A COMBUSTION HANDBOOK FOR CANADIAN FUELS

VOLUME 1 • FUEL OIL

F. D. FRIEDRICH
CANADIAN COMBUSTION RESEARCH LABORATORY

MINES BRANCH MONOGRAPH 877

MINES BRANCH
DEPARTMENT OF ENERGY, MINES AND RESOURCES

Available by mail from the Queen's Printer, Ottawa,
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Price: $7.50 Catalogue No. M37-1369/1

Price subject to change without notice

The Queen's Printer
Ottawa, Canada
1969

Production Editor CLAUDE LAFLEUR
Public Relations and Information Services,
Department of Energy, Mines and Resources

FOREWORD

The Fuels Research Centre of our Branch and its predecessor, the Fuels and Mining Practice Division, have collected over a period of more than sixty years analytical data on properties of Canadian fossil fuels. Concurrently, the Canadian Combustion Research Laboratory of the Fuels Research Centre, in carrying out numerous boiler acceptance tests, has prepared accurate data on combustion-air requirements, flue-gas volumes and boiler-heat losses for many of these fuels. In addition, the Laboratory has been active in research on many aspects of domestic, commercial and industrial combustion, and has contributed to recent technological advances relating to fireside corrosion and air pollution.

Having these analytical, calculated and research data, and furthermore having access to data-processing computers, the Laboratory has undertaken to prepare a handbook which should be of unique value to Canadian fuel-related industries. Indeed, a need for such a handbook has often been expressed.

Each of the main fuels – coal, oil and gas – is dealt with in a separate volume, and for each fuel analysis combustion and heat-loss data are provided in simple, accurate charts. Recent information relating to fireside corrosion and air pollution is also provided. No claim is made that every Canadian fuel is included but it is planned to update the handbook through periodic addenda.

The cooperation of the users of the handbook and others interested is requested by drawing oversights to our attention.

John Convey,
Director, Mines Branch

Ottawa, June 1969

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1. INTRODUCTION

Those concerned with utilization of fossil fuels have frequent need of combustion calculations. Air pollution authorities use them to establish the potential pollutant emission of a particular fuel; designers and consulting engineers use them to size gas-handling systems for fuel-burning installations; boiler and burner manufacturers use them to design combustion equipment; fan manufacturers use them to select equipment for draft systems on boilers; and owners or operators of combustion equipment use them to determine efficiency of operation to mention a few. Often there are inadequate background information and facilities to carry out complete sets of calculations for all the fuels that are likely to be encountered and they are done on an individual basis as the need arises to solve particular problems. Because combustion calculations are inherently cumbersome, approximations and rules of thumb have been introduced, which affect accuracy to a greater or lesser extent.

This Combustion Handbook for Canadian Fuels was prepared by the Canadian Combustion Research Laboratory because of its unique position of having considerable experience in the application of combustion calculations, having access to a wealth of information on fuel analyses, and having access to a computer to carry out accurate calculations without the usual tedium. The handbook includes most of the fuels used in commercial quantities and presents the combustion data in the form of a set of easy-to-use graphs for each fuel analysis. Specifically, the graphs show (a) per pound of fuel, the weight and volume of combustion air required and flue gas produced for a range of temperature and excess air conditions, (b) the heat losses resulting from combustion of the fuel for a range of conditions, calculated according to the ASME Power Test Code, and (c) where applicable, the theoretical concentration of SO_2 in the flue gas. Thus, the graphs eliminate most of the laborious calculations usually associated with designing a combustion system or measuring its efficiency. While the handbook is aimed primarily at boiler combustion systems, its usefulness extends to many other fuel-using processes.

The handbook is being published in three volumes; one each for coal, oil and gaseous fuels. In each volume the graphs are preceded by a section giving instructions for their use, including detailed examples. Also included is information common to all the fuel analyses, such as a psychrometric chart, a chart showing boiler radiation loss, and a brief discussion of low-temperature corrosion. Sample calculations showing the derivation of the graphs are given in Appendix A.

With one exception, the analyses given in the fuel oil volume of the handbook have been calculated. Sampling and analyzing the various grades of residual fuel oil produced by each refinery in Canada would have been a tedious undertaking, therefore analyses were calculated for a range of specific gravities and sulphur contents, using the empirical formulae developed by the U.S. Bureau of Standards, which are considered to be accurate within 1% (1). The aforementioned exception is No. 2 fuel oil which, being a refined product, is fairly consistent in quality throughout the country, hence calculations were based on an actual analysis. Specifications of the various grades of fuel oil are given in Canadian Government Specification (CGSB) 3–GP–2C Fuel Oil-Heating and 3–GP–12C Boiler Fuel-Naval.

It is recognized that some important fuels may have been inadvertently omitted from the handbook, and the author is prepared to publish addenda as omissions are brought to his attention.

2. DESCRIPTION OF THE HANDBOOK

As explained in the Introduction, ultimate analyses of the residual fuel oils dealt with in this handbook have been calculated. This was done for specific gravities (relative to water, 60/60°F) ranging from 0.90 to 1.05, at intervals of 0.01, and for sulphur contents from 0% to 4%, at intervals of 1%. The resulting 80 calculated analyses should enable one to deal reasonably accurately with most of the residual fuel oils in Canada.

The method of calculation is described in detail in Appendix B; it is sufficient to state here that nitrogen, oxygen, ash and moisture in the fuel oil are assumed to be negligible. For convenient identification, each graph bears a set number, of which the first two or three digits denote the specific gravity of the oil, while the last two digits denote the sulphur content. Thus, set 9730 denotes an oil with specific gravity of 0.97 and a sulphur content of 3.0%, while set 10400 denotes an oil with a specific gravity of 1.04 and 0.0% sulphur. The sets of graphs are arranged in ascending order of set number, that is, increasing specific gravity, and at each specific gravity, increasing sulphur content. No. 2 fuel oil is dealt with in set 8507.

In the calculations, one pound of oil was used as the basic unit of fuel. As a convenience, conversion factors dealing with each oil analysis in terms of Imperial gallons, U.S. gallons and millions of Btu (Btu x 10^6) are given prior to each set, along with the ultimate analysis which that set represents.

3. COMBUSTION DATA GRAPHS

3.1. Figure 1

In each set of graphs Figure 1 shows, for the combustion of one pound of oil, the weight of dry combustion air required and the weights of dry flue gas and total flue gas produced, versus per cent of total combustion air, the latter being defined as per cent excess air plus 100 or per cent of stoichiometric air. Flue gas analysis may be related to total combustion air by either the CO_2 curve or the O_2 curve. The calculations were made on a dry-air basis, i.e., moisture in the air was neglected, because its effect is usually less than one per cent. It will be shown later how a correction for moisture in the air can be applied, if desired. Dry flue gas represents the moisture-free components of the flue gas, namely CO_2, O_2 and N_2, while total flue gas represents the foregoing components plus the moisture resulting from combustion of hydrogen, but excluding moisture from combustion air. In some cases the weights of dry air and dry flue gas are so similar that they are represented by the same line on the graph.

3.2. Figure 2

Figure 2 shows the volumes at different temperatures of combustion air required and flue gas produced when burning one pound of oil, again plotted against total combustion air. The volumes shown are for an atmospheric pressure of 29.92 in. Hg. Corrections for other pressures may be made by applying a correction factor from Figure A, as shown in Example 1, or corrections for other pressures and temperatures may be made by employing the perfect gas law, $\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$, taking care to use absolute temperatures.

3.3. Direct Application of Combustion Data

For designers of combustion equipment the combustion handbook provides a rapid method for sizing forced-draft and induced-draft fans without carrying out the combustion calculations usually required. In sizing fans, good practice requires that a safety margin be added to the calculated requirements. Commonly accepted values are 15% on volume and 30% on pressure, but more liberal values are sometimes used. However, Figures 1 and 2 give calculated requirements only, and to remind the designer of this, the notation "plus margin" has been added to the capacity requirements arrived at in the examples.

Example 1.

A boiler is to be fitted with an oil burner having a maximum throughput of 150 U.S. gph. At this firing rate the flue-gas temperature is expected to be 520°F, and the CO_2 concentration is expected to be 13.5%. The oil has a specific gravity of 0.97 and a sulphur content of 2.5%. Combustion air will be drawn from the boiler room at 80°F. It is desired to find the required capacity, in lb/hr and cfm of (a) the forced-draft fan, and (b) the induced-draft fan, both at sea level and at an elevation of 2,000 ft above sea level.

Solution:

The sulphur content of 2.5% falls between sets 9720 and 9730. For greater accuracy, check both sets of charts and interpolate. From the conversion factors for either set 9720 or set 9730, 150 U.S. gph = 150 x 8.08686 = 1,213 lb oil/hr.

(a) *Forced-draft fan*

		Set 9720	Set 9730
From Figure 1 or Figure 2, % total combustion air at 13.5% CO_2	=	117.0	116.2
From Figure 1, at respective total-air levels, wt of dry air, lb/lb oil	=	16.3	16.05
From Figure 2, at combustion-air temperature of 80° F and at respective total-air levels, vol of dry air, cu ft/lb oil, at 29.92 in. Hg	=	220	219
Interpolating for oil with 2.5% sulphur; total combustion air at 13.5% CO_2	=	116.6%	
wt of dry air	=	116.18 lb/lb oil	
vol of dry air at 80° F and 29.92 in. Hg	=	219.5 cu ft/lb oil	

Required capacity of forced-draft fan

$$= 16.18 \times 1213 = \underline{19{,}630 \text{ lb/hr}} \text{ plus margin}$$

$$= \frac{219.5 \times 1213}{60} = \underline{4{,}438 \text{ cfm}} \text{ plus margin at sea level}$$

From Figure A, at 2,000 ft above sea level a correction factor, for elevation, of 1.076 must be applied to the volume.

∴ Required capacity of forced-draft fan

$$= 4{,}438 \times 1.076 = \underline{4{,}775 \text{ cfm}} \text{ plus margin at 2,000 ft above sea level.}$$

It may be noted that by not interpolating, that is, by using either set of graphs directly, the error introduced would have been less than one per cent.

(b) *Induced-draft fan*

		Set 9720	Set 9730
From part (a), % total combustion air at 13.5% CO_2	=	117.0	116.2
From Figure 1, at respective total-air levels, wt of total flue gas, lb/lb oil	=	17.2	17.05
From Figure 2, at flue-gas temperature of 520°F, and at respective total-air levels, vol of flue gas, cu ft/lb oil	=	422	419
Interpolating for oil with 2.5% sulphur; wt of total flue gas, lb/lb oil	=	17.12	
vol of total flue gas at 520°F, cu ft/lb oil	=	420.5	

Required capacity of induced-draft fan

$= 17.12 \times 1213 = \underline{20{,}767 \text{ lb/hr}}$ plus margin

$= \dfrac{420.5 \times 1213}{60} = \underline{8{,}501 \text{ cfm}}$ plus margin at sea level

As in part (a), a correction factor, for elevation, of 1.076 must be applied.

∴ Required capacity of induced-draft fan

$= 8{,}501 \times 1.076 = \underline{9{,}147 \text{ cfm}}$ plus margin at 2,000 ft above sea level.

Example 2.

A boiler burning residual oil with a specific gravity of 1.01 and a sulphur content of 3% normally operates with 3.5% O_2 in the flue gas and a stack temperature of 450° F. If excess air is reduced to give 2% O_2 in the flue gas, and the corresponding drop in stack temperature is 30° F, what will be the reduction in volume of flue gas, assuming an atmospheric pressure of 29.92 in. Hg?

Solution:

The oil in question is described in set 10130. From Figure 2, 3.5% O_2 = 119% total air. At 119% total air and 450° F vol flue gas, cu ft/lb oil = 390

From Figure 2, 2.0% O_2 = 110% total air. At 110% total air and 420° F vol of flue gas, cu ft/lb oil = 352

$$\text{Reduction in volume of flue gas} = \frac{390-352}{390} \times 100 = 9.74\%$$

3.4. Correction for Moisture in Combustion Air

Moisture in the combustion air increases the weight and volume of gas handled by the combustion air and flue-gas systems. Unless the weight of moisture exceeds 70 grains per pound of dry air, it may be neglected without introducing an error greater than 1%. If it is desired to make a correction, the relative humidity of the combustion air must be determined using a sling psychrometer, then the psychrometric chart may be used to determine the weight of moisture, as shown in Example 3. It should be pointed out that the psychrometric chart holds for an atmospheric pressure of 29.92 in. Hg, and becomes progressively less accurate as atmospheric pressure deviates from that figure. However, this should not be significant except in extreme cases, and then the weight of moisture per pound of air may be calculated using Carrier's Equation, which is to be found in any text on air conditioning.

Example 3.

In the case given in Example 1, correct the weights and volumes of combustion air and flue gas when the combustion air has a relative humidity of 80%, assuming atmospheric pressure = 29.92 in. Hg.

Solution:

(a) *Forced-draft fan*

From Example 1, on dry-air basis, required capacity of forced-draft fan	=	19,630 lb/hr
	=	4,438 cfm at 80° F
From the psychrometric chart, at 80° F and 80% RH lb moisture/lb dry air	=	0.0177
specific volume, cu/ft/lb dry air	=	13.95
Specific volume of dry air at 80° F, cu ft/lb dry air	=	13.60

On moist-air basis, required capacity of forced-draft fan

$= (0.0177 + 1) \times 19{,}630 = \underline{19{,}977 \text{ lb/hr}}$ plus margin

$= \dfrac{13.95}{13.60} \times 4{,}438 = \underline{4{,}552 \text{ cfm}}$ plus margin.

(b) *Induced-draft fan*

From Example 1, on dry air basis, required capacity of induced-draft fan = 20,767 lb/hr
= 8,501 cfm

From part (a) additional weight of moisture
= 19,977 − 19,630 = 347 lb/hr

additional volume of moisture at 80°F
= 4,552 − 4,438 = 114 cfm

Correct to a temperature of 520°F, using the perfect gas law:

$$\frac{P_1\,(114)}{460 + 80} = \frac{P_2\,(V_2)}{460 + 520}$$

There is no change in pressure, i.e. $P_1 = P_2$

$$\text{Therefore } V_2 = \frac{(114)\,(980)}{540} = 207 \text{ cfm}$$

On moist-air basis, required capacity of induced-draft fan

= 20,767 + 347 = 21,114 lb/hr plus margin

= 8,501 + 207 = 8,708 cfm plus margin.

4. HEAT-LOSS GRAPHS

4.1. Figure 3

In each set of graphs Figure 3 shows the heat loss, in per cent of fuel input, represented by the sensible heat in the dry flue gas leaving the system. This loss is dependent upon the excess-air level and the temperature of the flue gas above combustion-air temperature, therefore heat loss has been plotted against total combustion air for a range of temperature differentials. CO_2 and O_2 curves have been included to conveniently relate flue-gas analysis to total combustion air.

4.2. Figure 4

Figure 4 shows the heat loss, in per cent of fuel input, due to moisture in the flue gas formed from the combustion of hydrogen. Being based on gross calorific value, the loss consists of the heat of evaporation plus superheat; hence, for a fixed hydrogen content of fuel, it depends upon stack temperature and combustion-air temperature.

4.3. Figure 5

Figure 5 shows the heat loss in per cent of fuel input due to carbon monoxide in the flue gas, resulting from incomplete combustion. This loss increases with increasing CO concentration and decreasing CO_2 concentration, that is, for a given CO concentration the per cent loss is higher if excess air is present. However, with properly adjusted modern burners, combustion should be complete unless the excess-air level is below 5%. Therefore, Figure 5 has been simplified by plotting heat loss due to CO only for the case where there is negligible excess air. For a given CO concentration, if the excess-air level were actually 5% instead of 0, the error resulting from the use of Figure 5 would be about 2% of the indicated heat loss.

4.4. Other Heat Losses

In determining efficiency, the handbook applies the indirect method, or the heat-loss method, in which heat losses are measured in per cent of fuel input. For a full discussion of boiler heat losses the reader is referred to the ASME Power Test Code for Steam Generating Units (2). In most cases involving oil-fired equipment, however, no more than three heat losses need be considered in addition to the three already discussed. They are as follows:

1. heat loss due to unburned combustible,
2. heat loss due to moisture in the combustion air, and
3. heat loss due to radiation and convection from the combustion system.

Unburned combustible other than CO is primarily in the form of soot, and to accurately measure its concentration in the gas stream requires specialized instruments. Typical values of unburned combustible for a well-adjusted burner are 0.2% to 0.4% by weight of fuel input, and the concomitant heat loss in per cent of fuel input will be in the same range. The heat loss due to moisture in the air represents the heat required to superheat the moisture, which is already in vapour form, from the temperature of the combustion air to the temperature of the flue gas leaving the system. The loss therefore depends upon the weight of moisture per pound of fuel and the net temperature rise through the combustion system. It will be shown later how the loss due to moisture in the combustion air can be fairly accurately approximated, but since it usually represents less than 0.5% of fuel burned, it, together with the loss due to unburned combustible, is represented in most boiler heat balances by an "unmeasured losses" term, for which an arbitrary value is assumed. A reasonable value for "unmeasured losses" in most oil-fired boilers is 0.5% of fuel input.

The heat loss due to radiation and convection from a boiler or other combustion system is difficult to determine accurately. To do so involves establishing the area and emissivity of all surfaces exposed to ambient air, their temperature above ambient, and the air velocity over them. The standard "radiation loss chart" published by the American Boiler Manufacturers Association (Figure B), is a convenient, widely used method of approximating the radiation and convection heat loss. It assumes a temperature differential of 50°F between surface and ambient, an air velocity of 100 fpm over the surface, and an emissivity of 0.95. The accuracy of the chart increases with the size of the generator.

The heat losses obtained using this chart can be corrected for higher air velocities and higher surface-to-ambient temperature differentials using the correction factors given in Figure C. This involves establishing the average boiler casing temperature, preferably with a contact thermocouple, measuring ambient-air temperature, and measuring air velocity over the boiler casing by some means such as a vane anemometer. The ABMA radiation loss chart takes account of the number of water-cooled walls in the generator, since water-cooled walls usually have a lower surface temperature, and hence a lower radiation loss, than refractory walls. Most modern water-tube boilers have three or four water-cooled walls, and package firetube scotch-type boilers may be treated as having four water-cooled walls.

4.5. Application of Heat Loss Data

4.5.1. *Approximate Heat Balance*

To strike an approximate heat balance using the combustion handbook, the following information is required:

1. specific gravity and sulphur content of the fuel oil,
2. maximum continuous output rating of the boiler in Btu per hr,
3. actual output of the boiler in Btu per hr,
4. flue-gas temperature or stack temperature in °F,
5. combustion-air temperature in °F,
6. Orsat analysis of the flue gas; CO_2 or O_2, and CO, per cent by volume.

Assuming that the foregoing information is measured to the tolerances normal in the trade, the accuracy of the heat balance will depend on how well the actual fuel oil is represented by the set of graphs selected, and on the size of the combustion system or boiler. The importance of the latter is due to the fact that the per cent of radiation and convection loss rises sharply with decreasing heat output, and the accuracy with which the loss can be estimated from the ABMA chart decreases proportionately. For boilers operating at a full load output of 20 million Btu/hr or more, the radiation and convection loss can likely be estimated within 1/2% of total heat input, and the heat balance is likely to be accurate within 1%. For smaller boilers, or boilers operating at low loads, the estimated radiation and convection loss may be in error by 1% or 2% of total heat input, and the accuracy of the heat balance may be ± 3%.

Example 4.

A boiler rated at 50,000 lb steam/hr at 100 psig, dry and saturated, with a feedwater temperature of 180°F, is fired with residual oil having a specific gravity of 0.98 and a sulphur content of 2.0%. Find the boiler efficiency at 50%, 75% and 100% of full load rating, given the following operating conditions, neglecting heat loss due to unburned combustible and moisture in the air, but assuming "unmeasured losses" of 0.5% of fuel input.

	Per Cent of full-load rating		
	50	75	100
Stack temperature, °F	350	425	500
Combustion-air temperature, °F	70	70	70
CO_2 in flue gas, %	12.5	13.0	13.5
CO in flue gas, %	0	0	0

Solution:

The oil in question is dealt with in set 9820. From steam tables, heat picked up per pound of steam at given conditions = 1190 − 148 = 1042 Btu/lb. Therefore full-load rating = 50,000 x 1042 = 52.1 x 10^6 Btu/hr.

(a) Heat balance at 50% of full-load rating; heat output = 26.05 x 10^6 Btu/hr.

Heat Losses

1. Dry-flue-gas loss, from Figure 3, at CO_2 = 12.5% (total combustion air = 126.5%) and temperature differential of 350 − 70 = 280°F:	6.40%
2. Hydrogen loss, from Figure 4, at stack temperature of 350°F and combustion-air temperature of 70°F:	6.39%
3. CO loss at CO = 0%:	0.00%
4. Unmeasured losses (assumed)	0.50%
5. Radiation and convection loss, from ABMA radiation-loss chart, Figure B, assuming four water-cooled walls, actual output = 26.05 x 10^6 Btu/hr, full-load rating = 52.1 x 10^6 Btu/hr	1.30%
Total Heat Losses:	14.59%

Efficiency = 100 − 14.59 = 85.41%

(b) Heat balance at 75% of full-load rating; heat output = 39.08 x 10^6 Btu/hr.

Heat Losses

1. Dry-flue-gas loss, from Figure 3 at CO_2 = 13.0% and temperature differential of 355°F:	7.85%
2. Hydrogen loss, from Figure 4, at stack temperature of 425°F and combustion-air temperature of 70°F:	6.57%
3. CO loss at CO = 0%:	0.00%
4. Unmeasured losses (assumed)	0.50%
5. Radiation and convection loss, from Figure B, as before, except that actual output = 39.08 x 10^6 Btu/hr =	0.89%
Total Heat Losses:	15.81%

Efficiency = 100 − 15.81 = <u>84.19%</u>

(c) Heat balance at full-load rating; heat output = 52.1 x 10^6 Btu/hr.

Heat Losses

1. Dry-flue-gas loss, from Figure 3 at CO_2 = 13.5% and temperature differential of 430°F:	9.15%
2. Hydrogen loss, from Figure 4, at stack temperature of 500°F and combustion-air temperature of 70°F:	6.76%
3. CO loss at CO = 0%:	0.00%
4. Unmeasured losses (assumed)	0.50%
5. Radiation and convection loss, from Figure B, as before except that actual output = 52.1 x 10^6 Btu/hr:	0.68%
Total Heat Losses:	17.09%

Efficiency = 100 − 17.09 = <u>82.91%</u>

Example 5.

A high-temperature-water generator rated at 15 million Btu/hr burns residual fuel oil having a specific gravity of 1.00 and a sulphur content of 3%. It normally operates at full load with 15% excess air and a stack temperature of 530°F. What will be the gain in efficiency if excess air is reduced to 3%, resulting in 0.1% CO in the flue gas, and a stack temperature of 460°F. Combustion-air temperature is 80°F and "unmeasured losses" are assumed to be 0.5% of fuel input.

Solution:

The oil in question is dealt with in set 10030.

(a) Heat balance under normal conditions:

Heat Losses

1. Dry-flue-gas loss, from Figure 3, at 15% excess air and temperature differential of 450°F:	9.43%
2. Hydrogen loss, from Figure 4, at stack temperature of 530°F and combustion-air temperature of 80°F:	6.65%
3. CO loss at CO = 0%:	0.00%
4. Unmeasured losses (assumed)	0.50%
5. Radiation and convection loss, from Figure B, for heat output = 15 x 10^6 Btu/hr, 4 water-cooled walls:	1.27%
Total Heat Losses:	17.85%

Efficiency = 100 − 17.85 = <u>82.15%</u>

(b) Heat balance under low excess-air conditions

Heat Losses

1. Dry-flue-gas loss, from Figure 3, at 3% excess air and temperature differential of 380°F:	7.15%
2. Hydrogen loss, from Figure 4, at stack temperature of 460°F and combustion-air temperature of 80°F:	6.48%
3. CO loss, from Figure 5, at CO = 0.1%	0.30%
4. Unmeasured losses, as before:	0.50%
5. Radiation and convection loss, as before:	1.27%
Total Heat Losses:	15.70%

Efficiency = 100 − 15.70 = <u>84.30%</u>

Gain in efficiency with low excess air = 84.30 − 82.15 = <u>2.15%</u>

Example 6.

A boiler burns pitch with a specific gravity of 1.04 and a sulphur content of 3.5%. At full load it operates with 3% O_2 in the flue gas and a stack temperature of 500°F. Combustion-air temperature is 60°F. Find the gain in efficiency if an economizer is installed which reduces the stack temperature to 300°F.

Solution:

The sulphur content falls between sets 10430 and 10440. Check both sets of charts and interpolate. Only the dry-flue-gas loss and the hydrogen loss will be affected by the change in stack temperature.

(a) *Without Economizer*

	Set 10430	Set 10440
1. Dry-flue-gas loss, from Figure 3, at 3% O_2 and temperature differential of 440° F	9.40%	9.38%
2. Hydrogen loss, from Figure 4, at stack temperature of 500° F and combustion-air temperature of 60° F:	6.43%	6.40%

Interpolating for oil with 3.5% sulphur;

dry-flue-gas loss	=	9.39%
hydrogen loss	=	6.42%
Total	=	15.81%

(b) *With Economizer*

	Set 10430	Set 10440
1. Dry-flue-gas loss, from Figure 3, at 3% O_2 and temperature differential of 240° F:	5.15%	5.10%
2. Hydrogen loss, from Figure 4, at stack temperature of 300°F and combustion-air temperature of 60°F:	5.96%	5.94%

Interpolating for oil with 3.5% sulphur;

dry-flue-gas loss	=	5.12%
hydrogen loss	=	5.95%
Total	=	11.07%

Economizer increases efficiency by 15.81 – 11.07 = 4.74%

It should be noted that interpolating between the two sets of graphs increased the accuracy only very slightly. Either set would have provided an adequate level of accuracy.

4.5.2. *Accurate Heat Balance*

If it is desired to strike a heat balance with greater accuracy than provided by the method previously described, the following information must be obtained, in addition to the information required for an approximate heat balance:

1. unburned combustible in the flue gas, lb/lb fuel,
2. relative humidity of the combustion air,
3. temperature differential between the boiler casing and ambient, in °F, and
4. air velocity over the boiler casing in feet per second.

Again the accuracy of the heat balance will be limited by the accuracy with which the fuel oil can be matched by the analyses in the sets of graphs, and by the accuracy with which the ABMA radiation-loss chart can be interpolated. For boilers with a full-load output of 20 million Btu or more, there should be no difficulty in striking a heat balance within an error of ± 0.5%, assuming a close match of the fuel oil with a set of graphs.

Example 7.

A boiler rated at 80,000 lb steam/hr at 200 psig and steam temperature of 500°F when supplied with feedwater at 180°F burns residual fuel oil with a specific gravity of 0.97 and a sulphur content of 2.0%. At full load there is no CO, excess air is 15%, stack temperature is 480°F, and unburned combustible is measured at 0.25 lb/lb oil. Combustion air is supplied at 80°F with a relative humidity of 60%. Boiler room temperature is 80°F, average boiler-casing temperature is 160°F, and air velocity over the boiler casing is 10 fps. Find the boiler efficiency at full load.

Solution:

From steam tables, heat picked up per pound of steam under given conditions = 1268.0 – 147.9 = 1120.1 Btu/lb. Full-load output = 1120.1 x 80,000 = 896.1 x 10^6 Btu/hr. The fuel oil in question is dealt with in set 9720.

Heat Losses

1. Dry-flue-gas loss, from Figure 3, at 15% excess air and temperature differential of 400° F:	8.32%
2. Hydrogen loss, from Figure 4, at stack temperature of 480°F and combustion-air temperature of 80°F:	6.73%
3. CO loss at CO = 0%:	0.00%
4. Unburned combustible loss at 0.25 lb/lb unburned combustible:	0.25%

5. Loss due to moisture in combustion air at 80° F and relative humidity of 60%: From psychrometric chart, lb moisture/lb dry air = 0.0132.
From Figure 1, at 15% excess air, lb dry air/lb oil = 16.0.
lb moisture/lb oil = 16.0 x 0.0132 = 0.2112

Heat picked up by moisture, assuming specific heat of 0.46 = 0.2112 x 0.46 x (480 − 80) = 38.86 Btu/lb oil
Heat loss, % = 38.86 x 100 ÷ 18,470 (calorific value of oil, from first page of set 9720): 0.21%

6. Radiation and convection loss, from Figure B, at full load output of 896.1×10^6 Btu/hr, assuming four water-cooled walls, = 0.245%
From Figure C, transmission loss at boiler casing temperature difference of 160 − 80 = 80°F, and air velocity of 10 fps, = 360 Btu/sq ft/hr
From Figure C, transmission loss at condition in ABMA chart (temperature difference of 50°F, air velocity of 100 fpm) = 125 Btu/sq ft/hr
Correction factor for ABMA chart = 360 ÷ 125 = 2.88
Corrected heat loss = 0.245 x 2.88 = 0.71% 0.71%

Total Heat Losses: 16.22%

Efficiency = 100 − 16.22 = 83.78%

In the foregoing example, some assumptions were made which should be clarified. First, in establishing the unburned combustible loss, it was assumed that the unburned combustible had the same calorific value as the fuel oil. This is not necessarily the case; the unburned combustible may be nearly pure carbon with a calorific value of 14,600 Btu/lb. However, since this involves a fractional correction to a minor loss, for most heat balances there is no justification for determining the actual calorific value of the unburned combustion. Second, in calculating the loss due to moisture in the combustion air, the assumed specific heat of 0.46 for water vapour is a rough figure. The specific heat actually varies with temperature, but, as in the case of the unburned combustible loss, further refinement of the heat loss calculation is not usually warranted. Third, obtaining average temperature differentials and air velocities over the boiler casing involves approximations to an extent not readily determined. As can be seen from Figure C, increasing temperature differential and air velocity have a strong effect on the radiation and convection loss. Accordingly, to measure the loss accurately, the whole boiler surface must be marked off into suitable sections, the mean temperature differential and air velocity in each section must be measured, and the heat loss for each section must be calculated, using Figure C or appropriate formulae. The losses from each section must then be added together to obtain the total heat loss. This approach is described in Appendix C.

5. APPLICATION TO AIR POLLUTION PROBLEMS

5.1. Pollutant Emission

Combustion gases may contain a number of pollutants such as CO_2, CO, SO_2, SO_3, nitrogen oxides, acid soot and unburned hydrocarbons including polycyclics, olefins and paraffins. In most cases, their concentration cannot be reliably predicted from a knowledge of the fuel and the combustion conditions. A notable exception is CO_2, the concentration of which is given in Figures 1, 2 and 3 of each of the sets in the handbook, calculated from the fuel analysis and the excess-air level. The concentration of SO_2 in flue gas from oil-burning systems may be approximately predicted by assuming that all the sulphur in the oil burns to SO_2 and leaves the system as such. This assumption was made in plotting Figure D, which may be used to estimate SO_2 concentration in the flue gas, in terms of ppm by volume. The SO_2 emitted from a given chimney, in terms of cu ft/hr, may be calculated as shown in the following example.

Example 8.

A boiler burns 5,000 lb/hr of oil having a specific gravity of 0.95 and a sulphur content of 2.0%. It operates with 20% excess air and a stack temperature of 450°F. Find the maximum theoretical amount of SO_2 discharged into the atmosphere per hour if atmospheric pressure = 29.92 in. Hg.

Solution:

The oil in question is dealt with in set 9520.

From Figure 2, at 20% excess air and flue-gas temperature = 450°F, vol of flue gas, cu ft/lb oil = 406

Vol of flue gas, cu ft/hr at 450°F = 406 x 5000 = 2,030,000

From Figure D, at 20% excess air, 2% S, specific gravity = 0.95, SO_2 concentration, ppm by vol = 1110

SO_2 emission = $\frac{1110}{10^6} \times 2{,}030{,}000 = \underline{2{,}253.3}$ cu ft/hr at 450°F and 29.92 in. Hg.

Measured SO_2 concentrations may range from 50% to 200% of the calculated theoretical concentrations; low readings may occur because a variety of chemical reactions are capable of fixing the sulphur in forms other than SO_2, while high readings may occur because some measuring techniques, such as API-774-54, are susceptible to interference by nitrogen oxides or organic acids.

5.2. Plume-Rise Calculations

The calculation of plume rise is dealt with extensively in (3) and it will only be shown here how the handbook can facilitate such calculations.

To calculate plume rise, the sensible heat lost up the stack must be known. This is not simply the dry-flue-gas loss, because part of the loss due to combustion of hydrogen, i.e., the superheat in the water vapour, is a sensible-heat loss. The sensible-heat loss may be approximated by multiplying the dry-flue-gas loss by the weight ratio of total flue gas to dry flue gas, as shown in the following example.

Example 9.

A plant burning No. 2 fuel oil operates with 15% excess air and a stack temperature of 400°F. Combustion-air temperature is 70°F. Find the approximate sensible-heat loss.

Solution:

No. 2 fuel oil is dealt with in set 8507.

Dry-flue-gas loss, from Figure 3, at 115% total air and temperature difference of 400 - 70 = 330°F:	6.65%
From Figure 1, dry-flue-gas, lb/lb oil at 115% total air:	16.45%
From Figure 1, total flue gas, lb/lb oil at 115% total air:	17.65%

$$\text{Sensible-heat loss} = 6.65 \times \frac{(17.65)}{(16.45)} = \underline{7.13\%}$$

The foregoing method is only approximate because it assumes that water vapour has the same specific heat as dry flue gas, and because it takes no account of moisture from combustion air or from fuel. While the latter may be neglected in most cases, the difference in specific heat may be taken into account using the method shown in Example 10 if appropriate values for specific heat are known. The ASME method for calculating dry-flue-gas loss assumes a specific heat of 0.24 for dry flue gas, and 0.46 is a reasonable value for the specific heat of water vapour at low vapour pressures and temperatures up to 575°F.

Example 10.

For the case cited in Example 9, calculate the sensible-heat loss, assuming a specific heat of 0.24 for dry flue gas and a specific heat of 0.46 for water vapour.

Solution:

From Figure 1, dry flue gas, lb/lb oil at 115% total air:	16.45
From Figure 1, total flue gas, lb/lb oil at 115% total air:	17.65

Sensible-heat loss, Btu/lb oil = [(16.45) (0.24) + (17.65-16.45) (0.46)] × (400-70) = <u>1,485 Btu/lb oil</u>

Calorific value of the oil = 19,590 Btu/lb

Sensible-heat loss, % = 1485 × 100 ÷ 19,590 = 7.58%

6. LOW-TEMPERATURE CORROSION

6.1. The Mechanism of Low-Temperature Corrosion

Because low-temperature corrosion is one of the major problems facing users of sulphur-bearing fuels, it seems appropriate to discuss it to some extent in a combustion handbook. Low-temperature corrosion is caused by sulphuric acid (H_2SO_4) formed from sulphur in the fuel. While combustion calculations usually assume that all the sulphur in the fuel forms SO_2 during combustion, some of it forms the higher oxide, SO_3. The main mechanism by which this occurs is due to the presence in the flame of highly reactive atoms of oxygen. Some of these react with molecules of SO_2 as follows:

$$SO_2 + O \rightarrow SO_3$$

This reaction accounts for most of the SO_3 in the flue gas, although SO_2 may be oxidized to SO_3 by catalytic action of several agents such as vanadium, iron oxide and ferric sulphate. Catalyzed reactions may become very important in the vicinity of tube surfaces already attacked by corrosion. In boiler combustion systems the amount of SO_2 converted to SO_3 by the foregoing reactions may range from 0 to 10% of the total SO_2, with 2% being a typical figure for oil-firing systems.

Although SO_3 is a gas, it combines readily with water vapour to form sulphuric acid vapour.

$$H_2O \text{ (water vapour)} + SO_3 \rightarrow H_2SO_4$$

Since the flue gas from combustion of oil contains substantial quantities of water vapour, the above reaction can take place quite readily, and if the acid vapour is cooled by low-temperature-metal surfaces, it may condense on the surfaces as liquid sulphuric acid, and be diluted by additional condensation of moisture from the flue gas. In general, dilute sulphuric acid is more corrosive than highly concentrated sulphuric acid. Corrosion may then proceed according to the following equation:

$$Fe \text{ (iron from metal surface)} + \text{dilute } H_2SO_4 \rightarrow FeSO_4 \text{ (ferrous sulphate)} + H_2$$

In the presence of additional sulphuric acid and oxygen the ferrous sulphate may be converted to ferric sulphate as follows:

$$2\,FeSO_4 + H_2SO_4 + 1/2O_2 \rightarrow Fe_2\,(SO_4)_3 \text{ (ferric sulphate)} + H_2O$$

Once formed, ferric sulphate $Fe_2\,(SO_4)_3$ can accelerate corrosion by combining with moisture to produce additional H_2SO_4 and by acting as a catalyst to promote oxidation of SO_2 to SO_3.

6.2. Acid Dewpoint

The amount of water vapour which can be held in a gas such as air or flue gas, increases with increasing temperature. For any given concentration of water vapour in a gas, the water dewpoint is defined as that temperature at which the gas is saturated. If the gas is cooled below this temperature, some of the water vapour must condense. For combustion gases from oil, the water dewpoint is usually about 110°F. However, if small quantities of sulphuric acid vapour are present, condensation of sulphuric acid will occur at temperatures well above the water dewpoint. For a given mixture of gas and sulphuric acid vapour, the highest temperature at which acid condenses is commonly called the acid dewpoint. This is measured by a dewpoint meter, which consists of an air-cooled probe terminating in a non-conducting tip, usually glass, which has imbedded in its surface a pair of electrodes and a thermo-couple. The probe, with the cooling air turned off, is inserted in the gas stream at a point where the temperature is likely to be above the acid dewpoint, and allowed to warm up. Then a voltage difference is applied to the electrodes, and the cooling air is gradually turned on. As the temperature of the probe tip, as measured by the thermocouple, is gradually reduced by the cooling air, it approaches the temperature at which acid condensation occurs. When acid condenses on the probe tip it forms an electrical bridge, permitting current to flow between the electrodes. This flow of current is indicated by a microammeter, and the temperature of the probe tip at which it first occurs is regarded as the acid dewpoint. Although several investigators have attempted to correlate measured SO_3 concentration with measured acid dewpoint, it is not yet possible to reliably predict SO_3 concentration from acid dewpoint, or vice-versa. A correlation based on residual oil-flame measurements at the Canadian Combustion Research Laboratory is shown in Figure E, but it can only be assumed to hold for the conditions under which measurements were taken.

It should be kept in mind that metals are attacked by sulphuric acid only when it is in the liquid phase. As long as it remains in vapour form, no corrosion occurs. Thus the acid dewpoint, in denoting the maximum temperature at which acid will condense, signifies the maximum temperature at which low-temperature corrosion may occur. Figure E shows that the acid dewpoint for an oil containing 2.5% sulphur may be about 270°F. Medium- and high-pressure steam boilers without economizers or air heaters usually have their gas-swept surfaces at temperatures well above the acid dewpoint, and thus are safe from low-temperature corrosion. On the other hand, high-temperature-water generators, which frequently have return-water temperatures of 250°F or lower, and boilers equipped with economizers or air heaters, may have large heat-exchange surfaces at temperatures below the acid dewpoint, and low-temperature corrosion becomes a serious problem.

6.3. Rate of Acid Buildup

If a surface exposed to flue gas, such as a boiler tube, is cooled to the acid dewpoint, sulphuric acid will condense on it as previously explained. However, the amount will be small and the concentration will be high. If the surface is cooled to a lower temperature, a larger amount of acid will condense and it will be somewhat diluted by condensed water vapour, resulting in a more corrosive solution. Further cooling will result in condensation of still larger quantities of acid which may be very dilute and therefore less corrosive. Thus, at some temperature which is usually 20°F to 50°F below the acid dewpoint, there is a combination of acid condensation rate and acid concentration which represents the greatest corrosion potential. This temperature may be found by measuring the rate of acid buildup (RBU) using a dewpoint meter. This is done by measuring the acid dewpoint in the usual way, then adjusting the flow of cooling air to maintain the probe tip at a constant temperature which is below the acid dewpoint, for for example 10°F below the acid dewpoint, and recording the change in current flow across the electrodes during a given period of time. Since the probe tip is below the acid dewpoint, acid will continue to condense on the tip and the current flow will be proportional to the amount of condensed acid. Thus, if at a given tip temperature, at $t = 0$ the current is 50 microamperes (μA), and at $t = 2$ minutes the current is 210 μA, then current is increasing at an average rate of $(210\text{-}50) \div 2 = 80$ μA/min. This is an arbitrary measure of the rate at which acid is condensing at that temperature, and is called the rate of acid buildup. If the

RBU is measured in this fashion at temperatures progressively lower than the acid dewpoint, the results may be plotted as RBU versus surface temperatures as shown in Figure F, which, like Figure E, was prepared from data obtained with a residual oil flame at the Canadian Combustion Research Laboratory. Such curves typically have a maximum, and the temperature at which the maximum occurs is the temperature at which corrosion potential is greatest. The temperature at which the RBU is 0 corresponds to the acid dewpoint.

The RBU curve is affected by several variables; prominent among them are sulphur content of the fuel and excess air, both of which affect the amount of SO_3 formed in the flame. Figure F, then, shows the temperature of maximum corrosion potential of a specific fuel at three different levels of excess air.

While the chief value of the RBU is to indicate the surface temperature at which the most corrosion will occur, it also provides a rough indication of the amount of corrosion. For example, if the RBU of a certain surface temperature exceeds 100 μA/min, serious corrosion can be expected, whereas if it is less than 50 μA/min corrosion is likely to be negligible. However, this is an approximation of dubious reliability, particularly in medium temperature water systems, where the acid deposition rate in the furnace may be so high that only a portion of the SO_3 leaves the furnace, yielding RBU determinations in the breeching which are misleadingly low. For an accurate assessment of corrosion potential, corrosion probes must be used.

6.4. Corrosion Probes

Corrosion probes are used to measure rate of corrosion, and consist of an iron or steel surface of known area which is exposed to the flue gas and maintained at a constant temperature. After being exposed for a given period of time the surface is washed with hot distilled water (iron sulphates are soluble) and the washings are subjected to chemical analysis to determine the amount of iron, which can then be corrected for the area of the surface and the time of exposure to give iron loss per unit of area and time.

Figure G shows one type of corrosion probe. The corrosion surface consists of a polished cold-rolled steel hemisphere 1 in. in diameter, hence the surface area = $(\pi\ d^2) \div 2 = 1.5708$ sq in. The hemisphere is hollow, and is cooled by compressed air, while surface temperature is measured by a thermocouple imbedded in the centre of the hemisphere from the hollow side. As an example of its application, if it were desired to measure the corrosion rate in a steel tubular air heater operating at a metal temperature of 225°F, the corrosion probe would be inserted in the flue gas stream ahead of the air heater, and the surface would be maintained at 225°F by adjustment of the compressed air flow. After a given exposure time, usually one hour, had elapsed the probe would be removed and washed. After analysis of the washings, corrosion rate could be reported in micrograms per square inch per hour (μg/sq in. hr).

6.5. Prevention of Low-Temperature Corrosion

There are several ways in which low-temperature corrosion can be reduced or prevented, and the main ones will be discussed briefly in the following paragraphs. Most of them offer practical solutions only under special circumstances, but the use of acid-neutralizing additives has broad application to oil-fired combustion systems.

6.5.1. *Low-Sulphur Fuels*

The most obvious way of avoiding corrosion by sulphuric acid is to burn a fuel that contains little or no sulphur, such No. 2 fuel oil or natural gas. In many cases, of course, this is uneconomical or unfeasible.

6.5.2. *High Surface Temperatures*

It will be recalled that the acid dewpoint signifies the maximum temperature at which low-temperature corrosion may occur. Obviously, low-temperature corrosion can be avoided by maintaining all gas-swept metal surfaces at temperature above the acid dewpoint. For residual oil containing about 2.7% sulphur, the acid dewpoint is not likely to exceed 275°F. In this case, the minimum requirements to provide freedom from low-temperature corrosion will be an operating pressure of 75 psig for steam boilers, and a minimum return temperature of 275°F for high-temperature-water generators. This is assuming that there are no air heaters or economizers, and the sulphur content of the oil does not increase. A more reasonable safety margin is provided by an operating pressure of 100 psig or a minimum return temperature of 300°F. Preventing corrosion by maintaining high surface temperatures is well-suited to small and medium-sized installations in the design stage, but is usually not feasible for existing installations and uneconomical for large boilers which use auxiliary heat-recovery surface to achieve high efficiency.

A fact, often overlooked, is the ability of soot to trap SO_3 vapour by adsorption. This potentially corrosive soot may then adhere to metal surfaces, and while corrosion will not occur as long as the surface is above the acid dewpoint, corrosion will occur when the generator is subsequently taken out of service and allowed to cool. To avoid this, burners should be carefully maintained to minimize soot formation, and generator surfaces should be thoroughly water-washed at the beginning of any extended shutdown period.

6.5.3. *Low Excess Air*

Research has clearly established that at very low levels of excess air, little SO_3 is formed in the flame, and corrosion is negligible. Large installations burning liquid or gaseous fuels under steady load conditions are making increasing use of this fact, and avoid corrosion by operating with 0.5% to 1% oxygen in the flue gas. However, to operate at low excess air without danger of explosions requires accurate, reliable burner and control systems, and it may take a few years to develop systems suitable for small boilers or boilers subjected to rapidly fluctuating loads.

6.5.4. *Corrosion-Resistant Materials*

Stainless steel has the greatest potential as a corrosion-resistant material in boilers and auxiliary heat-transfer equipment, but its use is limited by its high cost. Cast iron is substantially more resistant to corrosion than steel, but because of its strength properties its use is limited to low-stressed components such as economizers. Pyrex tubes are sometimes used in air heaters. Because they maintain their original smooth finish, they have a self-cleaning tendency which offsets the lower heat-transfer characteristics of glass. However, they are more prone to damage by furnace puffs than are metal tubes.

6.5.5. *Acid-Neutralizing Additives*

Additives to improve combustion or prevent corrosion have had a long and turbulent history. While very few additive manufacturers have been able to prove their claims by quantitative tests under controlled conditions, research over the past few years has clearly demonstrated that certain additive formulations are capable of eliminating low-temperature corrosion from low-ash fuels.

This discussion will be limited to a description of the additive developed at the Canadian Combustion Research Laboratory, because it is at present the only one that has been thoroughly proved out, quantitatively and qualitatively, by several years of research on a bench scale, in pilot-plant operation and in long-term tests in utility boilers. This additive was developed primarily for use with residual fuel oil, and consists of particles of magnesia (MgO) and alumina (Al_2O_3) ranging in size from 1 to 7 microns, suspended in a light oil carrier, or more recently in a water carrier, with a surfactant and a dispersant. A commercial metering pump of moderate cost may be used to feed the additive directly into the oil line to the burners, and at the optimum dosage rate, which was experimentally established to be 1 lb additive to 1500 lb oil, the cost of treatment is modest.

The additive reacts with sulphuric acid according to the equation

$$MgO + H_2SO_4 \rightarrow MgSO_4 + H_2O$$

producing harmless magnesium sulphate ($MgSO_4$) and water. While only a portion of the sulphuric acid vapour is neutralized in the gas stream, the additive particles, because of their small size, tend to migrate to the walls of the gas passages, and deposit in a thin layer which neutralizes the condensing acid before it can attack the metal.

The additive has also been formulated as a water-base paint which can periodically be brushed or sprayed on the tube-sheets and exposed surfaces of small, fire-tube boilers, thus providing a protective layer which neutralizes the sulphuric acid as it condenses.

More detailed information on the properties and effects of the additive are available from recent publications (4, 5, 6).

Acknowledgments

The author wishes to express his appreciation to the following people who assisted in the preparation of Volume 1 of the Combustion Handbook:

E.R. Mitchell, Head, Canadian Combustion Research Laboratory, Fuels Research Centre, Mines Branch, Department of Energy, Mines and Resources, for his assistance, direction and encouragement;

R.G. Draper, Head, Petroleum and Gas Laboratory, Fuels Research Centre, Mines Branch, Department of Energy, Mines and Resources, who assisted in calculating the oil analyses;

N.A. Toews, Mining Research Centre, Mines Branch, Department of Energy, Mines and Resources, who prepared the computer program for the combustion and heat-loss calculations;

E. Nilsson, T. McCann and H. Raghunandan, for assistance in preparing the graphs; and

D.G. Savignac, Canadian Combustion Research Laboratory, Fuel Research Centre, Mines Branch, Department of Energy, Mines and Resources, for checking the graphs and calculations.

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APPENDICES

APPENDIX A

Combustion and Heat-loss Calculations

A.1. Fuel Properties

Fuel: Fuel Oil 9730, Specific Gravity 0.970

Ultimate Analysis, lb/lb

Carbon	(C_2)	0.8589
Hydrogen	(H_2)	0.1111
Sulphur	(S)	0.0300
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
Total		1.0000

Calorific Value, Btu/lb. 18,320

A.2. Combustion Calculations (assuming atmospheric pressure = 29.92 in. Hg)

A.2.1. **Conversion factors**

1 Imp gal oil = 9.700 lb oil
or Imp gal oil × 9.700 = lb oil
or lb oil × 0.1031 = Imp gal oil

1 U.S. gal oil = 9.700 × 0.8337 lb oil
or U.S. gal oil × 8.087 = lb oil
or lb oil × 0.1237 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}320} \text{ lb oil}$$

or Btu × 10^6 × 54.58 = lb oil
or lb oil × 0.01832 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{9.70 \times 18{,}320} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.627 = Imp gal oil
or Imp gal oil × 0.1777 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{8.087 \times 18{,}320} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.748 = U.S. gal oil
or U.S. gal oil × 0.1482 = Btu × 10^6

A.2.2. **Stoichiometric air required**

Combustible — *O_2 from air, lb*

$$C = \frac{15.999 \times 2}{12.011} \times 0.8589 = 2.285 \text{ (for } CO_2)$$

$$H_2 = \frac{15.999 \div 2}{1.008} \times 0.1111 = 0.882 \text{ (for } H_2O)$$

$$S = \frac{15.999 \times 2}{32.064} \times 0.0300 = 0.030 \text{ (for } SO_2)$$

Total O_2 from air, lb/lb oil = 3.197

$$\text{Associated } N_2 = \frac{76.85}{23.15} \times 3.197 = 10.613$$

Dry air, lb/lb oil =
3.197 + 10.613 = 13.810

A.2.3. **Combustion air for a range of total air**

Specific volume of dry air at 40°F = 12.59 cu ft/lb
60°F = 13.10
80°F = 13.60
100°F = 14.11
120°F = 14.62

Total air, %	100	140	160	200
Dry air, lb/lb oil	13.810	19.334	22.096	27.620
Air temp, °F	*Dry air, cu ft/lb oil*			
40	173.9	243.4	278.2	347.7
60	180.9	253.3	289.5	361.8
80	187.8	263.0	300.5	375.6
100	194.9	272.8	311.8	389.7
120	201.9	282.7	323.0	403.8

A.2.4. **Stoichiometric products of combustion, (dry air basis)**

Dry products — *lb*

CO_2 = 0.8589 + 2.285 = 3.144
N_2 = = 10.613
SO_2 = 0.030 + 0.030 = 0.060
Dry flue gas, lb/lb oil = 13.817

Wet products

H_2O = 0.1111 + 0.882 = 0.993
Total flue gas, lb/lb oil
= 13.817 + 0.993 = 14.810

A.2.5. **Products of combustion and % CO_2 for a range of total air**

At stoichiometric

Dry products

	lb/lb oil	÷ *Mol wt*	× *Mol vol*	*= cu ft at 32° F/lb oil*
CO_2	3.144	44.01	359	= 25.64
N_2	10.613	28.02	359	= 135.98
SO_2	0.060	64.07	359	= 0.34
Total dry products, cu ft at 32°F/lb oil				= 161.96

Wet products

H_2O 0.993 ÷ 18.02 × 359 = 19.79

Total flue gas, cu ft at 32°F/lb oil = 181.75

For 20% excess air

Additional O_2 = (0.20 × 3.197) ÷ 32.00 × 359 = 7.17

Additional N_2 = (0.20 × 10.613) ÷ 28.02 × 359 = 27.20

Additional products = 2.762 lb/lb oil = 34.37 cu ft at 32°F/lb oil

CO_2, cu ft at 32°F/lb oil = 25.64

Total air %	Dry flue gas lb/lb oil	Dry flue gas cu ft at 32° F/lb oil	Total flue gas lb/lb oil	Total flue gas cu ft at 32° F/lb oil	CO_2, % by vol, dry gas basis	O_2, % by vol, dry gas basis
100	13.82	162.0	14.81	181.8	15.83	0.00
120	16.58	196.3	17.57	216.1	13.06	3.65
140	19.34	230.7	20.33	250.5	11.12	6.22
160	22.10	265.1	23.10	284.9	9.67	8.12
180	24.86	299.4	25.86	319.2	8.56	9.58
200	27.63	333.8	28.62	353.6	7.68	10.74

A.2.6. **Volume of products of combustion for a range of total air and temperature**

$$\text{Volume correction for } 200°\text{F} = \frac{460 + 200}{460 + 32} = 1.341$$

250°F = 1.443
300°F = 1.545
350°F = 1.646
400°F = 1.748
450°F = 1.850
500°F = 1.951
550°F = 2.053
600°F = 2.154
650°F = 2.256

Total air, %	*Total flue gas, cu ft/lb oil* 100	140	160	200
Gas temp, °F				
32	181.8	250.5	284.9	353.6
200	243.7	335.9	382.0	474.2
250	262.3	361.4	411.0	510.2
300	280.8	387.0	440.1	546.3
350	299.2	412.3	468.9	582.0
400	317.7	437.8	497.9	618.1
450	336.2	463.4	527.0	654.2
500	354.6	488.7	555.8	689.9
550	373.1	514.2	584.8	725.9
600	391.5	539.6	613.6	761.6
650	410.0	565.1	642.6	797.7

A.3. Heat-Loss Calculations

A.3.1. **Dry-flue-gas loss**

$$\text{Loss in Btu/lb oil} = \frac{\text{lb dry gas}}{\text{lb oil}} \times 0.24 \times \text{(stack temp. minus combustion air temp.)}$$

Loss in % = above × 100 ÷ calorific value of oil (18,320 Btu/lb)

Heat loss, %

Stack temp minus comb. air temp, °F	Total air, % / lb dry gas / lb oil: 100 / 13.82	140 / 19.34	160 / 22.10	200 / 27.63
100	1.81	2.53	2.90	3.62
150	2.72	3.80	4.34	5.43
200	3.62	5.07	5.79	7.24
250	4.52	6.33	7.24	9.05
300	5.43	7.60	8.69	10.86
350	6.34	8.87	10.14	12.67
400	7.24	10.14	11.58	14.48
450	8.14	11.40	13.03	16.29
500	9.05	12.67	14.48	18.10
550	9.96	13.94	15.93	19.91
600	10.86	15.20	17.37	21.72
650	11.77	16.47	18.82	23.52

A.3.2. **Heat loss due to H_2O from combustion of H_2**

Heat loss in Btu/lb oil
if stack temp is below 575°F =

$$9 \times \frac{\text{lb } H_2}{\text{lb oil}} \times (1089 - \text{comb. air temp} + (0.46 \times \text{stack temp}))$$

if stack temp is above 575°F =

$$9 \times \frac{\text{lb } H_2}{\text{lb oil}} \times (1066 - \text{comb. air temp} + (0.50 \times \text{stack temp}))$$

Heat loss in % = above × 100 ÷ calorific value of oil (18,320 Btu/lb)

Heat loss, %

Stack temp °F	Combustion-air temp, °F			
	40	60	80	120
200	6.23	6.12	6.01	5.79
250	6.35	6.24	6.14	5.92
300	6.48	6.37	6.26	6.04
350	6.60	6.50	6.39	6.17
400	6.73	6.62	6.51	6.29
450	6.86	6.75	6.64	6.42
500	6.98	6.87	6.76	6.54
550	7.11	7.00	6.89	6.67
600	7.24	7.13	7.02	6.80
650	7.37	7.26	7.16	6.94

A.3.3. **Heat loss due to CO**

$$\text{Heat loss in Btu/lb oil} = \frac{CO}{CO_2 + CO} \times 10{,}160 \times \frac{\text{lb carbon}}{\text{lb oil}}$$

Heat loss in % = above × 100 ÷ calorific value of oil (18,320 Btu/lb)

Assume complete mixing: i.e. CO + CO always = 15.83

CO, %	*Heat loss, %*
0.5	1.50
1.0	3.01
1.5	4.51
2.0	6.02

APPENDIX B

Calculation of Fuel-Oil Properties

B.1. Empirical Formulae

Empirical formulae for calculating the carbon/-hydrogen ratio and calorific value of petroleum fuels were prepared many years ago in the United States, on the basis of substantial experimental data*, and are generally accurate within ± 1%.

The calorific value in calories per gram for crude petroleum and its liquid products, when free of ash, moisture and sulphur may be calculated from the following:

$$Q_v = 12{,}400 - 2100\ d^2$$
$$Q_p = Q_v - 50.45\ (\%\ H)$$
$$\%\ H = 26 - 15\ d \text{ (accurate to } \pm\ 1\%\ H)$$

where Q_v = total or gross heat of combustion at constant volume
Q_p = net heat of combustion at constant pressure
% H = hydrogen content, per cent by weight
d = specific gravity at 60°F, relative to water at 60°F

The calorific value of petroleum oils containing appreciable amounts of moisture, ash and sulphur may be calculated from the following relationships:

$$\overline{Q}_v = Q_v - 0.01\ Q_v\ (\%\ H_2O + \%\ ash + \%\ S) + X\ (\%\ S)$$
$$\overline{Q}_p = Q_p - 0.01\ Q_p\ (\%\ H_2O + \%\ ash + \%\ S) + X\ (\%\ S) - Y\ (\%\ H_2O)$$

where Q_v and Q_p are calculated from the formulae for ash, moisture and sulphur-free oil, converted to the units desired, and X and Y are taken from the following, depending on the units desired:

Units	X	Y
Calories/gram	22.5	5.85
Btu/lb	40.5	10.53
Btu/Imp gal	406d	105.4d

The additional symbols are defined as follows:

$\overline{Q}_v$ = total or gross heat of combustion at constant volume, corrected for moisture, ash and sulphur.
$\overline{Q}_p$ = net heat of combustion at constant pressure, corrected for moisture, ash and sulphur.
% H_2O = moisture content, per cent by weight.
% ash = non-combustible content, per cent by weight.
% S = sulphur content, per cent by weight.

B.2. Calculation of Ultimate Analysis

Ultimate analyses were calculated for a range of specific gravities and sulphur contents assuming moisture and ash to be negligible, and assuming that sulphur replaces carbon and hydrogen on a pro rata basis, as shown in the following example.

Given: specific gravity at 60/60°F = 1.01
sulphur content = 3.00%
% H = 26 − 15 d
26 − 15 (1.01) = 26 − 15.15 = 10.85
% C = 100.00 − 10.85 = 89.15
Correct for sulphur:
% H = 10.85 (0.97) = 10.52
% C = 89.15 (0.97) = 86.48
% S = 3.00
100.00

* Thermal properties of petroleum products, *Misc. Publ.*, Bur. Standards No. 97, U.S. Dept. Comm, 1929.

B.3. Calculation of Calorific Value

For each calculated ultimate analysis, the total or gross heat of combustion at constant volume was calculated assuming moisture and ash to be negligible, but correcting for sulphur, as shown in the following example.

Given: specific gravity at 60/60°F = 1.01
sulphur content = 3.00%

Q_v = 12,400 − 2100d²
= 12,400 − 2100 (1.01)² = 10,258 cal/g
1 cal/g = 0.5556 Btu/lb

Q_v = 10,258 ÷ 0.5556 = 18,463 Btu/lb

$\bar{Q}_v$ = Q_v − 0.01 Q_v (% H_2O) + % ash + % S) + X(% S)

% H_2O + % ash = 0

% S = 3.00

From B.1, for Btu/lb, X = 40.5

$\bar{Q}_v$ = 18,463 − 0.01 (18,463) (0 + 0 + 3.00) + 40.5 (3.00)
= 18,463 − 553.89 + 121.5
= 18,030 Btu/lb

APPENDIX C

Radiation and Convection Losses

C.1. Theory of Heat Loss due to Radiation and Convection

If a surface is exposed to still air having a lower temperature than the surface, it loses heat by radiation and by natural convection. The natural convection currents develop because as the layer of air next the surface becomes heated, it becomes more buoyant, and is displaced by unheated air. If the surface is placed in an air stream, then natural convection is replaced by forced convection, and the rate of heat loss is increased.

To calculate the heat losses due to ratiation and convection, the following formulae may be applied*:

Note: °R = °F + 460

Radiation Loss: $h_r = 17.4 \times 10^{-10} \times \epsilon\ (T_1{}^4 - T_2{}^4)$

where h_r = heat loss by radiation, Btu/hr/sq ft
ϵ = emissivity (see Table C.1)
T_1 = surface temperature, °R
T_2 = air temperature, °R

Natural-Convection Loss: $h_c = 0.53C \left(\frac{1}{T_{avg}}\right)^{0.18} dt^{1.27}$

where h_c = heat loss by natural convection, Btu/hr/sq ft
C = a constant depending on the shape of the surface (for a vertical surface, C = 1.39. For the crown of a furnace, C = 1.79)
T_{avg} = average of wall temperature and air temperature, °R
dt = wall temperature – air temperature, °F

Forced-Convection Loss: $h_{fc} = 1 + 0.225\ V$

where h_{fc} = heat transmission, Btu/hr/sq ft/°F
V = air velocity, ft/sec.

* Taken from p. 169, Manual of ASTM Standards on Refractory Materials, 8th edn., Nov. 1957. Publ. ASTM, 1916 Race Street, Philadelphia 3, Pa., USA

It should be noted that in using the last formula, to get the heat loss by forced convection in Btu/hr/sq ft, the value for h_{fc} must be multiplied by (surface temperature – air temperature, °F).

Figure C was prepared using the formulae for radiation loss and forced-convection loss. The radiation loss, of course, is independent of air velocity, and was calculated for an emissivity of 0.95. The forced-convection losses were calculated for various temperature differences and velocities, and to these were added the radiation losses at the corresponding temperature differences. Thus the curves show the total loss due to radiation and forced convection. However, they only apply for a surface with an emissivity of 0.95.

C.2. Emissivity Values

A great deal of research has been carried out to establish the emissivity of various materials. The following table lists values for some of the common materials used in the construction of combustion equipment*.

TABLE C. 1
Normal Total Emissivity of Various Surfaces

Surface	t, °F**	Emissivity
Metals and their Oxides		
Aluminum		
Polished	212	0.095
Commercial sheet	212	0.09
Heavily oxidized	200 - 940	0.20 - 0.31
Aluminum oxide	530 - 930	0.63 - 0.42
Aluminum oxide	930 - 1520	0.42 - 0.26
Aluminum alloy 75 ST cleaned with toluene, then methanol, repeatedly heated and cooled	450 - 900	0.22 - 0.16

* Selected from a compilation by H.C. Hottel, published in Table A.23 of Heat Transmission, 3rd Edition, 1954 by W.H. MacAdams. McGraw-Hill Book Co., Inc.

** When temperatures and emissivities appear in pairs separated by dashes, they correspond, and linear interpolation is possible.

Surface	t, °F*	Emissivity
Aluminum alloy 24 ST cleaned with toluene, then methanol, repeatedly heated and cooled	450 - 910	0.17 - 0.15
Brass		
Polished	100 - 600	0.10
Rolled plate, natural surface	72	0.06
Dull plate	120 - 660	0.22
Oxidized by heating at 1110°F	390 - 1110	0.61 - 0.59
Chromium, polished	100 - 2000	0.08 - 0.36
Copper		
Polished	242	0.023
Commercial, scraped shiny, but not mirrorlike	72	0.072
Plate, heated long time, covered with thick oxide layer	77	0.78
Plate heated at 1110°F	390 - 1110	0.57
Gold, pure, highly polished	440 - 1160	0.018 - 0.035
Inconel		
Type X, cleaned with toluene, then methanol, repeatedly heated and cooled	450 - 1620	0.55 - 0.78
Type B, cleaned with toluene, then methanol, repeatedly heated and cooled	450 - 1620	0.35 - 0.55
Iron and Steel Metallic Surfaces		
Steel, polished	212	0.066
Iron, polished	800 - 1880	0.14 - 0.38
Cast iron, polished	392	0.21
Smooth sheet iron	1650 - 1900	0.55 - 0.60
Mild steel, cleaned with toluene, then ethanol, repeatedly heated and cooled	450 - 1950	0.20 - 0.32
Iron and Steel Oxidized Surfaces		
Iron plate, completely rusted	67	0.69
Iron, dark grey surface	212	0.31
Rolled sheet steel	70	0.66
Cast iron, oxidized at 1100°F	390 - 1110	0.64 - 0.78
Steel, oxidized at 1100°F	390 - 1110	0.79

Surface	t, °F*	Emissivity
Iron oxide	930 - 2190	0.85 - 0.89
Sheet steel, strong, rough oxide layer	75	0.80
Sheet steel, dense, shiny oxide layer	75	0.82
Cast iron, rough, strongly oxidized	100 - 480	0.95
Wrought iron, dull, oxidized	70 - 680	0.94
Steel plate, rough	100 - 700	0.94 - 0.97
Lead, grey oxidized	75	0.28
Lead, oxidized at 300°F	390	0.63
Magnesium oxide	530 - 1520	0.55 - 0.20
Magnesium oxide	1650 - 3100	0.20
Monel metal, oxidized at 1110°F	390 - 1110	0.41 - 0.46
K Monel 5700, cleaned with toluene, then ethanol, repeatedly heated and cooled.	450 - 1610	0.46 - 0.65
Nickel, polished	212	0.072
Nickel plate, oxidized by heating at 1110°F	390 - 1110	0.37 - 0.48
Nichrome wire, bright	120 - 1830	0.65 - 0.79
Nichrome wire, oxidized	120 - 930	0.95 - 0.98
Platinum, pure, polished plate	440 - 1160	0.054 - 0.104
Silver, polished, pure	440 - 1160	0.020 - 0.032
Stainless Steels		
Polished	212	0.074
Type 301, cleaned with toluene, then ethanol, repeatedly heated and cooled	450 - 1740	0.57 - 0.55
Type 316, cleaned with toluene, then ethanol, repeatedly heated and cooled	450 - 1600	0.57 - 0.66
Type 347, cleaned with toluene, then ethanol, repeatedly heated and cooled	450 - 1650	0.52 - 0.65
Type 310, brown, splotched, oxidized from furnace service	420 - 980	0.90 - 0.97
Tin, bright	122	0.06

*When temperatures and emissivities appear in pairs separated by dashes, they correspond, and linear interpolation is possible.

Surface	t, °F*	Emissivity
Tin, commercial tin-plated sheet iron	212	0.07, 0.08
Zinc		
Commercial 99.1% pure, polished	440 - 620	0.045 - 0.053
Galvanized sheet iron, fairly bright	82	0.23
Galvanized sheet iron, grey oxidized	75	0.28
Refractories, Building Materials, Paints and Miscellaneous		
Alumina		
Mean grain size 10 microns	1850 - 2850	0.30 - 0.18
Mean grain size 50 microns	1850 - 2850	0.39 - 0.28
Mean grain size 100 microns	1850 - 2850	0.50 - 0.40
Asbestos board	74	0.96
Asbestos paper	100 - 700	0.93 - 0.94
Brick		
Red, rough, but no gross irregularities	70	0.93
Building	1832	0.45
Fireclay	1832	0.75
Carbon		
Filament	1900 - 2560	0.526
Rough plate	212 - 608	0.77
Rough plate	608 - 932	0.77 - 0.72
Lampblack, 0.003 in. or thicker	100 - 700	0.945
Lampblack, rough deposit	212 - 932	0.84 - 0.78
Graphite, pressed, filed surface	480 - 950	0.98
Carborundum (87 SiC, density 2.3)	1850 - 2550	0.92 - 0.82
Concrete tiles	1832	0.63
Enamel, white fused, on iron	66	0.90
Glass, pyrex, lead and soda	500 - 1000	0.95 - 0.85
Gypsum, 0.02 in. thick, on smooth or blackened plate	70	0.903
Magnesite refractory brick	1832	0.38
Marble, light grey, polished	72	0.93
Oak, planed	70	0.90
Paints, Lacquers, Varnishes		
Snow-white enamel varnish on rough iron plate	73	0.906
Black shiny lacquer, sprayed on iron	76	0.875
Black matte shellac	170 - 295	0.91
Black or white lacquer	100 - 200	0.80 - 0.95
Flat black lacquer	100 - 200	0.96 - 0.98
Oil paints, 16 different, all colours	212	0.92 - 0.96
Aluminum paints and lacquers 10% Al, 22% lacquer body on rough or smooth surfaces	212	0.52
Other A1 paints, varying age and A1 content	212	0.27 - 0.67
A1 lacquer, varnish binder, on rough plate	70	0.39
A1 paint, after heating to 620°F	300 - 600	0.35
Radiator paint, white, cream, bleach	212	0.79, 0.77, 0.84
Radiator paint, bronze	212	0.51
Lacquer coatings, 0.001 - 0.015 in. thick on aluminum alloys	100 - 300	0.87 to 0.97
Clear silicone vehicle coatings 0.001 - 0.015 in. thick, on mild steel	500	0.66
Aluminum paint with silicone vehicle, 2 coats on Inconel	500	0.29
Plaster, rough lime	50 - 190	0.91
Porcelain, glazed	72	0.92
Quartz, rough, fused	70	0.93
Roofing paper	69	0.91
Rubber, hard, glossy plate	74	0.94
Rubber, soft, grey, rough, (reclaimed)	76	0.86
Silica, mean grain size 10 microns	1850 - 2850	0.42 - 0.33
Silica, grain size 70 - 600 microns	1850 - 2850	0.62 - 0.46

*When temperatures and emissivities appear in pairs separated by dashes, they correspond, and linear interpolation is possible.

C.3. Calculation of Loss due to Radiation and Convection

From the heat-loss formulae and the table of emissivity values given in the foregoing sections, the heat loss due to radiation and convection from a boiler or other large object can be calculated fairly accurately, provided surface temperature, ambient temperature and air velocity are measured over all the surfaces. The procedure for calculating the heat loss is best demonstrated by the following simple example:

Example C.1 A drying oven is fired with No. 2 oil at the rate of 2 Igph. It is lined with refractory brick, but the outside casing is a steel cube with 6 ft sides. The front wall has an average surface temperature of 160°F, the other walls have an average surface temperature of 140°F. A ventilating system blows air with a velocity of 10 fps and a temperature of 80°F over the oven, but the bottom of the oven has a skirt, and loses heat by radiation only. The bottom of the oven is unpainted and rusty, the sides and top have a fresh coat of aluminum paint, but the top is covered with a thick layer of soot.

Find the total heat loss due to radiation and convection, in Btu/hr and per cent of heat input.

Solution: From the conversion factors for No. 2 oil, heat input = 2 × 8.50 × 19,590 = 333,030 Btu/hr

a. Bottom: Heat loss by radiation only.

$h_r = 17.4 \times 10^{-10} \times \epsilon \times (T_1^4 - T_2^4)$ Btu/sq ft/hr
$T_1 = 140° + 460 = 600°R$; $T_2 = 80 + 460 = 540°R$
From Table C.1, ϵ for rusty steel = 0.80
$\therefore h_r = 17.4 \times 10^{-10} \times 0.80 \times (600^4 - 540^4)$
= 62.08 Btu/sq ft/hr
Total radiation-heat loss from bottom = 36 × 62.08 = 2235 Btu/hr

b. Top: Heat loss by radiation and convection.

Radiation loss: same conditions as for the bottom, except that for emissivity, treat as for rough deposit of lampblack; i.e., $\epsilon = 0.84$

$\therefore h_r = 17.4 \times 10^{-10} \times 0.84 \times (600^4 - 540^4)$
= 65.19 Btu/hr/sq ft
Total radiation-heat loss from top = 36 × 65.19 = 2347 Btu/hr

Convection loss: $h_{fc} = 1 + 0.225\,V$ Btu/hr/sq ft/°F

V = 10 fps, temperature difference = 140 − 80 = 60°F
$h_{fc} = 1 + 0.225\,(10) = 3.25$ Btu/hr/sq ft/°F
Total convection-heat loss from top = 36 × 60 × 3.25 = 7020 Btu/hr

c. Front: Heat loss by radiation and convection.

Radiation loss: $T_1 = 160 + 460 = 620°R$; $T_2 = 80 + 460 = 540°R$
From Table C.1, ϵ for fresh aluminum paint = 0.27
$\therefore h_r = 17.4 \times 10^{-10} \times 0.27 \times (620^4 - 540^4)$
= 29.50 Btu/hr/sq ft
Total radiation-heat loss from front = 36 × 29.50 = 1062 Btu/hr

Convection loss: V = 10 fps, temperature difference = 160 − 80 = 80°F
$h_{fc} = 1 + 0.225\,(10) = 3.25$ Btu/hr/sq ft/°F
Total convection-heat loss from front = 36 × 80 × 3.25 = 9360 Btu/hr

d. Remaining 3 sides: Heat loss by radiation and convection.

Radiation loss: $T_1 = 140 + 460 = 600°R$
$T_2 = 80 + 460 = 540°R$ as for front, $\epsilon = 0.27$
$\therefore h_r = 17.4 \times 10^{-10} \times 0.27 \times (600^4 - 540^4)$
= 20.95 Btu/hr/sq ft
Total radiation-heat loss from 3 sides = 3 × 36 × 20.95 = 2263 Btu/hr

Convection loss: loss from each side is the same as for the top.
Total convection-heat loss from 3 sides = 3 × 7020 = 21,060 Btu/hr

Summary of Heat Losses

Bottom:	Radiation	2235 Btu/hr
Top:	Radiation	2347
	Convection	7020
Front:	Radiation	1062
	Convection	9360
3 Sides:	Radiation	2263
	Convection	21,060
	Total	45,347 Btu/hr

∴ Total heat loss due to radiation and convection = 45,347 Btu/hr
∴ Heat loss in per cent of fuel input = (45,347 × 100) ÷ 333,030 = 13.62%

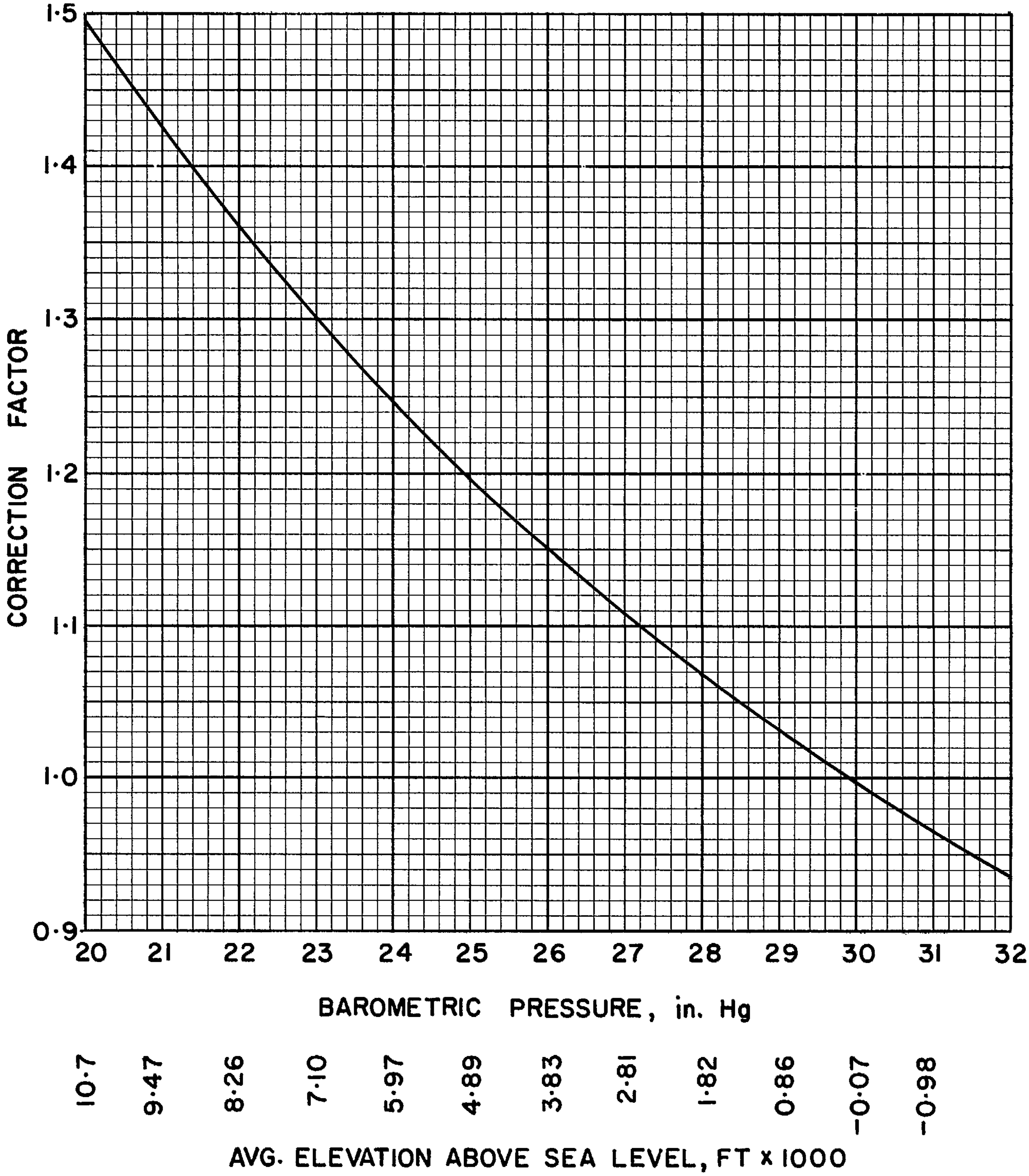


FIGURE A. ELEVATION CORRECTION FACTORS TO BE APPLIED TO THE VOLUMES OF COMBUSTION AIR AND FLUE GAS OBTAINED FROM FIGURE 2 WHEN ATMOSPHERIC PRESSURE IS OTHER THAN 29·92 in. Hg.

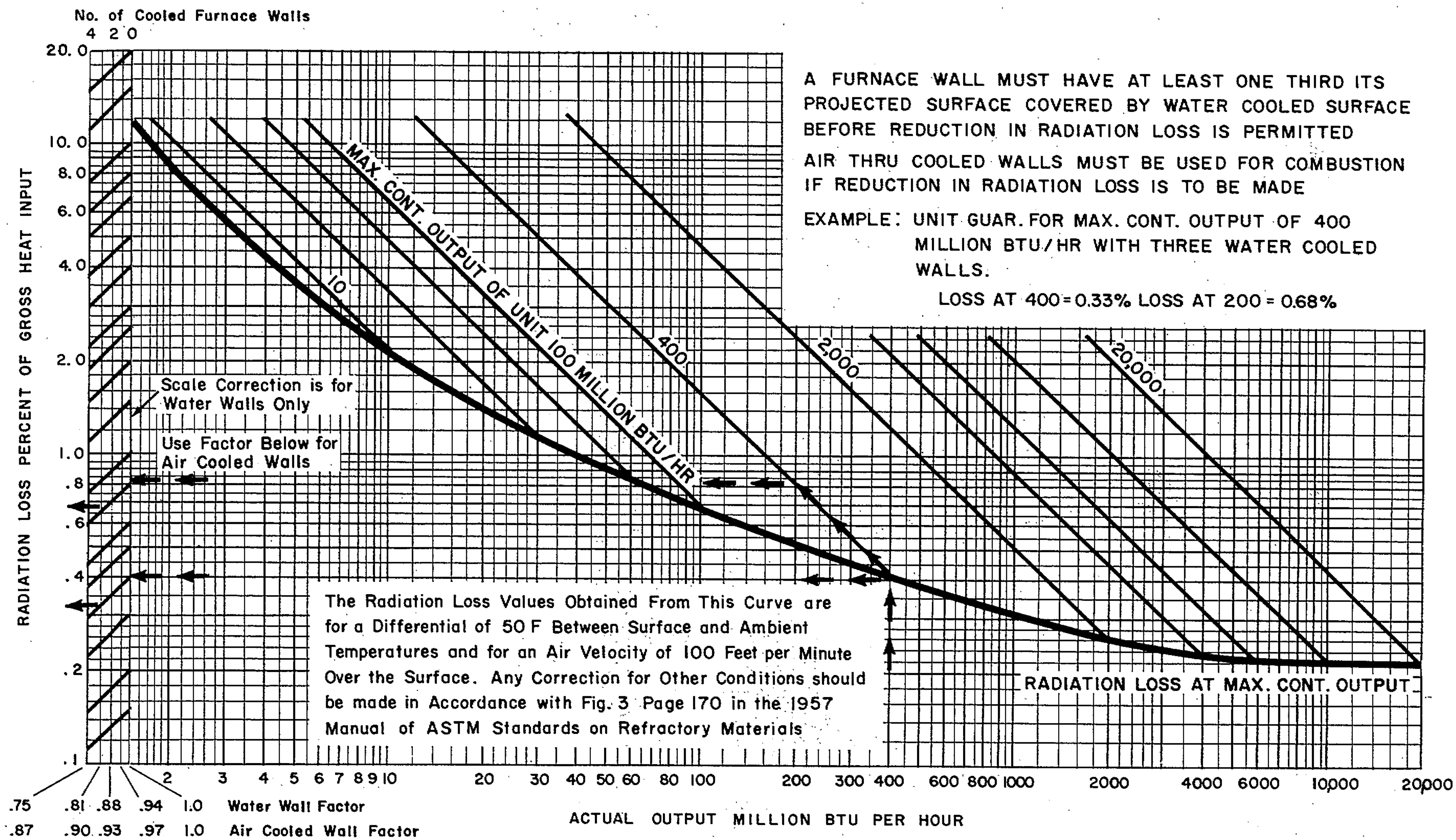


FIGURE B. RADIATION AND CONVECTION HEAT LOSS CHART, ASSUMING EMISSIVITY = 0·95.
PUBLISHED BY COURTESY OF THE AMERICAN BOILER MANUFACTURERS ASSOCIATION.

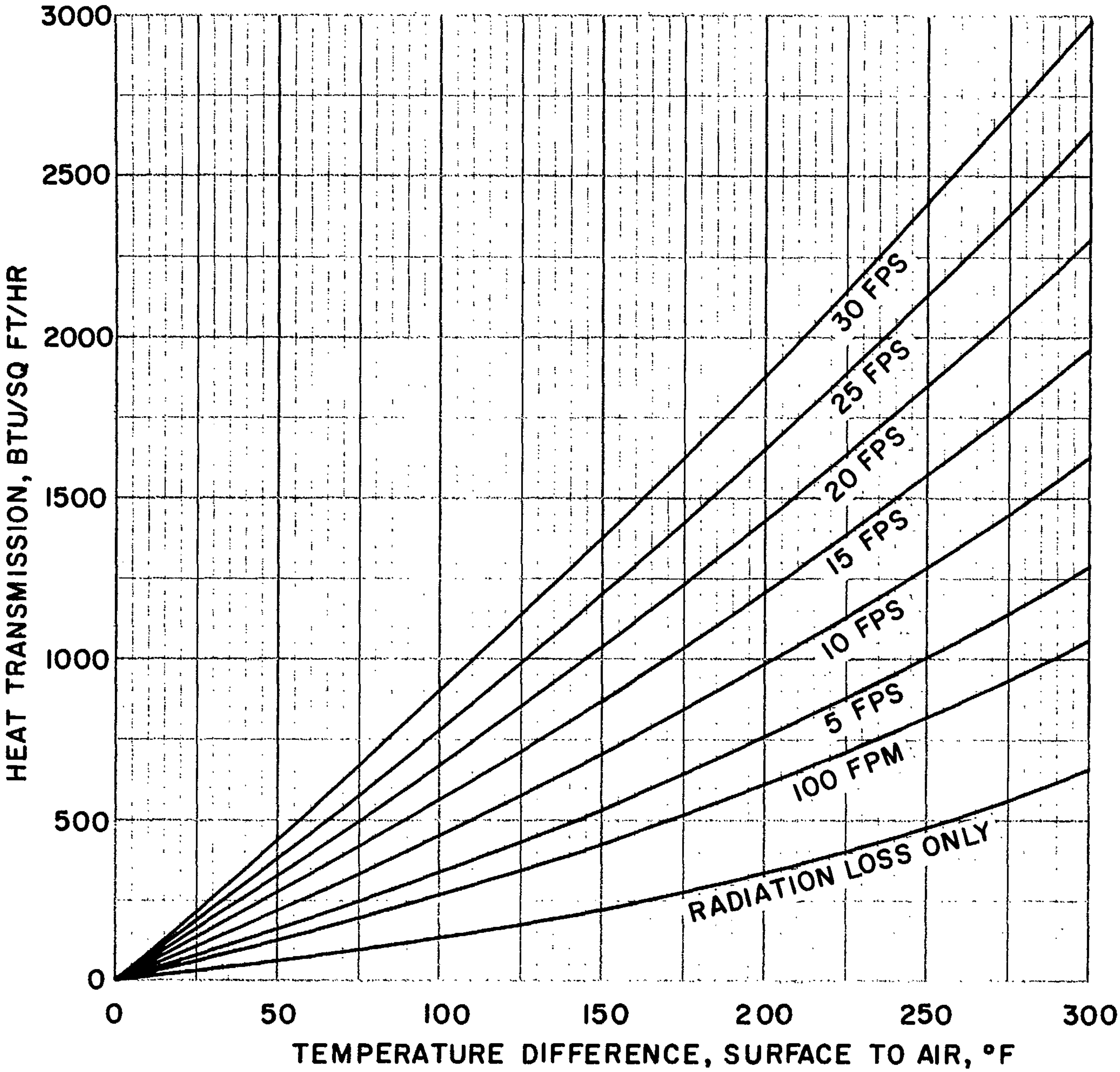


FIGURE C. SURFACE HEAT TRANSMISSION FOR A RANGE OF AIR VELOCITIES BASED ON AN EMISSIVITY OF 0·95 AND AN AIR TEMPERATURE OF 70 °F. PUBLISHED BY COURTESY OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

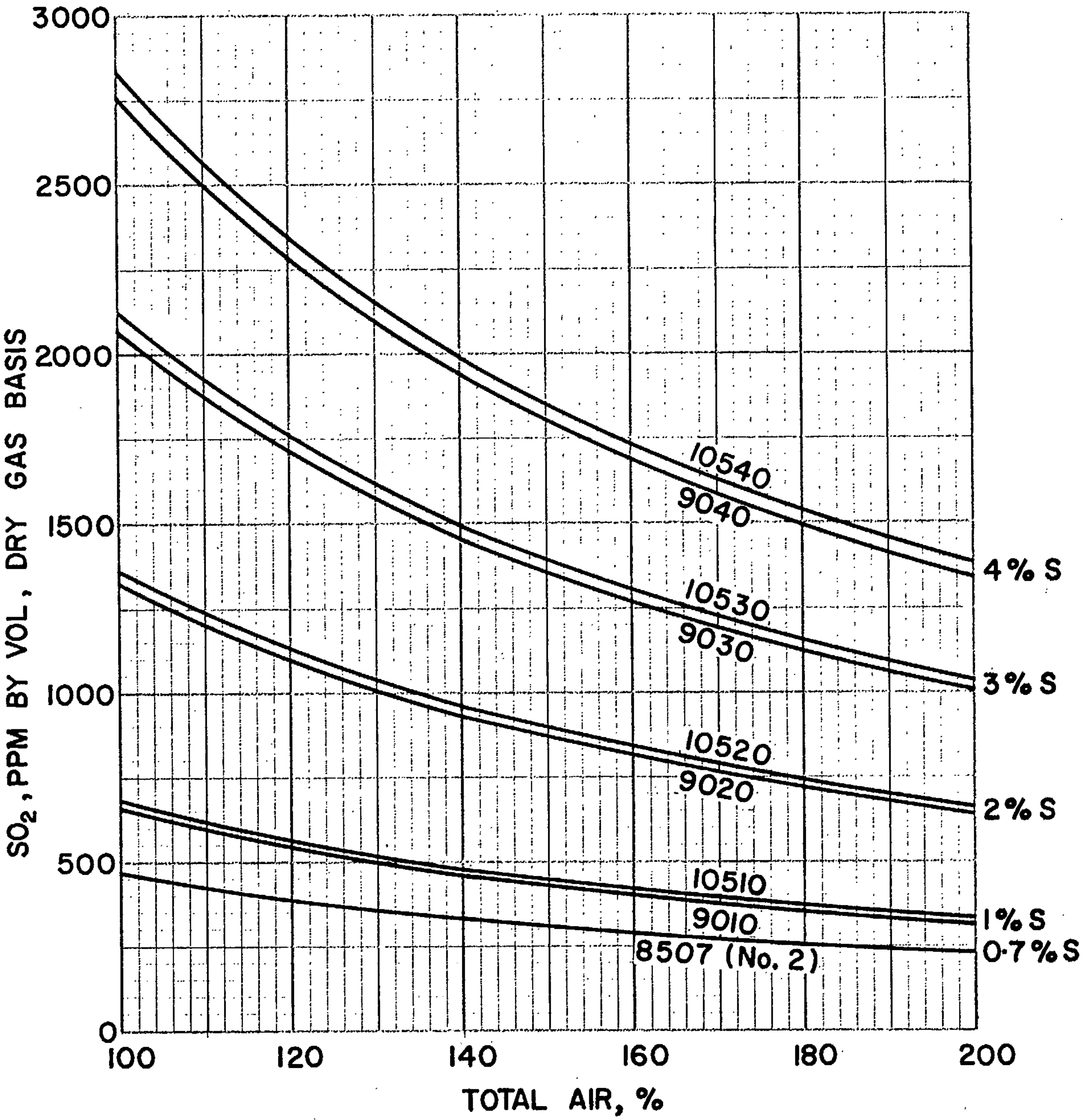


FIGURE D THEORETICAL MAXIMUM SO_2 CONCENTRATIONS FOR A RANGE OF TOTAL AIR AND SULPHUR CONTENT OF OIL.

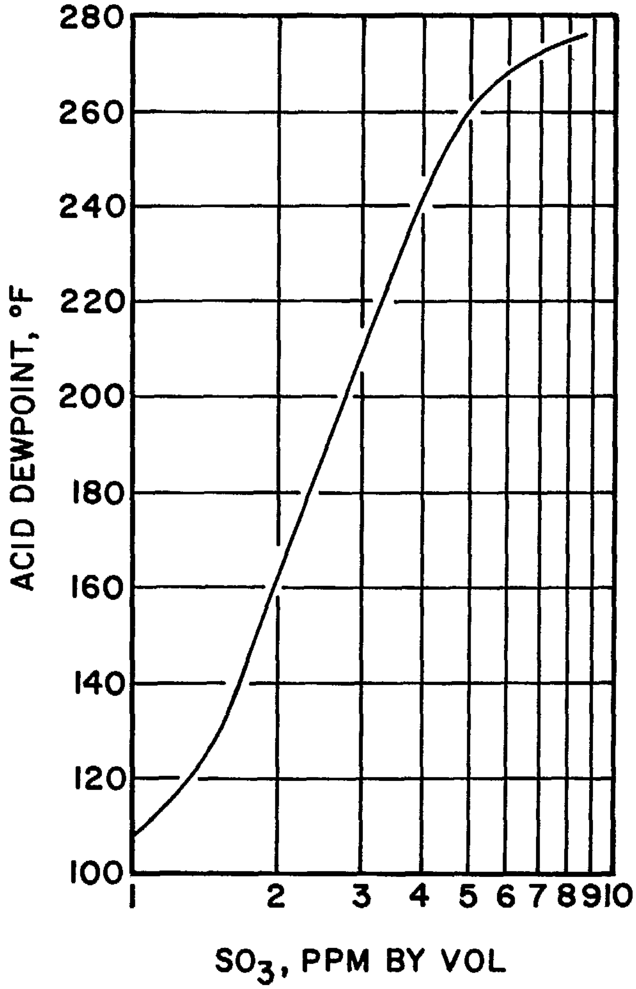
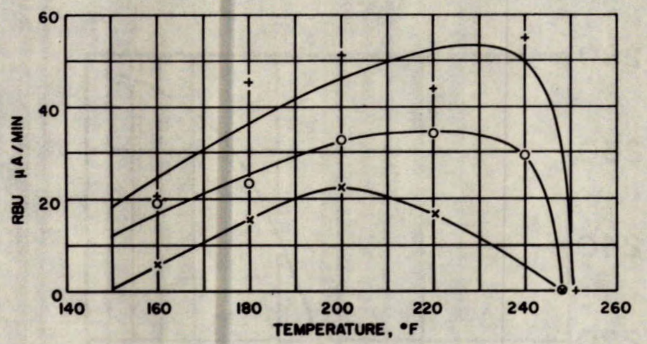


FIGURE E. A CORRELATION OF ACID DEWPOINT WITH SO_3 CONCENTRATION FOR RESIDUAL FUEL OIL BURNED IN A PILOT-SCALE BOILER USING AN AIR-ATOMIZING NOZZLE.



+ 5 % O_2 BY VOLUME
o 4 % O_2 BY VOLUME
× 3 % O_2 BY VOLUME

FIGURE F. TYPICAL RATE OF ACID BUILDUP CURVES FOR RESIDUAL FUEL OIL.

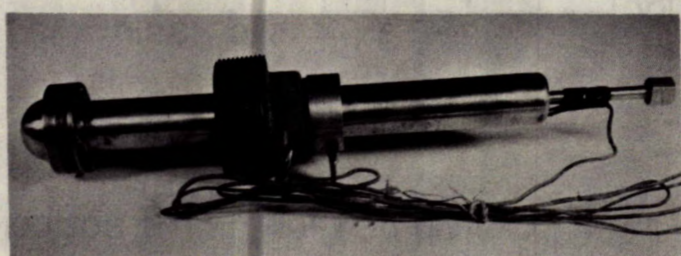


FIGURE G AN AIR—COOLED CORROSION PROBE.

