26	.012634	2.30	15.10	1.93	9.79
134	74	108.086	29.52	2.298	163.6	7558	9010	700	10.35	1.96	.55	11.90	1.64	9.98	.012348	2.31	14.54	1.93	8.98
145	68.5	76.667	29.99	2.305	163.6	7571	9018	690	10.44	1.90	.32	12.13	1.59	10.18	.012912	2.11	14.07	1.77	9.51
156	74	68.950	30.20	2.292	162.5	7543	8962	700	10.33	1.05	.28	13.32	.88	10.21	.012688	1.24	14.64	1.04	10.08
169	85	136.703	30.03	2.300	163.6	7597	9059	720	10.33	1.82	.11	11.25	1.53	.09	.012974	2.41	13.93	2.03	-
182	90	136.703	29.96	2.302	163.6	7624	9047	730	10.35	1.83	-	-	1.54	-	.012675	2.55	-	2.15	-
197	87	108.086	29.80	2.303	163.5	7636	9030	292	10.39	.99	.82	-	.84	-	.013304	1.34	-	1.14	-
185	88.5	127.863	30.14	2.311	163.5	7701	9082	723	10.38	1.76	6.11	-	1.49	-	.013309	2.41	-	2.04	-
208	84	94.354	29.91	2.302	163.6	7642	9015	718	10.37	1.32	.18	12.57	1.12	10.66	.012951	1.73	13.96	1.47	8.97

APPENDIX B

EMISSION INDEXES AND MATHEMATICAL MODELS
TF30-P1 AND J57-43WB ENGINES. NO_x INDEXES
ARE CORRECTED FOR HUMIDITY

APPENDIX B
LIST OF ILLUSTRATIONS

	Page
B-1 CO EI--TF30-P1 Engine--Idle Power	B-1
B-2 CO EI--J57-43 Engine--Idle Power	B-2
B-3 CO EI--TF30-P1 Engine--Approach Power	B-3
B-4 CO EI--J57-43 Engine--Approach Power	B-4
B-5 THC EI--TF30-P1 Engine--Idle Power	B-5
B-6 THC EI--J57-43 Engine--Idle Power	B-6
B-7 THC EI--TF30-P1 Engine--Approach Power	B-7
B-8 THC EI--J57-43 Engine--Approach Power	B-8
B-9 NO _x EI--TF30-P1 Engine--Approach Power	B-9
B-10 NO _x EI--J57-43 Engine--Approach Power	B-10
B-11 NO _x EI--TF30-P1 Engine--Cruise Power	B-11
B-12 NO _x EI--J57-43 Engine--Cruise Power	B-12
B-13 NO _x EI--TF30-P1 Engine--Maximum Continuous Power	B-13
B-14 NO _x EI--J57-43 Engine--Maximum Continuous Power	B-14
B-15 NO _x EI--J57-43 Engine Takeoff Power	B-15