COMBUSTION AND HEAT LOSS DATA

FUEL OIL 8507, SPECIFIC GRAVITY 0.850 (NO. 2 FUEL OIL)

Ultimate Analysis, lb/lb

Carbon	(C)	0.8600
Hydrogen	(H_2)	0.1330
Sulphur	(S)	0.0070
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		19,590

Conversion Factors

1 Imp gal oil = 8.500 lb oil
or Imp gal oil X 8.500 = lb oil
or lb oil X 0.1176 = Imp gal oil

1 U.S. gal oil = 8.500 X 0.8337 lb oil
or U.S. gal oil X 7.086 = lb oil
or lb oil X 0.1411 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal X 0.8327 = Imp gal
or Imp gal X 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{19{,}590} \text{ lb oil}$$

or Btu X 10^6 X 51.05 = lb oil
or lb oil X 0.0196 = Btu X 10^6

$$10^6 \text{ Btu} = \frac{10^6}{19{,}590 \times 8.500} \text{ Imp gal oil}$$

or Btu X 10^6 X 6.006 = Imp gal oil
or Imp gal oil X 0.1665 = Btu X 10^6

$$10^6 \text{ Btu} = \frac{10^6}{19{,}590 \times 7.086} \text{ U.S. gal oil}$$

or Btu X 10^6 X 7.205 = U.S. gal oil
or U.S. gal oil X 0.1388 = Btu X 10^6

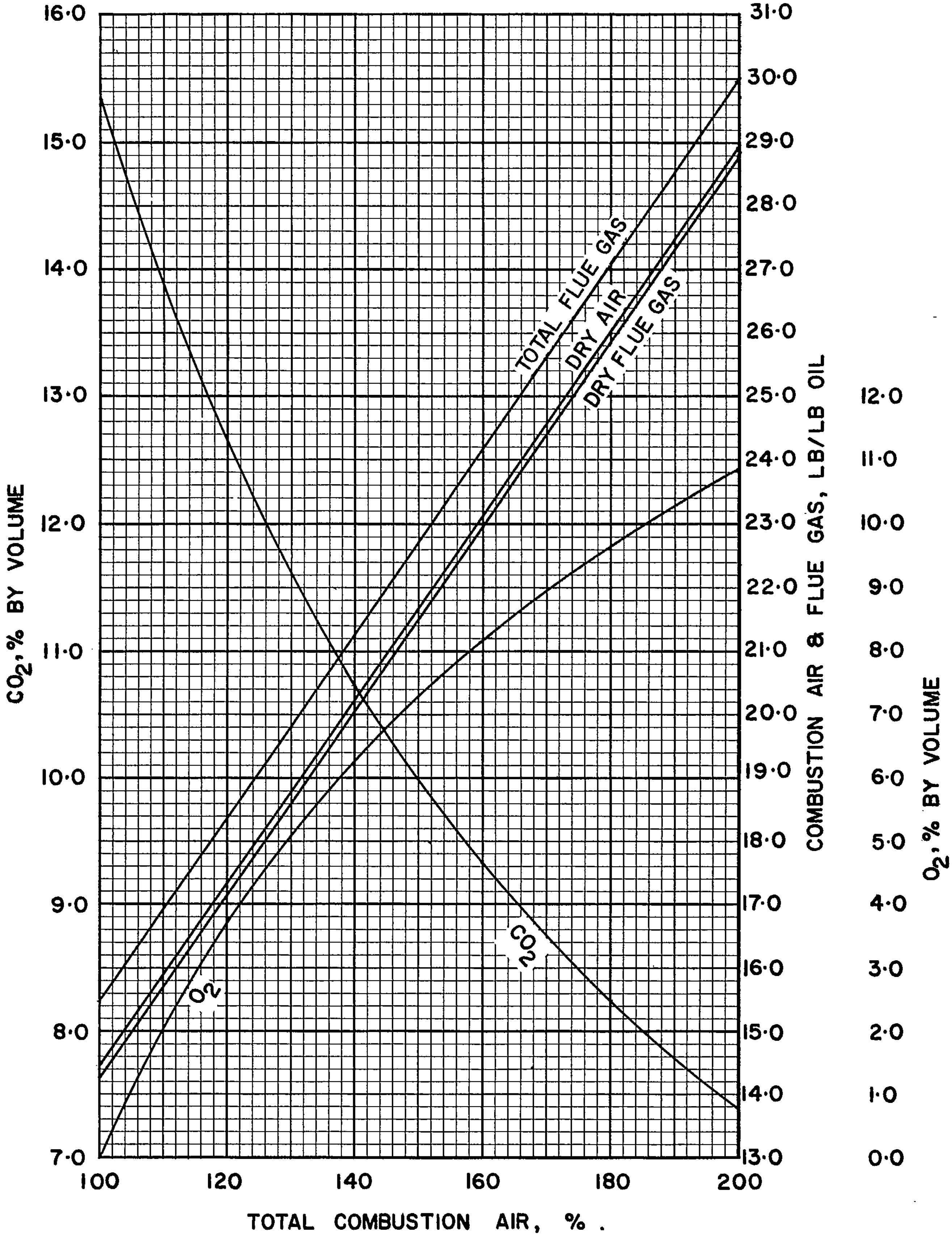


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS.
(NO· 2 FUEL OIL) 8507

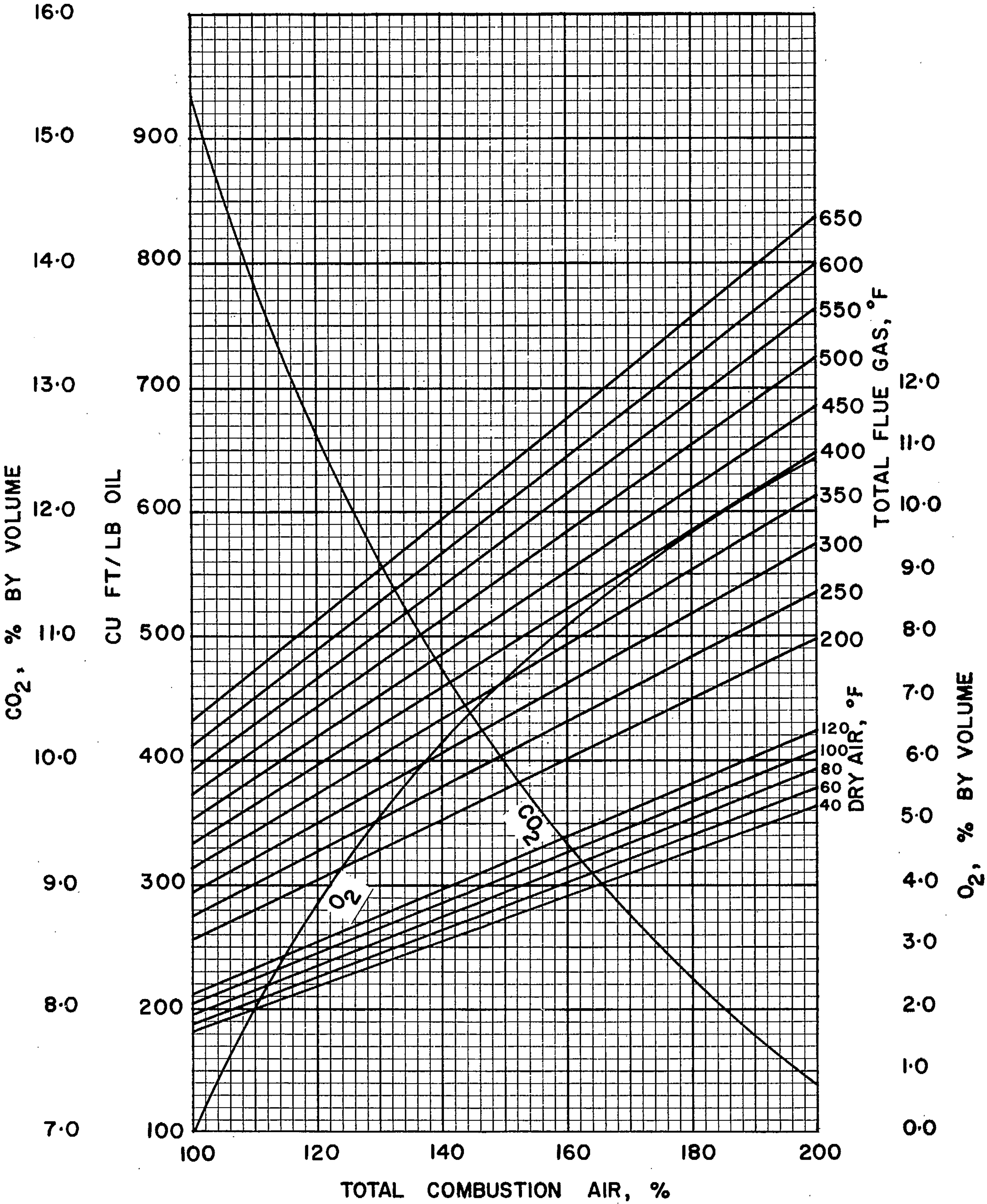


FIGURE 2. COMBUSTION DATA, VOLUME BASIS.
(NO. 2 FUEL OIL)

8507

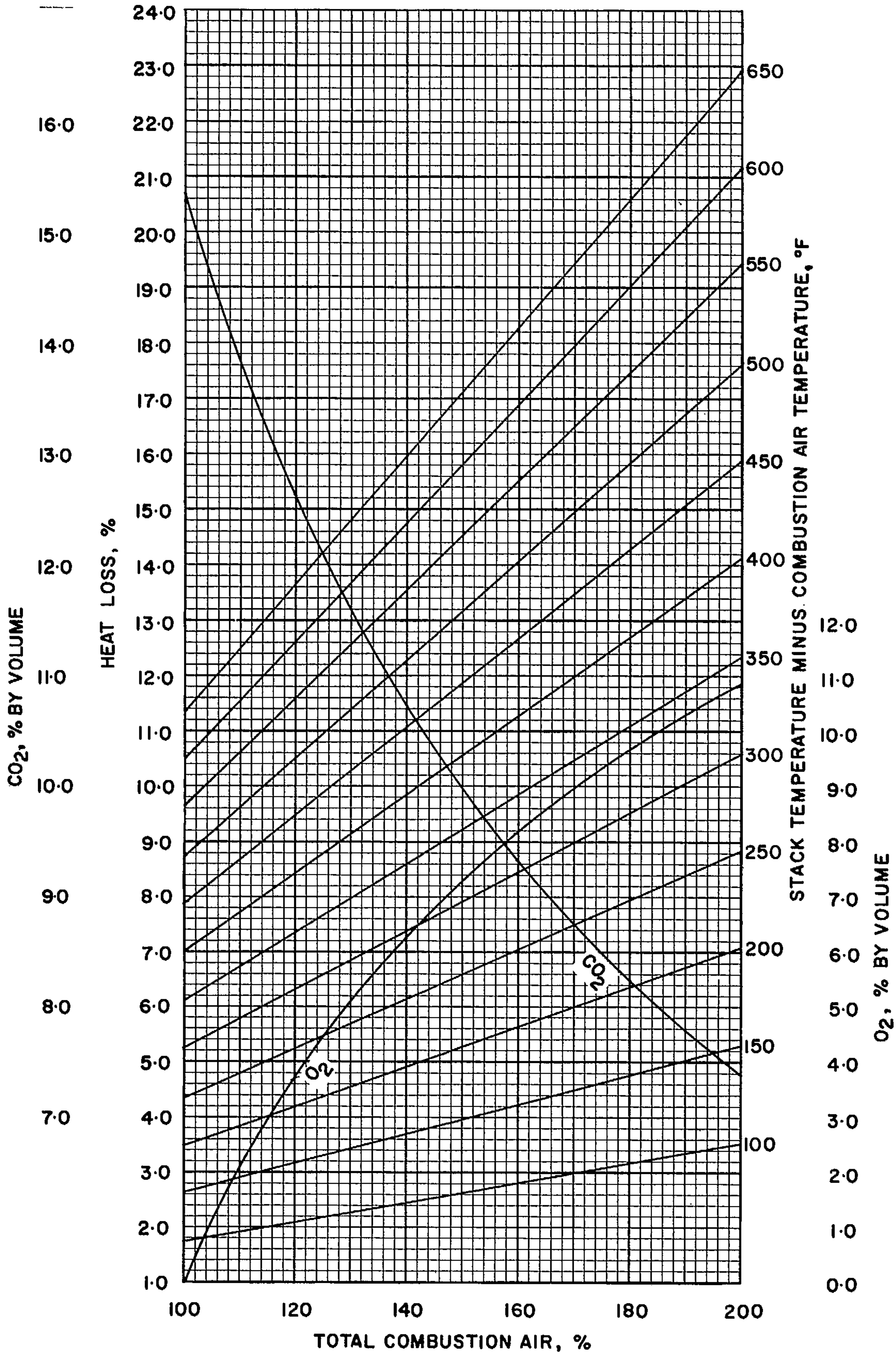


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS. (NO· 2 FUEL OIL)

8507

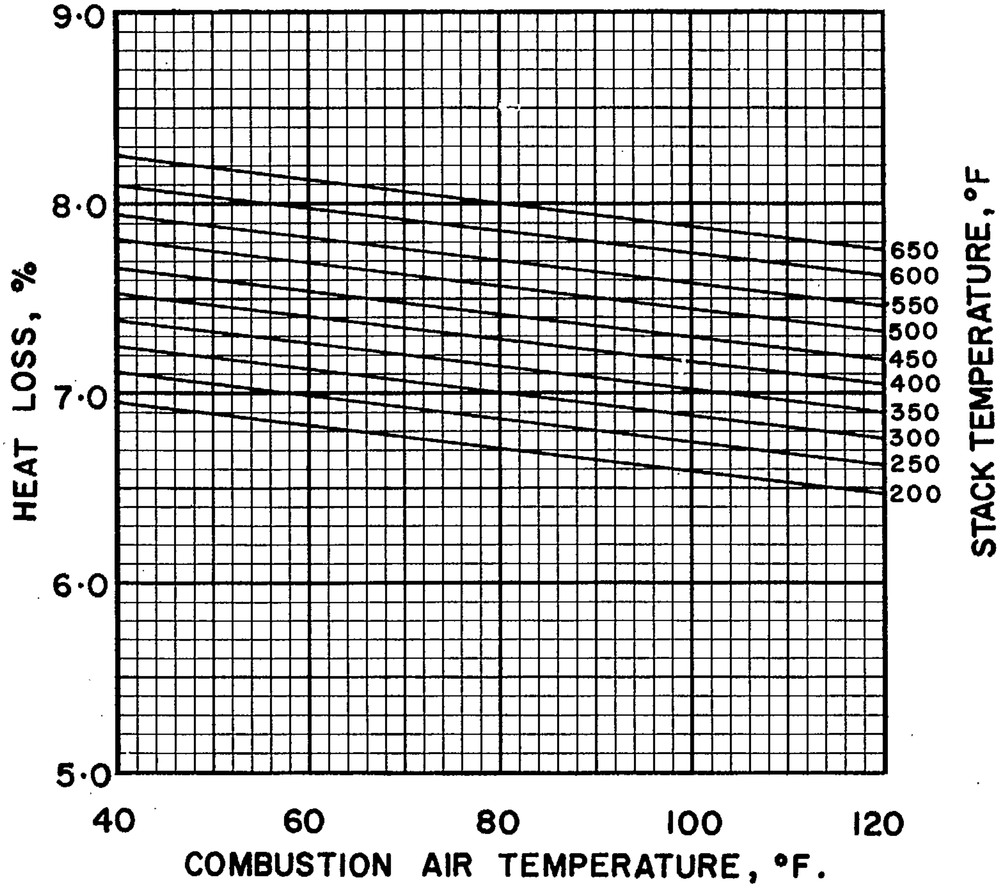


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES. (NO. 2 FUEL OIL) 8507

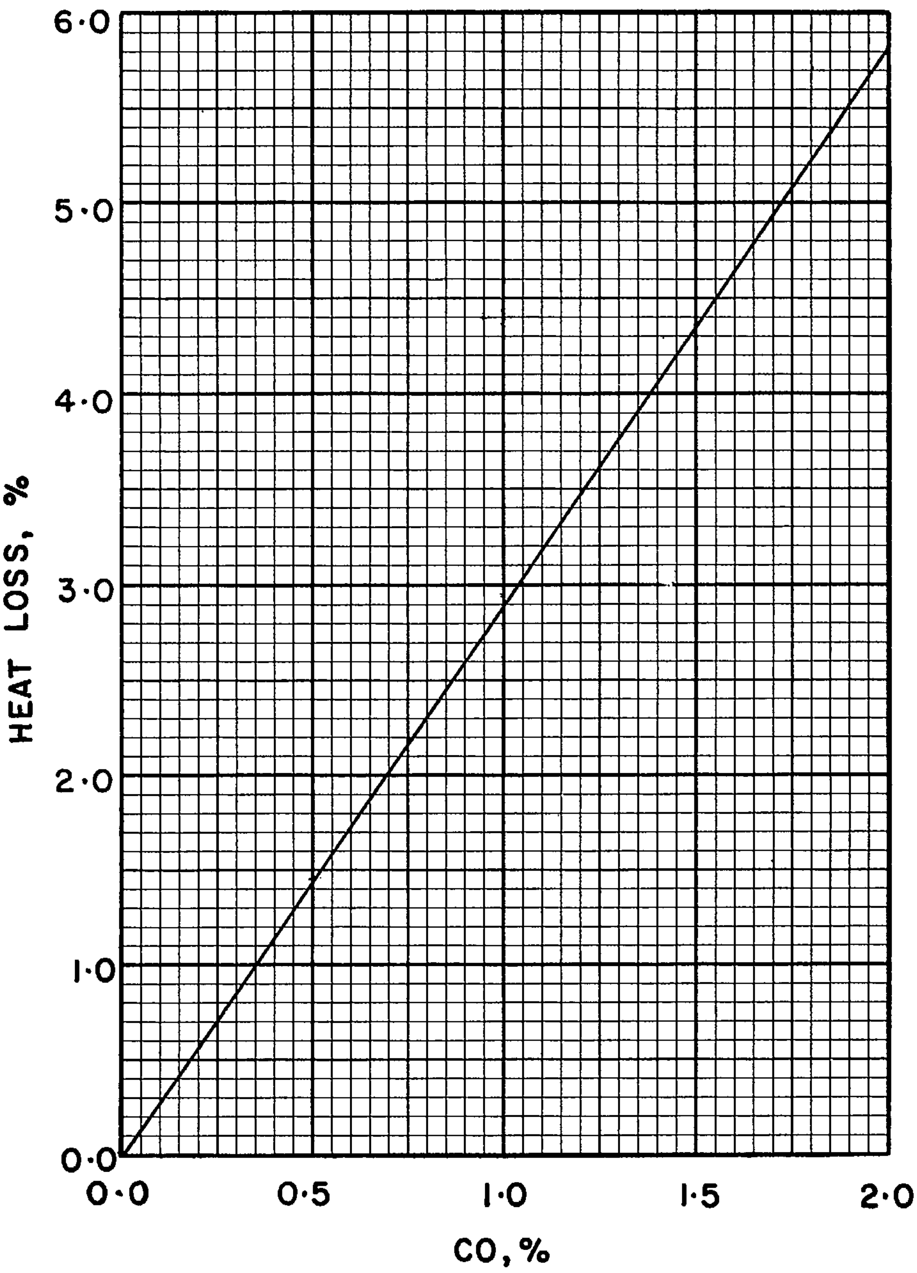


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR. (NO. 2 FUEL OIL)

8507

FUEL OIL 9000, SPECIFIC GRAVITY 0.900

Ultimate Analysis, lb/lb

Carbon	(C)	0.8750
Hydrogen	(H_2)	0.1250
Sulphur	(S)	0.0000
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		19,260

Conversion Factors

1 Imp gal oil = 9.00 lb oil
or Imp gal oil × 9.00 = lb oil
or lb oil × 0.1111 = Imp gal oil

1 U.S. gal oil = 9.00 × 0.8337 lb oil
or U.S. gal oil × 7.503 = lb oil
or lb oil × 0.1333 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{19{,}260} \text{ lb oil}$$

or Btu × 10^6 × 51.92 = lb oil
or lb oil × 0.0193 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{19{,}260 \times 9} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.769 = Imp gal oil
or Imp gal oil × 0.1733 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{19{,}260 \times 7.503} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.920 = U.S. gal oil
or U.S. gal oil × 0.1445 = Btu × 10^6

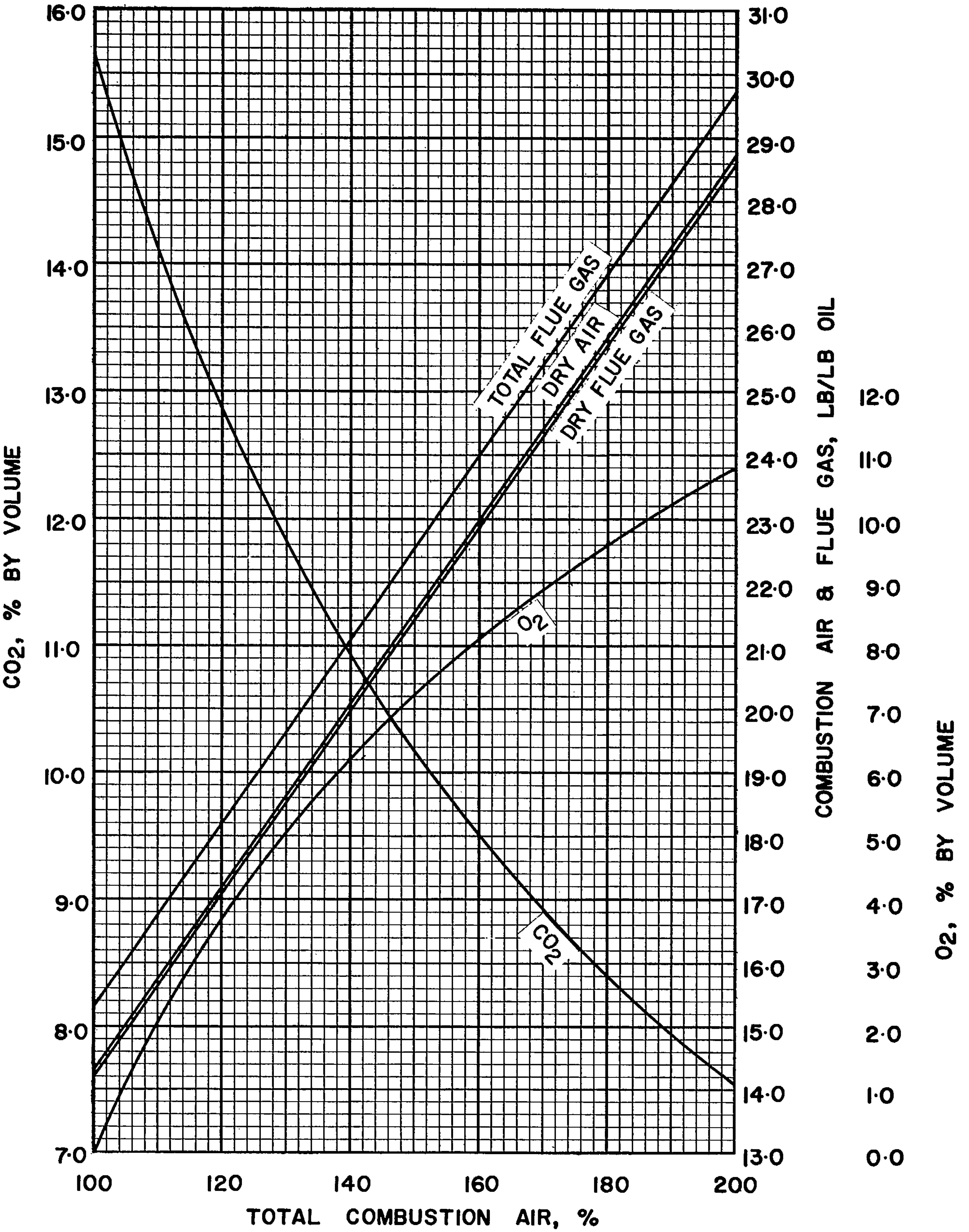


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS 9000

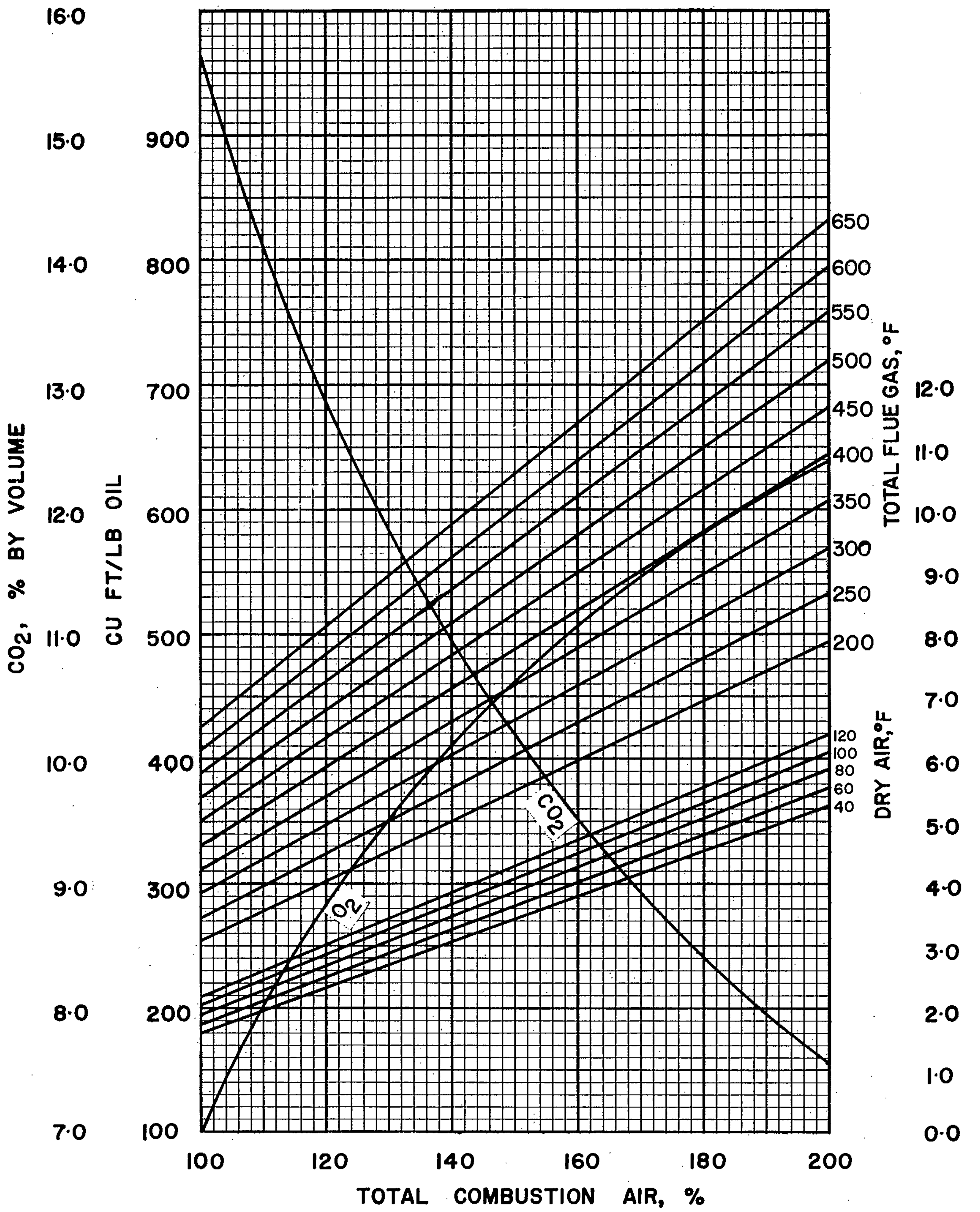


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 9000

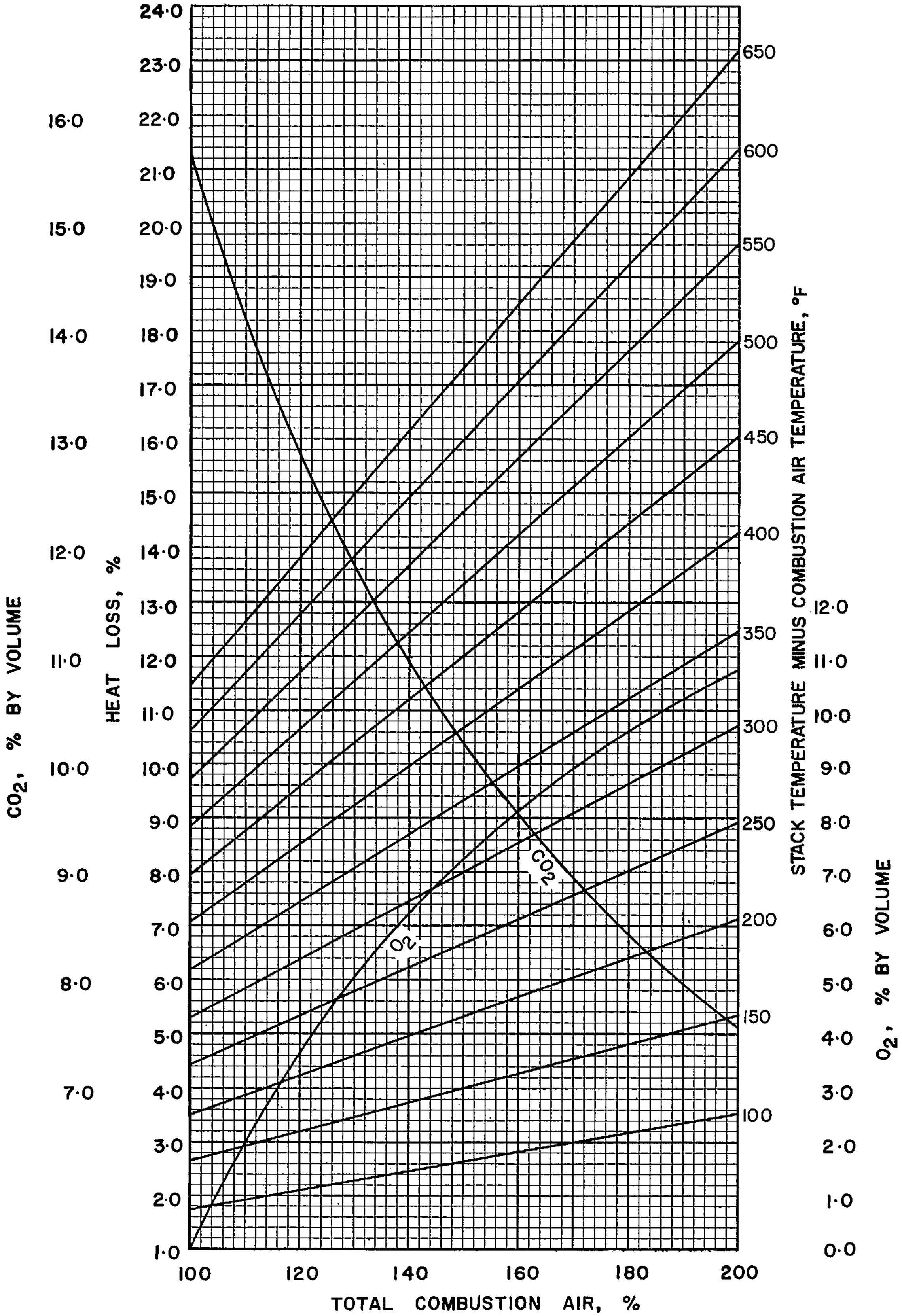


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

9000

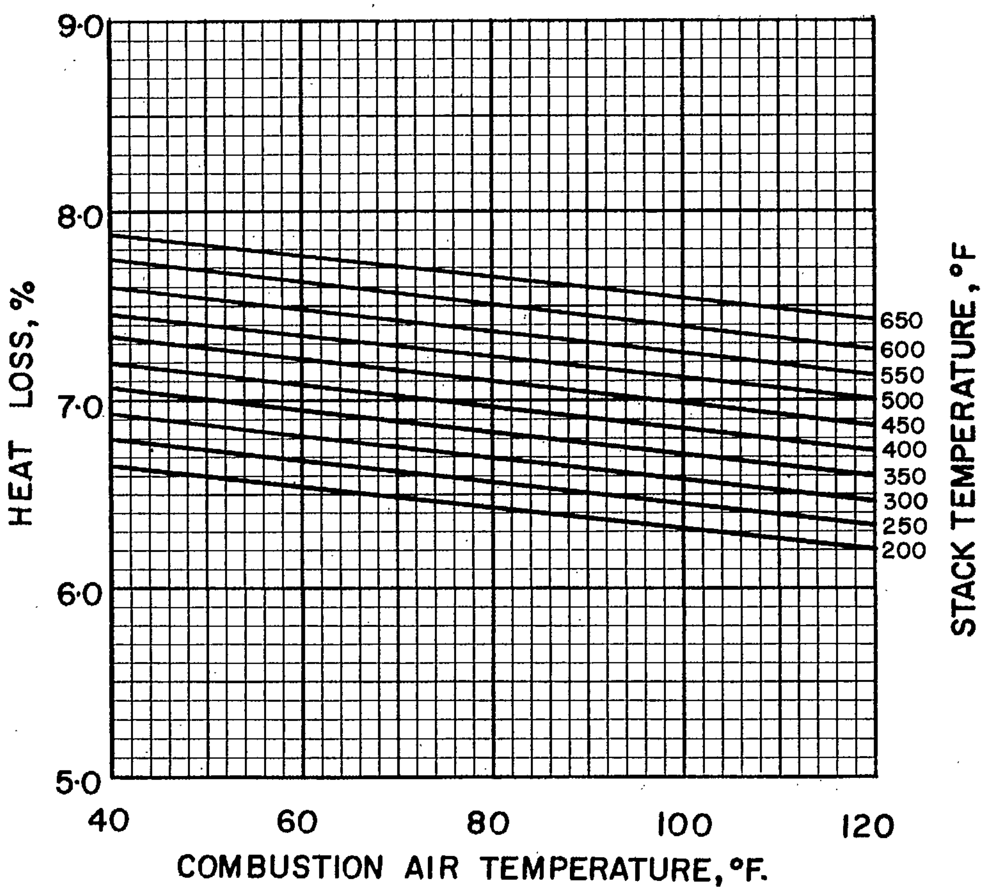


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

9000

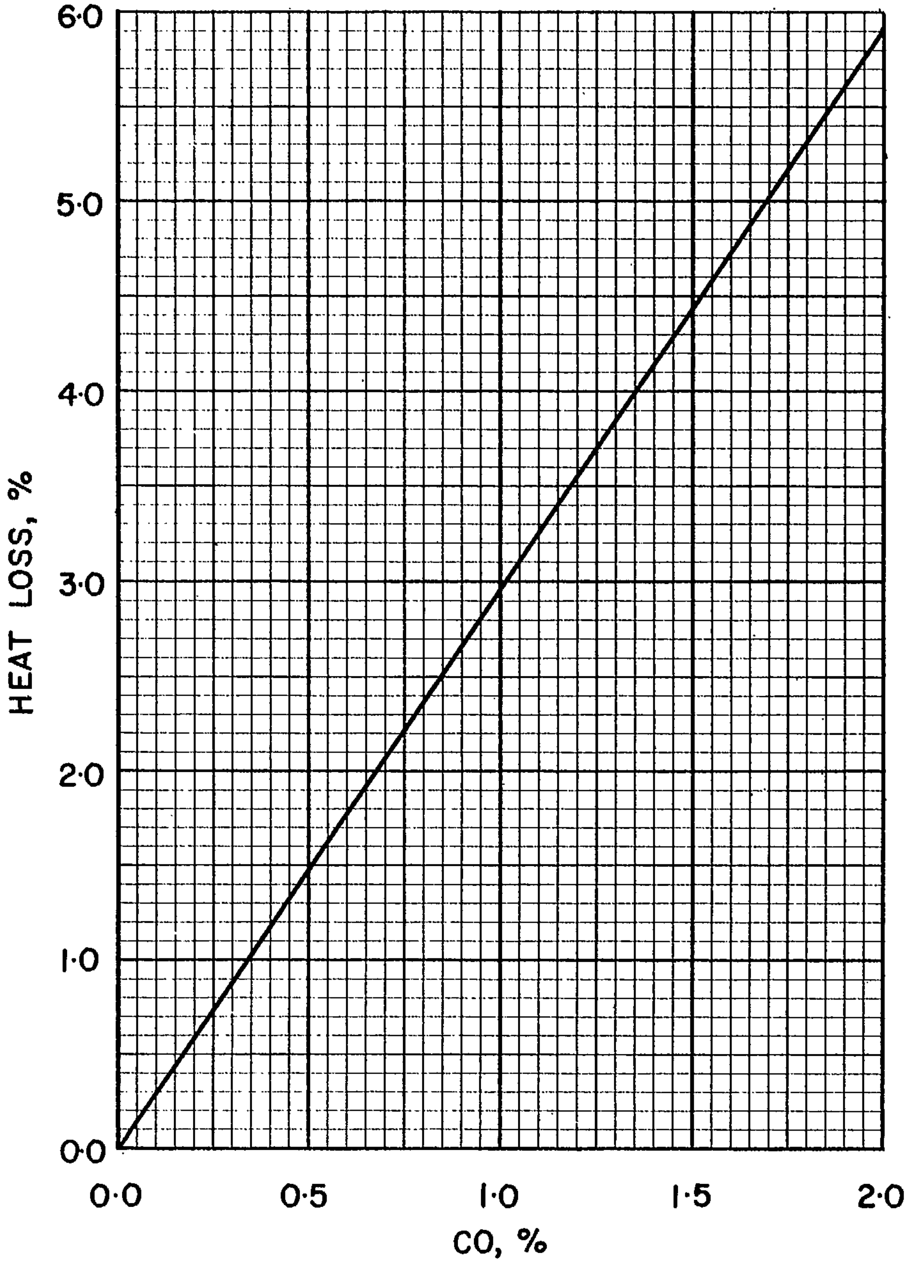


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

9000

FUEL OIL 9010, SPECIFIC GRAVITY 0.900

Ultimate Analysis, lb/lb

Carbon	(C)	0.8662
Hydrogen	(H_2)	0.1238
Sulphur	(S)	0.0100
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		19,100

Conversion Factors

1 Imp gal oil = 9.00 lb oil
or Imp gal oil × 9.00 = lb oil
or lb oil × 0.1111 = Imp gal oil

1 U.S. gal oil = 9.00 × 0.8337 lb oil
or U.S. gal oil × 7.503 = lb oil
or lb oil × 0.1333 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{19{,}100} \text{ lb oil}$$

or Btu × 10^6 × 52.36 = lb oil
or lb oil × 0.0191 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{19{,}100 \times 9} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.817 = Imp gal oil
or Imp gal oil × 0.1719 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{19{,}100 \times 7.503} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.978 = U.S. gal oil
or U.S. gal oil × 0.1433 = Btu × 10^6

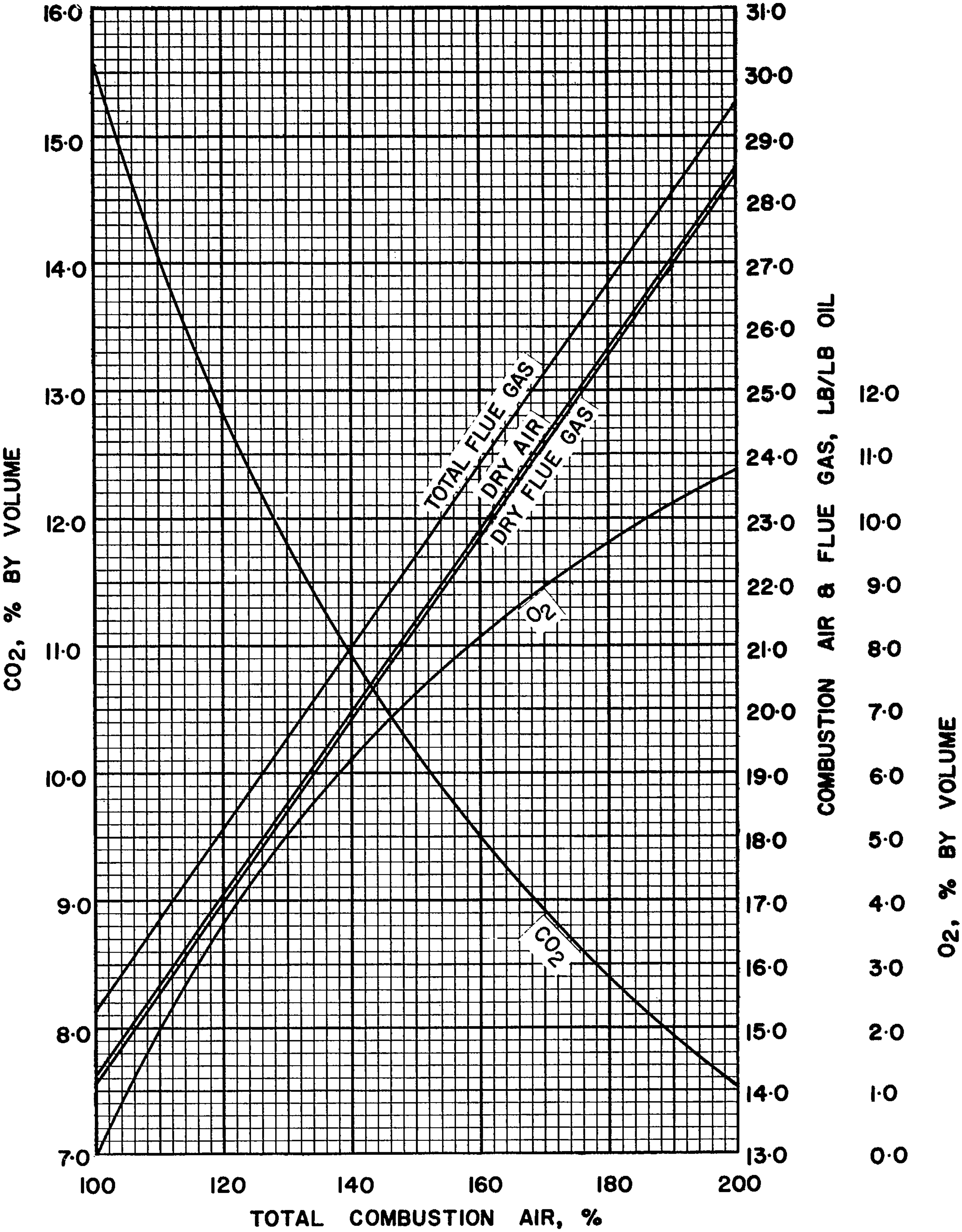


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS

9010

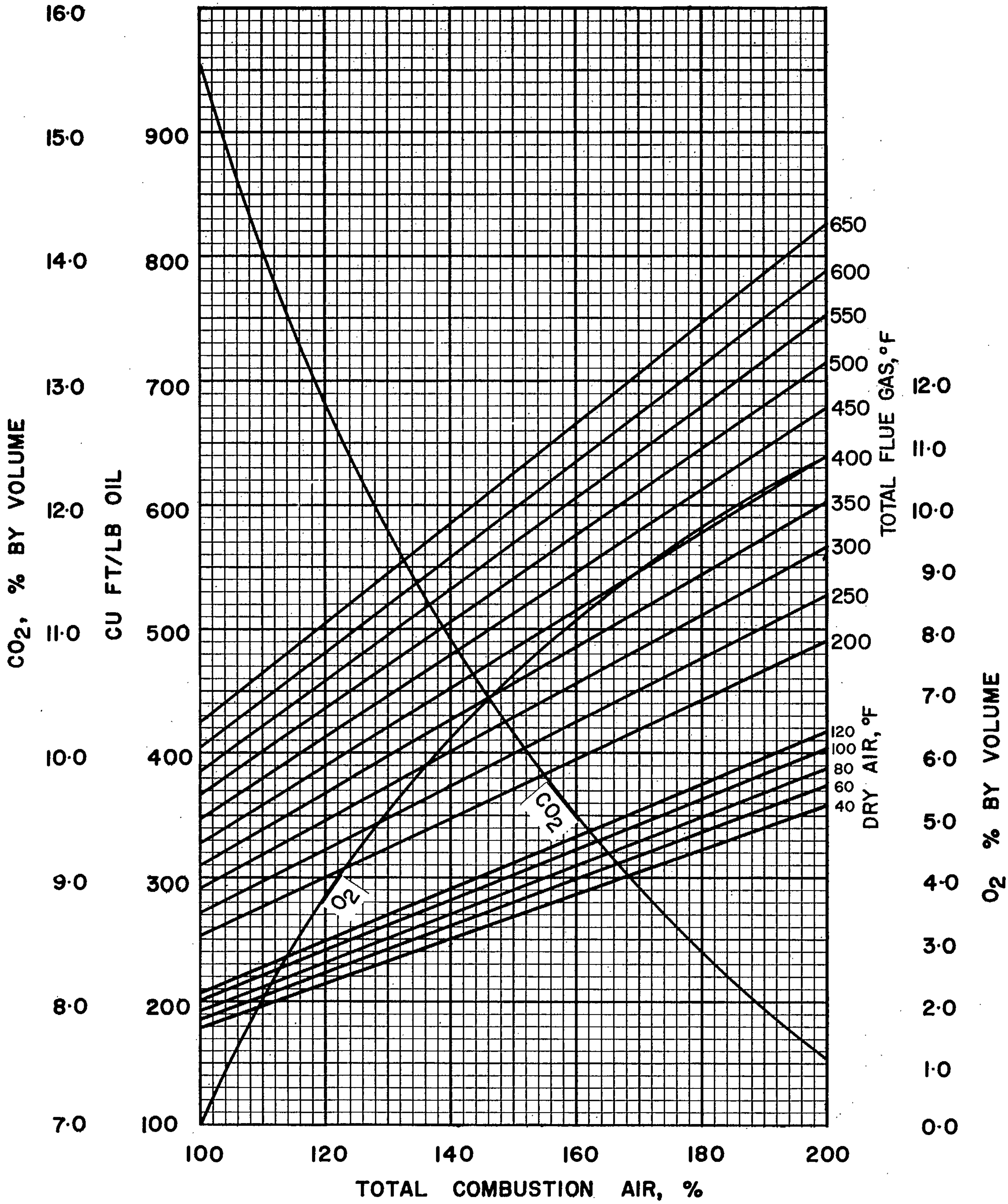


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 9010

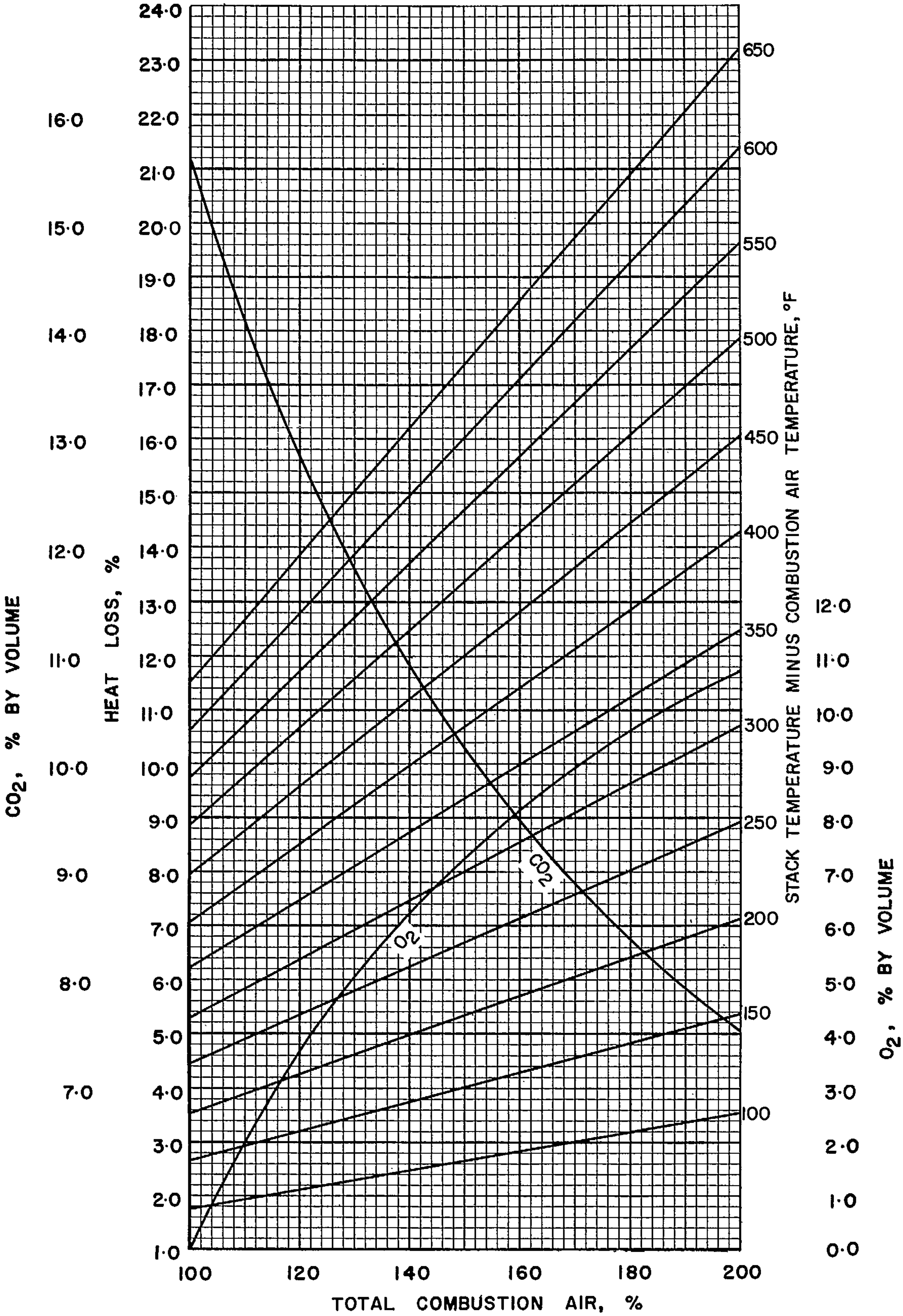


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

9010

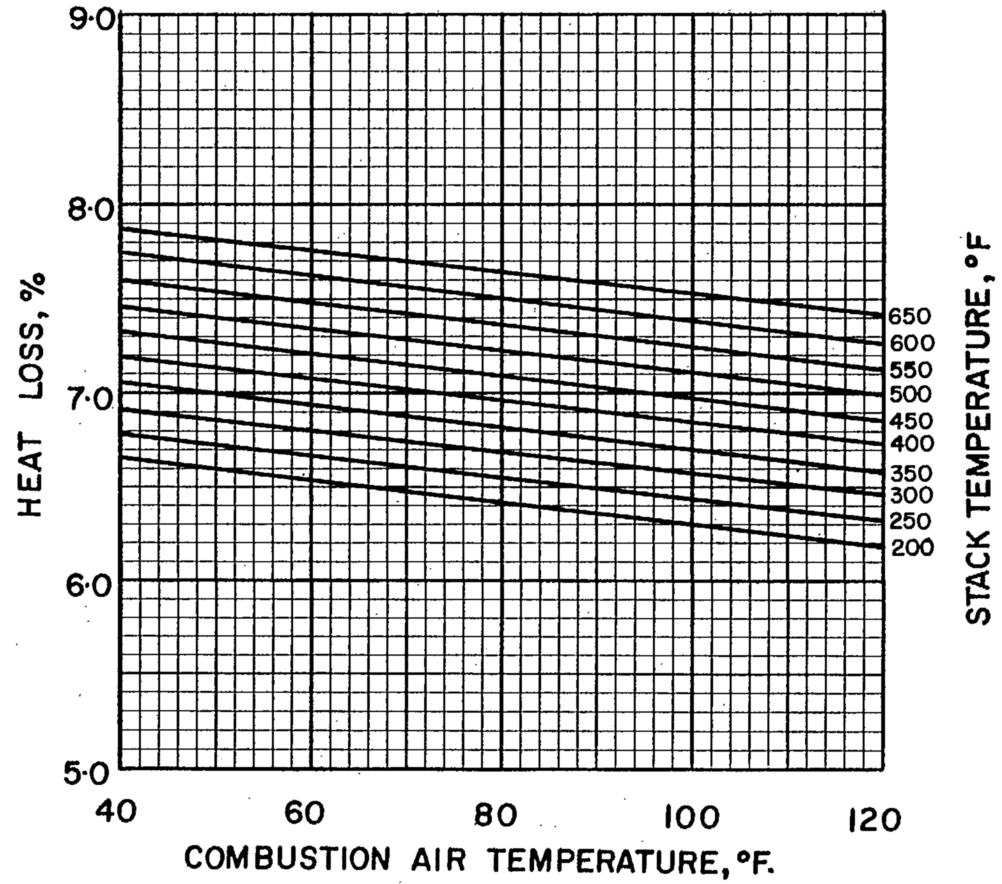


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

9010

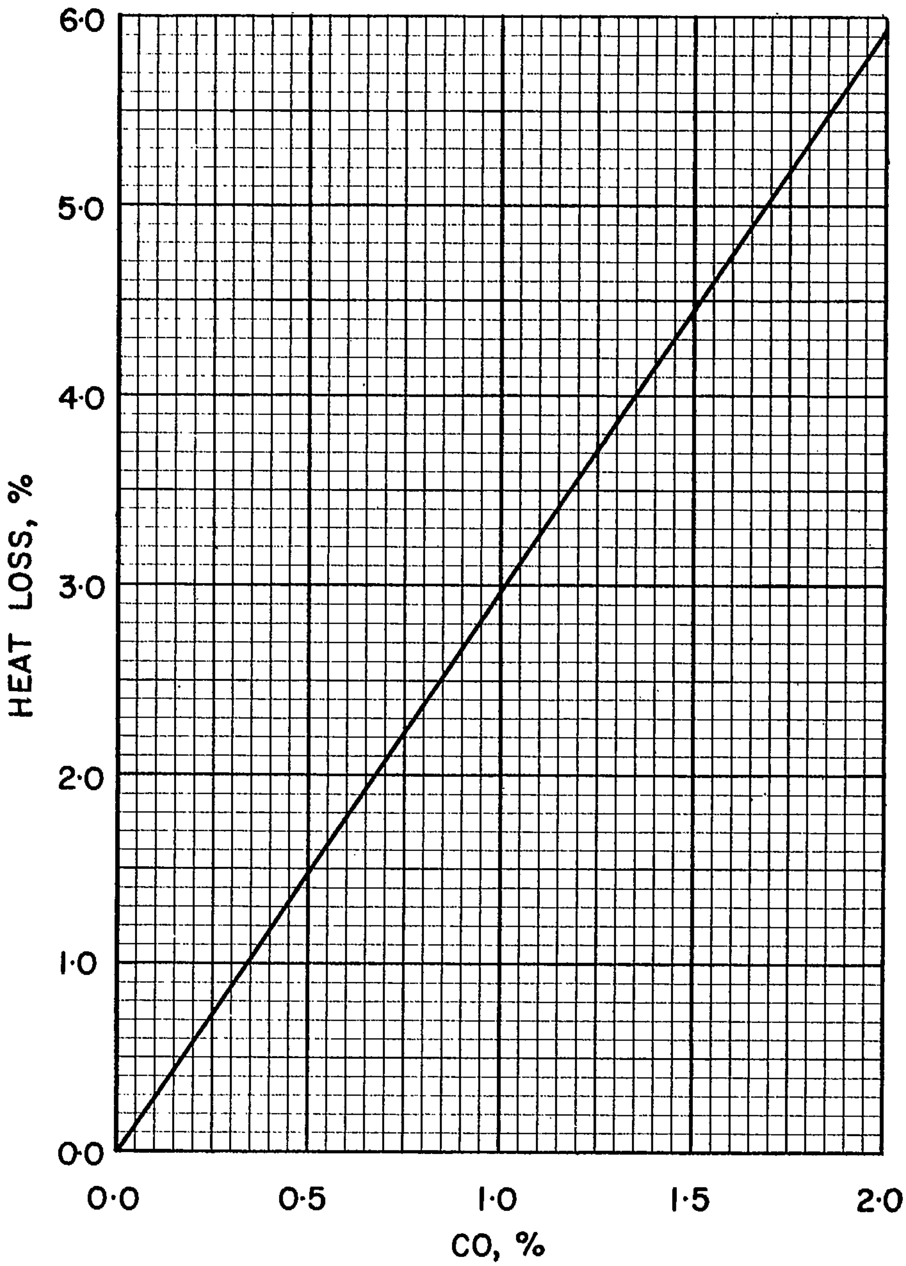


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

9010

FUEL OIL 9020, SPECIFIC GRAVITY 0.900

Ultimate Analysis, lb/lb

Carbon	(C)	0.8575
Hydrogen	(H_2)	0.1225
Sulphur	(S)	0.0200
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,950

Conversion Factors

1 Imp gal oil = 9.00 lb oil
or Imp gal oil × 9.00 = lb oil
or lb oil × 0.1111 = Imp gal oil

1 U.S. gal oil = 9.00 × 0.8337 lb oil
or U.S. gal oil × 7.503 = lb oil
or lb oil × 0.1333 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}950} \text{ lb oil}$$

or Btu × 10^6 × 52.77 = lb oil
or lb oil × 0.0190 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}950 \times 9} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.863 = Imp gal oil
or Imp gal oil × 0.1706 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}950 \times 7.503} \text{ U.S. gal oil}$$

or Btu × 10^6 × 7.032 = U.S. gal oil
or U.S. gal oil × 0.1422 = Btu × 10^6

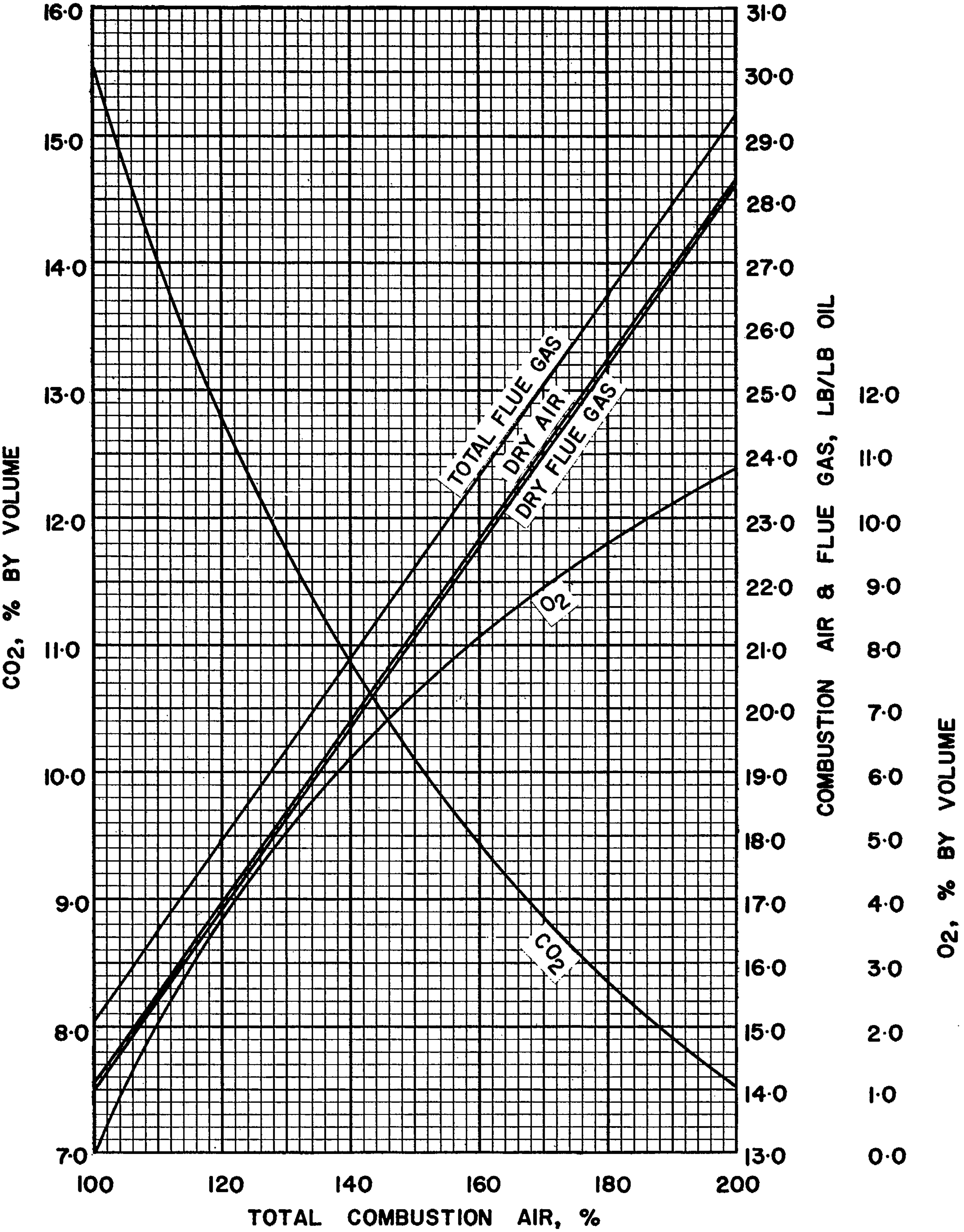


FIGURE I· COMBUSTION DATA, WEIGHT BASIS 9020

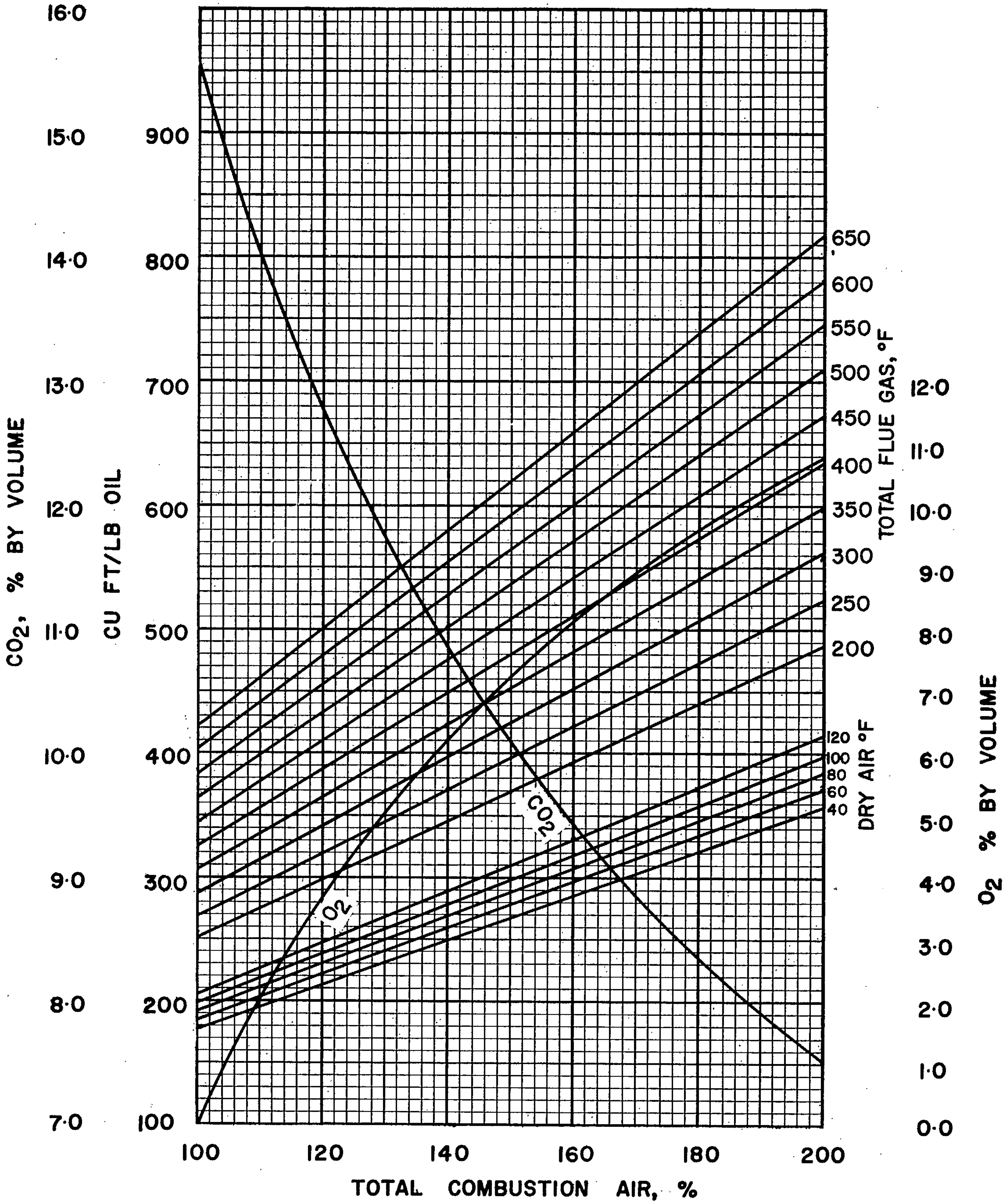


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 9020

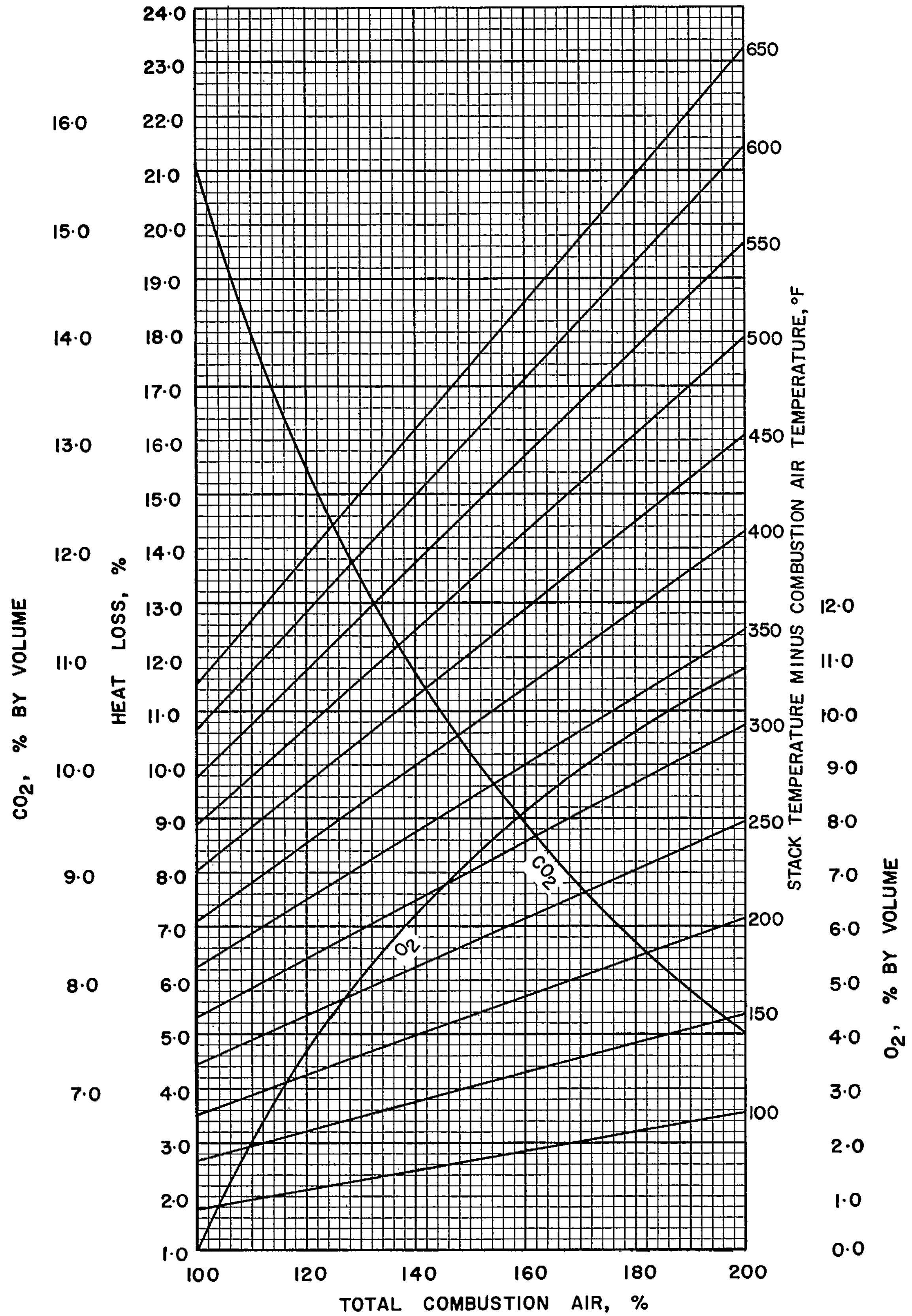


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS 9020

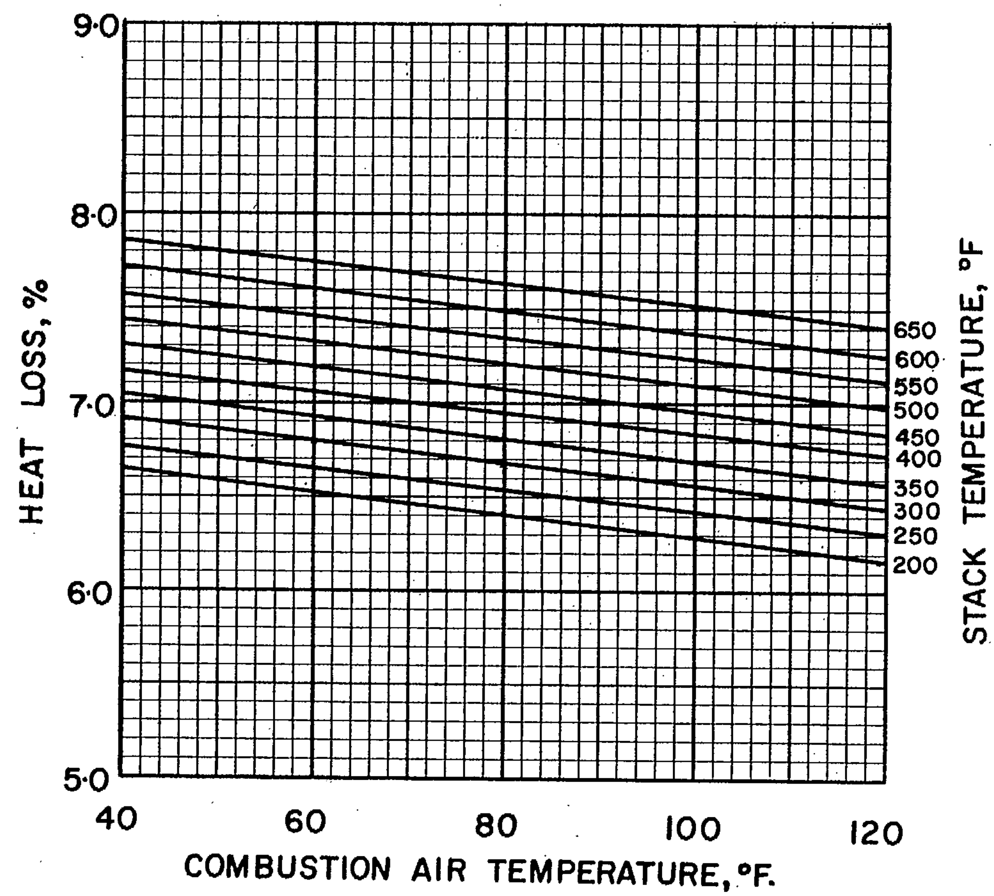


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

9020

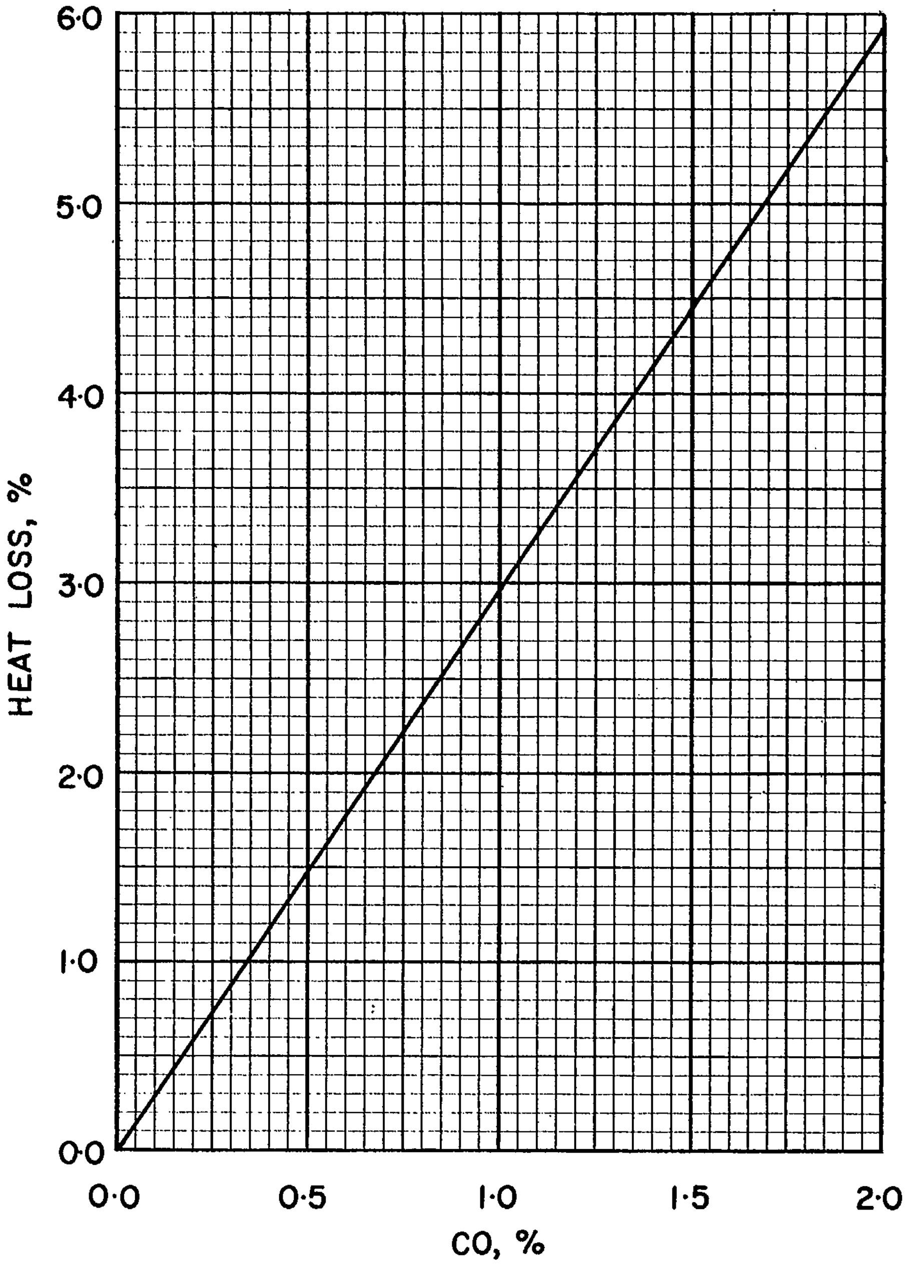


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

9020

FUEL OIL 9030, SPECIFIC GRAVITY 0.900

Ultimate Analysis, lb/lb

Carbon	(C)	0.8488
Hydrogen	(H_2)	0.1212
Sulphur	(S)	0.0300
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,800

Conversion Factors

1 Imp gal oil = 9.00 lb oil
or Imp gal oil × 9.00 = lb oil
or lb oil × 0.1111 = Imp gal oil

1 U.S. gal oil = 9.00 × 0.8337 lb oil
or U.S. gal oil × 7.503 = lb oil
or lb oil × 0.1333 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8321 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}800} \text{ lb oil}$$

or Btu × 10^6 × 53.19 = lb oil
or lb oil × 0.0188 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}800 \times 9.00} \text{ Imp gal oil}$$

of Btu × 10^6 × 5.910 = Imp gal oil
or Imp gal oil × 0.1692 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}800 \times 7.503} \text{ U.S. gal oil}$$

or Btu × 10^6 × 7.090 = U.S. gal oil
or U.S. gal oil × 0.1411 = Btu × 10^6

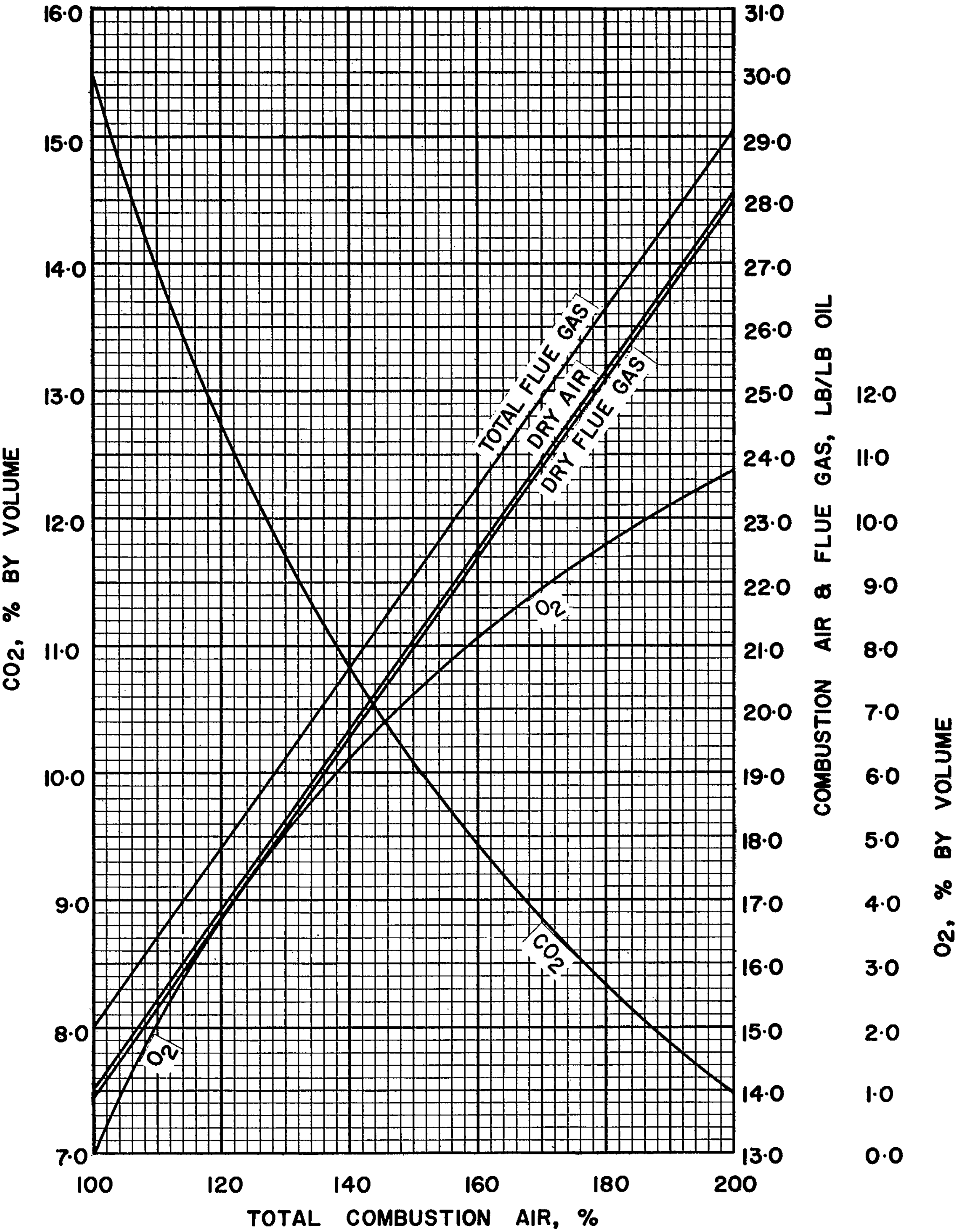


FIGURE I· COMBUSTION DATA, WEIGHT BASIS 9030

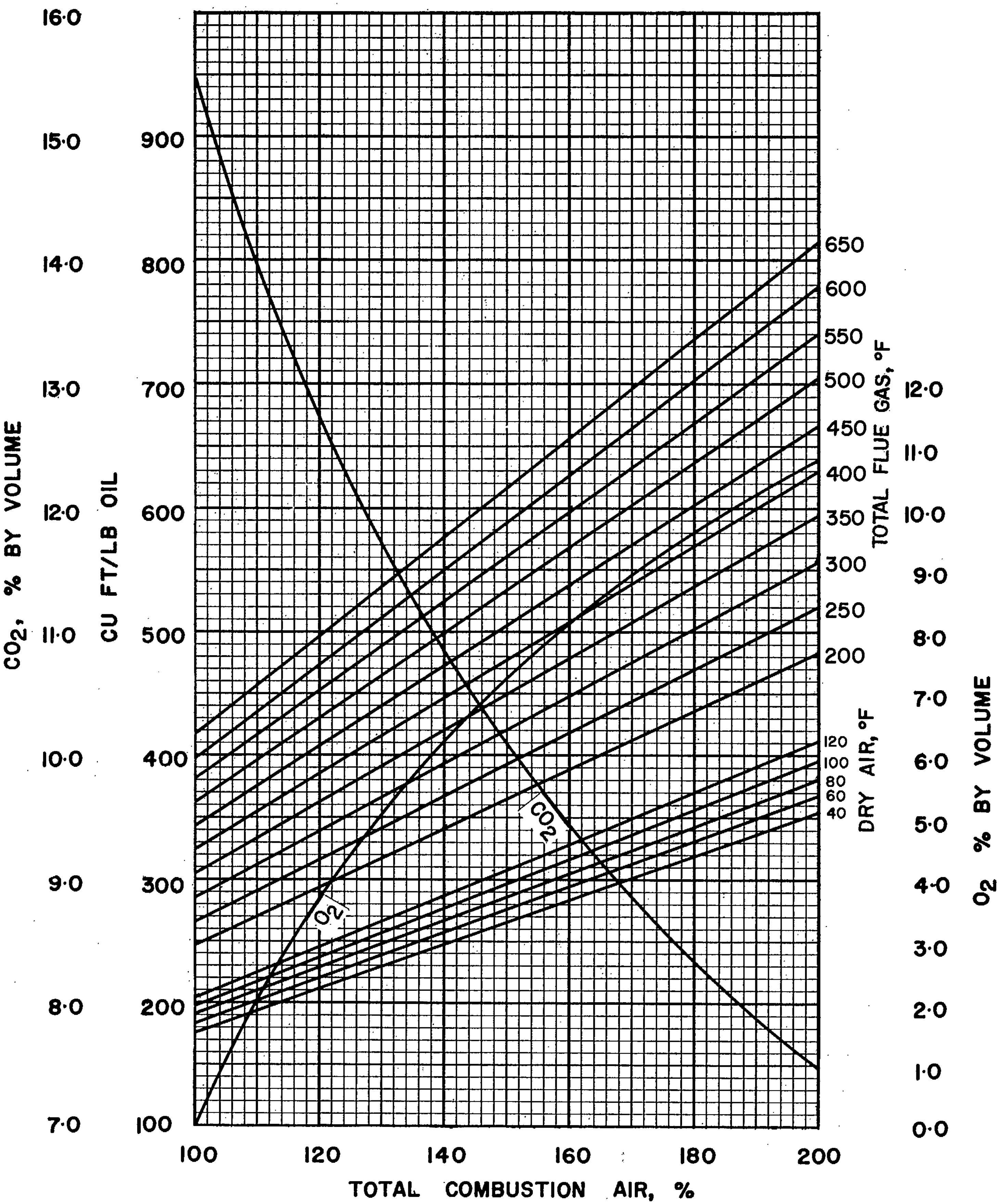


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 9030

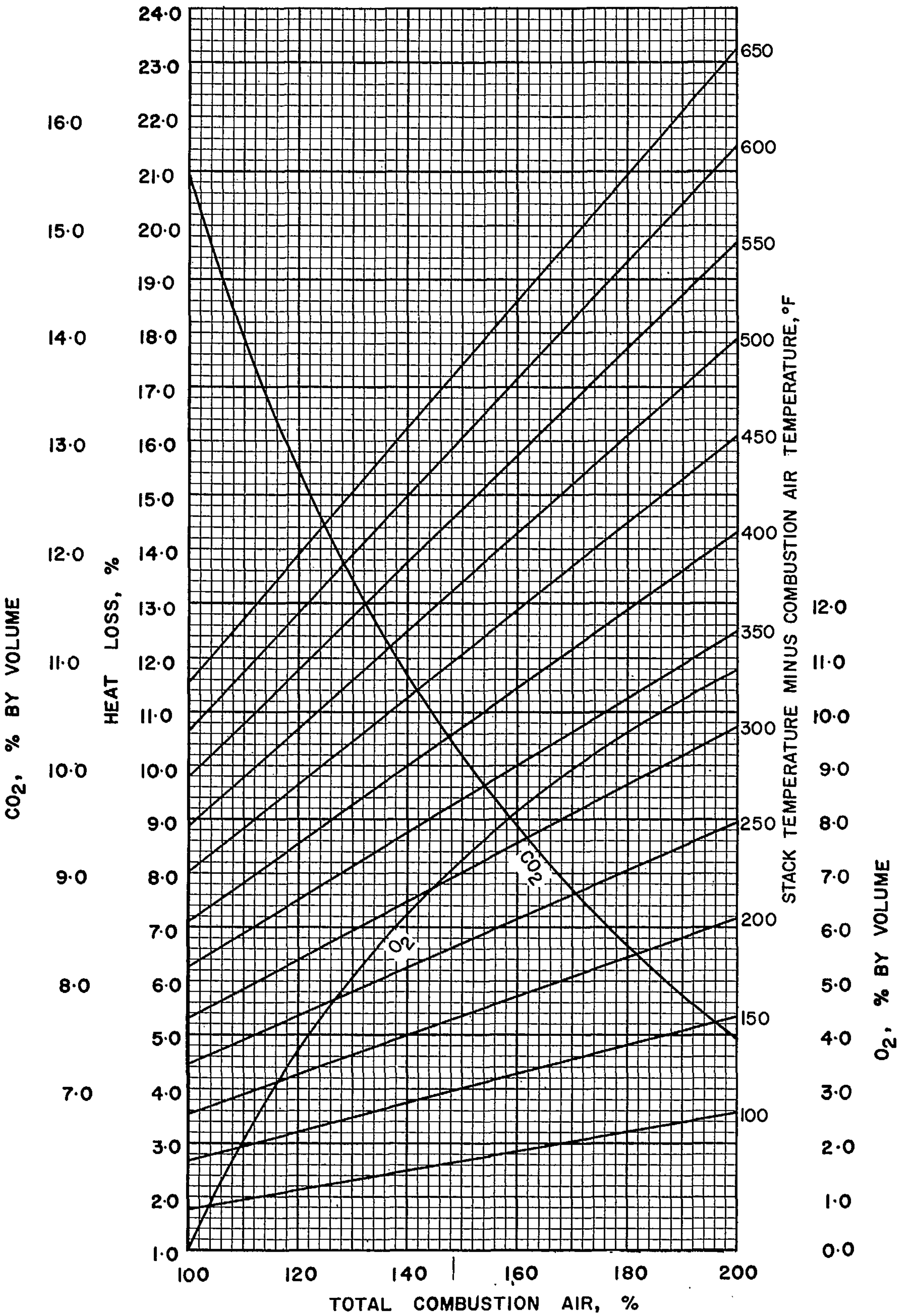


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

9030

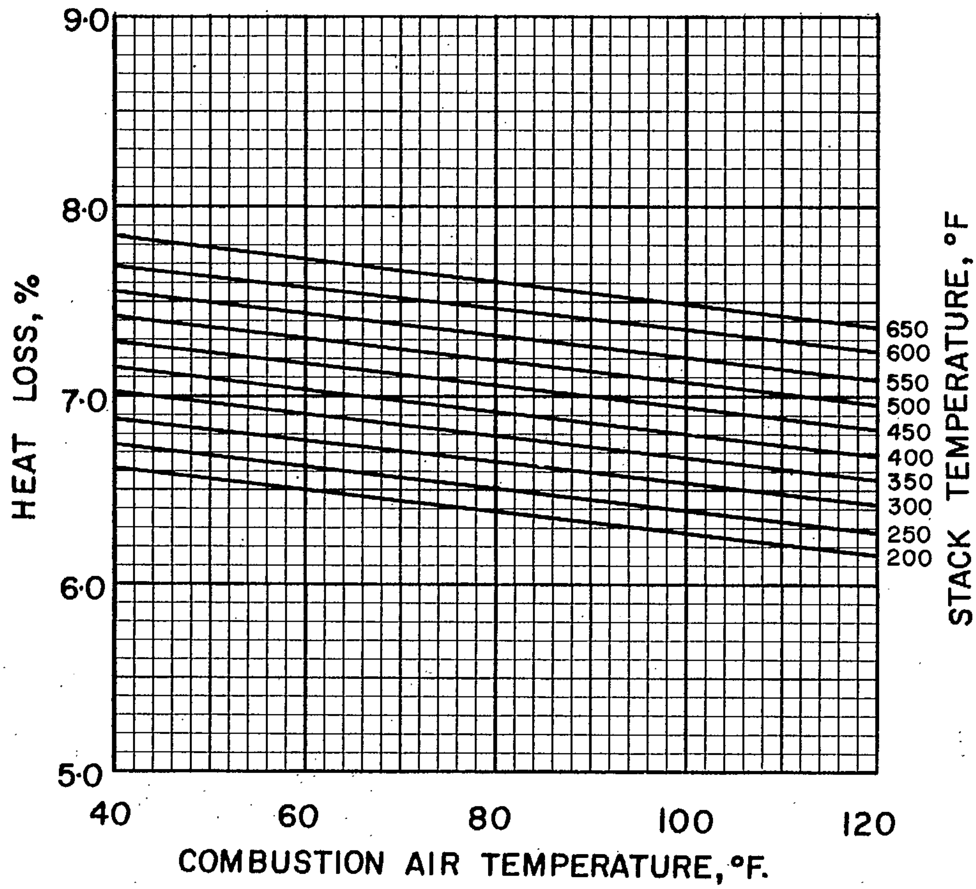


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

9030

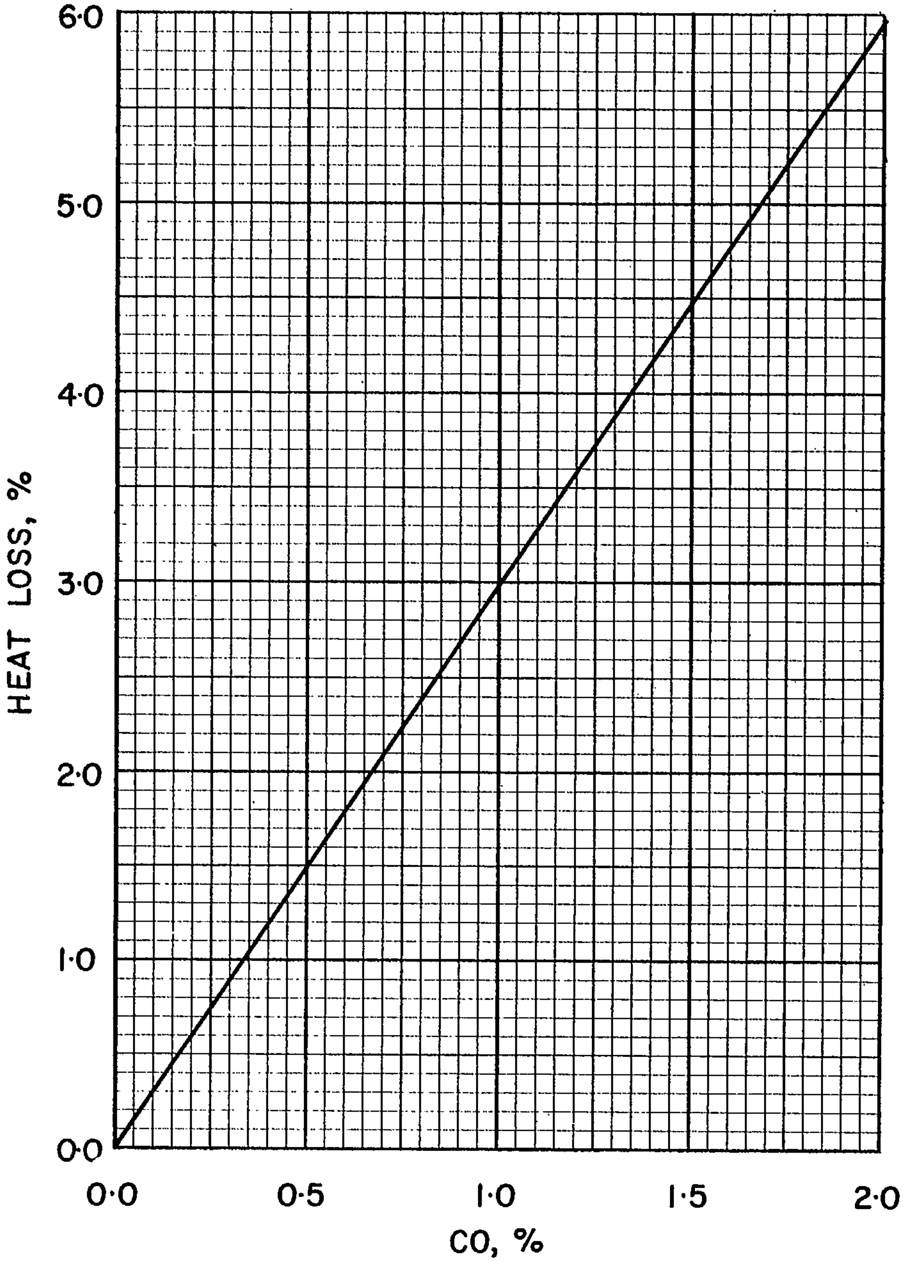


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

9030

FUEL OIL 9040, SPECIFIC GRAVITY 0.900

Ultimate Analysis, lb/lb

Carbon	(C)	0.8400
Hydrogen	(H_2)..............	0.1200
Sulphur	(S)	0.0400
Nitrogen	(N_2)..............	–
Oxygen	(O_2)..............	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,650