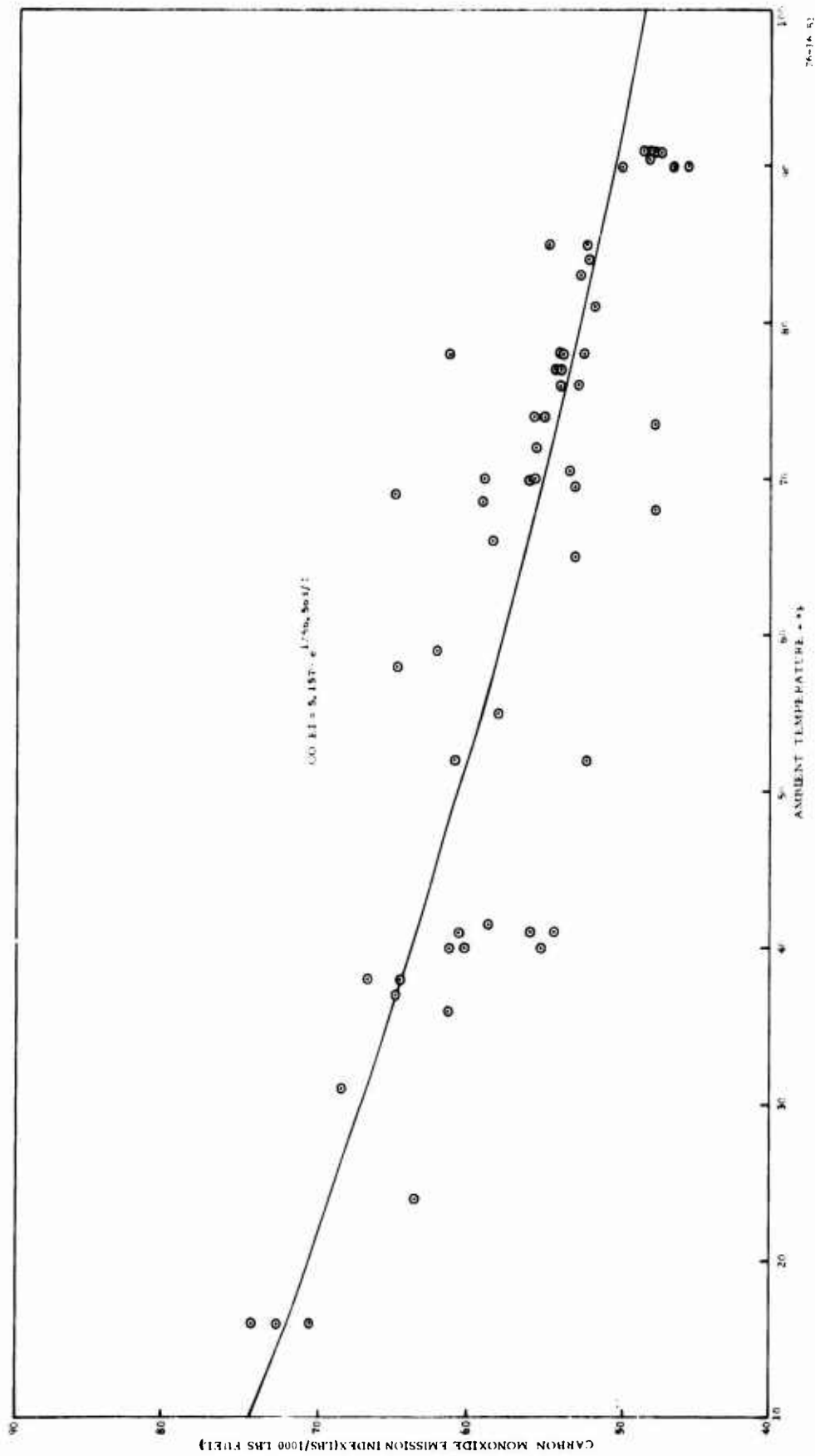


FIGURE B-1. CO EI--TF30-P1 ENGINE--IDLE POWER

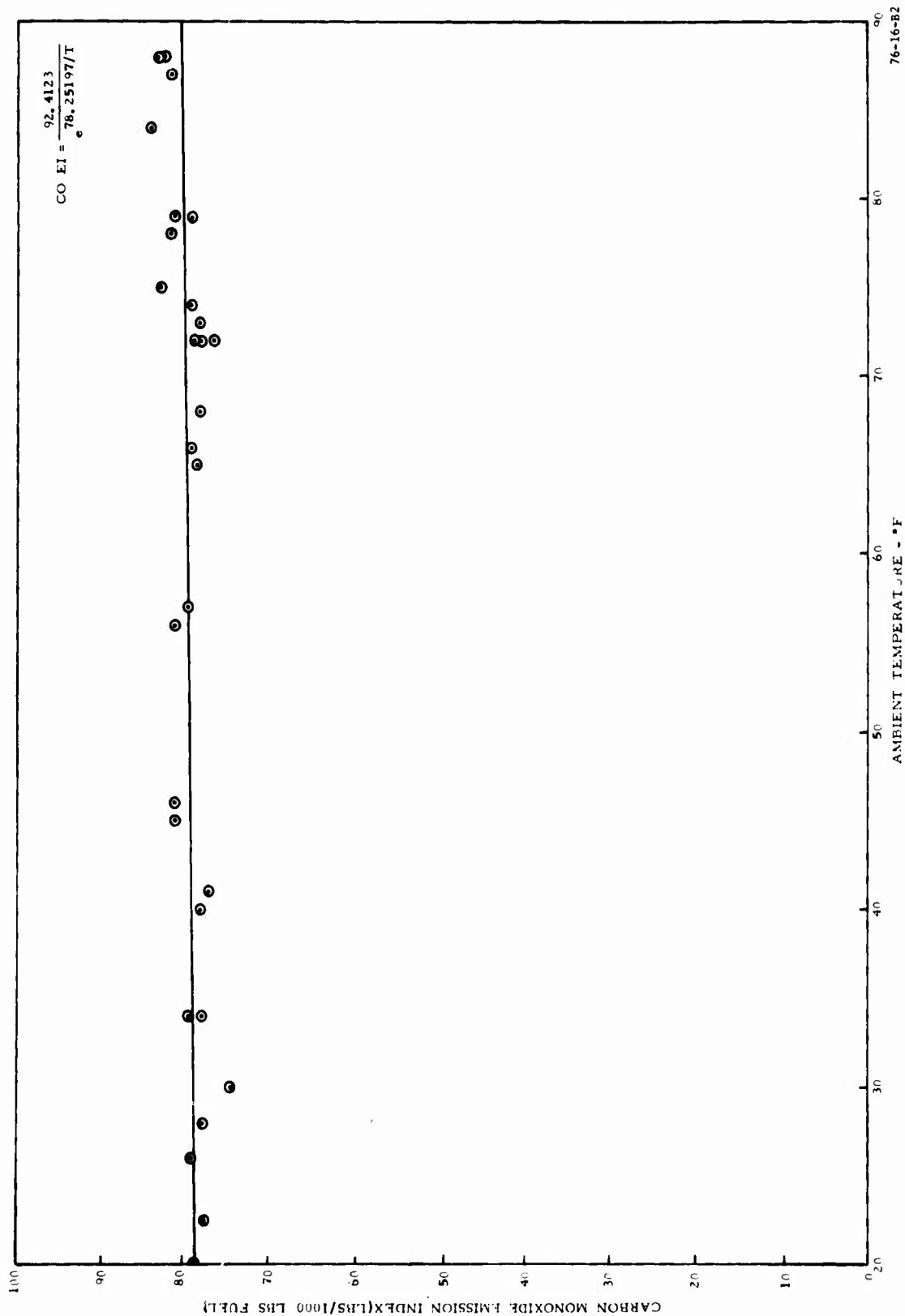


FIGURE B-2. CO EI--J57-43 ENGINE--IDLE POWER

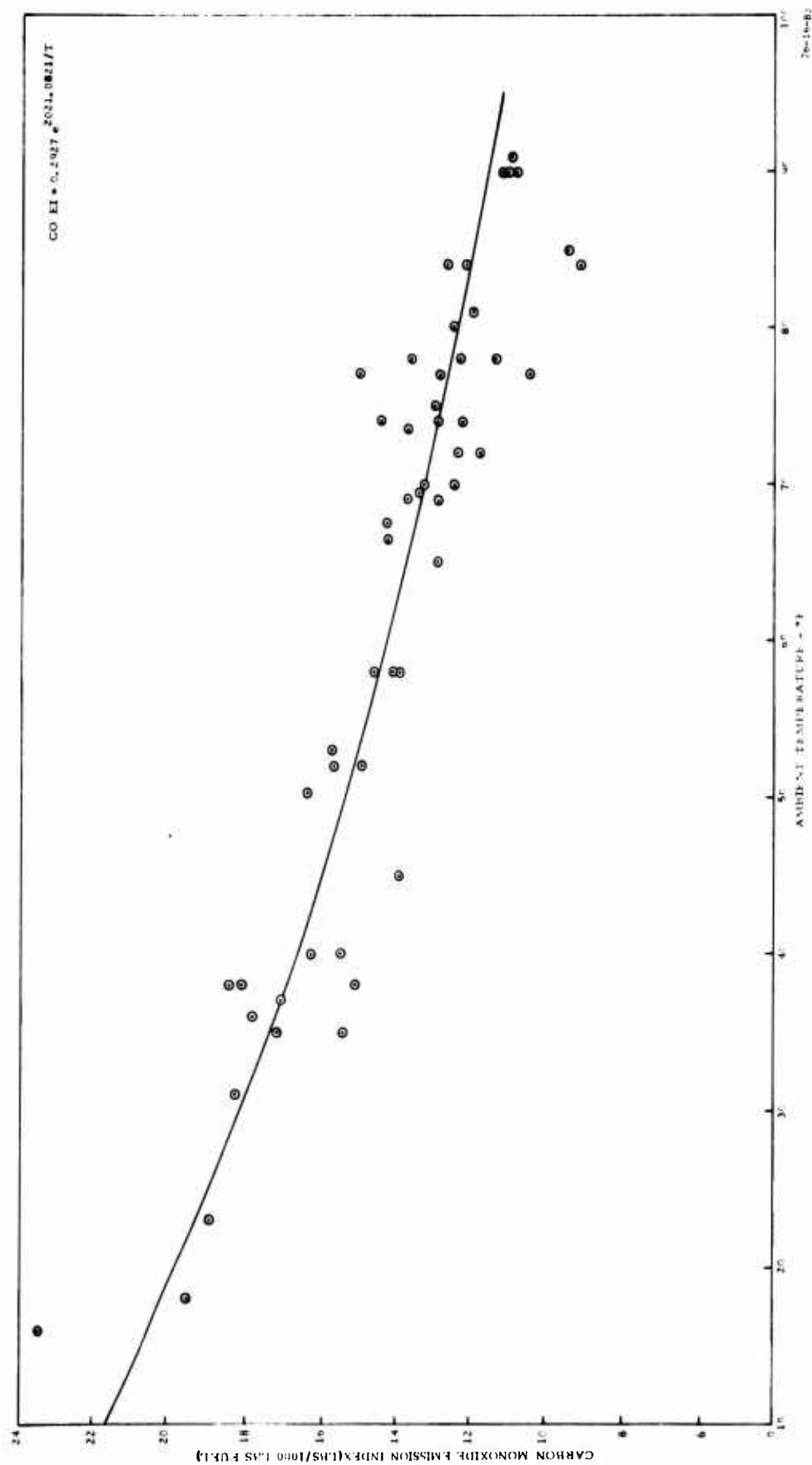


FIGURE B-3. CO EI--TF30-P1 ENGINE--APPROACH POWER

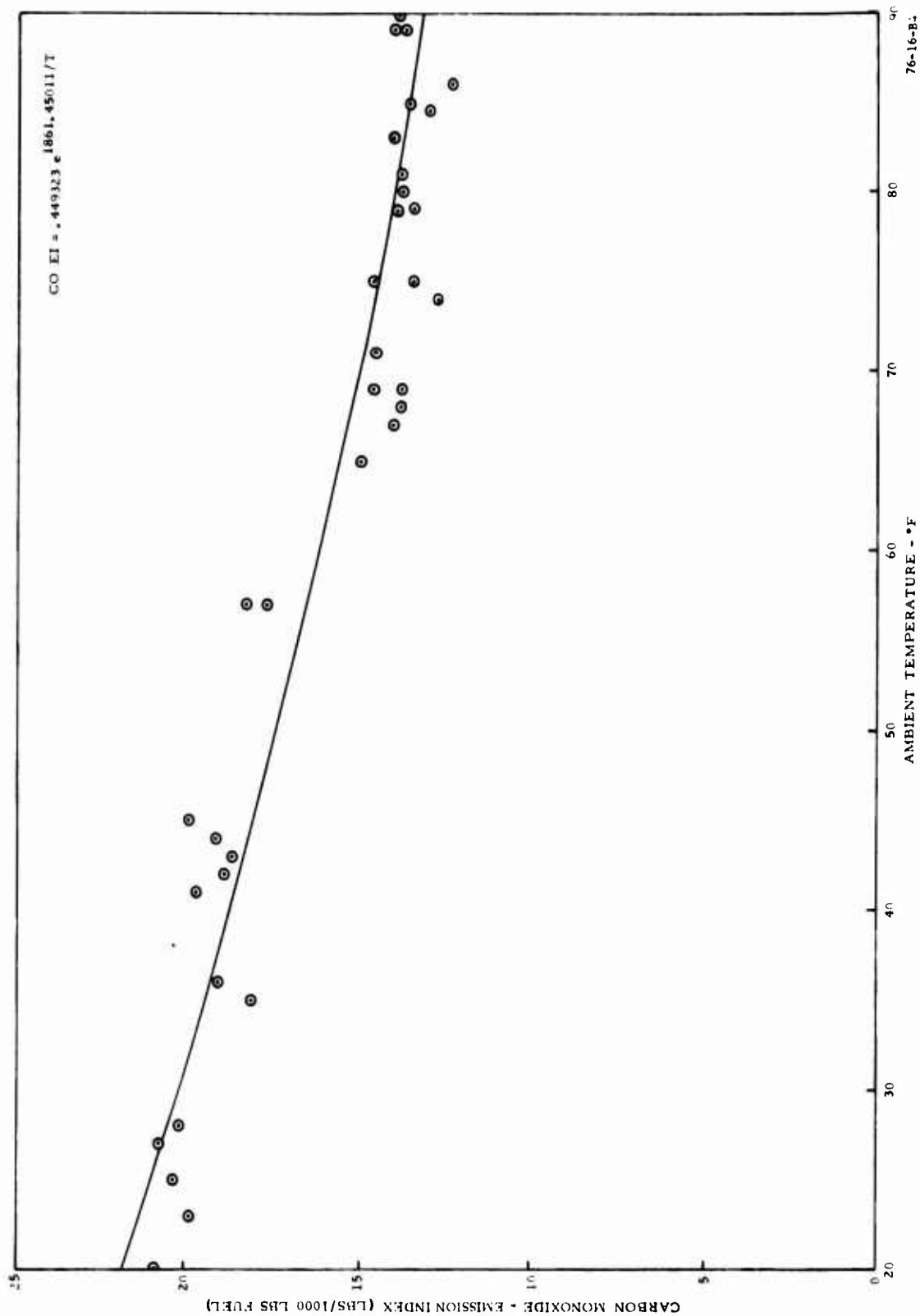


FIGURE B-4. CO EI--J57-43 ENGINE--APPROACH POWER

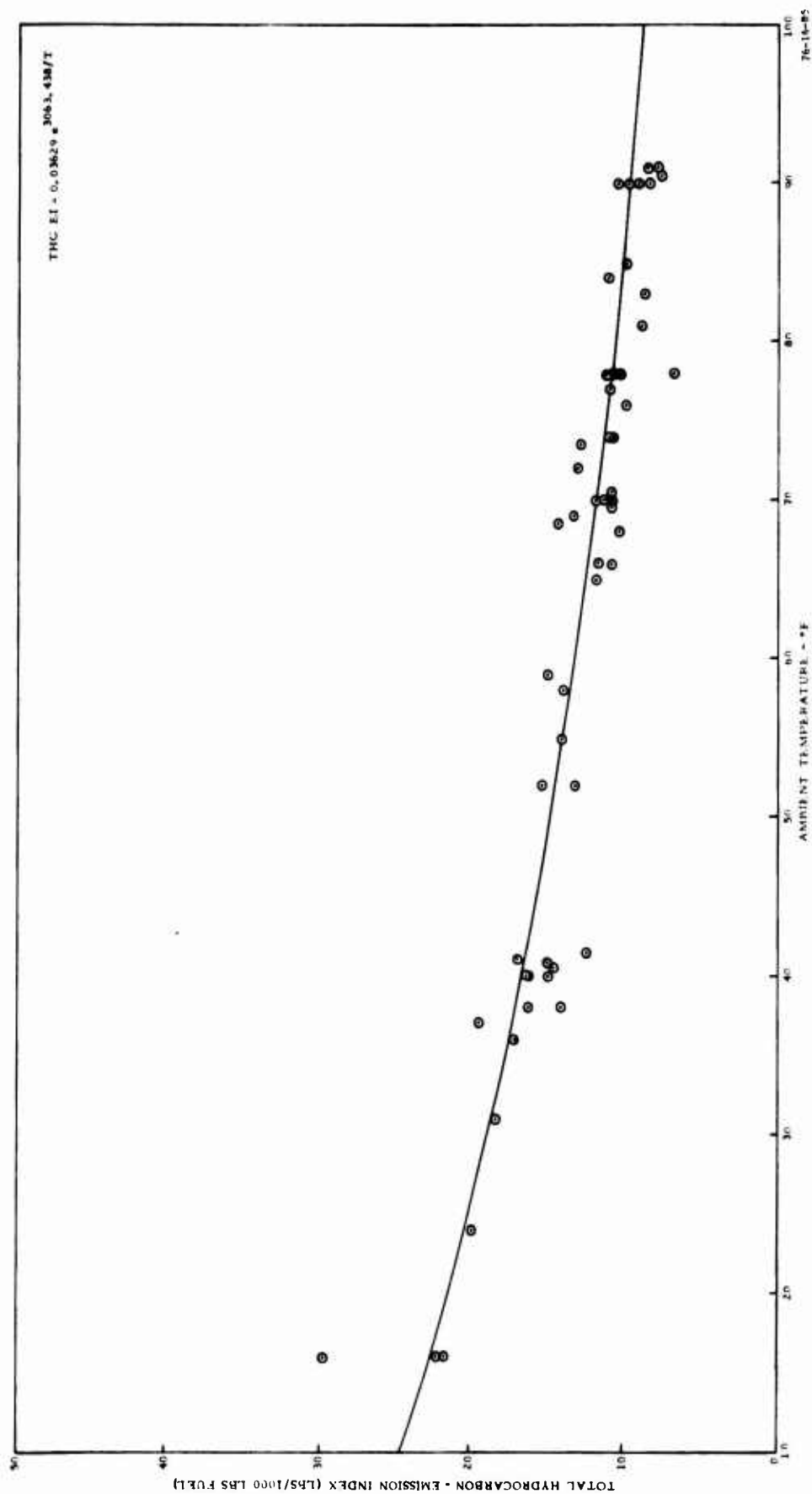


FIGURE B-5. THC EI--TF30-P1 ENGINE--IDLE POWER

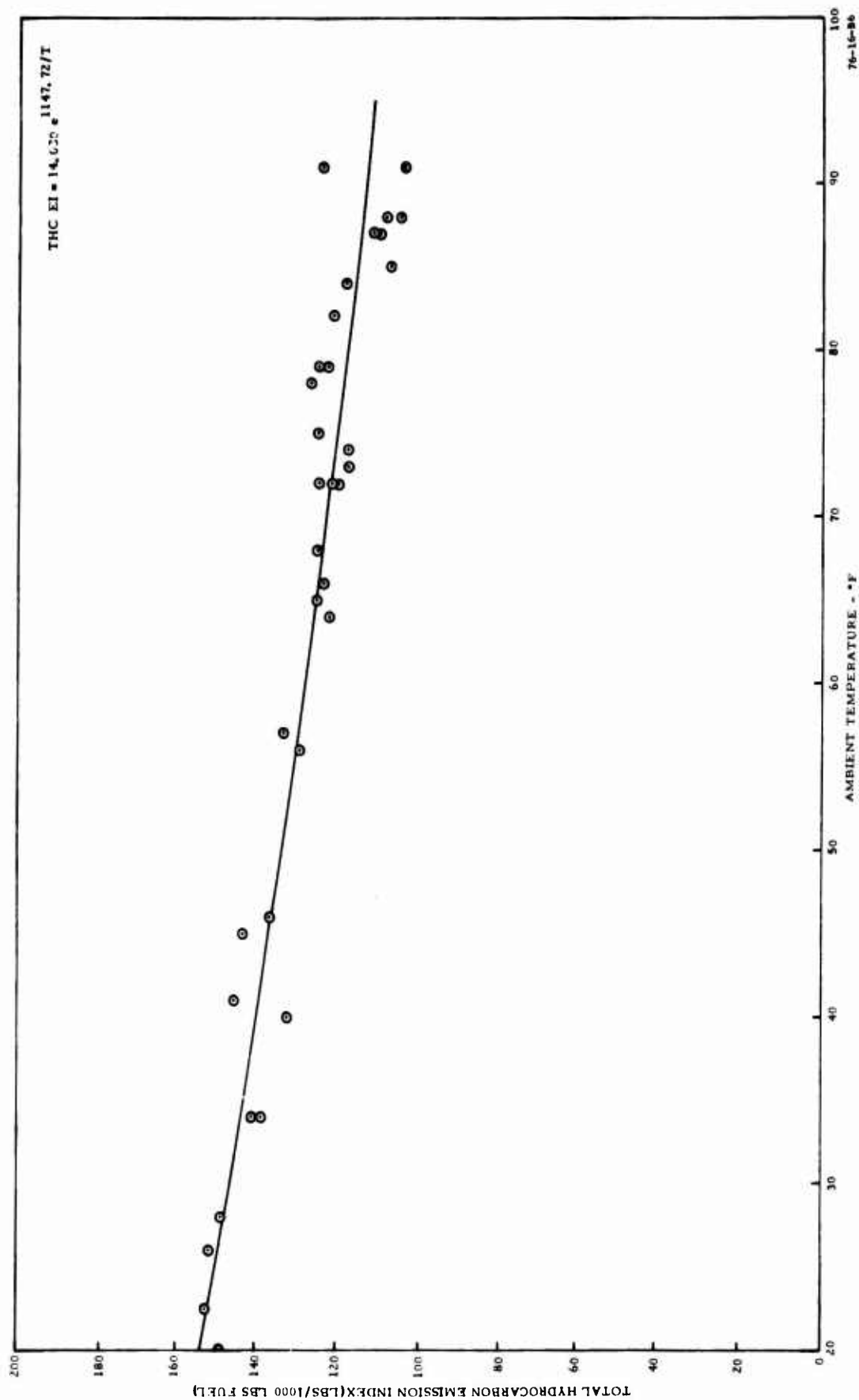


FIGURE B-6. THC EI--J57-43 ENGINE--IDLE POWER

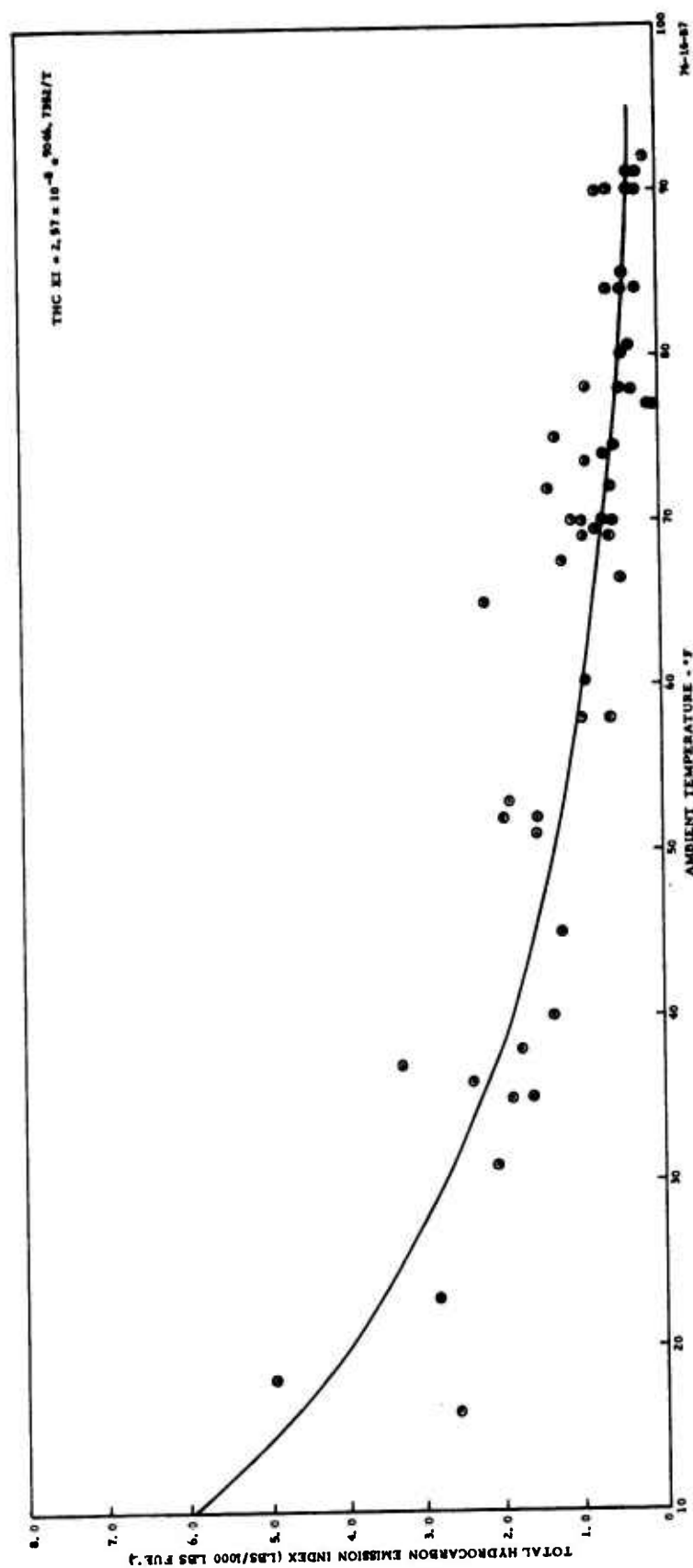


FIGURE B-7. THC EI--TF30-P1 ENGINE APPROACH POWER

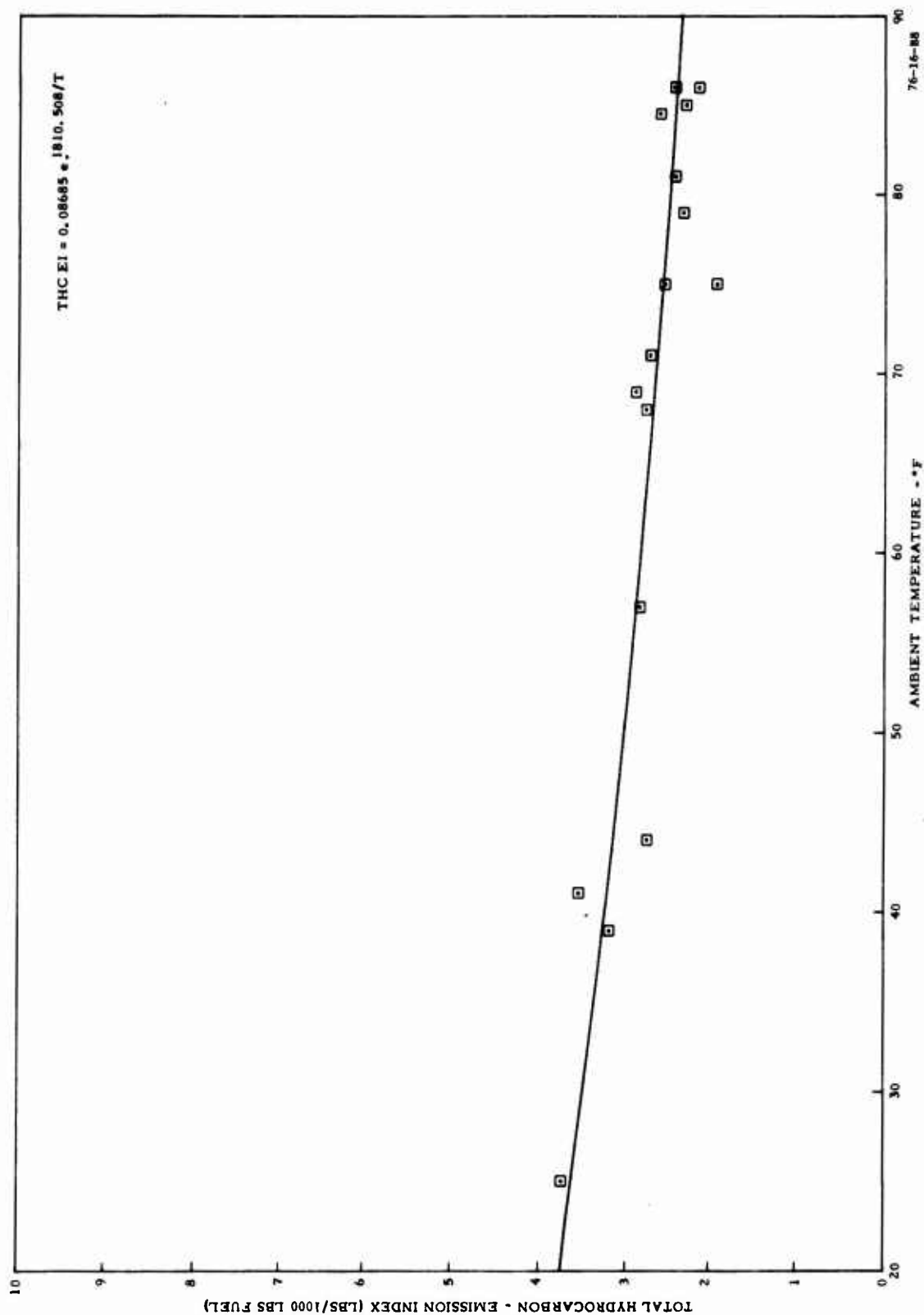


FIGURE B-8. THC EI--J57-43 ENGINE--APPROACH POWER

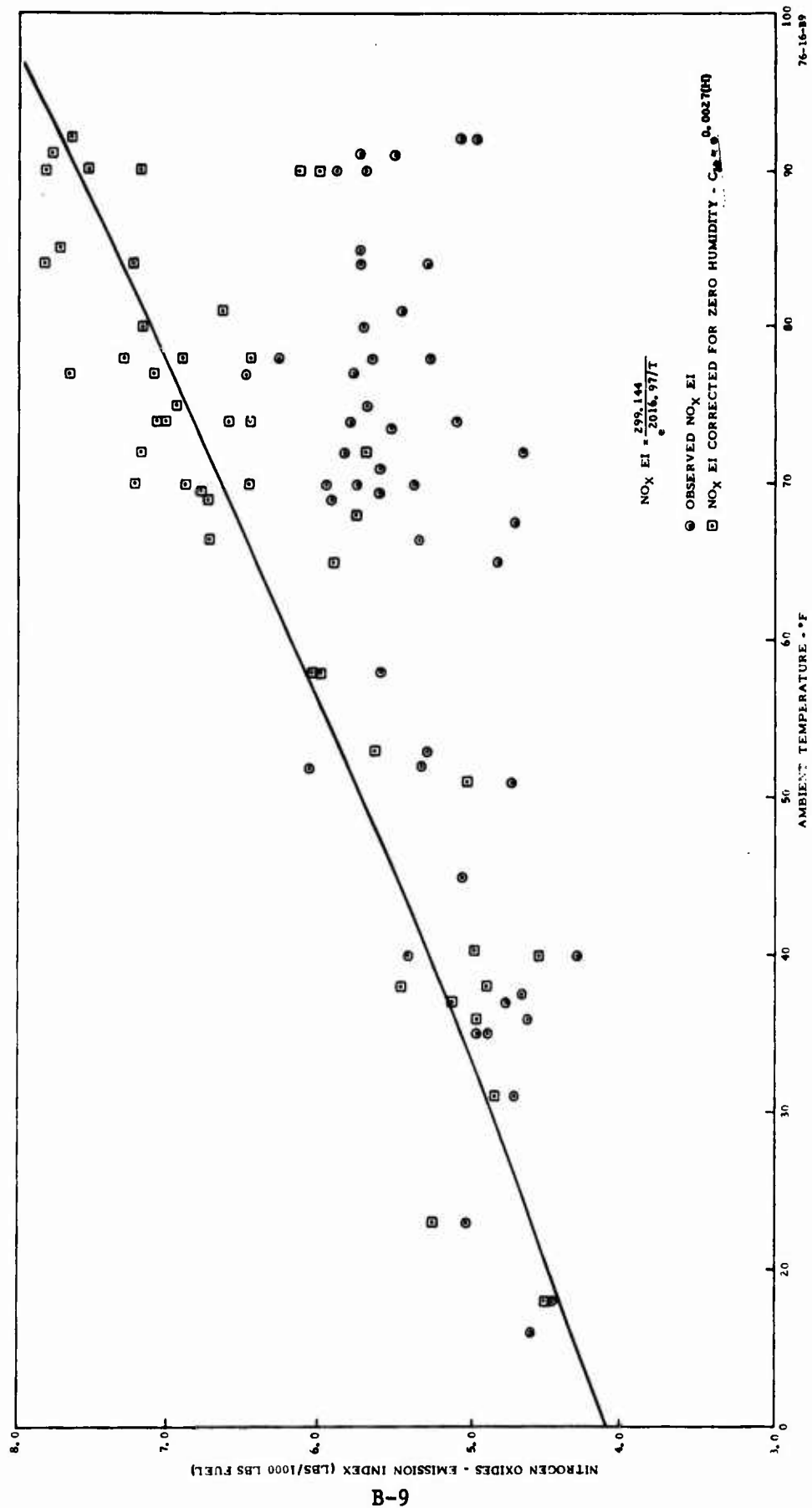


FIGURE B-9. NO_x EI--TF30-P1 ENGINE--APPROACH POWER

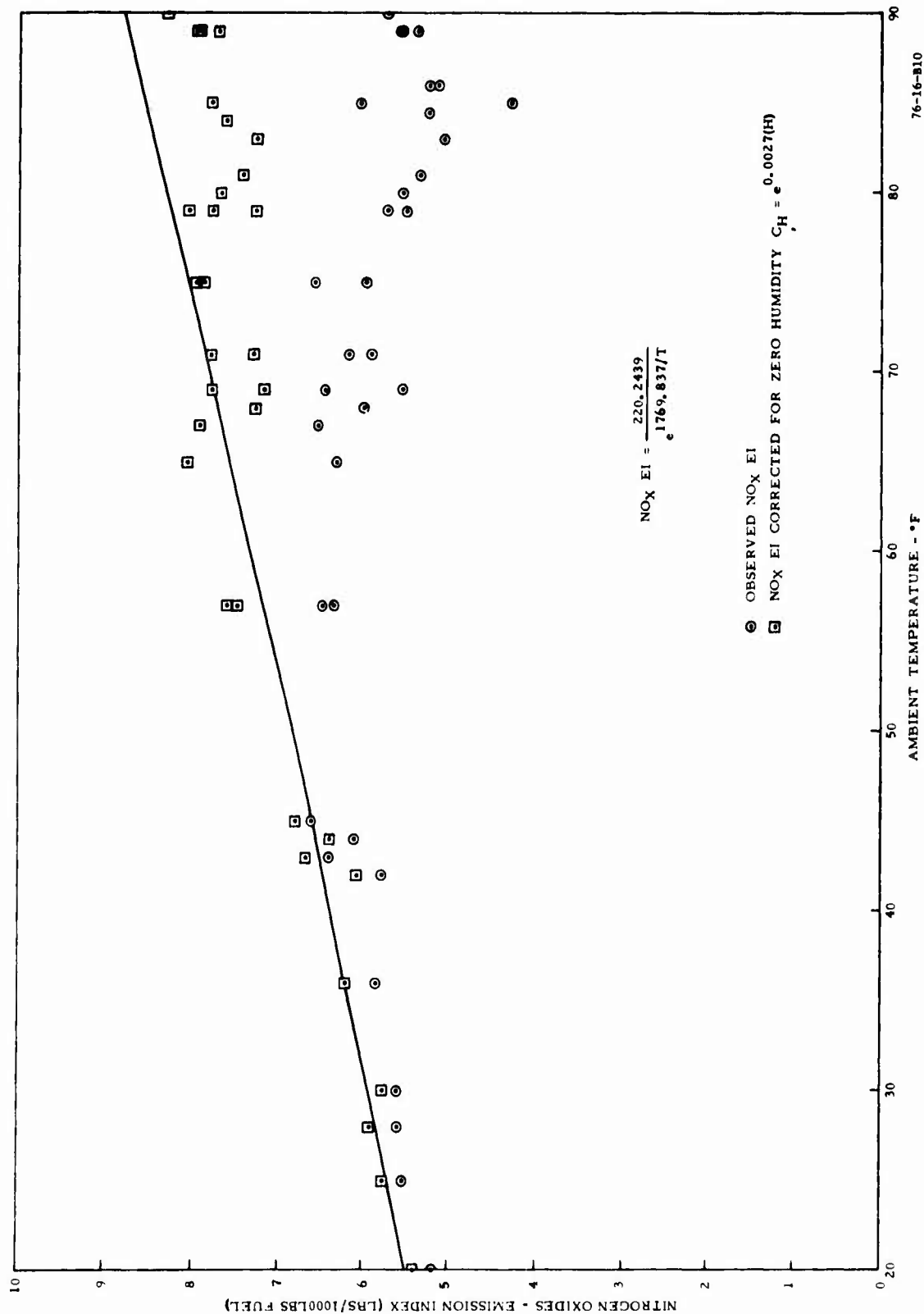


FIGURE B-10. NO_x EI--J57-43 ENGINE---APPROACH POWER

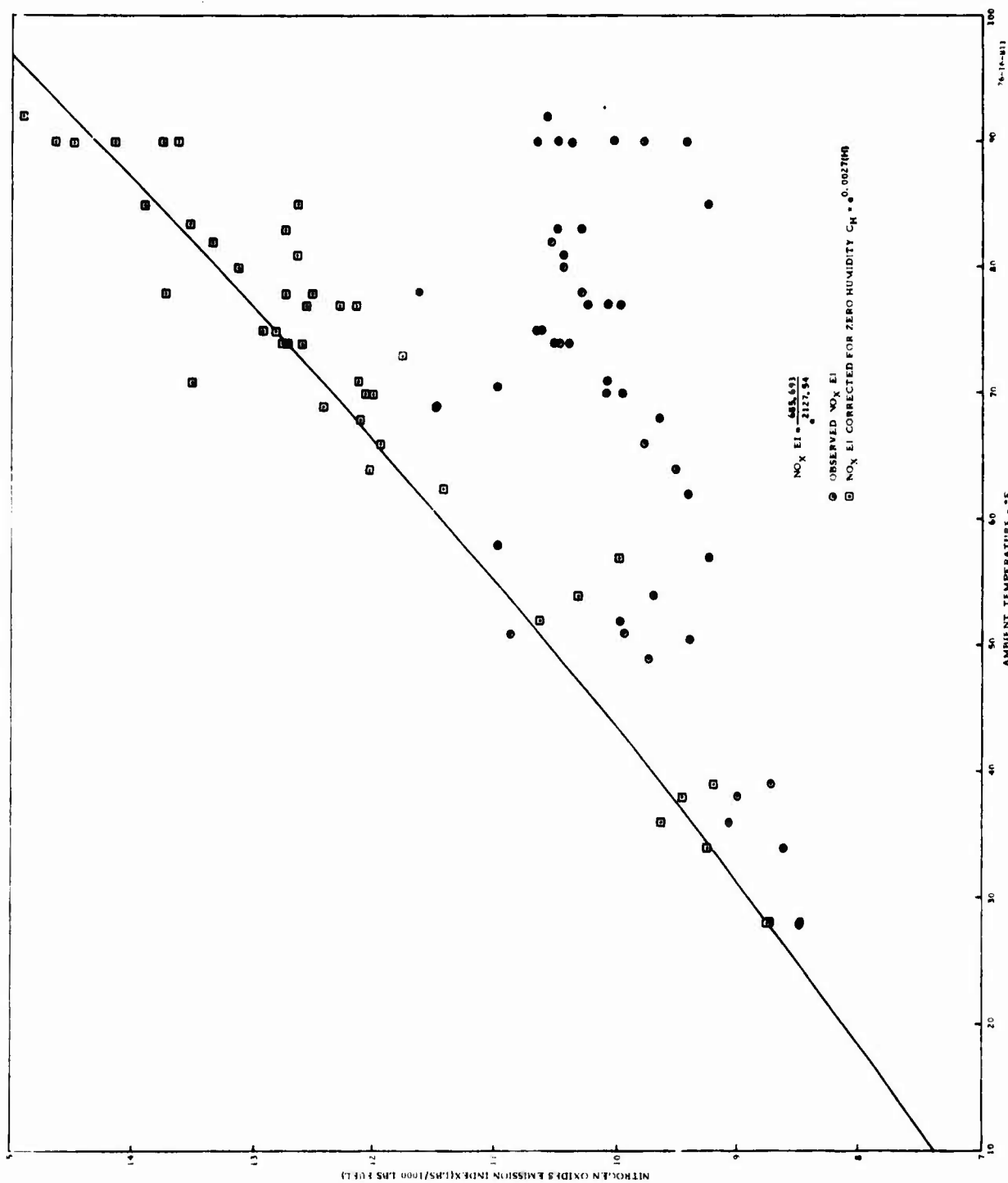


FIGURE B-11. NOx EI-TF30-P1 ENGINE--CRUISE POWER

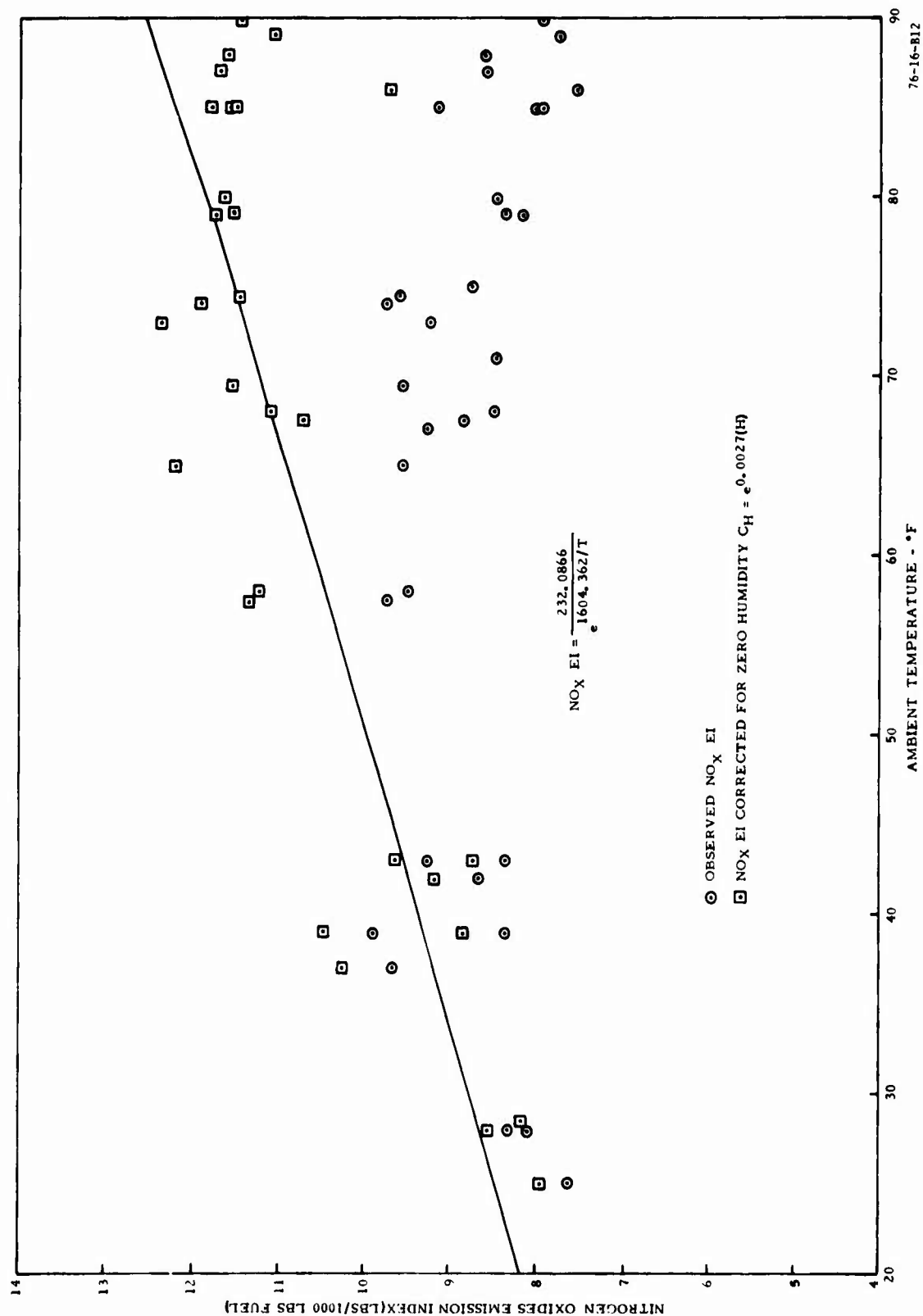


FIGURE B-12. NO_x EI--J57-43 ENGINE CRUISE POWER

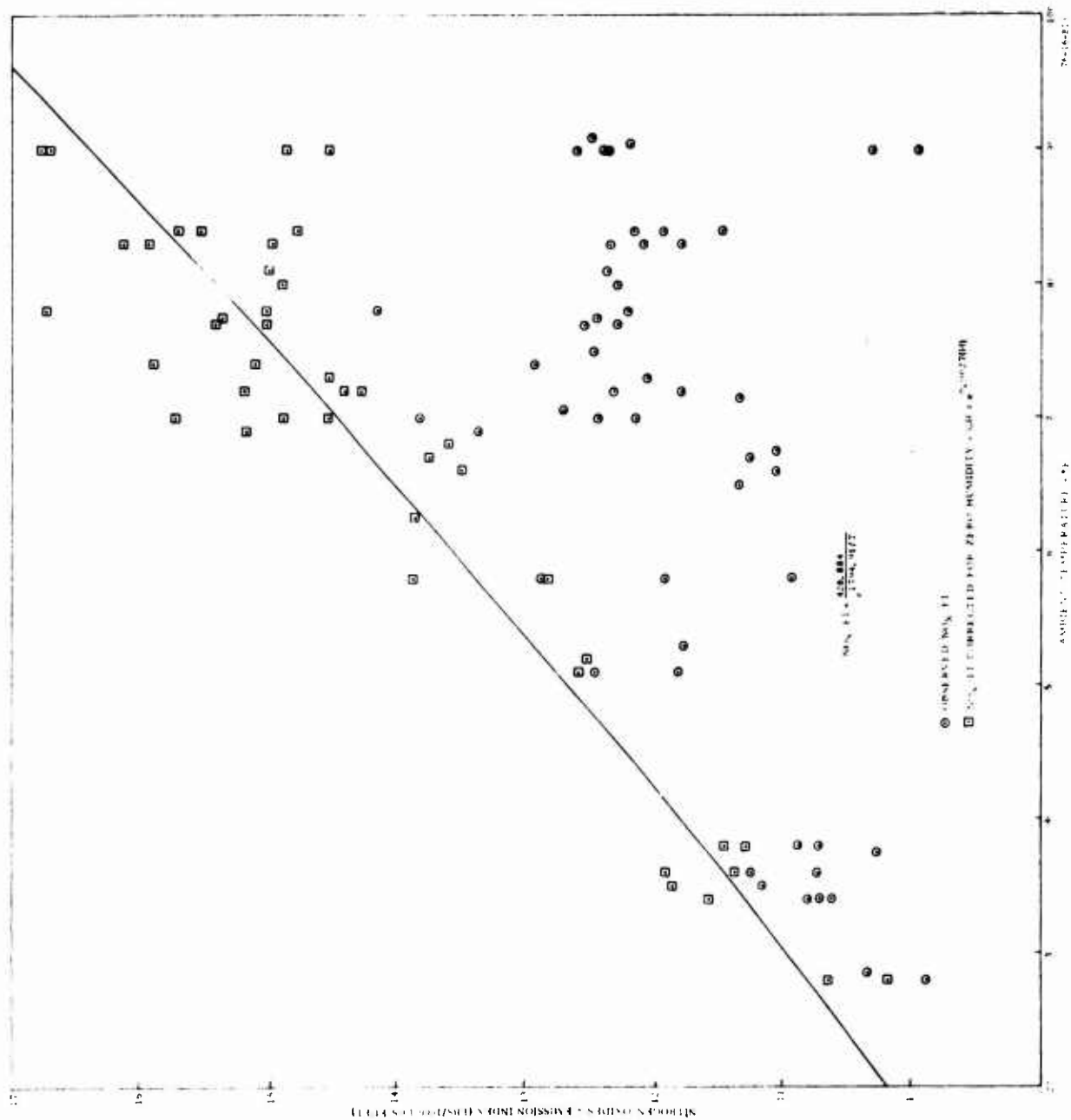


FIGURE B-13. NOx EI-TF30-P1 ENGINE--MAXIMUM CONTINUOUS POWER

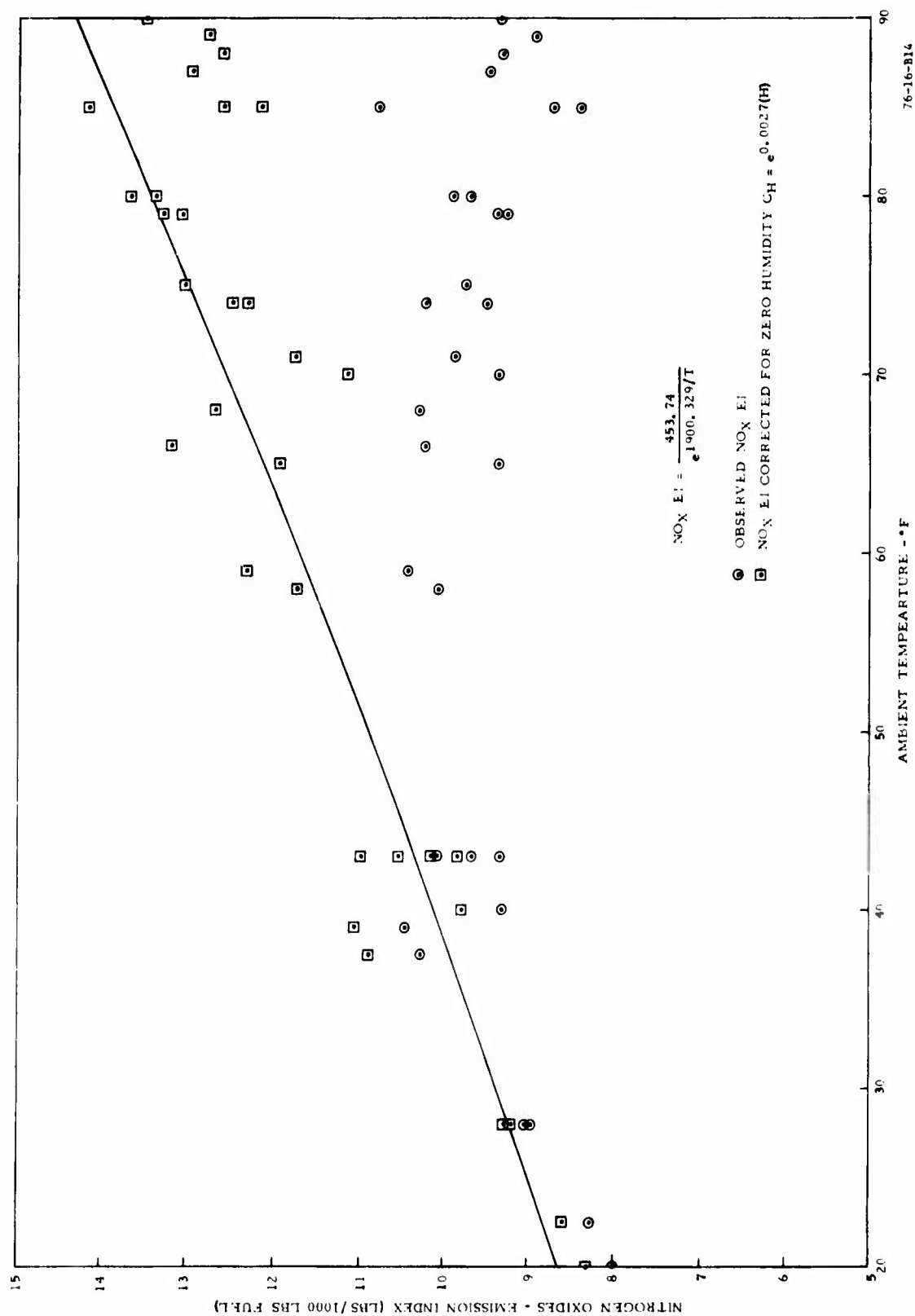


FIGURE B-14. NO_x EI--J57-43 ENGINE--MAXIMUM CONTINUOUS POWER