Conversion Factors

1 Imp gal oil = 9.00 lb oil
or Imp gal oil × 9.00 = lb oil
or lb oil × 0.1111 = Imp gal oil

1 U.S. gal oil = 9.00 × 0.8337 lb oil
or U.S. gal oil × 7.503 = lb oil
or lb oil × 0.1333 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}650} \text{ lb oil}$$

or Btu × 10^6 × 53.62 = lb oil
or lb oil × 0.0186 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}650 \times 9.00} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.958 = Imp gal oil
or Imp gal oil × 0.1678 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}650 \times 7.503} \text{ U.S. gal oil}$$

or Btu × 10^6 × 7.148 = U.S. gal oil
or U.S. gal oil × 0.1399 = Btu × 10^6

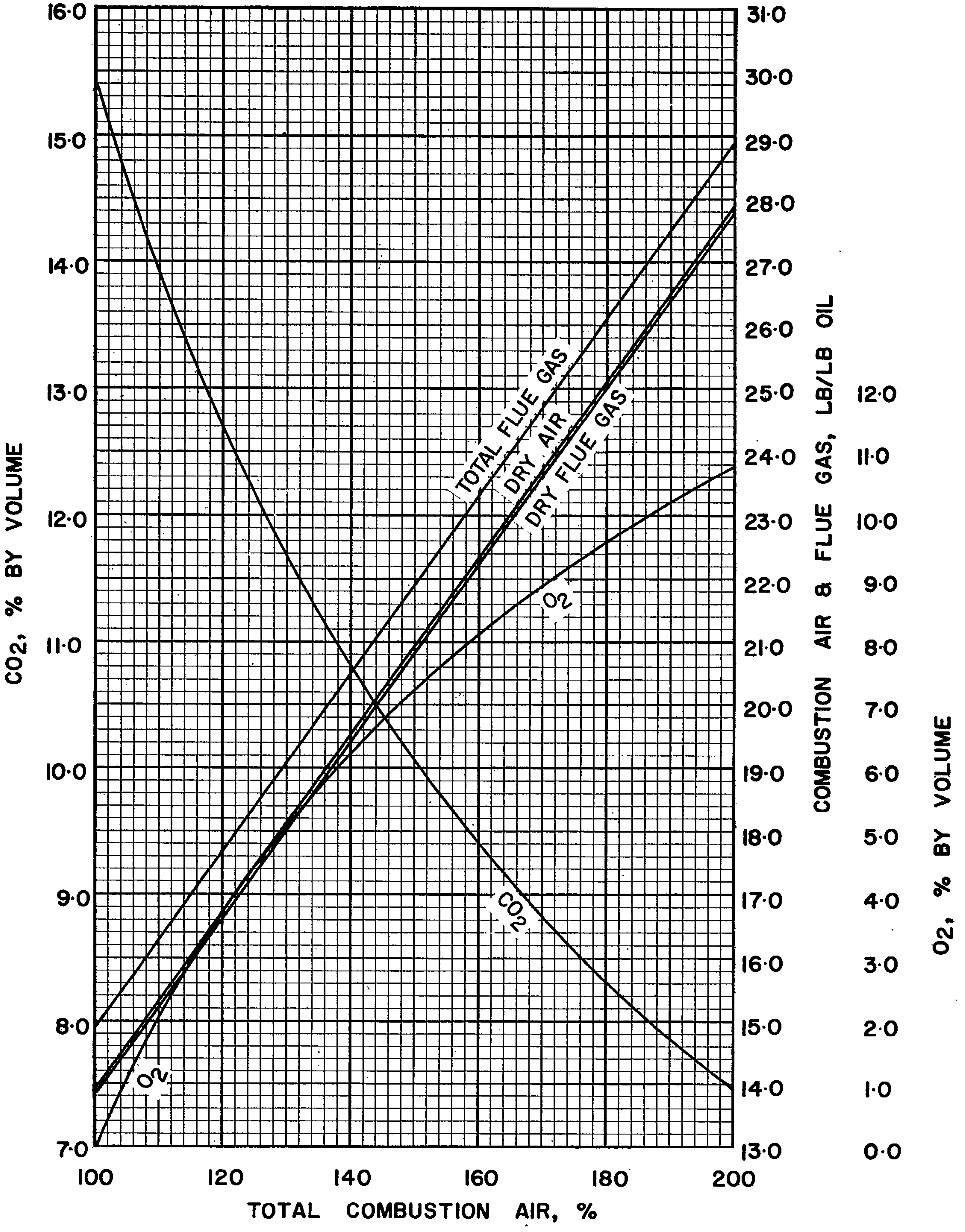


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS

9040

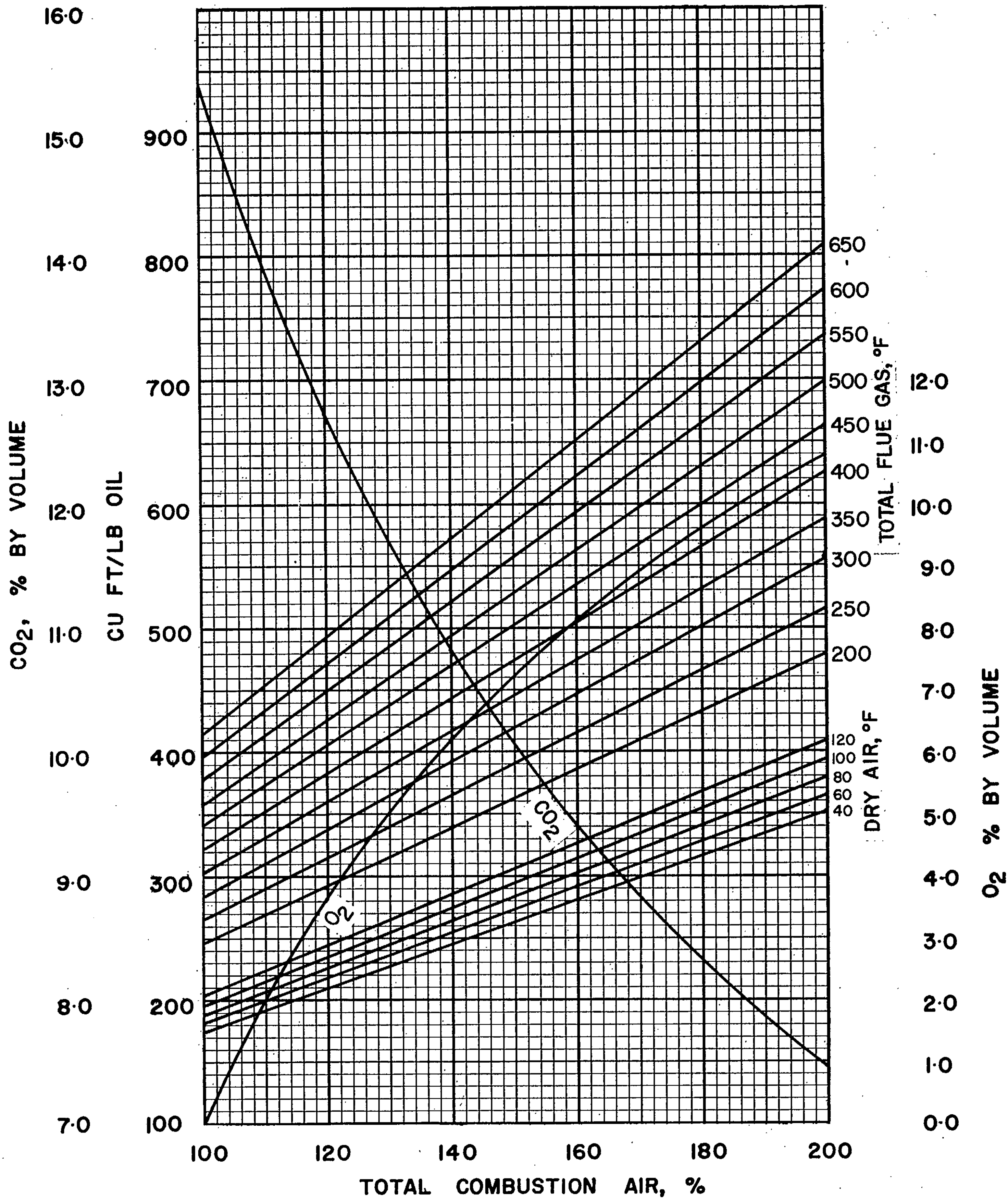


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 9040

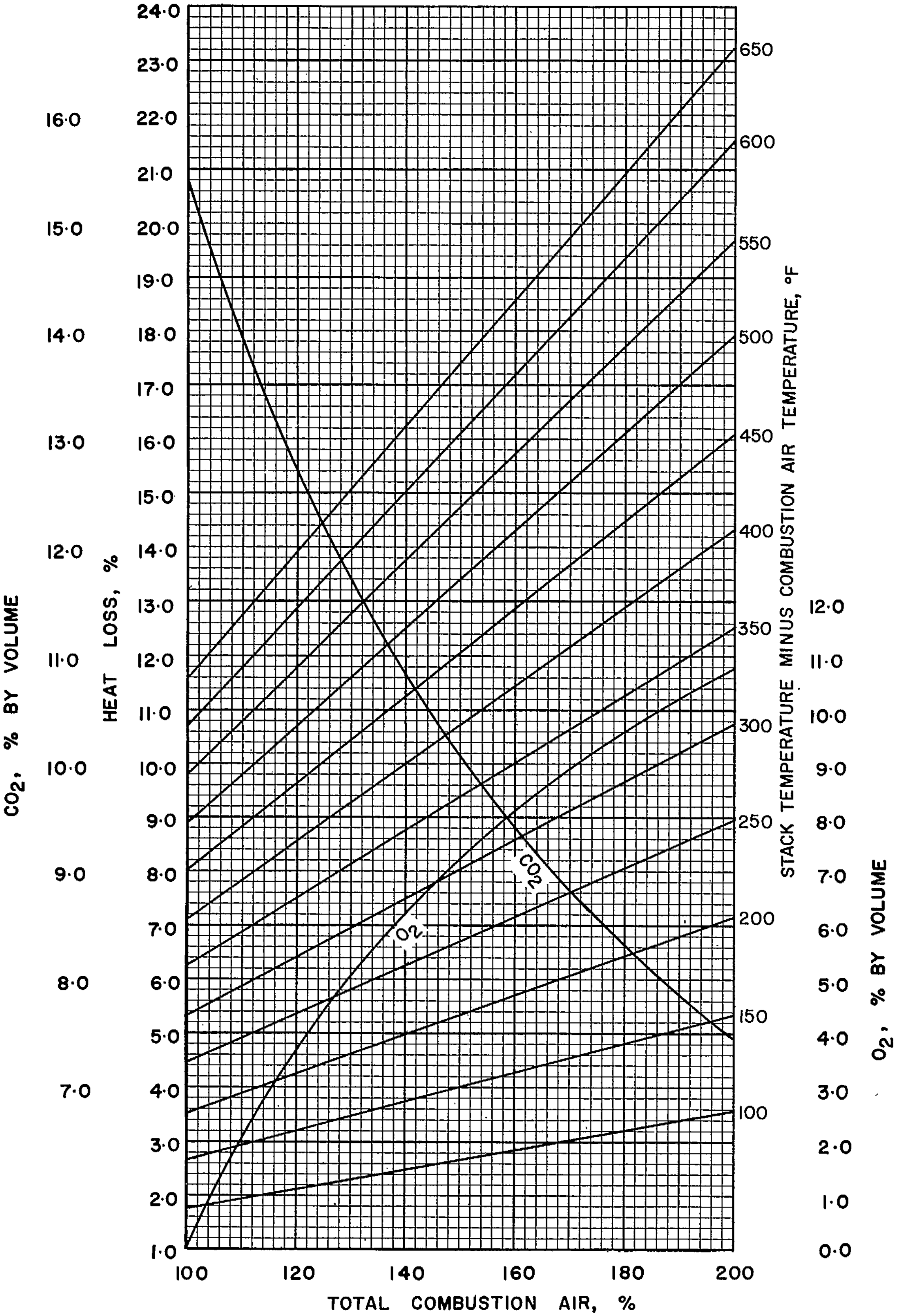


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

9040

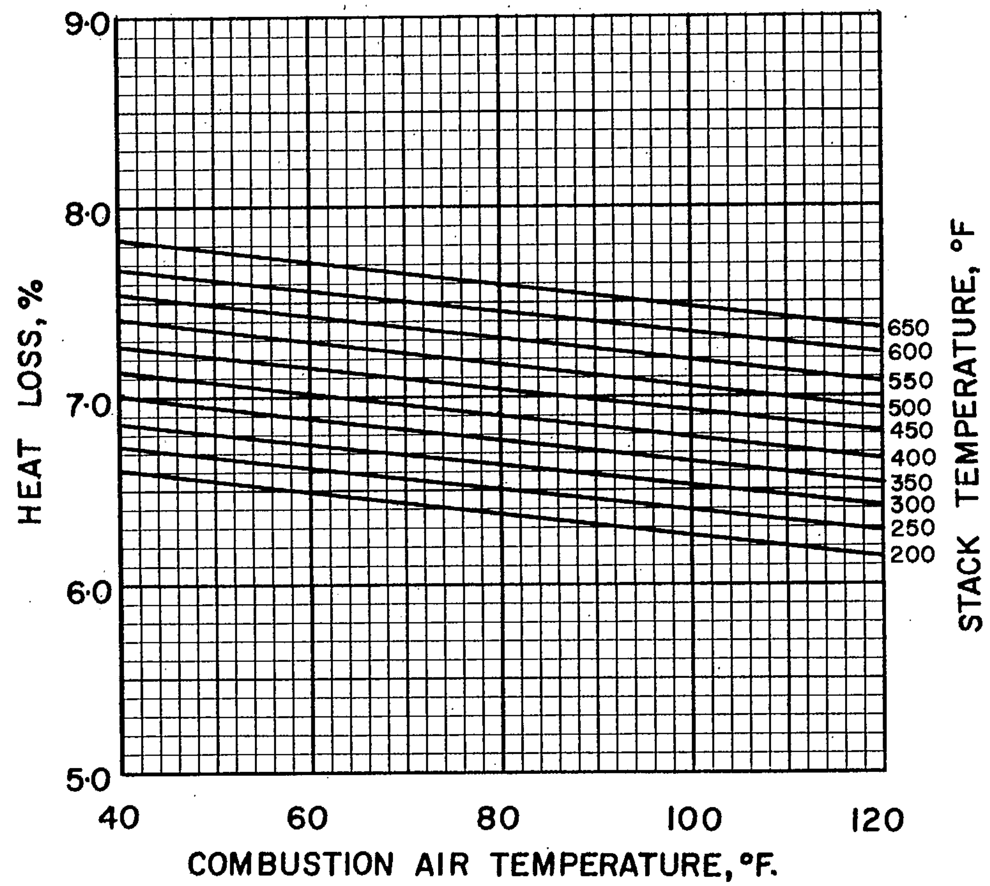


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

9040

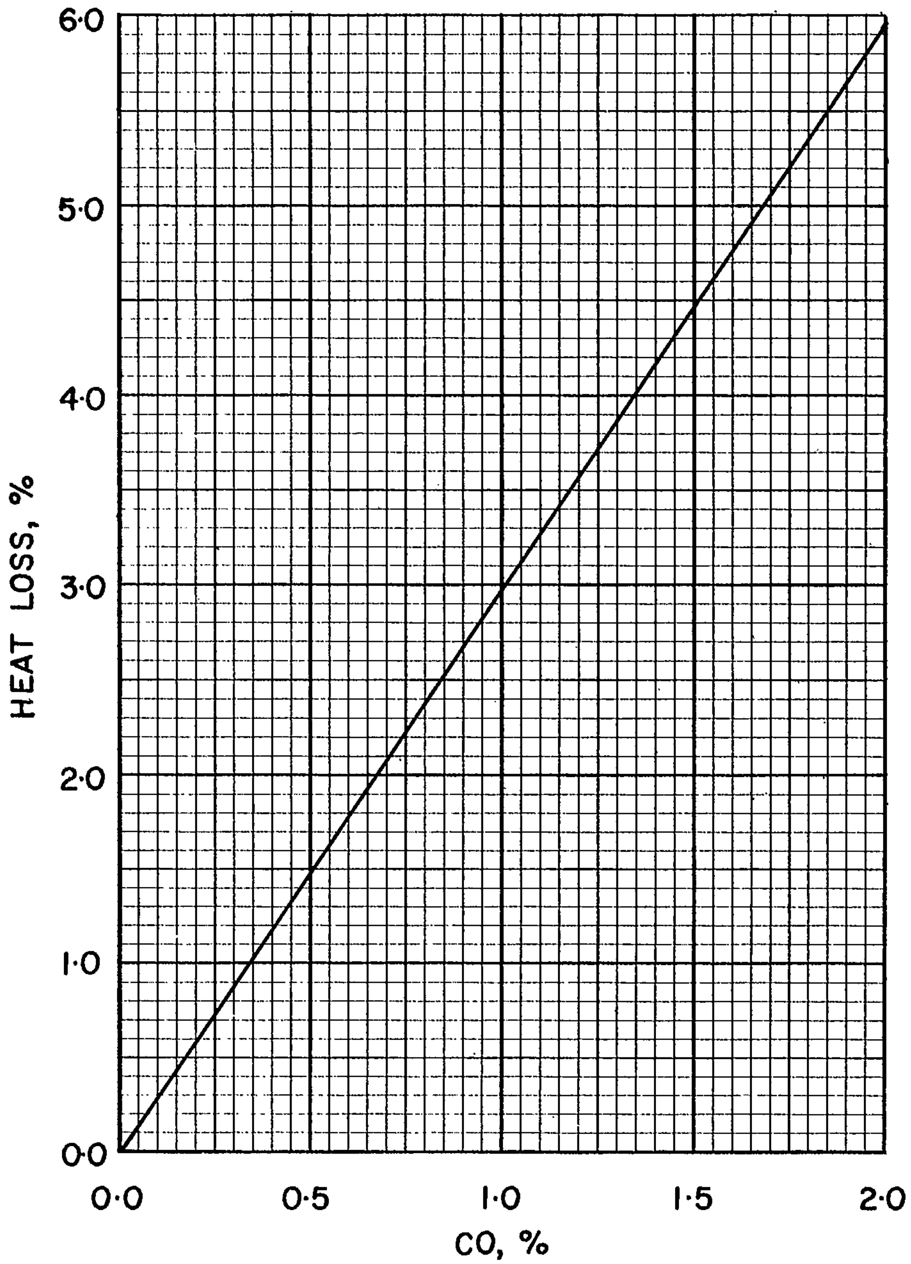


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

9040

FUEL OIL 9100, SPECIFIC GRAVITY 0.91

Ultimate Analysis, lb/lb

Carbon	(C)	0.8765
Hydrogen	(H_2)	0.1235
Sulphur	(S)	–
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		19,190

Conversion Factors

1 Imp gal oil = 9.100 lb oil
or Imp gal oil × 9.100 = lb oil
or lb oil × 0.1099 = Imp gal oil

1 U.S. gal oil = 9.100 × 0.8337 lb oil
or U.S. gal oil × 7.587 = lb oil
or lb oil × 0.1318 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{19{,}190} \text{ lb oil}$$

or Btu × 10^6 × 52.11 = lb oil
or lb oil × 0.0192 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{19{,}190 \times 9.100} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.726 = Imp gal oil
or Imp gal oil × 0.1746 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{19{,}190 \times 7.587} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.868 = U.S. gal oil
or U.S. gal oil × 0.1456 = Btu × 10^6

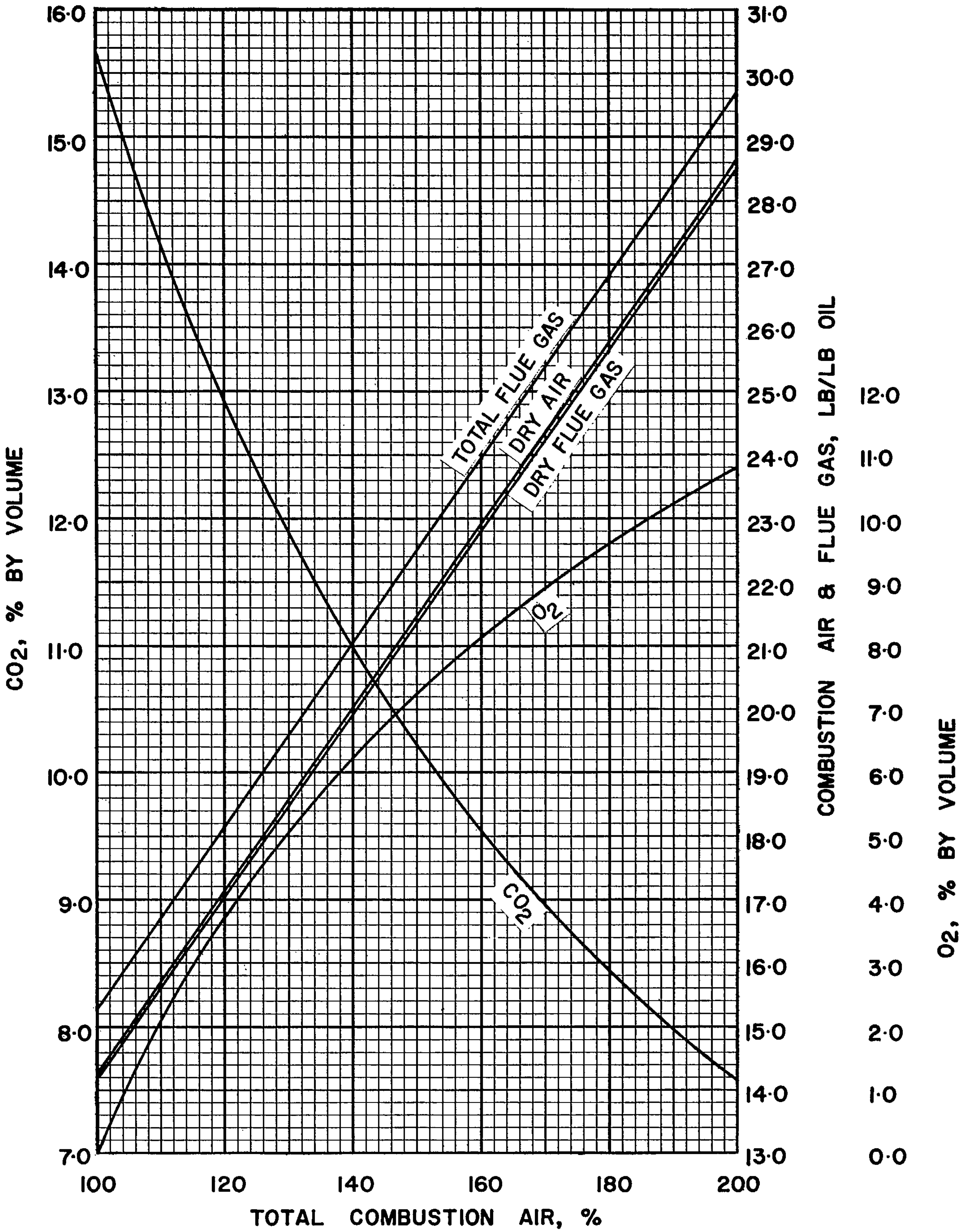


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS 9100

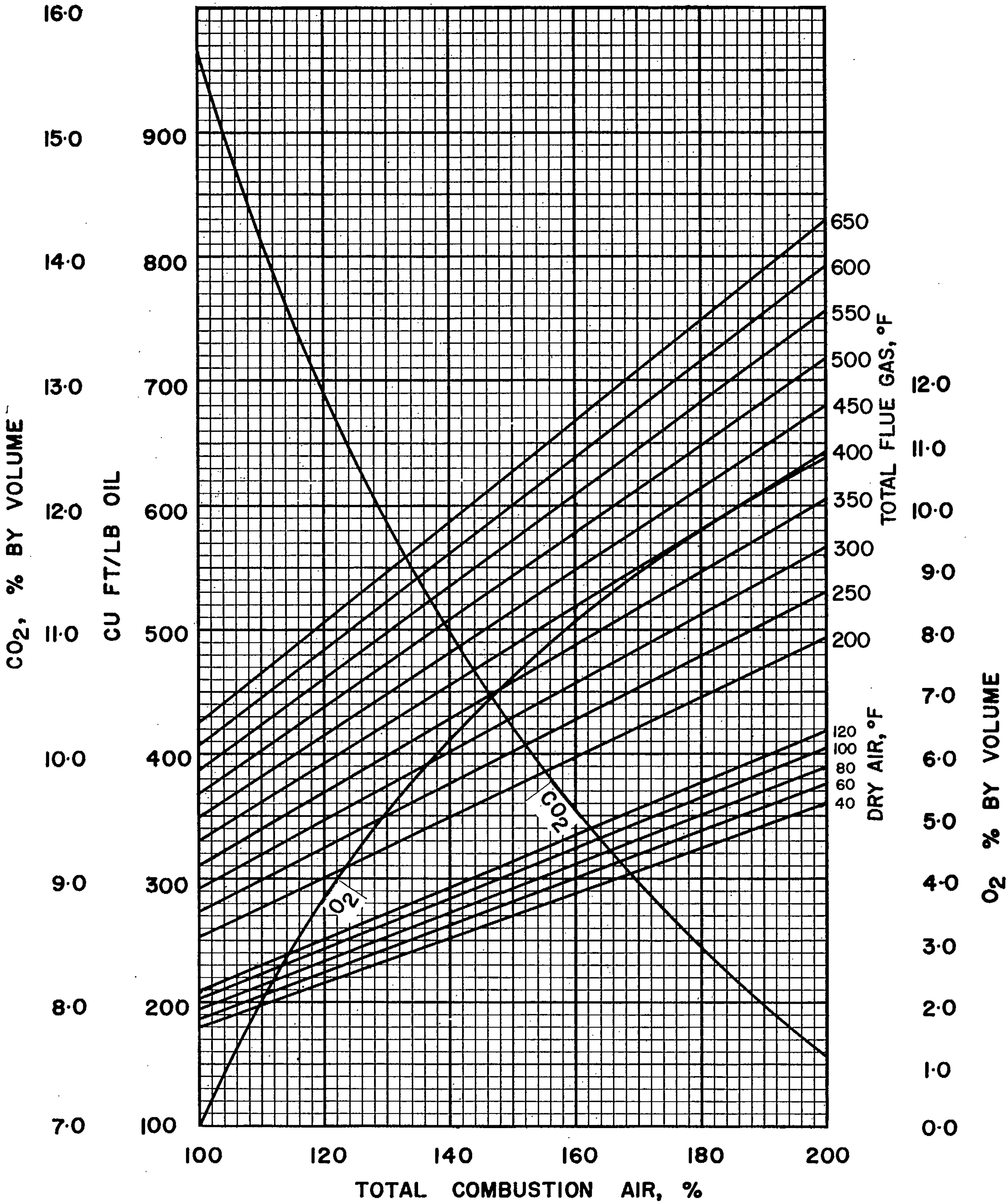


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 9100

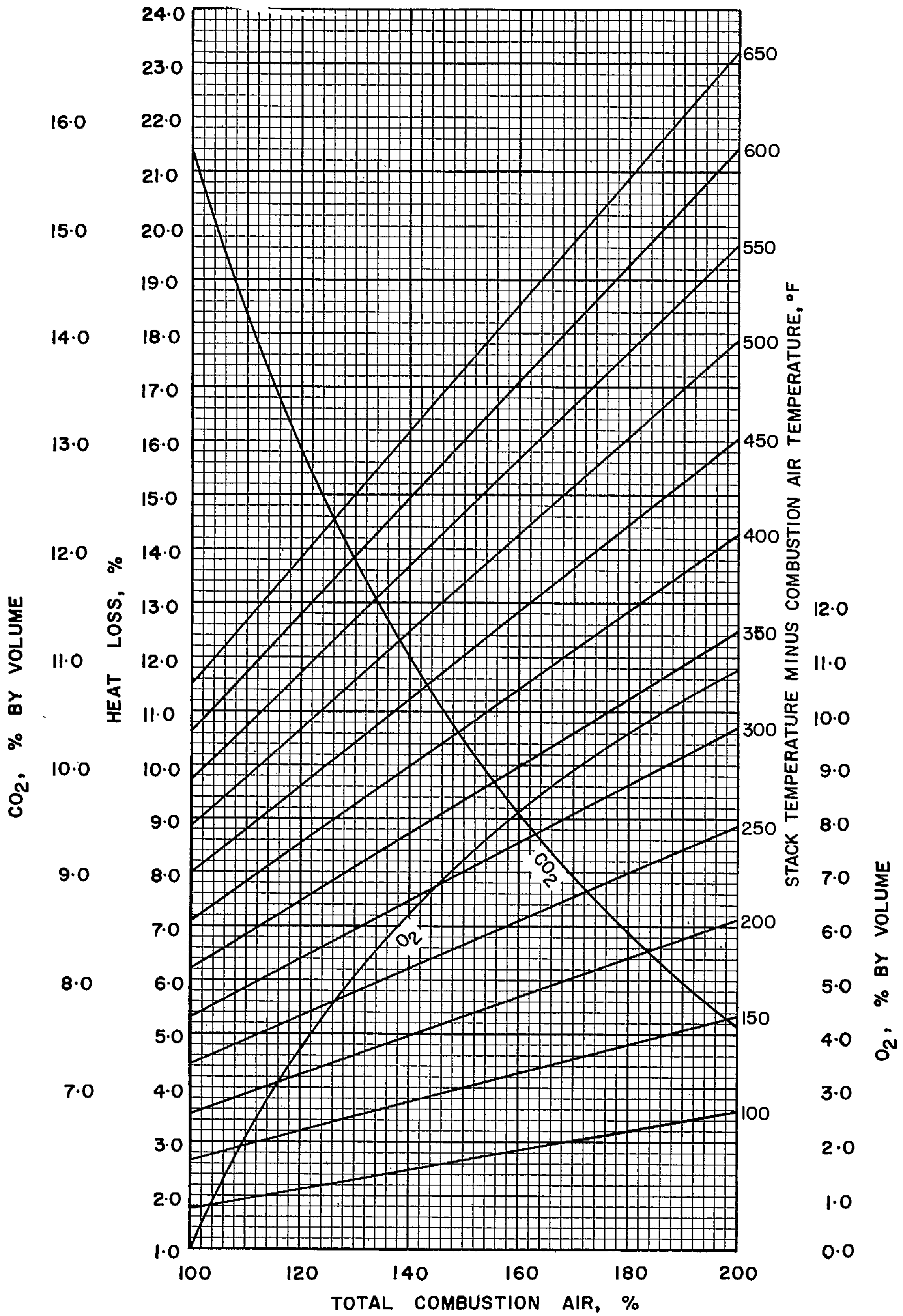


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

9100

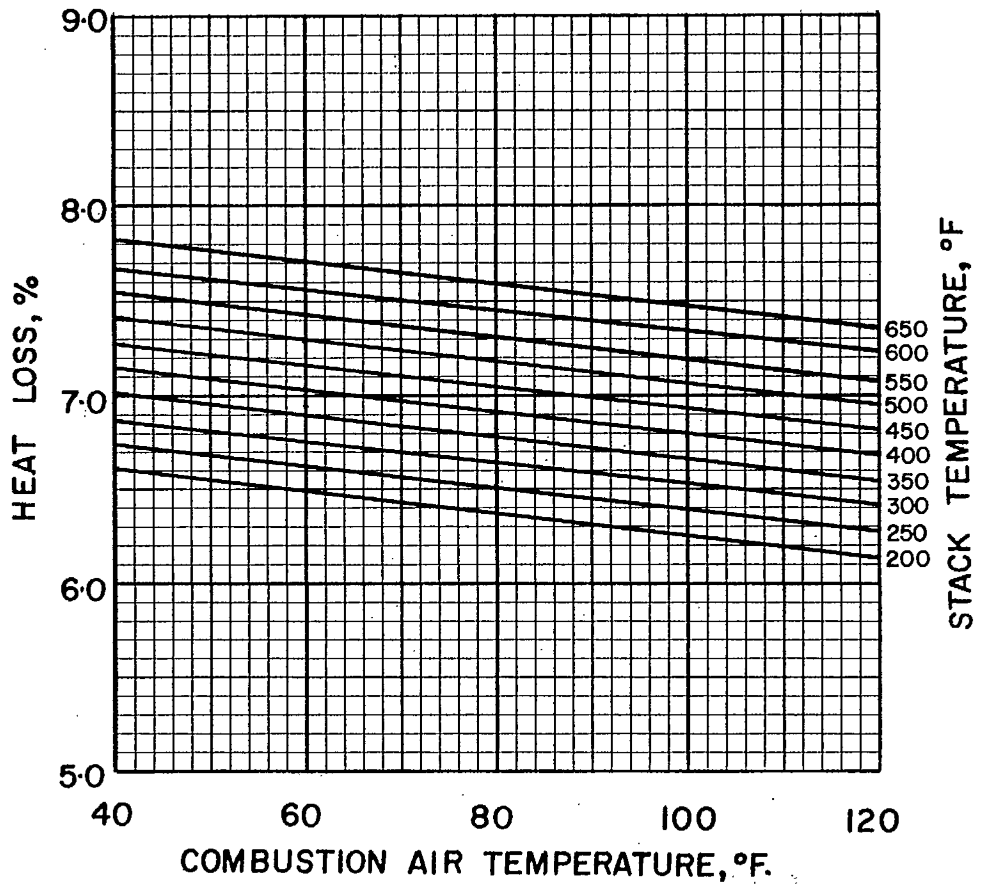


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

9100

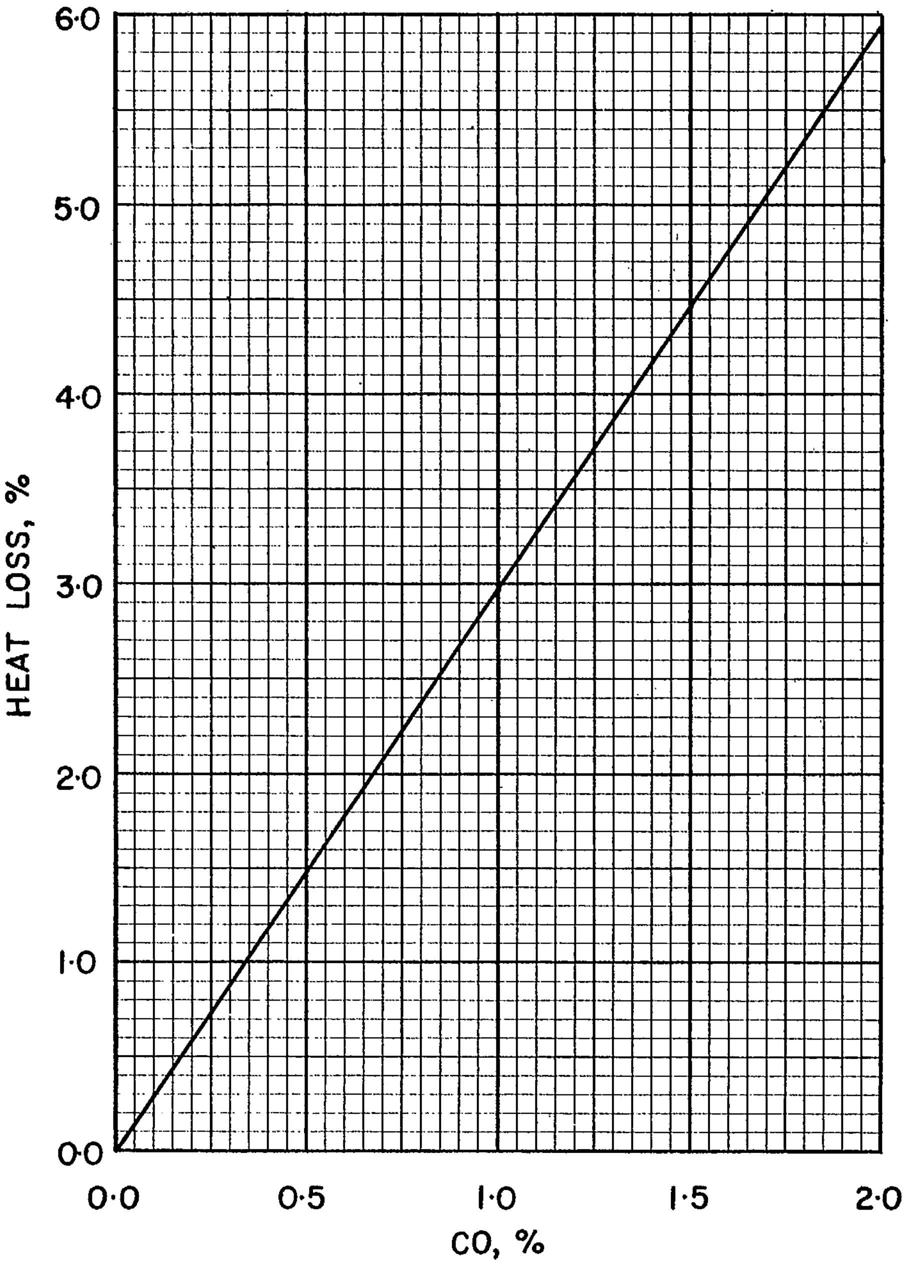


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR. 9100

FUEL OIL 9110, SPECIFIC GRAVITY 0.910

Ultimate Analysis, lb/lb

Carbon	(C)	0.8677
Hydrogen	(H_2)	0.1223
Sulphur	(S)	0.0100
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		19,040

Conversion Factors

1 Imp gal oil = 9.100 lb oil
or Imp gal oil × 9.100 = lb oil
or lb oil × 0.1099 = Imp gal oil

1 U.S. gal oil = 9.100 × 0.8337 lb oil
or U.S. gal oil × 7.587 = lb oil
or lb oil × 0.1318 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{19{,}040} \text{ lb oil}$$

or Btu × 10^6 × 52.52 = lb oil
or lb oil × 0.0190 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{19{,}040 \times 9.100} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.772 = Imp gal oil
or Imp gal oil × 0.1732 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{19{,}040 \times 7.587} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.923 = U.S. gal oil
or U.S. gal oil × 0.1445 = Btu × 10^6

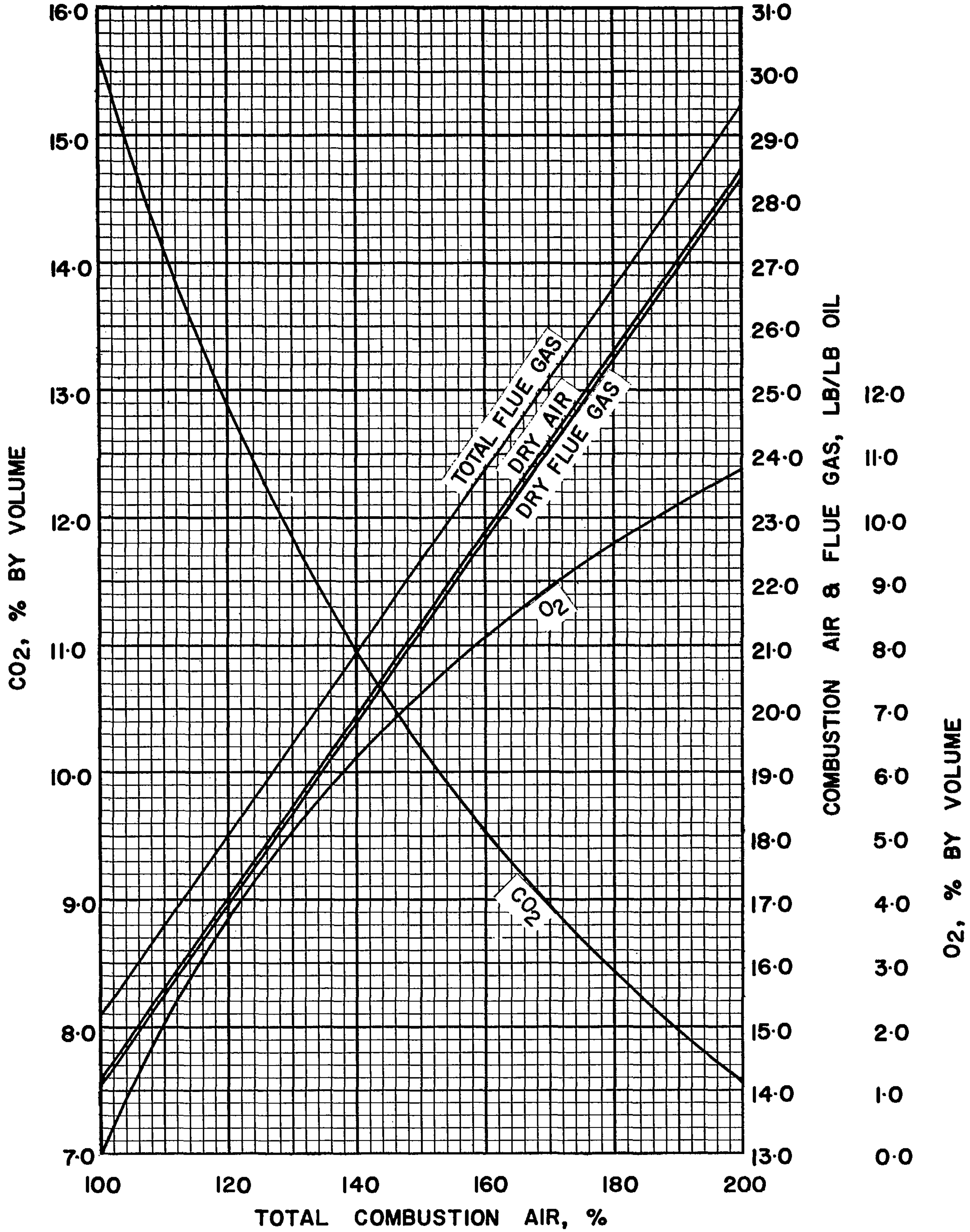


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS

9110

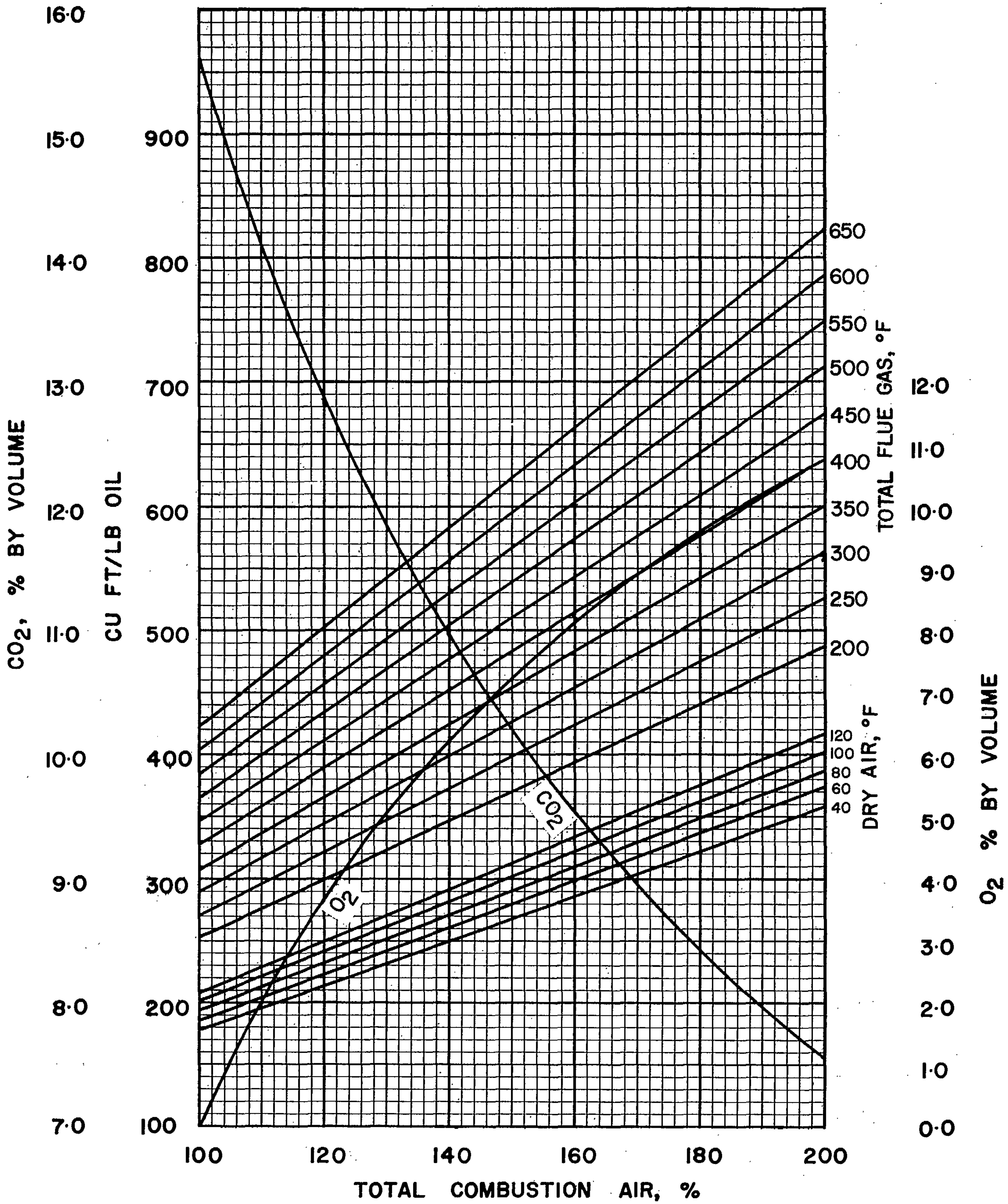


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 9110

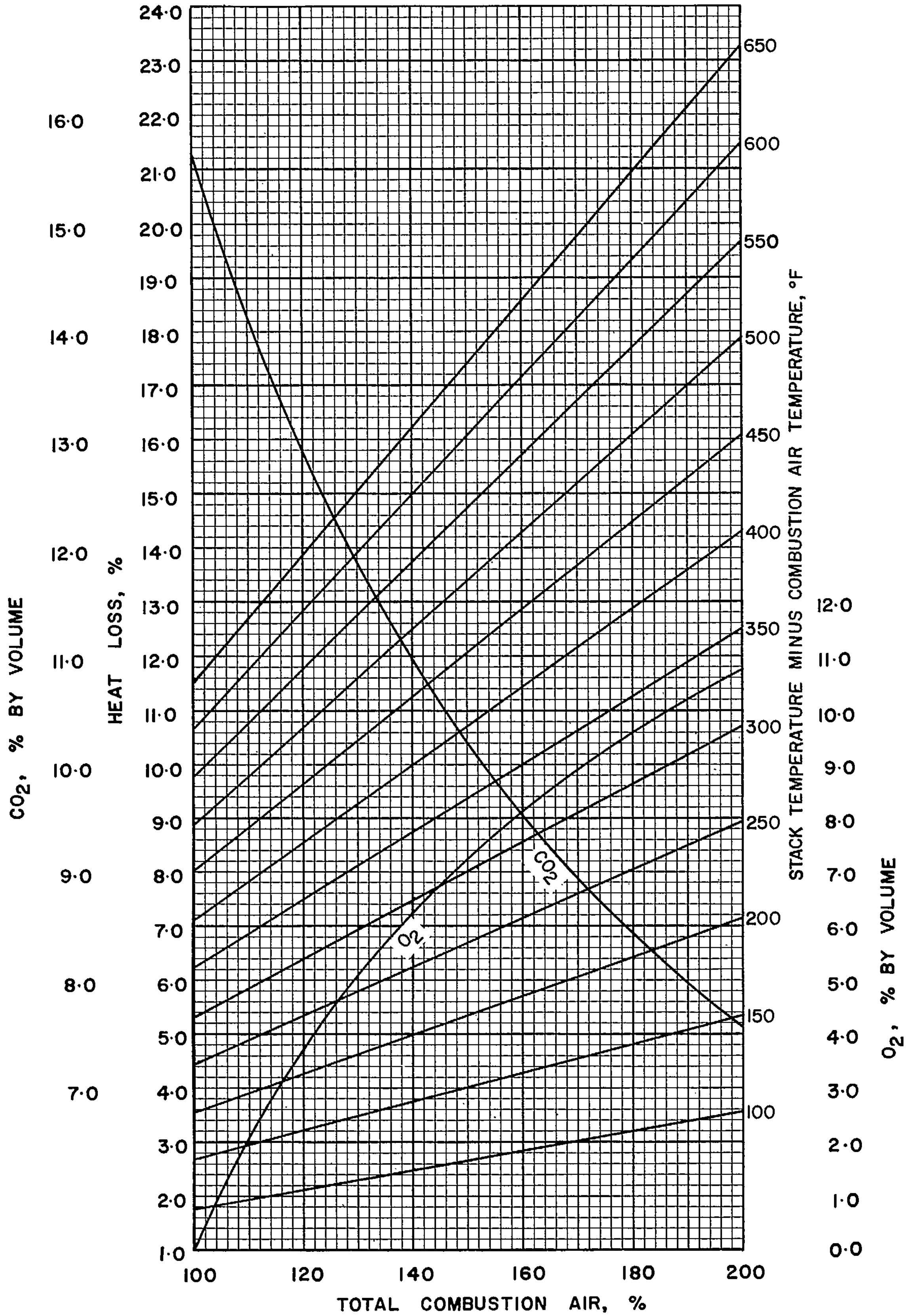


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

9110

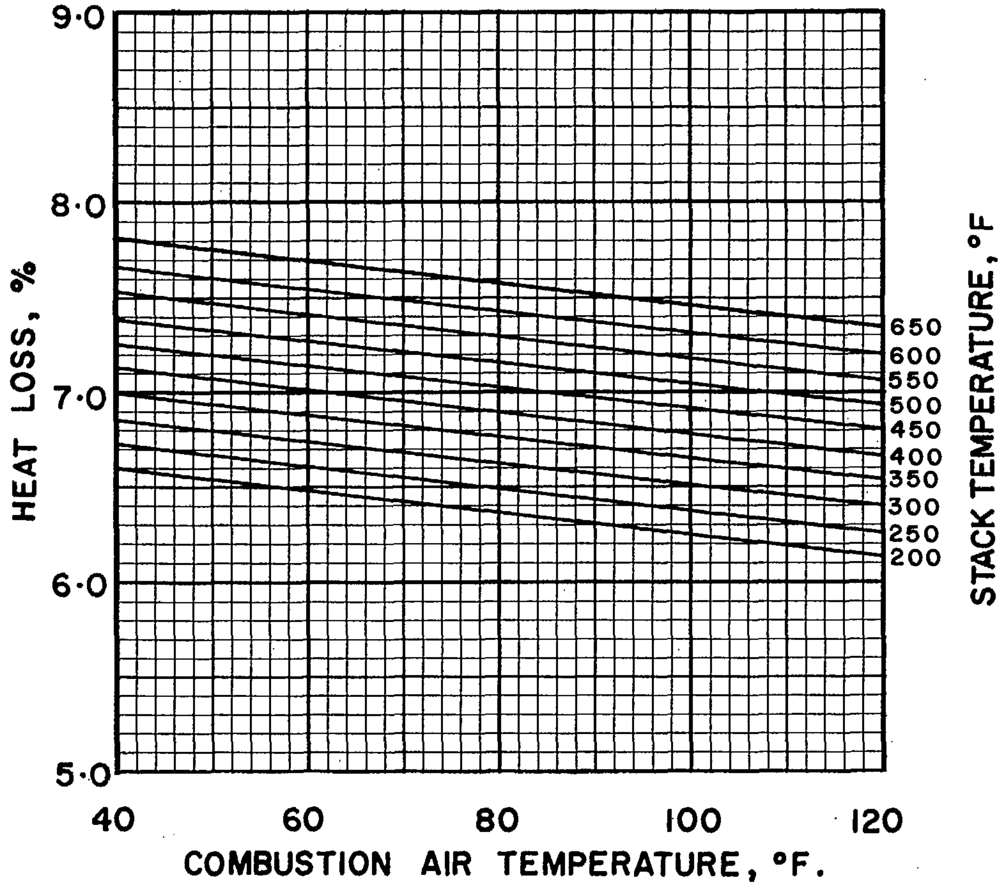


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

9110

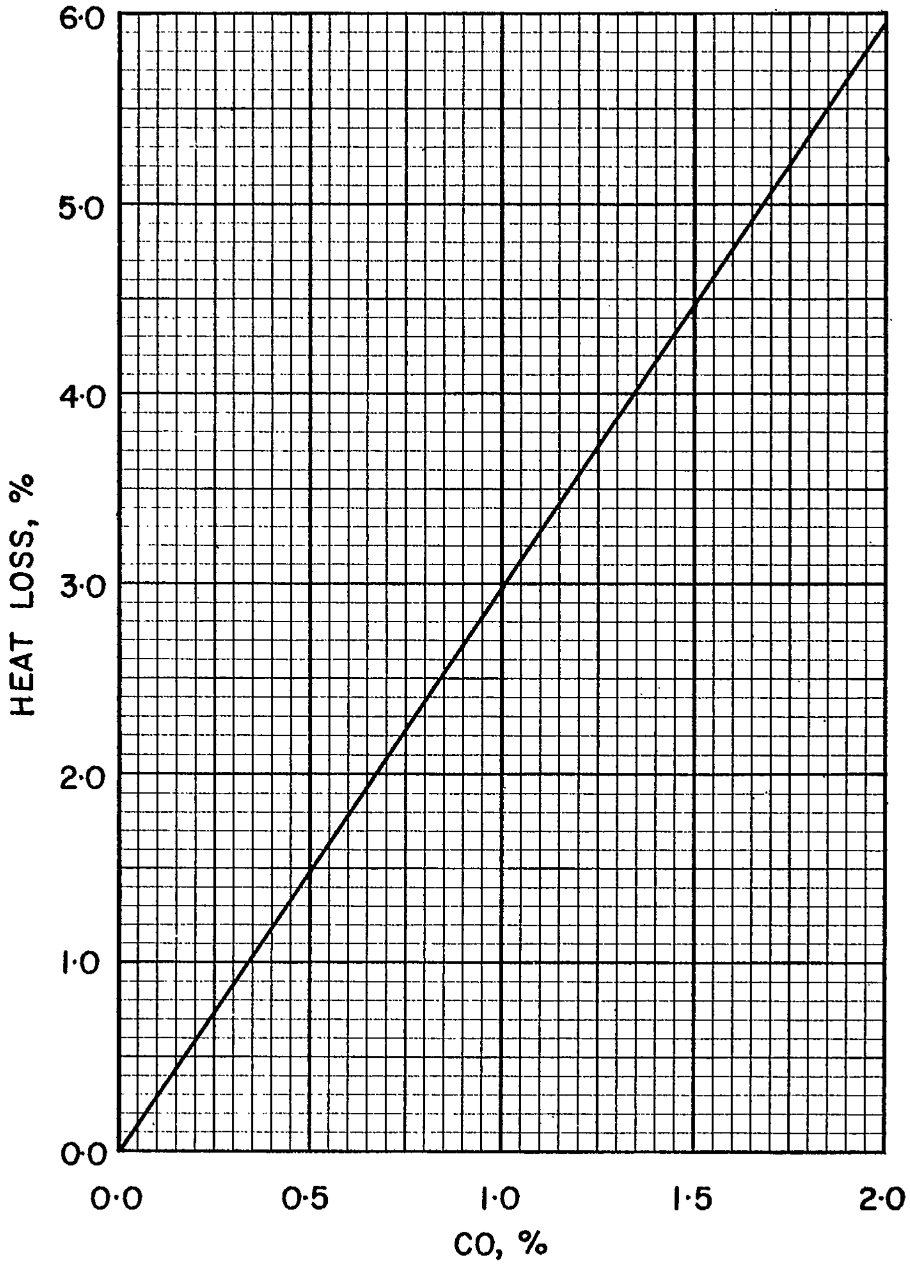


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

9110

FUEL OIL 9120, SPECIFIC GRAVITY 0.910

Ultimate Analysis, lb/lb

Carbon	(C)	0.8590
Hydrogen	(H_2)	0.1210
Sulphur	(S)	0.0200
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,890

Conversion Factors

1 Imp gal oil = 9.100 lb oil
or Imp gal oil × 9.100 = lb oil
or lb oil × 0.1099 = Imp gal oil

1 U.S. gal oil = 9.100 × 0.8337 lb oil
or U.S. gal oil × 7.587 = lb oil
or lb oil × 0.1318 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}890} \text{ lb oil}$$

or Btu × 10^6 × 52.94 = lb oil
or lb oil × 0.0189 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}890 \times 9.100} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.817 = Imp gal oil
or Imp gal oil × 0.1719 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}890 \times 7.587} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.978 = U.S. gal oil
or U.S. gal oil × 0.1433 = Btu × 10^6

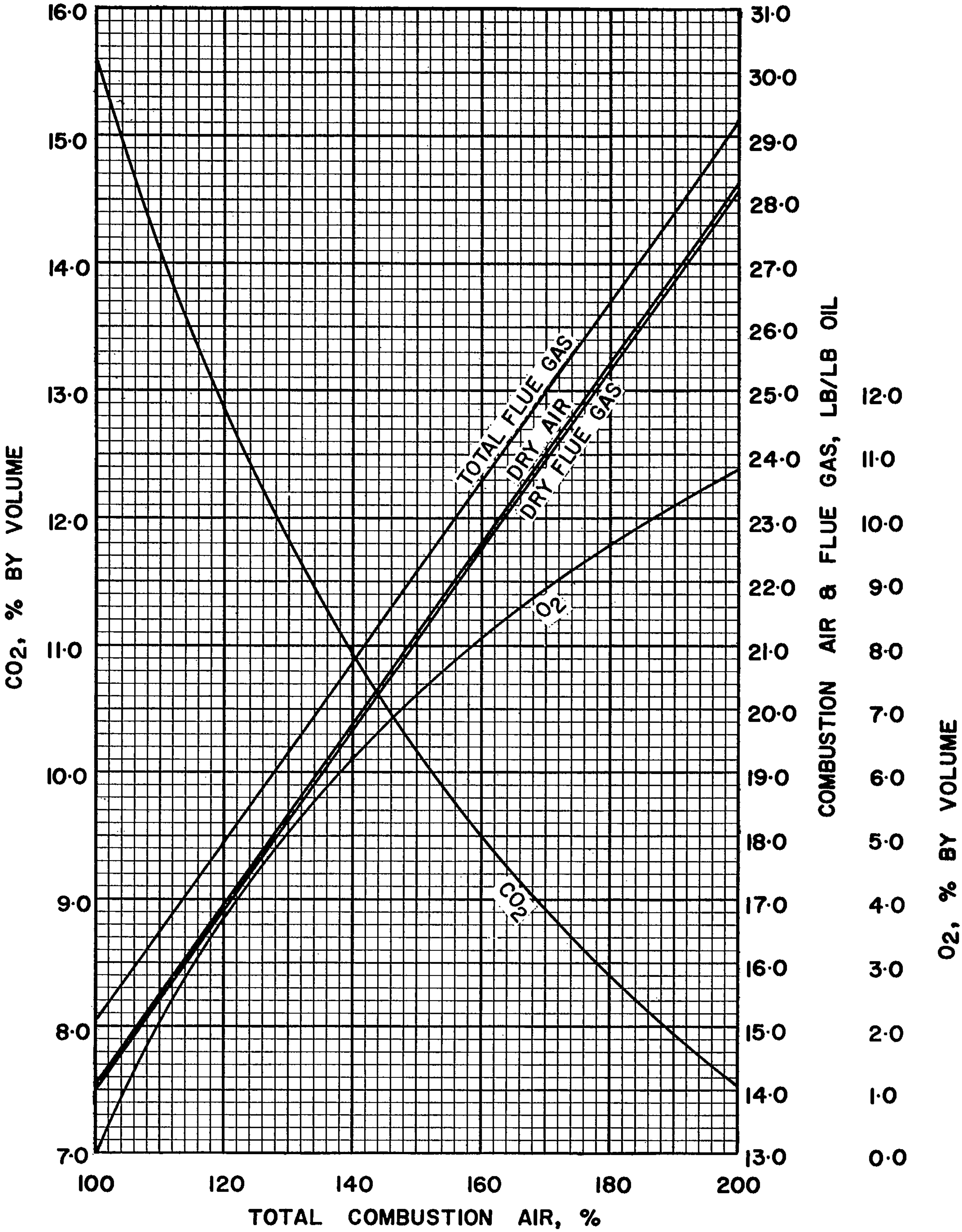


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS

9120

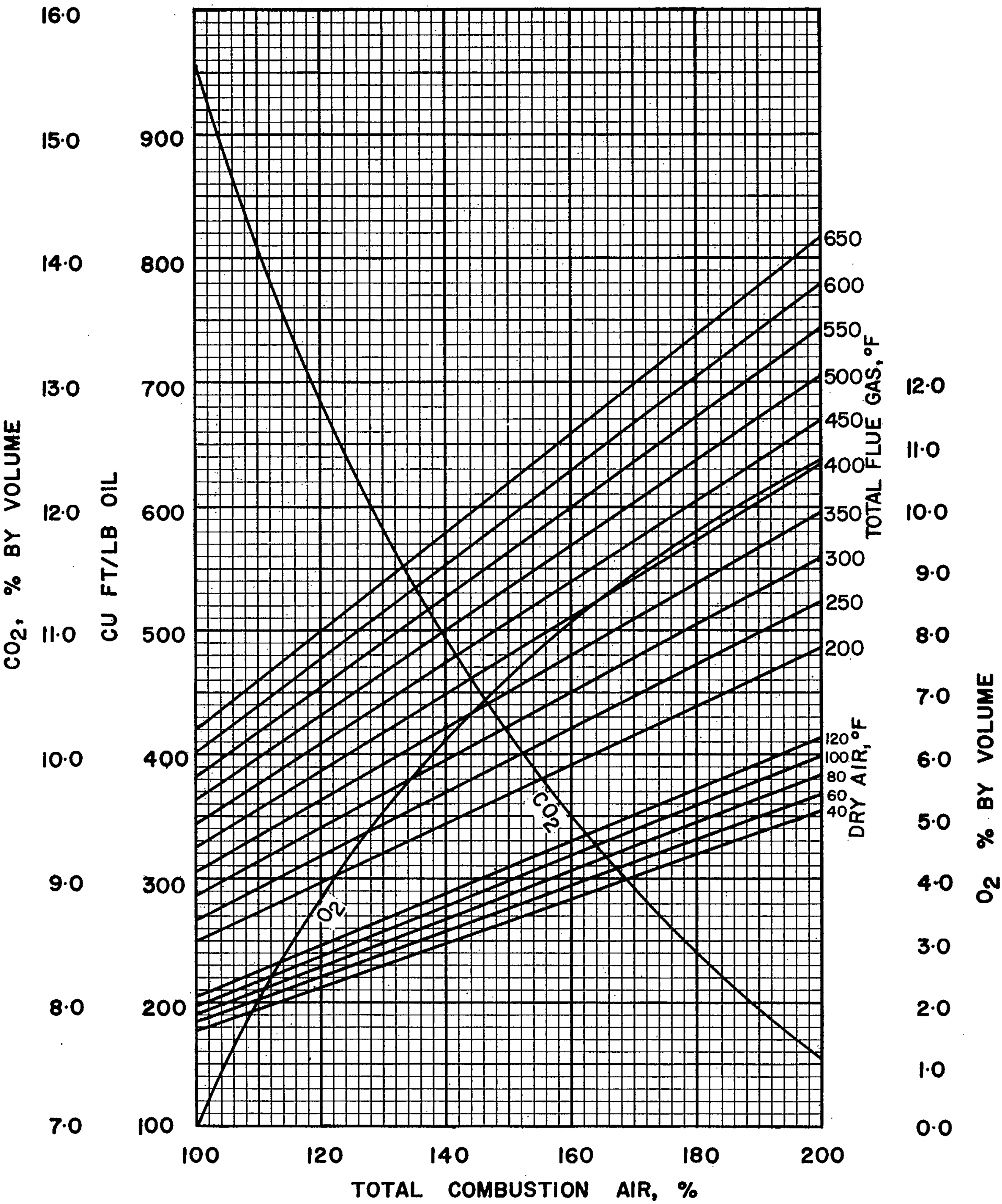


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 9120

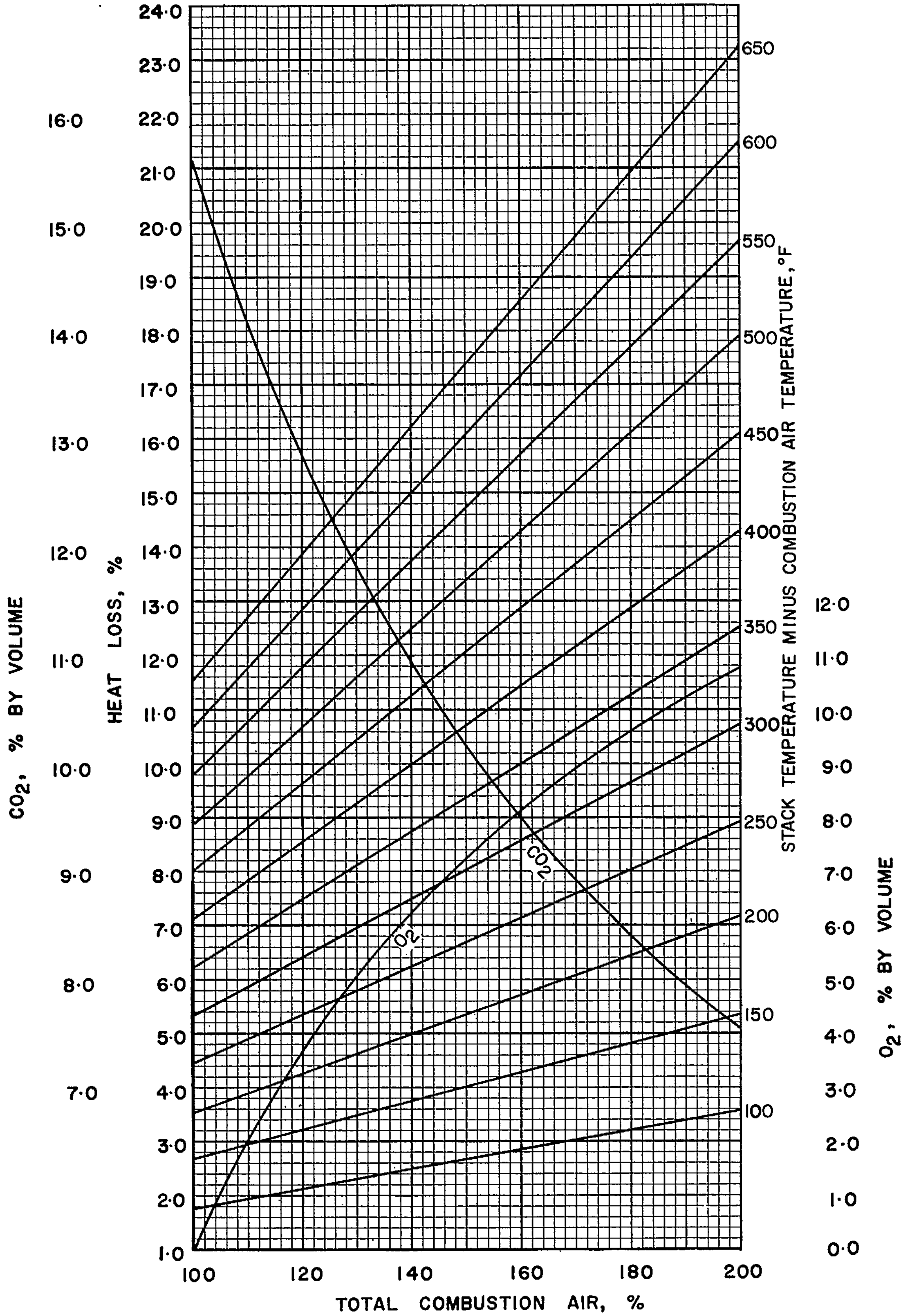


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

9120

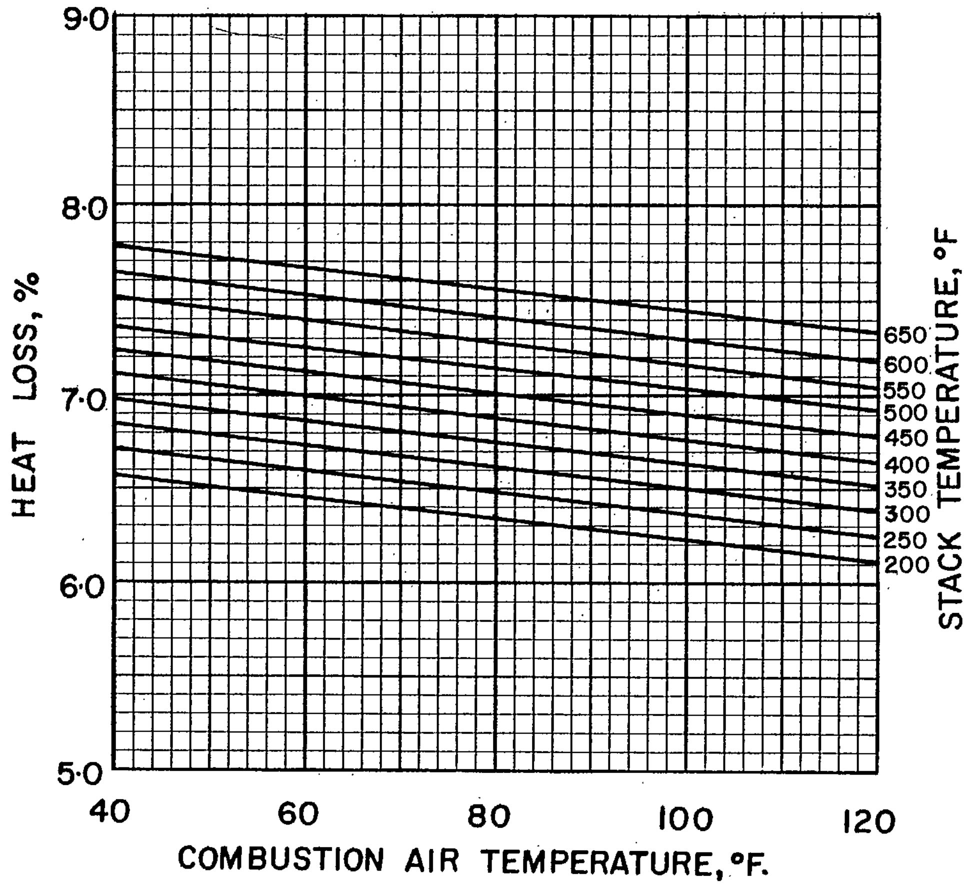


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

9120

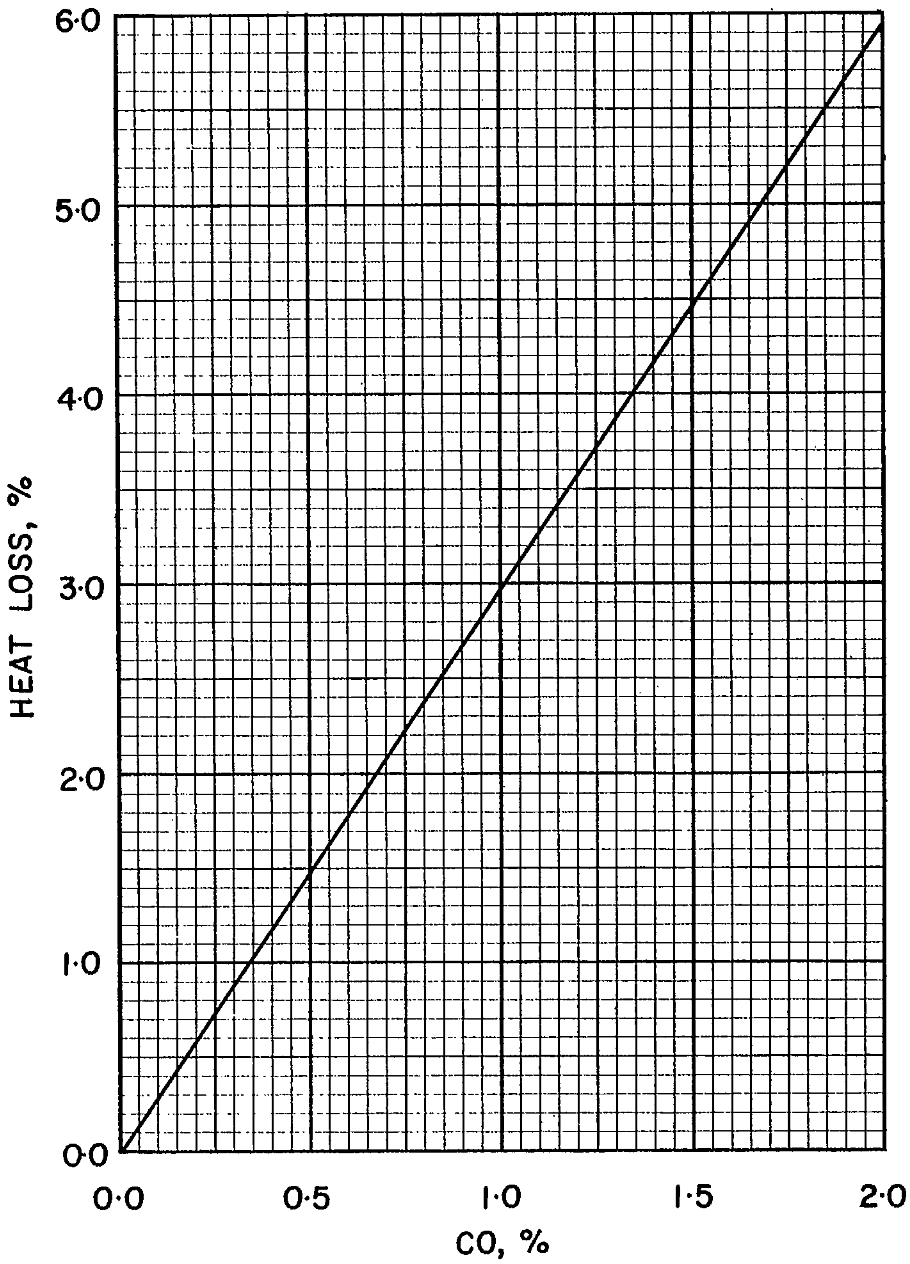


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

9120

FUEL OIL 9130, SPECIFIC GRAVITY 0.910

Ultimate Analysis, lb/lb

Carbon	(C)	0.8502
Hydrogen	(H_2)	0.1198
Sulphur	(S)	0.0300
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,740

Conversion Factors

1 Imp gal oil = 9.100 lb oil
or Imp gal oil × 9.100 = lb oil
or lb oil × 0.1099 = Imp gal oil

1 U.S. gal oil = 9.100 × 0.8337 lb oil
or U.S. gal oil × 7.587 = lb oil
or lb oil × 0.1318 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}740} \text{ lb oil}$$

or Btu × 10^6 × 53.36 = lb oil
or lb oil × 0.0187 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}740 \times 9.100} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.864 = Imp gal oil
or Imp gal oil × 0.1705 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}740 \times 7.587} \text{ U.S. gal oil}$$

or Btu × 10^6 × 7.032 = U.S. gal oil
or U.S. gal oil × 0.1422 = Btu × 10^6

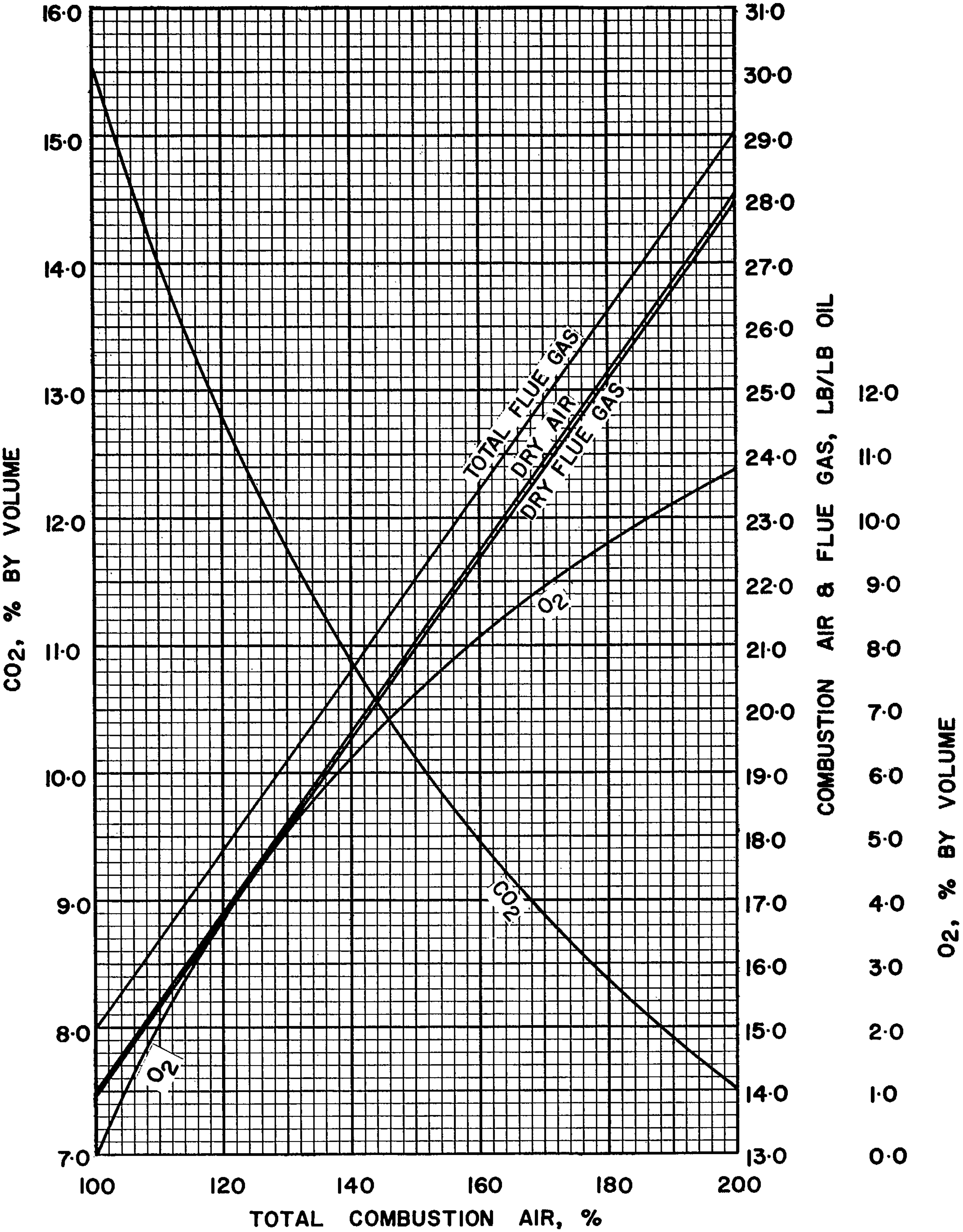


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS

9130

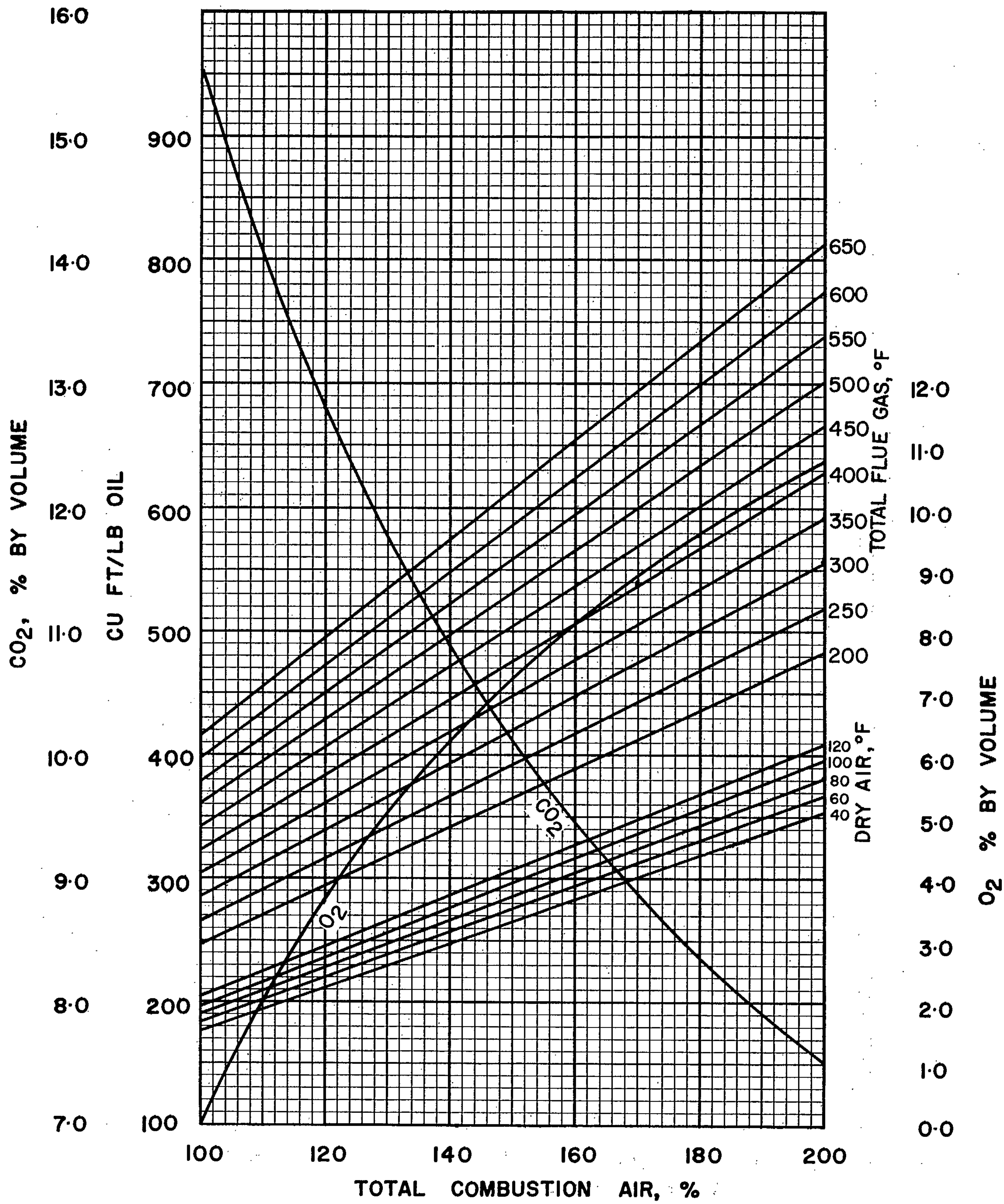


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 9130

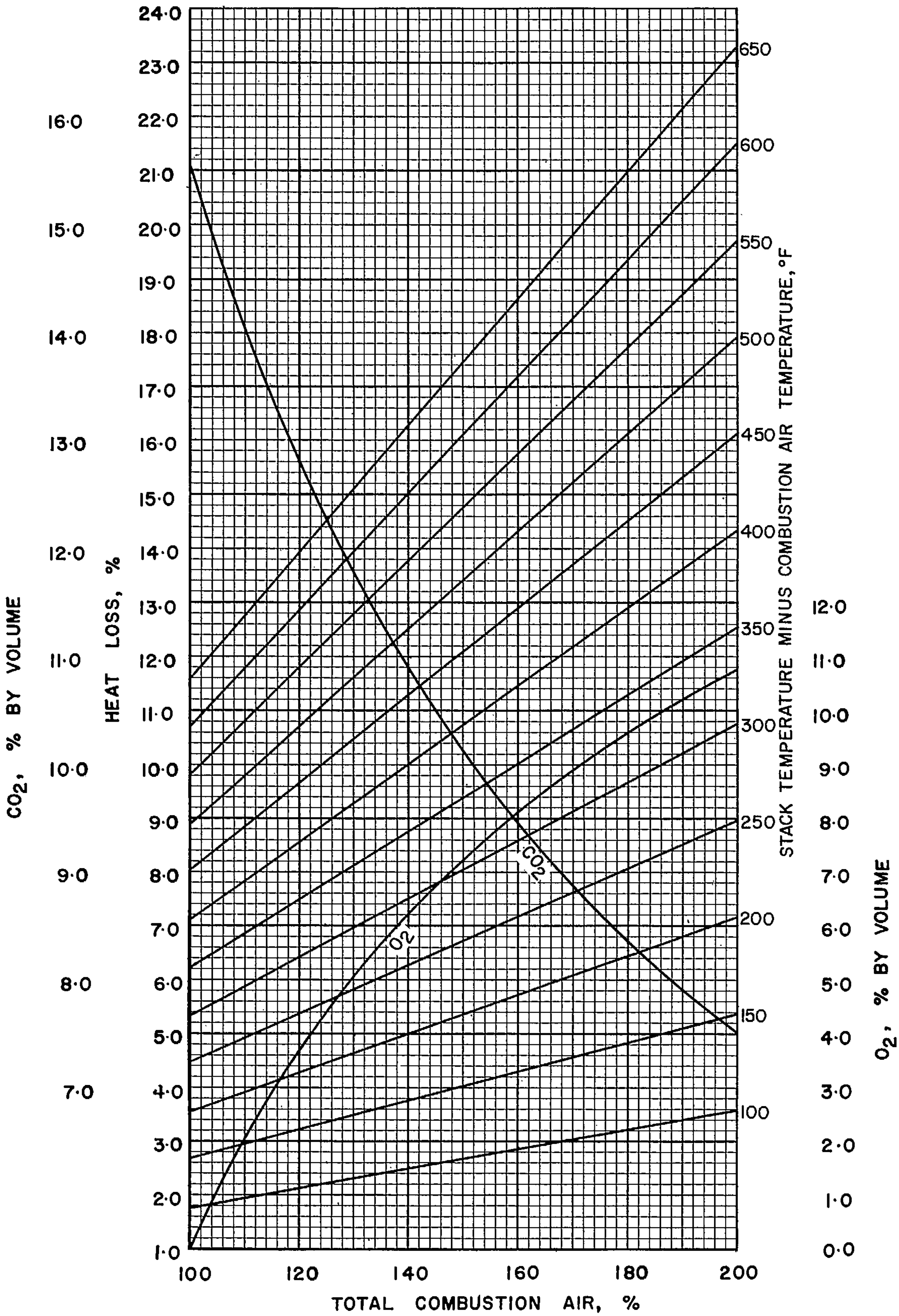


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

9130

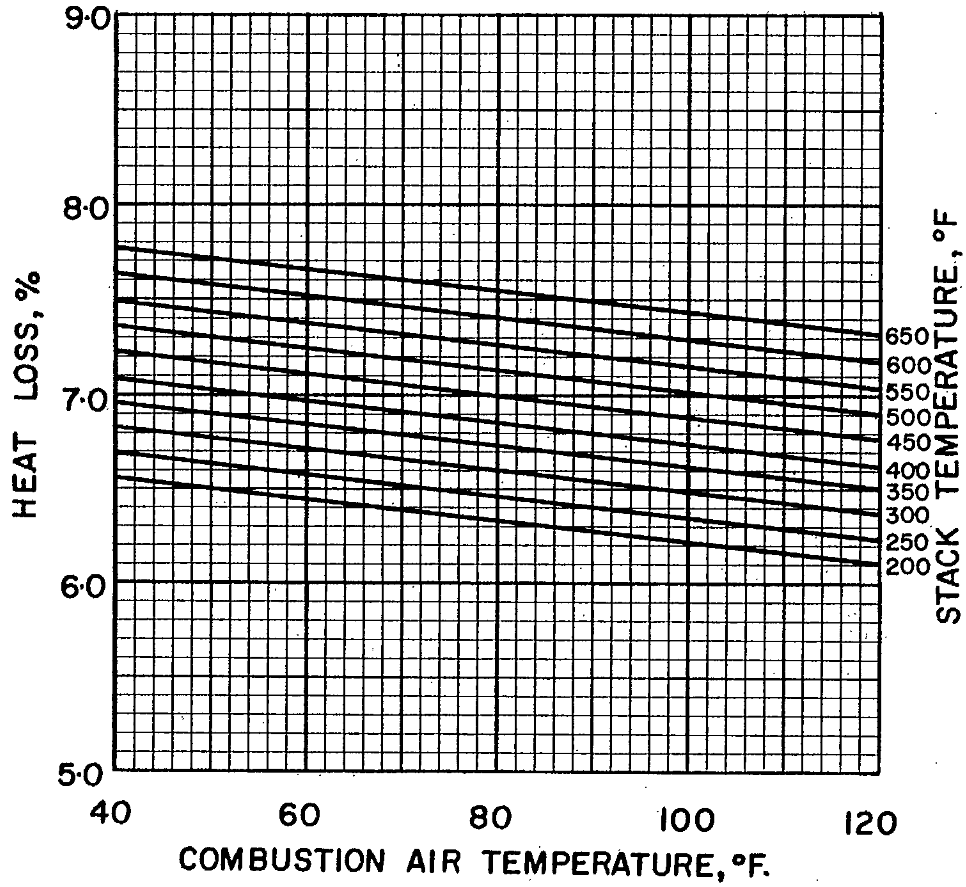


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

9130

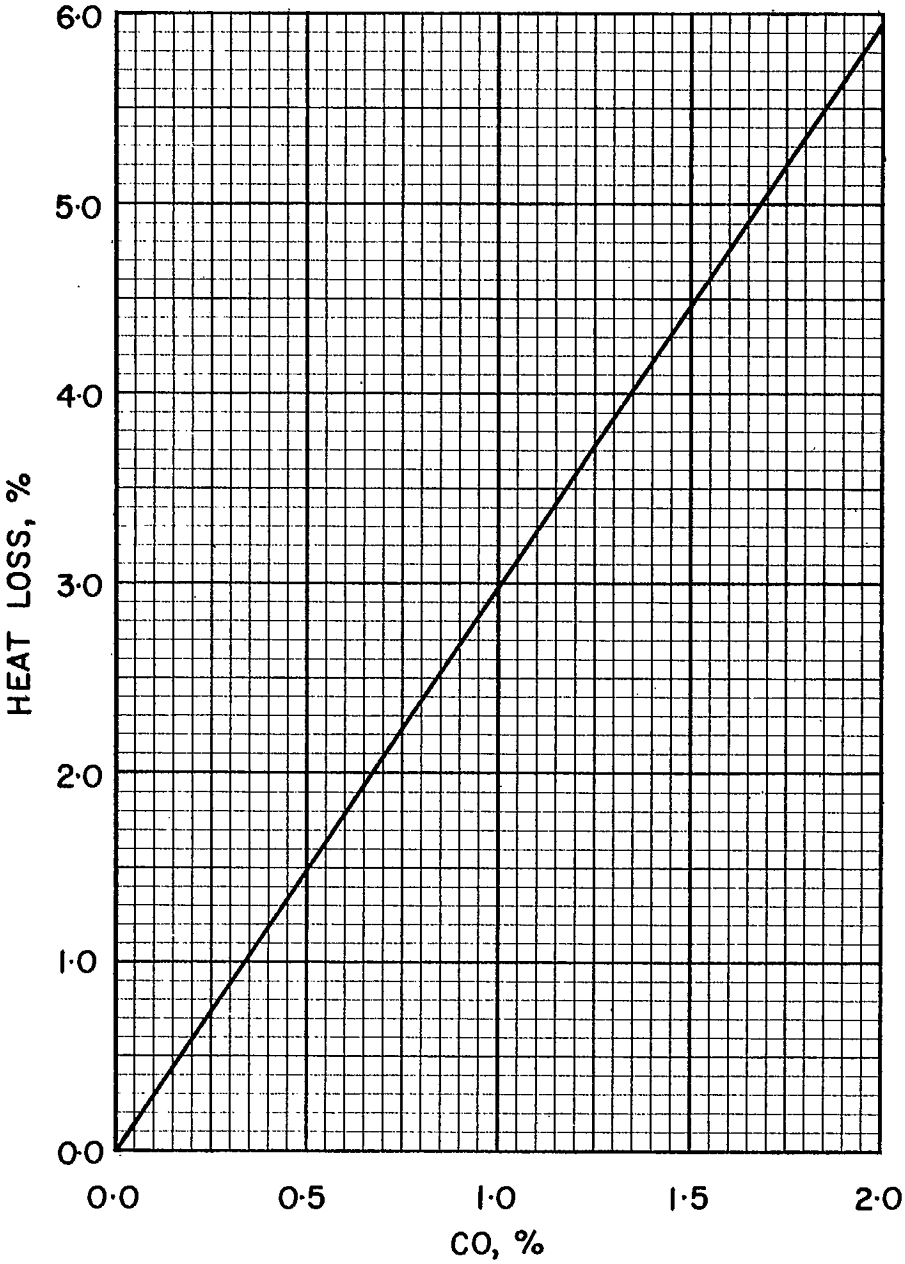


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

9130

FUEL OIL 9140, SPECIFIC GRAVITY 0.910

Ultimate Analysis, lb/lb

Carbon	(C)	0.8414
Hydrogen	(H_2)	0.1186
Sulphur	(S)	0.0400
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,580