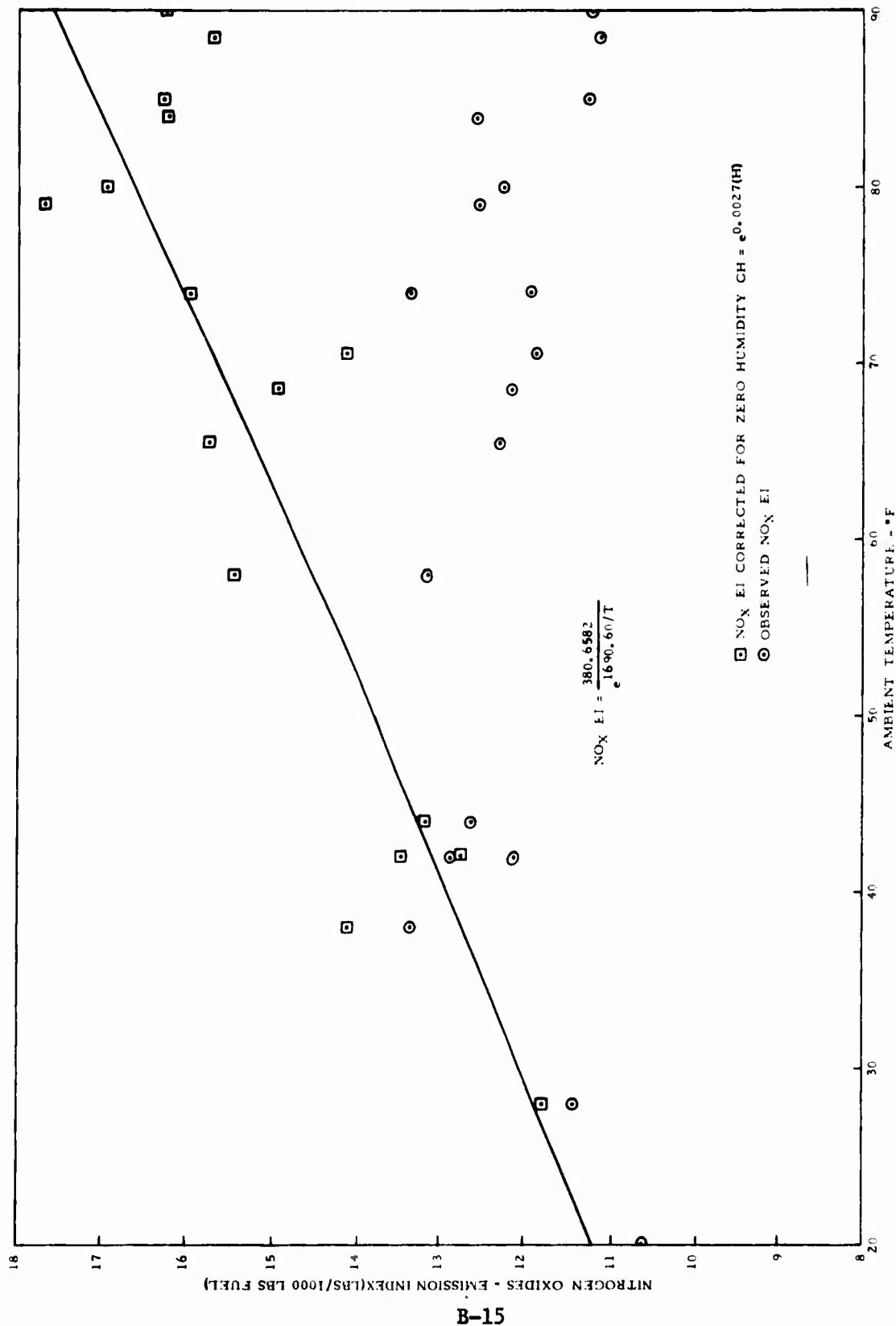


FIGURE B-15. NO_x EI--J57-43 ENGINE TAKEOFF POWER

APPENDIX C

CORRELATION COEFFICIENTS, ANALYSIS OF VARIANCE
VALUES AND COEFFICIENTS FROM REGRESSION ANALYSIS

APPENDIX C

LIST OF TABLES

C-1	CO lbs/1,000 lbs Fuel, Idle Power, EPR 1.08-- TF30-P1 Engine	C-2
C-2	CO lbs/1,000 lbs Thrust, Idle Power, EPR 1.08-- TF30-P1 Engine	C-2
C-3	CO lbs/1,000 lbs Fuel, Approach Power, EPR 1.31-- TF30-P1 Engine	C-3
C-4	CO lbs/1,000 lbs Thrust, Approach Power, EPR 1.31-- TF30-P1 Engine	C-3
C-5	CO lbs/1,000 lbs Fuel, Cruise Power, EPR 1.76-- TF30-P1 Engine	C-4
C-6	CO lbs/1,000 lbs Thrust, Cruise Power, EPR 1.76-- TF30-P1 Engine	C-4
C-7	CO lbs/1,000 lbs Fuel, Maximum Continuous Power, EPR 1.905--TF30-P1 Engine	C-5
C-8	CO lbs/1,000 lbs Thrust, Maximum Continuous Power, EPR 1.905--TF30-P1 Engine	C-5
C-9	CO lbs/1,000 lbs Fuel, Takeoff Power, EPR 2.05-- TF30-P1 Engine	C-6
C-10	CO lbs/1,000 lbs Thrust, Takeoff Power, EPR 2.05-- TF30-P1 Engine	C-6
C-11	THC lbs/1,000 lbs Fuel, Idle Power, EPR 1.08-- TF30-P1 Engine	C-7
C-12	THC lbs/1,000 lbs Thrust, Idle Power, EPR 1.08-- TF30-P1 Engine	C-7
C-13	THC lbs/1,000 lbs Fuel, Approach Power, EPR 1.31-- TF30-P1 Engine	C-8
C-14	THC lbs/1,000 lbs Thrust, Approach Power, EPR 1.31-- TF30-P1 Engine	C-8
C-15	THC lbs/1,000 lbs Fuel, Cruise Power, EPR 1.76-- TF30-P1 Engine	C-9

LIST OF TABLES (Continued)

Table		Page
C-16	THC 1bs/1,000 1bs Thrust, Cruise Power EPR 1.76-- TF30-P1 Engine	C-9
C-17	THC 1bs/1,000 1bs Fuel, Maximum Continuous Power, EPR 1.905--TF30-P1 Engine	C-10
C-18	THC 1bs/1,000 1bs Thrust, Maximum Continuous Power, EPR 1.905--TF30-P1 Engine	C-10
C-19	THC 1bs/1,000 1bs Fuel, Takeoff Power, EPR 2.05-- TF30-P1 Engine	C-11
C-20	THC 1bs/1,000 1bs Thrust, Takeoff Power EPR 2.05-- TF30-P1 Engine	C-11
C-21	NO _x 1bs/1,000 1bs Fuel, Idle Power EPR 1.08-- TF30-P1 Engine	C-12
C-22	NO _x 1bs/1,000 1bs Thrust, Idle Power, EPR 1.08-- TF30-P1 Engine	C-12
C-23	NO _x 1bs/1,000 1bs Fuel, Approach Power, EPR 1.31-- TF30-P1 Engine	C-13
C-24	NO _x 1bs/1,000 1bs Thrust, Approach Power, EPR 1.31-- TF30-P1 Engine	C-13
C-25	NO _x 1bs/1,000 1bs Fuel, Cruise Power, EPR 1.76-- TF30-P1 Engine	C-14
C-26	NO _x 1bs/1,000 Thrust, Cruise Power, EPR 1.76-- TF30-P1 Engine	C-14
C-27	NO _x 1bs/1,000 Fuel, Maximum Continuous Power, EPR 1.905--TF30-P1 Engine	C-15
C-28	NO _x 1bs/1,000 Thrust, Maximum Continuous Power, EPR 1.905--TF30-P1 Engine	C-15
C-29	NO _x 1bs/1,000 Fuel, Takeoff Power, EPR 2.05-- TF30-P1 Engine	C-16
C-30	NO _x 1bs/1,000 Thrust, Takeoff Power, EPR 2.05-- TF30-P1 Engine	C-16

APPENDIX C

CORRELATION COEFFICIENTS, ANALYSIS OF VARIANCE VALUES AND COEFFICIENTS FROM REGRESSION ANALYSIS

DEFINITION OF TERMS.