Conversion Factors

1 Imp gal oil = 9.100 lb oil
or Imp gal oil × 9.100 = lb oil
or lb oil × 0.1099 = Imp gal oil

1 U.S. gal oil = 9.100 × 0.8337 lb oil
or U.S. gal oil × 7.587 = lb oil
or lb oil × 0.1318 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}580} \text{ lb oil}$$

or Btu × 10^6 × 53.82 = lb oil
or lb oil × 0.0186 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}580 \times 9.100} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.914 = Imp gal oil
or Imp gal oil × 0.1691 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}580 \times 7.587} \text{ U.S. gal oil}$$

or Btu × 10^6 × 7.092 = U.S. gal oil
or U.S. gal oil × 0.1410 = Btu × 10^6

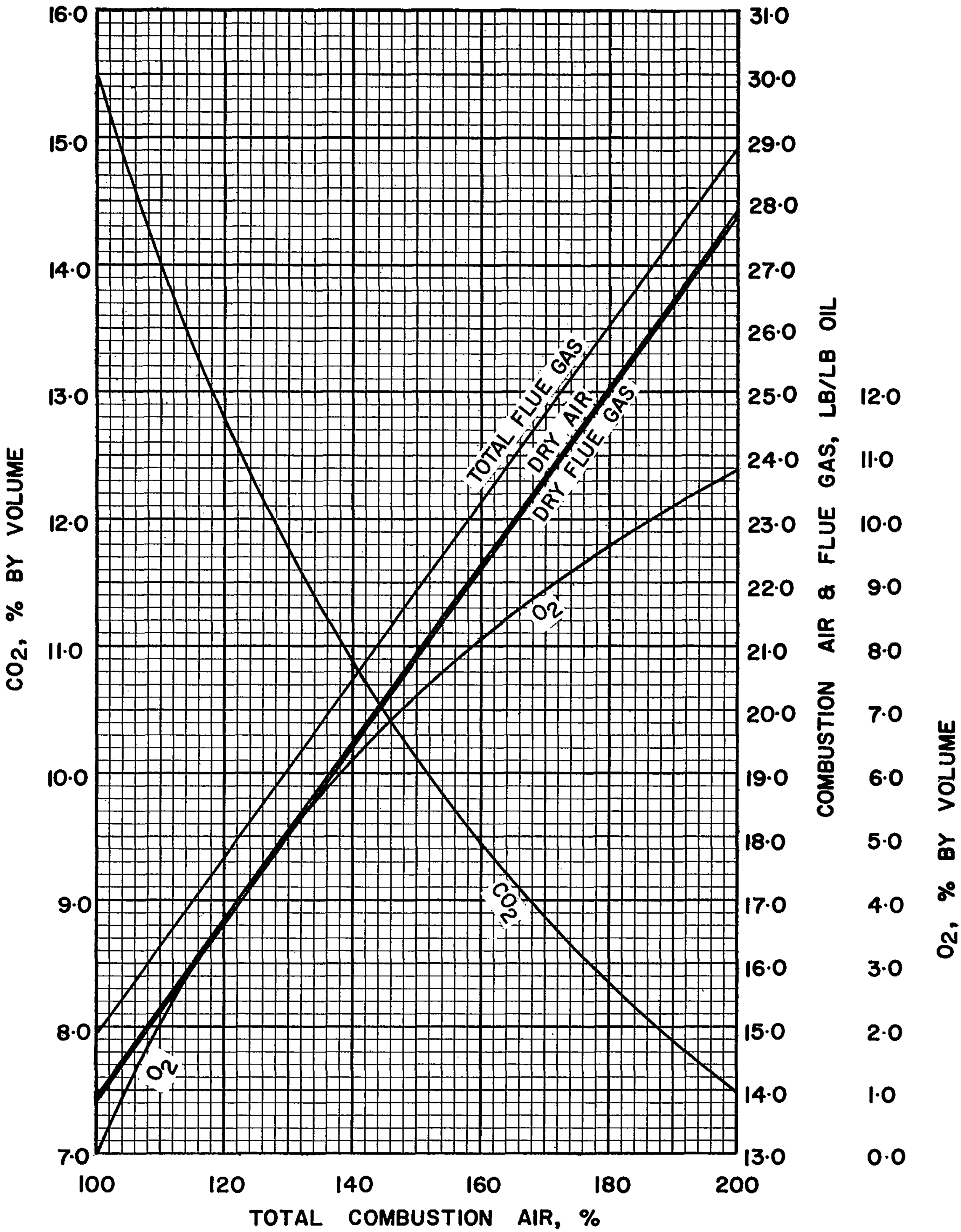


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS 9140

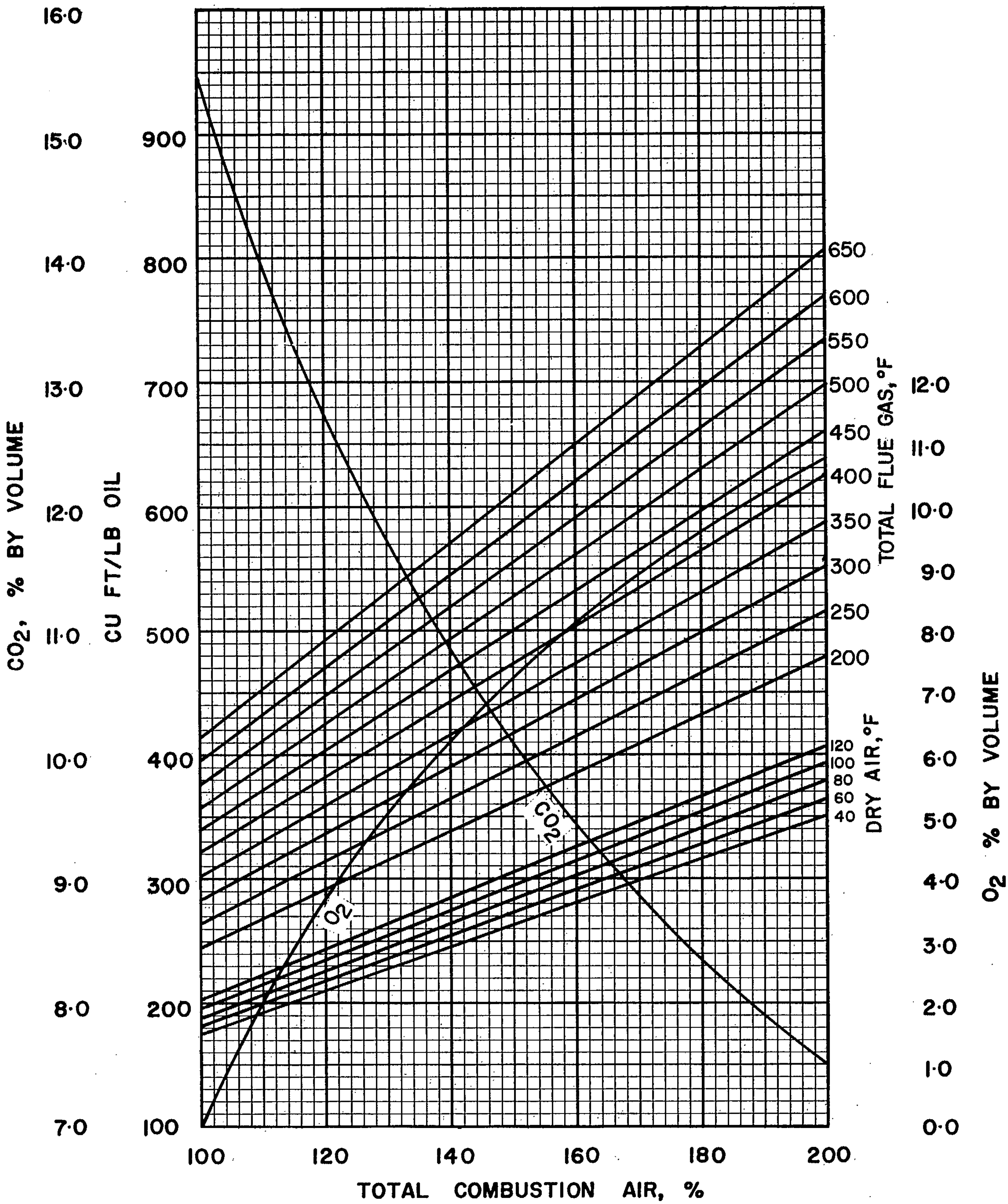


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 9140

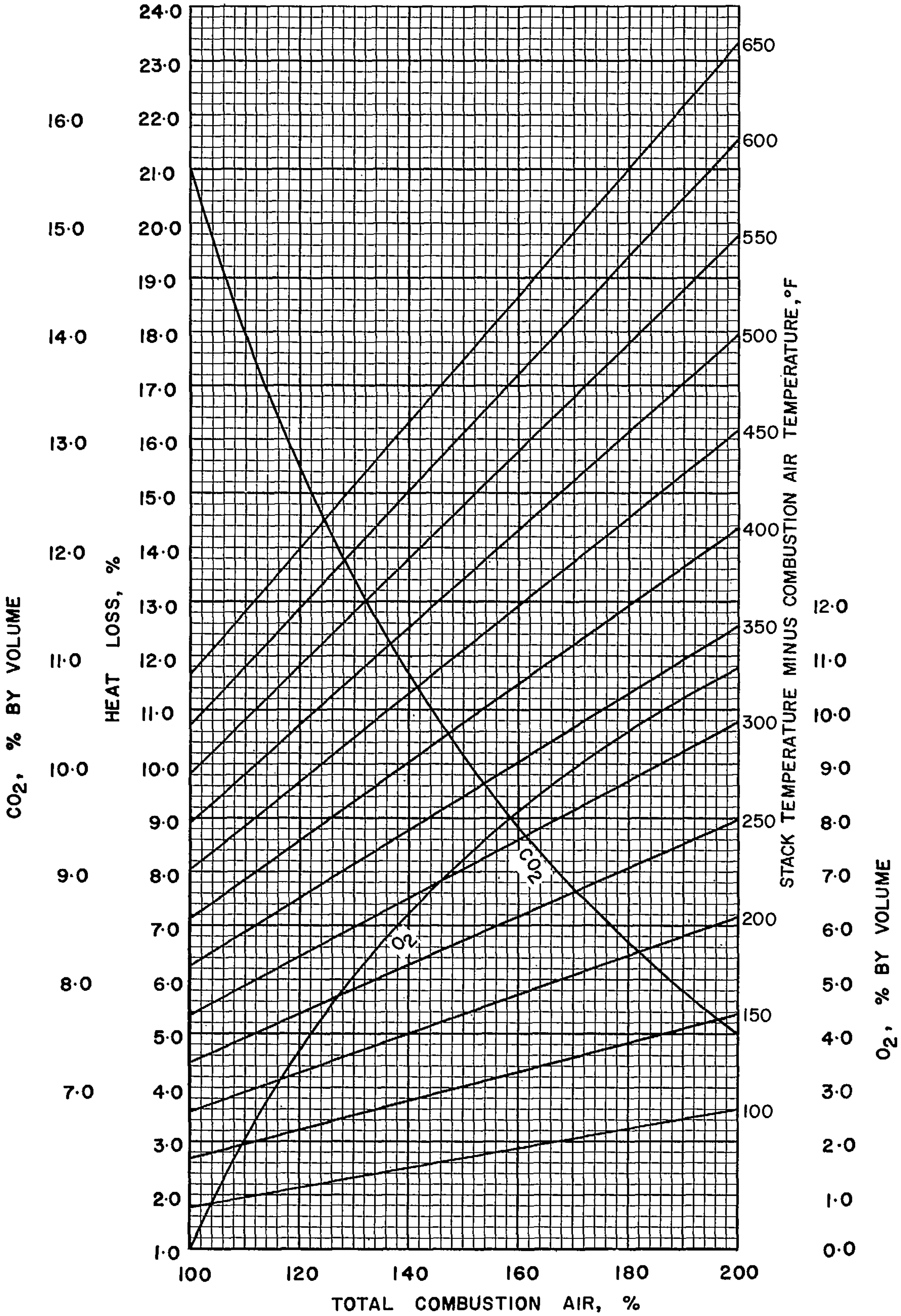


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

9140

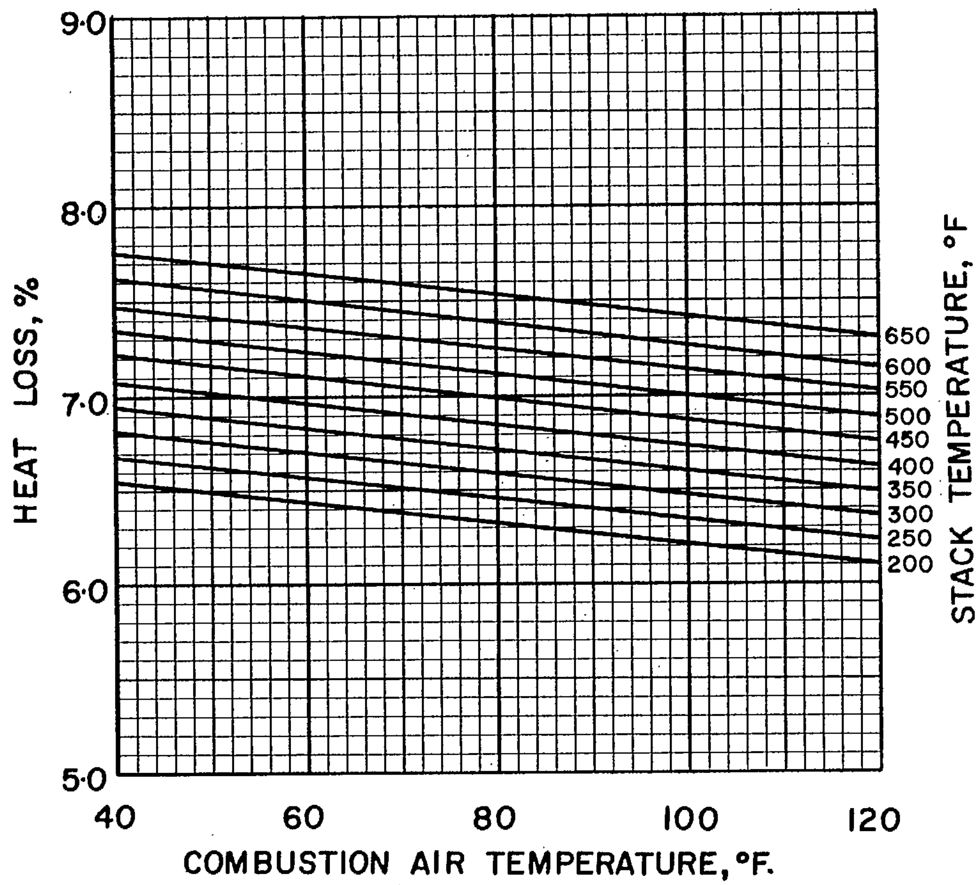


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

9140

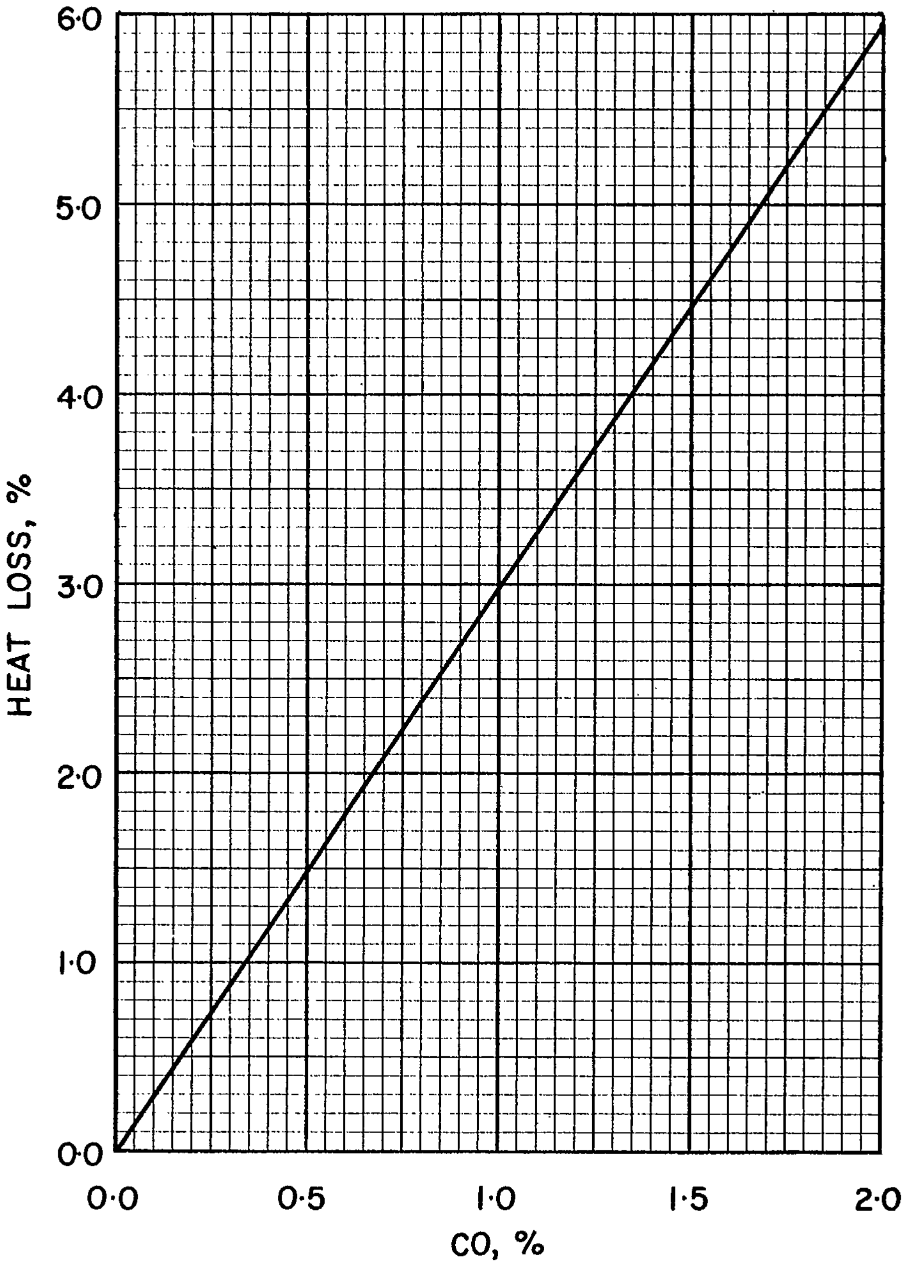


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

9140

FUEL OIL 9200, SPECIFIC GRAVITY 0.920

Ultimate Analysis, lb/lb

Carbon	(C)	0.8780
Hydrogen	(H_2)	0.1220
Sulphur	(S)	–
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		19,120

Conversion Factors

1 Imp gal oil = 9.200 lb oil
or Imp gal oil × 9.200 = lb oil
or lb oil × 0.1087 = Imp gal oil

1 U.S. gal oil = 9.200 × 0.8337 lb oil
or U.S. gal oil × 7.670 = lb oil
or lb oil × 0.1304 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{19{,}120} \text{ lb oil}$$

or Btu × 10^6 × 52.30 = lb oil
or lb oil × 0.0191 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{19{,}120 \times 9.200} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.685 = Imp gal oil
or Imp gal oil × 0.1759 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{19{,}120 \times 7.670} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.817 = U.S. gal oil
or U.S. gal oil × 0.1467 = Btu × 10^6

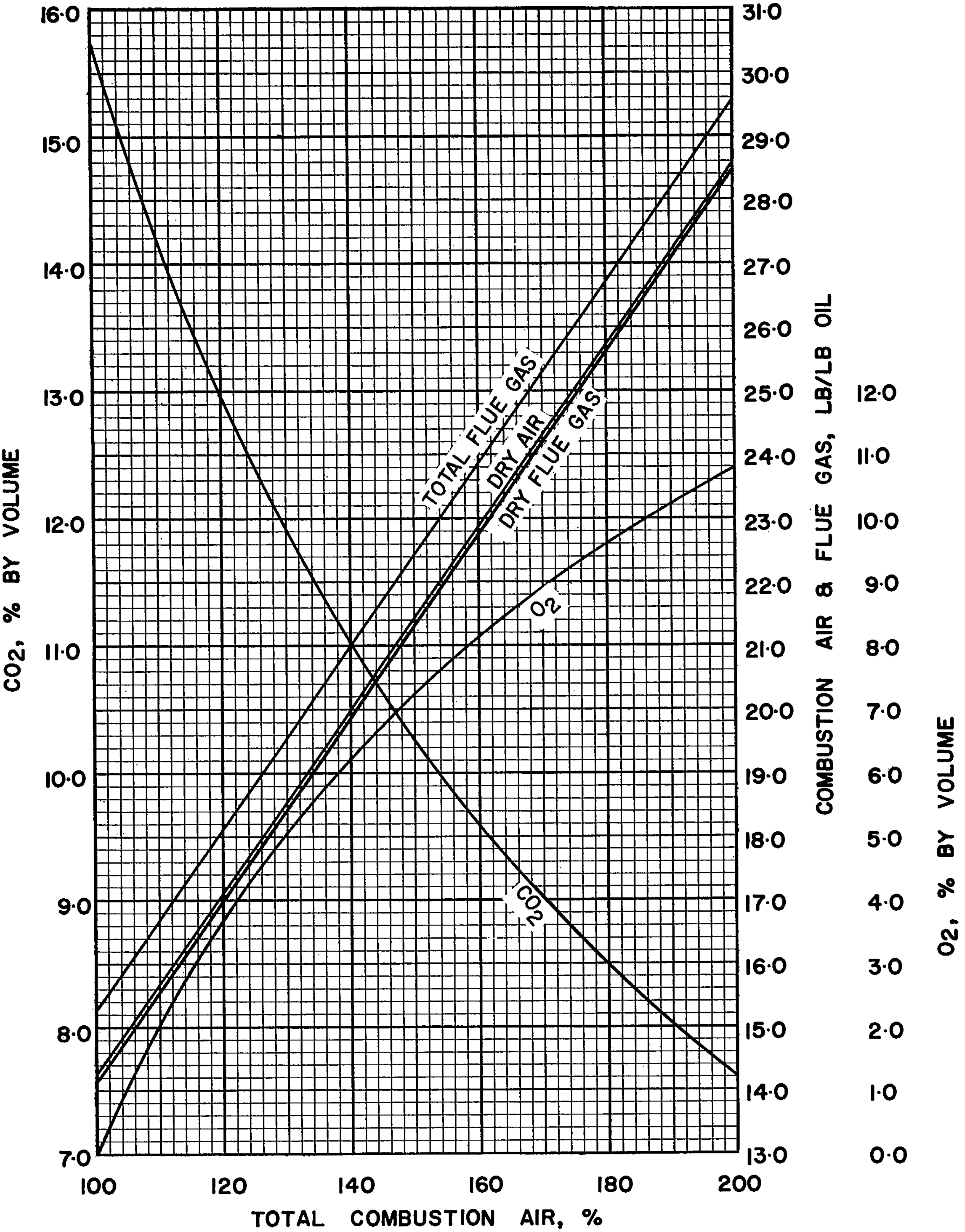


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS 9200

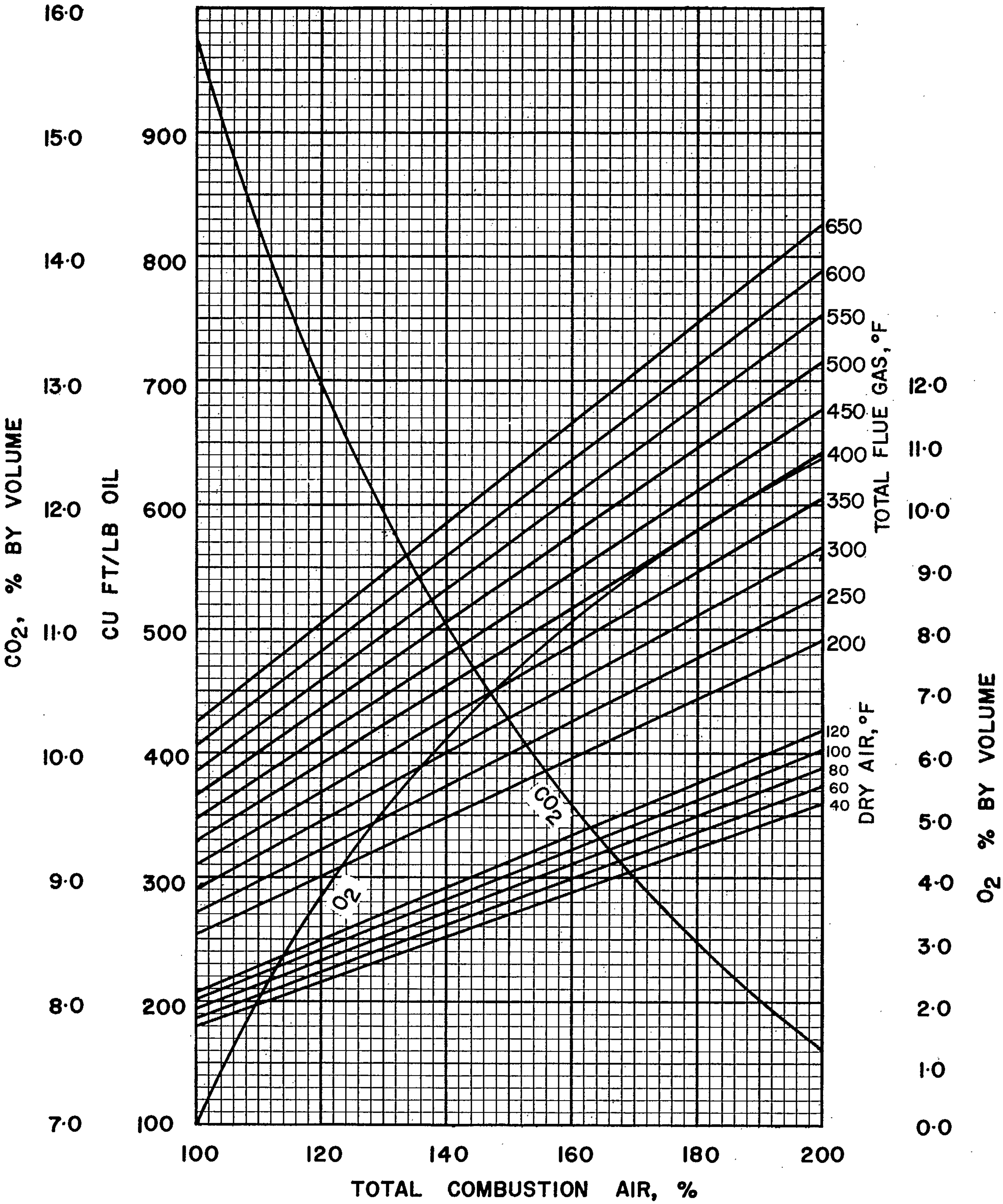


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 9200

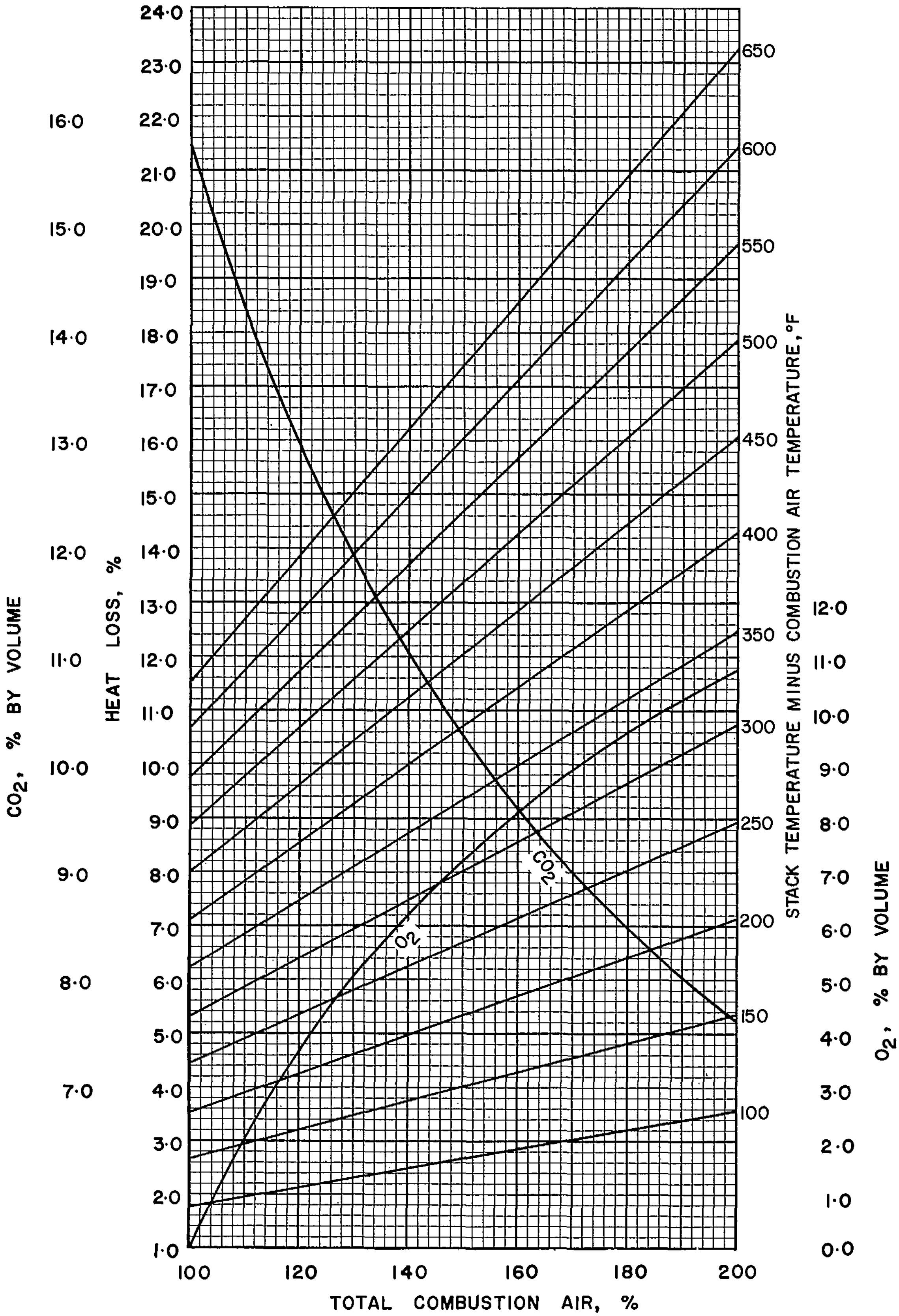


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

9200

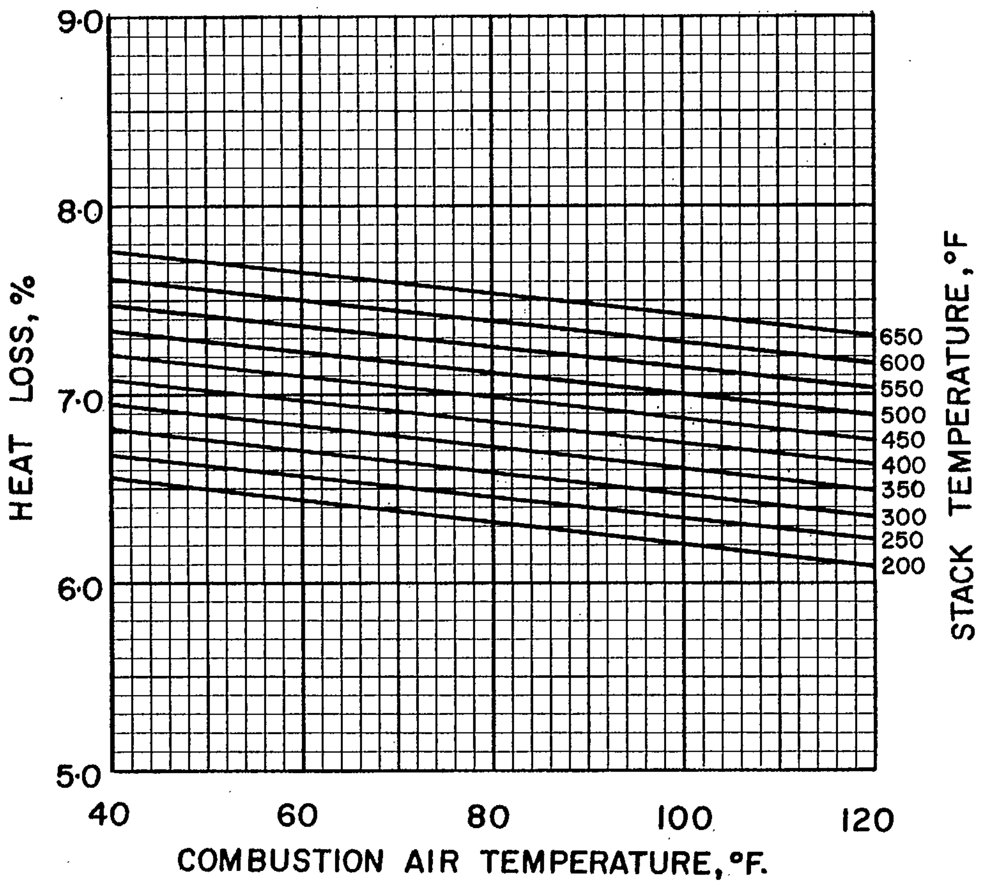


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

9200

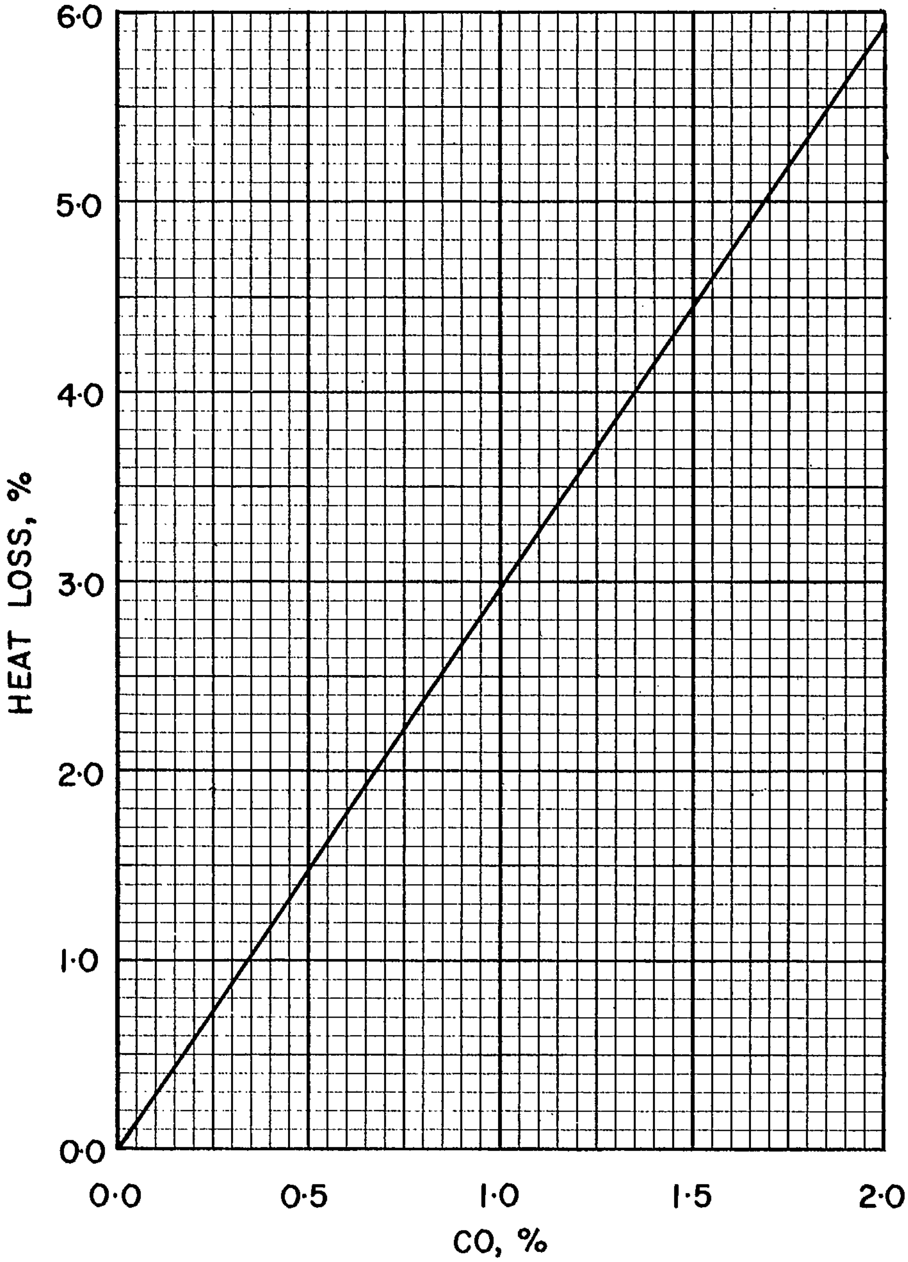


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

9200

FUEL OIL 9210, SPECIFIC GRAVITY 0.920

Ultimate Analysis, lb/lb

Carbon	(C)	0.8692
Hydrogen	(H_2)	0.1208
Sulphur	(S)	0.0100
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,970

Conversion Factors

1 Imp gal oil = 9.200 lb oil
or Imp gal oil × 9.200 = lb oil
or lb oil × 0.1087 = Imp gal oil

1 U.S. gal oil = 9.200 × 0.8337 lb oil
or U.S. gal oil × 7.670 = lb oil
or lb oil × 0.1304 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}970} \text{ lb oil}$$

or Btu × 10^6 × 52.72 = lb oil
or lb oil × 0.0190 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}970 \times 9.20} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.730 = Imp gal oil
or Imp gal oil × 0.1745 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}970 \times 7.670} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.873 = U.S. gal oil
or U.S. gal oil × 0.1455 = Btu × 10^6

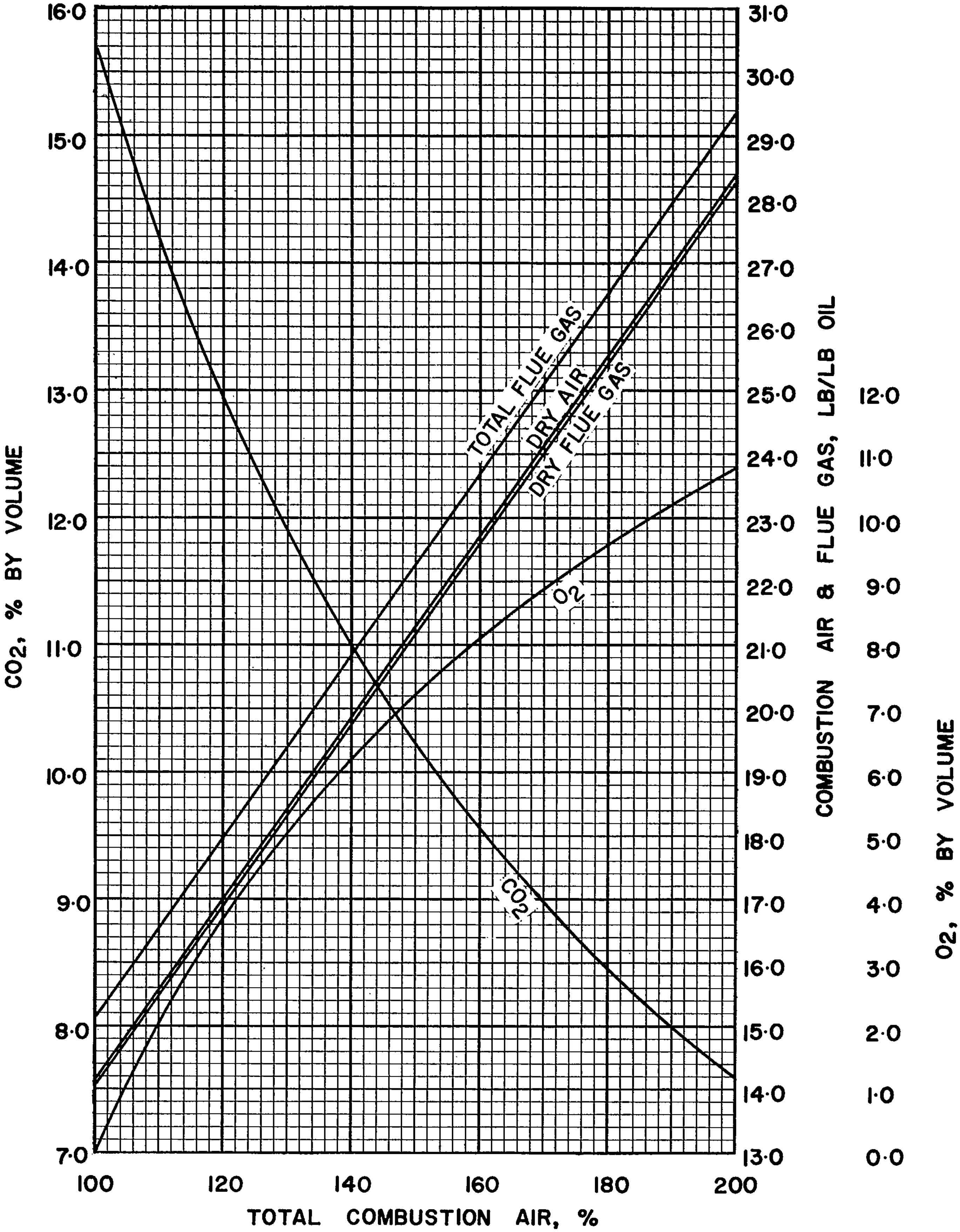


FIGURE I· COMBUSTION DATA, WEIGHT BASIS 9210

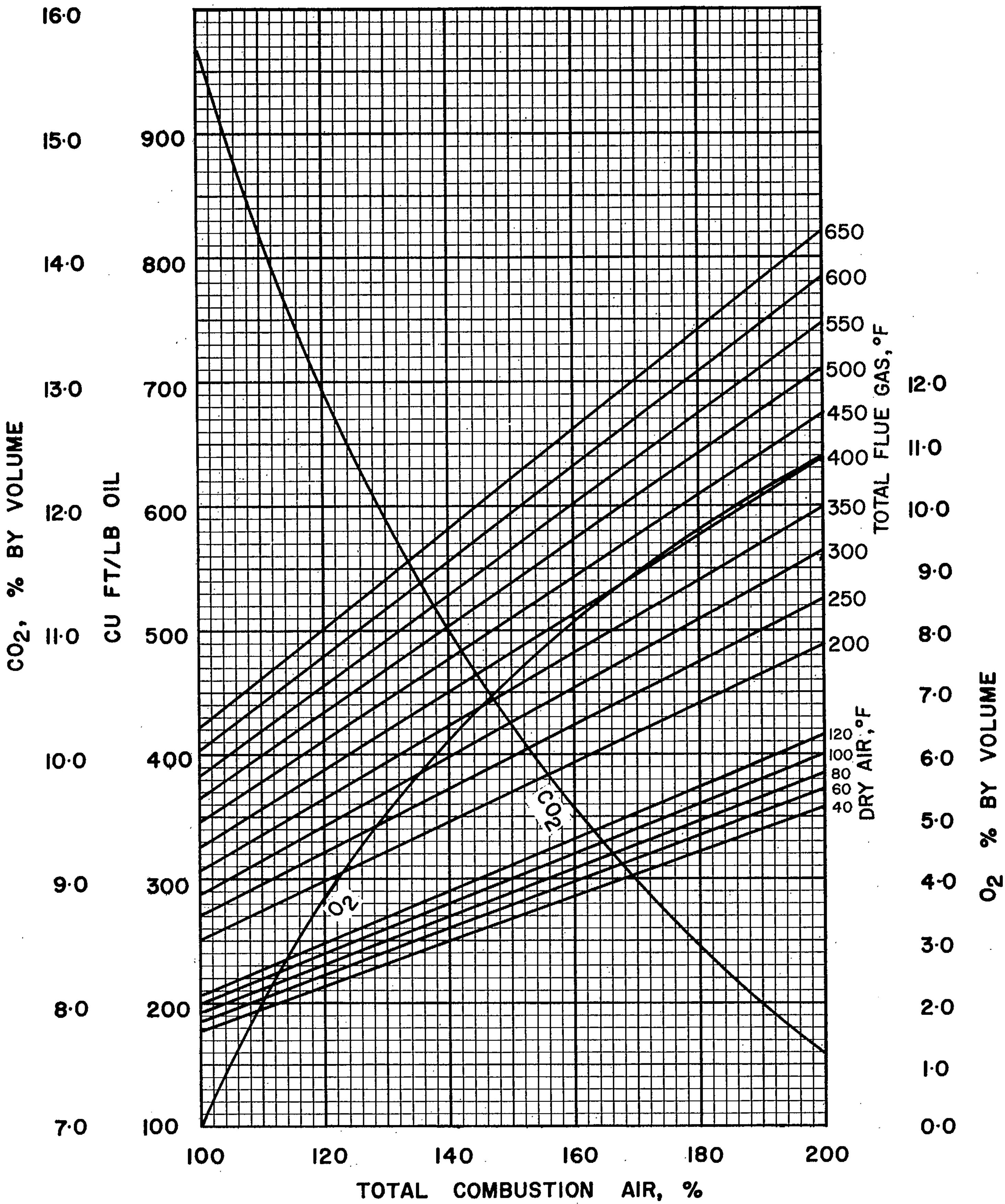


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 9210

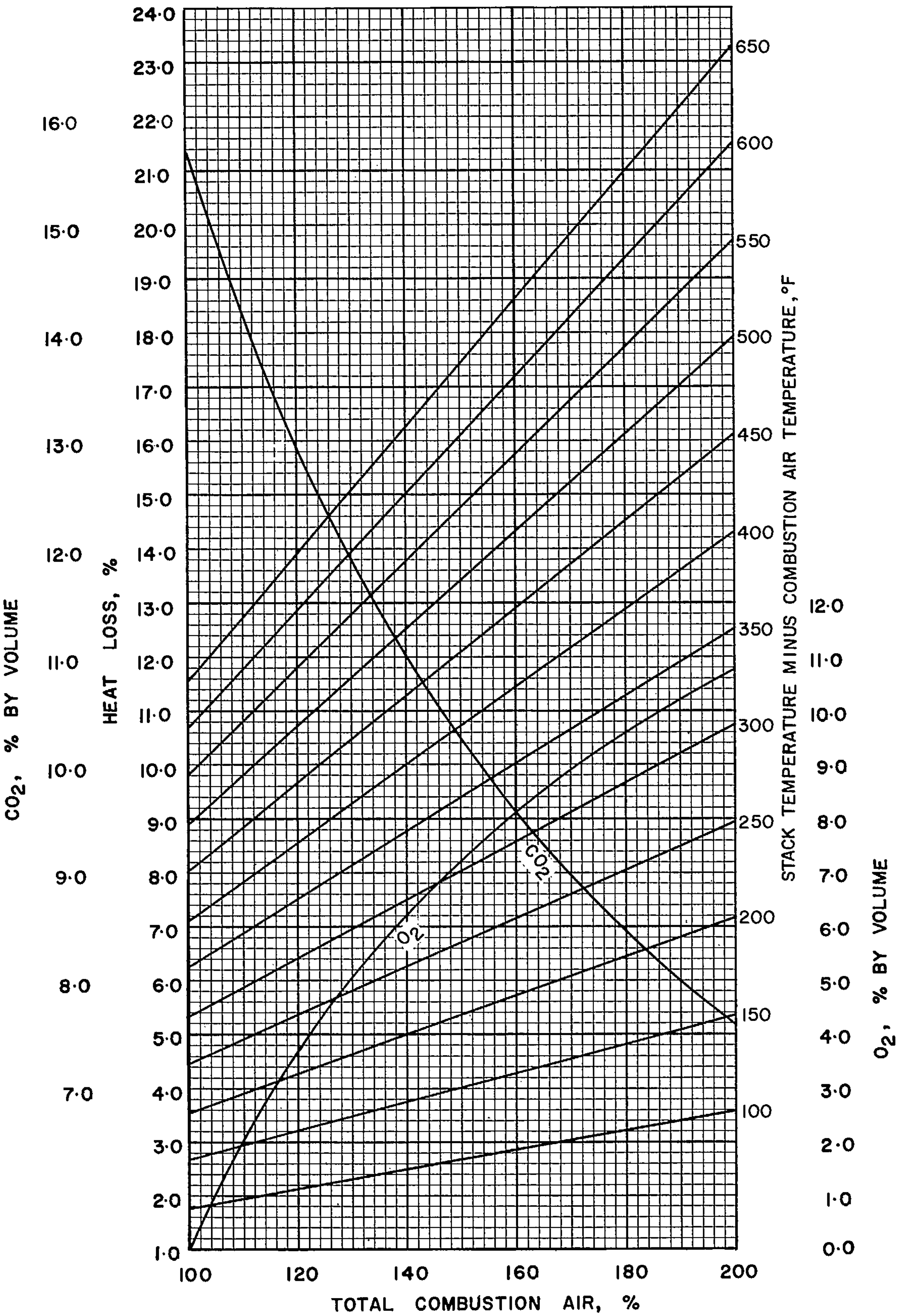


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

9210

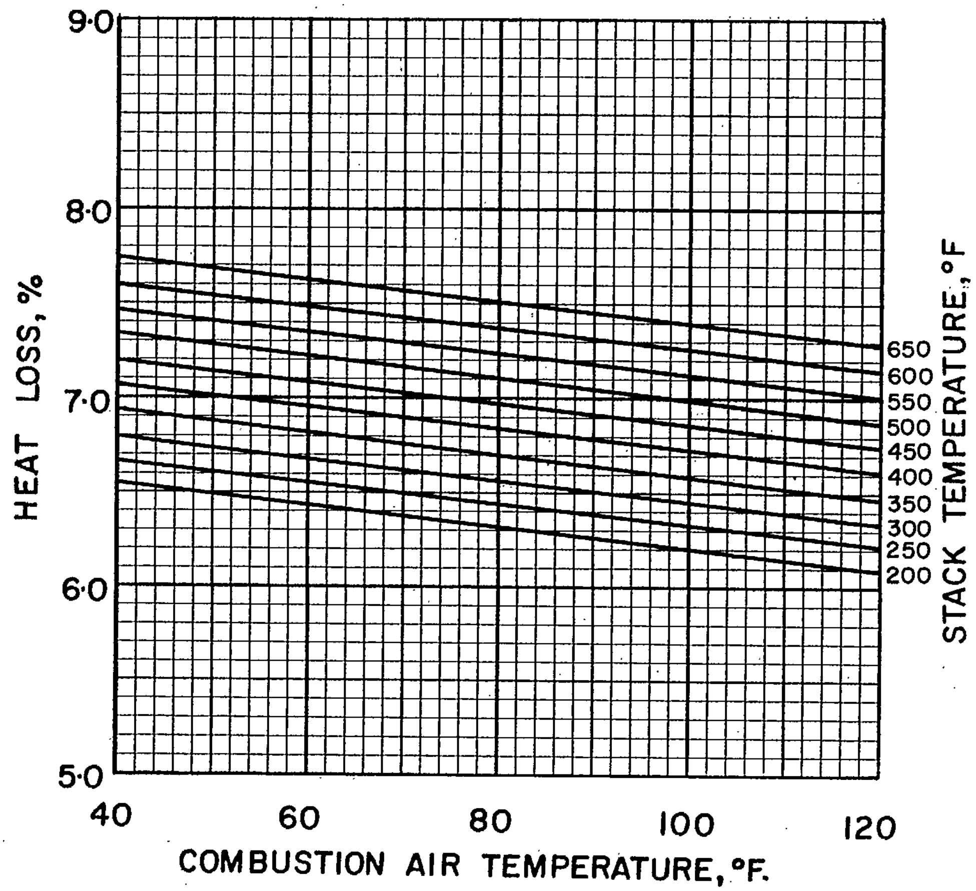


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

9210

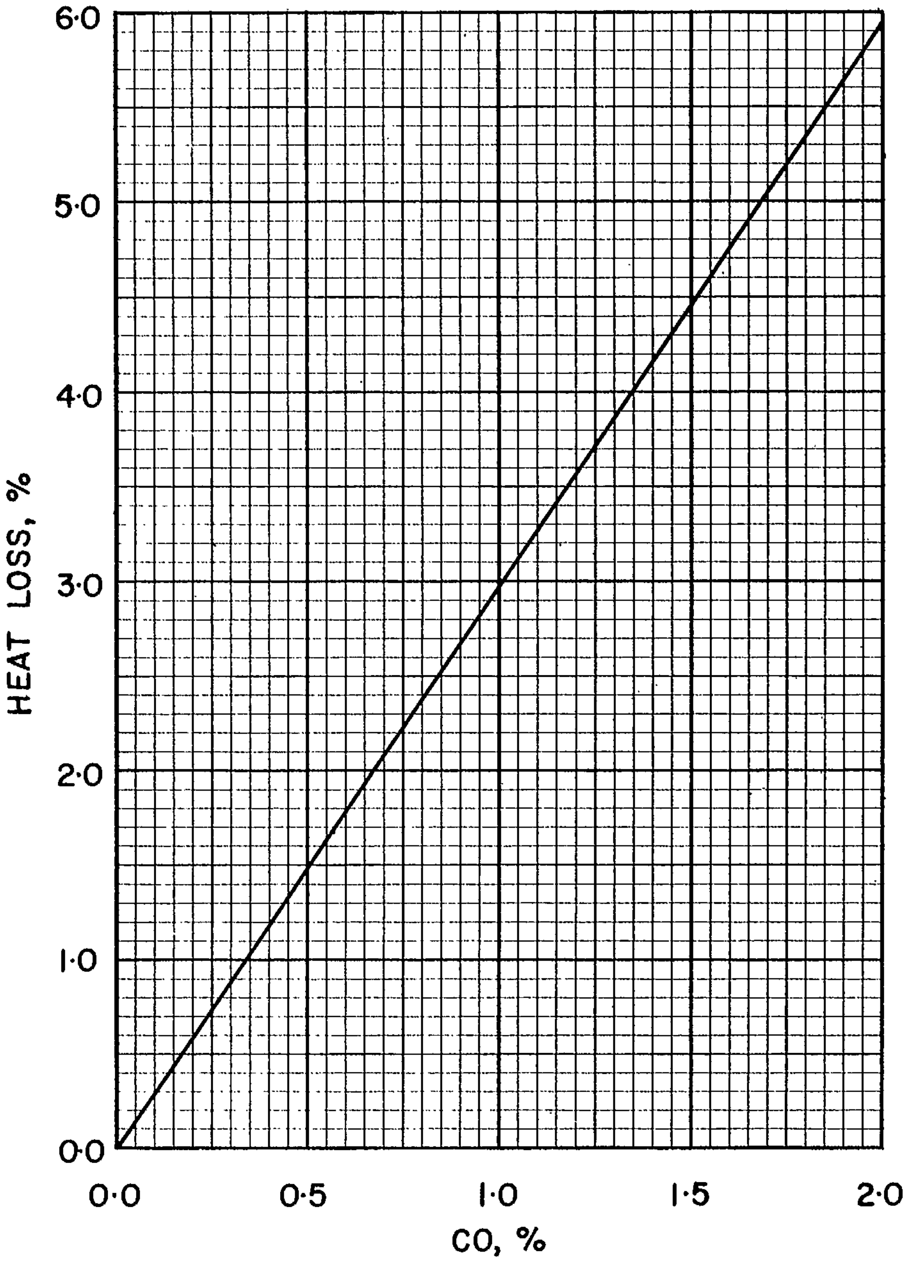


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR. 9210

FUEL OIL 9220, SPECIFIC GRAVITY 0.920

Ultimate Analysis, lb/lb

Carbon	(C)	0.8604
Hydrogen	(H_2)	0.1196
Sulphur	(S)	0.0200
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,820

Conversion Factors

1 Imp gal oil = 9.20 lb oil
or Imp gal oil × 9.20 = lb oil
or lb oil × 0.1087 = Imp gal oil

1 U.S. gal oil = 9.20 × 0.8337 lb oil
or U.S. gal oil × 7.670 = lb oil
or lb oil × 0.1304 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}820} \text{ lb oil}$$

or Btu × 10^6 × 53.14 = lb oil
or lb oil × 0.0188 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}820 \times 9.20} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.776 = Imp gal oil
or Imp gal oil × 0.1731 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}820 \times 7.670} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.930 = U.S. gal oil
or U.S. gal oil × 0.1443 = Btu × 10^6

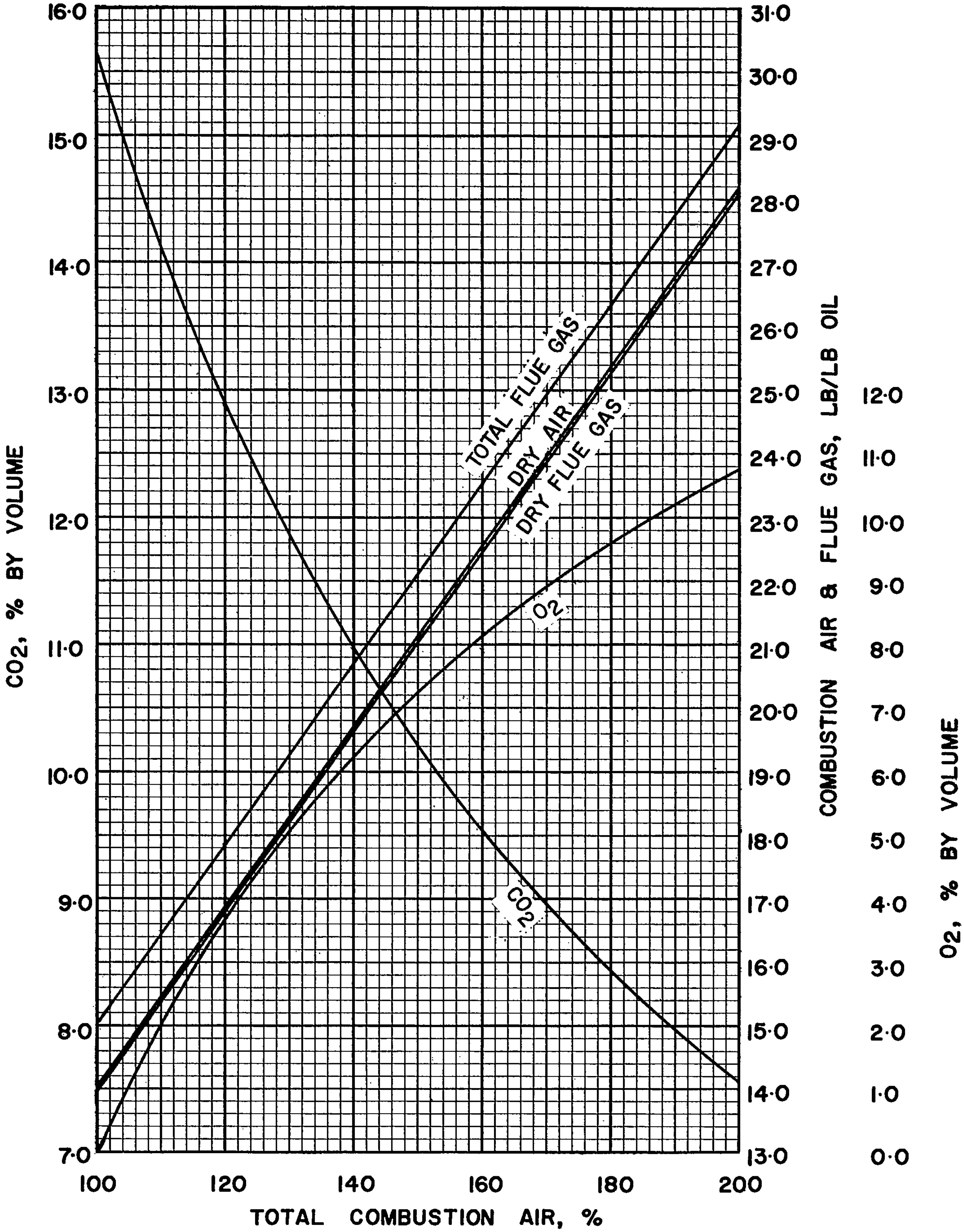


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS

9220

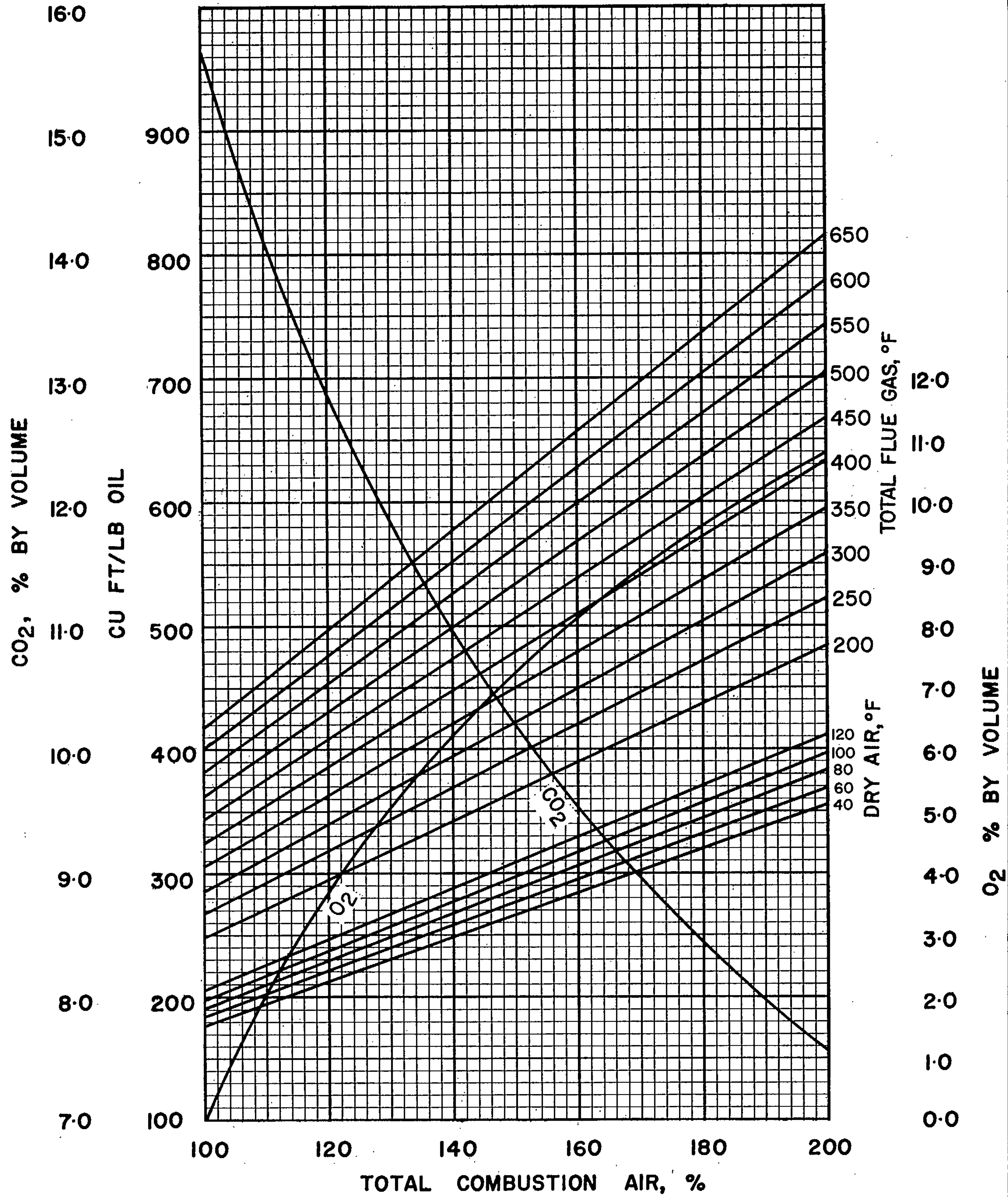


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 9220

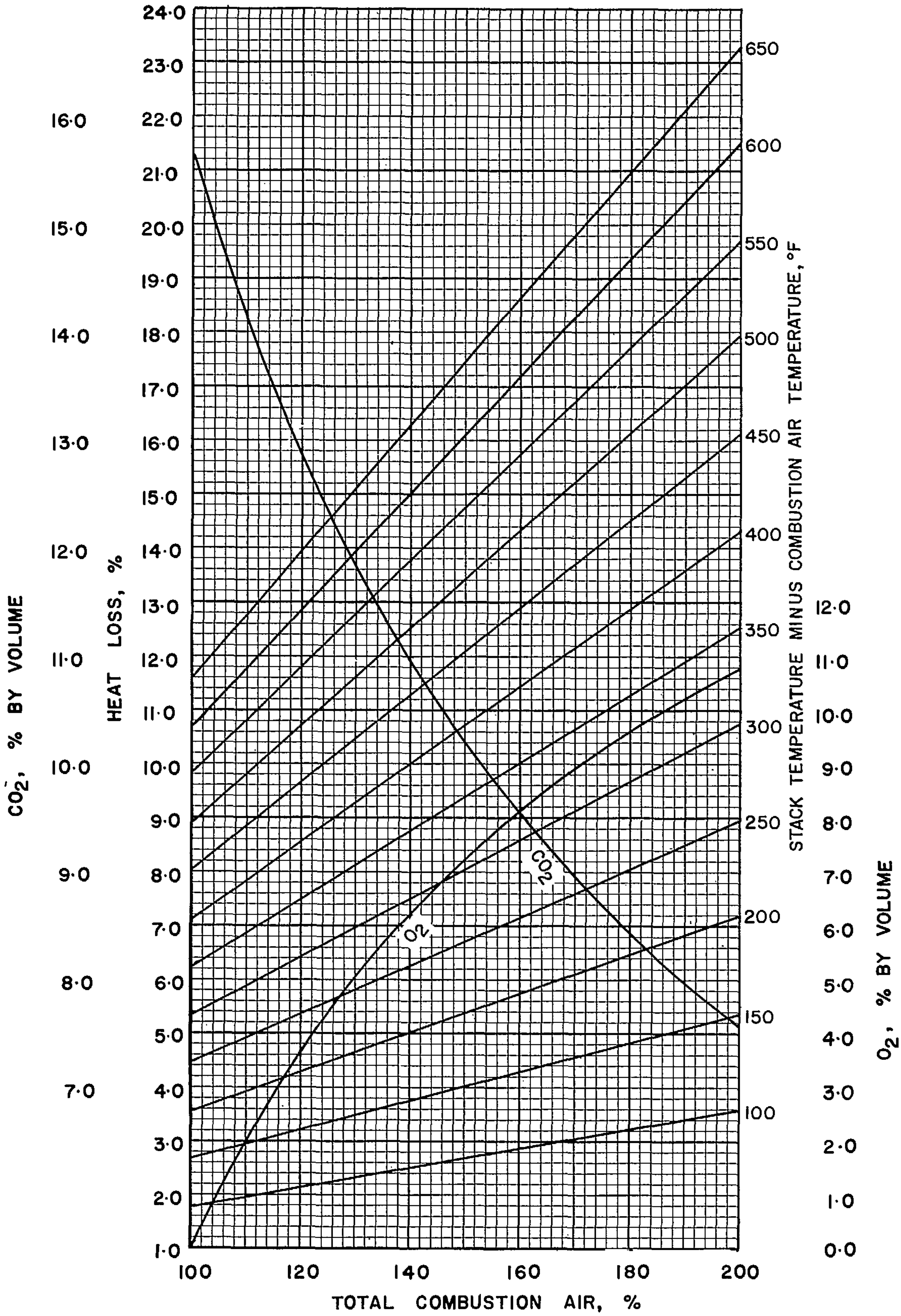


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

9220

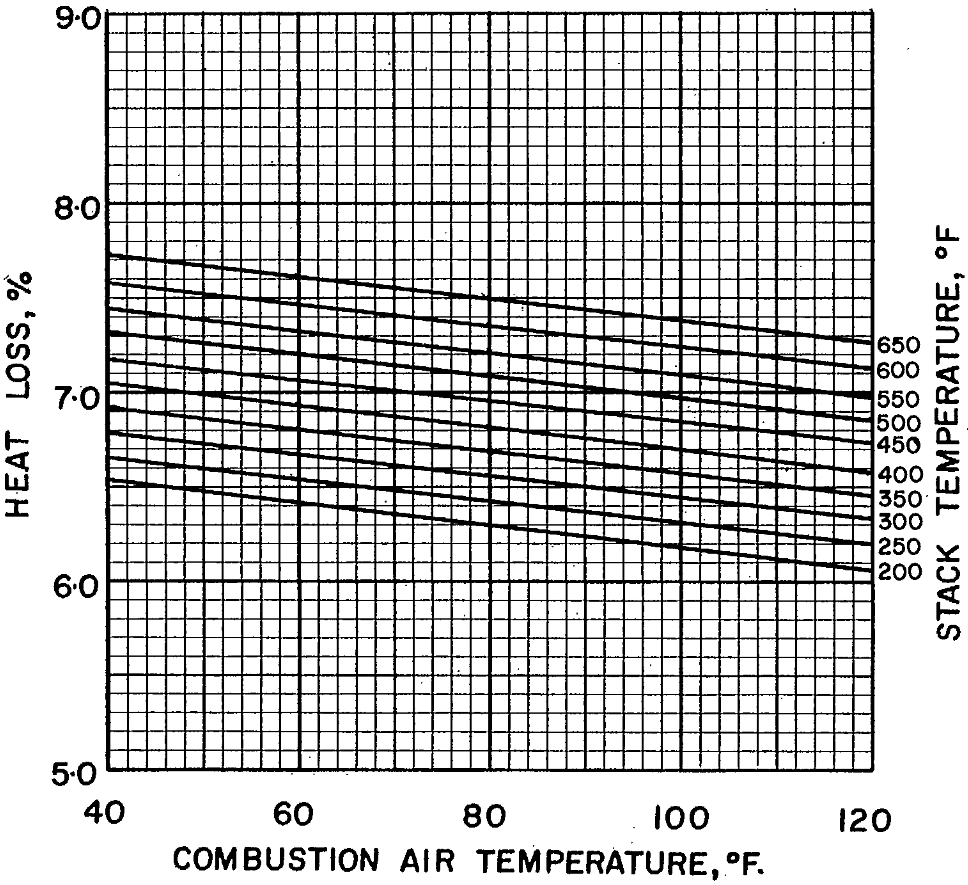


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

9220

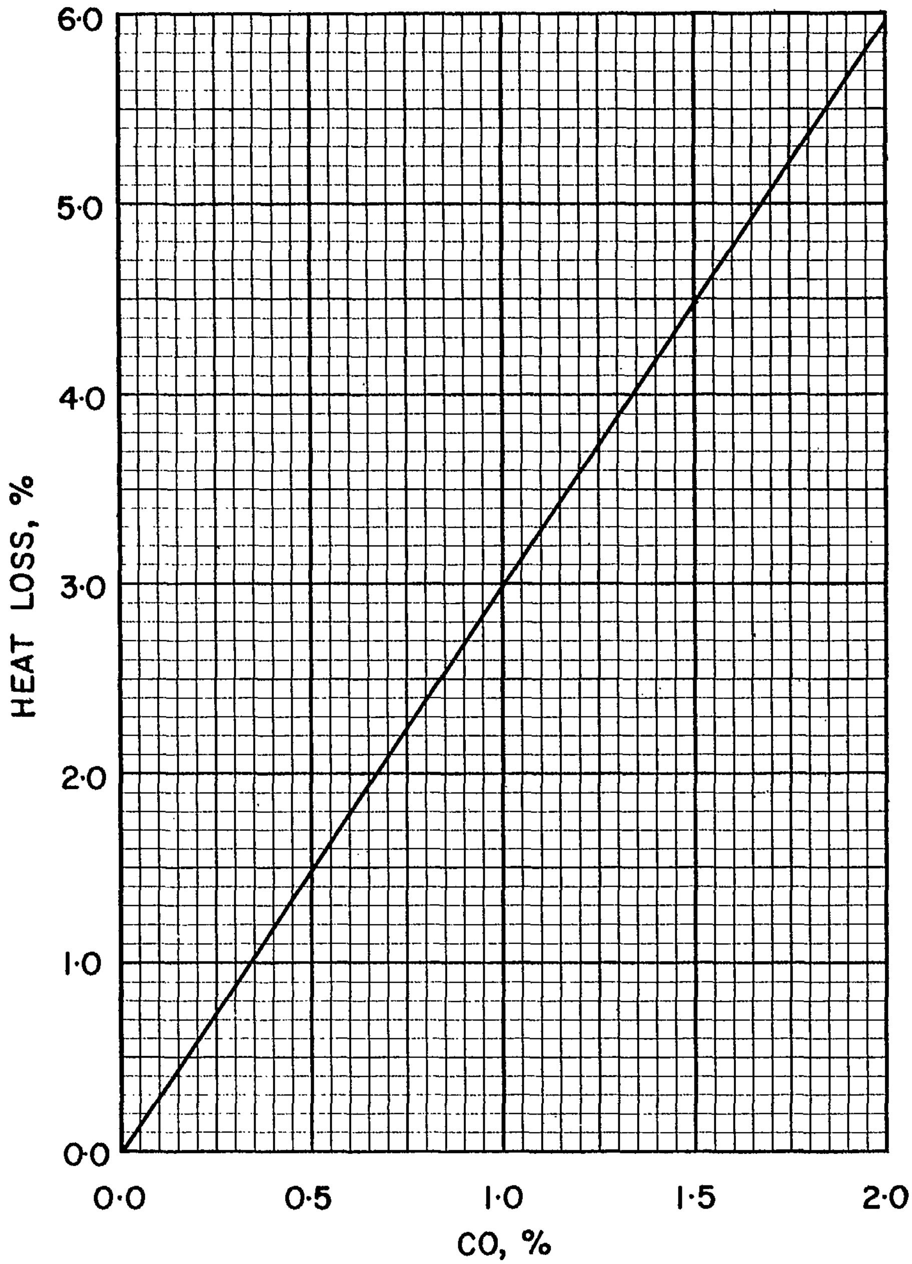


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

9220

FUEL OIL 9230, SPECIFIC GRAVITY 0.920

Ultimate Analysis, lb/lb

Carbon	(C)	0.8517
Hydrogen	(H_2)..............	0.1183
Sulphur	(S)	0.0300
Nitrogen	(N_2)..............	–
Oxygen	(O_2)..............	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,670

Conversion Factors

1 Imp gal oil = 9.20 lb oil
or Imp gal oil × 9.20 = lb oil
or lb oil × 0.1087 = Imp gal oil

1 U.S. gal oil = 9.20 × 0.8337 lb oil
or U.S. gal oil × 7.670 = lb oil
or lb oil × 0.1304 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}670} \text{ lb oil}$$

or Btu × 10^6 × 53.56 = lb oil
or lb oil × 0.0187 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}670 \times 9.20} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.822 = Imp gal oil
or Imp gal oil × 0.1718 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}670 \times 7.670} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.983 = U.S. gal oil
or U.S. gal oil × 0.1432 = Btu × 10^6

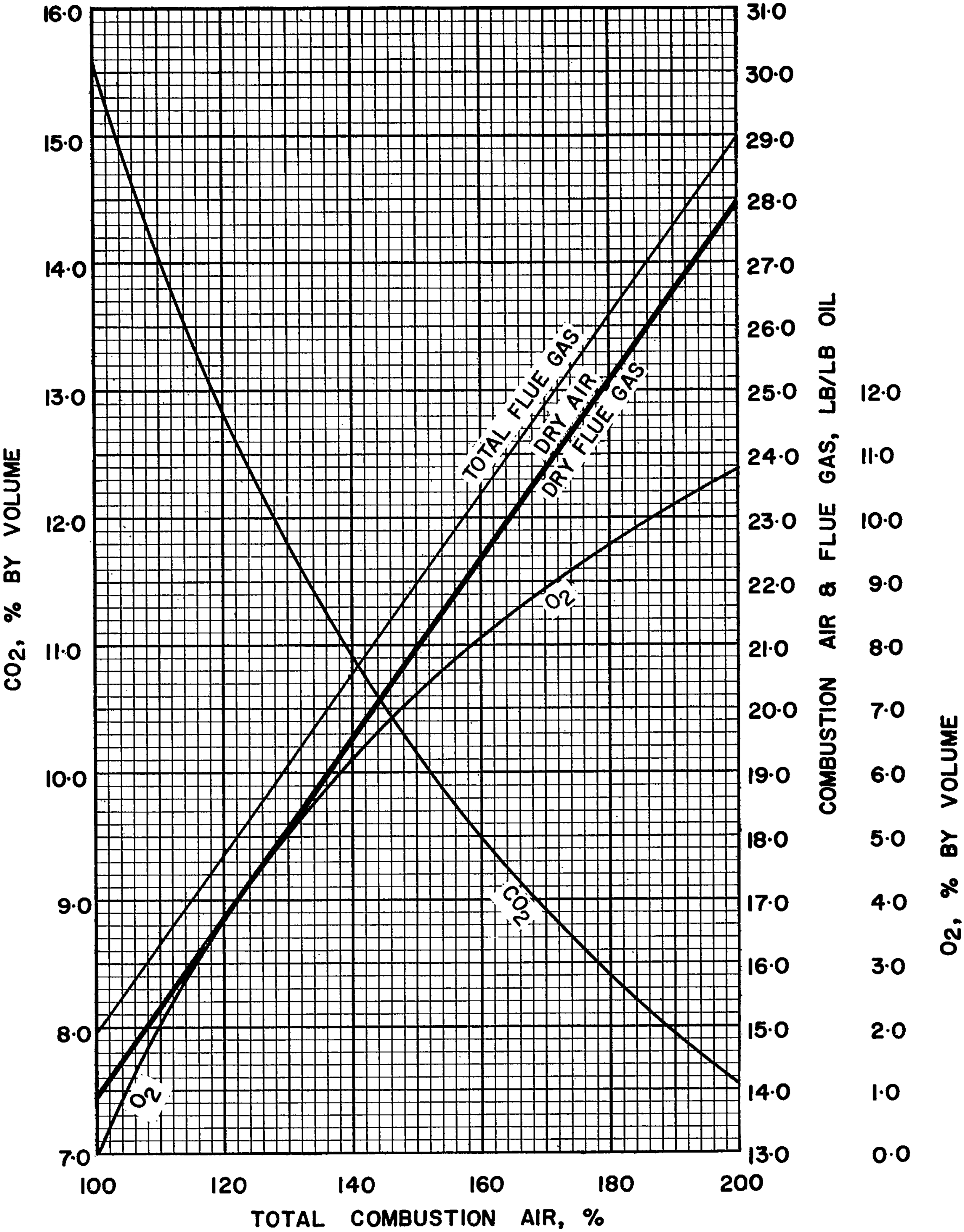


FIGURE I· COMBUSTION DATA, WEIGHT BASIS 9230

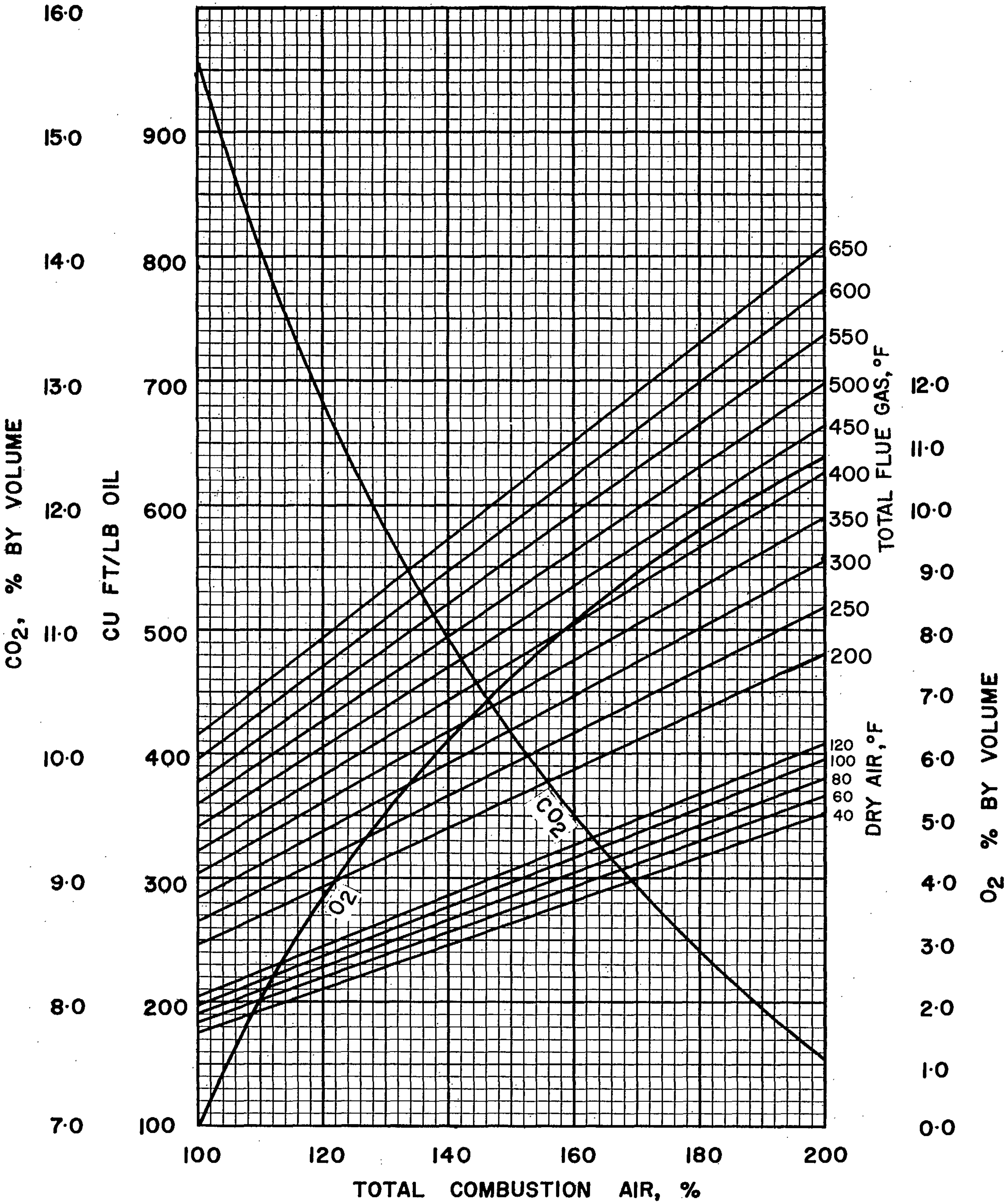


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 9230

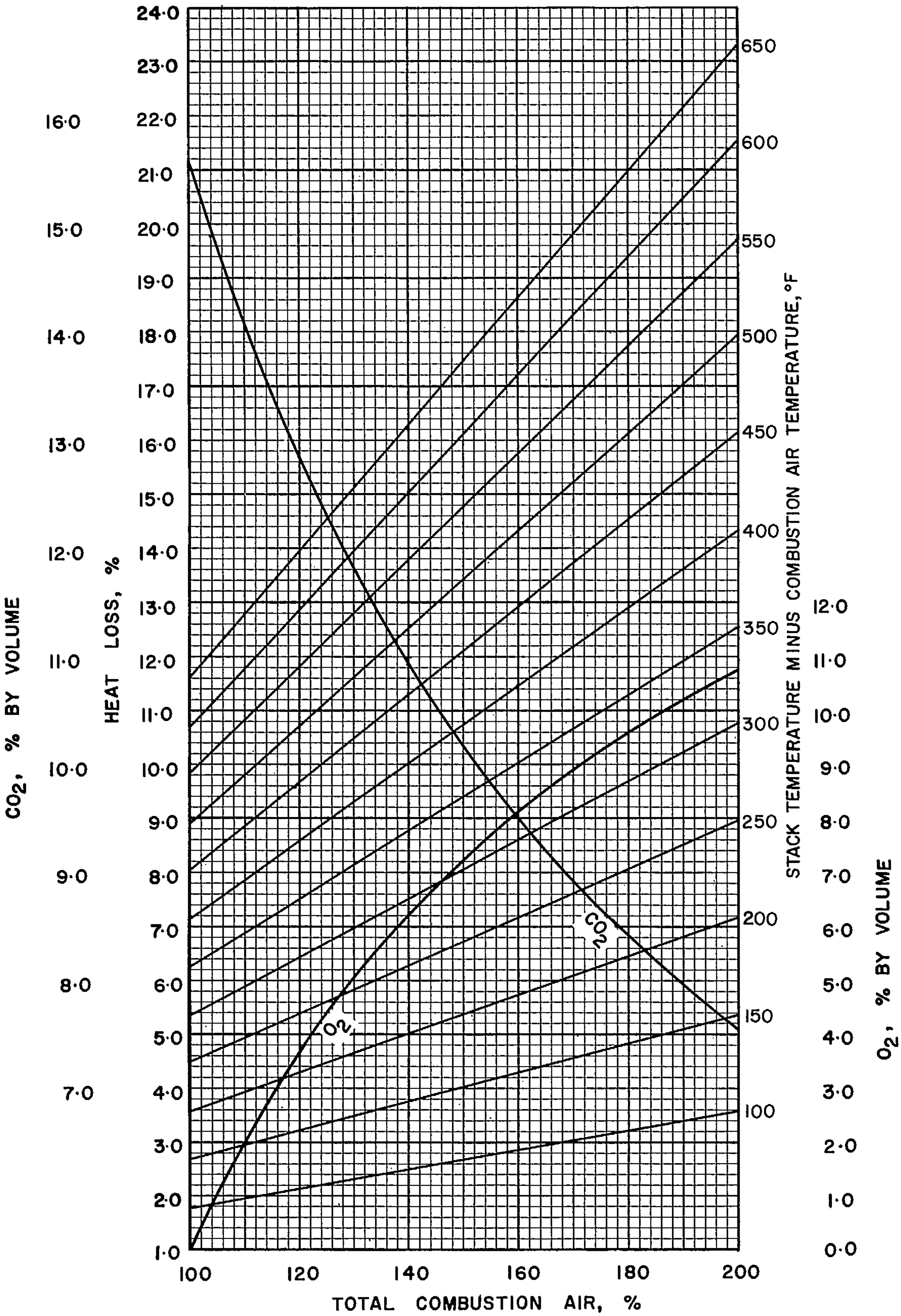


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

9230

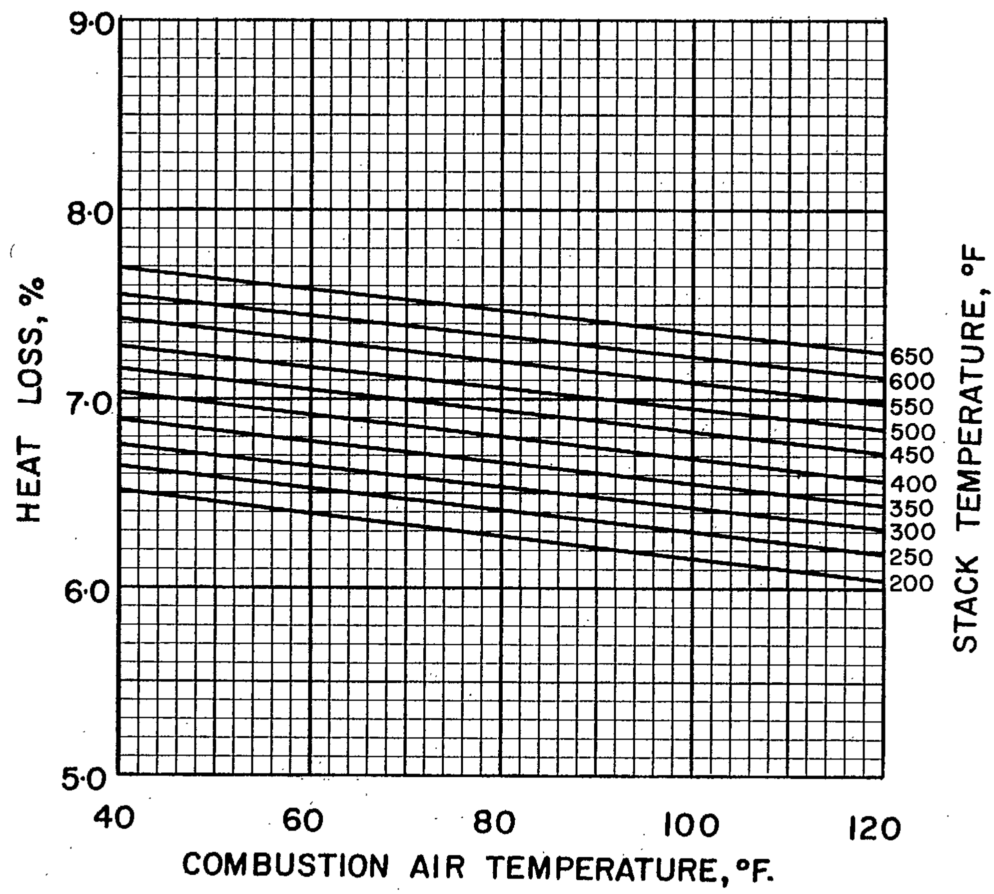


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

9230

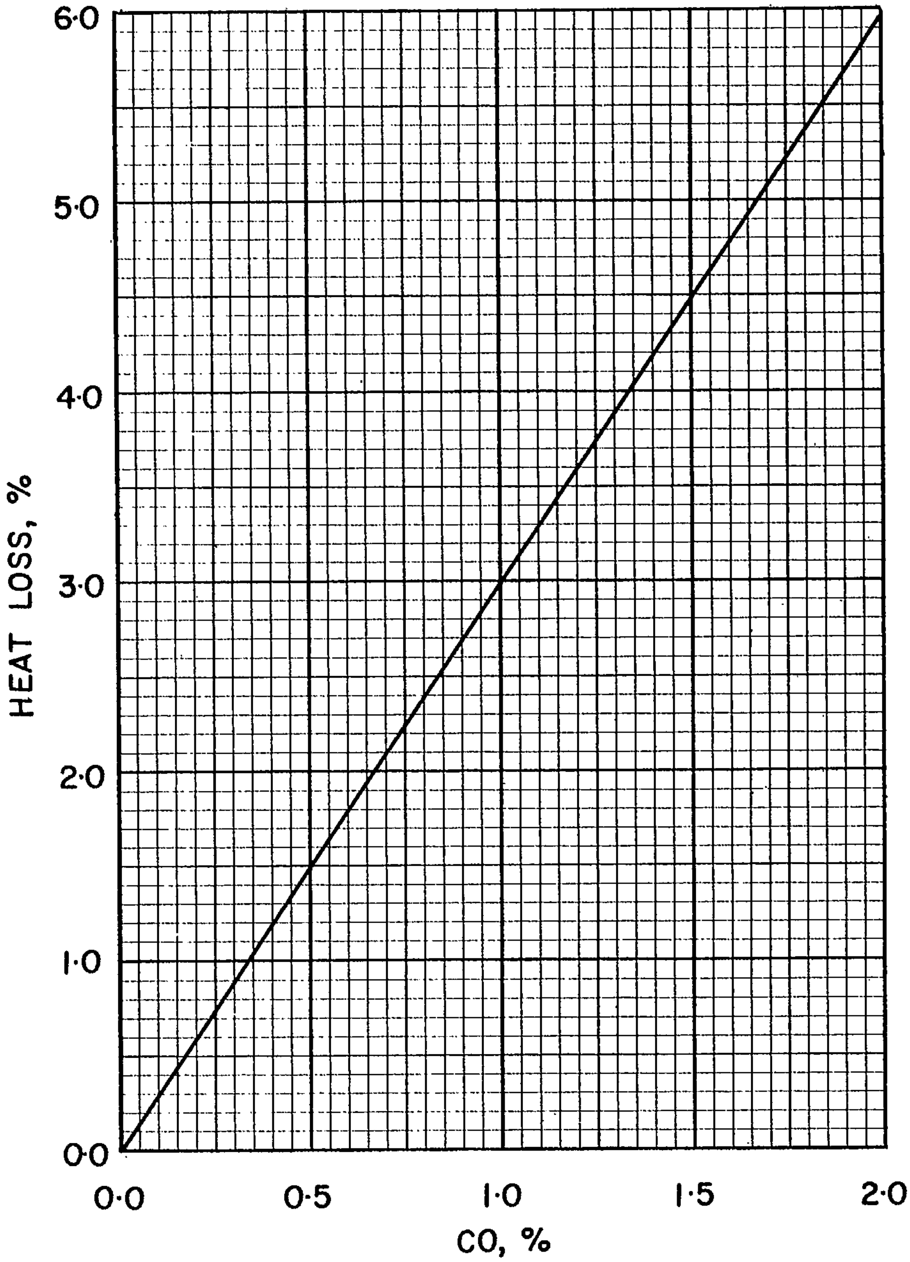


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR. 9230

FUEL OIL 9240, SPECIFIC GRAVITY 0.920

Ultimate Analysis, lb/lb

Carbon	(C)	0.8429
Hydrogen	(H_2)	0.1171
Sulphur	(S)	0.0400
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,520

Conversion Factors

1 Imp gal oil = 9.20 lb oil
or Imp gal oil × 9.20 = lb oil
or lb oil × 0.1087 = Imp gal oil

1 U.S. gal oil = 9.20 × 0.8337 lb oil
or U.S. gal oil × 7.670 = lb oil
or lb oil × 0.1304 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}520} \text{ lb oil}$$

or Btu × 10^6 × 54.00 = lb oil
or lb oil × 0.0185 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}520 \times 9.20} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.869 = Imp gal oil
or Imp gal oil × 0.1704 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}520 \times 7.670} \text{ U.S. gal oil}$$

or Btu × 10^6 × 7.042 = U.S. gal oil
or U.S. gal oil × 0.1420 = Btu × 10^6

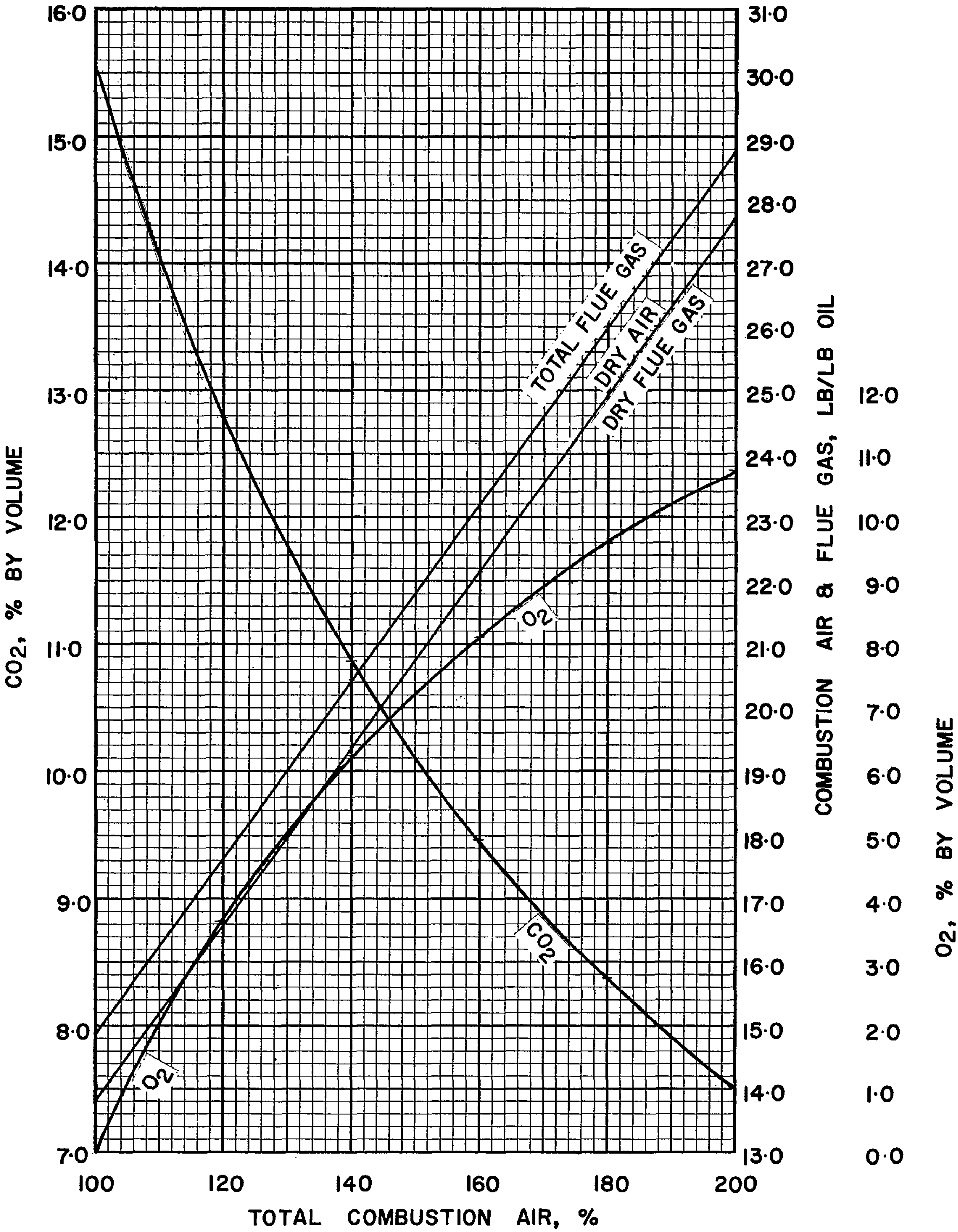


FIGURE I· COMBUSTION DATA, WEIGHT BASIS 9240

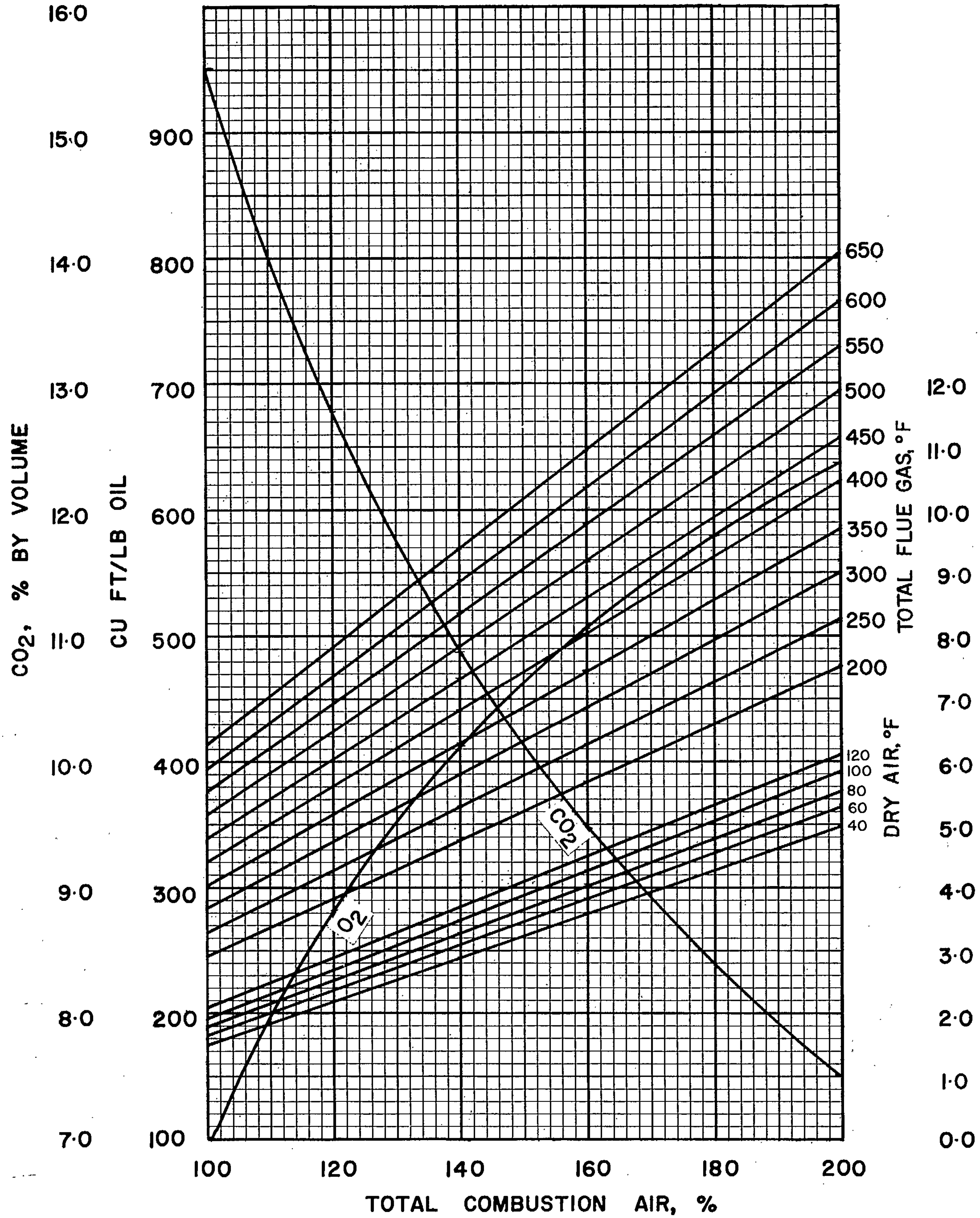


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 9240

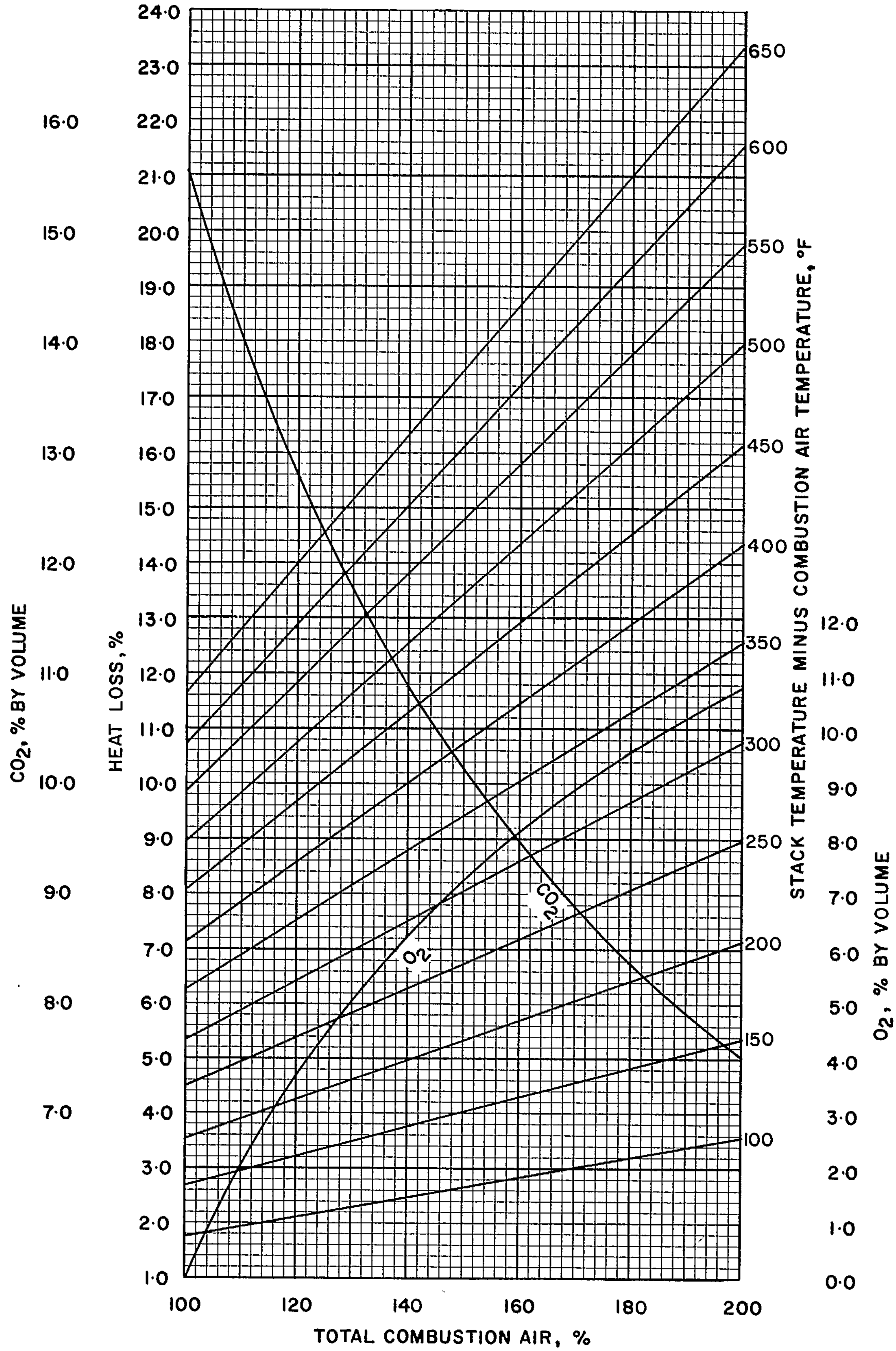


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS.