The correlation coefficient represents the proportion of the total variation of the emission index explained by the associated variable. The multiple correlation coefficient squared represents the proportion of the total variation accounted for by the fitted equation. The F value is used to test the "significance" of the multiple correlation coefficient squared, where the degrees-of-freedom are 2 for the numerator and N-3 for the denominator and N is sample size. Computed "t" value is the ratio of the regression coefficient and its standard deviation. It used to determine if its regression coefficient is different from zero.

Partial correlation coefficient represent the proportion of the total variation of the emission index explained by the associated variable while the other variables are kept constant. Regression coefficients are the values for multiple regression equation model. The log transformation in these tables are to the base 10.

TABLE C-1. CO LBS/1,000 LBS FUEL, IDLE POWER, EPR 1.08--TF30-P1 ENGINE

Regression Equation	Multiple Cor. Coef.			Analysis of Variance Regression Analysis F Value	Computed t Value			Partial Correlation Coefficients			Regression Equation Constants			SE*	S**	
	Correlation Coefficients				Value			Coefficients			Equation					
	T	H	P		T	H	P	T	H	P	A	T	H			P
Linear (5)	-.849	-.835	+.545	.881	42.7	-3.09	-1.59	1.98	-.453	-.253	.309	-.79.46	-.156	-.045	2.71	41
Linear (5)	-.849	-.835		.868	57.8	-2.90	-2.20		-.425	-.336		70.70	-.151	-.062	2.81	41
1/T (3)	.769	-.835	.545	.883	43.82	3.23	-4.78	1.36	.469	-.618	.219	-44.55	220.46	-.086	2.68	41
1/T (3)	.769	-.835		.877	63.4	3.43	-.542		.486	-.660		58.75	233.9	-.093	2.71	41
Log K (6)	.837	-.843	.550	.880	42.4	2.67	-2.20	1.93	.401	-.341	.302	.1828	259.9570	-.00045	.02047	41
Log K (6)	.837	-.843		.867	57.3	2.51	-2.81		.377	-.415		1.306	253.3	-.0006	.021	41
Log K (6)	.857	.864		.886	82.1	2.81	-3.26		.386	-.437		1.2787	268.7686	-.00060	.0210	48

TABLE C-2. CO LBS/1,000 LBS THRUST, IDLE POWER, EPR 1.08--TF30-P1 ENGINE

Regression Equation	Correlation Coefficients			Multiple Cor. Coef.	Analysis of Variance Regression Analysis F Value	Computed t Value			Partial Correlation Coefficients			Regression Equation Constants			SE*	S**									
	T					H			P			A					T			H			P		
	T	H	P			T	H	P	T	H	P	T	H	P			A	T	H	P					
Linear (5)	-.720	-.731	.624	.665	23.1	-1.90	-.91	3.30	-.306	-.152	.487	-228.2	-.111	-.030	3.05	39									
Linear (5)	-.720	-.731		.749	22.9	-1.44	-1.83		-.232	-.292		58.5	-.095	-.065	3.45	39									
1/T (3)	.682	-.731	.624	.822	24.34	2.22	-2.74	2.89	.352	-.420	.439	-197.95	170.71	-.057	3.00	39									
1/T (3)	.682	-.731		.774	26.9	2.39	-3.47		.370	-.500		49.5	199.6	-.075	3.29	39									
Log K (6)	.719	-.751	.619	.820	23.87	1.57	-1.48	3.11	.257	-.243	.466	-.97661	201.928	-.00040	.02610	39									
Log K (6)	.719	-.751		.762	24.95	1.213	-2.34		.198	-.364		1.394	172.4	-.001	.029	39									
Log K (6)	.747	-.789		.796	36.44	1.183	-2.947		.179	-.414		1.448	144.12	-.0007	.026	45									

TABLE C-3. CO LBS/1,000 LBS FUEL, APPROACH POWER, EPR 1.31--TF30-P1 ENGINE

Regression Equation	Correlation Coefficients			Multiple Cor. Coef.	Analysis of Variance Regression Analysis F Value	Computed t Value			Partial Correlation Coefficients			Regression Equation Constants			SF*	S**	
	T		P			T	H	P	T	H	P	A	T	H			P
Linear (5)	-	.939	-.815	.441	.939	72.6	-7.29	.60	.04	.804	.111	.007	20.3	-.116	.007	.732	33
Linear (5)	-	.939	-.815		.939	112.7	-7.47	.61		-.807	.112		21.2	-.116	.007	.720	33
1/T (3)		.882	-.815	.441	.920	53.13	5.80	-3.55	1.08	.73	-.551	-.197	42.46	141.20	-.030	-.968	33
1/T (3)		.882	-.815		.916	78.7	5.74	-3.42		.724	-.530		13.5	132.79	-.029	.841	33
Log K (6)		.935	-.823	.428	.935	67.39	6.72	-.067	-.337	.780	-.012	-.062	-.17193	807.9265	-.00002	-.00743	33
Log K (6)		.935	-.823		.935	104.11	6.84	-.022		.780	-.094		-.385	802.3	-.000	.021	33
Log K (6)		.944	.871		.946	146.14	6.70	-1.22		.754	-.204		-.28118	755.566	-.00032	.022	37

TABLE C-4. CO LBS/1,000 THRUST, APPROACH POWER, EPR 1.31--TF30-P1 ENGINE

Regression Equation	Correlation Coefficients			Multiple Cor. Coef.	Analysis of Variance Regression Analysis F Value	Computed t Value	Partial Correlation Coefficients			Regression Equation Constants			SE*	S**		
	T						T			T						
	H	P	P				T	H	P	A	T	H			P	
Linear (5)	-.579	-.411	.224	.608	6.85	-3.44	1.23	-.0330	-.492	.203	-.056	24.1	-.071	.015	1.16	39
Linear (5)	-.579	-.411		.607	10.5	-3.17	1.36	-.490	.222			12.6	-.070	.016	1.15	39
1/T (3)	.528	-.411	.234	.544	4.91	2.52	-.749	-.746	.392	-.126	-.125	36.44	79.20	-.007	1.23	39
1/T (3)	.528	-.411		.534	7.17	2.47	-.555		.374	-.092		8.05	72.45	-.0046	1.22	39
Log K (6)	.573	-.403	.195	.601	6.61	3.29	1.02	-.603	.486	.170	-.101	.287	865.5	.001	-.034	39
Log K (6)	.573	-.403		.596	9.90	3.27	1.22		.479	.199		-.709	843.1	.001	.056	39
Log K (6)	.732	-.583		.740	21.26	4.02	.967		.562	.161						

TABLE C-5. (X) LBS/1,000 LBS FUEL, CRUISE POWER, EPR 1.76--TF30-P1 ENGINE

Regression Equation	Correlation Coefficients			Multiple Cor. Coef.		Analysis of Variance Regression Analysis F Value		Computed t Value		Partial Correlation Coefficients			Regression Equation Constants			SE*	S**
	T		P	H	P	T	H	P	T	H	P	A	T	H	P		
	T	H															
Linear (5)	-.914	-.816	.140	.917	61.8	-6.10	.51	1.08	-.718	.086	.180	-2.97	-.036	.002	.281	.259	39
Linear (5)	-.914	-.816		.914	91.7	-6.11	.04		-.713	.006		5.38	-.034	.00012		.260	39
1/T (3)	.893	-.816	.140	.911	57.27	5.72	-1.86	.892	.695	-.300	.149	-4.79	68.87	-.005	.237	.268	39
1/T (3)	.893	-.816		.909	86.0	5.79	2.49		.694	-.383		2.43	65.09	-.006		.267	39
Log K (6)	.901	-.831	.177	.908	55.0	5.13	-.320	1.27	.655	-.054	.209	-2.98	1108.6	-.0002	.045	.036	39
Log K (6)	.901	-.831		.903	80.4	4.98	-.98		.639	-.16		-1.40	1006.6	-.0004		.036	39
Log K (6)	.940	-.897		.943	188.4	6.28	-2.54		.696	-.365		-1.204	910.05	-.0007		.028	45

TABLE C-6. (X) LBS/1,000 LBS THRUST, CRUISE POWER, EPR 1.76--TF30-P1 ENGINE

Regression Equation	Correlation Coefficients			Multiple Cor. Coef.	Analysis of Variance Regression Analysis F Value	Computed t Value			Partial Correlation Coefficients			Regression Equation Constants			SE*	S**	
	T		P			T	H	P	T	H	P	A	T	H			P
	T	H															
Linear (5)	.904	.812	.146	.908	54.5	-5.62	.37	1.07	-.688	.062	.178	-1.73	-.019	.0007	.160	.150	39
Linear (5)	.904	.812		.904	80.8	-5.60	-.11		-.682	-.019		3.03	-.018	.0002		.150	39
1/T (3)	.882	.812	.147	.903	51.52	5.34	-1.84	.910	.670	.297	.152	-2.75	36.83	-.003	.138	.153	39
1/T (3)	.882	.812		.901	77.2	5.37	-2.48		.668	-.382		1.46	34.63	-.0034		.153	39
Log K (6)	.887	.826	.179	.895	46.98	4.55	-.504	1.134	.609	-.085	.188	-2.87	995.0	-.000	.041	.037	39
Log K (6)	.887	.826		.891	69.28	4.42	-1.121		.594	-.184		-1.43	902.5	-.000		.037	39

TABLE C-7. CO LBS/1,000 LBS FUEL, MAXIMUM CONTINUOUS POWER, EPR 1.905--TF30-P1 ENGINE

Regression Equation	Correlation Coefficients			Multiple Cor. Coef.	Analysis of Variance Regression Analysis F Value	Computed t Value	Partial Correlation Coefficients			Regression Equation Constants			SE*	S**		
	T						T			A						
	T	H	P				T	H	P	A	T	H			P	
Linear (5)	.938	-.848	.144	.938	93.0	-6.80	.06	.380	-.741	-.010	.061	1.86	-.022	-.0001	.162	42
Linear (5)	.938	-.848		.938	142.5	-7.22	-.26		-.757	-.042		3.76	-.022	-.0005	.160	42
1/T (3)	.909	-.848	.144	.931	82.10	6.13	-2.82	.317	.705	-.415	.051	1.65	42.15	-.004	.171	42
1/T (3)	.909	-.848		.931	126.0	6.55	-3.40		.723	-.48		1.88	41.34	-.0045	.169	42
Log K (6)	.920	-.848	.171	.924	73.61	5.68	-.639	.658	.677	-.103	.106	-2.16	975.3	-.000	.033	42
Log K (6)	.920	-.848		.923	111.83	5.89	-.066		.686	-.168		-1.40	933.9	-.000	.033	42
Log K (6)	.974	-.917		.975	405.44	9.735	-1.834		.835	-.274		-1.42	941.666	-.00034	.00036	44

TABLE C-8. CO LBS/1,000 LBS THRUST, MAXIMUM CONTINUOUS POWER, EPR 1.905--TF30-P1 ENGINE

Regression Equation	Correlation Coefficients			Multiple Cor. Coef.	Analysis of Variance Regression Analysis F Value	Computed t Value	Partial Correlation Coefficients			Regression Equation Constants			SE*	S**		
	T						H			P						
	T	H	P				T	H	P	A	T	H			P	
Linear (5)	.935	.860	.170	.937	90.7	-6.28	-.50	.601	-.713	-.081	.097	.49	-.011	.0005	.089	42
Linear (5)	.935	.860		.936	138.2	-6.55	-.87		-.724	-.139		2.14	-.011	.0008	.089	42
1/T (3)	.904	.860	.170	.933	84.95	5.92	-3.15	.586	.693	-.455	.095	-.515	21.90	-.003	.092	42
1/T (3)	.904	.860		.932	129.4	6.20	-3.91		.704	-.531		1.19	21.09	-.0028	.091	42
Log K (6)	.915	.861	.196	.922	71.60	5.12	-1.11	.790	.639	-.177	.127	-2.16	820.2	-.000	.031	42
Log K (6)	.915	.861		.922	71.60	5.12	-1.11	7.90	.639	-.177	.127	-2.16	820.2	-.000	.031	42
Log K (6)	.915	.861		.920	108.13	5.22	-1.67		.641	-.258		-1.31	773.3	-.001	.031	42

TABLE C-9. C0 LBS/1,000 LBS FUEL, TAKEOFF POWER, EPR 2.05--TF30-P1 ENGINE

Regression Equation	Correlation Coefficients			Multiple Cor. Coef.	Analysis of Variance Regression Analysis F Value	Computed t Value			Partial Correlation Coefficients			Regression Equation Constants			SE*	S**									
	T					H			P			A					T			H			P		
	T	H	P			T	H	P	T	H	P	T	H	P			T	H	P	T	H	P			
Linear (5)	-.945	-.871	.463	.947	37.8	-4.17	-.26	.46	-.757	-.072	.125	.544	.014	-.0005	.080	.104	17								
Linear (5)	-.945	-.871		.946	59.9	-4.27	-.44		-.752	-.116		2.94	-.014	-.0007		.101	17								
1/T (3)	.869	-.871	.464	.926	25.86	2.97	-2.32	.640	.636	-.541	.175	-2.13	20.73	-.004	.134	.123	17								
1/T (3)	.869	-.871		.852	40.3	2.97	-3.04		.621	-.630		1.92	19.92	-.004		.120	17								
Log K (6)	.939	-.885	.478	.946	37.16	3.73	-.865	.576	.719	-.233	.158	-1.59	665.0	-.000	.021	.022	17								
Log K (6)	.939	-.885		.945	58.36	3.78	-1.16		.711	-.296		-.927	654.9	-.000		.022	17								
Log K (6)	.947	-.891		.951	80.89	4.47	-1.17		.735	-.274		-.9598	670.276	-.00033		.0199	20								

TABLE C-10. C0 LBS/1,000 LBS THRUST, TAKEOFF POWER, EPR 2.05--TF30-P1 ENGINE

Regression Equation	Correlation Coefficients			Multiple Cor. Coef.	Analysis of Variance Regression Analysis F Value	Computed t Value			Partial Correlation Coefficients			Regression Equation Constants			SE*	S**									
	T					H			P			A					T			H			P		
	T	H	P			T	H	P	T	H	P	T	H	P			T	H	P						
Linear (5)	.860	-.749	.428	.870	16.6	-3.53	.41	1.06	-.662	.103	.257	-3.36	-.010	.0007	.173	.103	20								
Linear (5)	.860	-.749		.860	24.1	-3.42	0.42		-.638	.010		1.84	-.010	.0006		.103	20								
1/T (3)	.755	-.749	.428	.813	10.38	2.10	-1.21	.935	.465	-.290	.228	-4.35	13.81	-.002	.182	.121	20								
1/T (3)	.755	-.749		.801	15.2	1.96	1.84		.43	-.41		1.16	12.62	-.0025		.121	20								
Log K (6)	.828	-.736	.437	.842	13.03	2.95	.129	1.10	.594	.032	.265	-3.71	859.4	.000	.072	.041	20								
Log K (6)	.828	-.736		.829	18.71	29.01	-.294		.563	-.071		-1.146	815.9	.000		.041	20								
Log K (6)	.942	-.929		.960	87.57	3.29	-2.52		.647	-.545		-.773	472.07	-.0006		.018	18								

TABLE C-11. THC LBS/1,000 LBS FUEL, IDLE POWER EPR 1.08--TF30-P1 ENGINE

Regression Equation	Correlation Coefficients			Multiple Cor. Coef.	Analysis of Variance Regression Analysis F Value	Computed t Value			Partial Correlation Coefficients			Regression Equation Constants			SE*	S**	
	T	H	P			T	H	P	T	H	P	A	T	H			P
Linear (5)	-.873	-.704	.528	.923	65.47	-8.50	3.37	4.68	-.825	.825	.572	-153.63	-.248	.056	5.98	1.55	38
Linear (5)	-.873	-.704		.884	62.27	-6.74	1.75		-.752	.283		26.26	-.235	.032		1.86	38
1/T (3)	.955	-.704	.528	.967	160.92	14.30	-.764	2.89	.926	-.130	.444	-78.23	374.36	-.005	2.84	1.03	38
1/T (3)	.955	-.704		.958	196.14	13.43	-1.61		.915	-.263		7.11	383.85	-.012		1.14	38
Log K (6)	.920	-.779	.513	.941	87.90	8.75	1.86	3.35	.832	.303	.498	-5.45238	1560.453	.00070	.11782	.037	38
Log K (6)	.920	-.779		.921	97.70	7.45	.671		.783	.113		-1.77	1504.8	.000		.042	38
Log K (6)	.923	-.852		.925	113.17	5.88	-.998		.690	-.160		1.327	1279.56	.00038		.040	38

TABLE C-12. THC LBS/1,000 LBS THRUST, IDLE POWER, EPR 1.08--TF30-P1 ENGINE

Regression Equation	Analysis of Variance										Regression Equation Constants					SE*	S**	
	Multiple Cor. Coef.			Regression Analysis F Value			Computed t Value			Partial Correlation Coefficients			Regression Equation Constants					
	T	H	P	T	H	P	T	H	P	T	H	P	A	I	H			P
Linear (5)	-.785	-.653	.540	.833	27.88		-5.01	1.72	2.94	-.636	.272	.435	-138.81	-.176	.034	5.31	1.94	41
Linear (5)	-.785	-.653		.789	31.22		-4.43	.771		-.584	.124		20.87	-.170	.016		2.13	41
1/T (3)	.884	-.653	.540	.900	52.85		7.98	-.213	2.22	.759	-.035	.343	-89.63	306.50	-.002	3.18	1.52	41
1/T (3)	.884	-.653		.886	60.57		7.98	-.924		.791	-.148		5.86	318.71	-.009		1.60	41
Log K (6)	.807	-.718	.512	.830	27.26		4.13	.284	2.05	.561	.047	.320	-5.1592	1257.72	.00018	.12565	.0659	41
Log K (6)	.807	-.718		.808	35.76		3.88	-.359		.513	-.058		-1.32	1231.7	-.000		.069	41
Log K (6)	.883	-.859		.898	74.98		3.55	-2.23		.509	-.348		-.602	881.6	-.001		.042	41

TABLE C-13. THC LBS/1,000 LBS FUEL, APPROACH POWER, EPR 1.31--TF30-P1 ENGINE

Regression Equation	Correlation Coefficients			Multiple Cor. Coef.	Analysis of Variance Regression Analysis F Value	Computed t Value	Partial Correlation Coefficients			Regression Equation Constants			SE*	S**			
	T						H			P							
	T	H	P				T	H	P	A	T	H			P		
Linear (5)	-.882	-.690	.43	.893	43.35	-7.21	1.66	-.283	-.781	.278	-.049	8.40	.060	.008	.129	.435	37
Linear (5)	-.882	-.690		.892	66.79	-7.33	1.79	-	.782	.294		4.48	.008	.005		.429	37
1/T (3)	.928	.690	.431	.946	94.47	11.48	-2.68	-2.71	.894	-.423	-.427	27.61	93.42	-.006	-.926	.312	37
1/T (3)	.928	-.690		.931	116.34	10.28	-1.79		.870	-.293		-	.172	86.47	-.004	.340	37
Log K (6)	.783	-.735	.284	.820	22.52	3.30	-1.75	-2.02	.498	-.292	-.331	7.49	3569.0	-.004	-.472	.222	37
Log K (6)	.783	-.735		.795	29.11	2.90	-1.27		.446	-.213		-	6.10	3278.9	-.003	.232	37
Log K (6)	.898	-.874		.918	91.31	4.15	-2.79		.580	-.432		-	4.95	2666.37	-.0035	.135	37

TABLE C-14. THC LBS/1,000 LBS THRUST, APPROACH POWER, EPR 1.31--TF30-P1 ENGINE

Regression Equation	Correlation Coefficients			Multiple Cor. Coef.	Analysis of Variance Regression Analysis F Value	Computed t Value	Partial Correlation Coefficients			Regression Equation Constants			SE*	S**			
	T		P				T		H	P	A				T	H	P
	T	H	P				T	H	P	A	T	H			P		
Linear (5)	-.884	-.711	.476	.895	44.05	-6.80	1.67	.789	-.764	.279	.136	-3.90	-.034	.005	.216	.271	37
Linear (5)	-.884	-.711		.892	66.50	-6.97	1.55		-.767	.257		2.63	-.035	.004		.270	37
1/T (3)	.910	-.711	.476	.849	62.02	8.49	-2.13	-.838	.828	-.347	.144	6.17	51.75	-.004	-.207	.235	37
1/T (3)	.910	-.711		.919	93.50	8.67	-1.99		.830	-.322		-.035	50.22	-.003		.234	37
Log K (6)	.810	-.772	.342	.832	24.65	3.10	-1.75	-1.16	.475	-.291	-.198	1.56305	3288.8562	-.00404	-.26428	.22532	37
Log K (6)	.810	-.772		.824	35.93	2.96	-1.54		.453	-.255		-6.10	3133.5	-.003		.226	37
Log K (6)	.894	-.883		.918	46.02	3.75	-3.12		.531	-.461		-4.67	2424.3	-.004		.139	39

TABLE C-15. THC LBS/1,000 LBS FUEL, CRUISE POWER, EPR 1.76--TF30-P1 ENGINE

Regression Equation	Correlation Coefficients			Multiple Cor. Coef.	Analysis of Variance Regression Analysis F Value	Computed t Value			Partial Correlation Coefficients			Regression Equation Constants			SE*	S**									
	T					H			P			A					T			H			P		
	T	H	P			T	H	P	T	H	P	T	H	P			A	T	H	P					
Linear (5)	-.620	-.539	-.123	.630	6.15	-1.64	.015	-.687	-.295	.003	-.129	5.64	-.009	.001	-.157	.215	32								
Linear (5)	-.620	-.539		.622	9.15	-2.13	.360		-.368	.067		.96	-.011	.001		.213	32								
1/T (3)	.516	-.539	-.123	.586	4.87	.384	-1.71	-1.20	.072	.307	-.221	8.91	4.18	-.004	-.280	.224	32								
1/T (3)	.516	-.539		.556	6.49	.873	-1.33		.160	-.241		.349	8.91	-.003		.226	32								
Log K (6)	.646	-.578	-.092	.651	6.87	1.68	-.113	-.530	.303	-.021	-.100	-2.03	3247.4	-.000	-.159	.281	32								
Log K (6)	.646	-.573		.647	10.42	2.12	.140		.367	.026		-7.68	3670.0	-.001		.278	32								
Log K (6)	.778	-.705		.778	22.23	2.82	-.062		.464	-.011		-6.75	3206.74	-.0001		.202	32								

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9

TABLE C-16. THC LBS/1,000 LBS THRUST, CRUISE POWER, EPR 1.76--TF30-P1 ENGINE

Regression Equation	Correlation Coefficients			Multiple Cor. Coef.	Analysis of Variance Regression Analysis F Value	Computed t Value			Partial Correlation Coefficients			Regression Equation Constants			SE*	S**	
	I	H	P			T	H	P	I	H	P	A	I	H			P
Linear (5)	-.612	-.531	-.121	.622	5.89	-1.63	.049	-.654	-.295	.009	-.123	3.13	-.005	.000	-.087	.124	32
Linear (5)	-.612	-.531		.615	8.80	-2.12	.382		-.366	.071		.552	-.006	.001		.123	32
1/T (3)	.509	-.531	-.121	.576	4.64	.384	-1.66	-1.17	.072	-.299	-.215	5.02	2.42	-.002	-.159	.130	32
1/T (3)	.509	-.531		.547	6.20	.861	-1.30		.158	-.234		.201	5.08	-.002		.131	32
Log K (6)	.639	-.565	-.098	.645	6.64	1.65	-.118	-.565	.297	-.022	-.106	-1.80	314.7	-.001	-.168	.278	32
Log K (6)	.639	-.565		.640	10.04	2.09	.151		.363	-.028		-7.75	3590.3	.001		.275	32
Log K (6)	.774	-.705		.774	21.74	2.73	-.123		.453	-.023		-6.74	1127.9	.002		.200	

TABLE C-17. THC LBS/1,000 LBS FUEL, MAXIMUM CONTINUOUS POWER, EPR 1.905--TF30-P1 ENGINE

Regression Equation	Correlation Coefficients			Multiple Cor. Coef.	Analysis of Variance Regression Analysis F Value	Computed t Value			Partial Correlation Coefficients			Regression Equation Constants			SE*	S**	
	I		P			T	H	P	T	H	P	A	T	H			P
	I	H															
Linear (5)	-.549	-.464	.018	.561	5.04	-2.16	.737	.519	-.352	.127	.090	-2.23	-.012	.002	.139	.243	37
Linear (5)	-.549	-.464		.555	7.58	-2.14	.588		-.345	.100		.900	-.011	.002		.240	37
1/T (3)	.483	-.464	.017	.496	3.59	1.13	-.644	.143	.194	-.111	.025	-1.02	12.100	-.002	.040	.255	37
1/T (3)	.483	-.464		.496	5.54	1.18	-.761		.198	-.129		.190	12.41	-.002		.251	37
Log K (6)	.587	-.508	-.043	.589	5.83	1.96	.326	.007	.323	.057	.001	-8.58	4033.5	.002	.002	.338	37
Log K (6)	.587	-.508		.589	9.02	2.14	.357		.345	.061		-8.50	4028.4	.002		.333	37
Log K (6)	.694	-.639		.694	17.20	2.29	-.153		.353	.025		-7.22	3402.0	-.0004		.281	40

C-10

TABLE C-18. THC LBS/1,000 LBS THRUST, MAXIMUM CONTINUOUS POWER, EPR 1.905--TF30-P1 ENGINE

Regression Equation	Correlation Coefficients			Multiple Cor. Coef.	Analysis of Variance Regression Analysis F Value	Computed t Value			Partial Correlation Coefficients			Regression Equation Constants			SE*	S**		
	T H P					T H P			T H P			A T H P						
	T	H	P			T	H	P	T	H	P	A	T	H			P	
Linear (5)	-.541	-.456	.007	.551	4.80		-2.10	.708	.433	-.344	.122	.075	-1.46	-.007	.001	.067	.140	37
Linear (5)	-.541	-.456		.548	7.28		-2.11	.594		-.341	.101		.516	-.006	.001		.138	37
1/T (3)	.473	-.456	.007	.487	3.41		1.07	-.669	.057	.182	-.116	.010	-.159	7.02	-.001	.009	.146	37
1/T (3)	.473	-.456		.486	5.27		1.14	-.754		.191	-.128		.118	6.88	-.001		.144	37
Log K (6)	.573	-.496	-.049	.575	5.44		1.88	.303	-.040	.311	.053	-.007	-7.91	3840.1	.001	-.015	.336	37
Log K (6)	.573	-.496		.575	8.41		2.08	.351		.335	.060		-8.41	3870.5	.002		.331	37
Log K (6)	.703	-.629		.703	17.64		2.66	.139		.405	.023		-8.31	3828.1	.0004		.280	

TABLE C-19. THC LBS/1,000 LBS FUEL, TAKEOFF POWER, EPR 2.05--TF30-P1 ENGINE

Regression Equation	Correlation Coefficients			Multiple Cor. Coef.	Analysis of Variance Regression Analysis F Value	Computed t Value			Partial Correlation Coefficients			Regression Equation Constants			SE*	S**									
	T					H			P			A					I			H			P		
	T	H	P			T	H	P	T	H	P	T	H	P			T	H	P	T	H	P			
Linear (5)	-.635	-.516	.216	.655	3.50	-1.99	.760	.440	.470	.199	.117	-3.88	-.015	.004	.163	0.222	18								
Linear (5)	-.635	-.516		.649	5.45	-2.00	.683		-.459	.174		1.01	-.014	.003		.216	18								
1/T (3)	.571	-.516	.216	.585	2.43	1.26	-.246	.406	.325	-.066	.108	-4.89	18.43	-.001	.163	.239	18								
1/T (3)	.571	-.516		.578	3.77	1.24	-.434		.306	-.111		.064	17.27	-.001		.232	18								
Log K (6)	.650	-.572	.129	.651	3.43	1.49	.069	-.170	.369	.018	-.045	-5.67	4001.9	.000	-.090	.317	18								
Log K (6)	.650	-.572		.650	5.49	1.58	.128		.378	.033		-8.53	4069.1	.001		.307	18								
Log K (6)	.796	-.684		.799	15.03	2.83	.480		.566	.115		-10.614	5116.99	.0017		.243	20								

TABLE C-20. THC LBS/1,000 LBS THRUST, TAKEOFF POWER, EPR 2.05--TF30-P1 ENGINE

Regression Equation	Correlation Coefficients			Multiple Cor. Coef.	Analysis of Variance		Computed t Value			Partial Correlation Coefficients			Regression Equation Constants			SE*	S**
	T				Regression Analysis F Value	T	H	P	T	H	P	A	T	H	P		
	T	H	P														
Linear (5)	-.604	-.448	-.301	.728	4.13	-1.63	.374	-1.59	-.440	.112	-.433	6.80	-.006	.001	-.210	.071	15
Linear (5)	-.604	-.448		.649	4.36	-2.14	1.08		-.525	.297		.544	-.007	.002		.075	15
1/T (3)	.584	-.448	-.301	.675	3.06	.884	-.488	-1.48	.258	-.146	-.408	6.71	9.24	-.000	-.222	.076	15
1/T(3)	.584	-.448		.588	3.18	1.64	.321		.427	.092		.128	16.09	.000		.080	15
Log K (6)	.582	-.392	-.211	.681	3.18	1.96	.890	-.813	.509	.259	-.238	2.03	6461.9	.006	-.383	2.50	15
Log K (6)	.582	-.392		.657	4.56	2.42	1.40		.573	.375		-15.41	7390.9	.008		2.46	15
Log K (6)	.793	-.672		.800	11.58	2.61	.662		.586	.180		-11.86	5661.19	.0022		.20	