9240

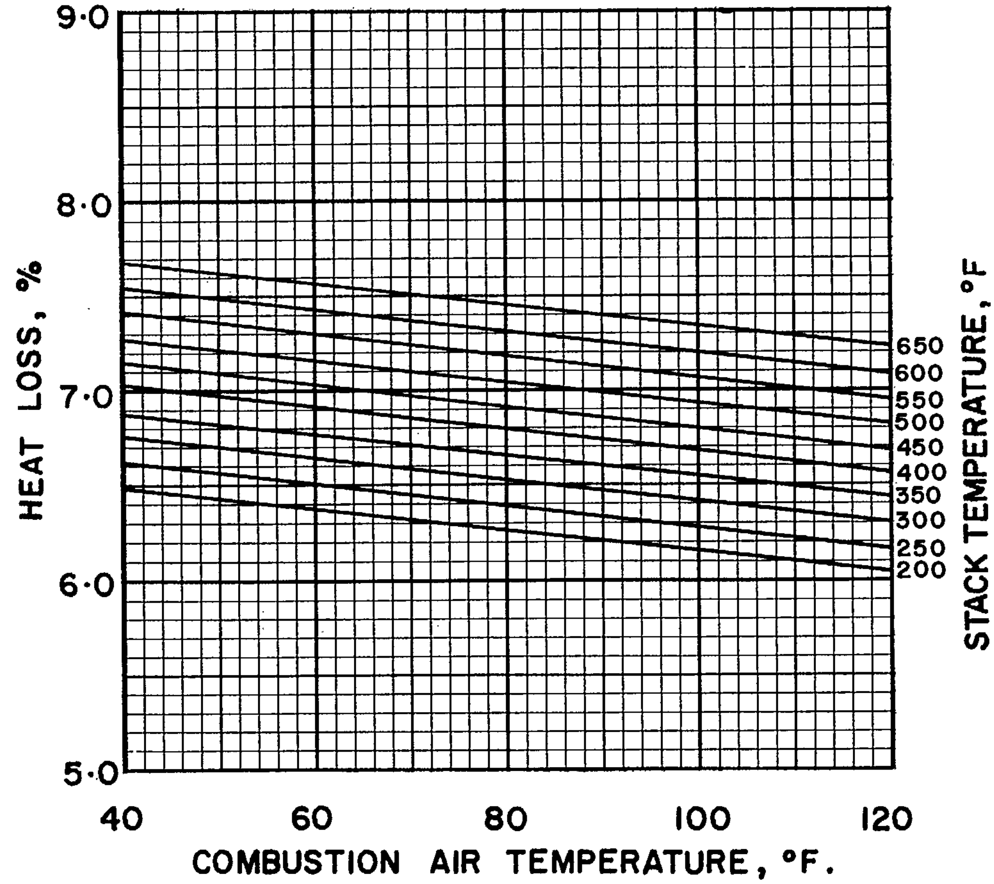


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

9240

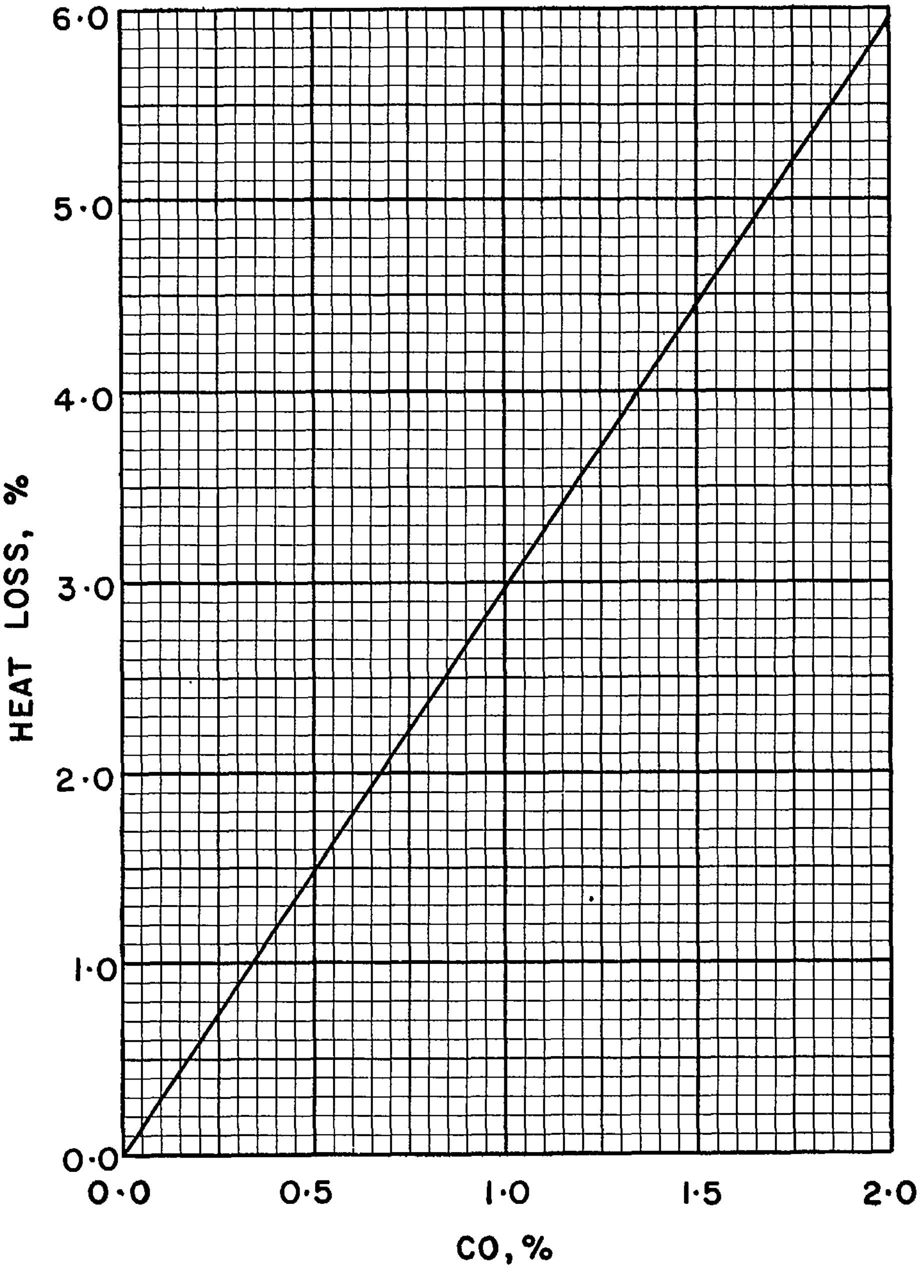


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

9240

FUEL OIL 9300, SPECIFIC GRAVITY 0.930

Ultimate Analysis, lb/lb

Carbon	(C)	0.8795
Hydrogen	(H_2)	0.1205
Sulphur	(S)	–
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		19,050

Conversion Factors

1 Imp gal oil = 9.30 lb oil
or Imp gal oil × 9.30 = lb oil
or lb oil × 0.1075 = Imp gal oil

1 U.S. gal oil = 9.30 × 0.8337 lb oil
or U.S. gal oil × 7.753 = lb oil
or lb oil × 0.1290 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{19{,}050} \text{ lb oil}$$

or Btu × 10^6 × 52.49 = lb oil
or lb oil × 0.0191 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{19{,}050 \times 9.30} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.645 = Imp gal oil
or Imp gal oil × 0.1772 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{19{,}050 \times 7.753} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.770 = U.S. gal oil
or U.S. gal oil × 0.1477 = Btu × 10^6

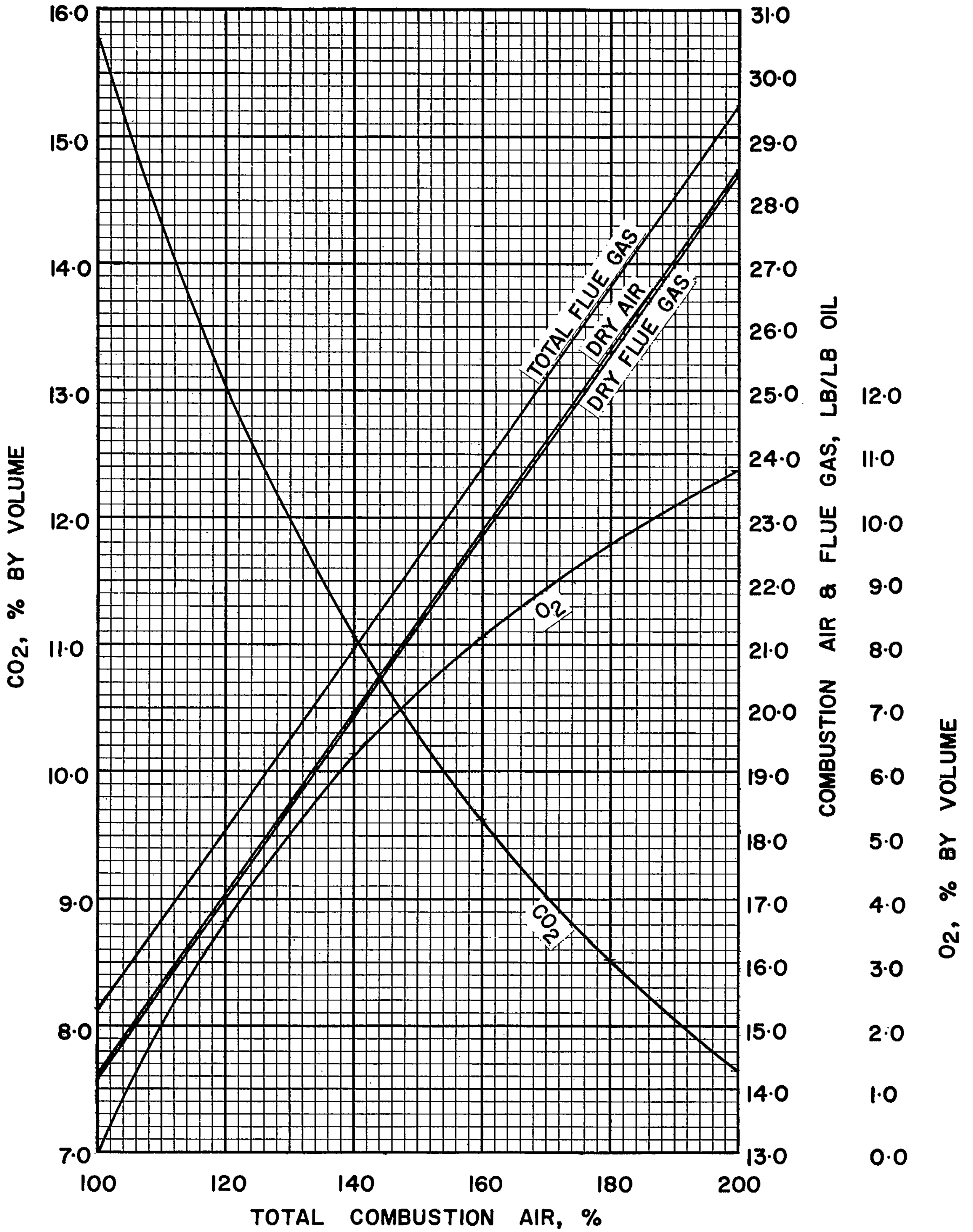


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS 9300

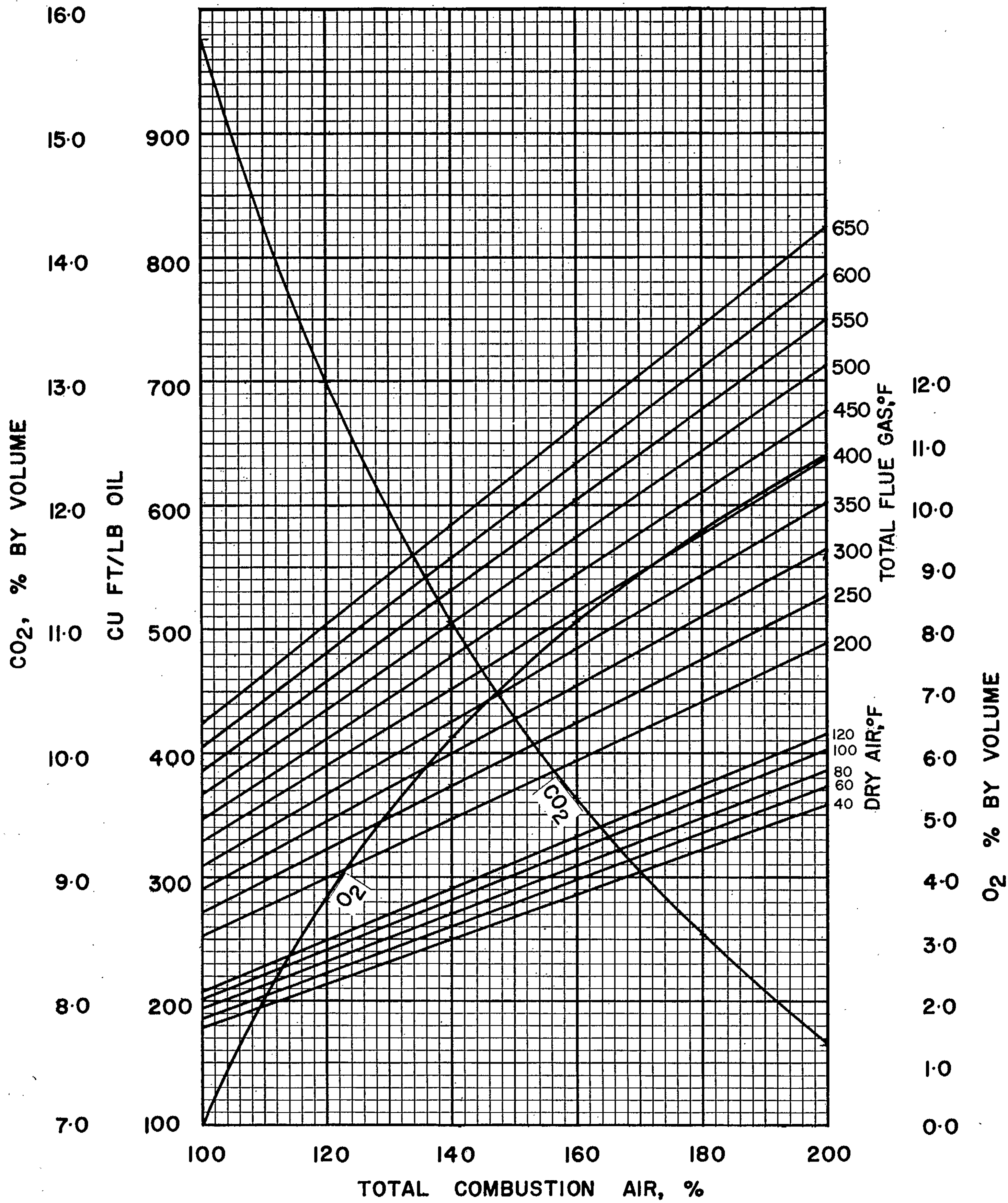


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 9300

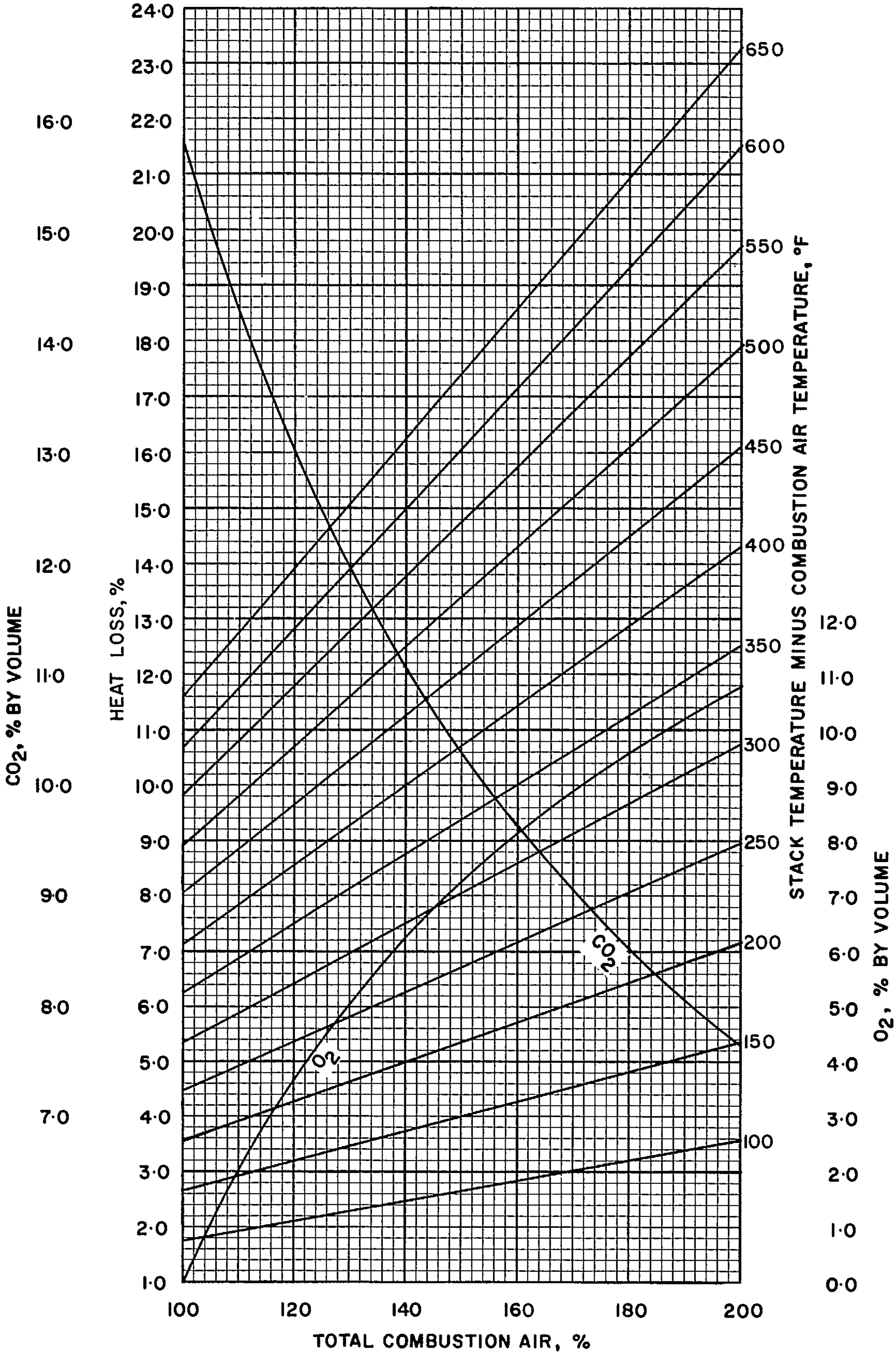


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS·

9300

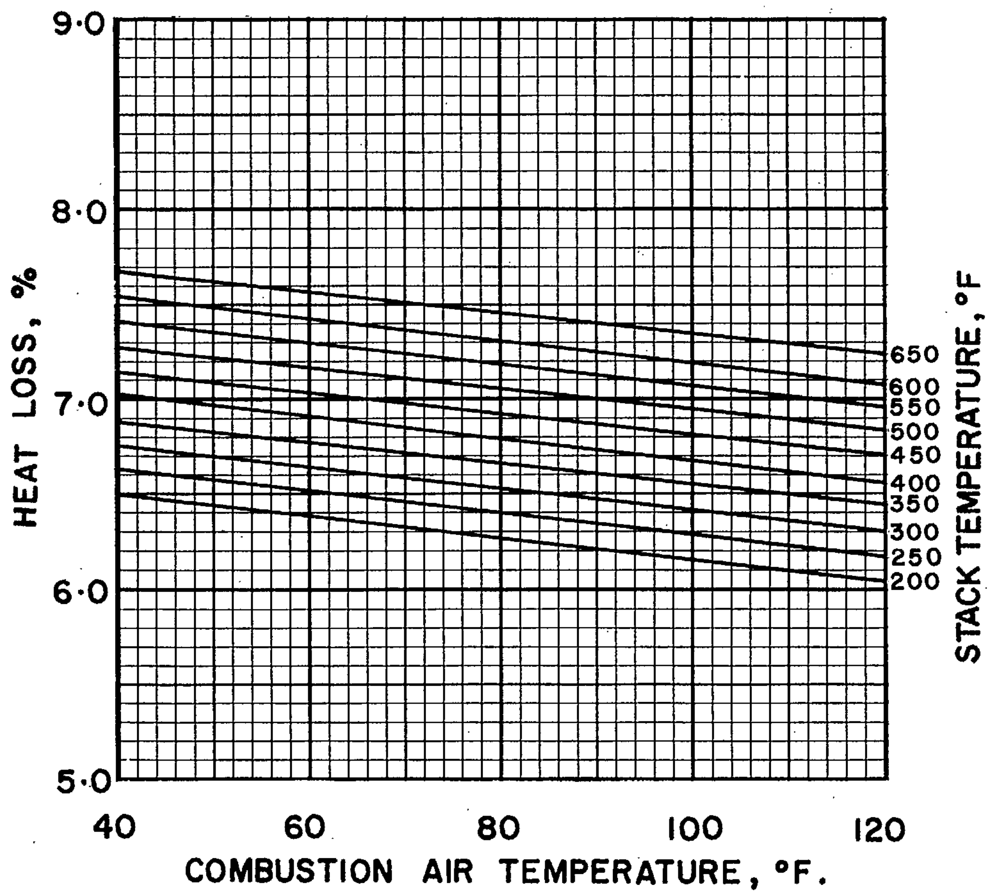


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

9300

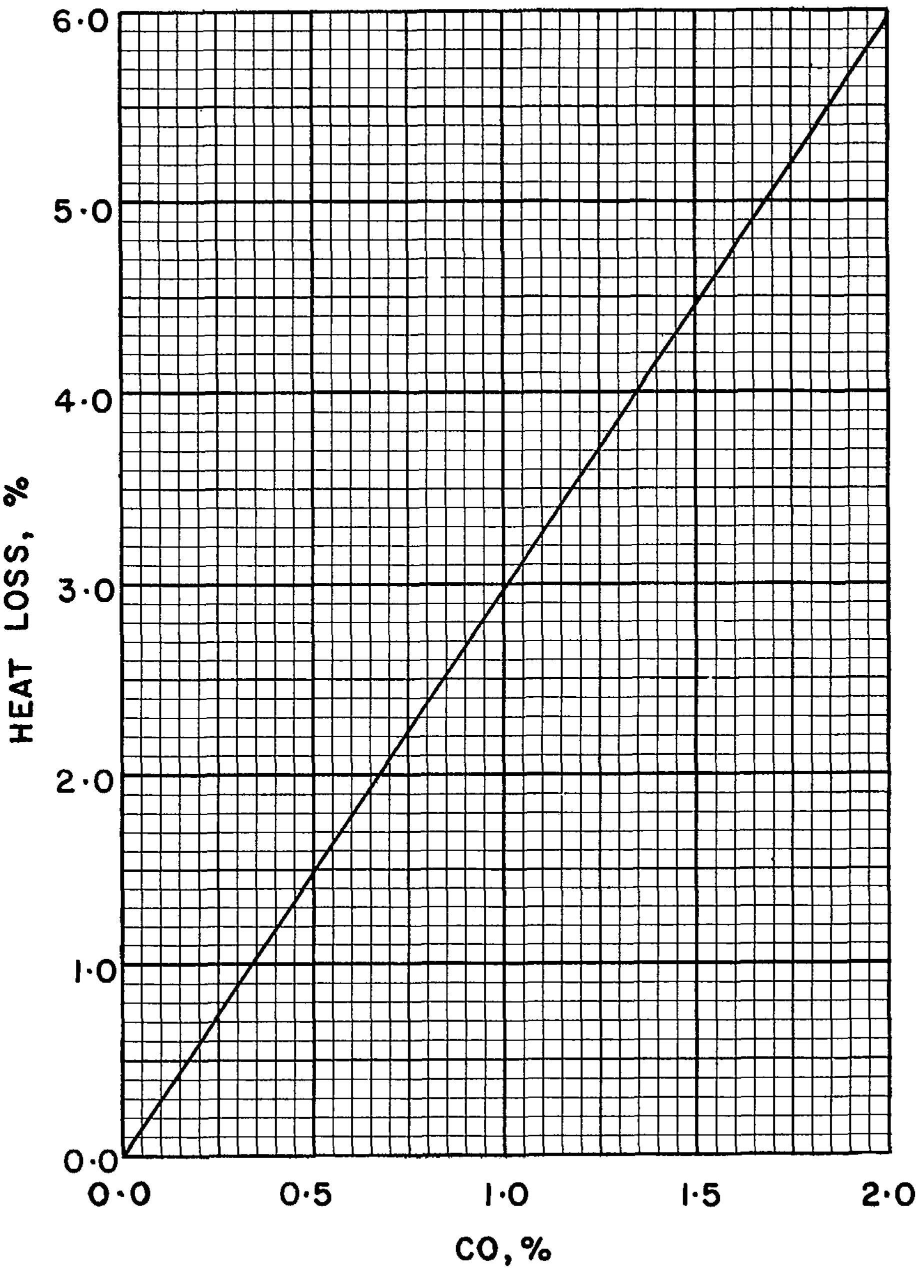


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

9300

FUEL OIL 9310, SPECIFIC GRAVITY 0.930

Ultimate Analysis, lb/lb

Carbon	(C)	0.8707
Hydrogen	(H_2)	0.1193
Sulphur	(S)	0.0100
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,900

Conversion Factors

1 Imp gal oil = 9.30 lb oil
or Imp gal oil × 9.30 = lb oil
or lb oil × 0.1075 = Imp gal oil

1 U.S. gal oil = 9.30 × 0.8337 lb oil
or U.S. gal oil × 7.753 = lb oil
or lb oil × 0.1290 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}900} \text{ lb oil}$$

or Btu × 10^6 × 52.91 = lb oil
or lb oil × 0.1890 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}900 \times 9.30} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.689 = Imp gal oil
or Imp gal oil × 0.1758 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}900 \times 7.753} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.826 = U.S. gal oil
or U.S. gal oil × 0.1465 = Btu × 10^6

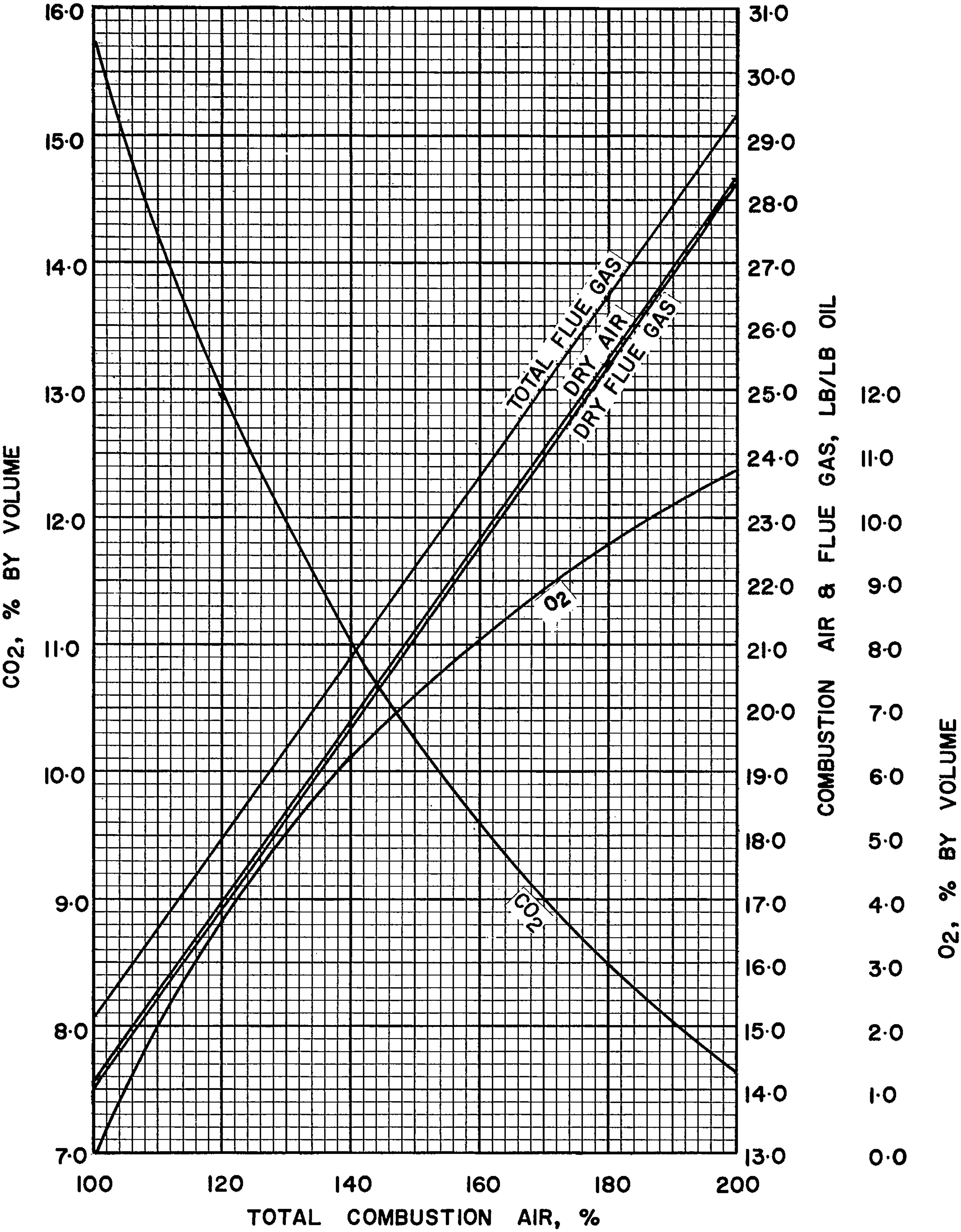


FIGURE I· COMBUSTION DATA, WEIGHT BASIS 9310

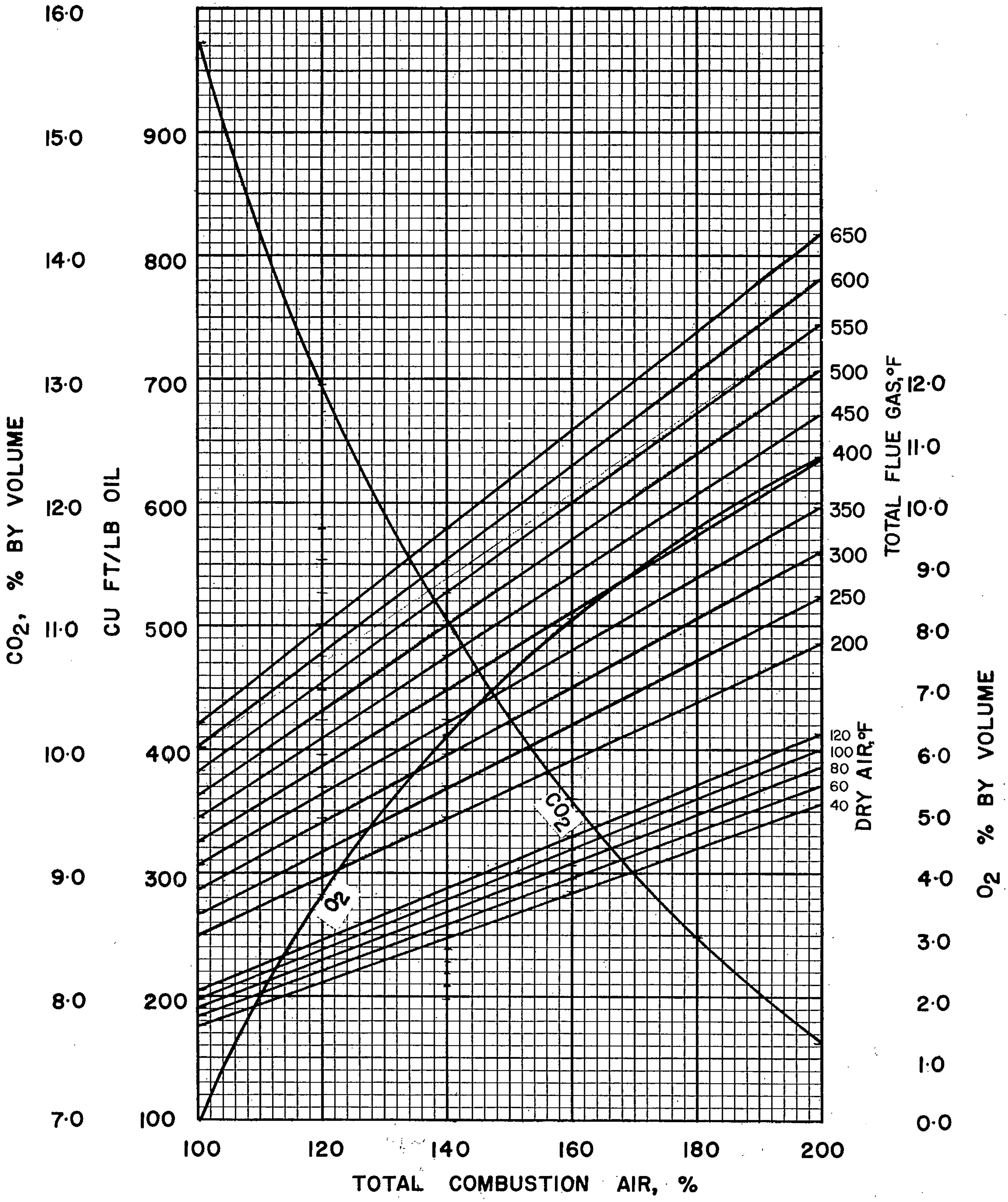


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 9310

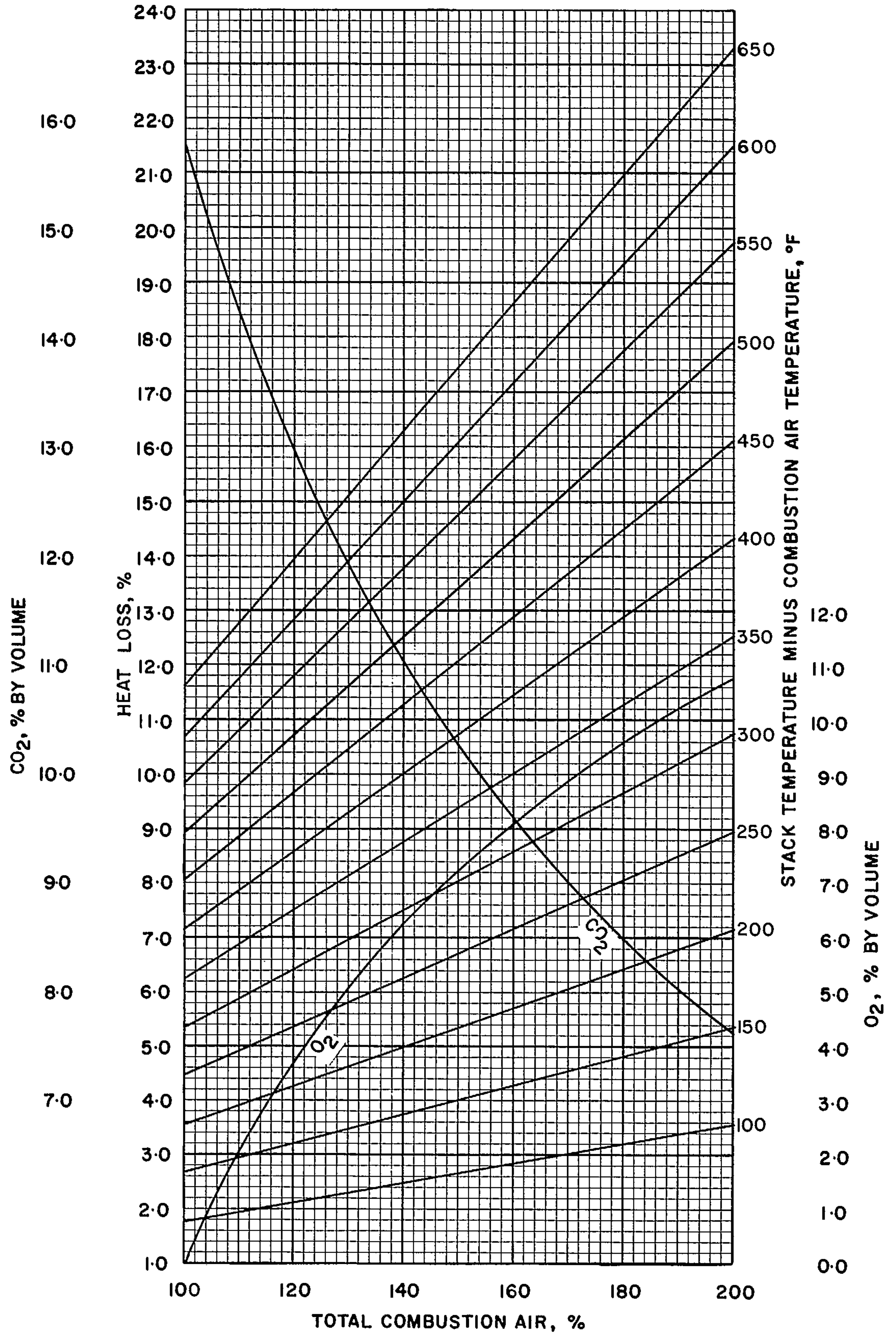


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS·

9310

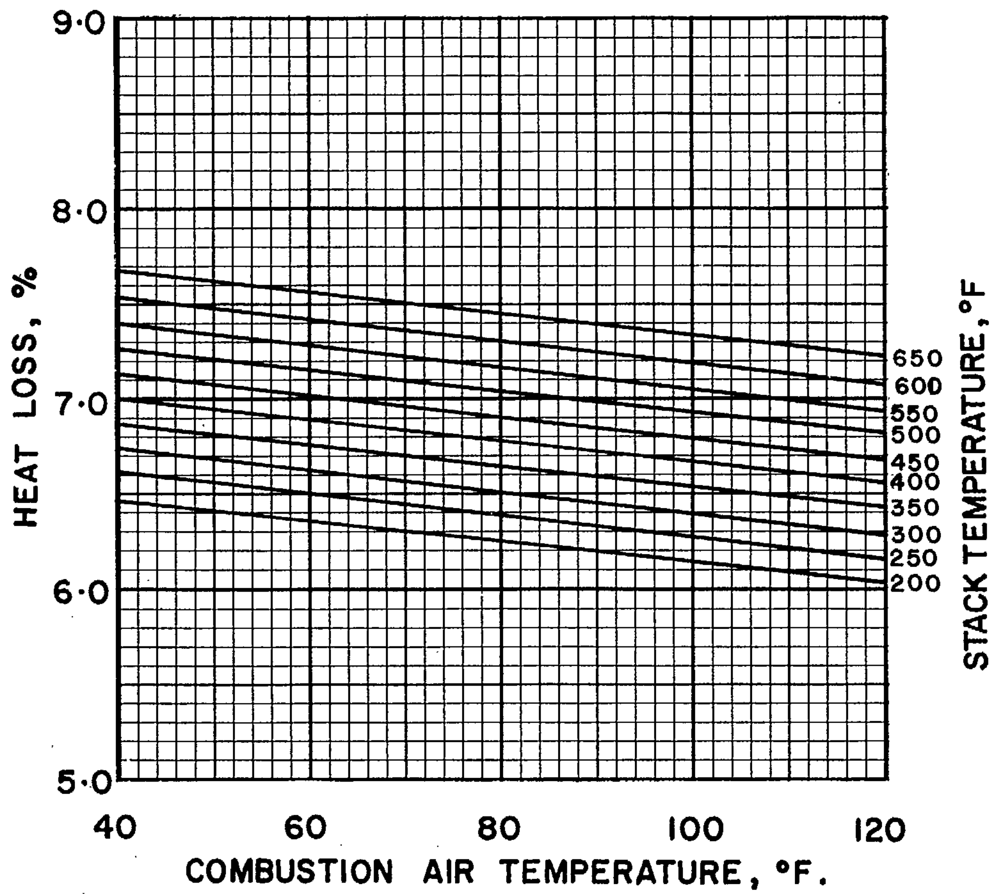


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

9310

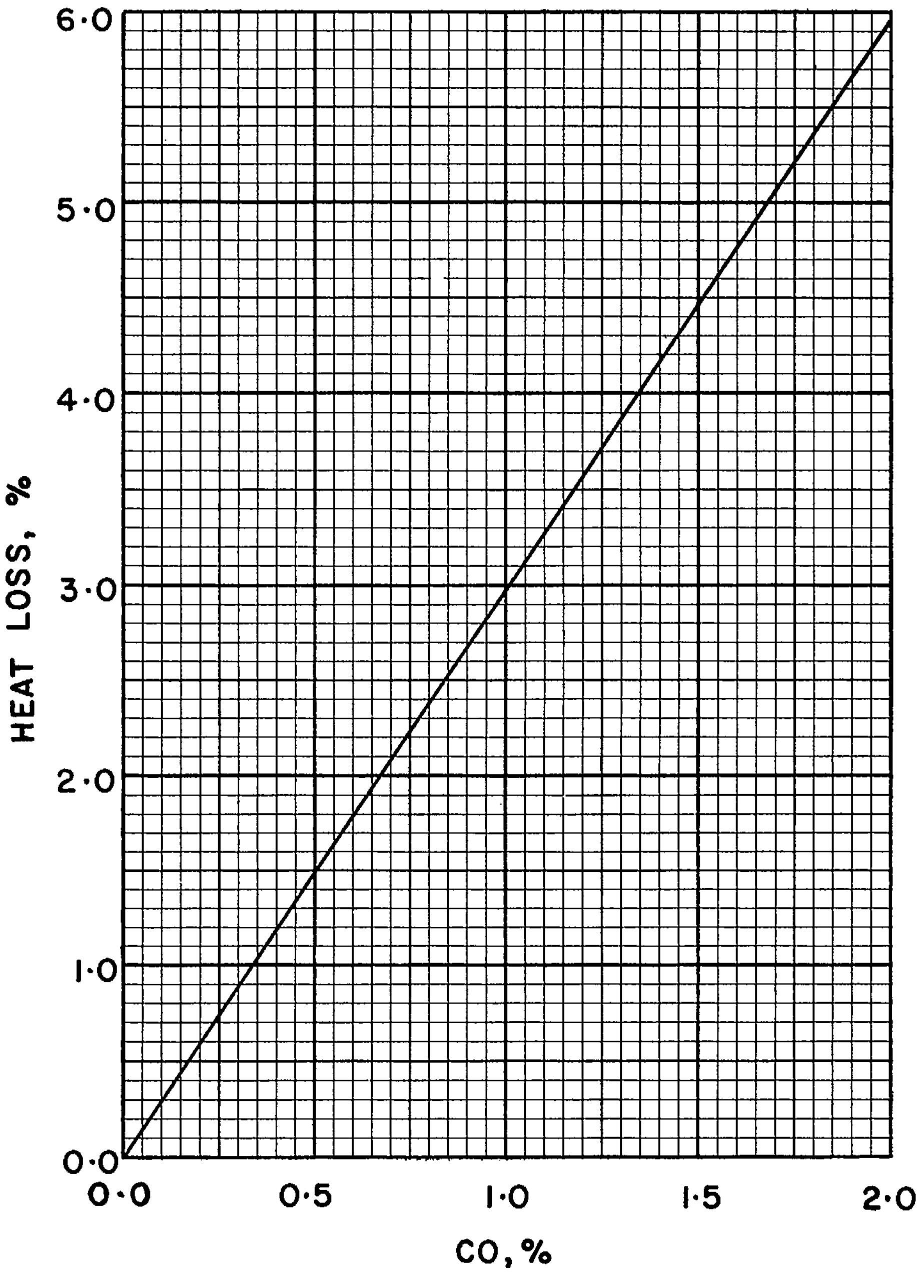


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

9310

FUEL OIL 9320, SPECIFIC GRAVITY 0.930

Ultimate Analysis, lb/lb

Carbon	(C)	0.8619
Hydrogen	(H_2)	0.1181
Sulphur	(S)	0.0200
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,750

Conversion Factors

1 Imp gal oil = 9.30 lb oil
or Imp gal oil × 9.30 = lb oil
or lb oil × 0.1075 = Imp gal oil

1 U.S. gal oil = 9.30 × 0.8337 lb oil
or U.S. gal oil × 7.753 = lb oil
or lb oil × 0.1290 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}750} \text{ lb oil}$$

or Btu × 10^6 × 53.33 = lb oil
or lb oil × 0.0188 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}750 \times 9.30} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.735 = Imp gal oil
or Imp gal oil × 0.1744 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}750 \times 7.753} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.878 = U.S. gal oil
or U.S. gal oil × 0.1454 = Btu × 10^6

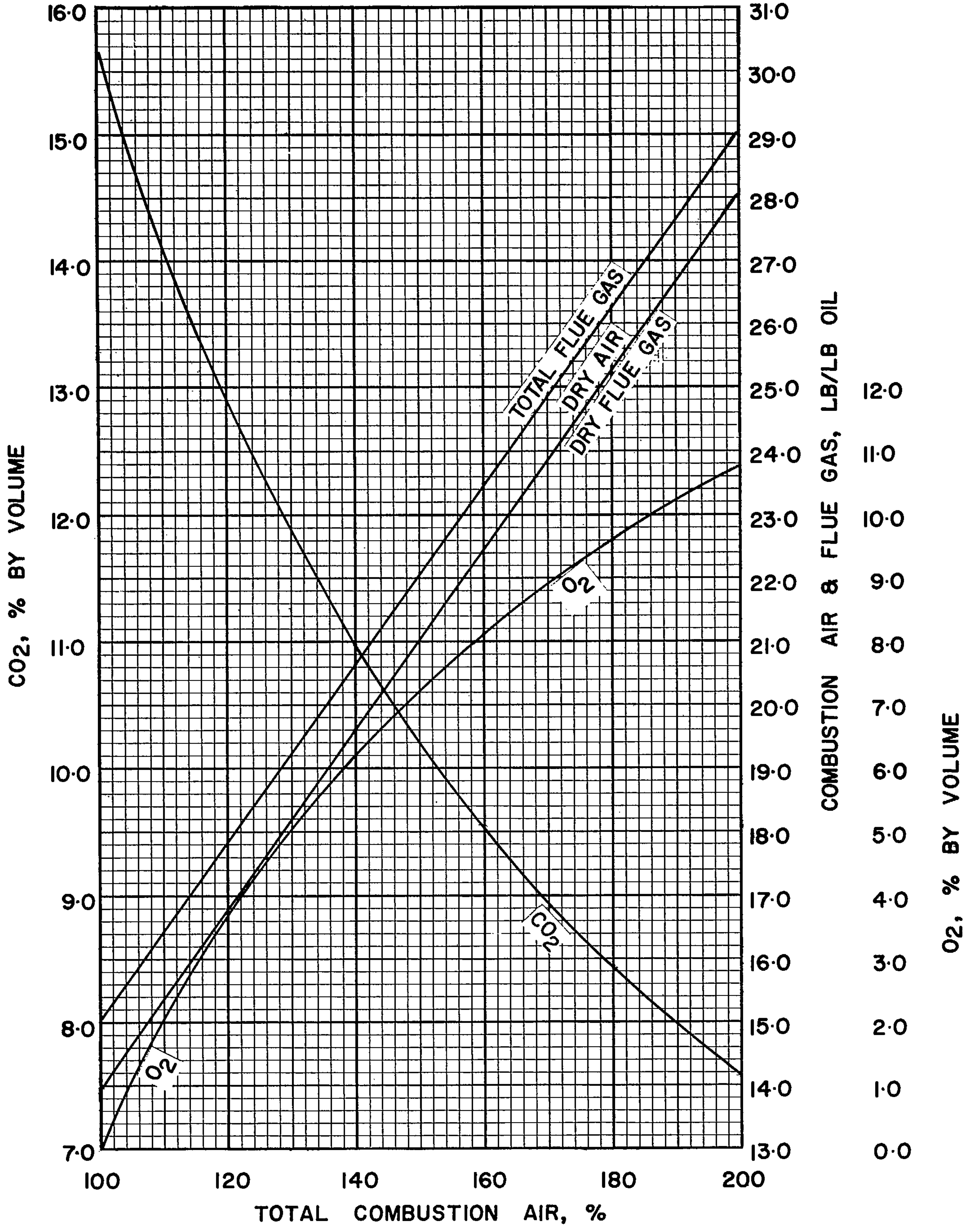


FIGURE I· COMBUSTION DATA, WEIGHT BASIS 9320

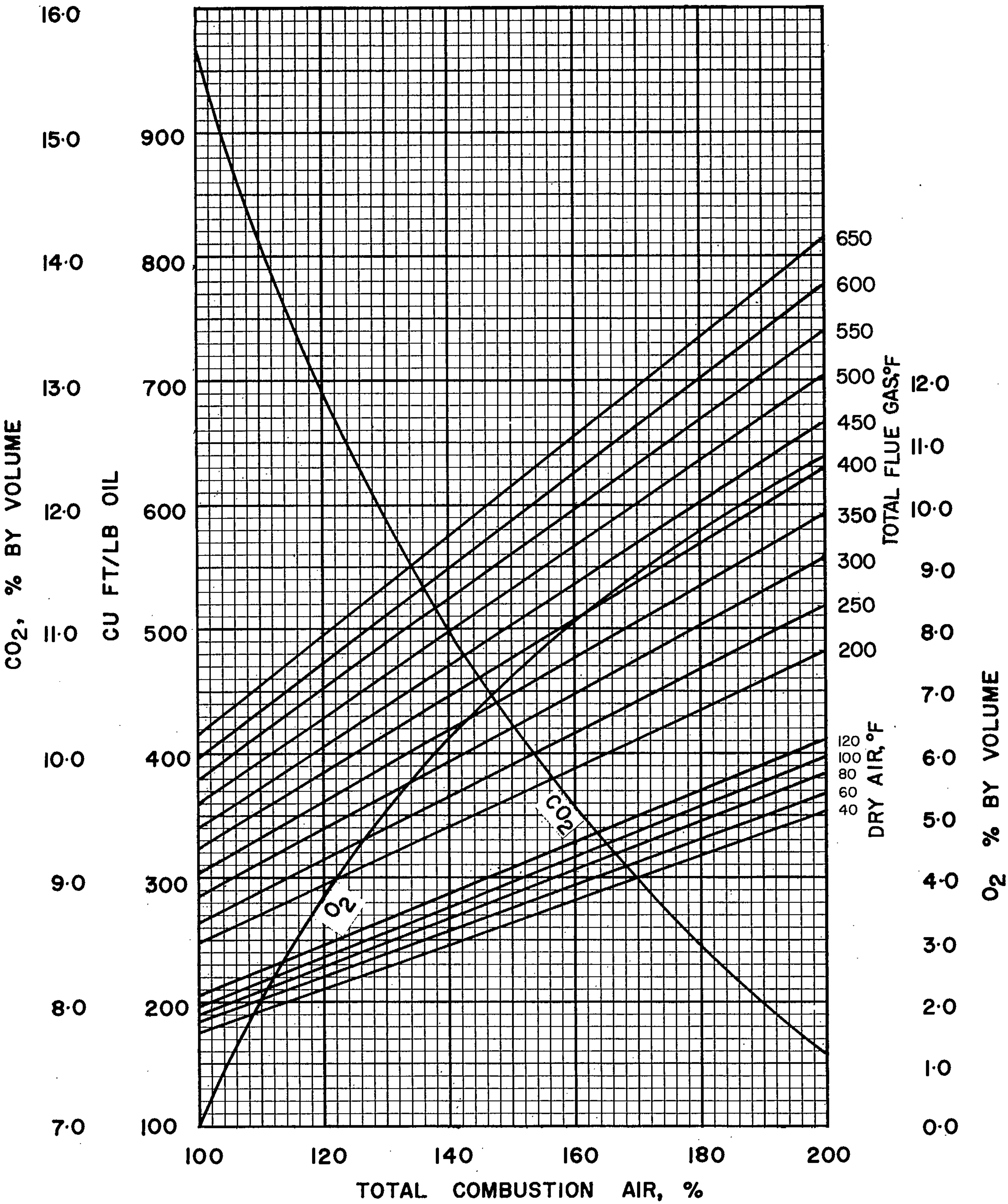


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 9320

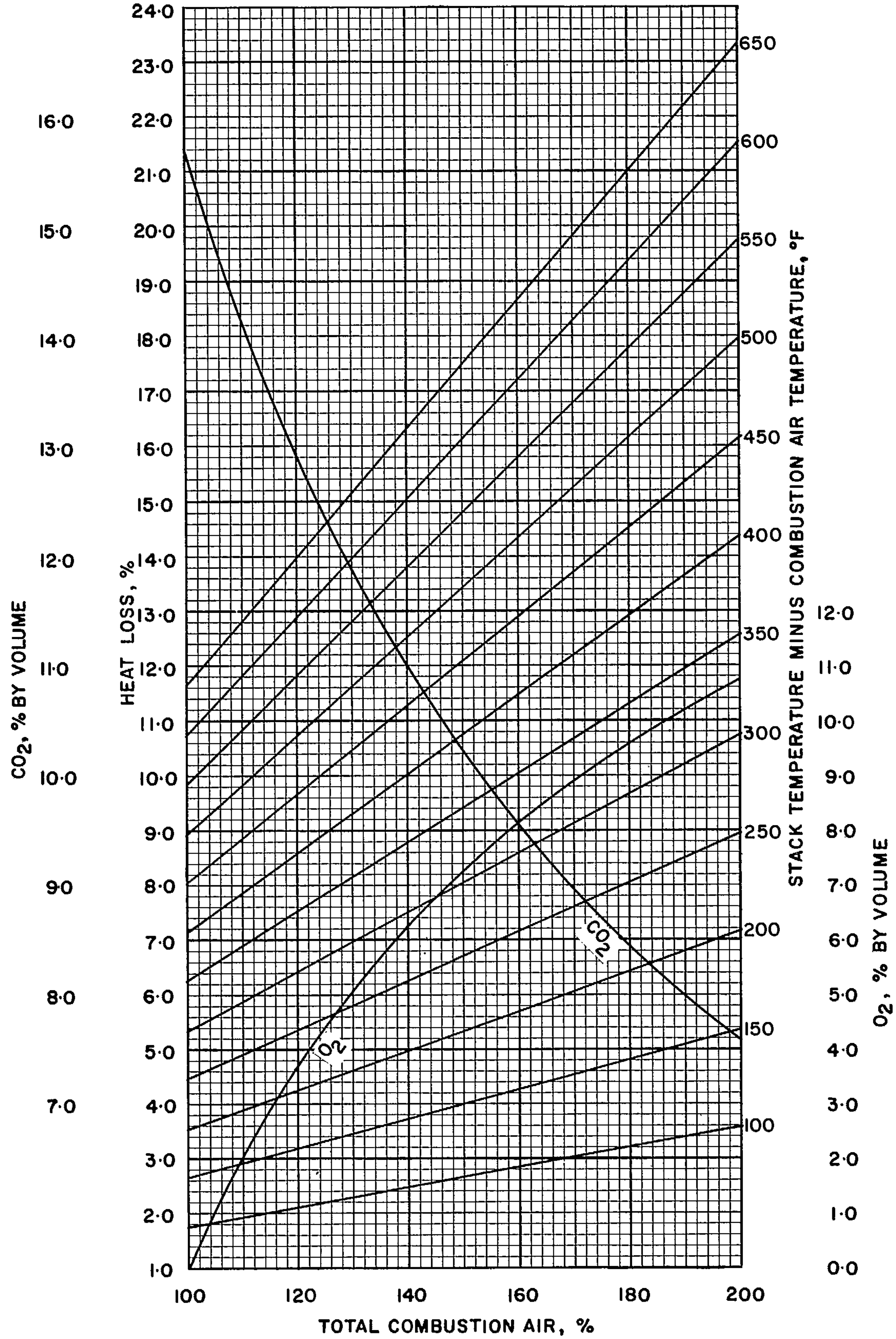


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS·

9320

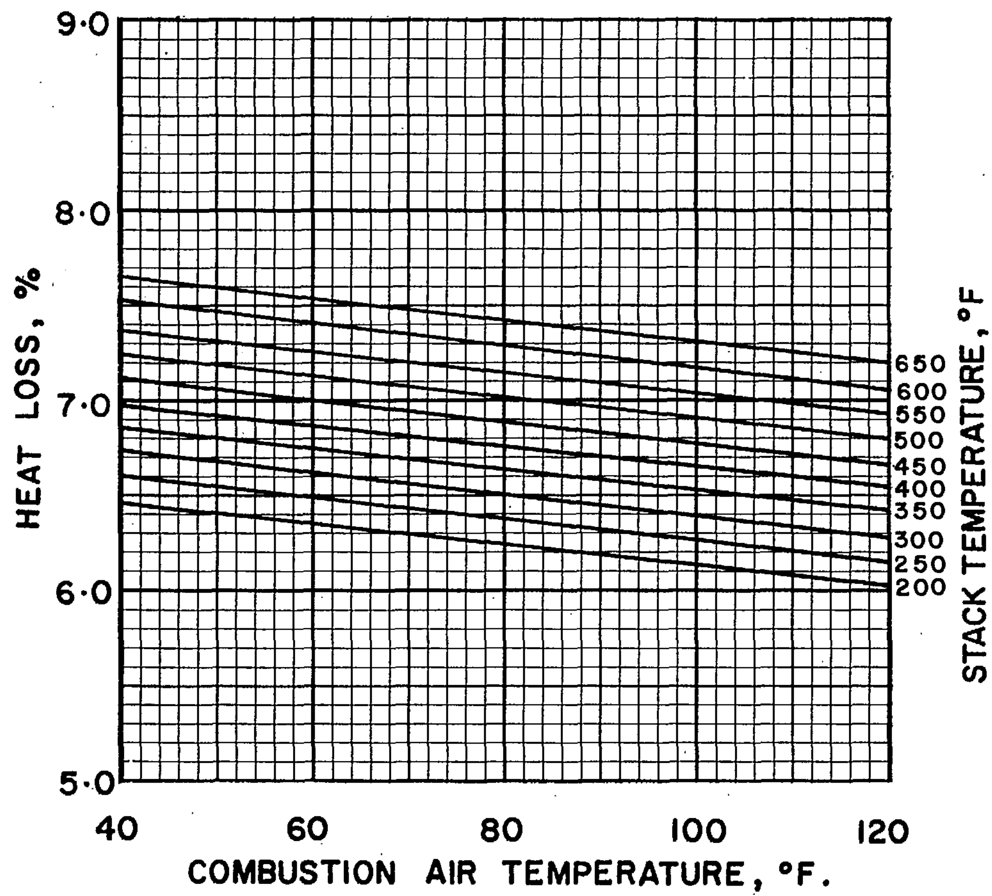


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

9320

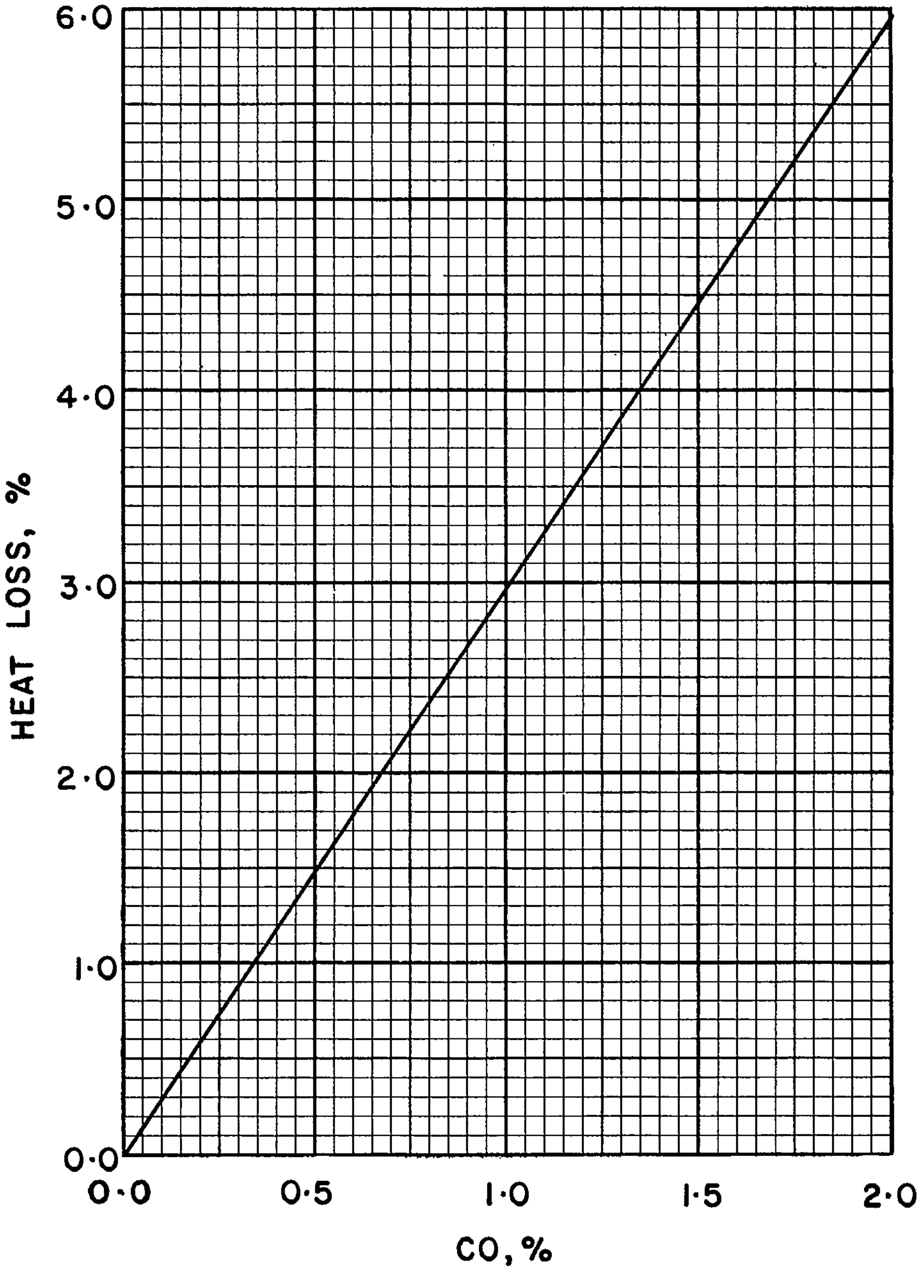


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

9320

FUEL OIL 9330, SPECIFIC GRAVITY 0.930

Ultimate Analysis, lb/lb

Carbon	(C)	0.8531
Hydrogen	(H_2)	0.1169
Sulphur	(S)	0.0300
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,600

Conversion Factors

1 Imp gal oil = 9.30 lb oil
or Imp gal oil × 9.30 = lb oil
or lb oil × 0.1075 = Imp gal oil

1 U.S. gal oil = 9.30 × 0.8337 lb oil
or U.S. gal oil × 7.753 = lb oil
or lb oil × 0.1290 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}600} \text{ lb oil}$$

or Btu × 10^6 × 53.76 = lb oil
or lb oil × 0.0186 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}600 \times 9.30} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.781 = Imp gal oil
or Imp gal oil × 0.1730 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}600 \times 7.753} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.935 = U.S. gal oil
or U.S. gal oil × 0.1442 = Btu × 10^6

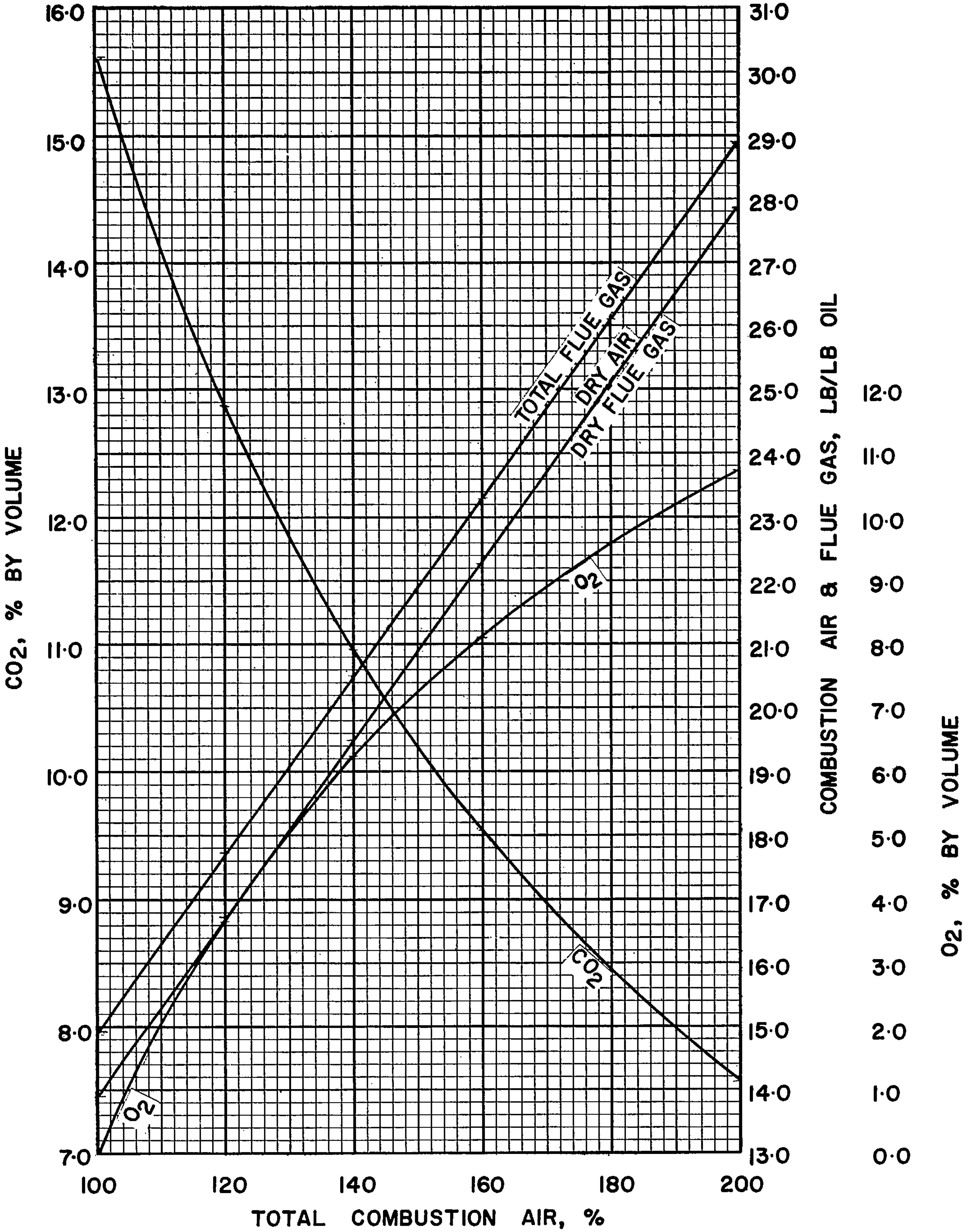


FIGURE I· COMBUSTION DATA, WEIGHT BASIS

9330

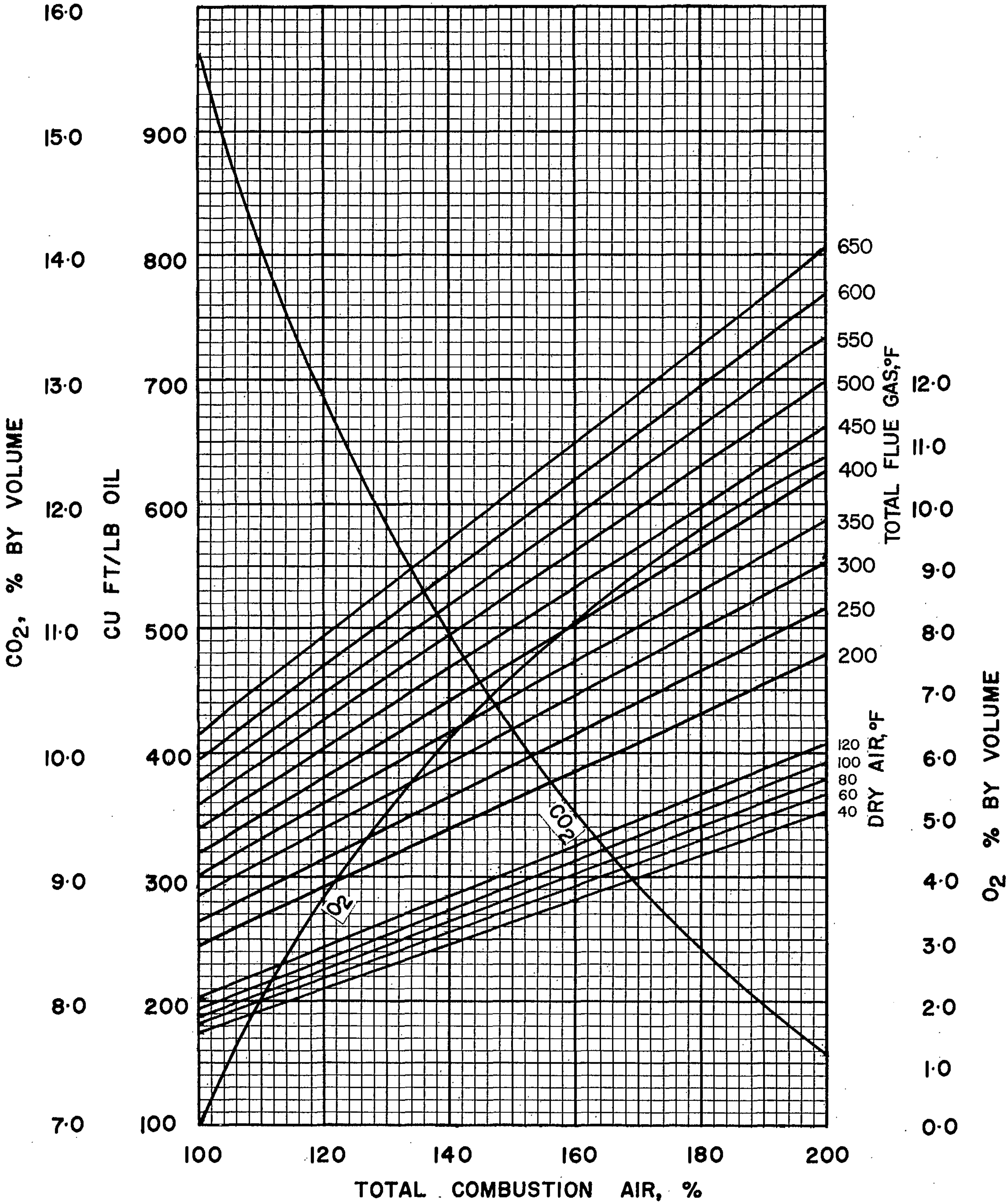


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 9330

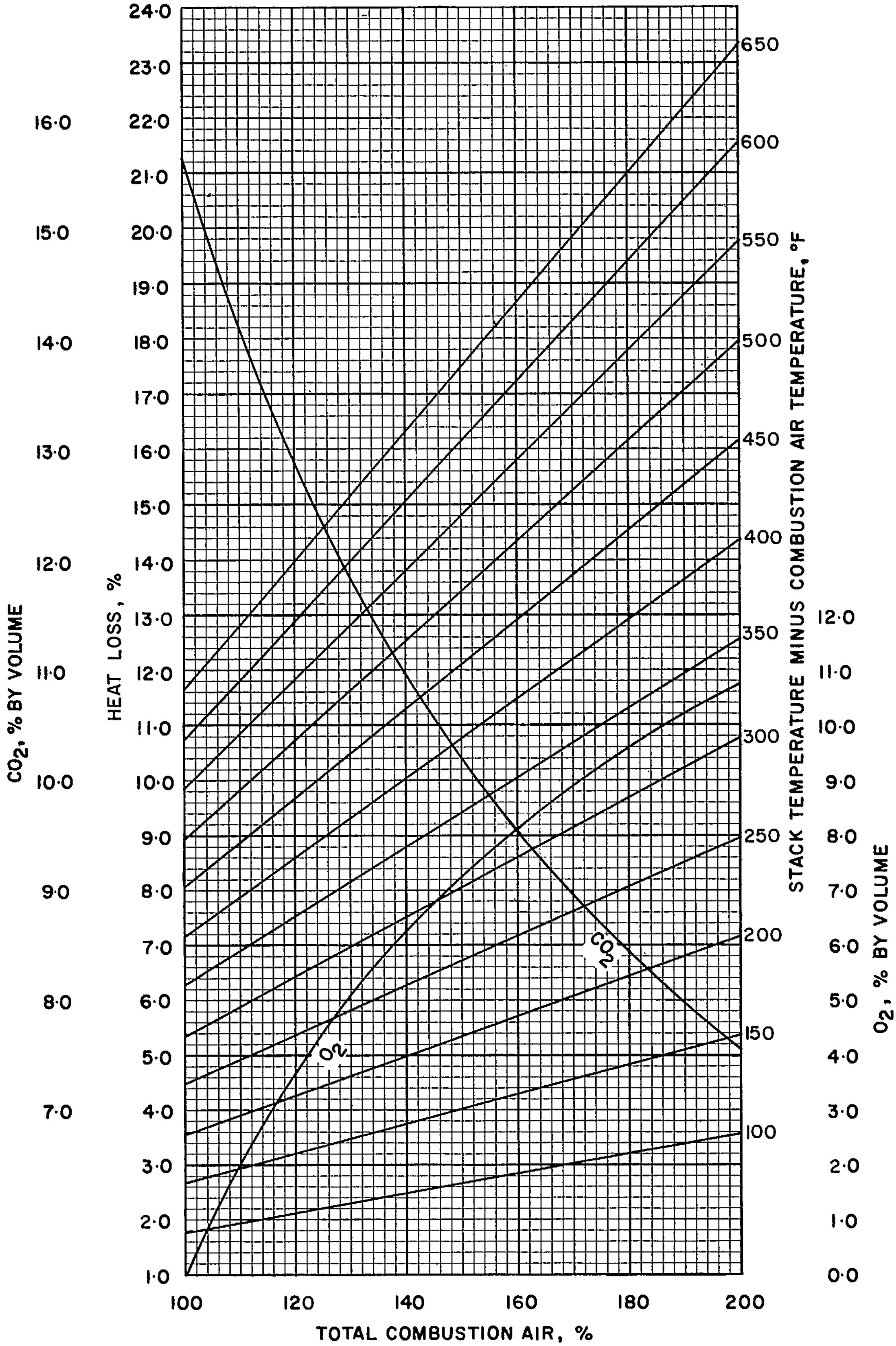


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS·

9330

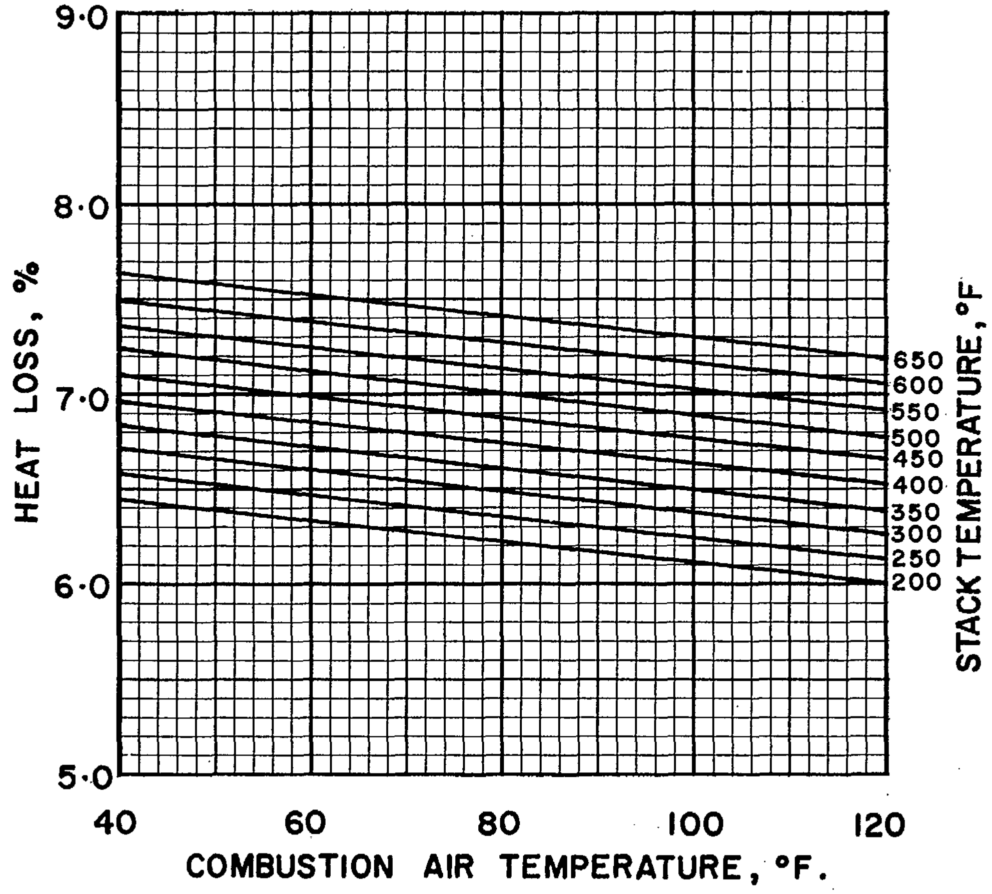


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

9330

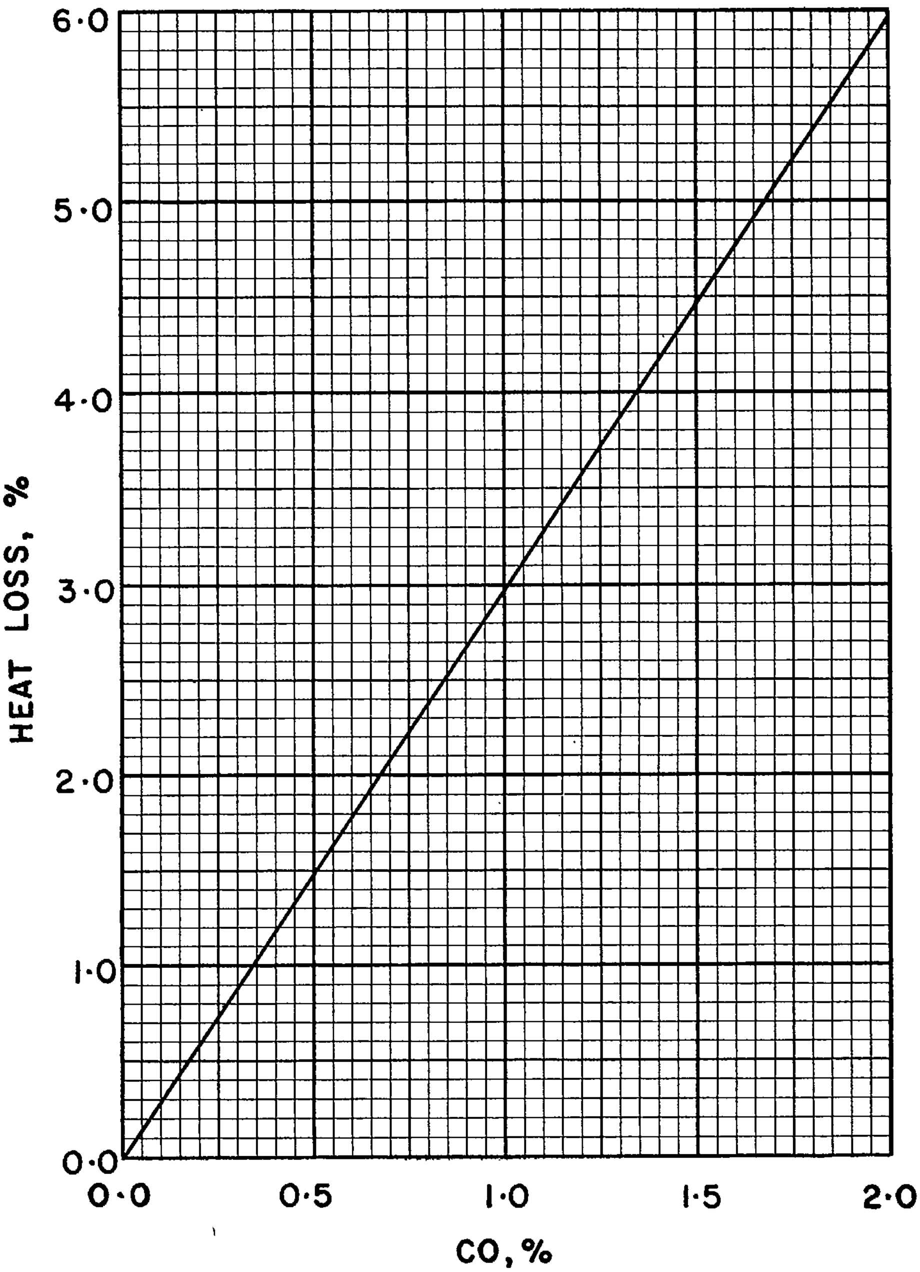


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

9330

FUEL OIL 9340, SPECIFIC GRAVITY 0.9300

Ultimate Analysis, lb/lb

Carbon	(C)	0.8443
Hydrogen	(H_2)	0.1157
Sulphur	(S)	0.0400
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,450

Conversion Factors

1 Imp gal oil = 9.30 lb oil
or Imp gal oil × 9.30 = lb oil
or lb oil × 0.1075 = Imp gal oil

1 U.S. gal oil = 9.30 × 0.8337 lb oil
or U.S. gal oil × 7.753 = lb oil
or lb oil × 0.1290 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}450} \text{ lb oil}$$

or Btu × 10^6 × 54.20 = lb oil
or lb oil × 0.0185 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}450 \times 9.30} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.828 = Imp gal oil
or Imp gal oil × 0.1716 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}450 \times 7.753} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.993 = U.S. gal oil
or U.S. gal oil × 0.1430 = Btu × 10^6

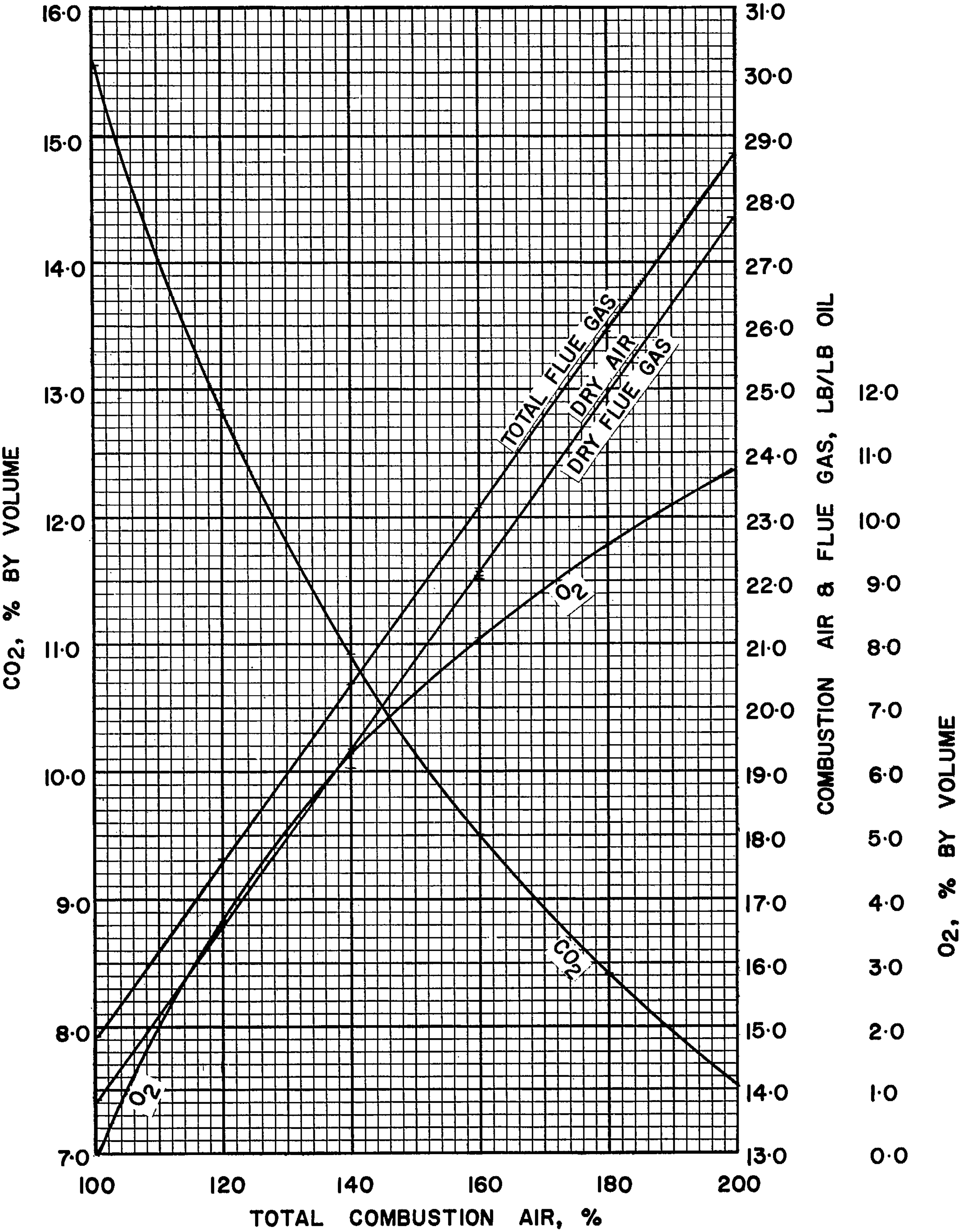


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS

9340

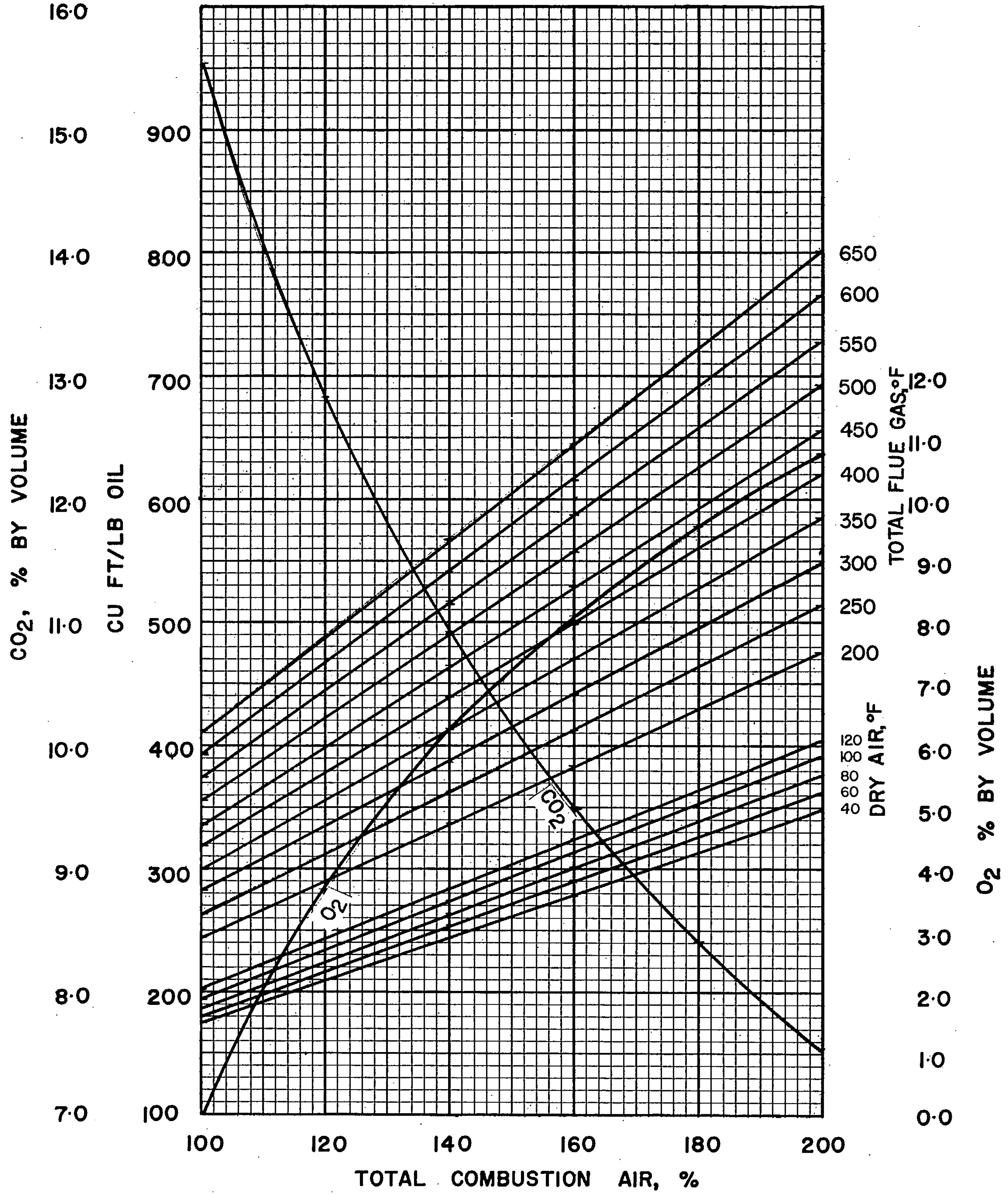


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 9340

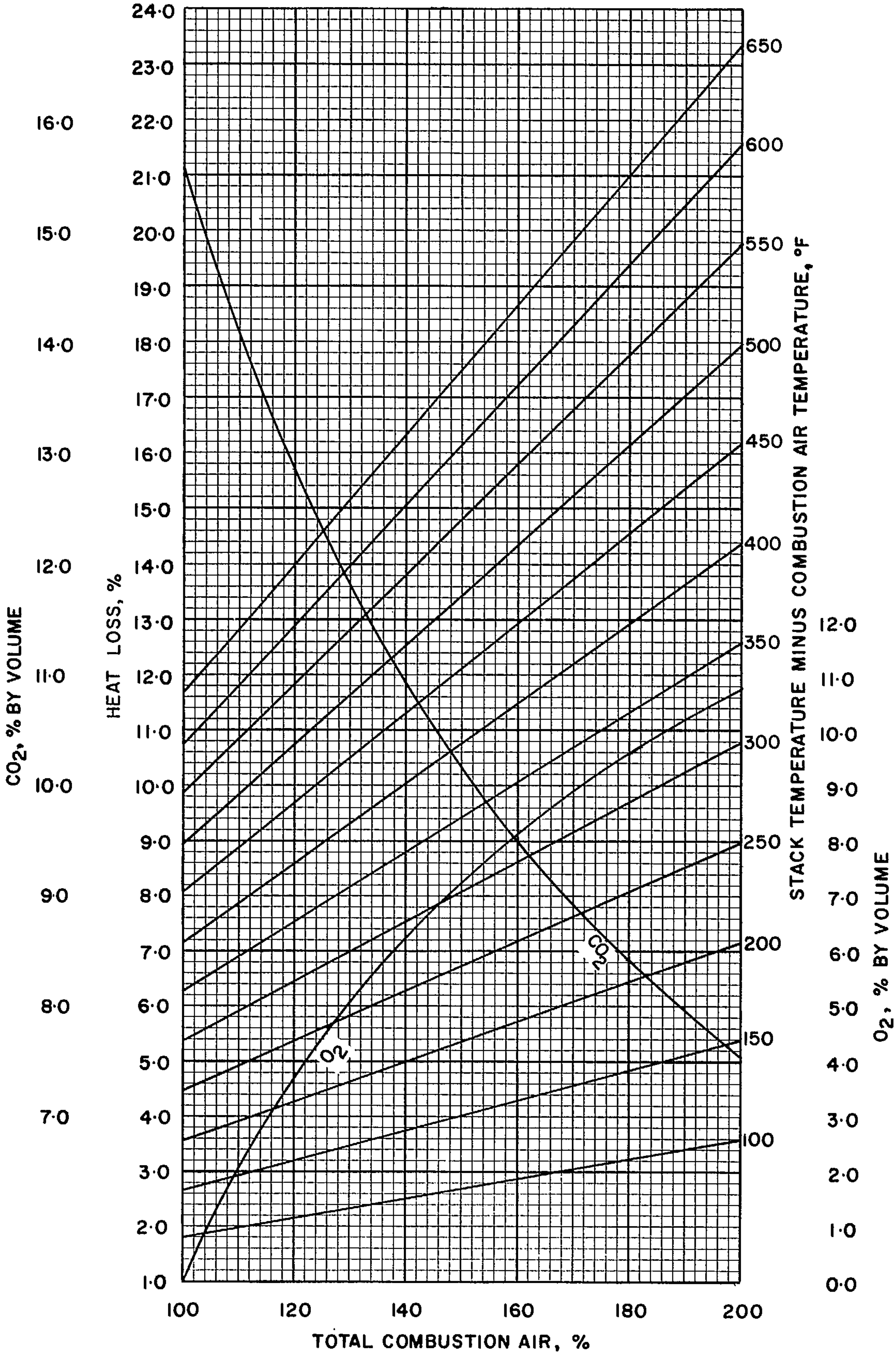


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS·

9340

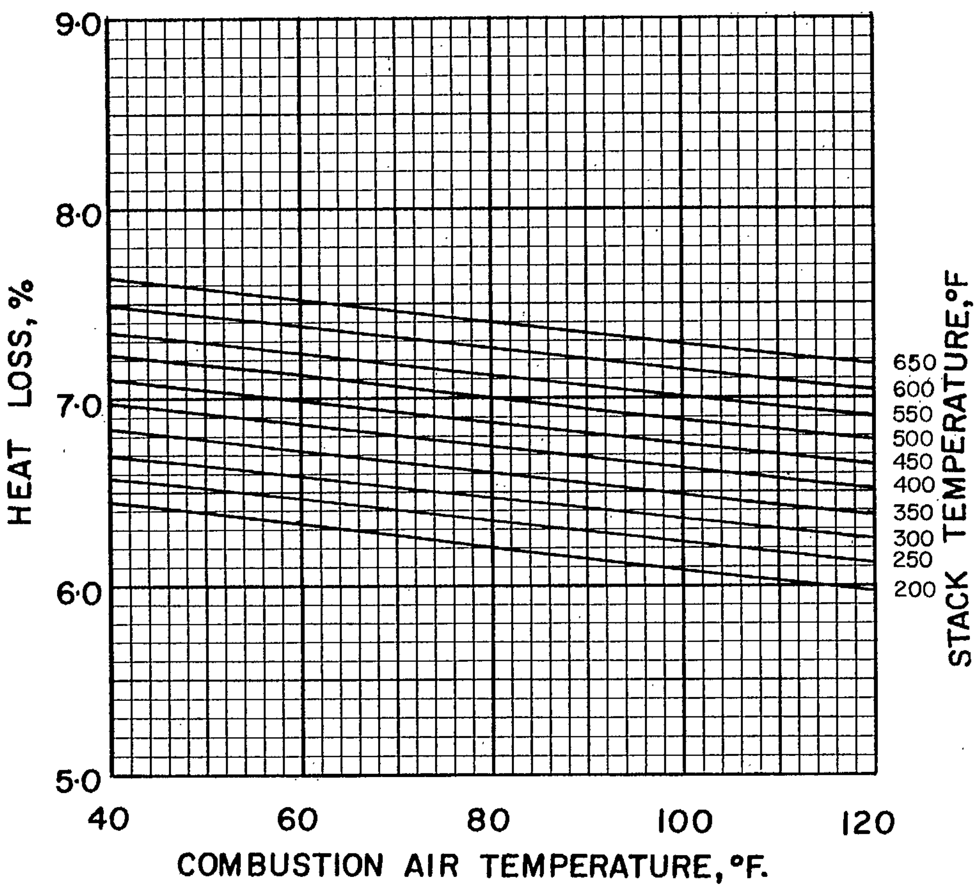


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

9340

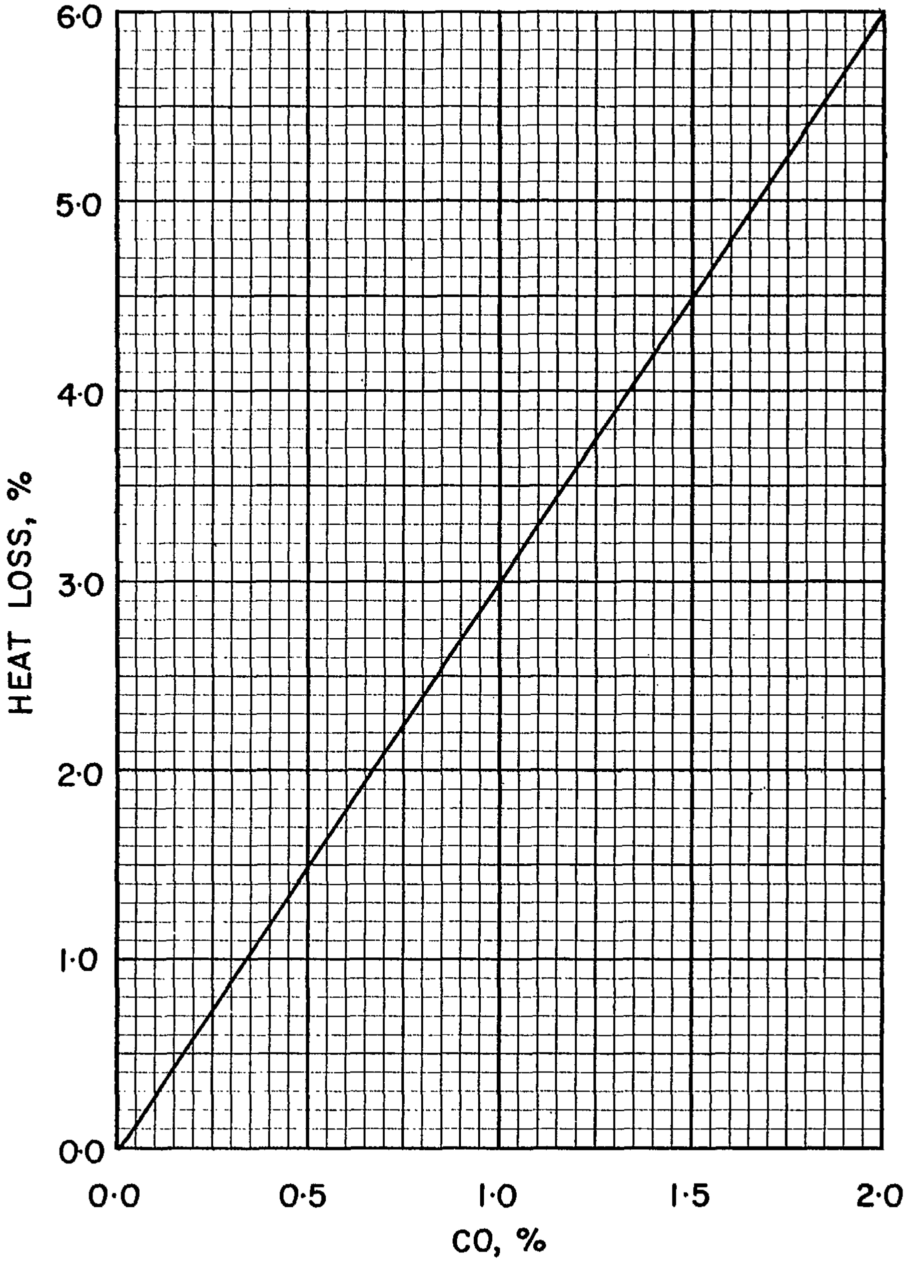


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

9340

FUEL OIL 9400, SPECIFIC GRAVITY 0.940

Ultimate Analysis, lb/lb

Carbon	(C)	0.8810
Hydrogen	(H_2)	0.1190
Sulphur	(S)	–
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,980