TABLE C-21. NO_x LBS/1,000 LBS FUEL, IDLE POWER, EPR 1.08--TF30-P1 ENGINE

Regression Equation	Correlation Coefficients			Multiple Cor. Coef.	Analysis of Variance Regression Analysis F Value	Computed t Value			Partial Correlation Coefficients			Regression Equation Constants			SE*	S**									
	T					H			P			A					T			H			P		
	T	H	P			T	H	P	T	H	P	T	H	P			A	T	H	P					
Linear (5)	.472	.278	-.197	.557	5.70	3.54	-2.20	-.759	.498	-.336	-.122	9.73	.025	-.009	-.270	.386	42								
Linear (5)	.472	.278		.568	8.40	3.52	-2.07		.491	-.315		1.59	.024	-.008		.383	42								
1/T (3)	-.480	.278	-.197	.485	3.90	-2.75	-.509	-.113	-.408	-.082	-.018	4.55	-28.39	-.001	-.043	.406	42								
1/T (3)	-.480	.278		.485	5.99	-2.84	-.504		.413	-.080		3.26	-28.57	-.001		.401	42								
Log K (6)	-.515	.315	-.214	.585	6.57	-3.70	-2.10	-.720	-.515	-.323	-.116	3.96	-1123.1	-.001	-.043	.065	42								
Log K (6)	-.515	.315		.577	9.72	-3.69	-1.99		-.509	-.304		2.62	-1113.1	-.001		.065	42								
Log K (6)	-.563	.317		.667	16.43	-5.04	-3.07		-.619	-.432		2.17	-882.5	-.0011		.038	44								

TABLE C-22. NO_x LBS/1,000 LBS THRUST, IDLE POWER, EPR 1.08--TF30-P1 ENGINE

Regression Equation	Correlation Coefficients			Multiple Cor. Coef.	Analysis of Variance Regression F Value	Computed t Value			Partial Correlation Coefficients			Regression Equation Constants			SE*	S**	
	T					H			T			A					
	T	H	P			T	H	P	T	H	P	A	T	H			P
Linear (5)	.547	.300	-.061	.655	9.03	4.56	-2.58	.317	.605	-.395	.053	-1.43	.024	-.008	.086	.283	40
Linear (5)	.547	.300		.654	13.82	4.67	-2.89		.609	-.429		1.16	.024	-.008		.279	40
1/T (3)	-.516	.300	-.061	.542	4.99	-3.15	-.149	1.06	-.465	-.075	.174	-6.95	-25.25	-.000	.321	.315	40
1/T (6)	-.516	.300		.521	6.90	-3.04	-.500		.447	-.082		2.72	-24.22	-.001		.315	40
Log K (6)	-.556	.305	-.069	.654	8.96	-4.53	-2.45	.326	-.603	-.378	.054	2.33	-1283.3	-.001	.019	.060	40
Log K (6)	-.556	.305		.653	13.73	-4.63	-2.75		-.606	-.412		2.90	-1291.0	-.002		.059	40
Log K (6)	-.613	.233		.848	43.52	-8.97	-6.45		-.838	-.742		2.47	-1060.2	-.0015		.024	37

TABLE C-23. NO_x LBS/1,000 LBS FUEL, APPROACH POWER EPR 1.31--TF30-P1 ENGINE

Regression Equation	Correlation Coefficients			Multiple Cor. Analysis Coef.	Analysis of Variance Regression Analysis F Value	Computed t Value			Partial Correlation Coefficients			Regression Equation Constants			SE*	S**	
	T	H	P			T	H	P	T	H	P	A	T	H			P
Linear (5)	.578	.280	-.024	.776	17.69	6.58	-3.44	2.42	-.744	-.502	.378	-21.77	-.040	-.012	.842	.338	39
Linear (5)	.578	.280		.732	20.82	5.96	-3.97		.705	-.552		3.73	.039	.014		.360	39
1/T (3)	-.547	.280	-.022	.652	8.62	-4.37	.069	2.61	-.594	.012	.403	-27.89	-45.34	.000	1.135	.407	39
1/T (3)	-.547	.280		.560	8.21	-3.51	-.847		-.505	-.140		6.18	-37.53	-.002		.438	39
Log K (6)	-.594	.294	-.034	.772	17.22	-6.44	-3.07	2.46	-.736	-.461	.384	.231	-832.6	-.001	.071	.028	39
Log K (6)	-.594	.294		.726	20.01	-5.78	-3.63		-.694	-.518		2.30	-792.2	-.001		.030	39
Log K (6)	-.597	.232		.812	33.8	-7.88	-5.56		-.800	-.685		2.476	-875.91	-.0012		.023	38

C-13

TABLE C-24. NO_x LBS/1,000 LBS THRUST, APPROACH POWER, EPR 1.31--TF30-P1 ENGINE

Regression Equation	Correlation Coefficients			Multiple Regression Cor. Coef.	Analysis of Variance Regression Analysis		Computed t Value			Partial Correlation Coefficients			Regression Equation Constants			SE*	S**
	T				F Value	Value	T			T			A				
	H	P					H	P		H	P		I	H	P		
Linear (5)	.367	.039	.141	.735	12.50	5.89	-4.12	2.31	.721	-.588	.378	-20.29	.034	.013	.739	.314	36
Linear (5)	.367	.039		.680	14.22	5.33	-4.49		.680	-.616		2.09	.032	-.015		.334	36
1/T (3)	-.438	.039	.141	.668	8.61	-4.85	-1.53	2.86	-.651	-.261	.451	-27.05	-42.50	-.004	1.04	.344	36
1/T (3)	-.438	.039		.553	7.25	-3.80	-2.32		-.552	-.374		4.24	-35.14	-.006		.379	36
Log K (6)	-.428	.083	.100	.750	13.69	-6.18	-4.05	2.30	-.738	-.582	.377	-.029	-1143.0	-.002	.094	.040	36
Log K (6)				.795	26.73	-7.200	-5.63		-.791	-.711		2.42	-949.29	-.0015		.028	34

TABLE C-25. NO_x LBS/1,000 LBS FUEL, CRUISE POWER, EPR 1.76--TF30-P1 ENGINE

Regression Equation	Correlation Coefficients			Multiple Cor. Coef.	Analysis of Variance Regression Analysis F Value	Computed t Value			Partial Correlation Coefficients			Regression Equation Constants			SE*	S**						
	T					H			P			T					H			P		
	T	H	P			T	H	P	T	H	P	T	H	P			A	T	H	P		
Linear (5)	.605	.295	.179	.817	23.35	7.30	-5.10	-.107	.777	-.653	-.018	.521	.087	-.035	-.055	.521	39					
Linear (5)	.605	.295		.817	36.01	7.91	-5.70		.797	-.689		.514	.087	-.035		.514	39					
1/T (3)	-.756	.295	.179	.759	15.80	-5.85	-2.10	.230	-.703	-.452	.039	.588	-154.95	-.017	.134	.588	39					
1/T (3)	-.657	.295		.758	24.32	-6.42	-3.48		-.731	-.502		.581	-157.09	-.018		.581	39					
Log K (6)	-.641	.321	.167	.836	26.97	-7.81	-5.29	-.277	-.797	-.666	-.047	.021	-1000.3	-.001	-.006	.021	39					
Log K (6)	-.641	.321		.835	41.48	-8.41	-5.84		-.814	-.697		.021	-987.0	-.001		.021	39					
Log K (6)	-.655	.341		.860	55.24	-9.65	-6.81		-.839	-.737		.018	-924.0	-.0012		.018	42					

TABLE C-26. NO_x LBS/1,000 LBS THRUST, CRUISE POWER, EPR 1.76--TF30-P1 ENGINE

Regression Equation	Correlation Coefficients			Multiple Cor. Coef.	Analysis of Variance Regression Analysis F Value	Computed t Value			Partial Correlation Coefficients			Regression Equation Constants			SE*	S**						
	T					H			P			A					T			P		
	T	H	P			T	H	P	T	H	P	T	H	P			A	T	H	P		
Linear (5)	.648	.351	.140	.881	42.78	7.35	-4.90	-.317	.779	-.638	-.053	-.79.46	.057	-.022	-.106	.337	39					
Linear (5)	.648	.351		.823	37.83	7.87	-5.37		.795	-.667		3.50	.056	-.021		.333	39					
1/T (3)	-.686	.351	.140	.759	15.86	-5.70	-2.62	.076	-.694	-.405	.013	7.26	-.99.13	-.010	.029	.387	39					
1/T (3)	-.686	.351		.759	24.46	-6.20	-2.99		-.719	-.446		8.16	-.99.59	-.010		.381	39					
Log K (6)	-.679	.373	.135	.842	28.31	-7.81	-5.05	-.425	-.797	-.649	-.072	3.29	-1117.2	-.002	-.010	.024	39					
Log K (6)	-.679	.373		.841	43.37	-8.34	-5.48		-.812	-.675		2.94	-1094.6	-.002		.024	39					
Log K (6)	-.739	.451		.895	76.78	-10.71	-6.99		.866	-.750		2.66	-.955.88	-.0012		.016	41					

TABLE C-27. NO_x LBS/1,000 LBS FUEL, MAXIMUM CONTINUOUS POWER, EPR 1.905--TF30-P1 ENGINE

Regression Equation	Correlation Coefficients			Multiple Cor. Coef.	Analysis of Variance Regression Analysis F Value	Computed t Value			Partial Correlation Coefficients			Regression Equation Constants			SE*	S**	
	T	H	P			T	H	P	T	H	P	A	T	H			P
Linear (5)	.435	.055	.364	.860	36.01	9.14	-7.29	1.44	.829	-.763	.288	-16.44	.102	-.047	.820	.549	42
Linear (5)	.435	.055		.851	51.55	10.13	-8.73		.851	-.813		8.02	.107	-.051		.556	42
1/T (3)	-.532	.055	.364	.815	25.13	-7.51	-5.13	1.09	-.773	-.640	.174	-4.39	-194.57	-.029	.714	.623	42
1/T (3)	-.532	.055		.809	36.93	-8.57	-6.48		-.808	-.720		17.36	-205.41	-.032		.624	42
Log K (6)	-.457	.058	.363	.871	39.71	-9.64	-7.60	1.29	-.842	-.777	.205	2.26902	-981.172	-.00168	.02600	.019	42
Log K (6)	-.457	.058		.865	57.73	-10.72	-9.12		-.864	-.825		3.15	-1028.3	-.002		.019	42
Log K (6)	-.644	.410		.797	33.94	-7.06	-4.85		-.749	-.614		2.63	-779.52	-.0012		.019	42

TABLE C-28. NO_x LBS/1,000 LBS THRUST MAXIMUM CONTINUOUS POWER, EPR 1.905--TF30-P1 ENGINE

Regression Equation	Correlation Coefficients			Multiple Cor. Coef.	Analysis of Variance Regression Analysis F Value	Computed t Value			Partial Correlation Coefficients			Regression Equation Constants			SE*	S**									
	T					H			P			A					T			H			P		
	T	H	P			T	H	P	T	H	P	T	H	P			A	T	H	P					
Linear (5)	.511	.171	.371	.808	22.01	6.70	-4.99	.941	.750	-.645	.157	-.0.89	.068	-.029	.447	.424	39								
Linear (5)	.511	.171		.803	32.67	7.90	-6.23		.796	-.721		4.37	.072	-.032		.424	39								
1/T (3)	-.561	.171	.371	.735	13.73	-5.03	-3.10	.660	-.648	-.464	.111	-.88	-132.11	-.017	.377	.489	39								
1/T (3)	-.561	.171		.731	20.70	-6.25	-4.13		-.722	-.567		10.66	-140.86	-.018		.485	39								
Log K (6)	-.532	.180	.375	.817	23.47	-6.89	-5.06	.834	-.759	-.650	.140	2.32354	-1081.5529	-.0017	.02359	.02503	39								
Log K (6)	-.532	.180		.813	35.15	-8.18	-6.34		-.806	-.727		3.15	-1146.9	-.002		.025	39								
Log K (6)	-.651	.348		.848	50.17	-9.13	-6.42		-.825	-.717		2.87	-102.55	-.0013		.02	42								

TABLE C-29. NO_x LBS/1,000 FUEL, TAKEOFF POWER, EPR 2.05--TF30-P1 ENGINE

Regression Equation	Correlation Coefficients			Multiple Cor. Coef.	Analysis of Variance Regression Analysis F Value		Computed t Value			Partial Correlation Coefficients			Regression Equation Constants			SE*	S**				
	T				H			P			T			H				P			
	T	H	P		T	H	P	T	H	P	T	H	P	A	T			H	P		
Linear (5)	.618	.357	.094	.813	9.76	4.22	-1.83	2.19	.737	-.427	.492	.492	-58.08	.074	-.018	2.26	.610	19			
Linear (5)	.618	.357		.744	9.90	3.90	-2.47		.698	-.526			9.93	.076	-.026		.678	19			
1/T (3)	-.664	.357	.095	.749	6.40	-3.22	-.534	1.39	-.639	-.137	.338	.338	-34.27	-125.06	-.005	1.67	.694	19			
1/T (3)	-.664	.357		.711	8.16	-3.49	-1.44		-.658	-.339			16.35	-136.48	-.012		.714	19			
Log K (6)	-.650	.374	.081	.827	10.81	-4.44	-1.82	2.12	-.754	-.426	.480	.480	.292	-63.59	-.001	.069	.019	19			
Log K (6)	-.650	.374		.768	11.47	-4.18	-2.55		-.723	-.537			2.43	-658.9	-.001		.021	19			
Log K (6)	-.735	.445		.864	26.58	-6.25	-3.83		-.827	-.670			2.35	-625.0	-.0007		.014	21			

TABLE C-30. NO_x LBS/1,000 LBS THRUST, TAKEOFF POWER, EPR 2.05--TF30-P1 ENGINE

Regression Equation	Correlation Coefficients			Multiple Cor. Coef.	Analysis of Variance Regression Analysis F Value	Computed t Value			Partial Correlation Coefficients			Regression Equation Constants			SE*	S**									
	T					H			P			A					T			H			P		
	T	H	P			T	H	P	T	H	P	T	H	P			A	T	H	P					
Linear (5)	.550	.223	.159	.780	7.78	4.25	-2.65	.876	.739	-.565	.221	.221	20.21	.071	-.025	.850	.577	19							
Linear (5)	.550	.223		.767	11.45	4.58	-3.34		.753	-.641			5.28	.074	-.029		.573	19							
1/T (3)	-.598	.223	.159	.709	5.04	-3.31	-1.32	.799	-.650	-.322	.202	.202	-15.34	-118.76	-.011	.879	.651	19							
1/T (3)	-.598	.223		.693	7.41	-3.64	-1.95		-.673	-.439			11.32	-125.57	-.014		.644	19							
Log K (6)	-.581	.243	.147	.792	8.40	-4.40	-2.64	.834	-.751	-.563	.211	.211	1.59	-958.4	-.001	.041	.029	19							
Log K (6)	-.581	.243		.781	12.49	-4.75	-3.34		-.765	-.640			2.91	-998.9	-.001		.029	19							

*Standard Error of the Estimate

**Sample Size

APPENDIX D

GRAPHICAL SOLUTION FOR K_3 HUMIDITY CONSTANT FOR NO_x
EI--J57-43 ENGINE

APPENDIX D
LIST OF ILLUSTRATIONS

Figure		Page
D-1	NO _x EI versus Combustor Inlet Temperature--Specific Humidity 0 to 20 Grains H ₂ O per Pound of Dry Air	D-1
D-2	NO _x EI versus Combustor Inlet Temperature--Specific Humidity 60 to 80 Grains H ₂ O per Pound of Dry Air	D-2
D-3	NO _x EI versus Combustor Inlet Temperature--Specific Humidity 130 to 150 Grains H ₂ O per Pound Dry Air	D-3
D-4	Humidity Constant "K ₃ "	D-4