Conversion Factors

1 Imp gal oil = 9.40 lb oil
or Imp gal oil × 9.40 = lb oil
or lb oil × 0.1064 = Imp gal oil

1 U.S. gal oil = 9.40 × 0.8337 lb oil
or U.S. gal oil × 7.837 = lb oil
or lb oil × 0.1276 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}980} \text{ lb oil}$$

or Btu × 10^6 × 52.69 = lb oil
or lb oil × 0.0190 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}980 \times 9.40} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.605 = Imp gal oil
or Imp gal oil × 0.1784 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}980 \times 7.837} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.720 = U.S. gal oil
or U.S. gal oil × 0.1488 = Btu × 10^6

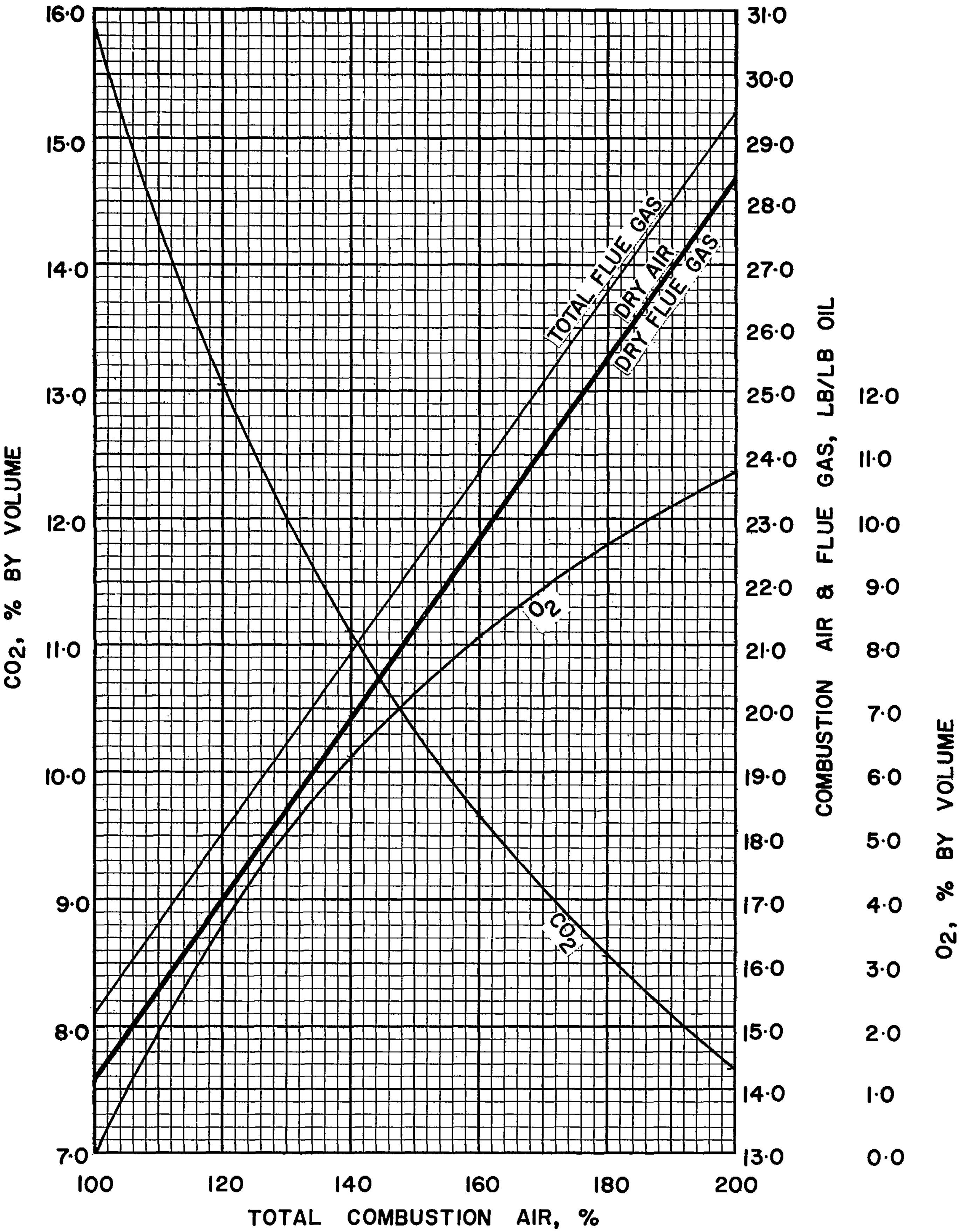


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS

9400

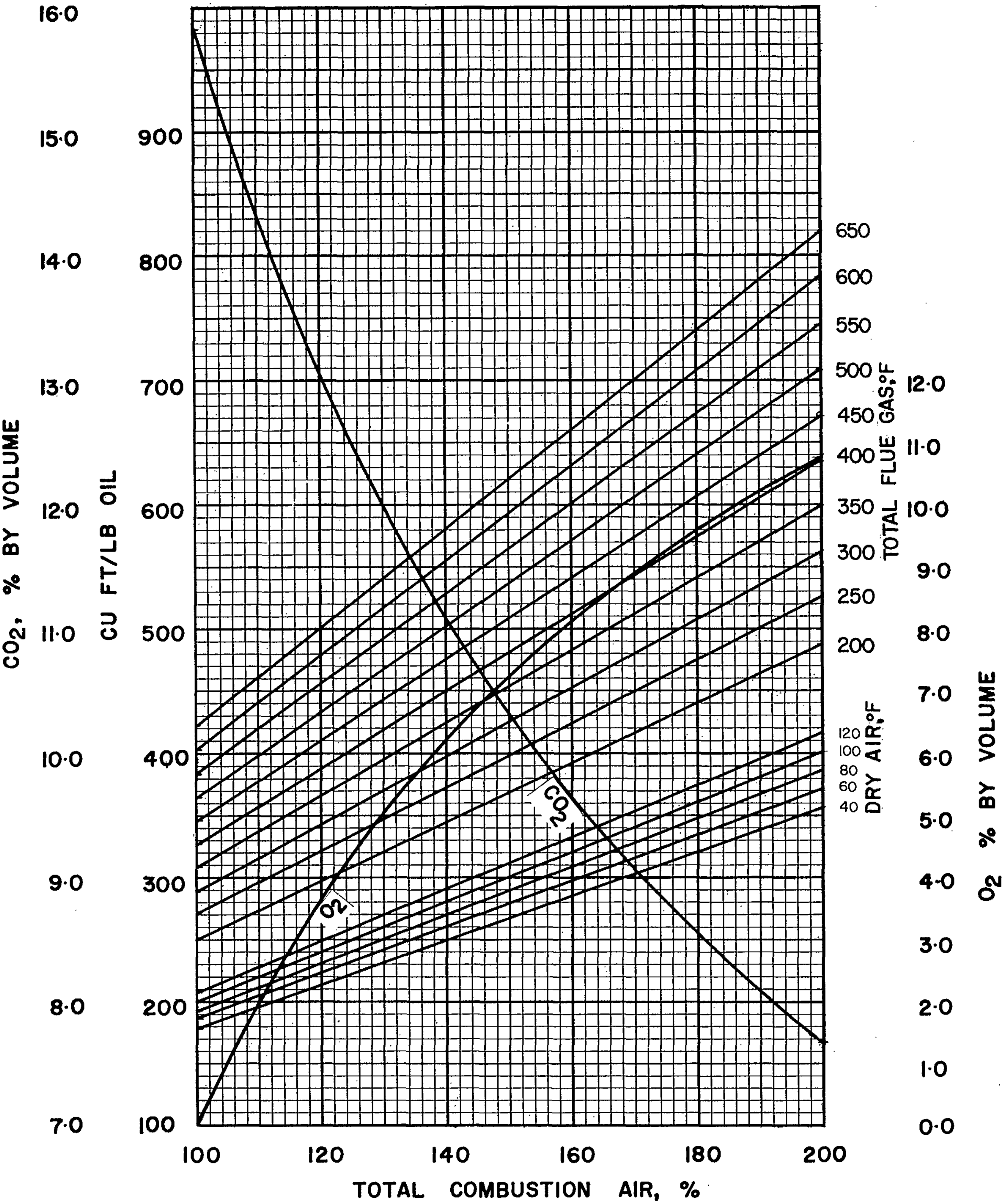


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 9400

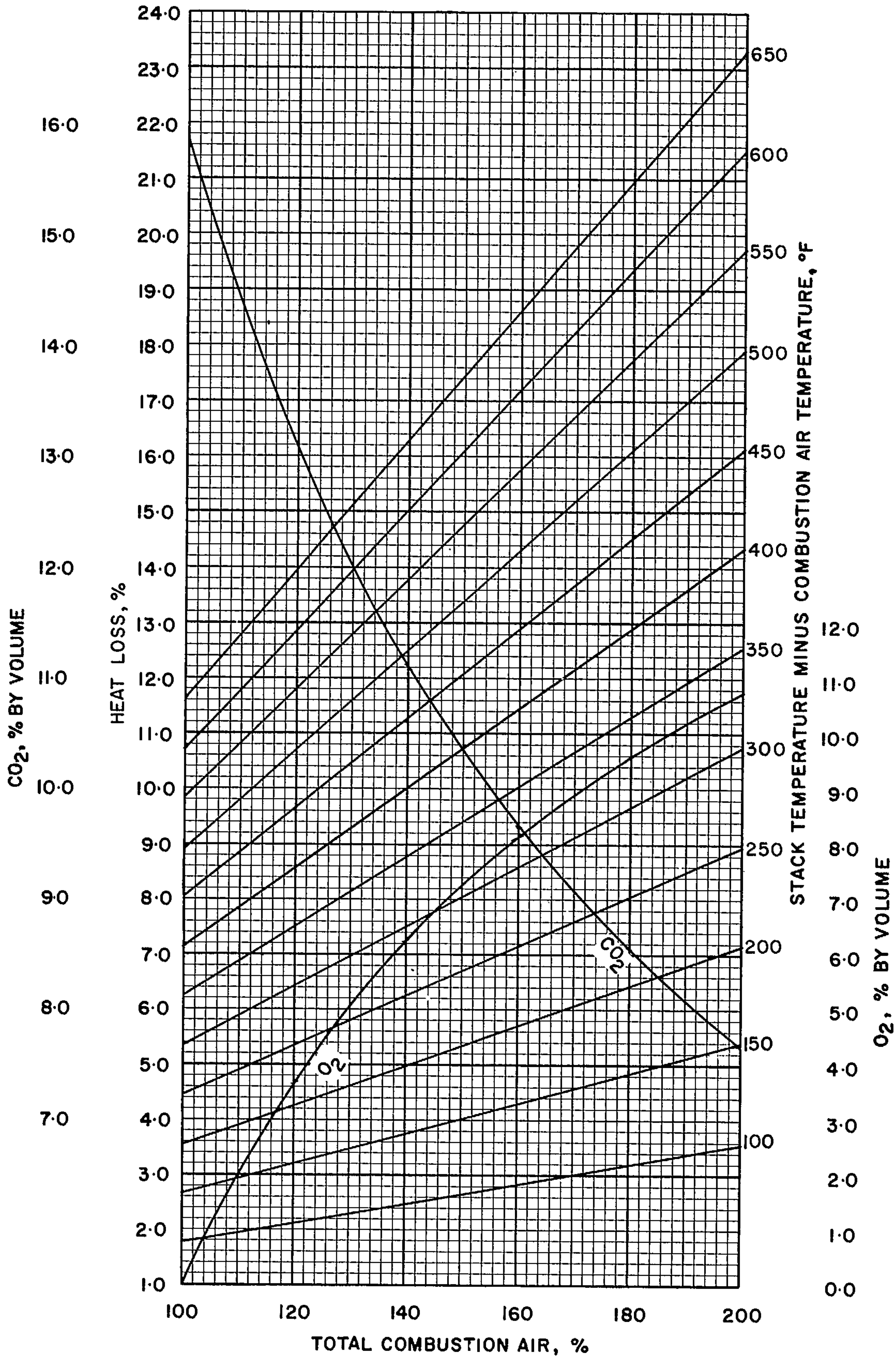


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS·

9400

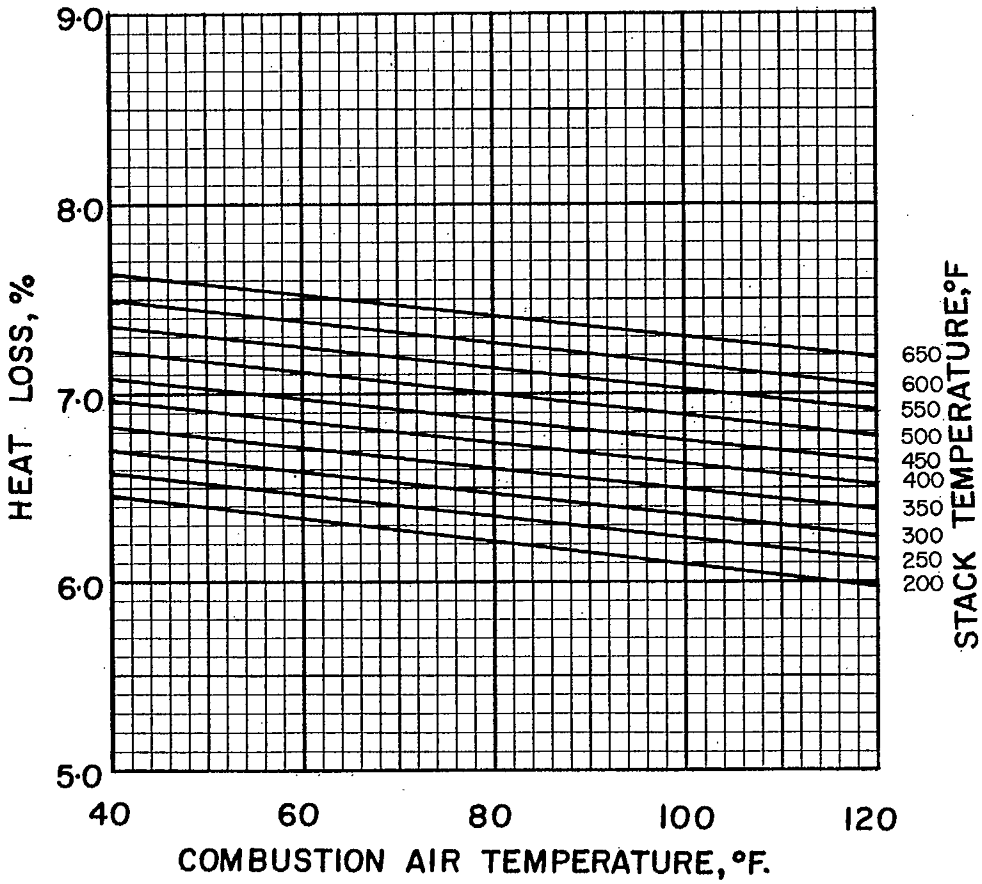


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

9400

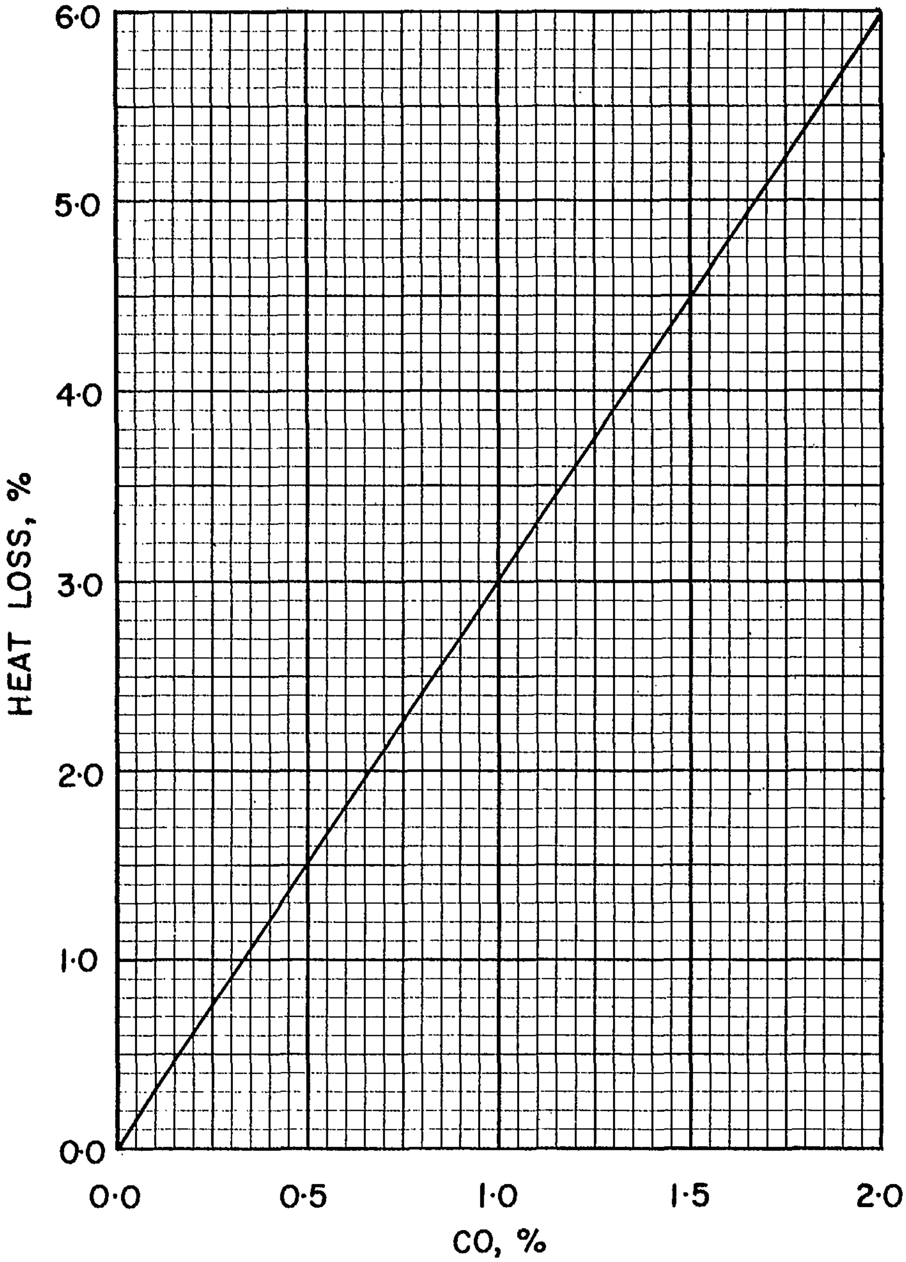


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

9400

FUEL OIL 9410, SPECIFIC GRAVITY 0.940

Ultimate Analysis, lb/lb

Carbon	(C)	0.8722
Hydrogen	(H_2)	0.1178
Sulphur	(S)	0.0100
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,830

Conversion Factors

1 Imp gal oil = 9.40 lb oil
or Imp gal oil × 9.40 = lb oil
or lb oil × 0.1064 = Imp gal oil

1 U.S. gal oil = 9.40 × 0.8337 lb oil
or U.S. gal oil × 7.837 = lb oil
or lb oil × 0.1276 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}830} \text{ lb oil}$$

or Btu × 10^6 × 53.11 = lb oil
or lb oil × 0.0188 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}830 \times 9.40} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.650 = Imp gal oil
or Imp gal oil × 0.1770 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}830 \times 7.837} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.775 = U.S. gal oil
or U.S. gal oil × 0.1476 = Btu × 10^6

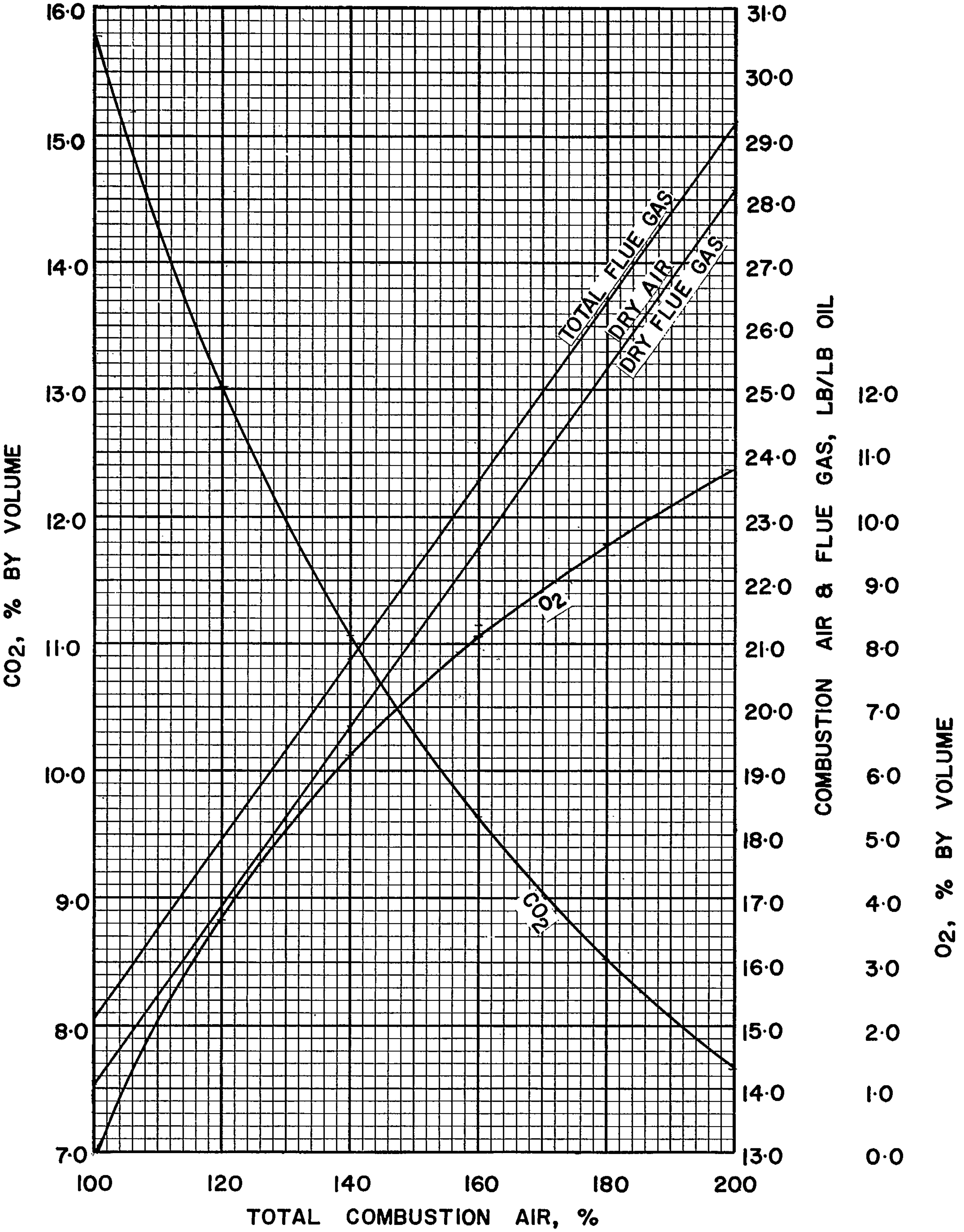


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS

9410

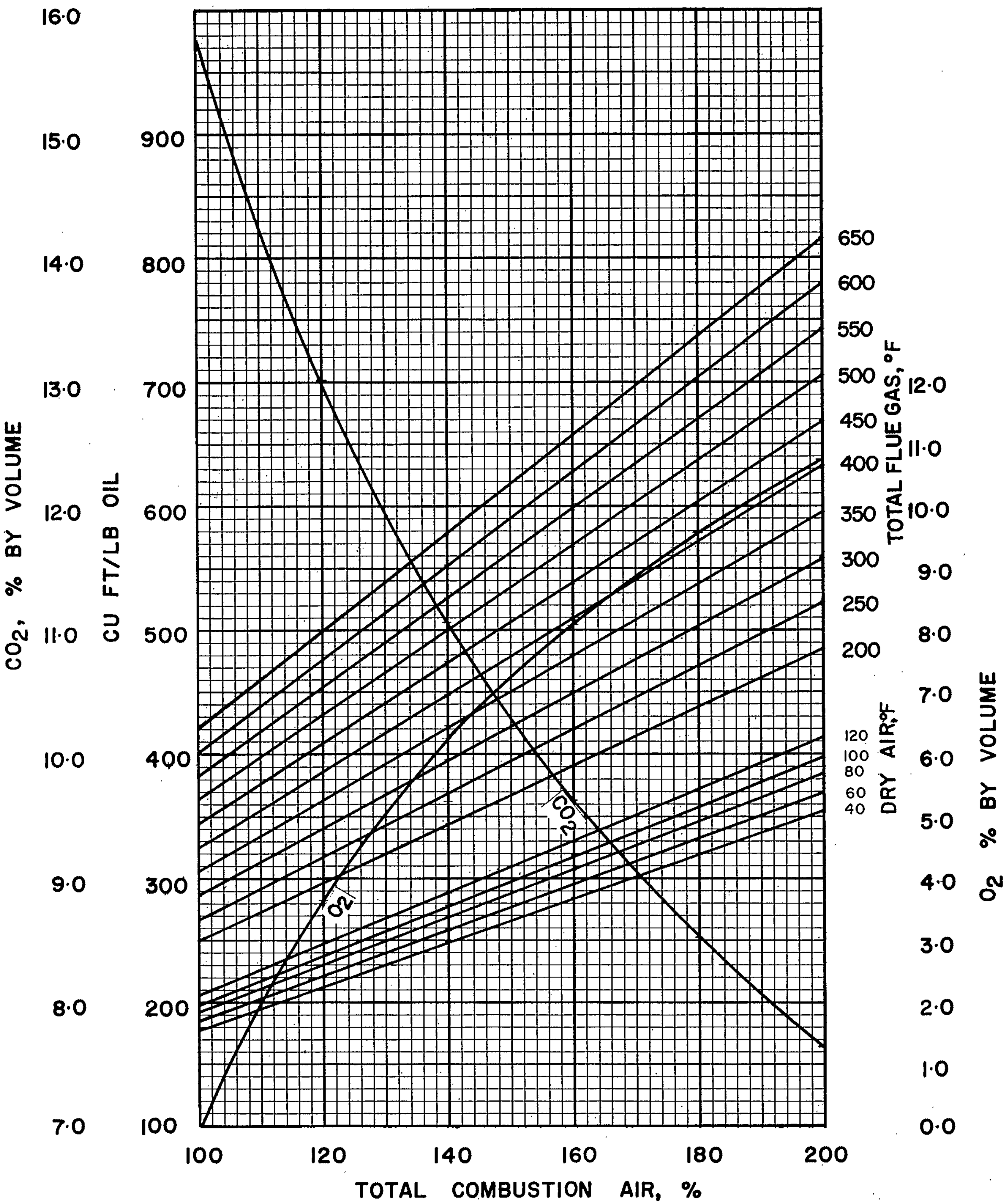


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 9410

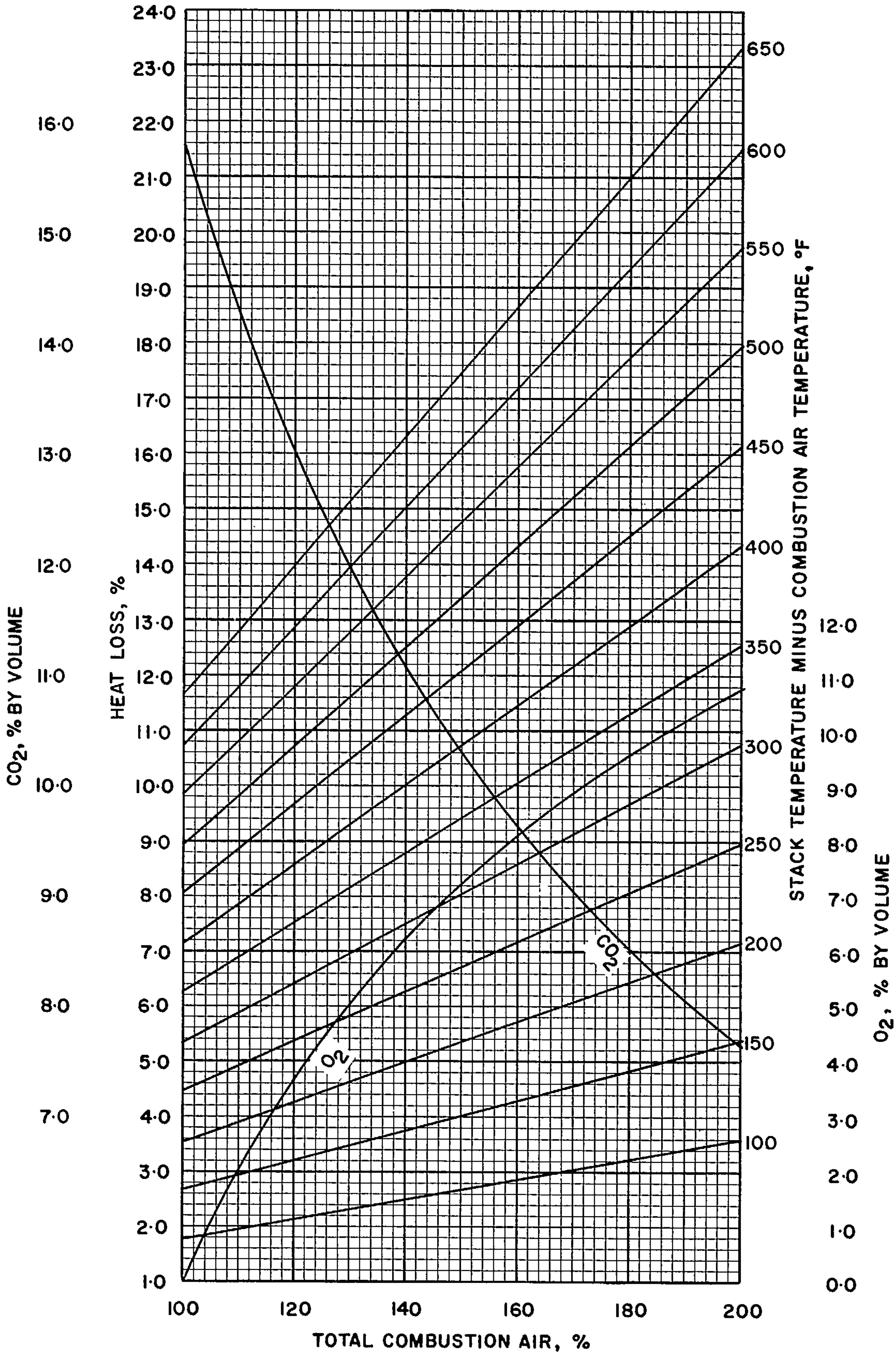


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS·

9410

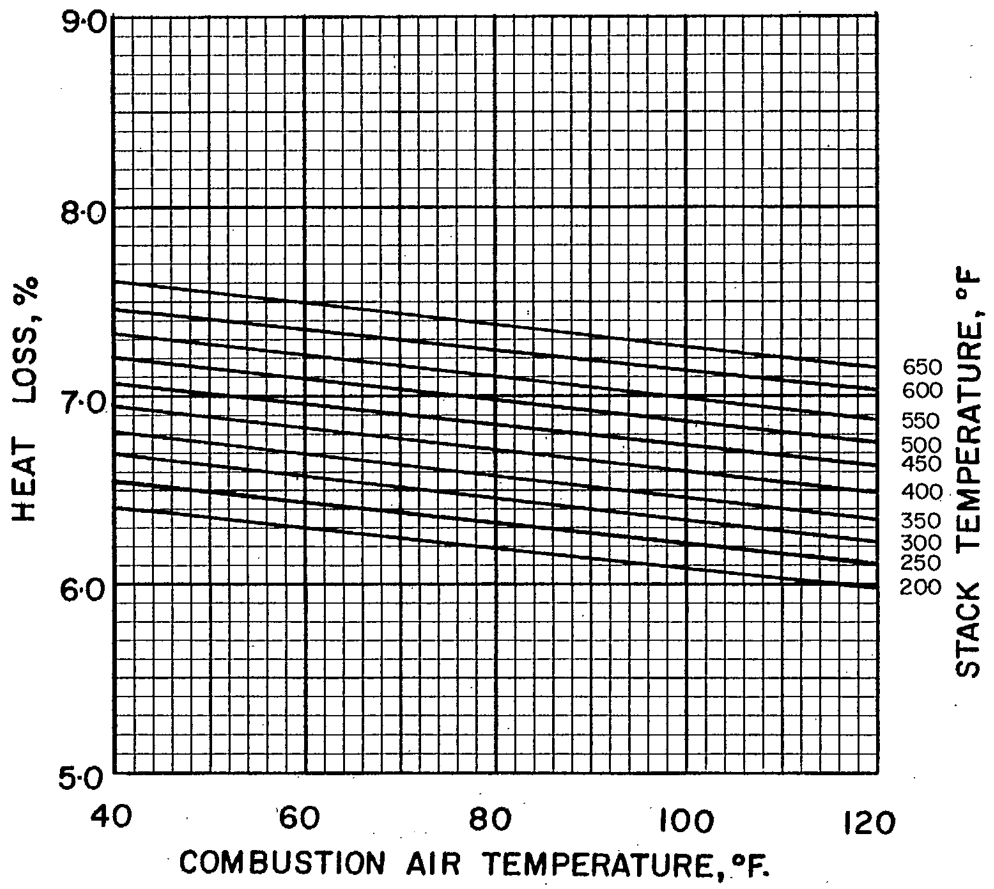


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

9410

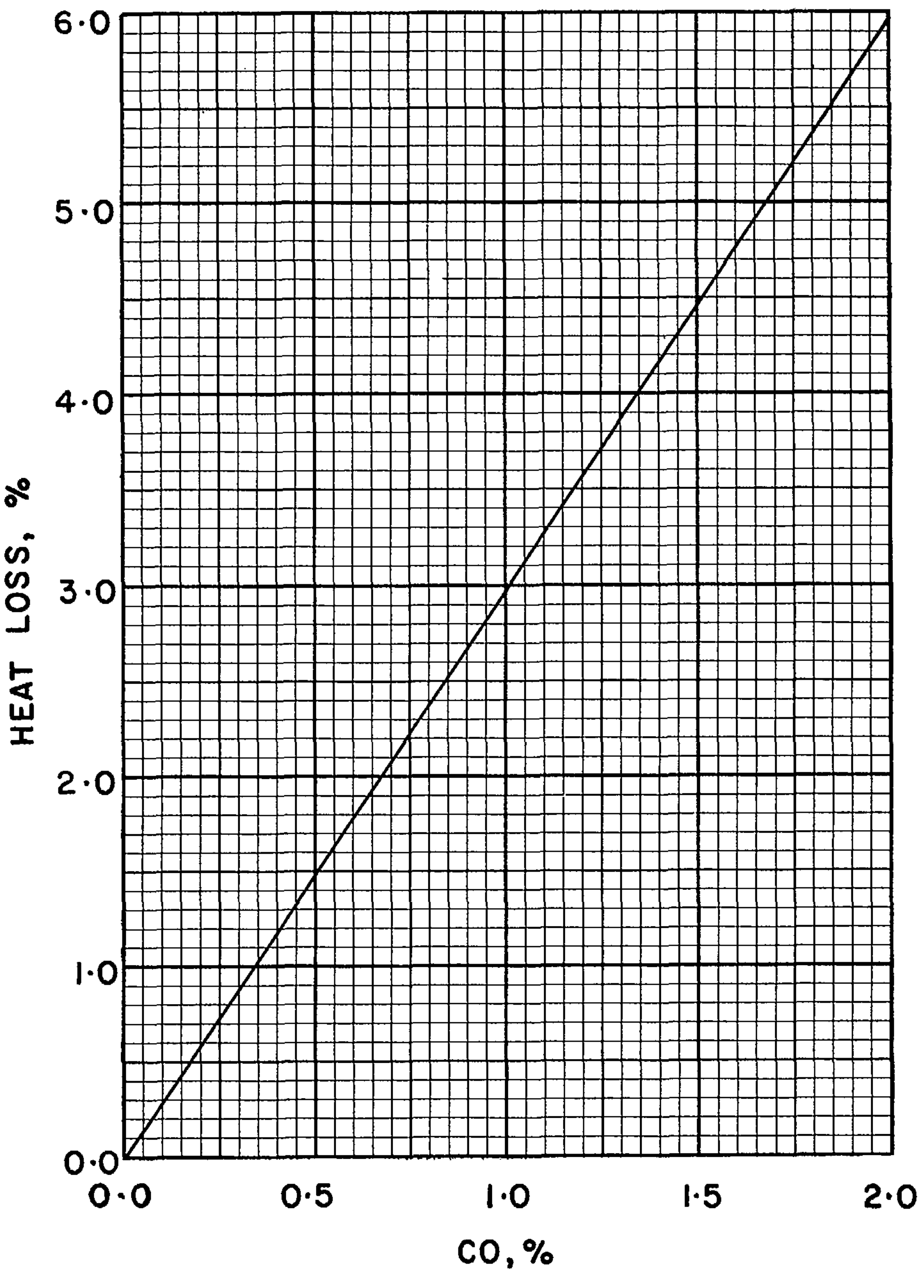


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

9410

FUEL OIL 9420, SPECIFIC GRAVITY 0.940

Ultimate Analysis, lb/lb

Carbon	(C)	0.8634
Hydrogen	(H_2)	0.1166
Sulphur	(S)	0.0200
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,680

Conversion Factors

1 Imp gal oil = 9.40 lb oil
or Imp gal oil × 9.40 = lb oil
or lb oil × 0.1064 = Imp gal oil

1 U.S. gal oil = 9.40 × 0.8337 lb oil
or U.S. gal oil × 7.837 = lb oil
or lb oil × 0.1276 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}680} \text{ lb oil}$$

or Btu × 10^6 × 53.53 = lb oil
or lb oil × 0.0187 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}680 \times 9.40} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.695 = Imp gal oil
or Imp gal oil × 0.1756 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}680 \times 7.837} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.831 = U.S. gal oil
or U.S. gal oil × 0.1464 = Btu × 10^6

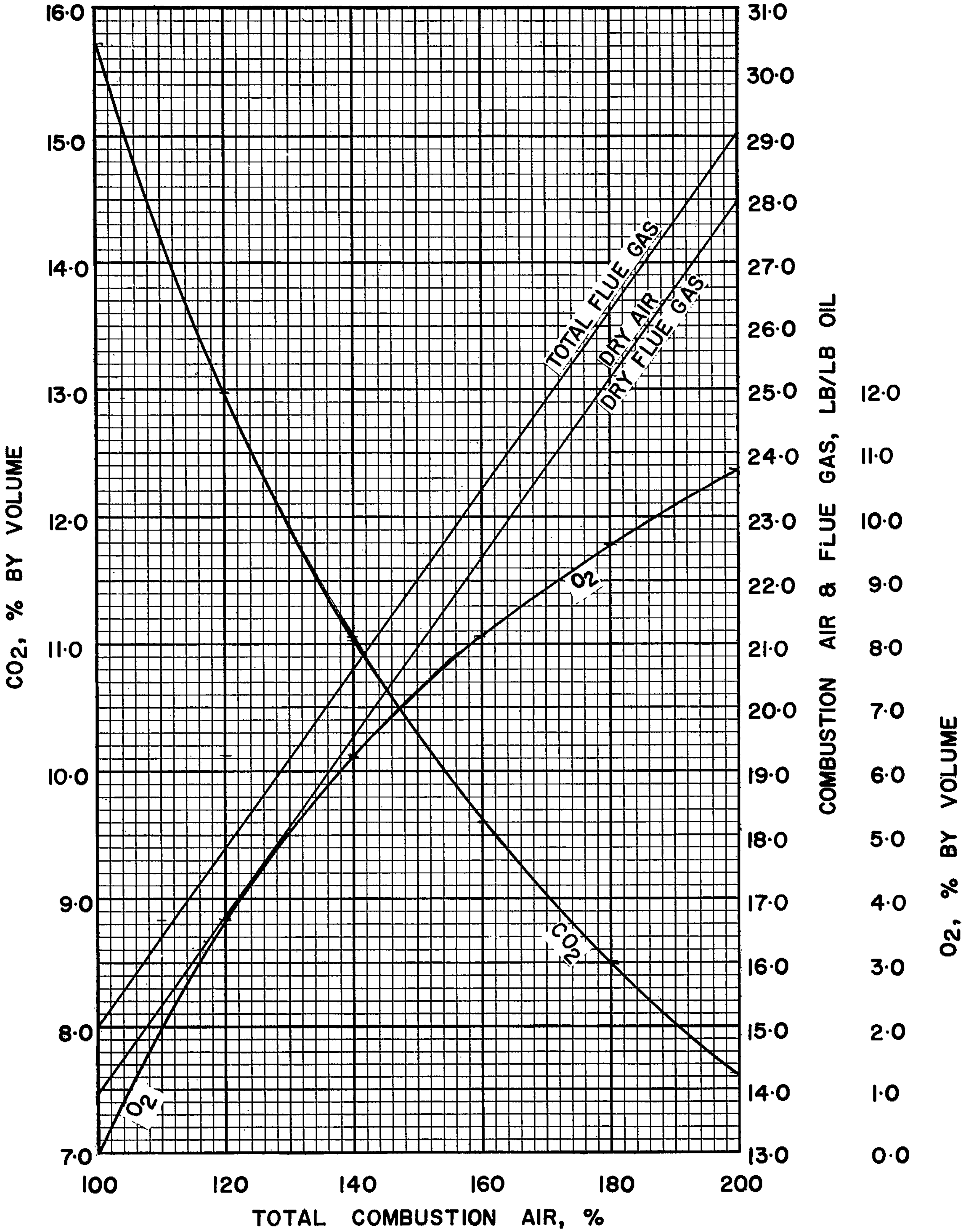


FIGURE I· COMBUSTION DATA, WEIGHT BASIS

9420

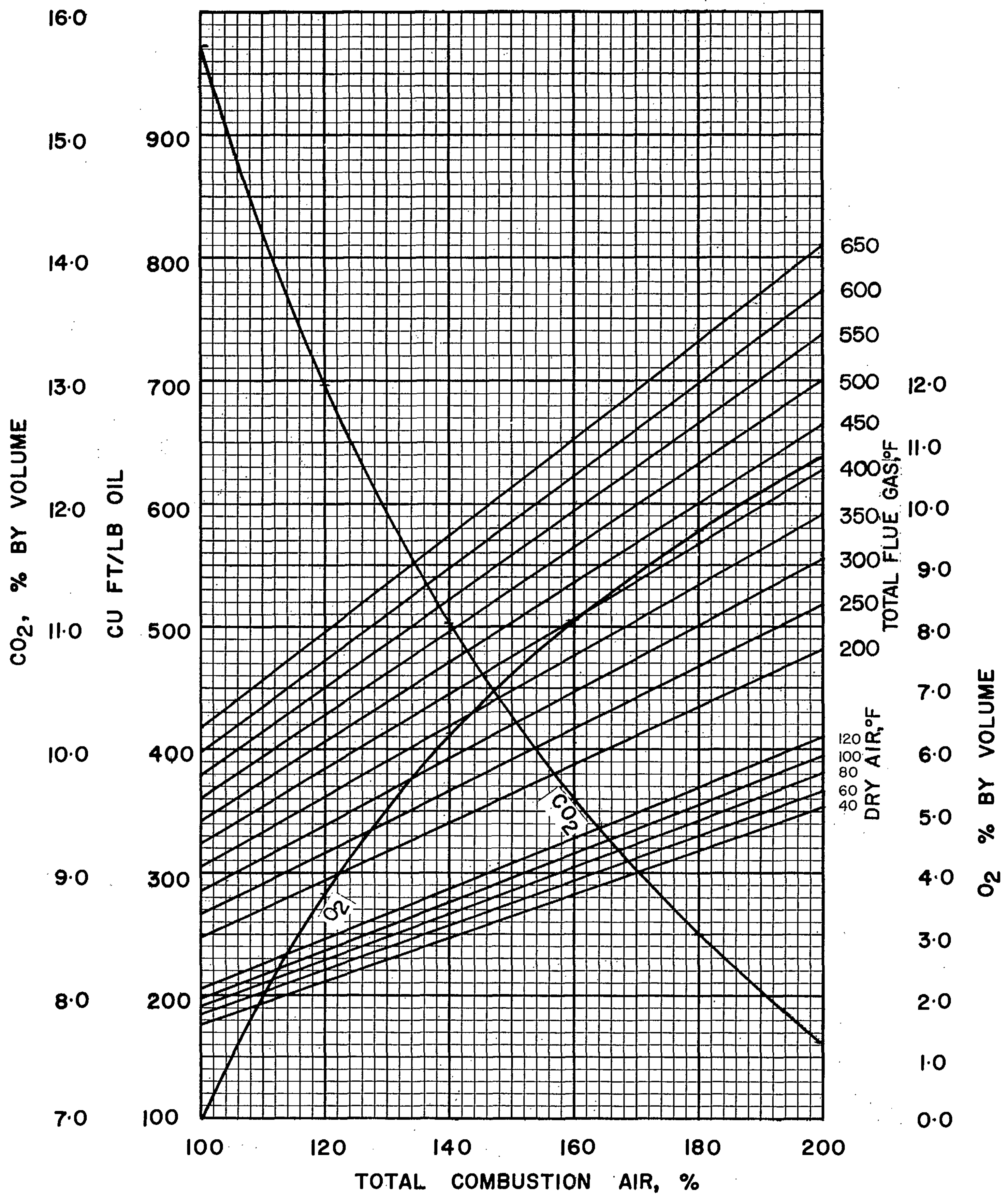


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 9420

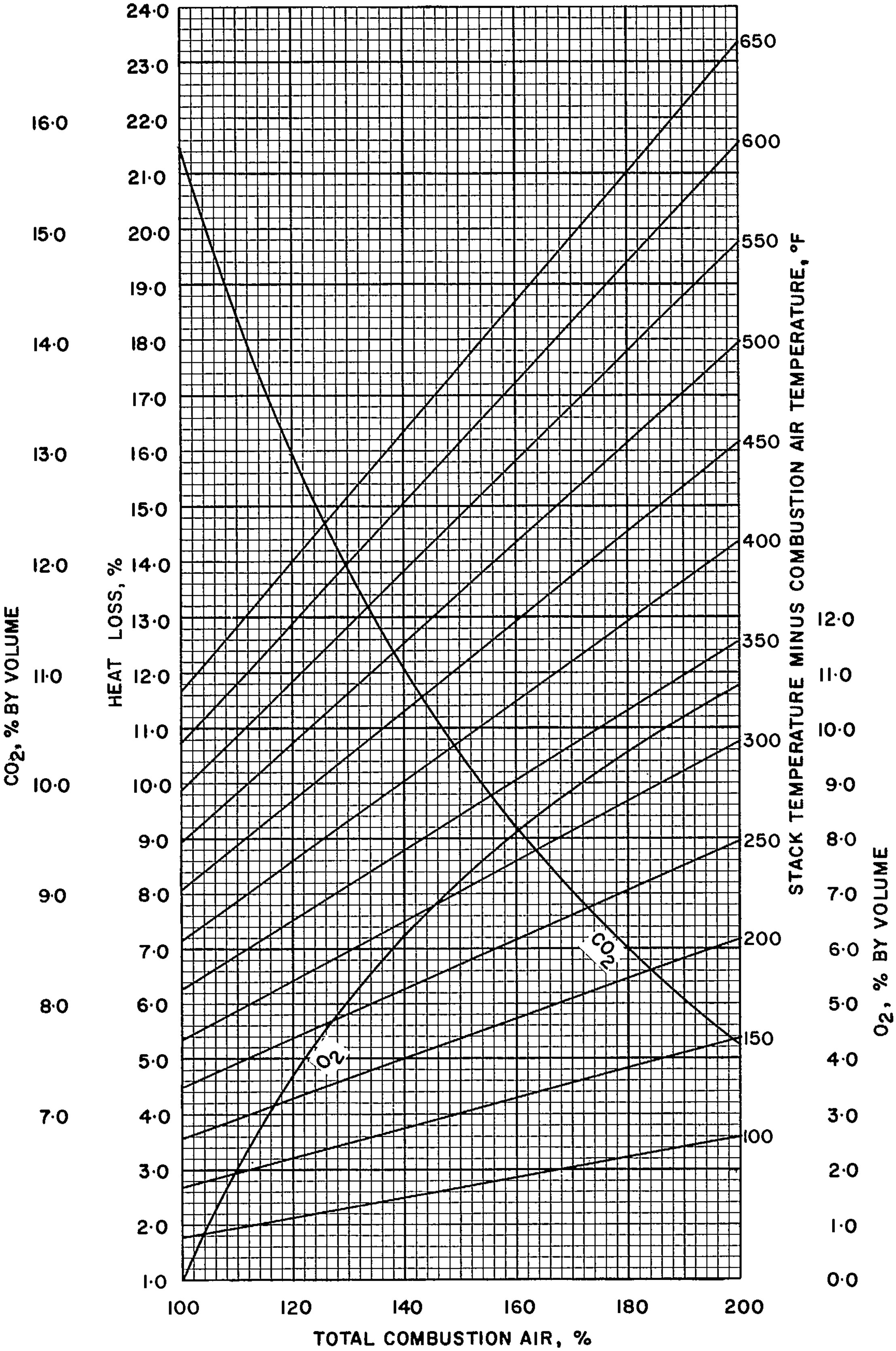


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS·

9420

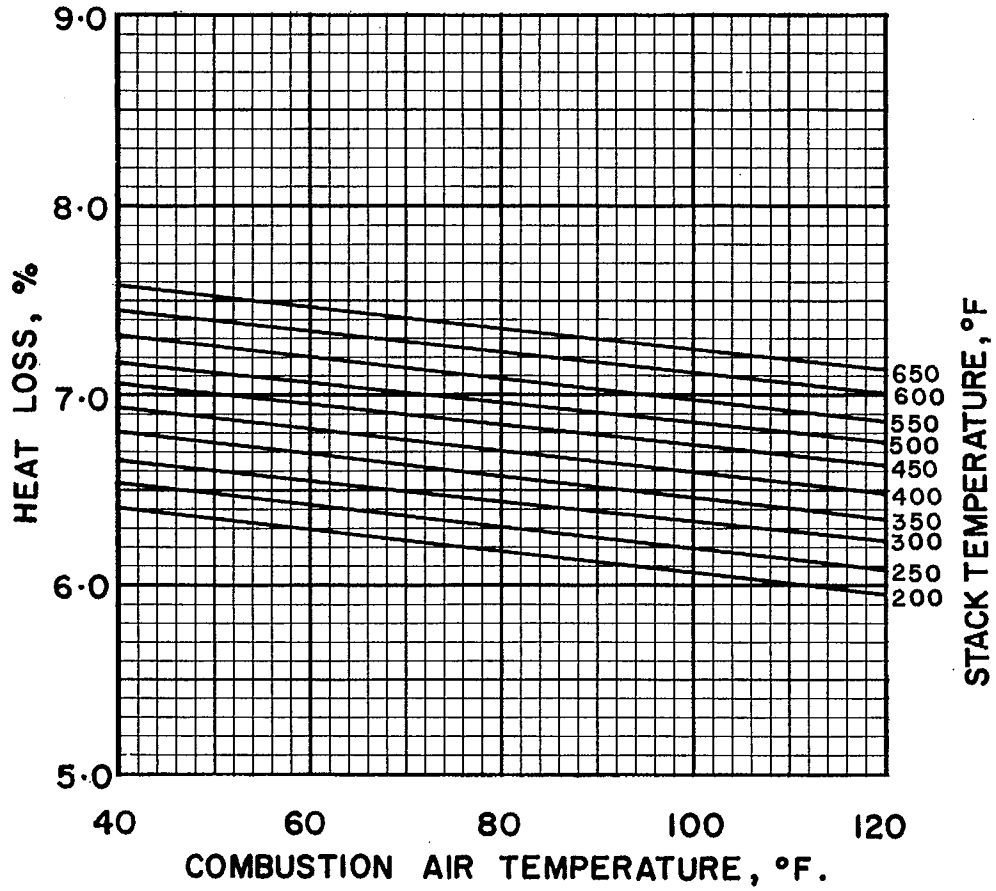


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

9420

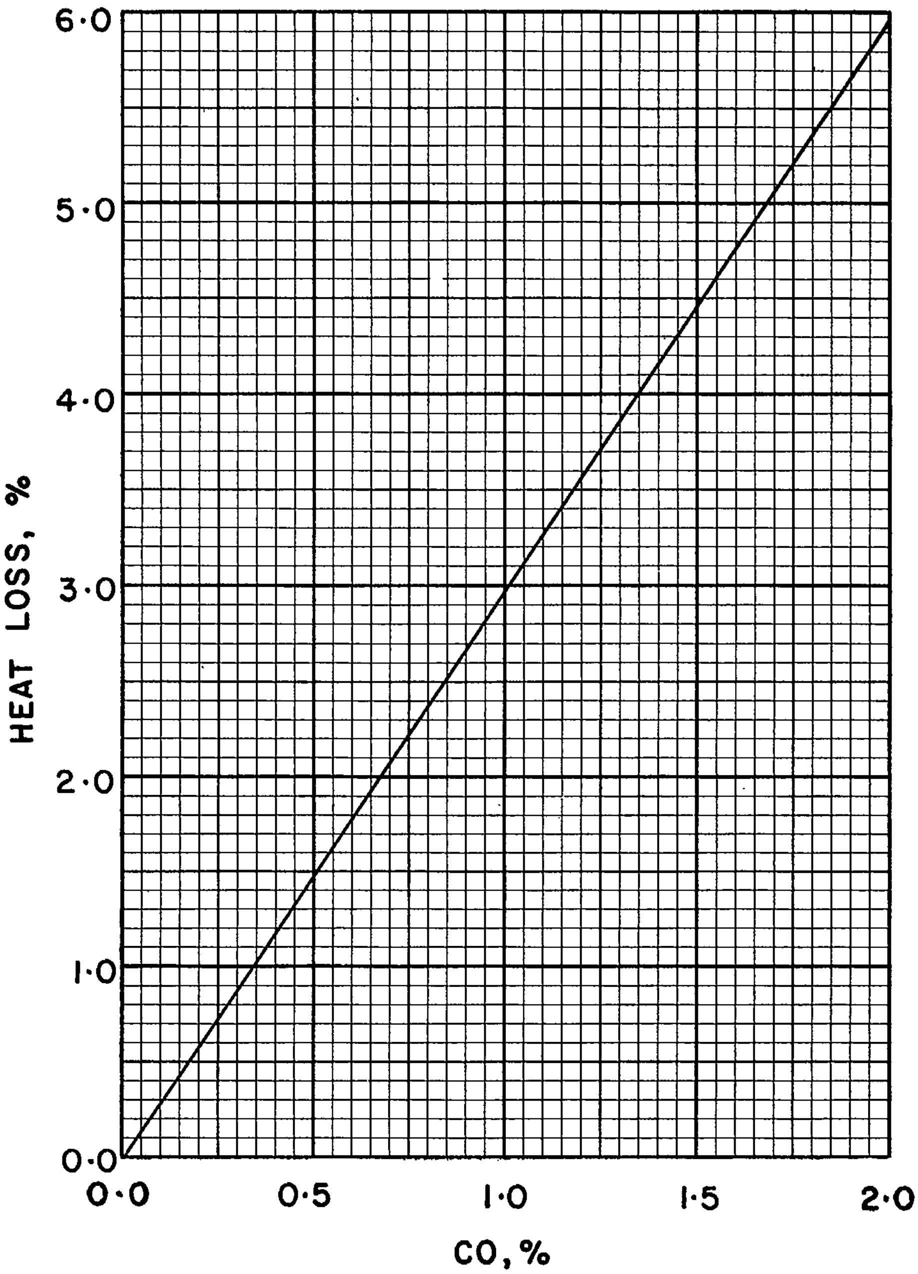


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

9420

FUEL OIL 9430, SPECIFIC GRAVITY 0.940

Ultimate Analysis, lb/lb

Carbon	(C)	0.8546
Hydrogen	(H_2)	0.1154
Sulphur	(S)	0.0300
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,530

Conversion Factors

1 Imp gal oil = 9.40 lb oil
or Imp gal oil × 9.40 = lb oil
or lb oil × 0.1064 = Imp gal oil

1 U.S. gal oil = 9.40 × 0.8337 lb oil
or U.S. gal oil × 7.837 = lb oil
or lb oil × 0.1276 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}530} \text{ lb oil}$$

or Btu × 10^6 × 53.97 = lb oil
or lb oil × 0.0185 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}530 \times 9.40} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.741 = Imp gal oil
or Imp gal oil × 0.1742 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}530 \times 7.837} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.887 = U.S. gal oil
or U.S. gal oil × 0.1452 = Btu × 10^6

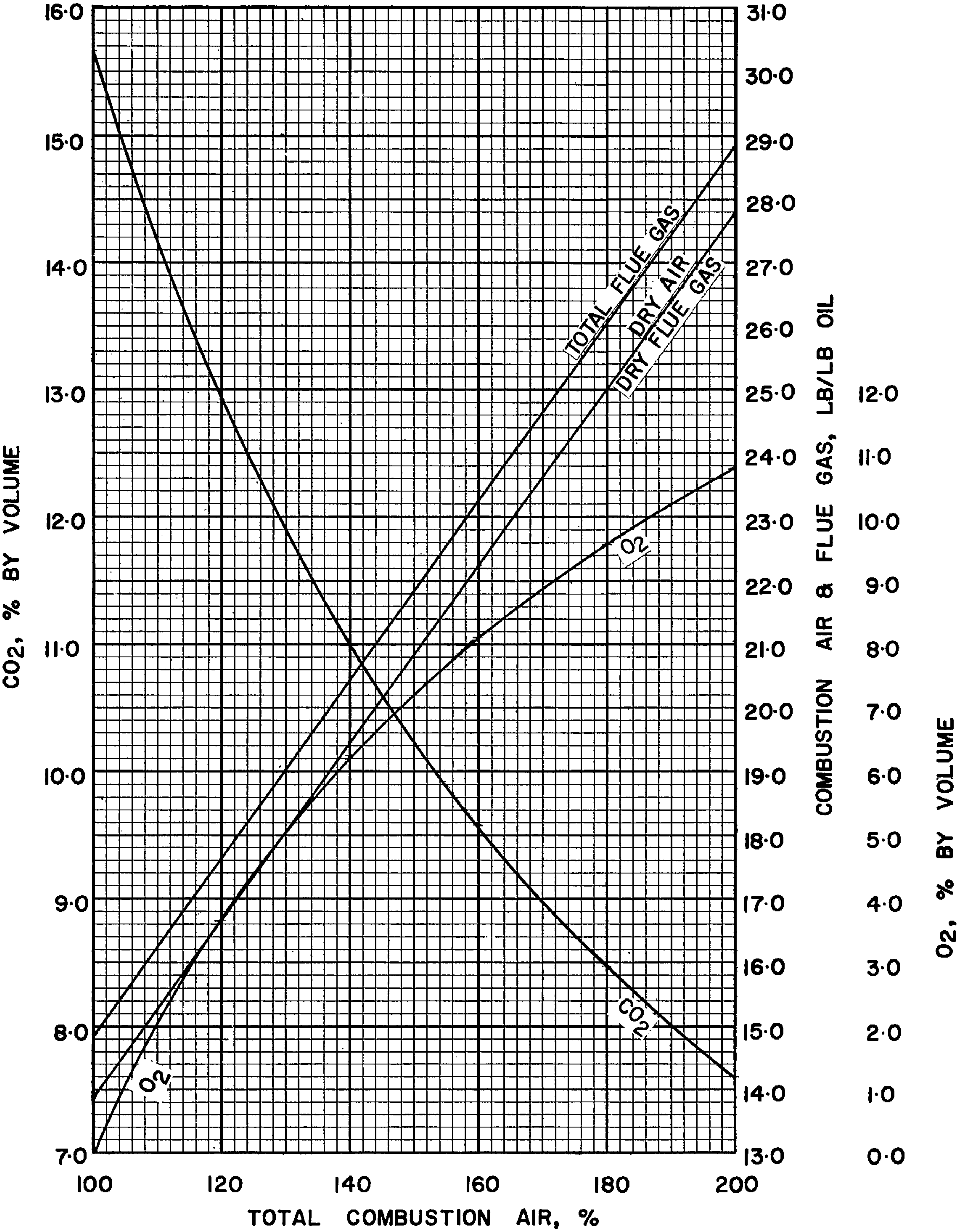


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS

9430

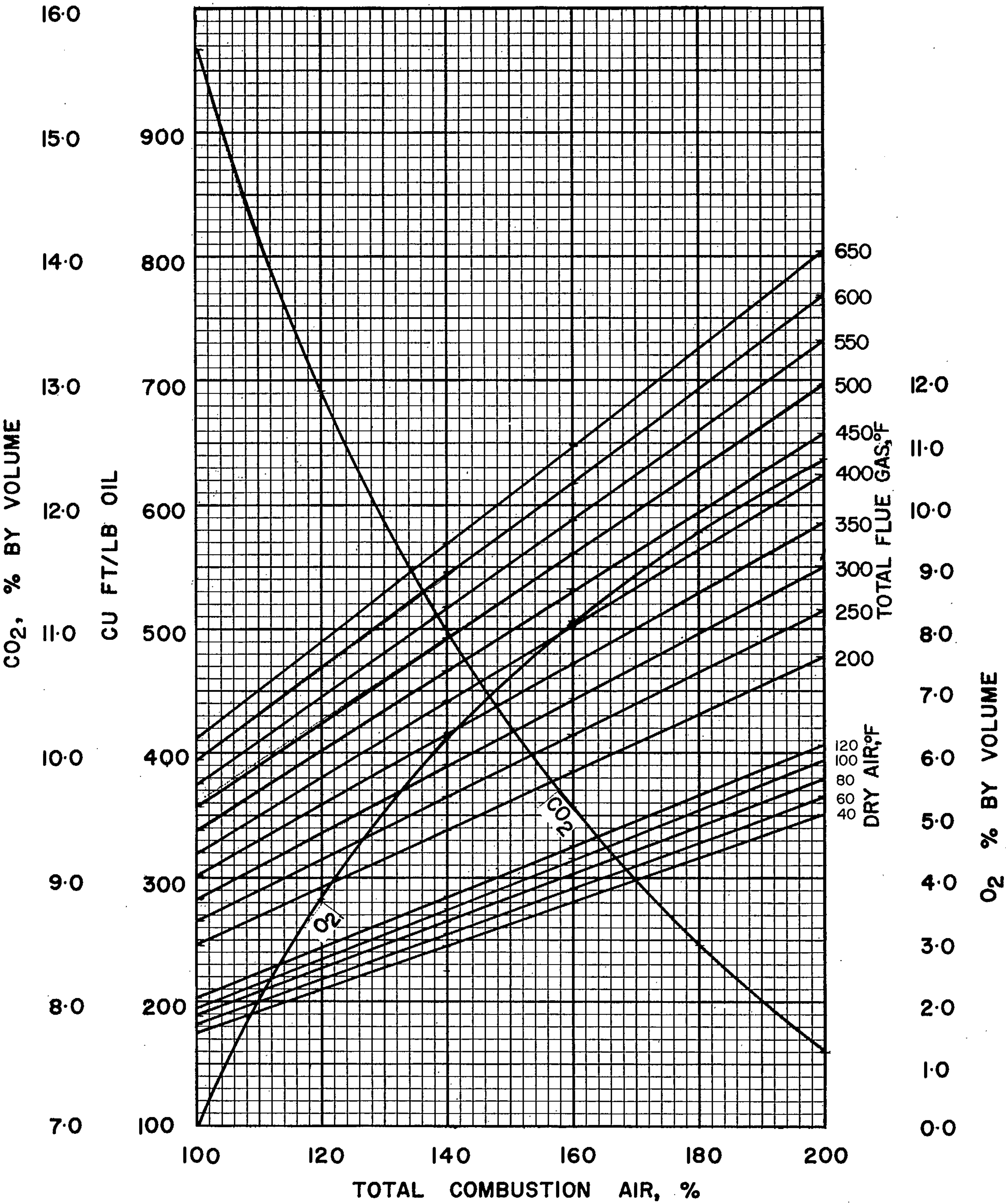


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 9430

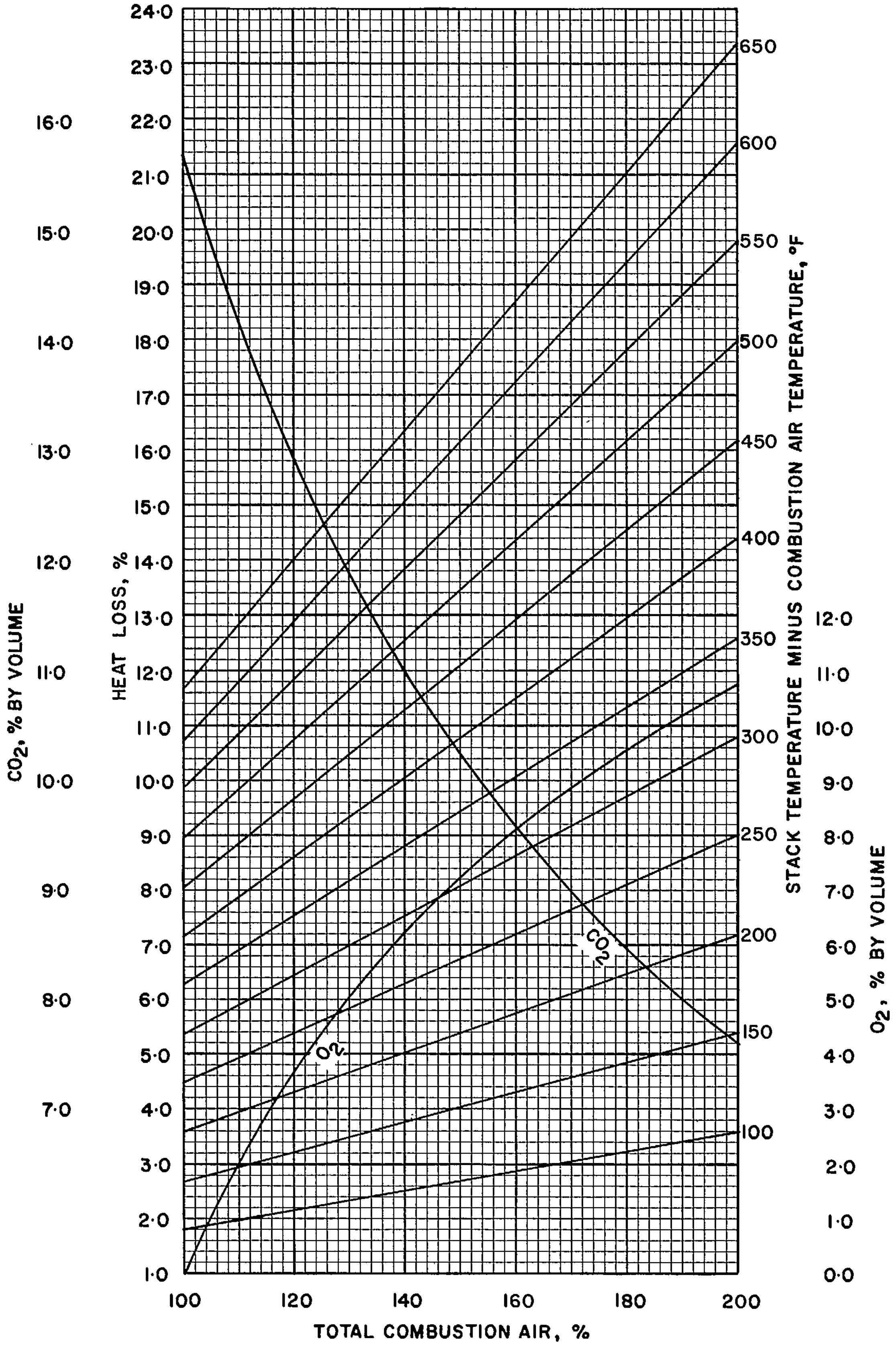


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS·

9430

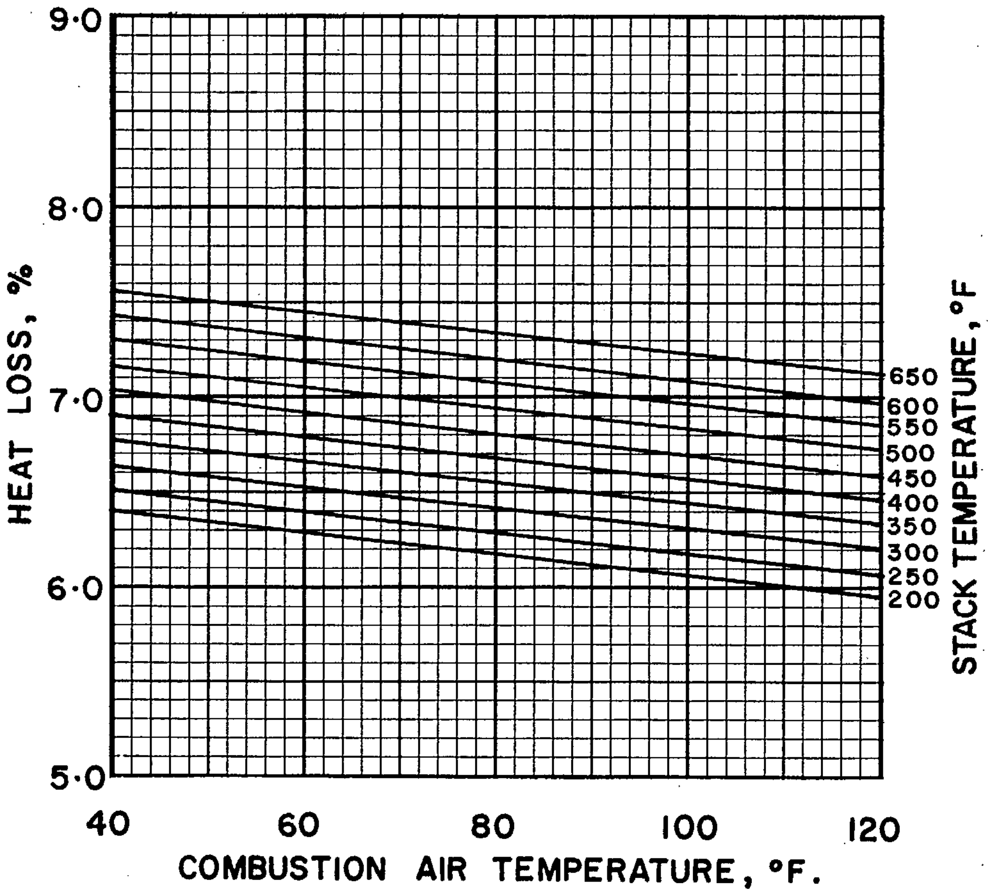


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

9430

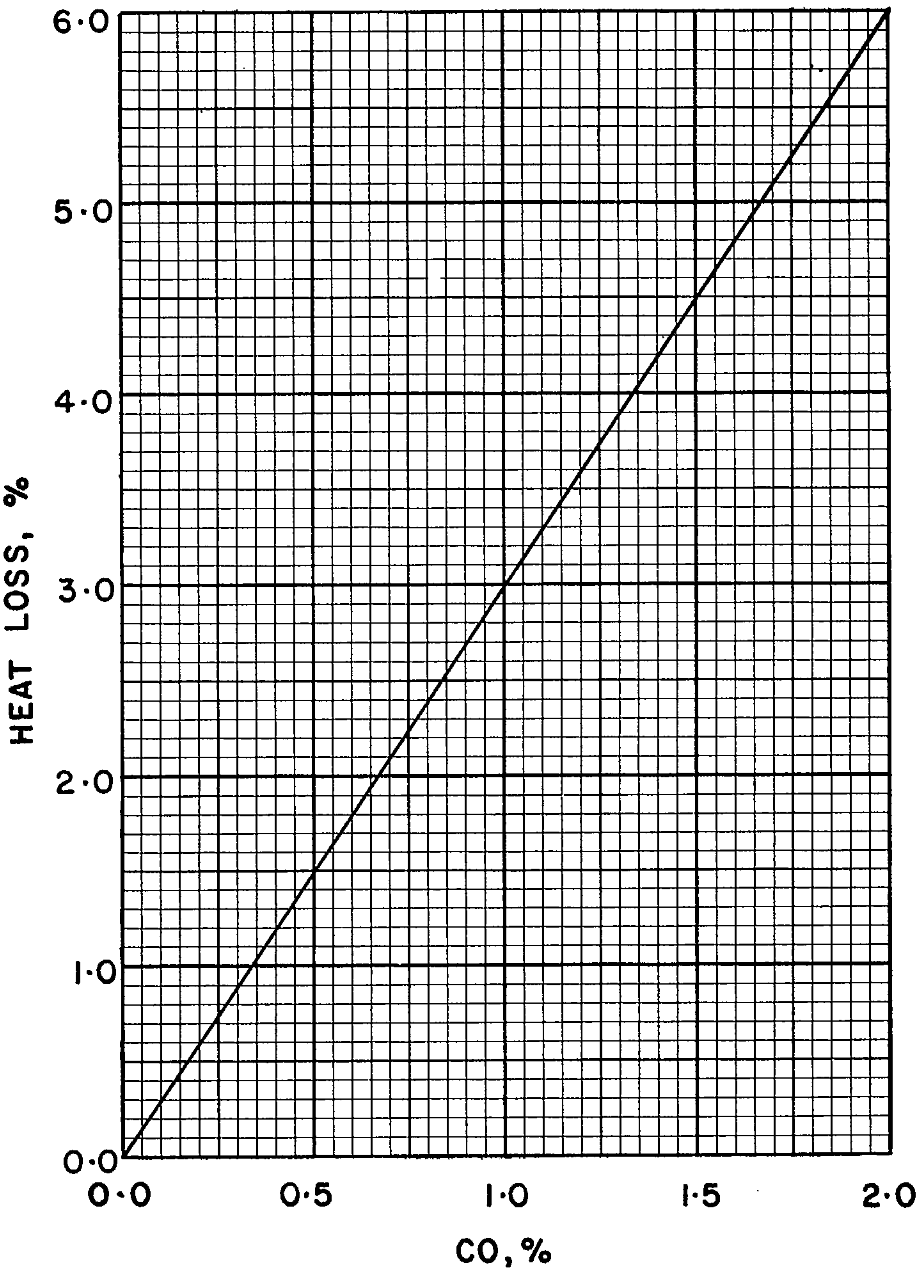


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

9430

FUEL OIL 9440, SPECIFIC GRAVITY 0.940

Ultimate Analysis, lb/lb

Carbon	(C)	0.8458
Hydrogen	(H_2)	0.1142
Sulphur	(S)	0.0400
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,380

Conversion Factors

1 Imp gal oil = 9.40 lb oil
or Imp gal × 9.40 = lb oil
or lb oil × 0.1064 = Imp gal oil

1 U.S. gal oil = 9.40 × 0.8337 lb oil
or U.S. gal oil × 7.837 = lb oil
or lb oil × 0.1276 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}380} \text{ lb oil}$$

or Btu × 10^6 × 54.41 = lb oil
or lb oil × 0.01838 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}380 \times 9.40} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.788 = Imp gal oil
or Imp gal oil × 0.1728 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}380 \times 7.837} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.944 = U.S. gal oil
or U.S. gal oil × 0.1440 = Btu × 10^6

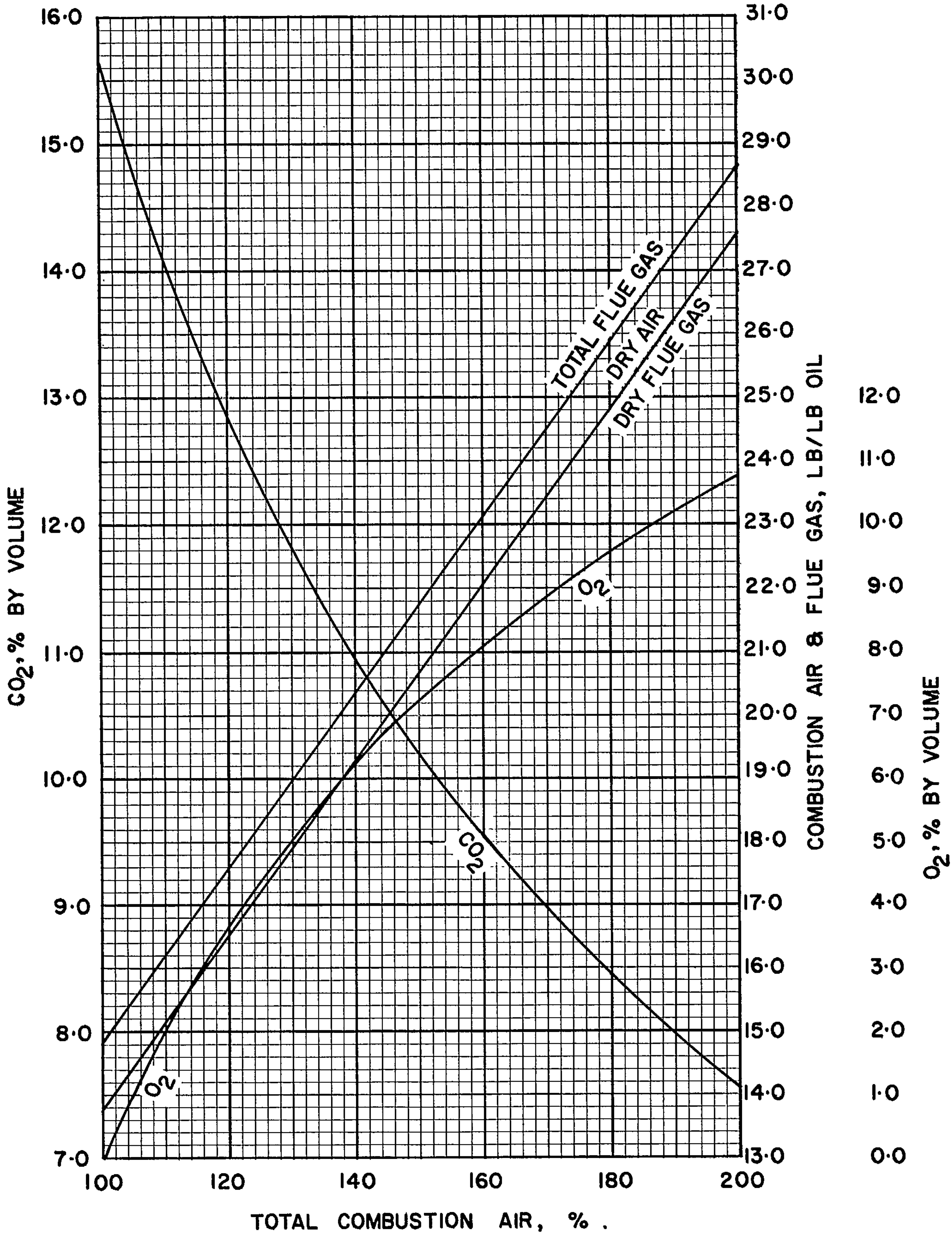


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS.

9440

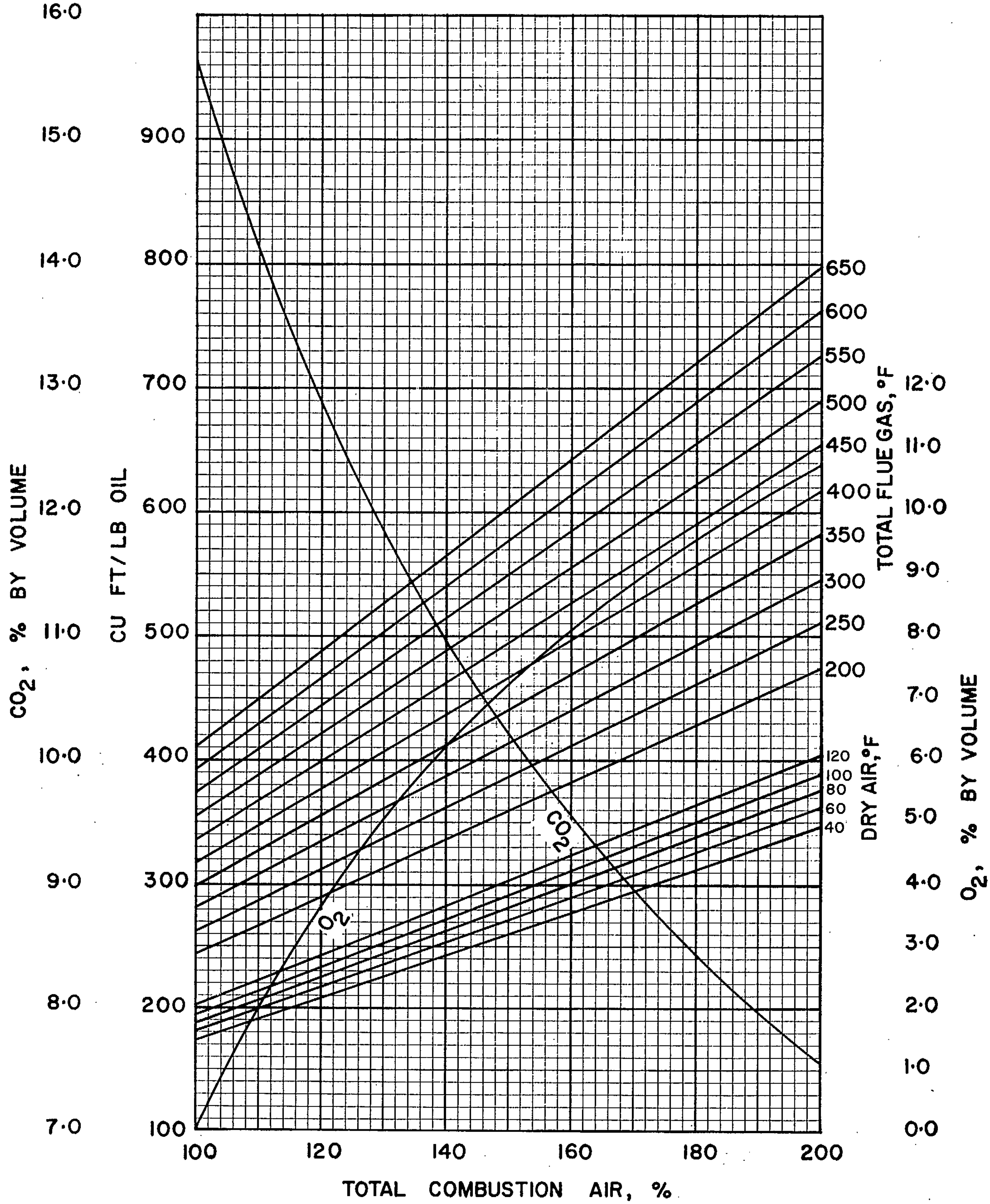


FIGURE 2. COMBUSTION DATA, VOLUME BASIS.

9440

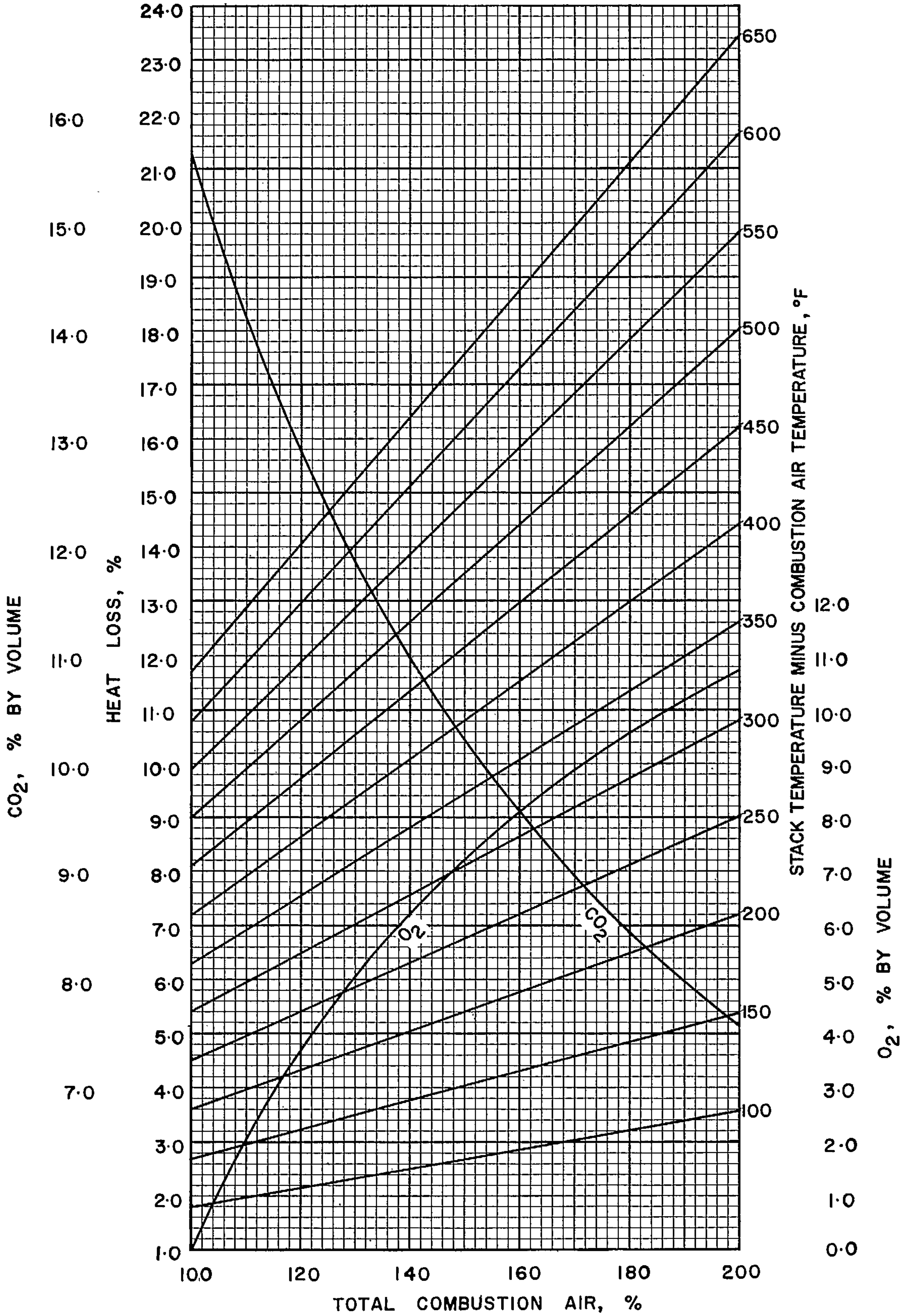


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

9440

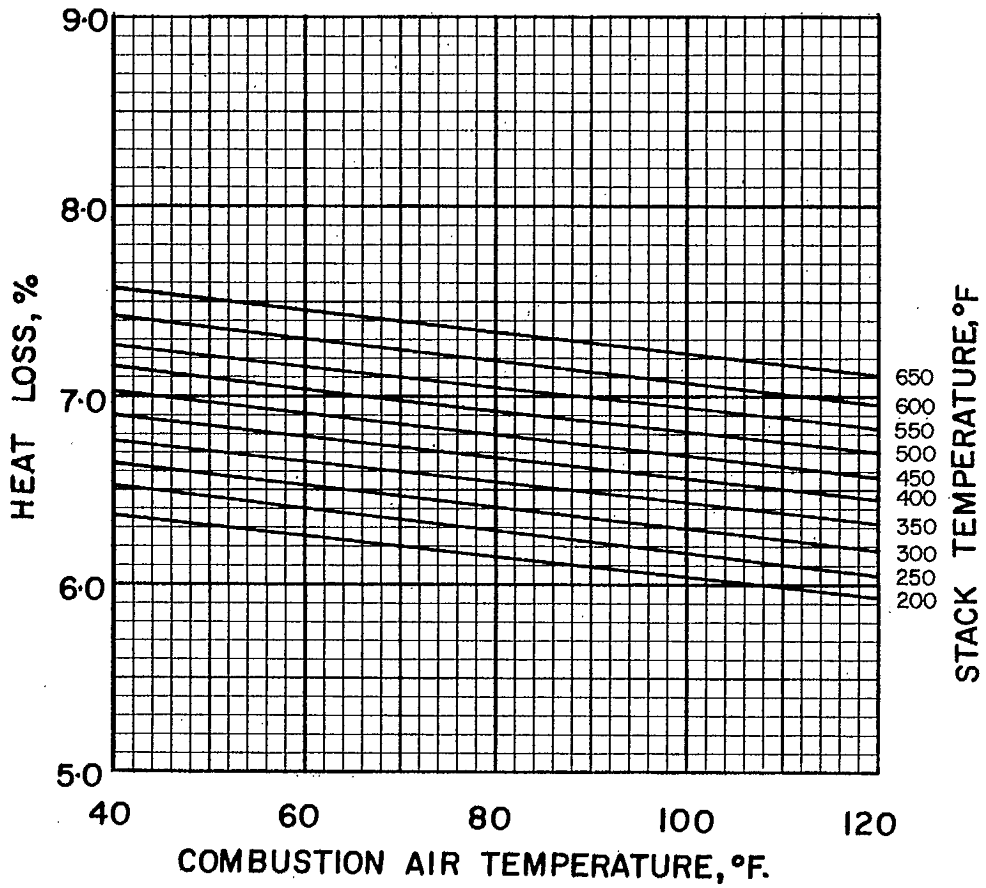


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

9440

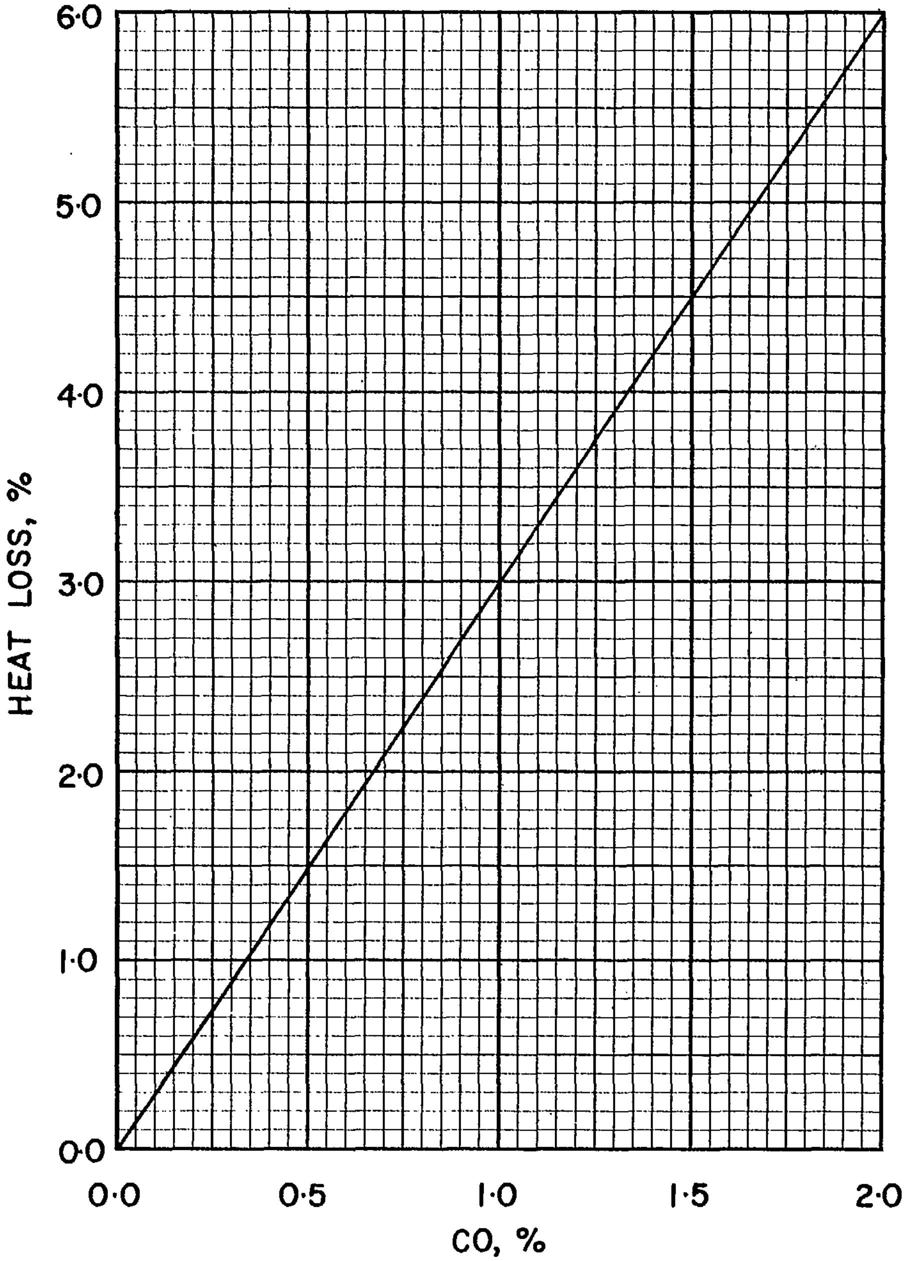


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

9440

FUEL OIL 9500, SPECIFIC GRAVITY 0.950

Ultimate Analysis, lb/lb

Carbon	(C)	0.8825
Hydrogen	(H_2)	0.1175
Sulphur	(S)	–
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,910

Conversion Factors

1 Imp gal oil = 9.50 lb oil
or Imp gal oil × 9.50 = lb oil
or lb oil × 0.1053 = Imp gal oil

1 U.S. gal oil = 9.50 × 0.8337 lb oil
or U.S. gal oil × 7.920 = lb oil
or lb oil × 0.1263 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}910} \text{ lb oil}$$

or Btu × 10^6 × 52.88 = lb oil
or lb oil × 0.0189 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}910 \times 9.50} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.567 = Imp gal oil
or Imp gal oil × 0.1796 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}910 \times 7.920} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.676 = U.S. gal oil
or U.S. gal oil × 0.1498 = Btu × 10^6

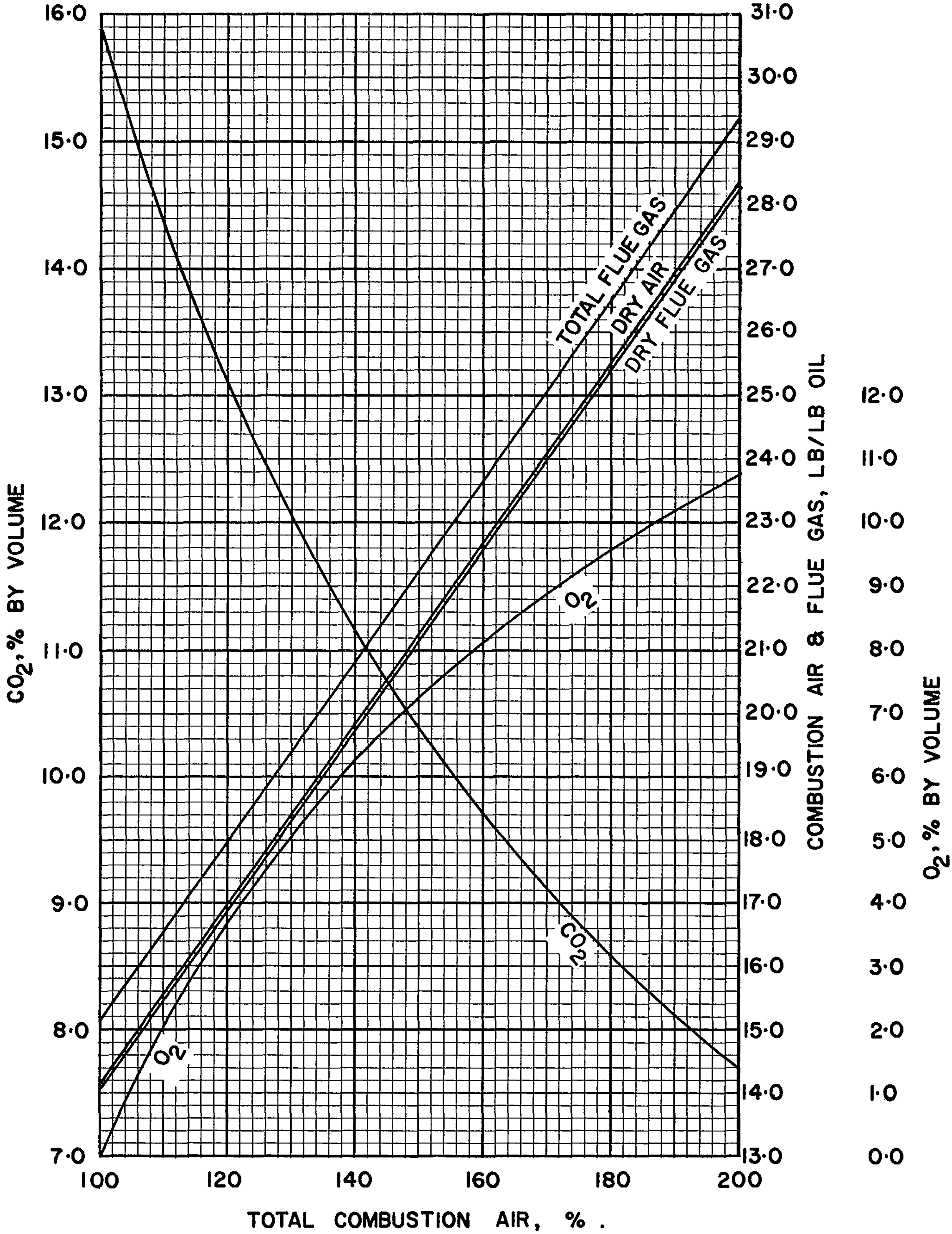


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS.

9500

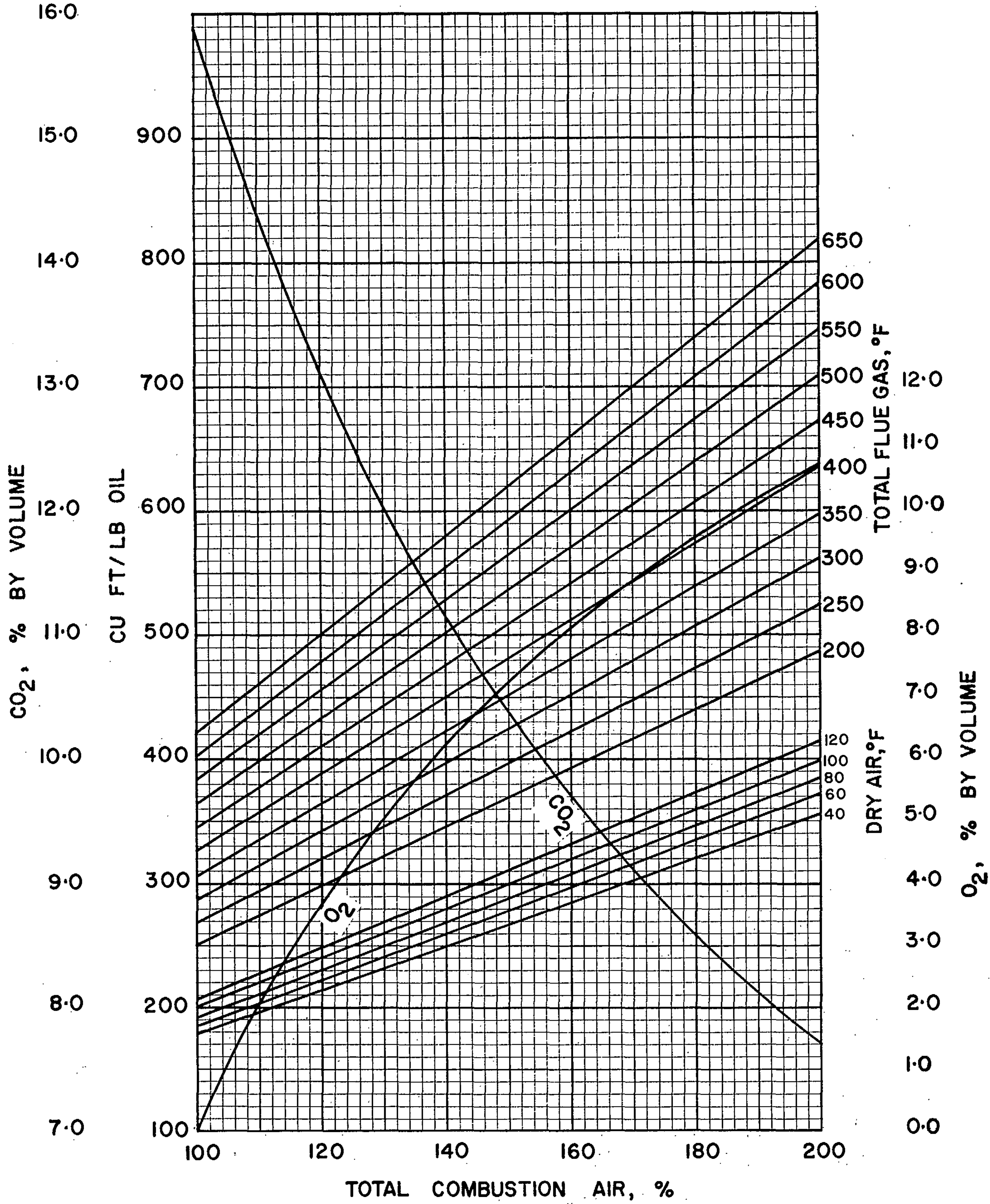


FIGURE 2. COMBUSTION DATA, VOLUME BASIS.

9500

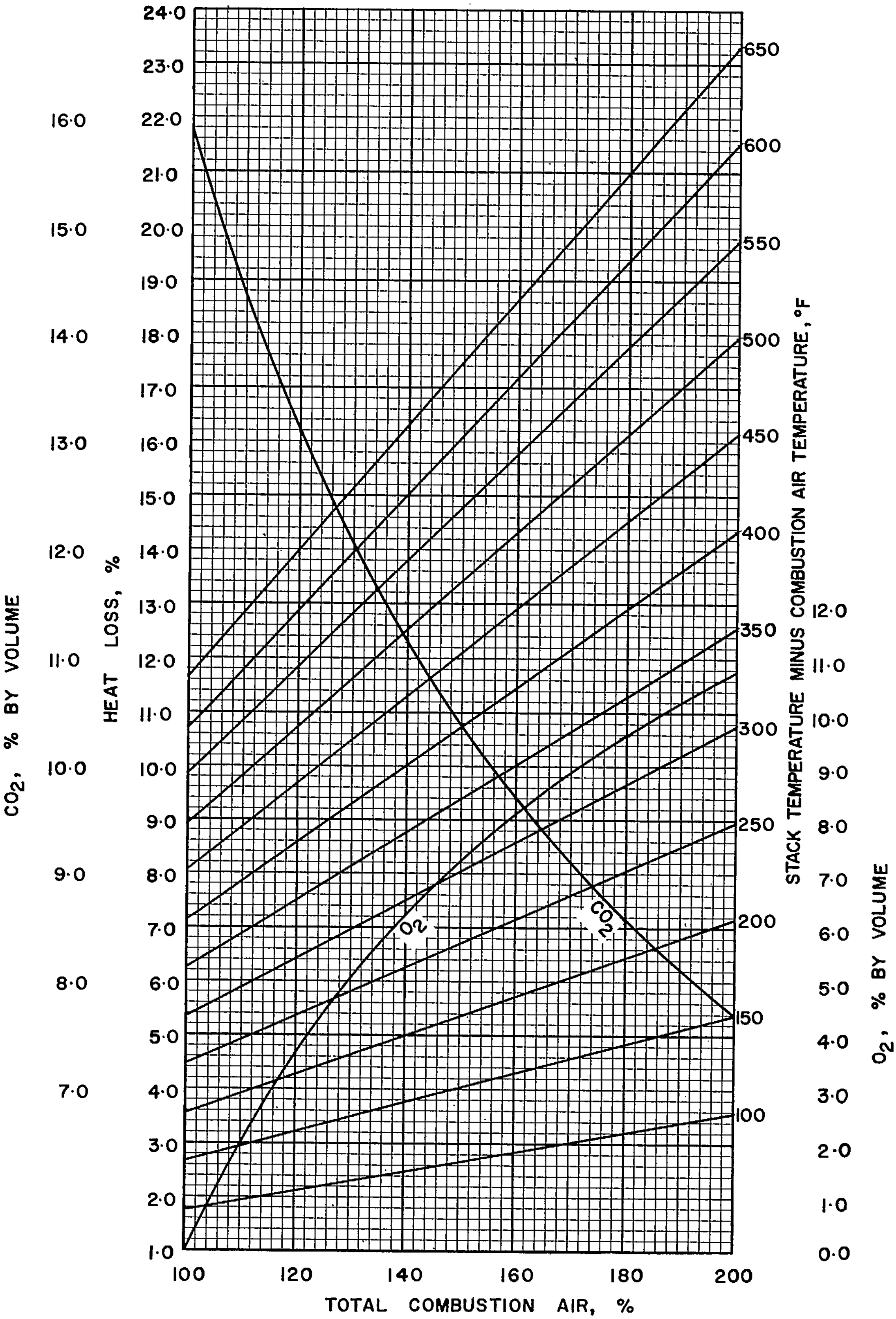


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

9500

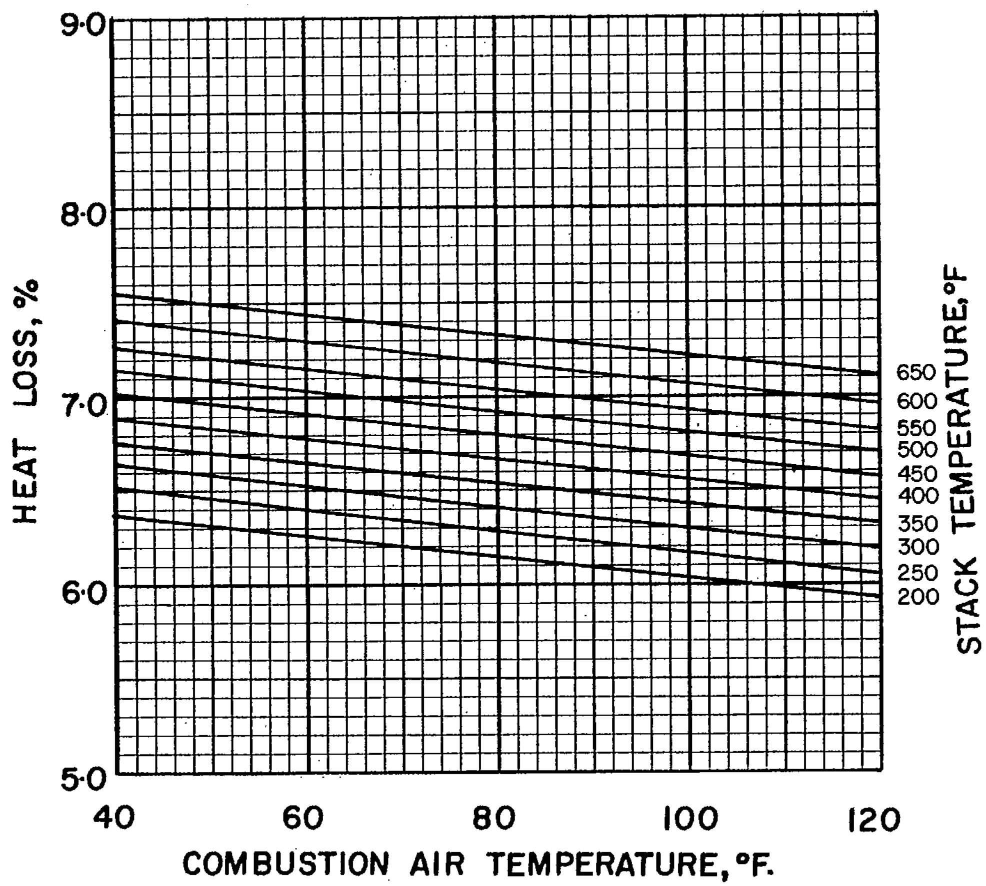


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

9500

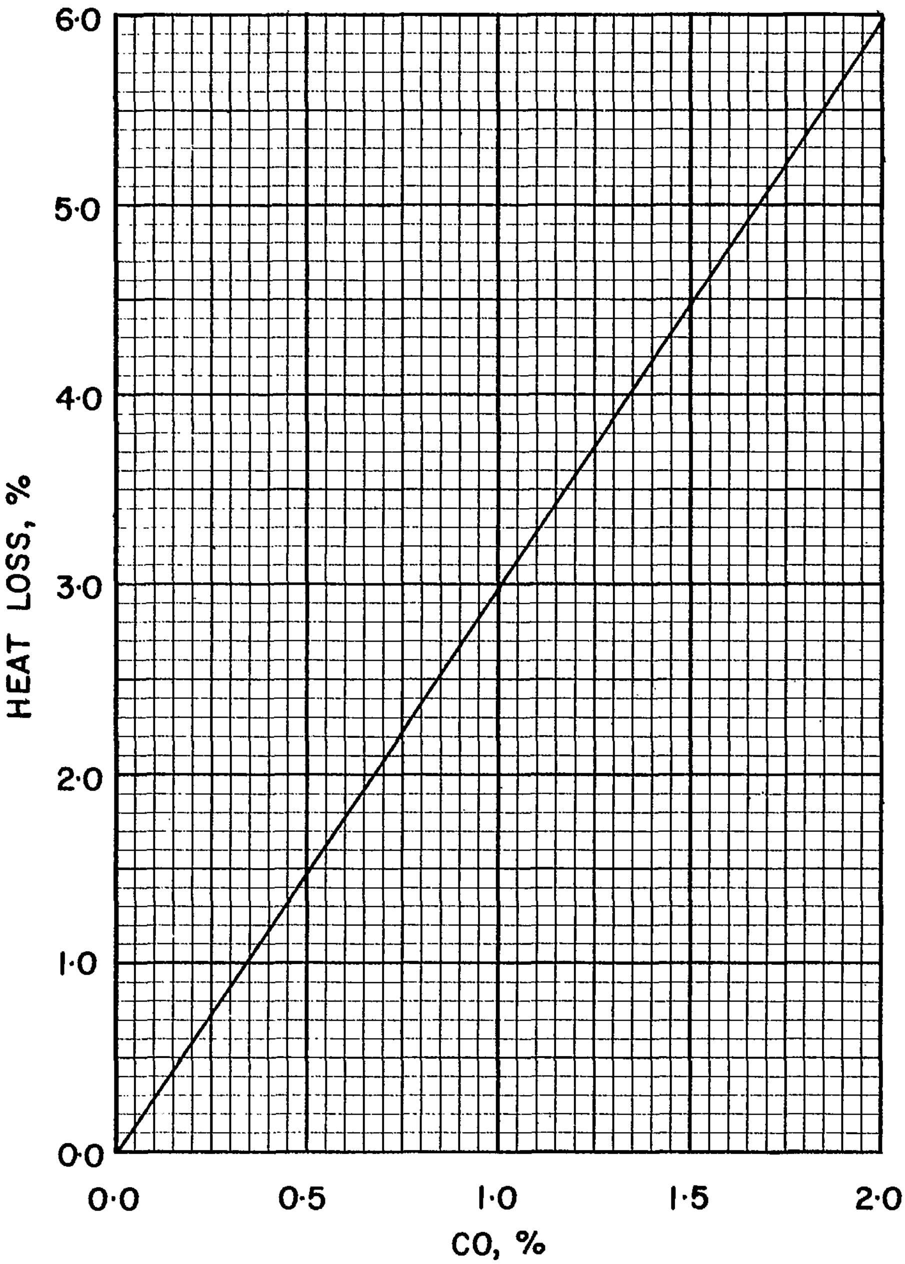


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

9500

FUEL OIL 9510, SPECIFIC GRAVITY 0.950

Ultimate Analysis, lb/lb

Carbon	(C)	0.8737
Hydrogen	(H_2)	0.1163
Sulphur	(S)	0.0100
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,760

Conversion Factors

1 Imp gal oil = 9.50 lb oil
or Imp gal oil × 9.50 = lb oil
or lb oil × 0.1053 = Imp gal oil

1 U.S. gal oil = 9.50 × 0.8337 lb oil
or U.S. gal oil × 7.920 = lb oil
or lb oil × 0.1263 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}760} \text{ lb oil}$$

or Btu × 10^6 × 53.31 = lb oil
or lb oil × 0.01876 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}760 \times 9.50} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.611 = Imp gal oil
or Imp gal oil × 0.1782 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}760 \times 7.920} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.730 = U.S. gal oil
or U.S. gal oil × 0.1486 = Btu × 10^6

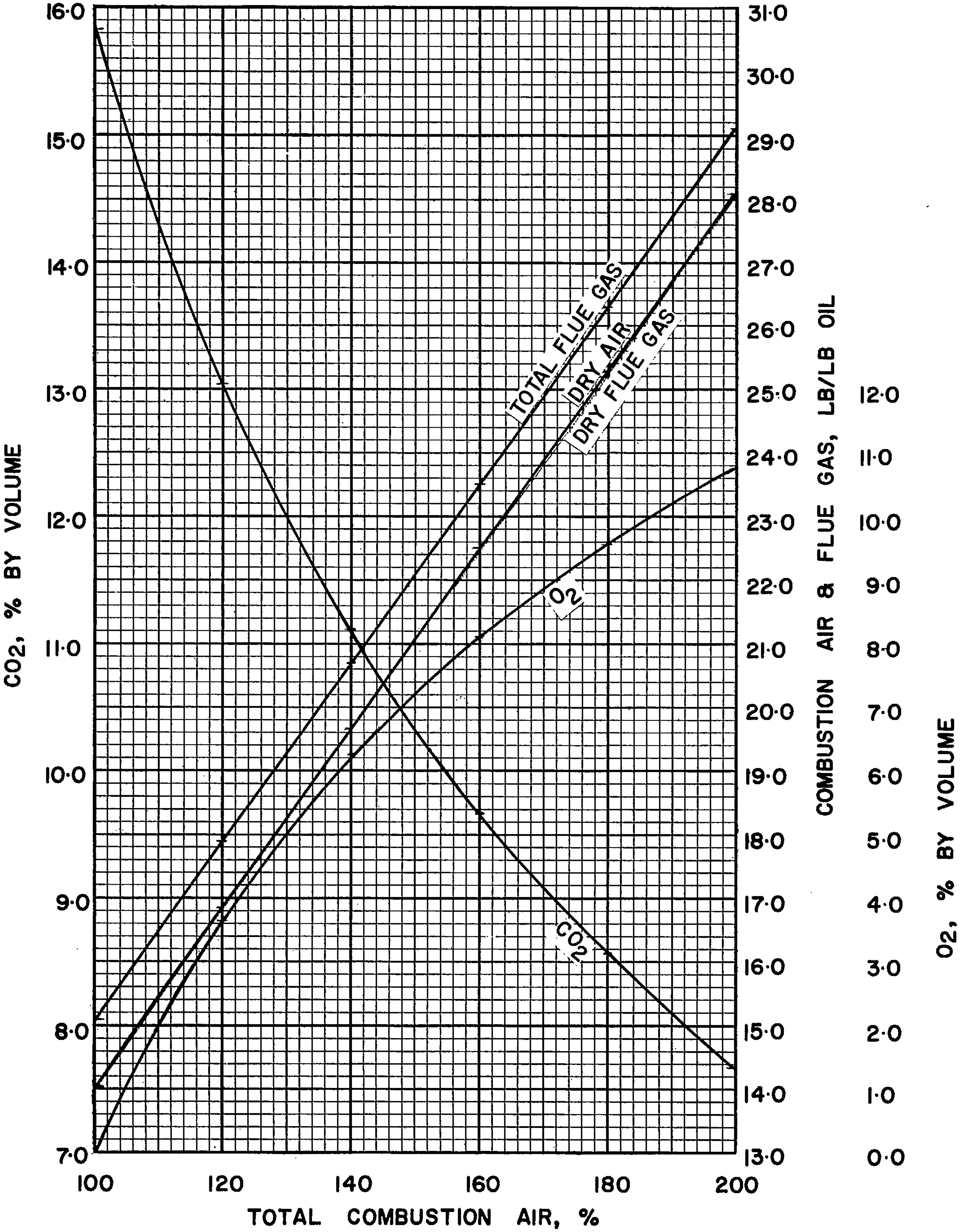


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS 9510

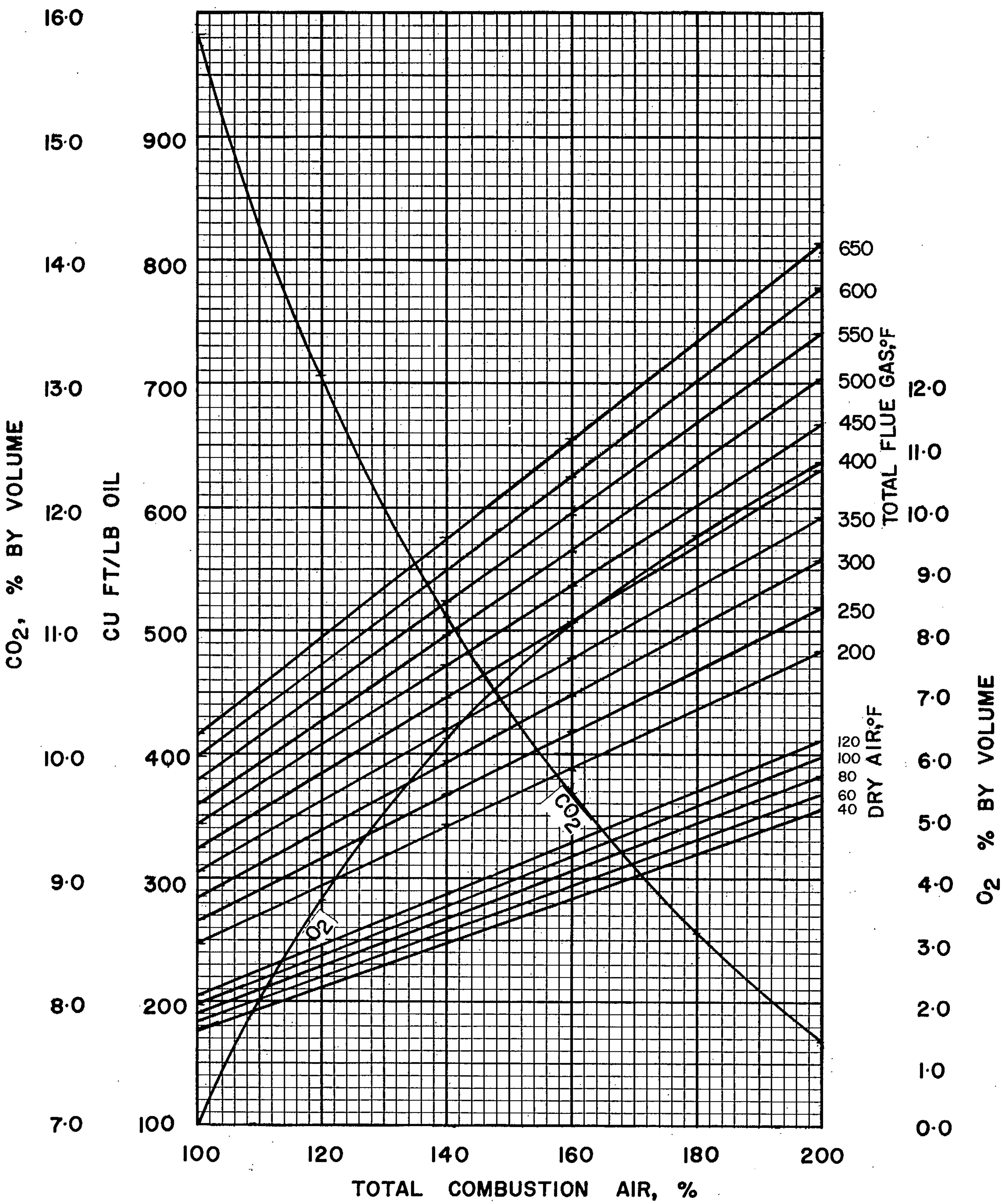


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 9510

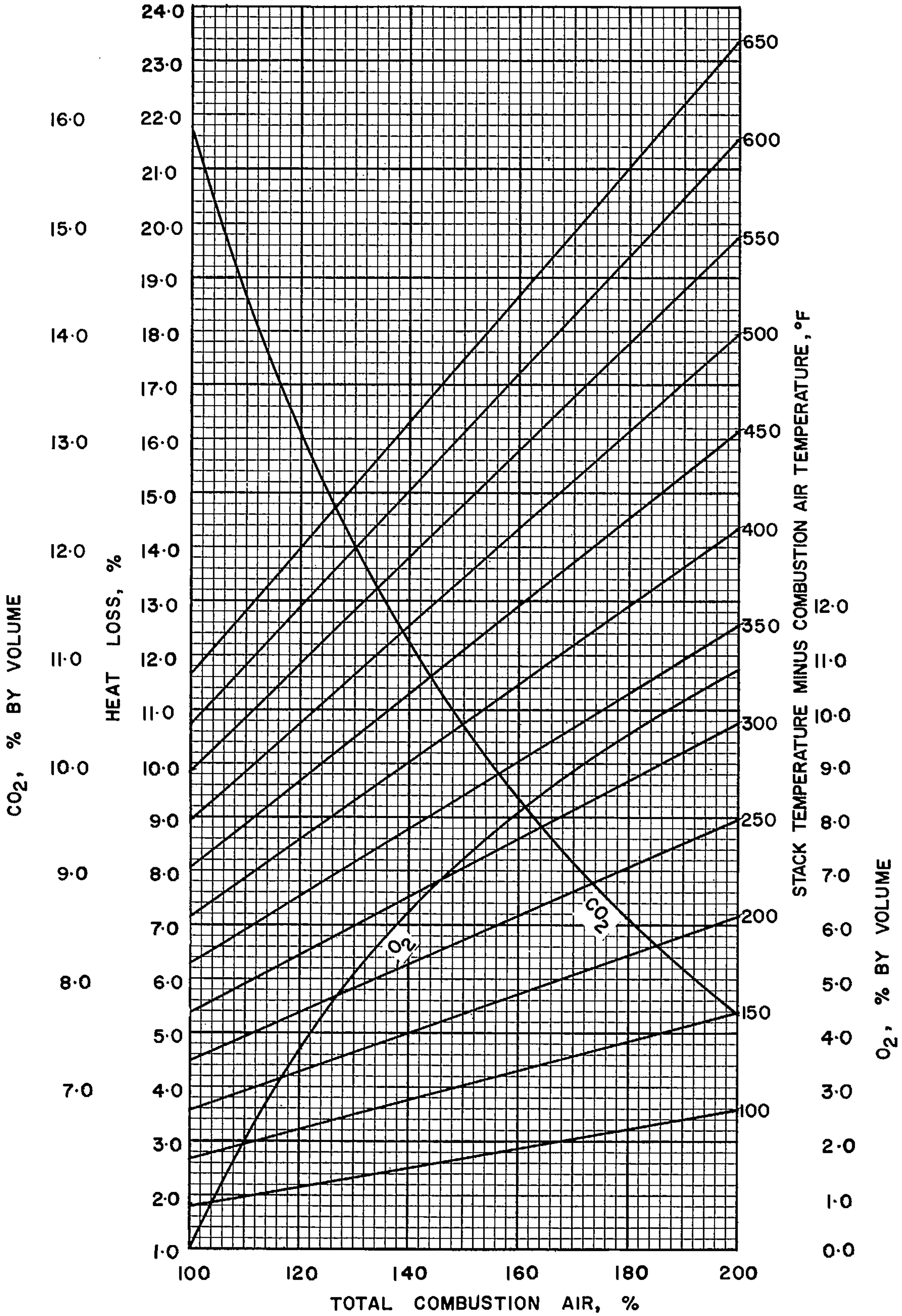


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

9510

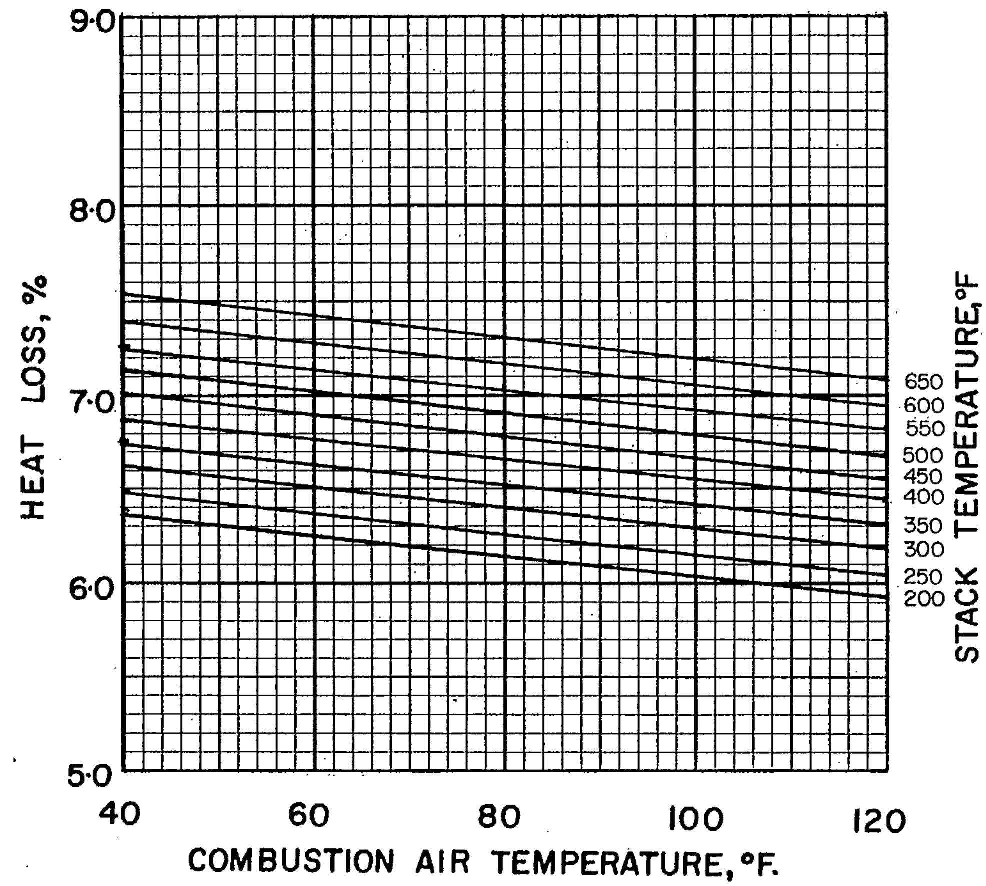


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

9510

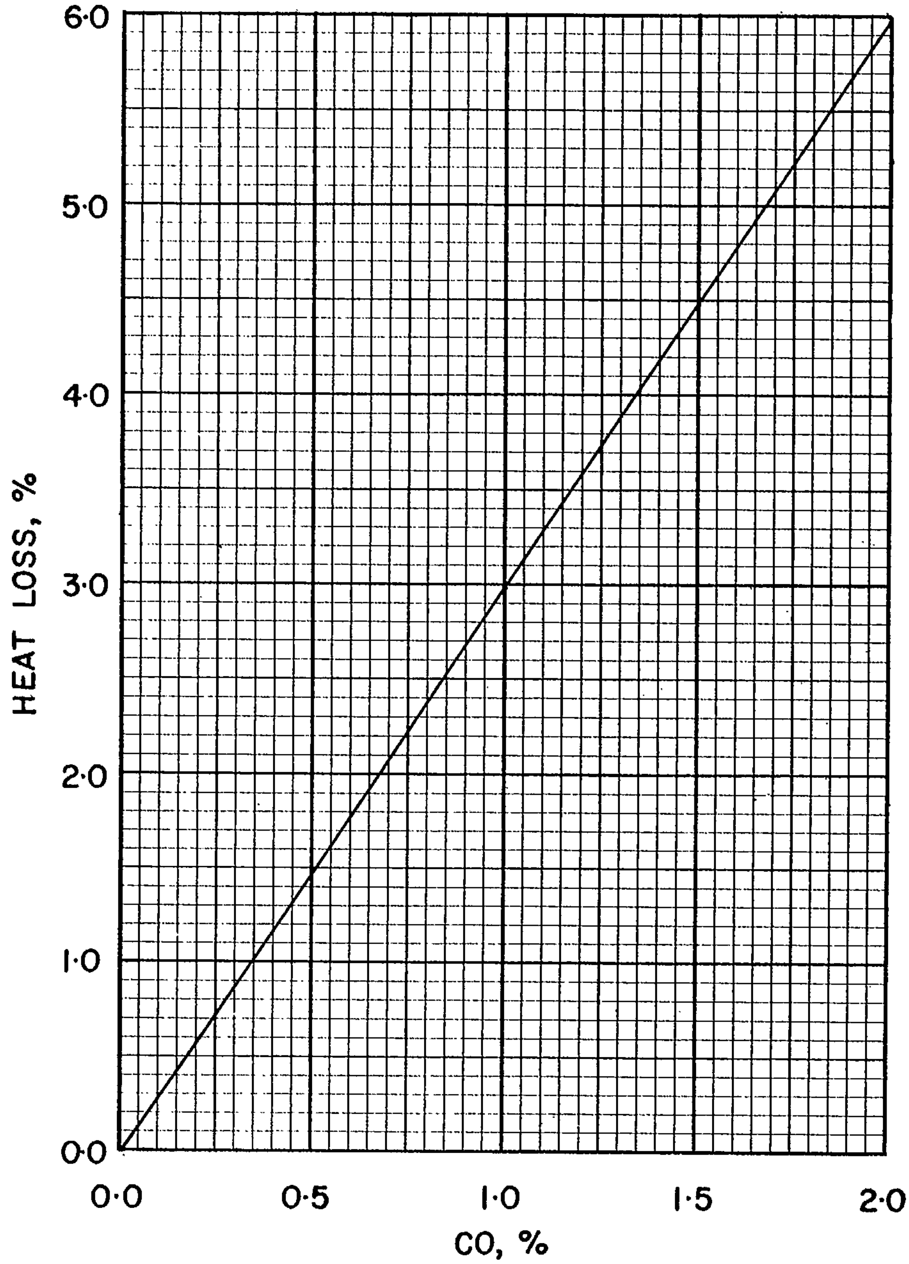


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

9510

FUEL OIL 9520, SPECIFIC GRAVITY 0.950

Ultimate Analysis, lb/lb

Carbon	(C)	0.8648
Hydrogen	(H_2)	0.1152
Sulphur	(S)	0.0200
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,610

Conversion Factors

1 Imp gal oil = 9.50 lb oil
or Imp gal oil × 9.50 = lb oil
or lb oil × 0.1053 = Imp gal

1 U.S. gal oil = 9.50 × 0.8337 lb oil
or U.S. gal oil × 7.920 = lb oil
or lb oil × 0.1263 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}610} \text{ lb oil}$$

or Btu × 10^6 × 53.74 = lb oil
or lb oil × 0.0186 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}610 \times 9.50} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.656 = Imp gal oil
or Imp gal oil × 0.1768 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}610 \times 7.920} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.784 = U.S. gal oil
or U.S. gal oil × 0.1474 = Btu × 10^6

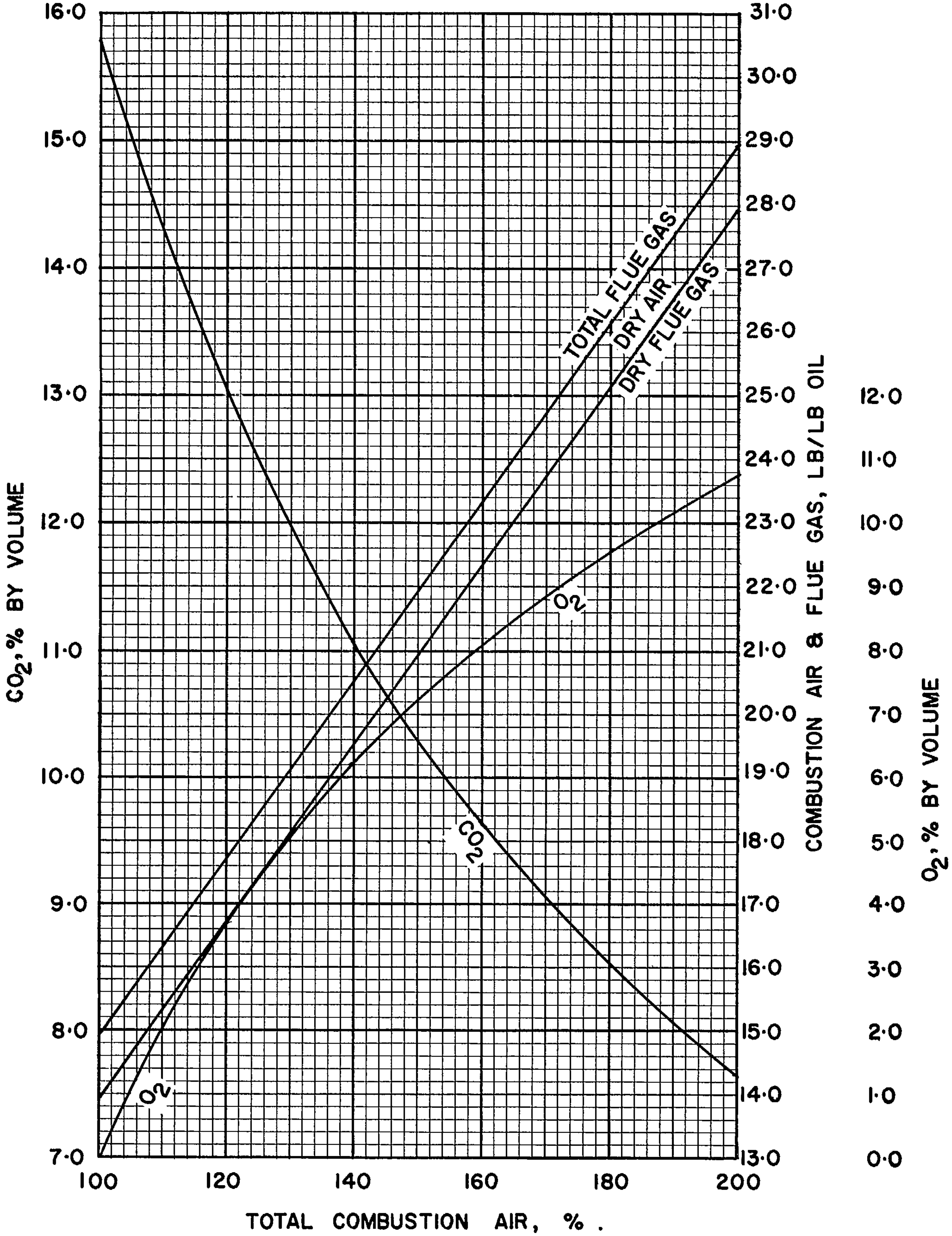


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS.

9520

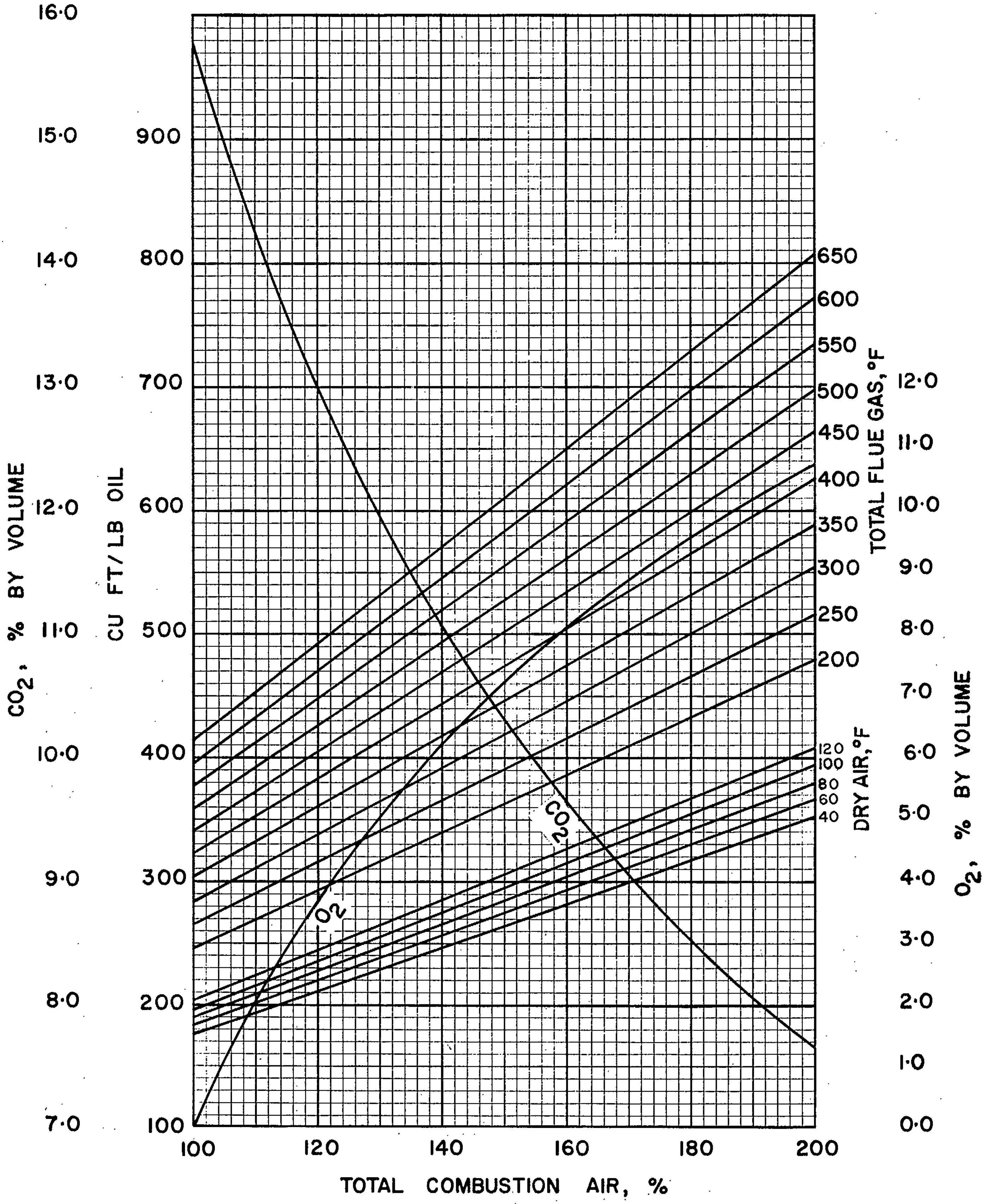


FIGURE 2. COMBUSTION DATA, VOLUME BASIS.

9520

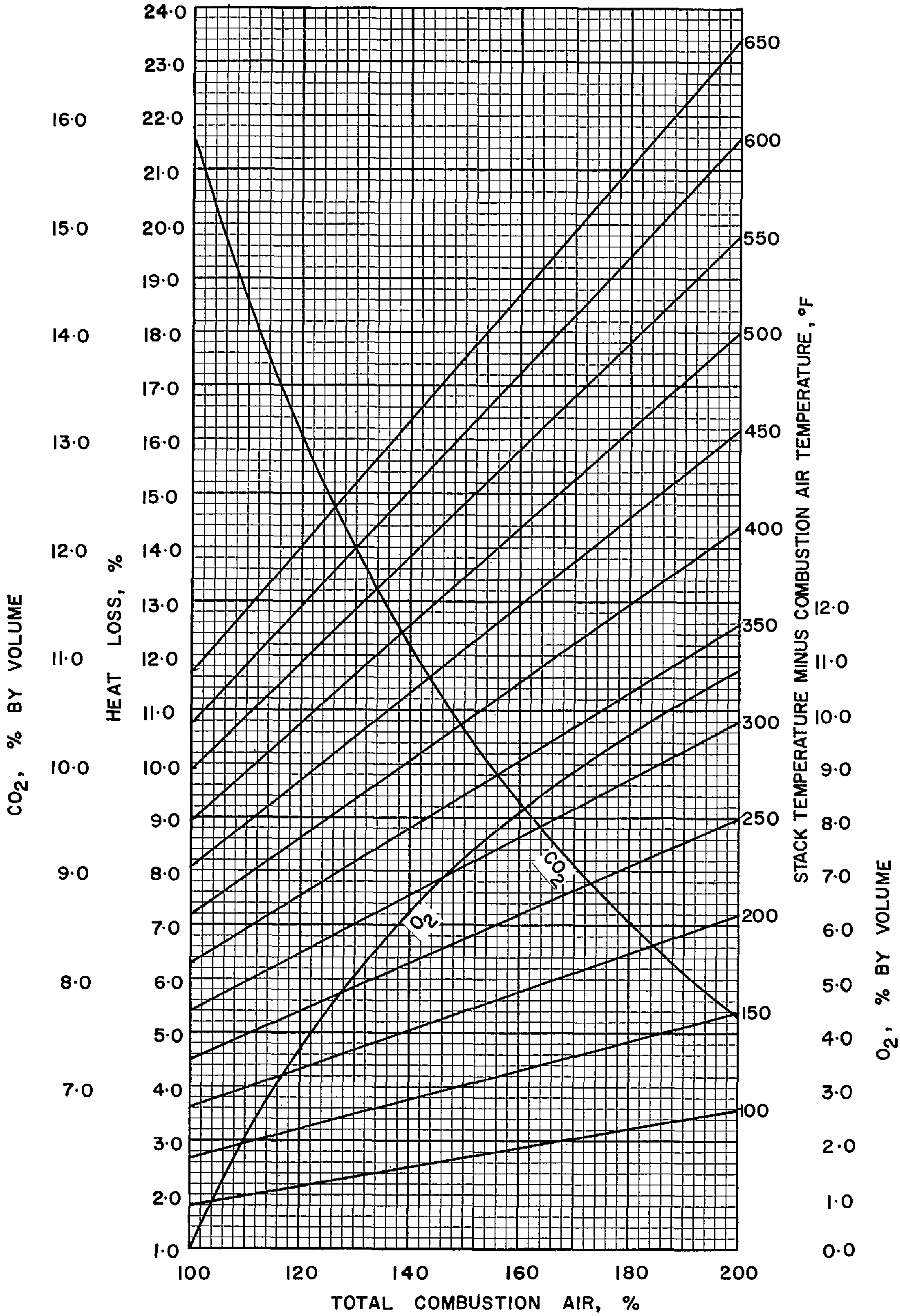


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

9520

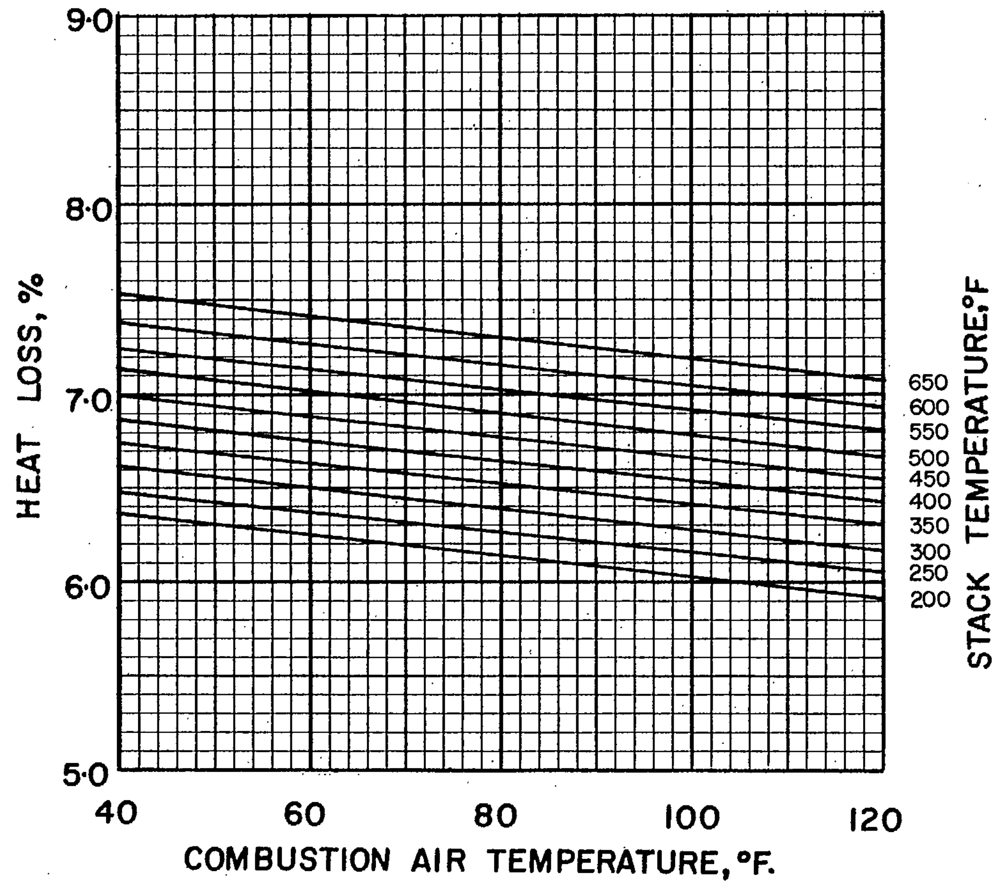


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

9520

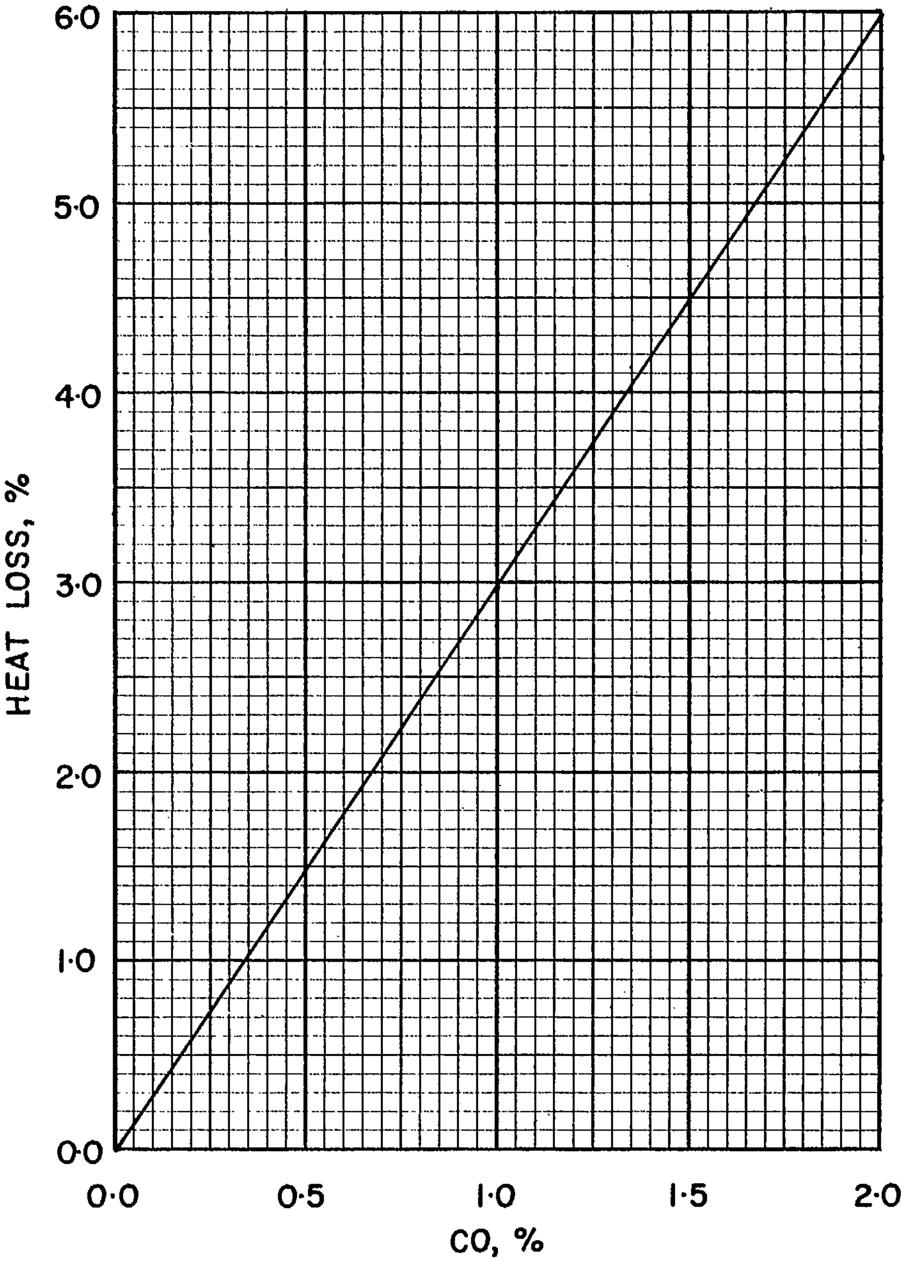


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

9520

FUEL OIL 9530, SPECIFIC GRAVITY 0.950

Ultimate Analysis, lb/lb

Carbon	(C)	0.8560
Hydrogen	(H_2)	0.1140
Sulphur	(S)	0.0300
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,460

Conversion Factors

1 Imp gal oil = 9.50 lb oil
or Imp gal oil × 9.50 = lb oil
or lb oil × 0.1053 = Imp gal oil

1 U.S. gal oil = 9.50 × 0.8337 lb oil
or U.S. gal oil × 7.920 = lb oil
or lb oil × 0.1263 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}460} \text{ lb oil}$$

or Btu × 10^6 × 54.17 = lb oil
or lb oil × 0.0185 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}460 \times 9.50} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.702 = Imp gal oil
or Imp gal oil × 0.1754 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}460 \times 7.920} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.840 = U.S. gal oil
or U.S. gal oil × 0.1462 = Btu × 10^6

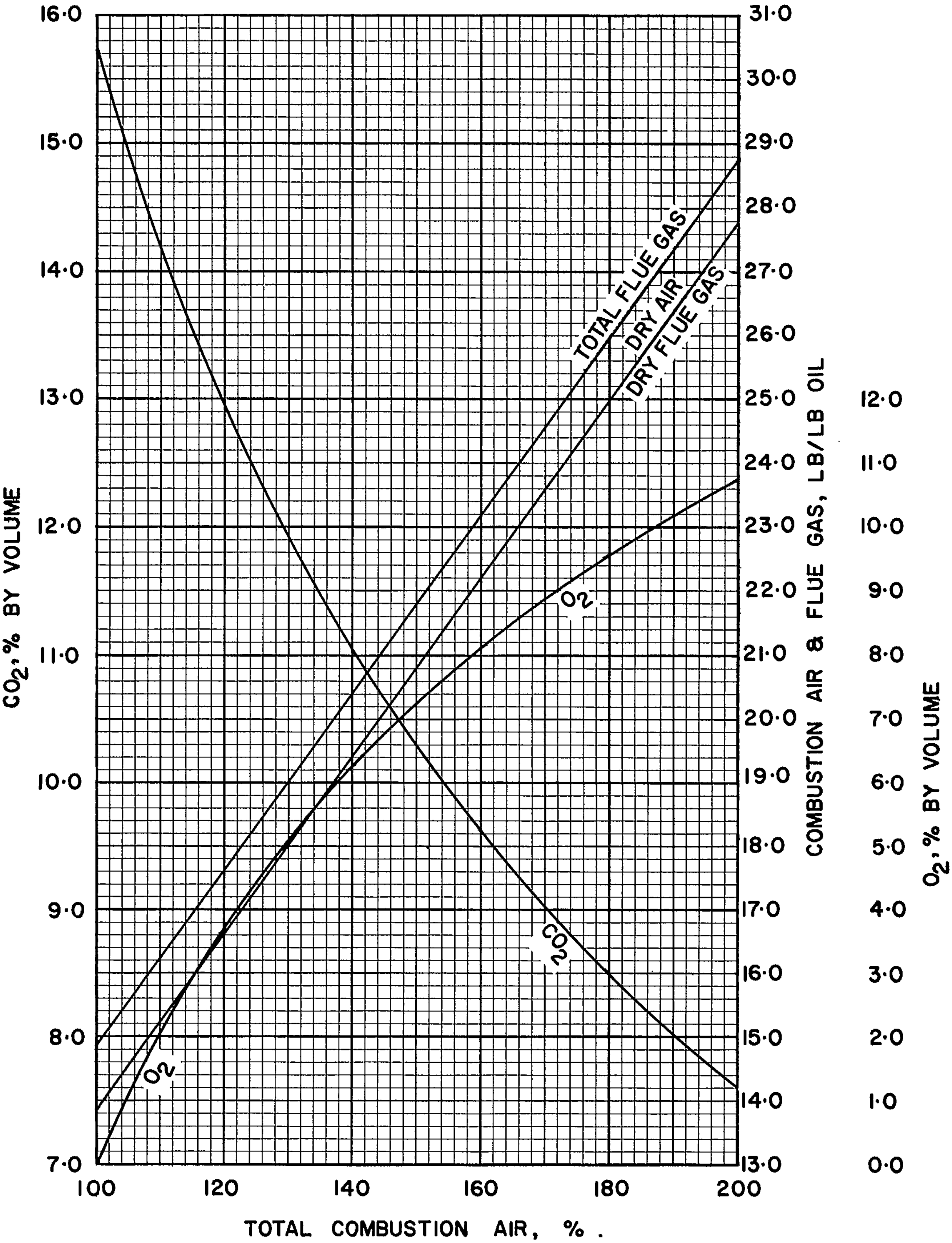


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS.

9530

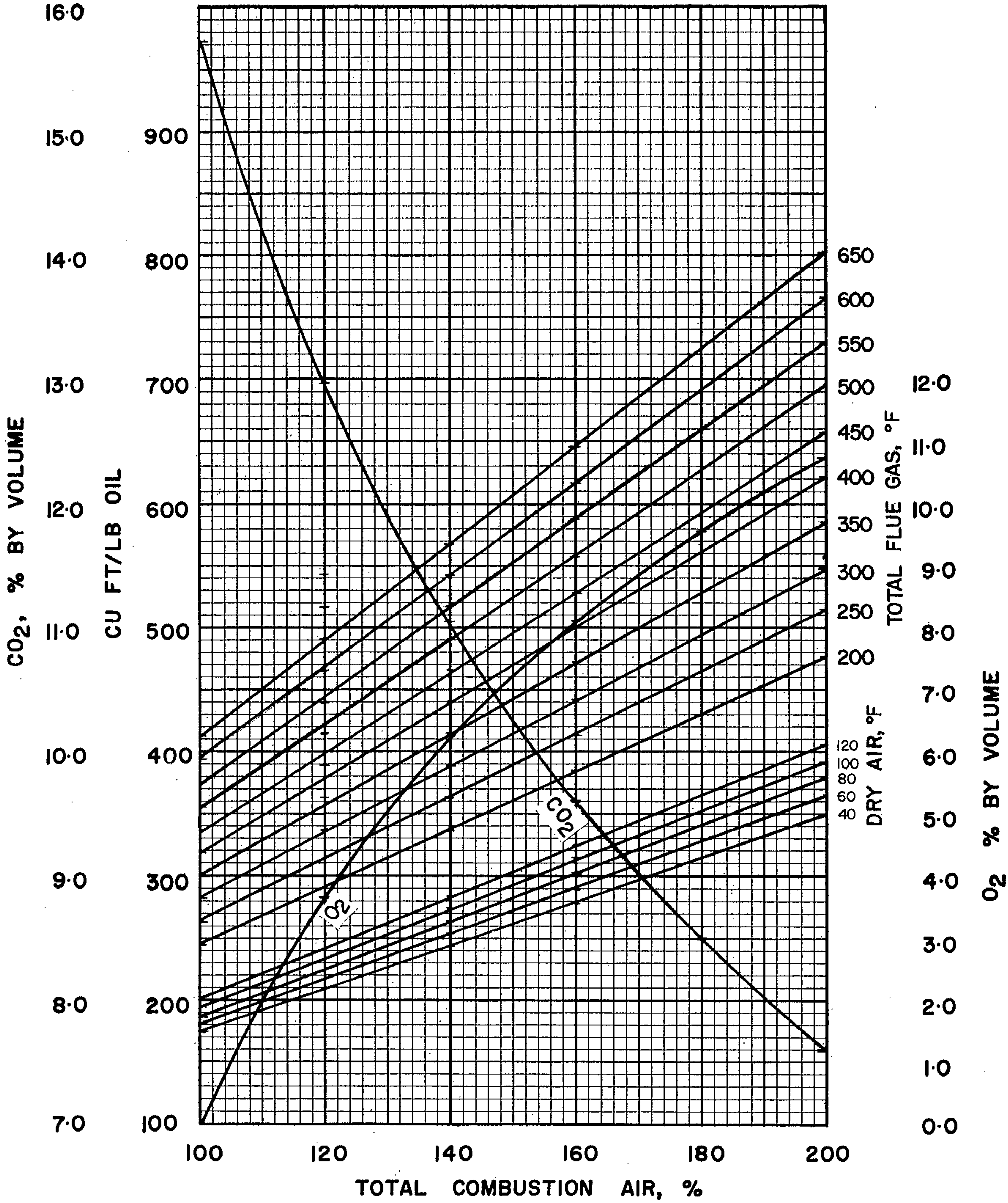


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 9530

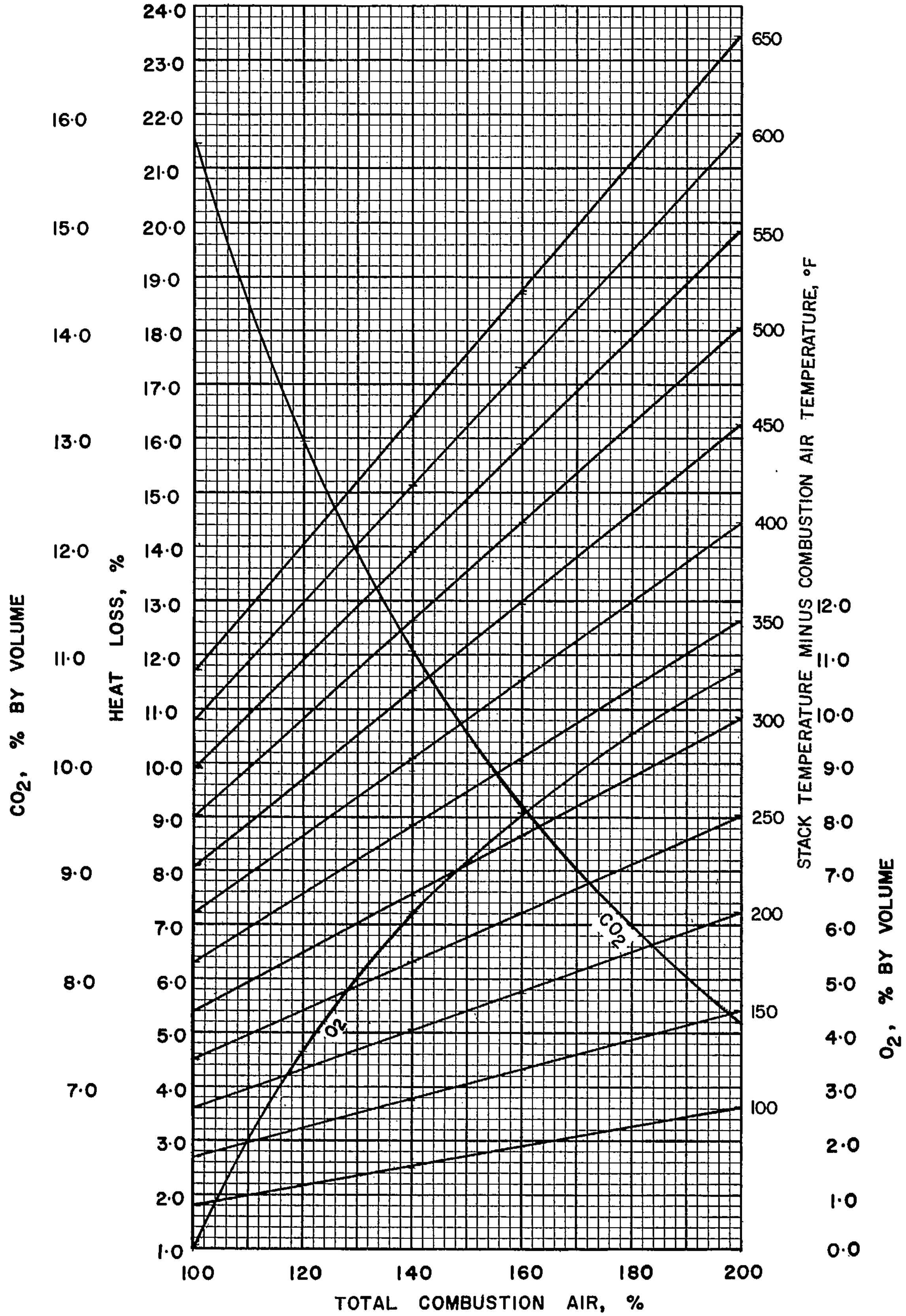


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

9530

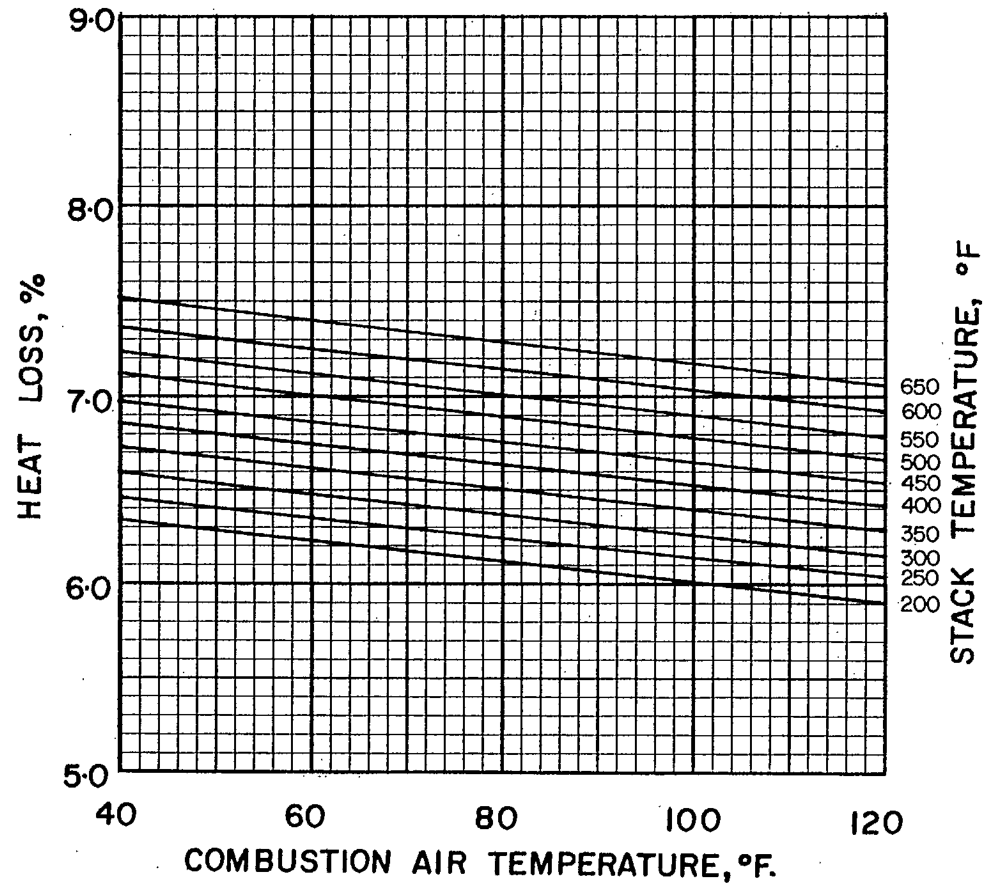


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

9530

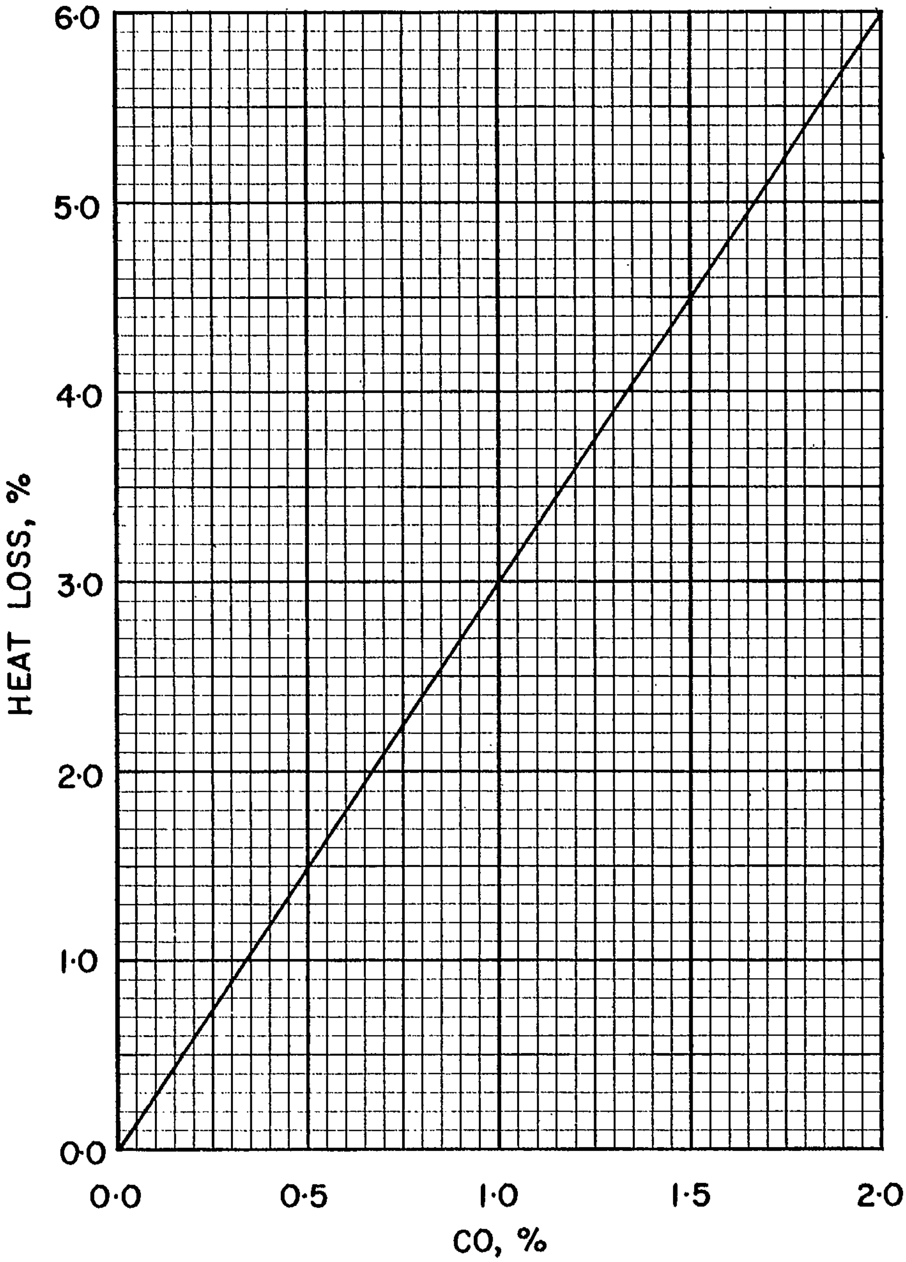


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

9530

FUEL OIL 9540, SPECIFIC GRAVITY 0.950

Ultimate Analysis, lb/lb

Carbon	(C)	0.8472
Hydrogen	(H_2)	0.1128
Sulphur	(S)	0.0400
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,320

Conversion Factors

1 Imp gal oil = 9.50 lb oil
or Imp gal oil × 9.50 = lb oil
or lb oil × 0.1053 = Imp gal oil

1 U.S. gal oil = 9.50 × 0.8337 lb oil
or U.S. gal oil × 7.920 = lb oil
or lb oil × 0.1263 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}320} \text{ lb oil}$$

or Btu × 10^6 × 54.59 = lb oil
or lb oil × 0.0183 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}320 \times 9.50} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.746 = Imp gal oil
or Imp gal oil × 0.174 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}320 \times 7.920} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.892 = U.S. gal oil
or U.S. gal oil × 0.1451 = Btu × 10^6

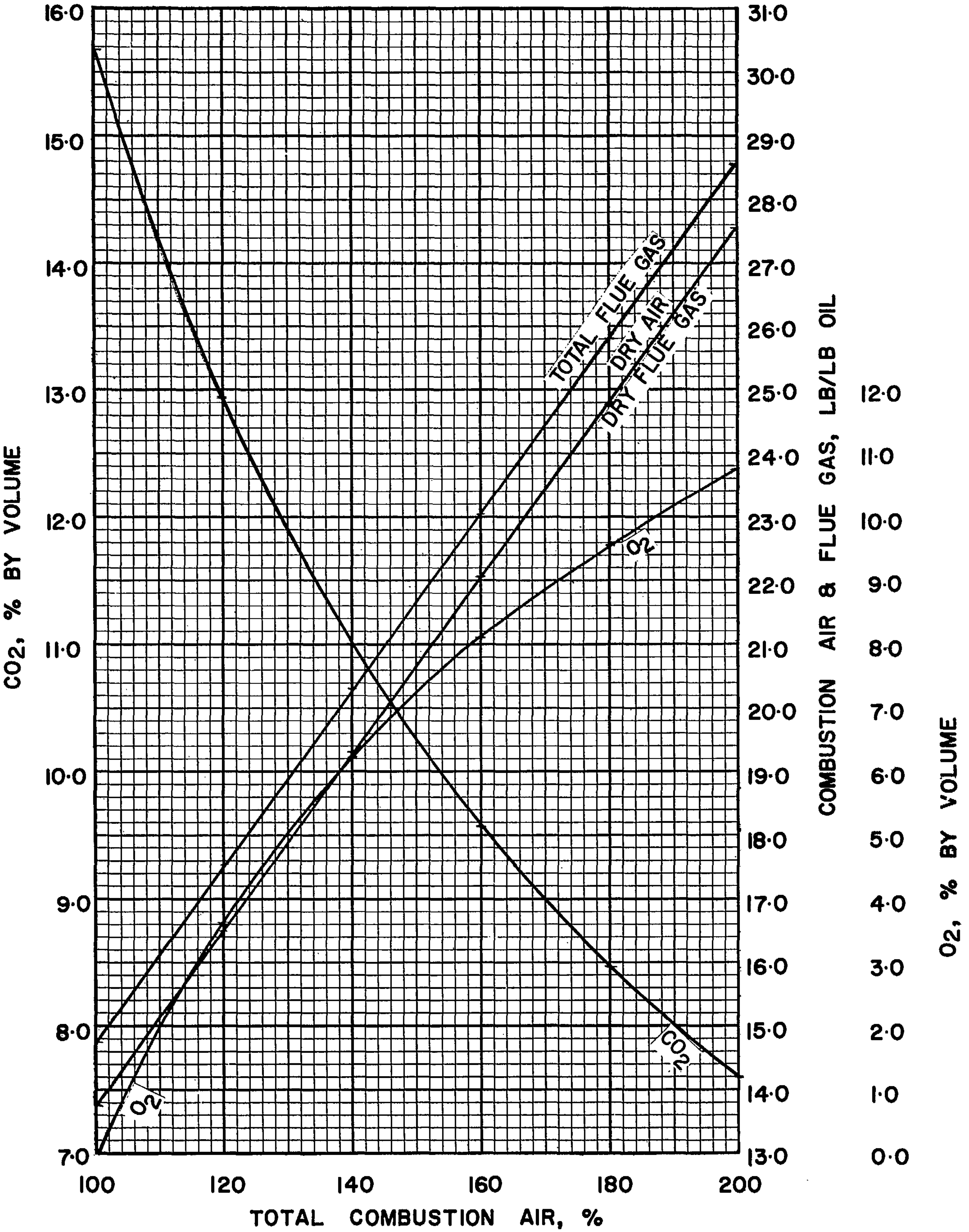


FIGURE I· COMBUSTION DATA, WEIGHT BASIS

9540

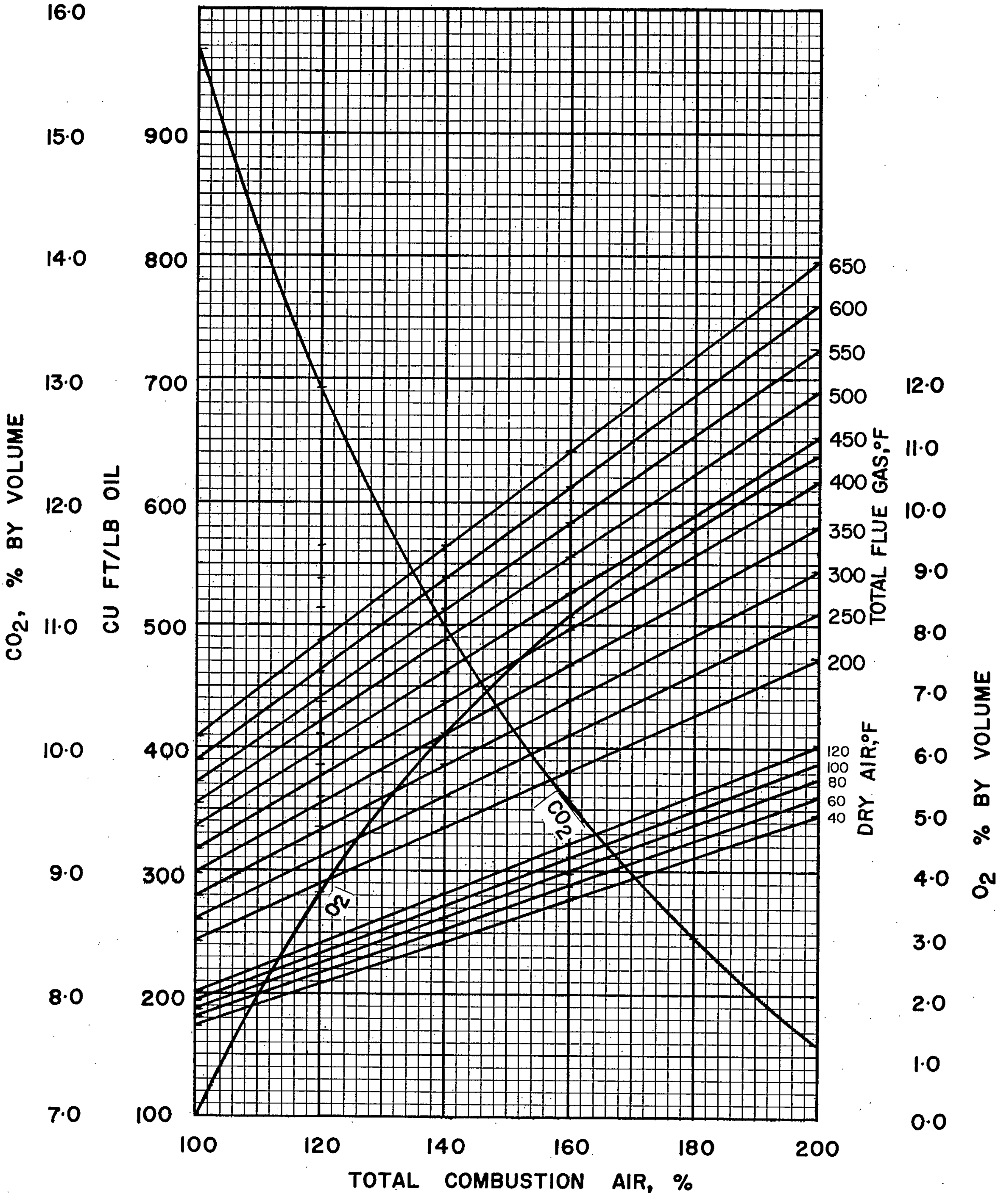


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 9540

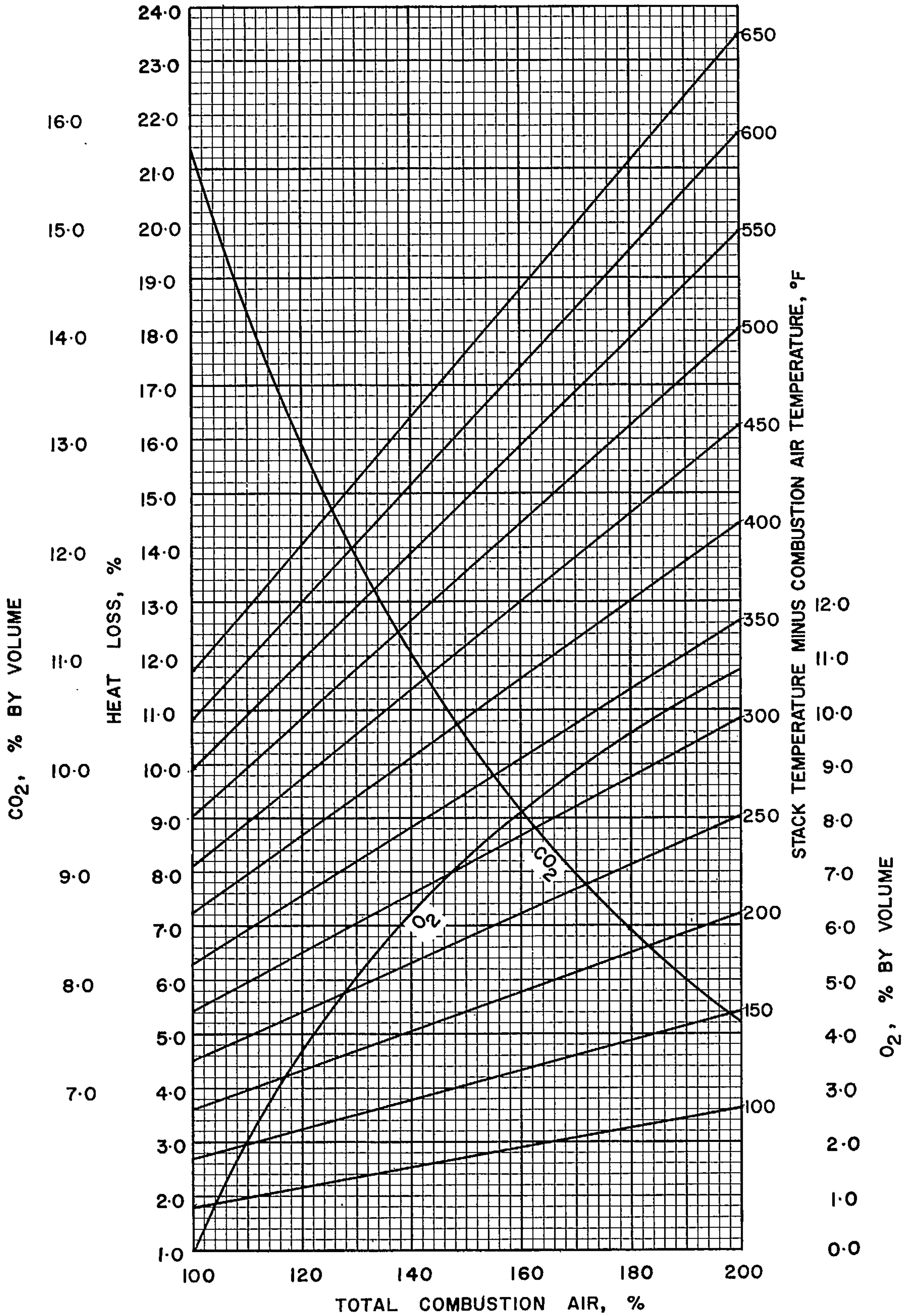


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

9540

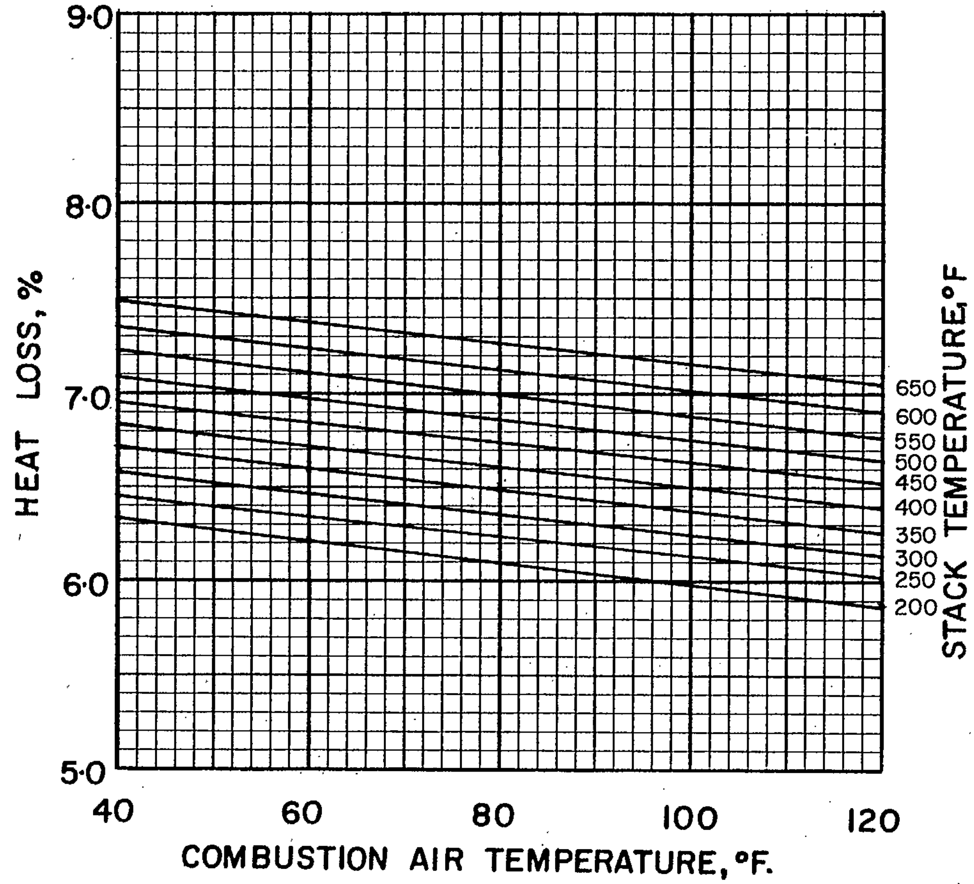


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

9540

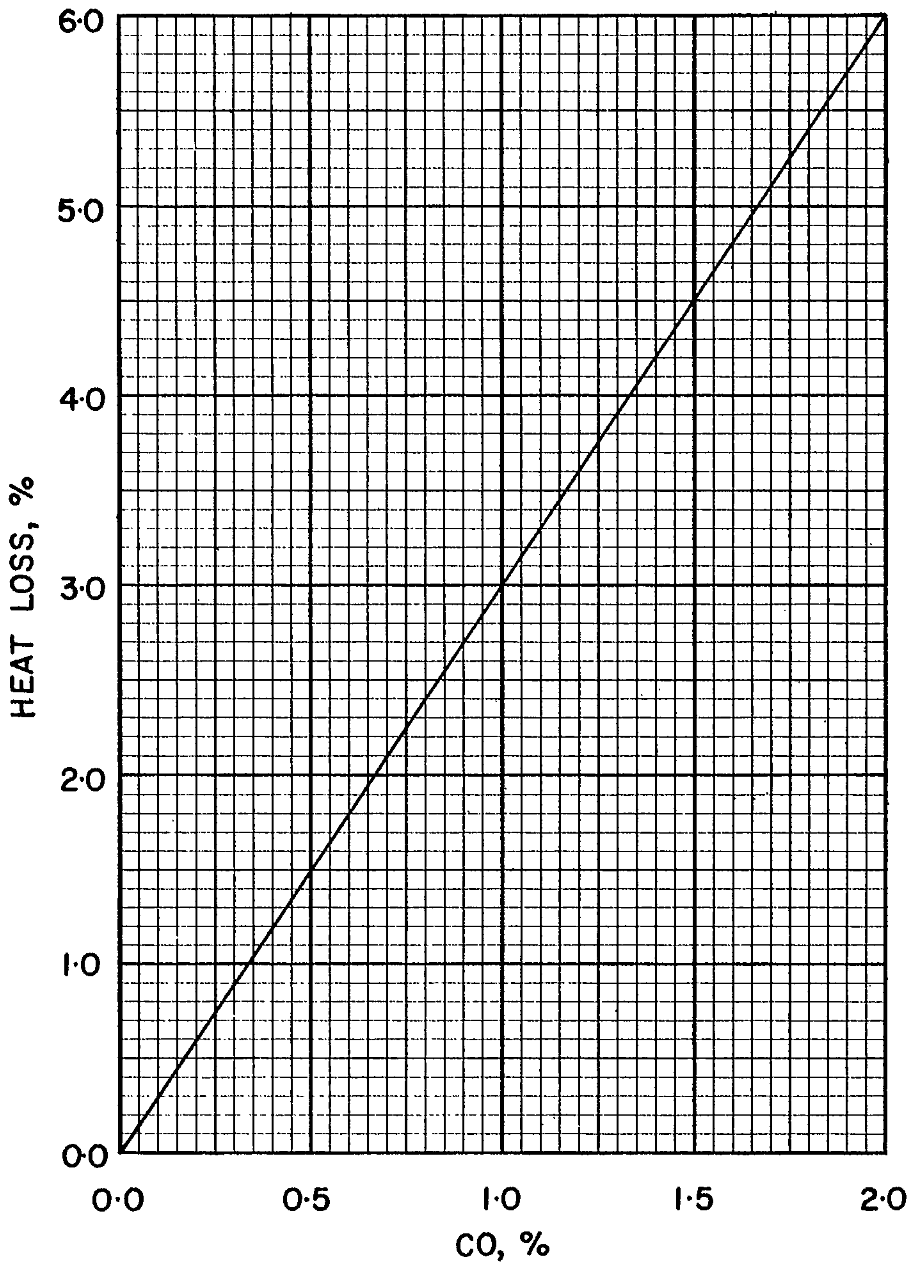


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

9540

FUEL OIL 9600, SPECIFIC GRAVITY 0.960

Ultimate Analysis, lb/lb

Carbon	(C)	0.8840
Hydrogen	(H_2)	0.1160
Sulphur	(S)	–
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,830

Conversion Factors

1 Imp gal oil = 9.60 lb oil
or Imp gal oil × 9.60 = lb oil
or lb oil × 0.1042 = Imp gal oil

1 U.S. gal oil = 9.60 × 0.8337 lb oil
or U.S. gal oil × 8.004 = lb oil
or lb oil × 0.1249 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}830} \text{ lb oil}$$

or Btu × 10^6 × 53.11 = lb oil
or lb oil × 0.0188 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}830 \times 9.60} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.532 = Imp gal oil
or Imp gal oil × 0.1808 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}830 \times 8.004} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.636 = U.S. gal oil
or U.S. gal oil × 0.1507 = Btu × 10^6

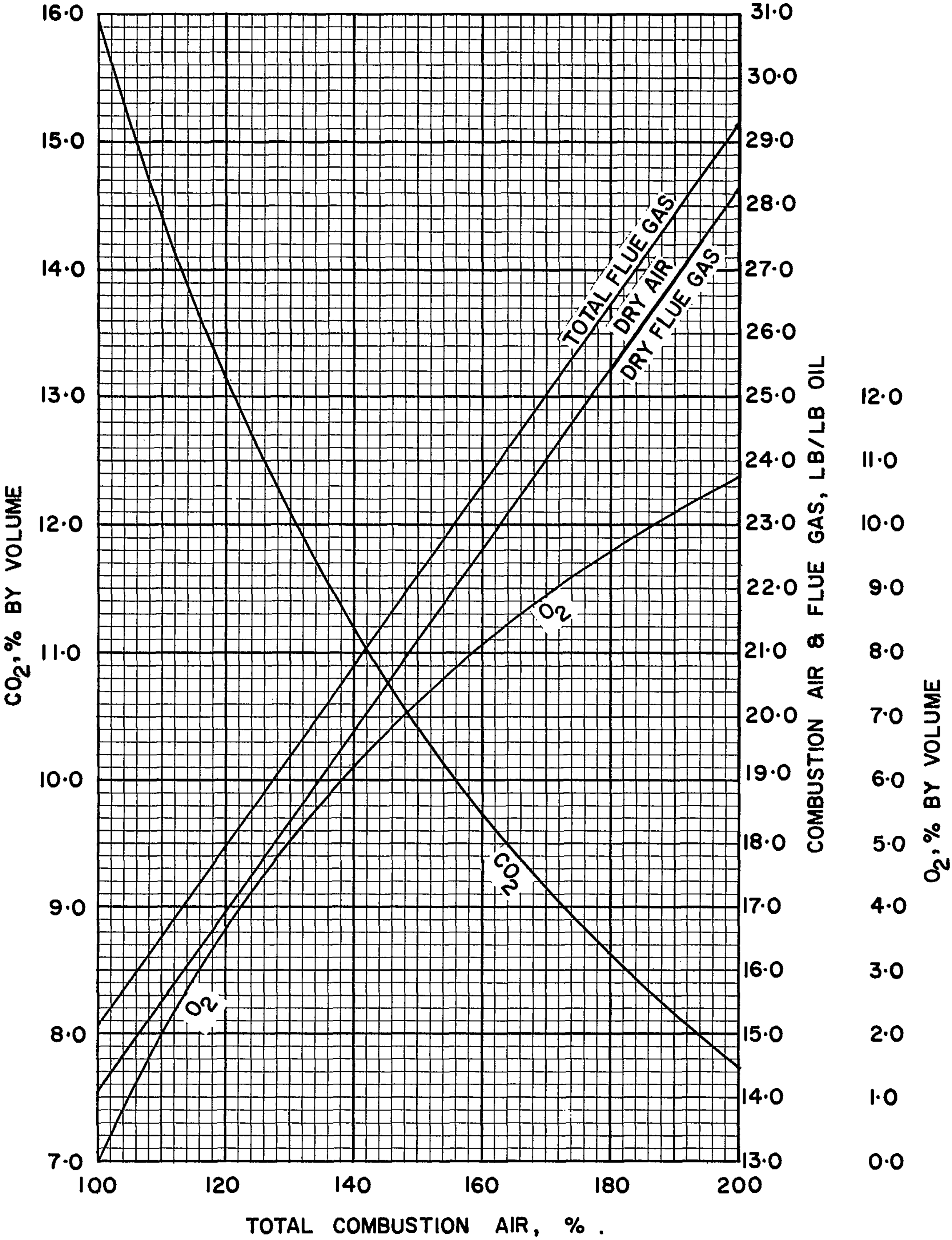


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS.