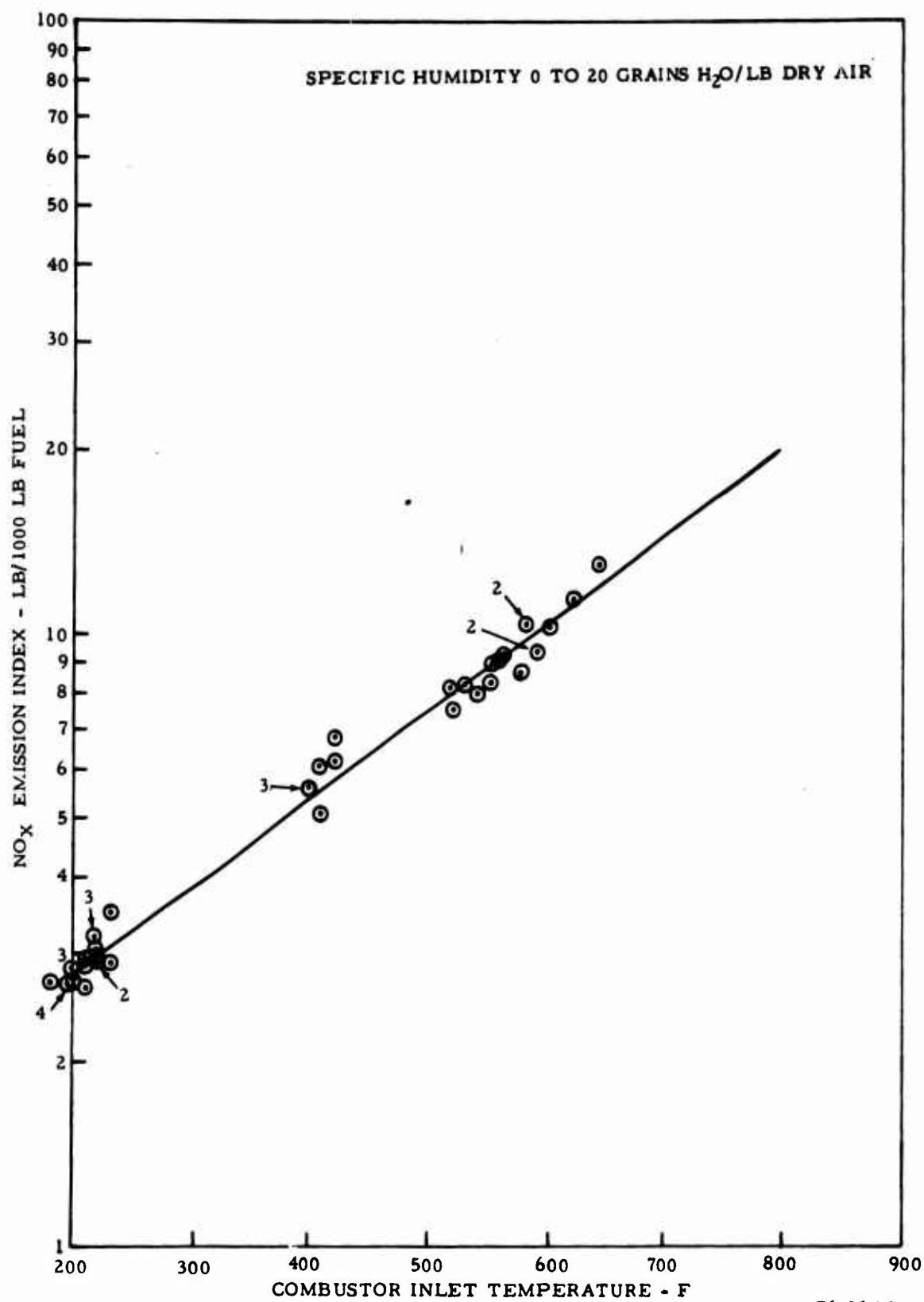


FIGURE D-1. NO_x EI VERSUS COMBUSTOR INLET TEMPERATURE--SPECIFIC HUMIDITY 0 TO 20 GRAINS H_2O PER POUND OF DRY AIR 76-16-D1

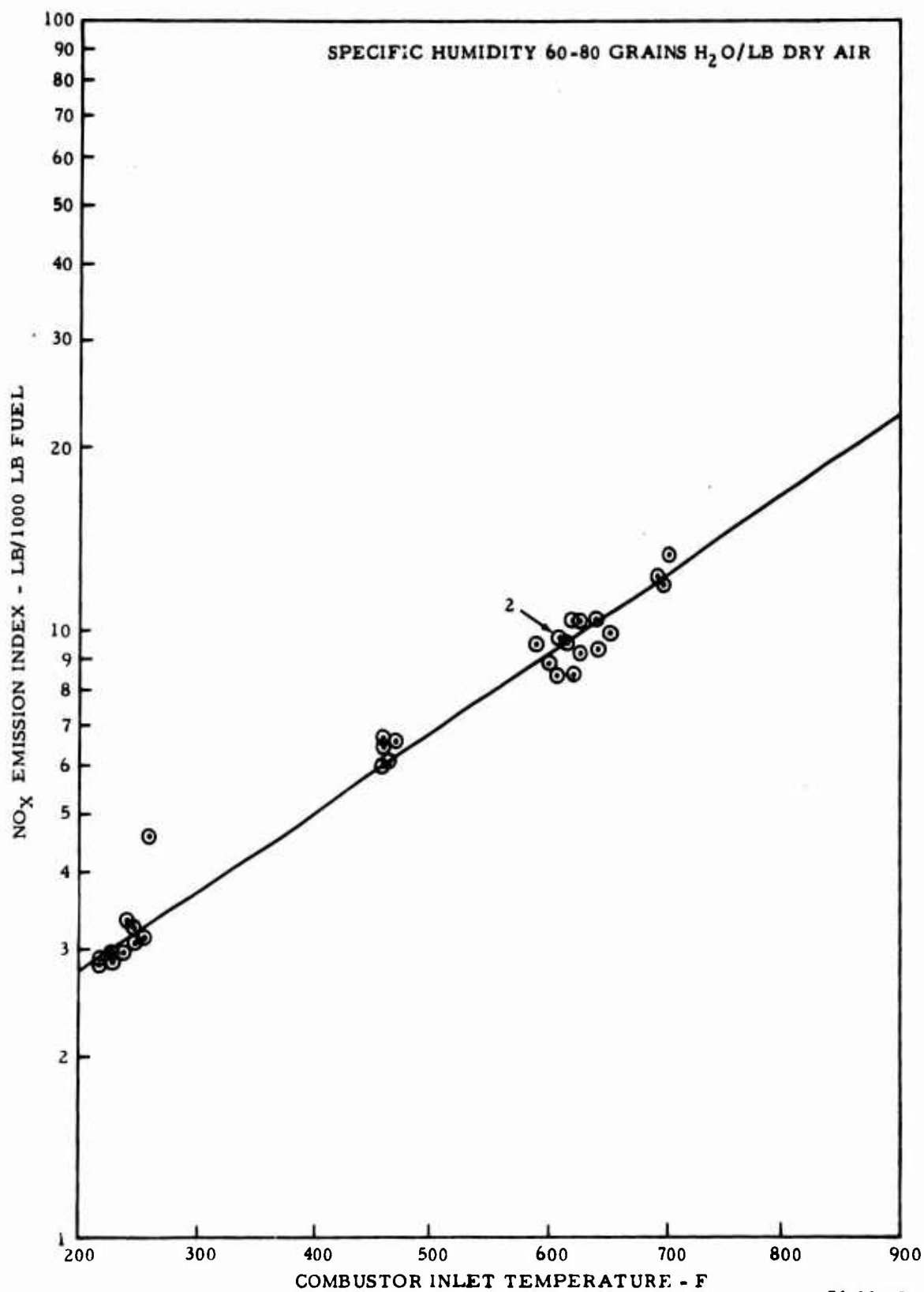


FIGURE D-2. NO_x EI VERSUS COMBUSTOR INLET TEMPERATURE--SPECIFIC HUMIDITY 60 TO 80 GRAIN H_2O PER POUND OF DRY AIR

76-16-D2

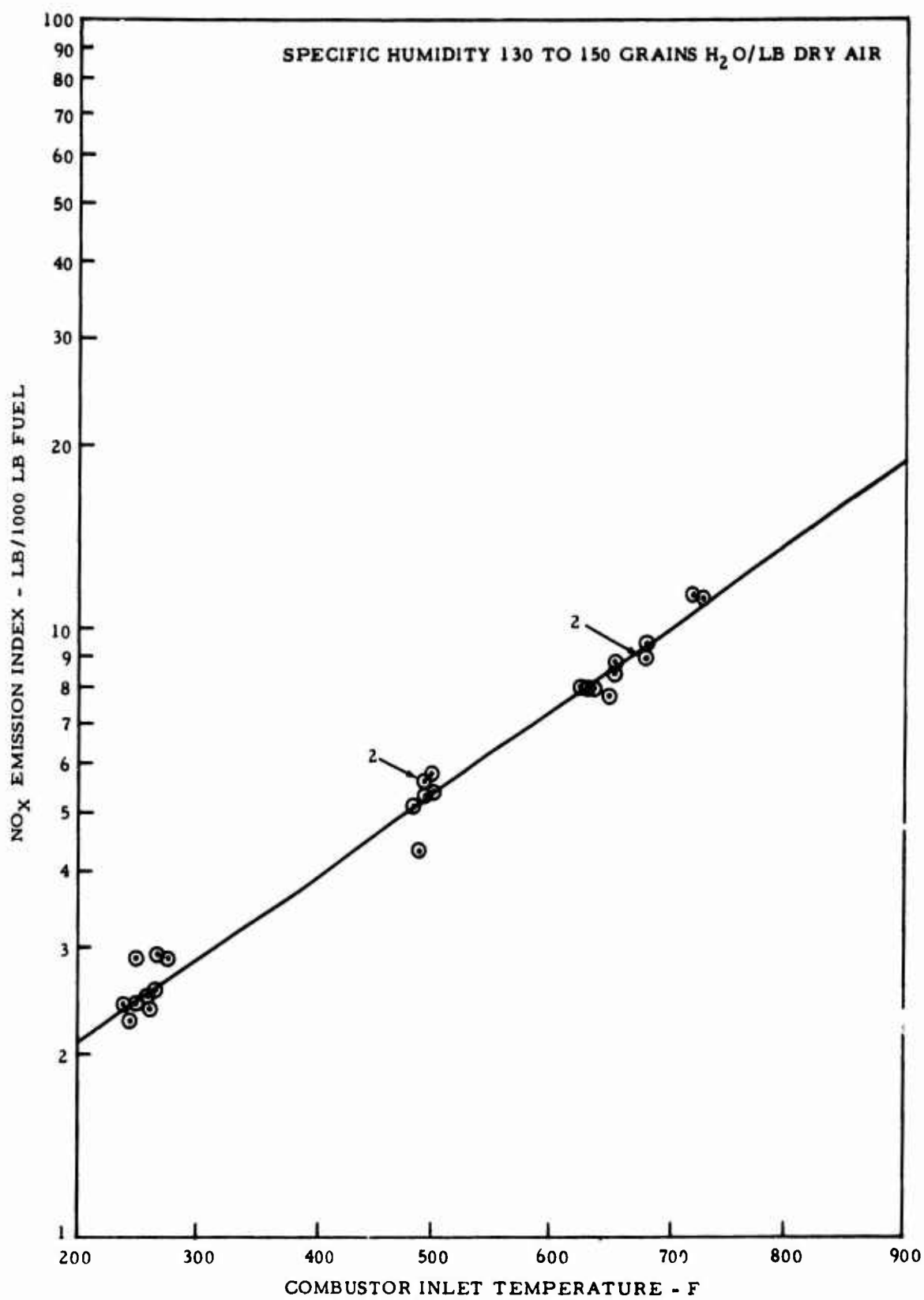


FIGURE D-3. NO_x EI VERSUS COMBUSTOR INLET TEMPERATURE--SPECIFIC HUMIDITY 130 TO 150 GRAIN H_2O PER POUND DRY AIR 76-16-D3

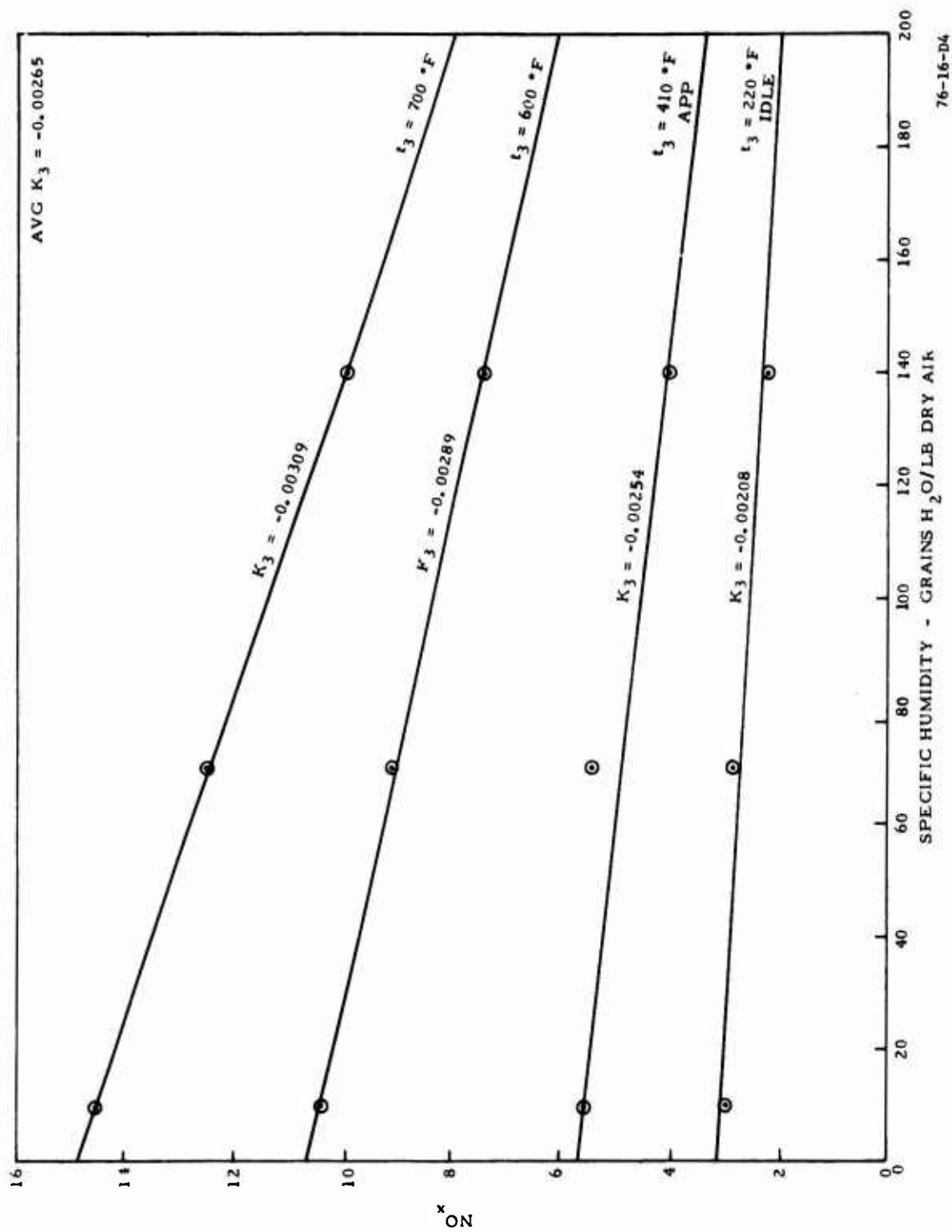


FIGURE D-4. HUMIDITY CONSTANT " K_3 "