9600

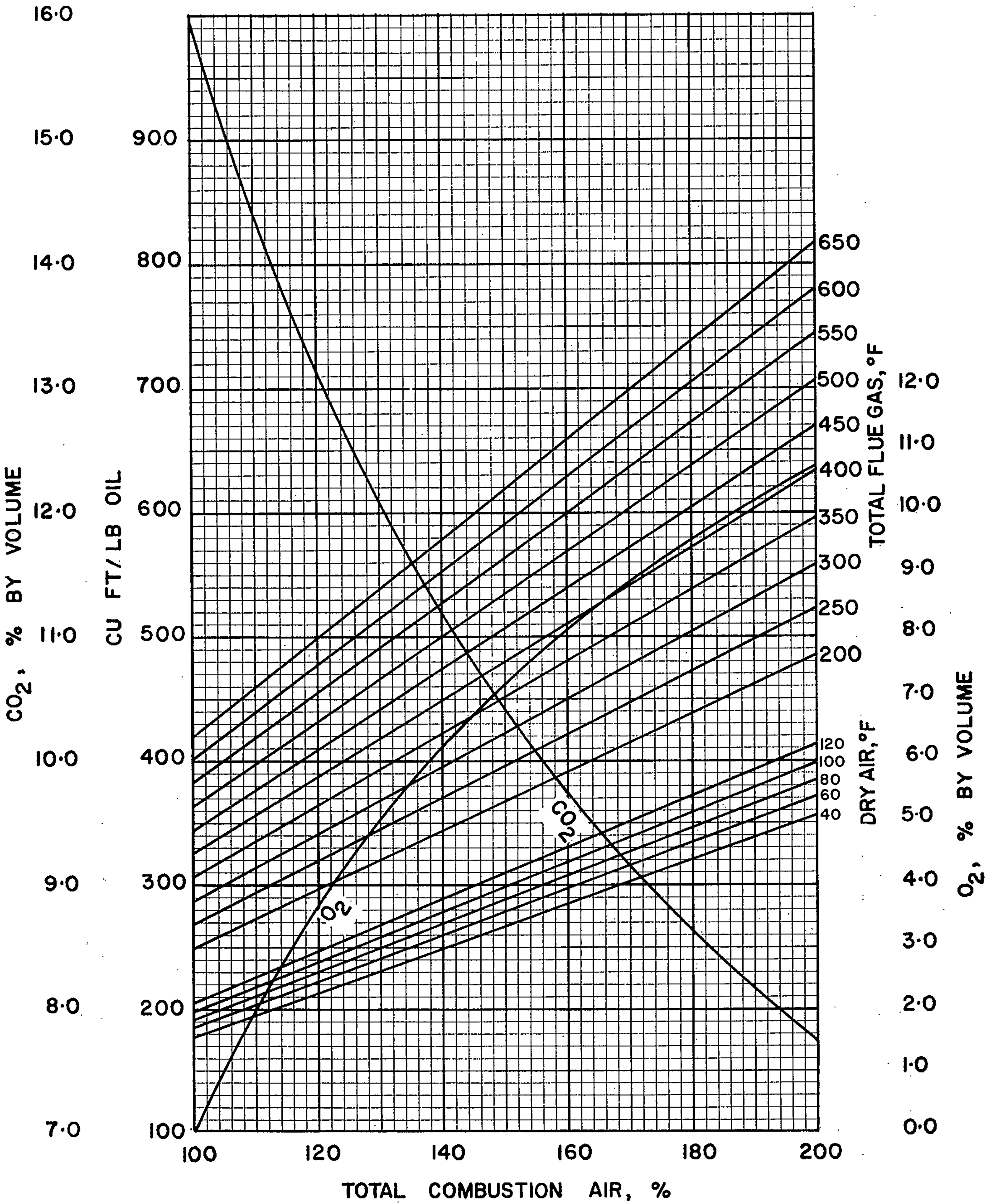


FIGURE 2. COMBUSTION DATA, VOLUME BASIS.

9600

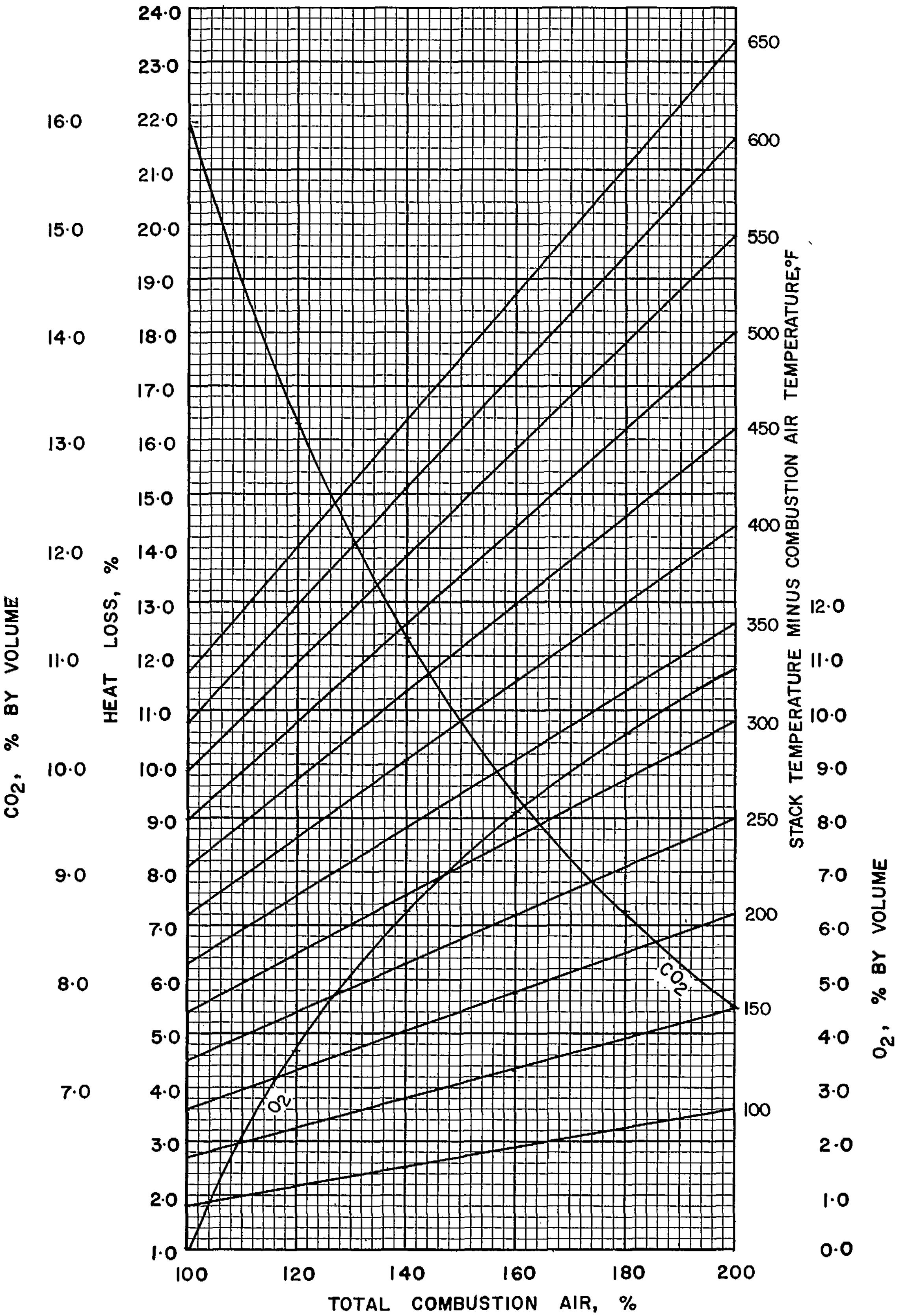


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

9600

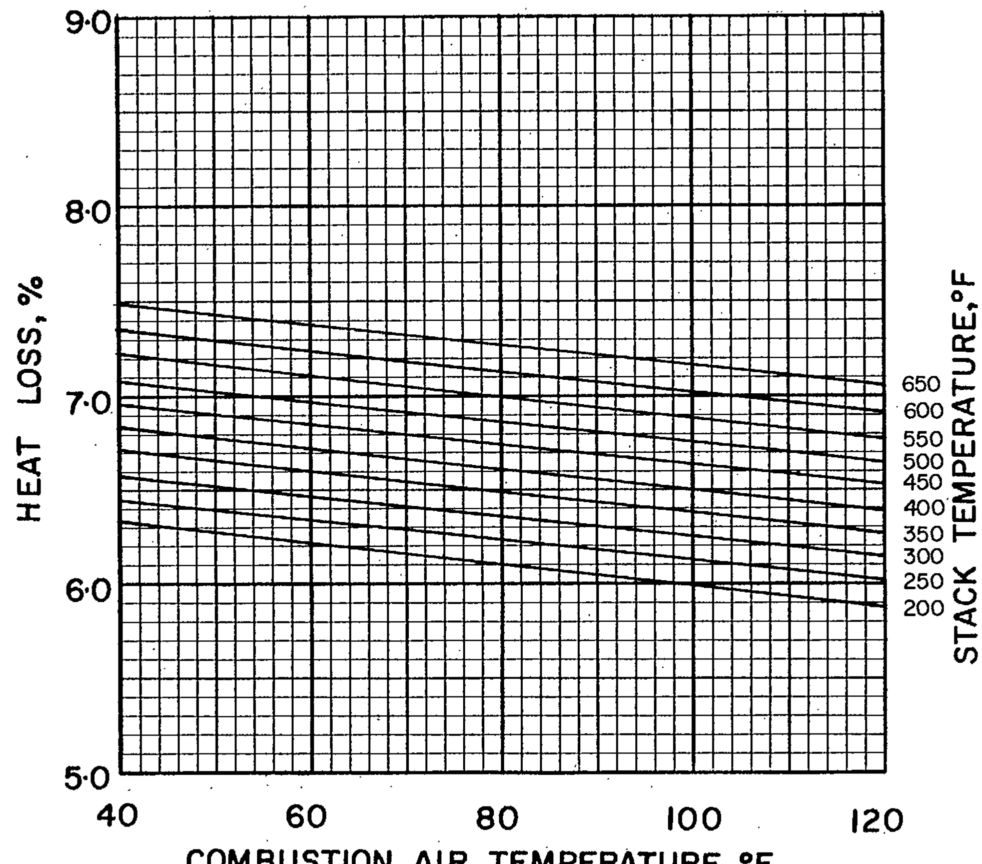


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

9600

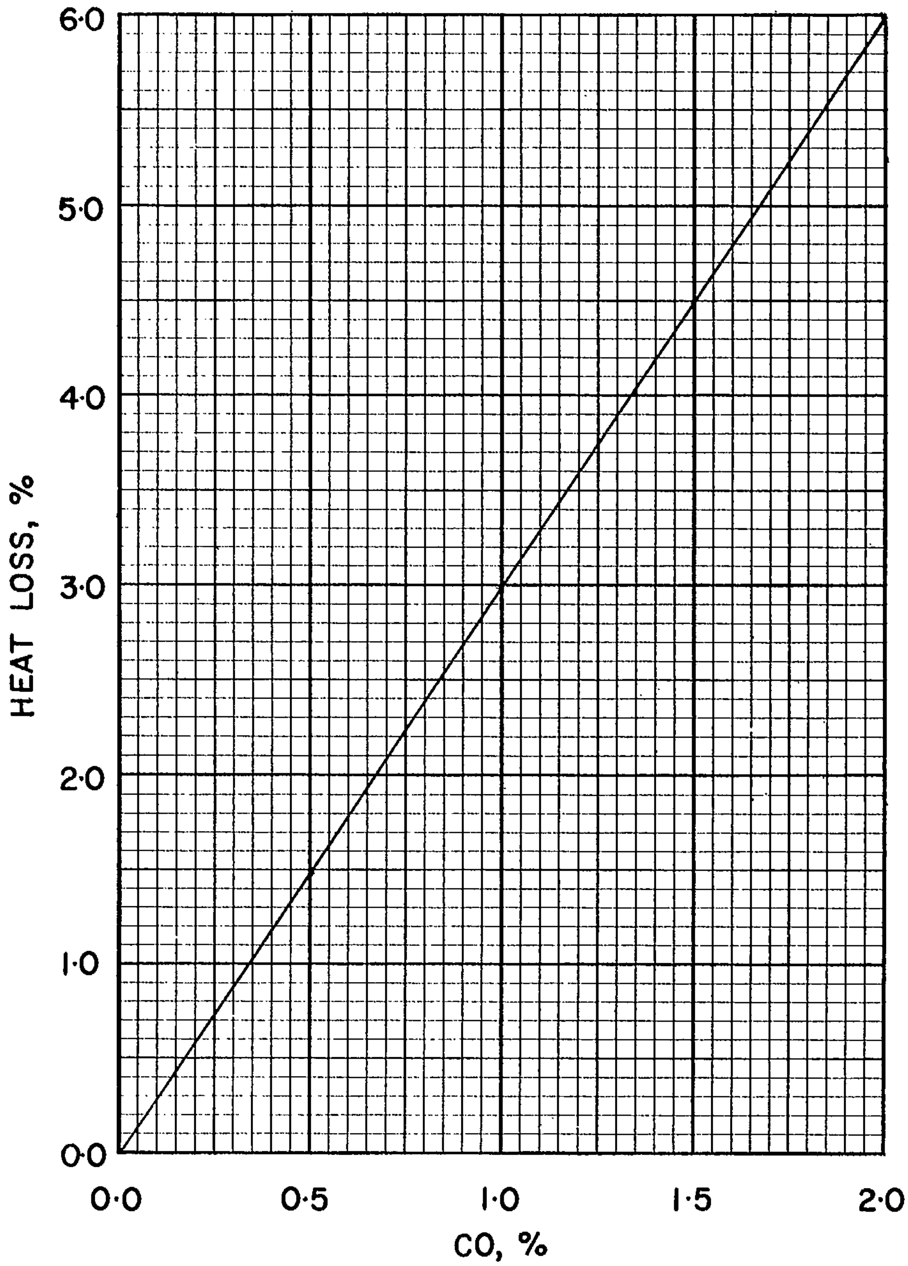


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

9600

FUEL OIL 9610, SPECIFIC GRAVITY 0.960

Ultimate Analysis, lb/lb

Carbon	(C)	0.8752
Hydrogen	(H_2)	0.1148
Sulphur	(S)	0.0100
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,680

Conversion Factors

1 Imp gal oil = 9.60 lb oil
or Imp gal oil × 9.60 = lb oil
or lb oil × 0.1042 = Imp gal oil

1 U.S. gal oil = 9.60 × 0.8337 lb oil
or U.S. gal oil × 8.004 = lb oil
or lb oil × 0.1249 = U.S. gal

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}680} \text{ lb oil}$$

or Btu × 10^6 × 53.53 = lb oil
or lb oil × 0.0187 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}680 \times 9.60} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.576 = Imp gal oil
or Imp gal oil × 0.1793 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}680 \times 8.004} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.689 = U.S. gal oil
or U.S. gal oil × 0.1495 = Btu × 10^6

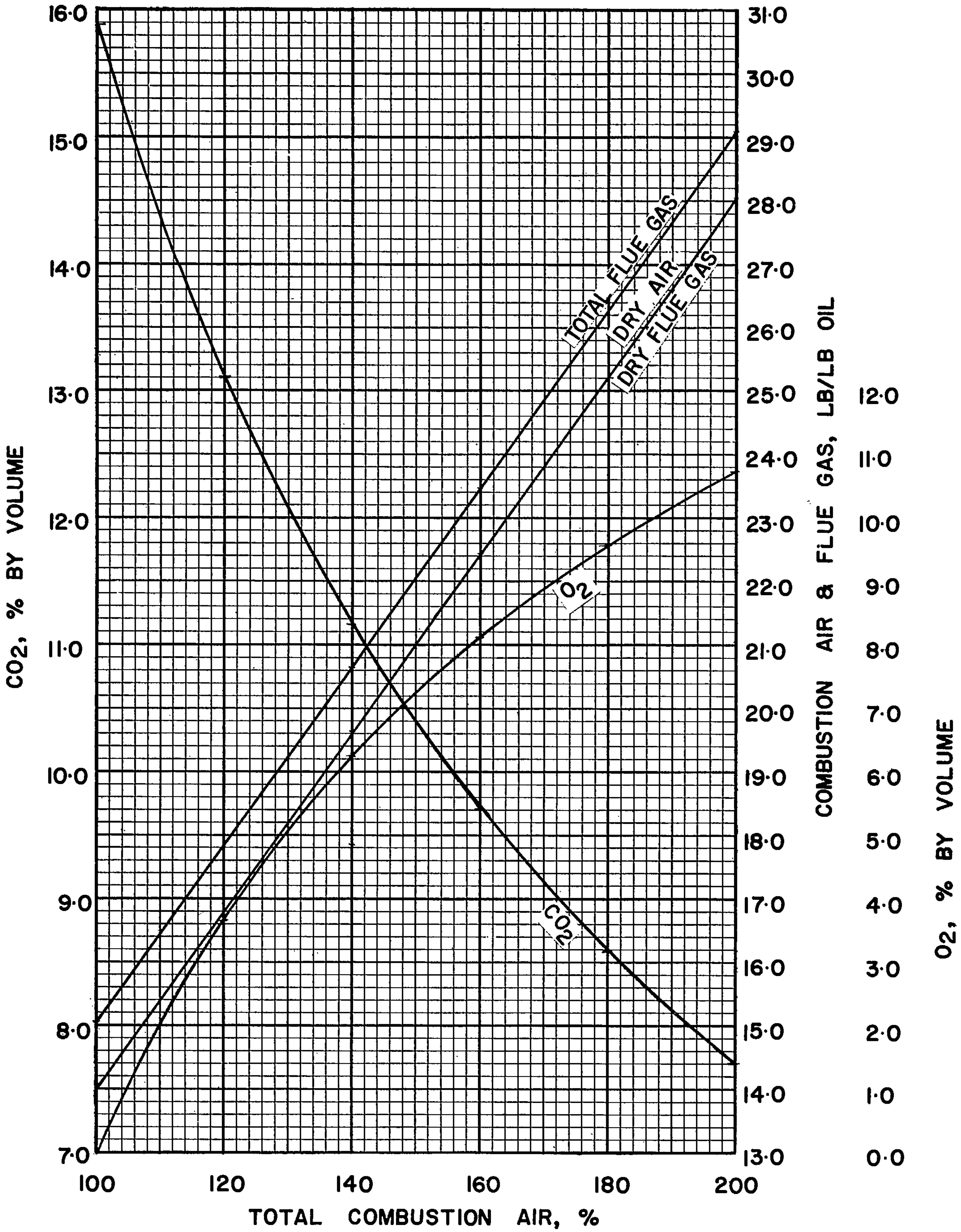


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS 9610

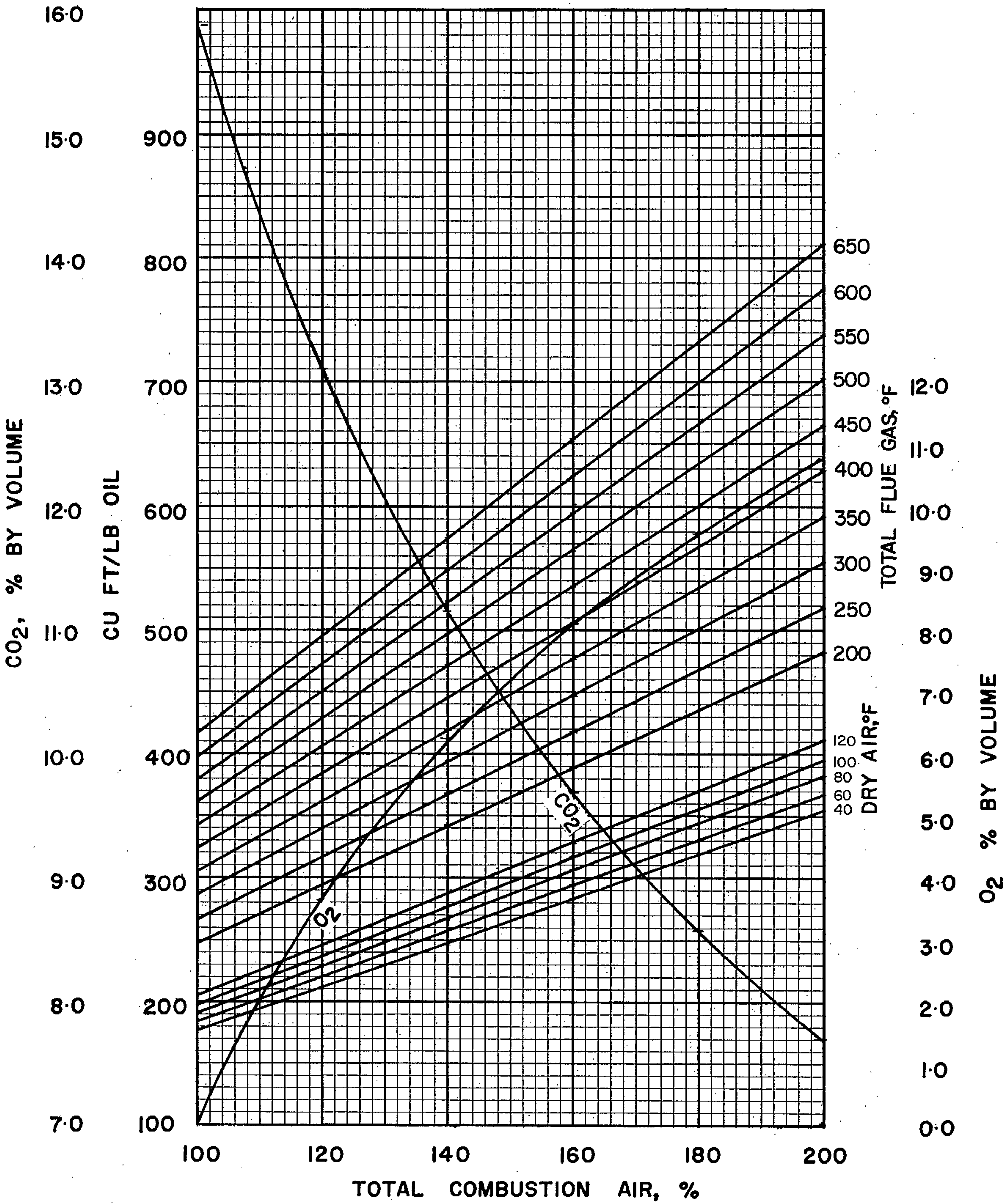


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 9610

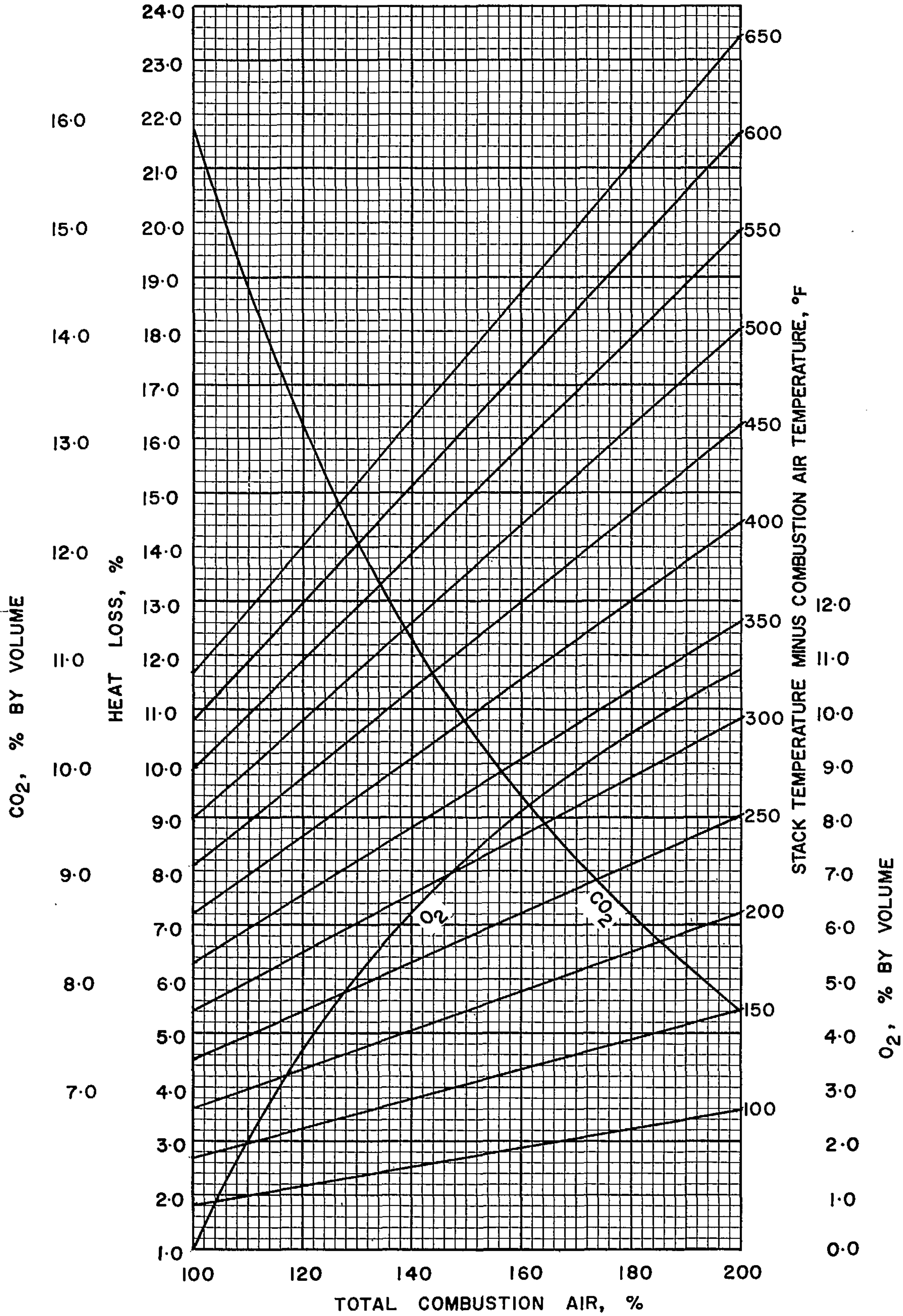


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

9610

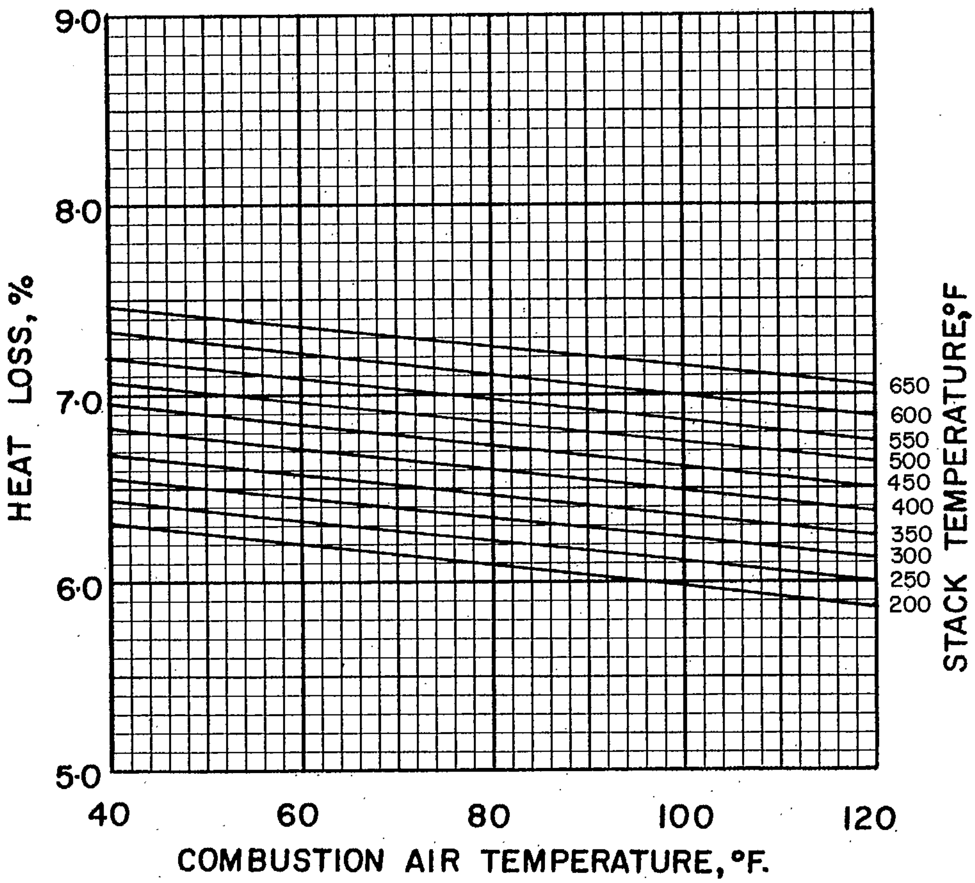


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

9610

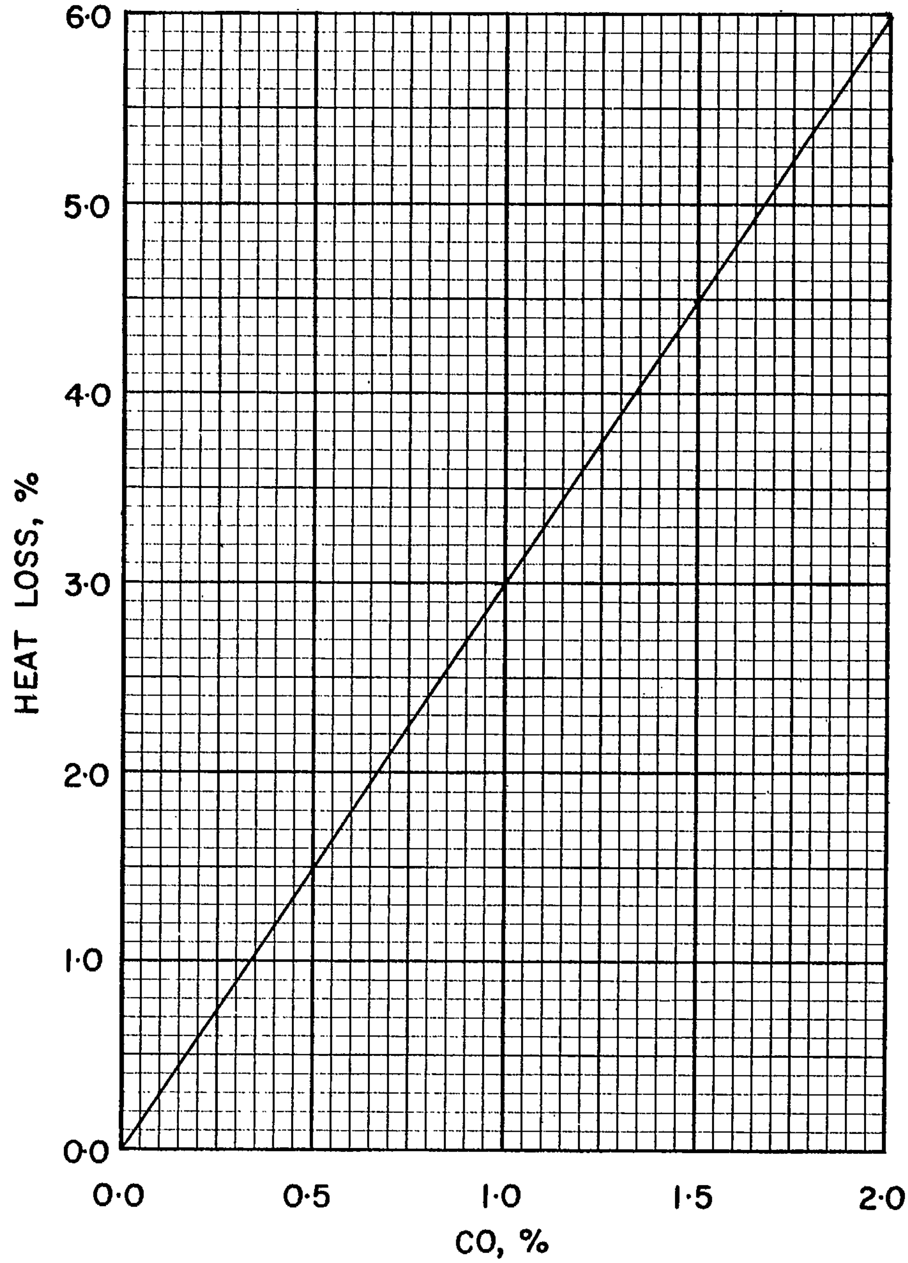


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

9610

FUEL OIL 9620, SPECIFIC GRAVITY 0.960

Ultimate Analysis, lb/lb

Carbon	(C)	0.8663
Hydrogen	(H_2)	0.1137
Sulphur	(S)	0.0200
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,530

Conversion Factors

1 Imp gal oil = 9.60 lb oil
or Imp gal oil × 9.60 = lb oil
or lb oil × 0.1042 = Imp gal oil

1 U.S. gal oil = 9.60 × 0.8337 lb oil
or U.S. gal oil × 8.004 = lb oil
or lb oil × 0.1249 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}530} \text{ lb oil}$$

or Btu × 10^6 × 53.97 = lb oil
or lb oil × 0.0185 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}530 \times 9.60} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.622 = Imp gal oil
or Imp gal oil × 0.1779 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}530 \times 8.004} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.743 = U.S. gal oil
or U.S. gal oil × 0.1483 = Btu × 10^6

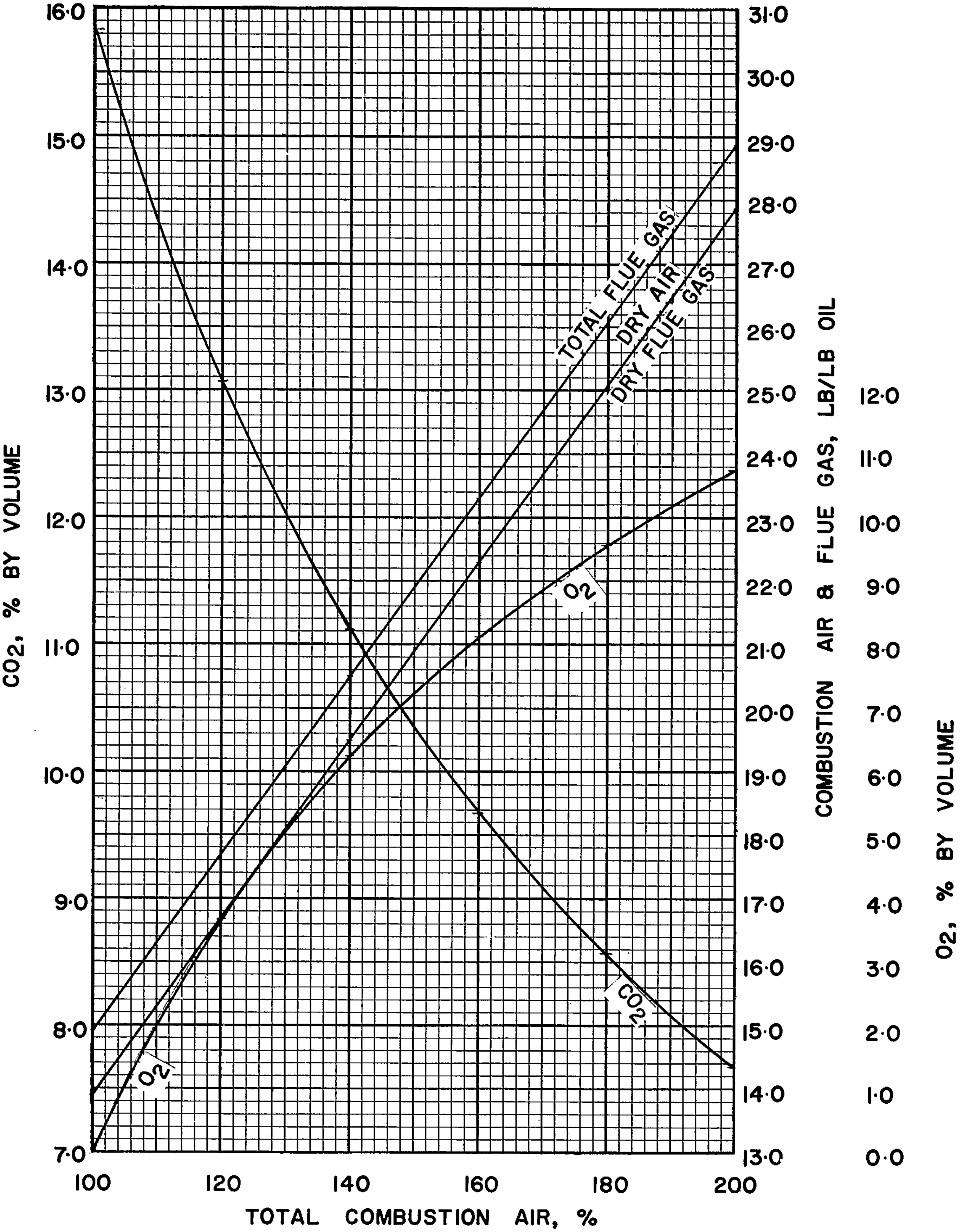


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS 9620

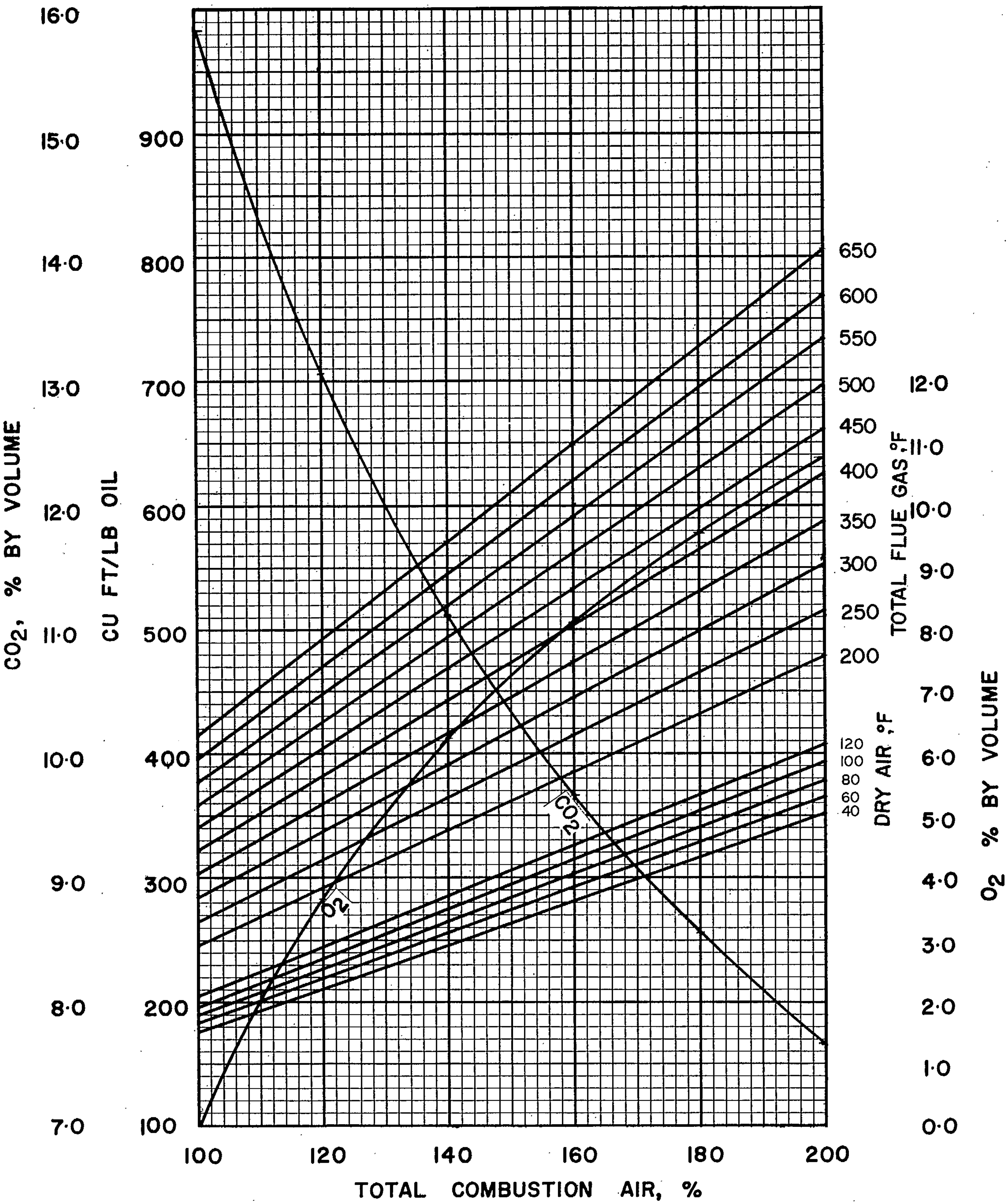


FIGURE 2· COMBUSTION DATA, VOLUME BASIS

9620

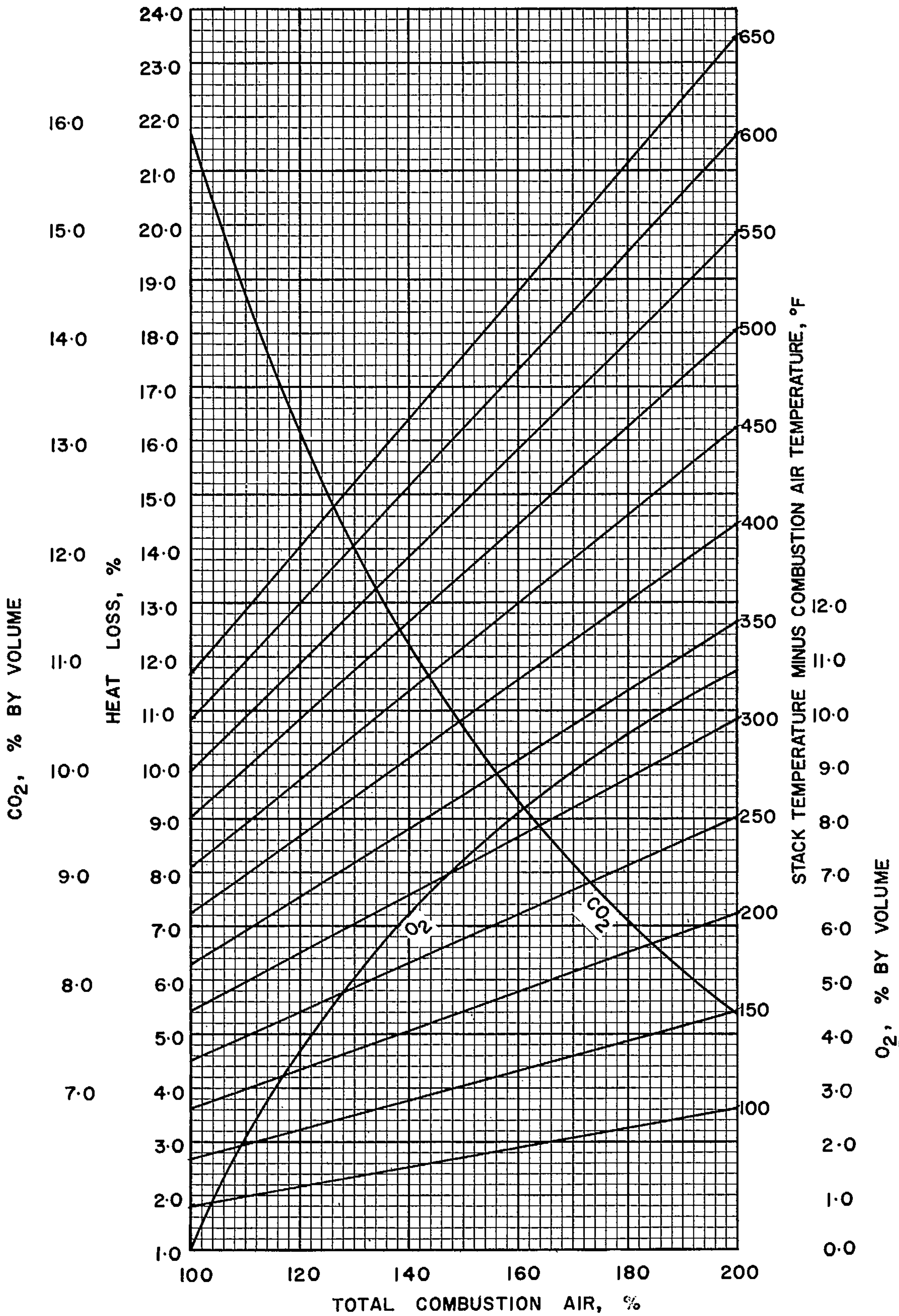


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

9620

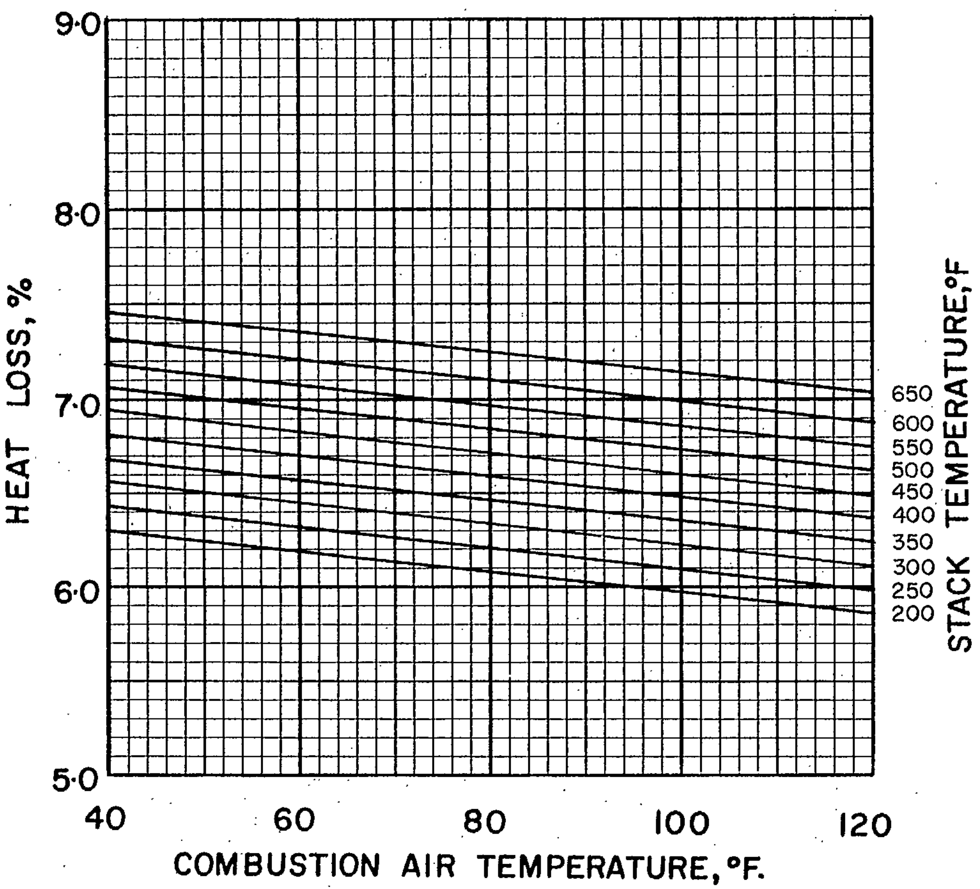


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

9620

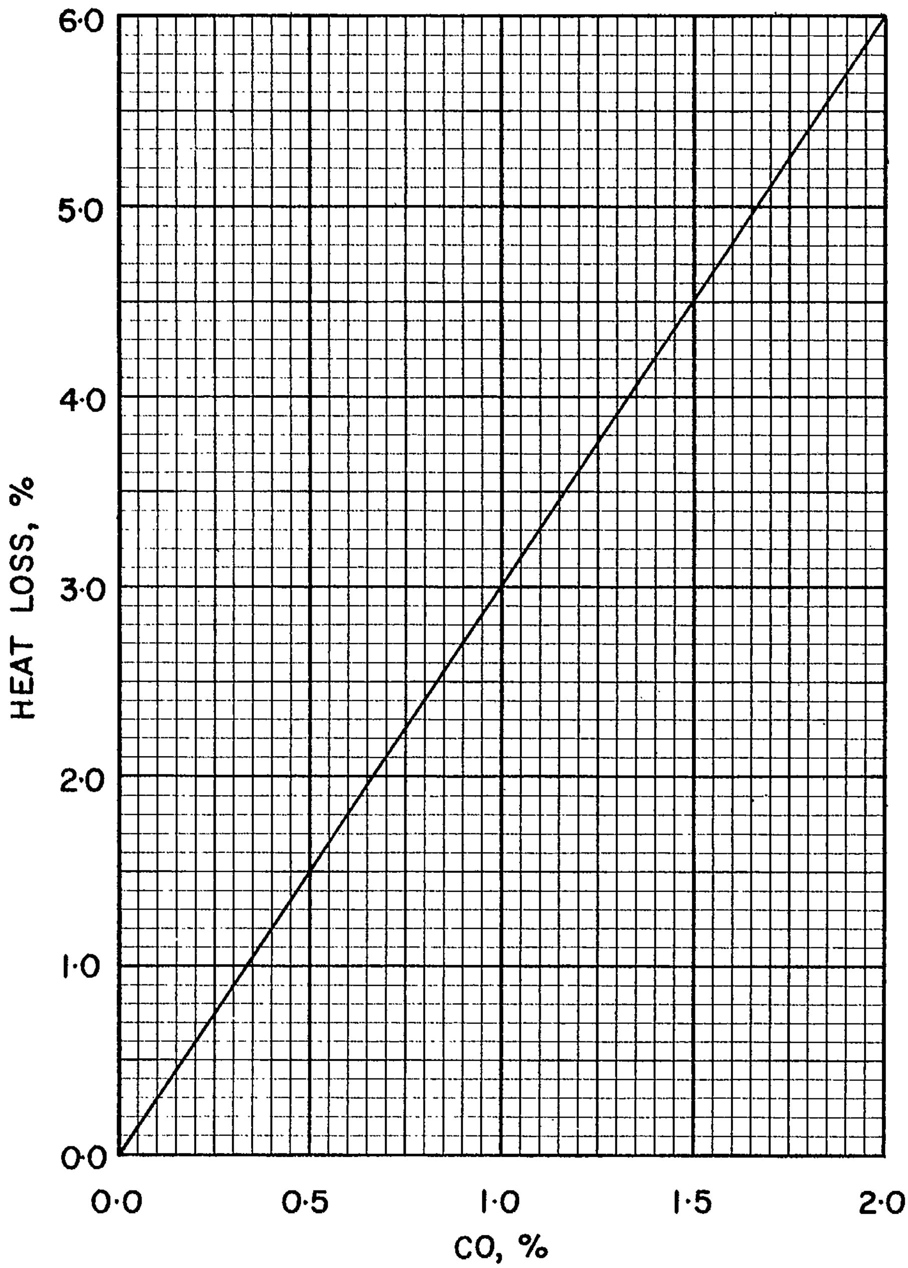


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

9620

FUEL OIL 9630, SPECIFIC GRAVITY 0.960

Ultimate Analysis, lb/lb

Carbon	(C)	0.8575
Hydrogen	(H_2)	0.1125
Sulphur	(S)	0.0300
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,390

Conversion Factors

1 Imp gal oil = 9.60 lb oil
or Imp gal oil × 9.60 = lb oil
or lb oil × 0.1042 = Imp gal oil

1 U.S. gal oil = 9.60 × 0.8337 lb oil
or U.S. gal oil × 8.004 = lb oil
or lb oil × 0.1249 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}390} \text{ lb oil}$$

or Btu × 10^6 × 54.38 = lb oil
or lb oil × 0.0184 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}390 \times 9.60} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.664 = Imp gal oil
or Imp gal oil × 0.1766 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}390 \times 8.004} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.793 = U.S. gal oil
or U.S. gal oil × 0.1472 = Btu × 10^6

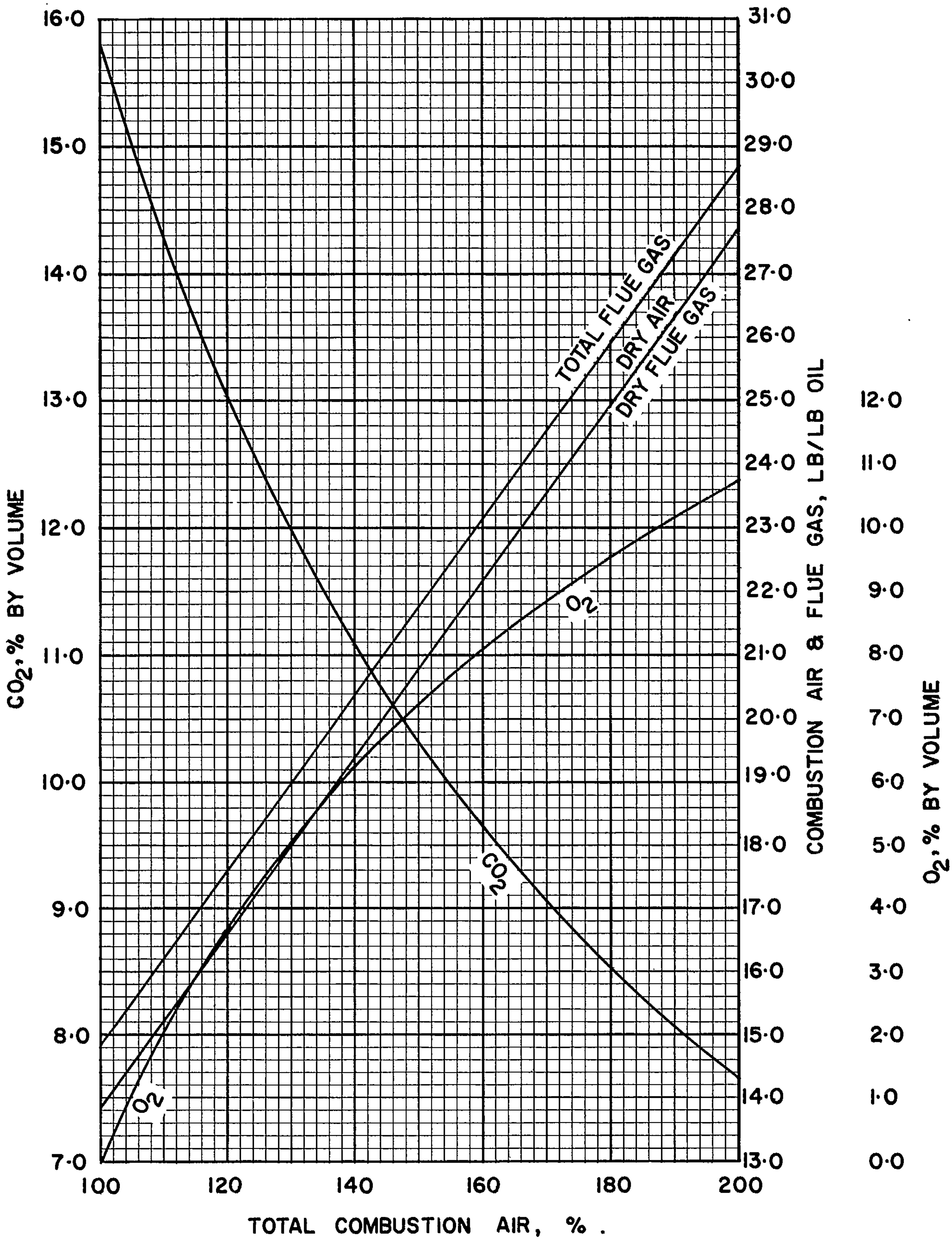


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS.

9630

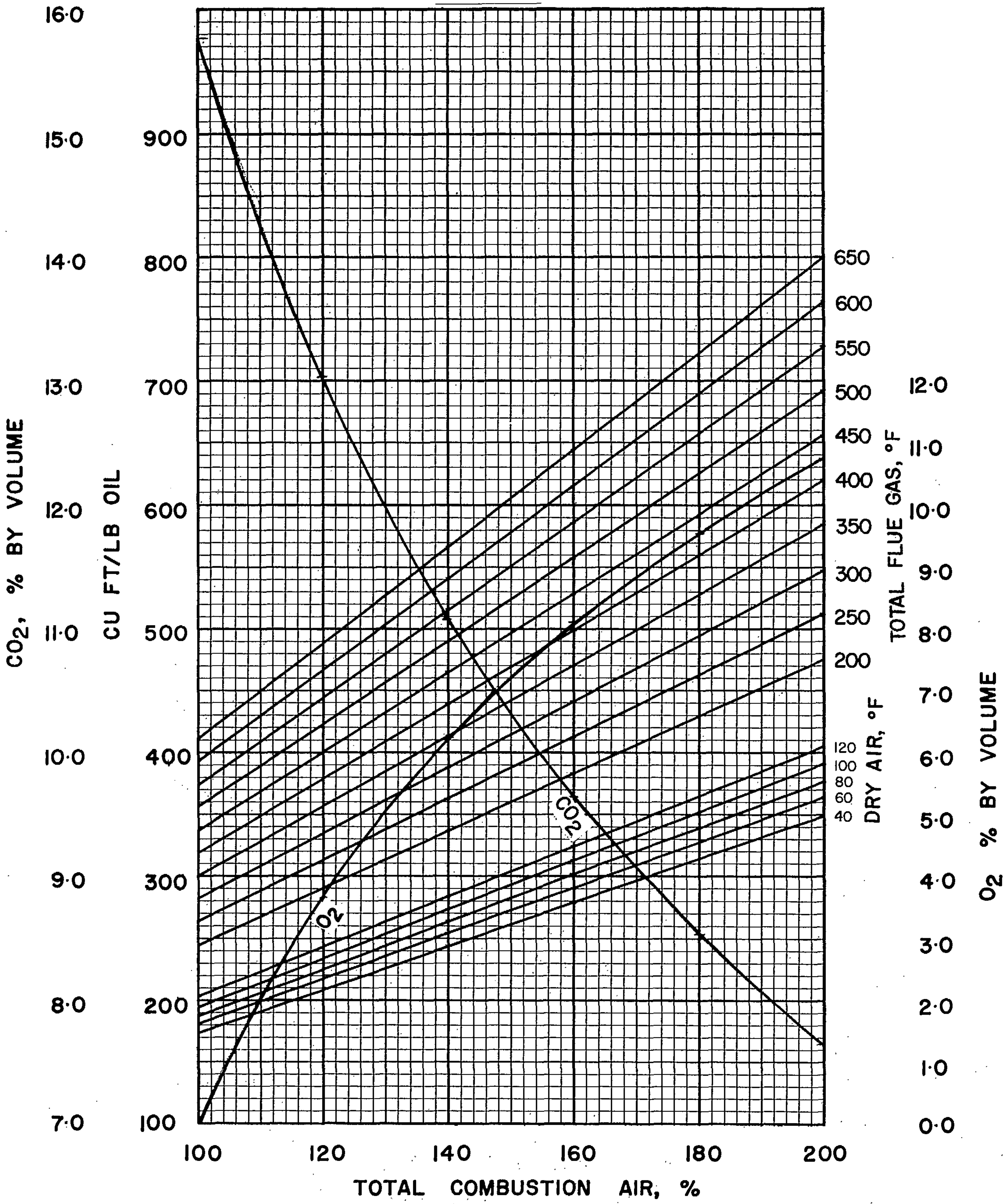


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 9630

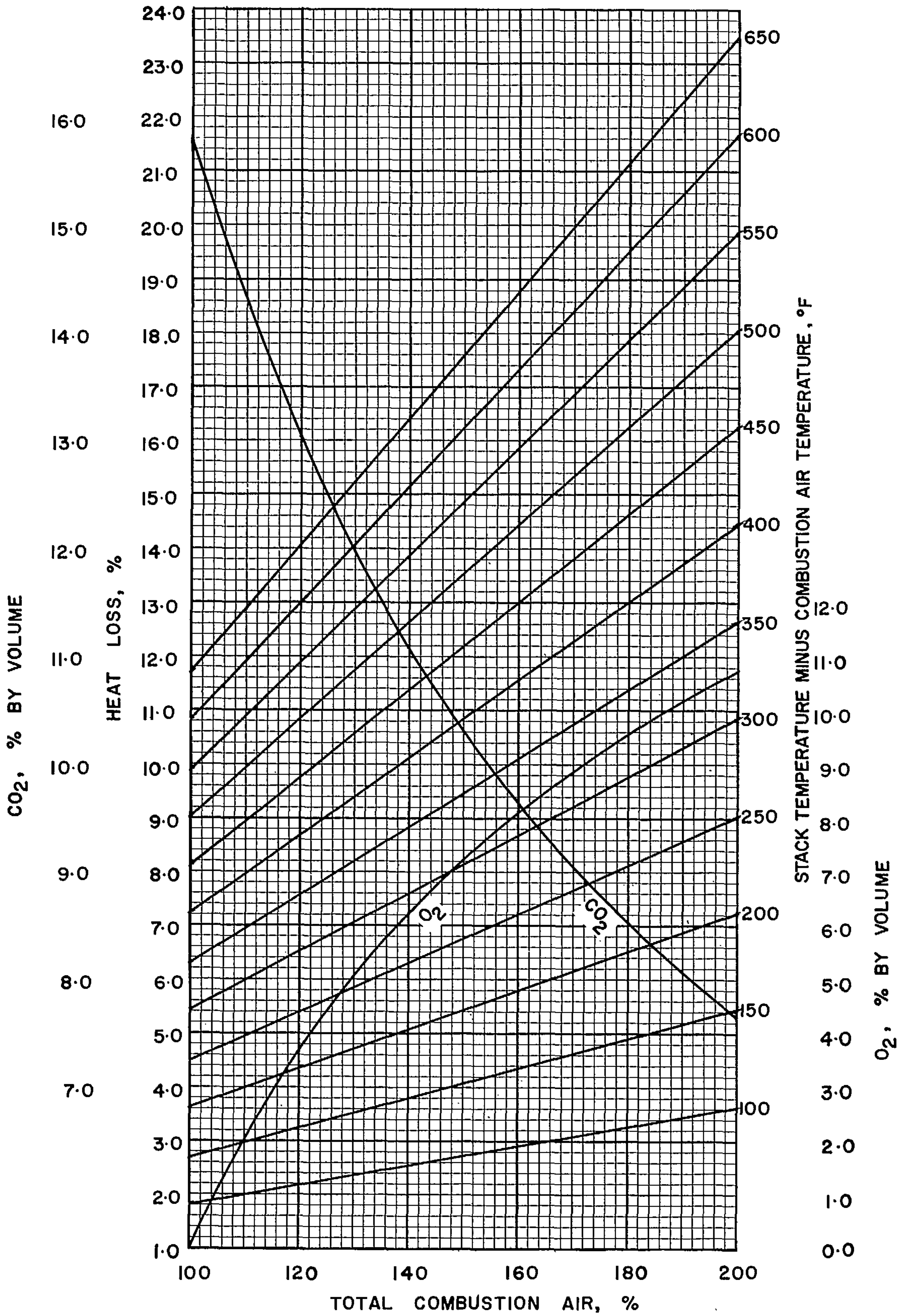


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

9630

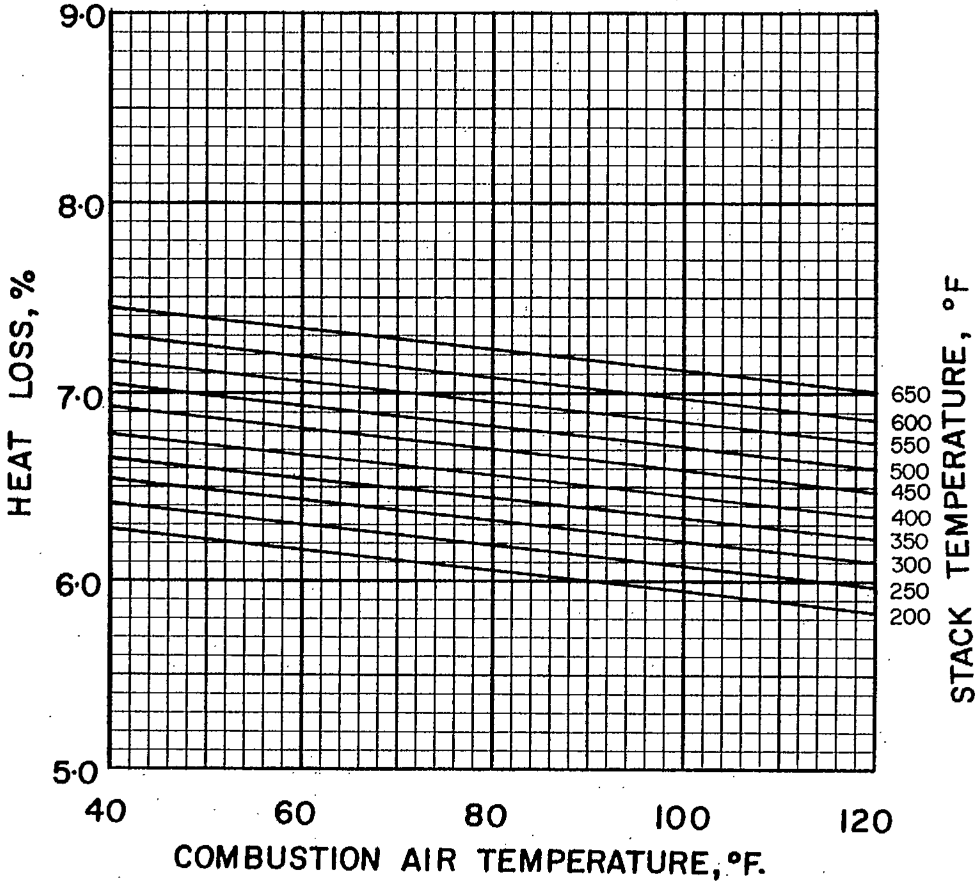


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

9630

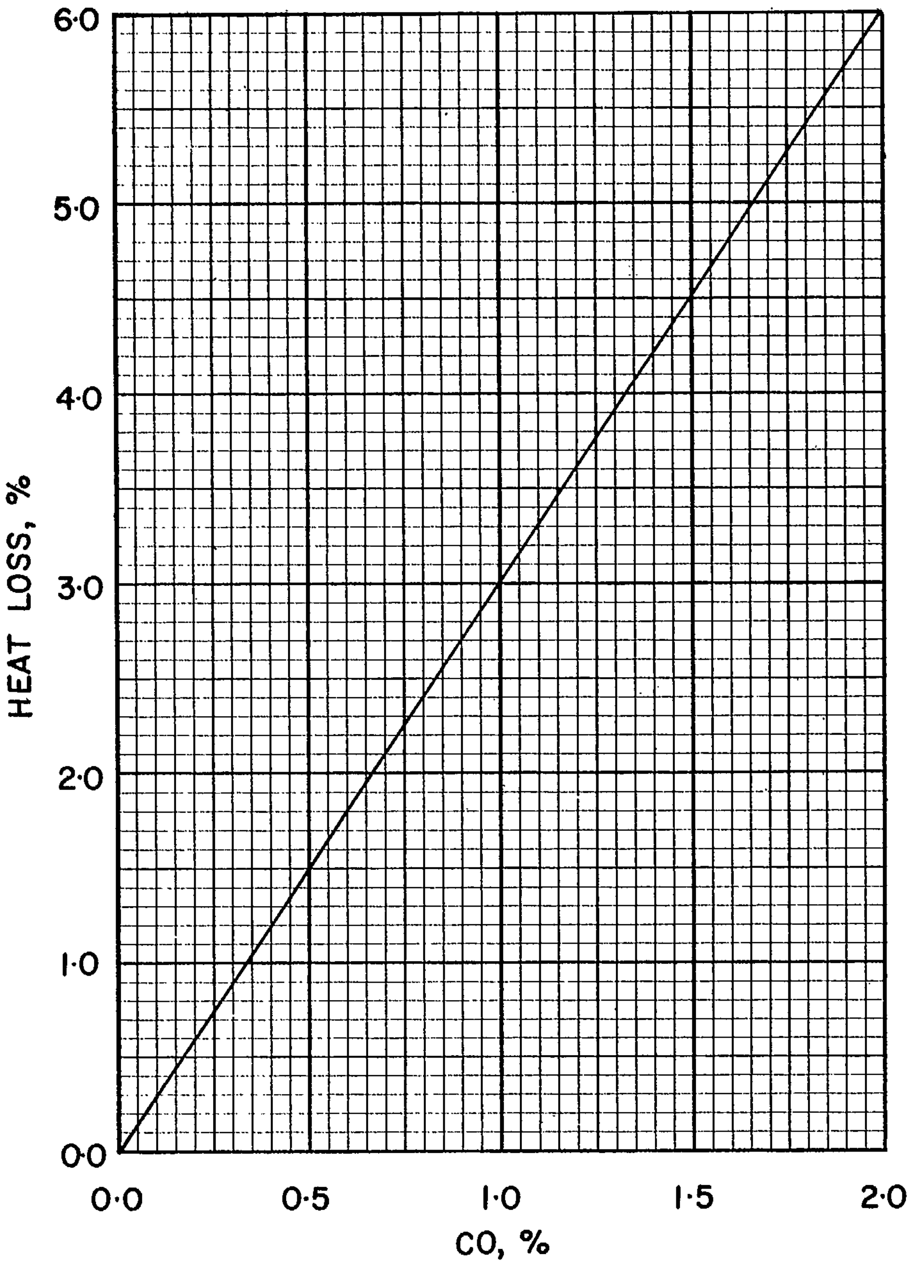


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

9630

FUEL OIL 9640, SPECIFIC GRAVITY 0.960

Ultimate Analysis, lb/lb

Carbon	(C)	0.8486
Hydrogen	(H_2)	0.1114
Sulphur	(S)	0.0400
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,240

Conversion Factors

1 Imp gal oil = 9.60 lb oil
or Imp gal oil × 9.60 = lb oil
or lb oil × 0.1042 = Imp gal oil

1 U.S. gal oil = 9.60 × 0.8337 lb oil
or U.S. gal oil × 8.004 = lb oil
or lb oil × 0.1249 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}240} \text{ lb oil}$$

or Btu × 10^6 × 54.83 = lb oil
or lb oil × 0.0182 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}240 \times 9.60} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.711 = Imp gal oil
or Imp gal oil × 0.1751 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}240 \times 8.004} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.849 = U.S. gal oil
or U.S. gal oil × 0.1460 = Btu × 10^6

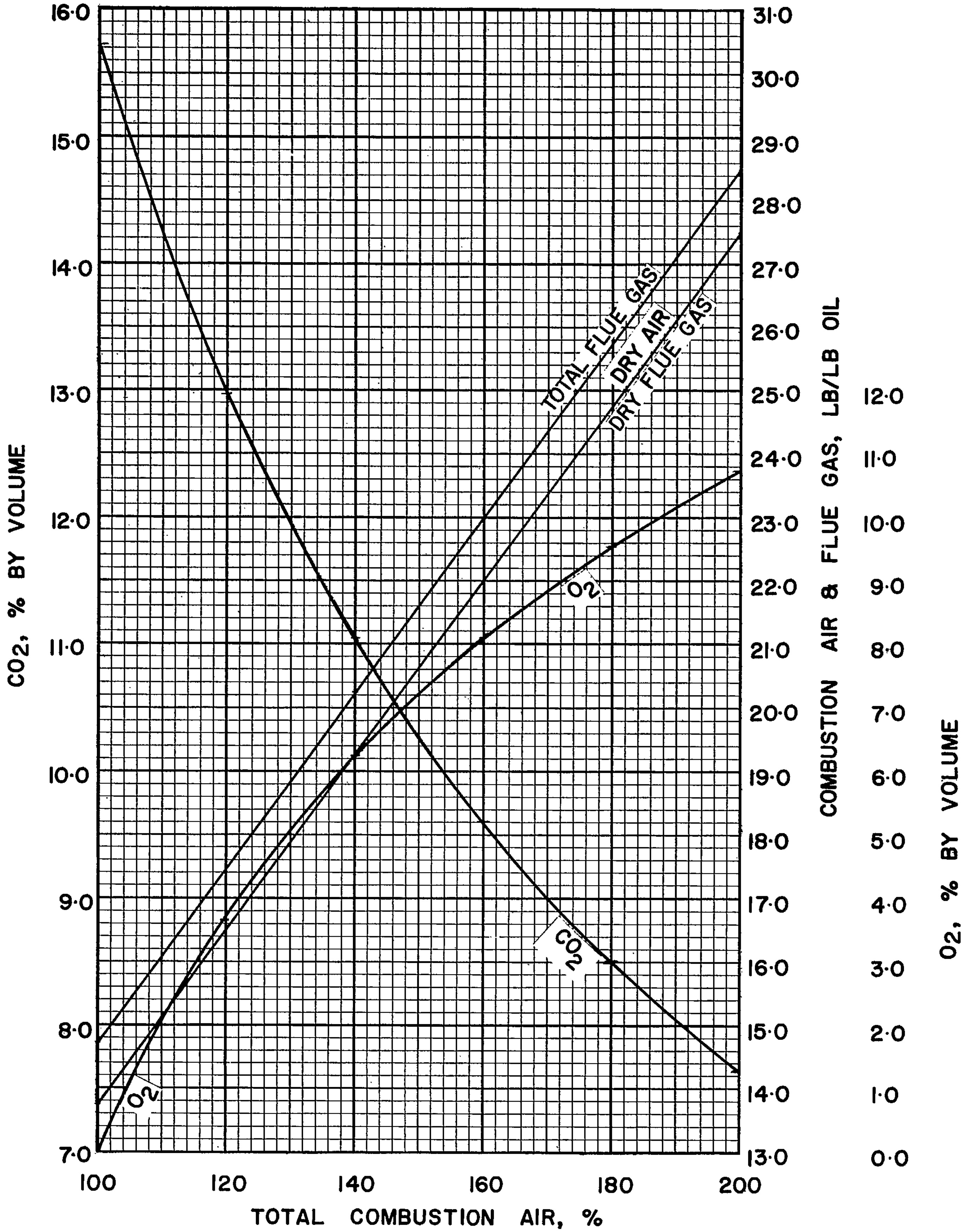


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS

9640

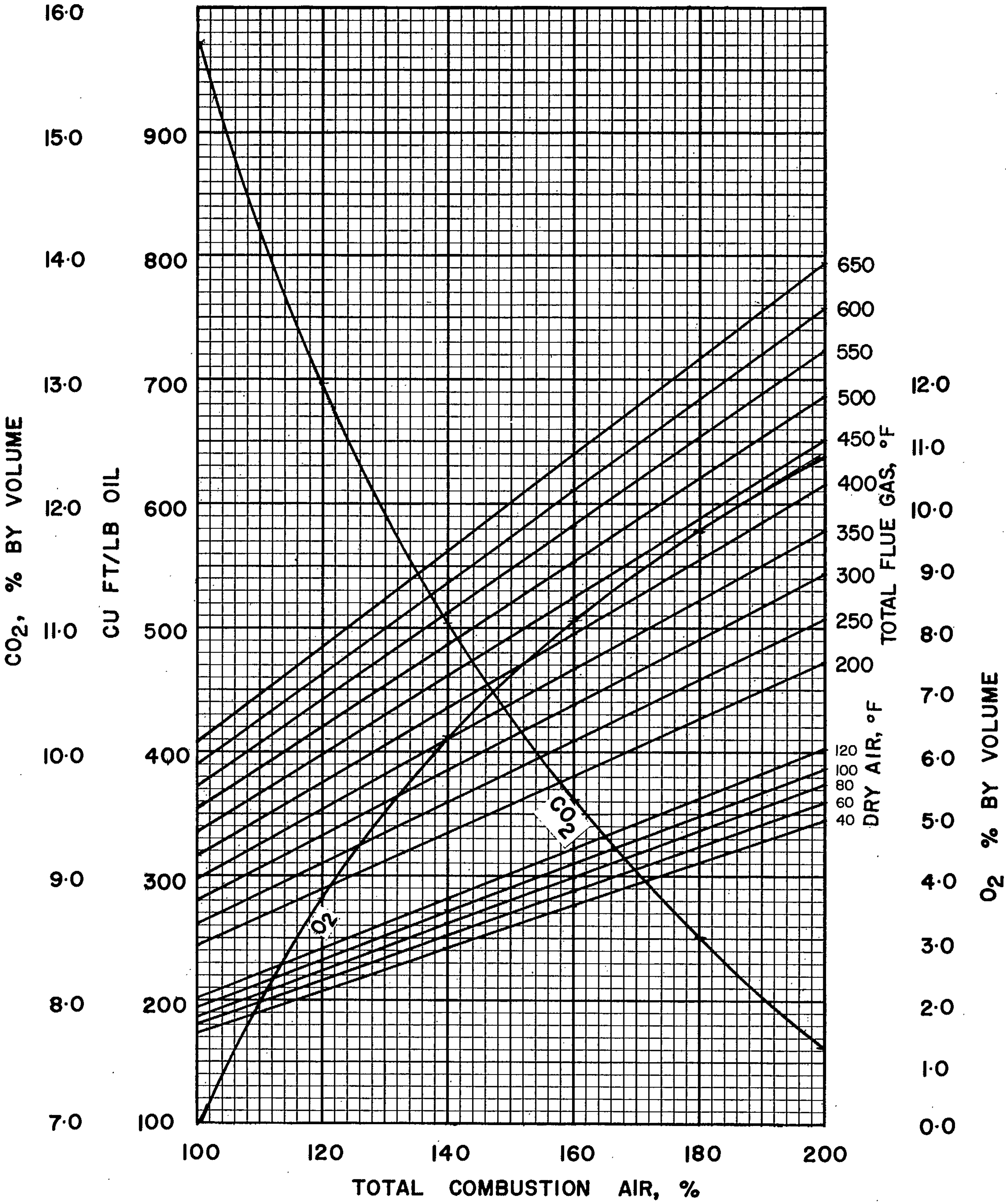


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 9640

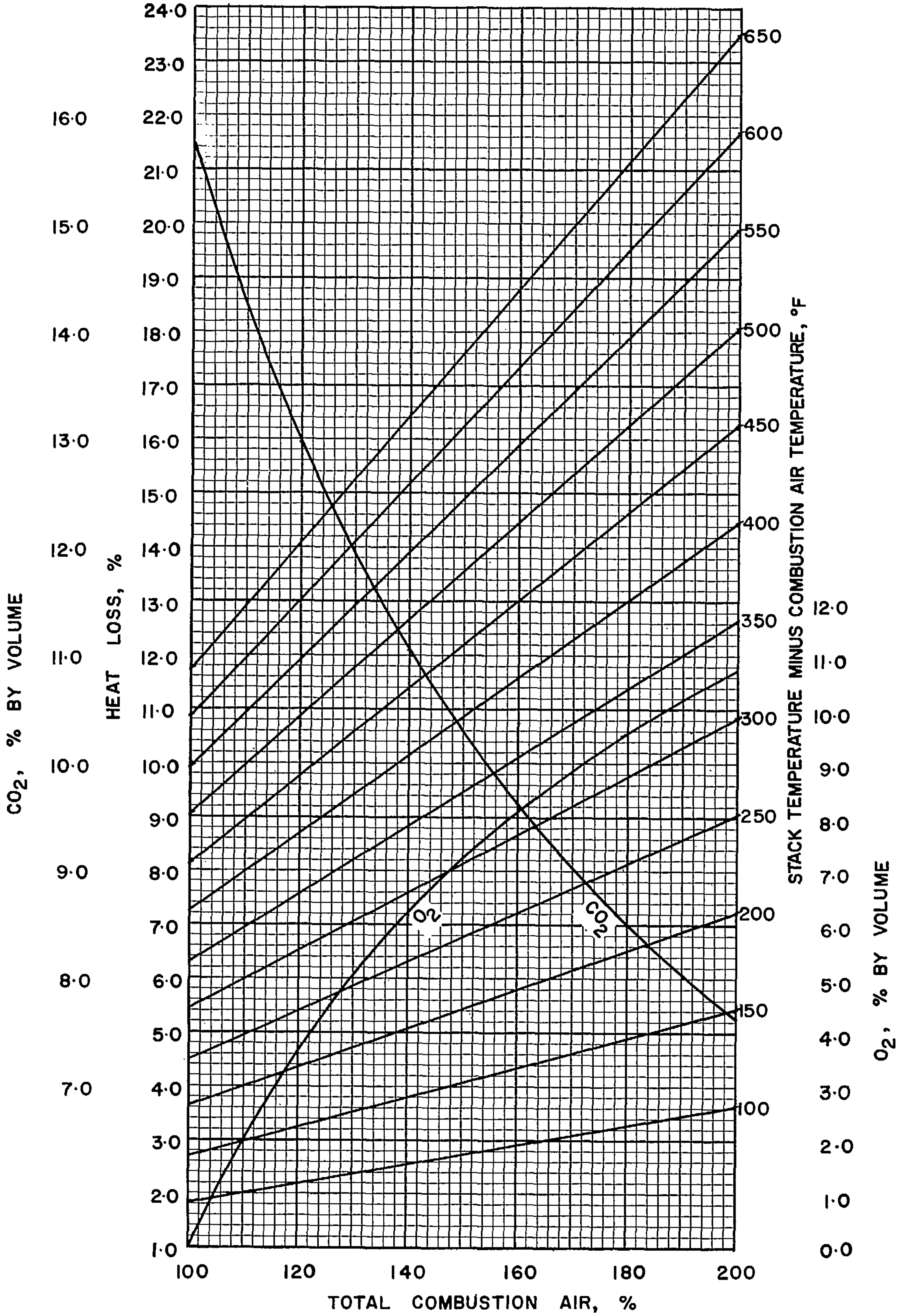


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

9640

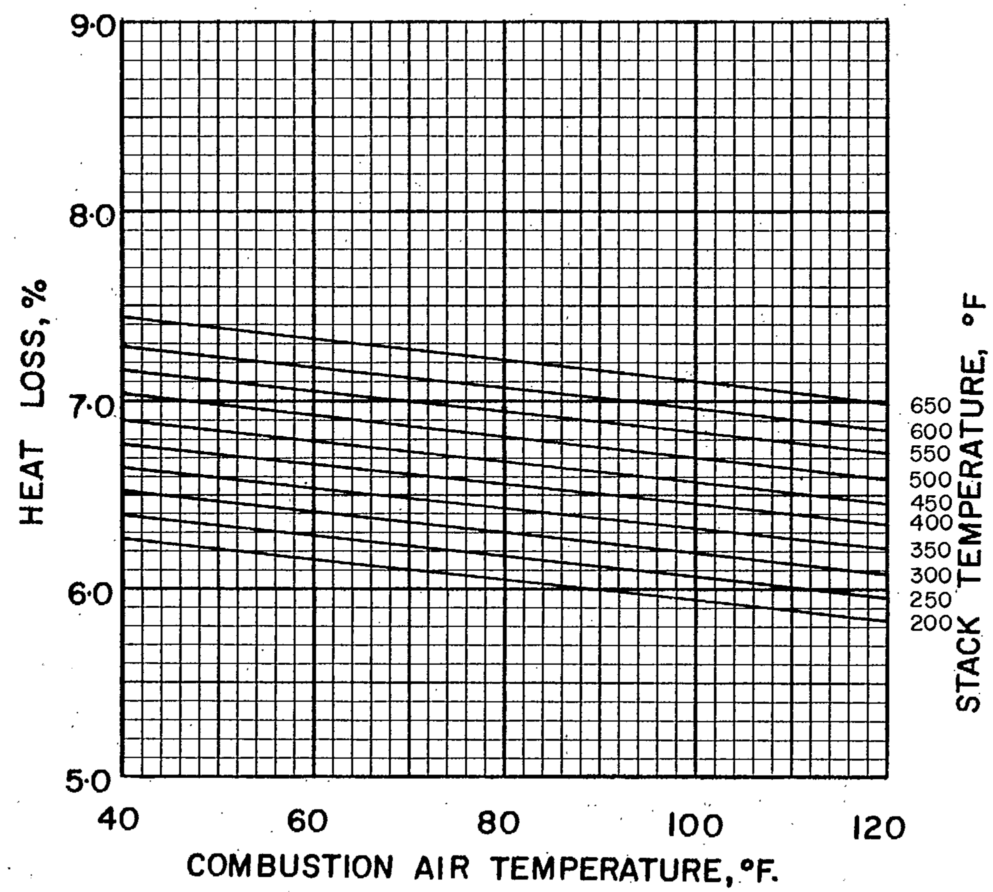


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

9640

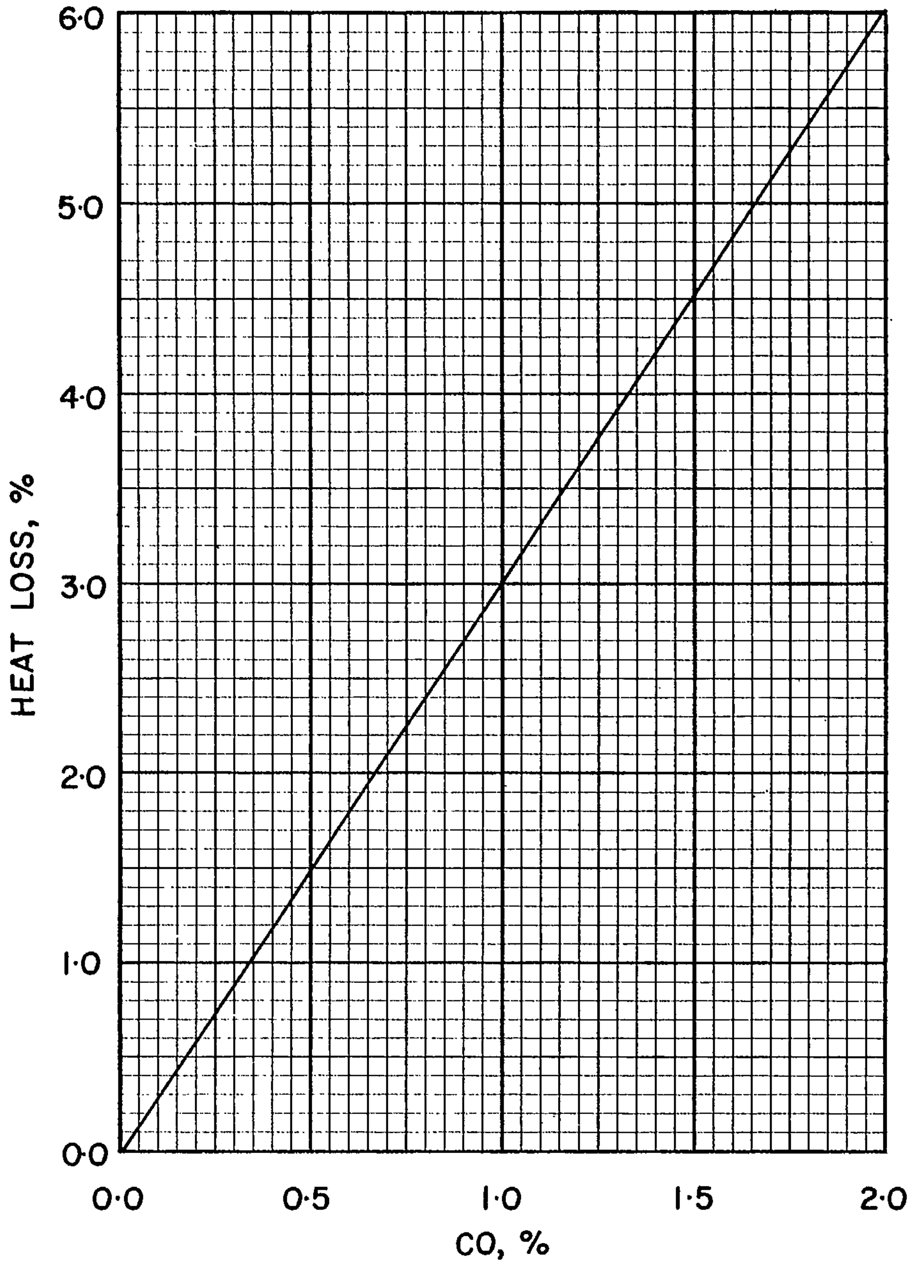


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

9640

FUEL OIL 9700, SPECIFIC GRAVITY 0.970

Ultimate Analysis, lb/lb

Carbon	(C)	0.8855
Hydrogen	(H_2)	0.1145
Sulphur	(S)	–
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,760

Conversion Factors

1 Imp gal oil = 9.70 lb oil
or Imp gal oil $\times$ 9.70 = lb oil
or lb oil $\times$ 0.1031 = Imp gal oil

1 U.S. gal oil = 9.70 $\times$ 0.8337 lb oil
or U.S. gal oil $\times$ 8.087 = lb oil
or lb oil $\times$ 0.1237 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal $\times$ 0.8327 = Imp gal
or Imp gal $\times$ 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}760} \text{ lb oil}$$

or Btu $\times$ 10^6 $\times$ 53.31 = lb oil
or lb oil $\times$ 0.0188 = Btu $\times$ 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}760 \times 9.70} \text{ Imp gal oil}$$

or Btu $\times$ 10^6 $\times$ 5.495 = Imp gal oil
or Imp gal oil $\times$ 0.1820 = Btu $\times$ 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}760 \times 8.087} \text{ U.S. gal oil}$$

or Btu $\times$ 10^6 $\times$ 6.592 = U.S. gal oil
or U.S. gal oil $\times$ 0.1517 = Btu $\times$ 10^6

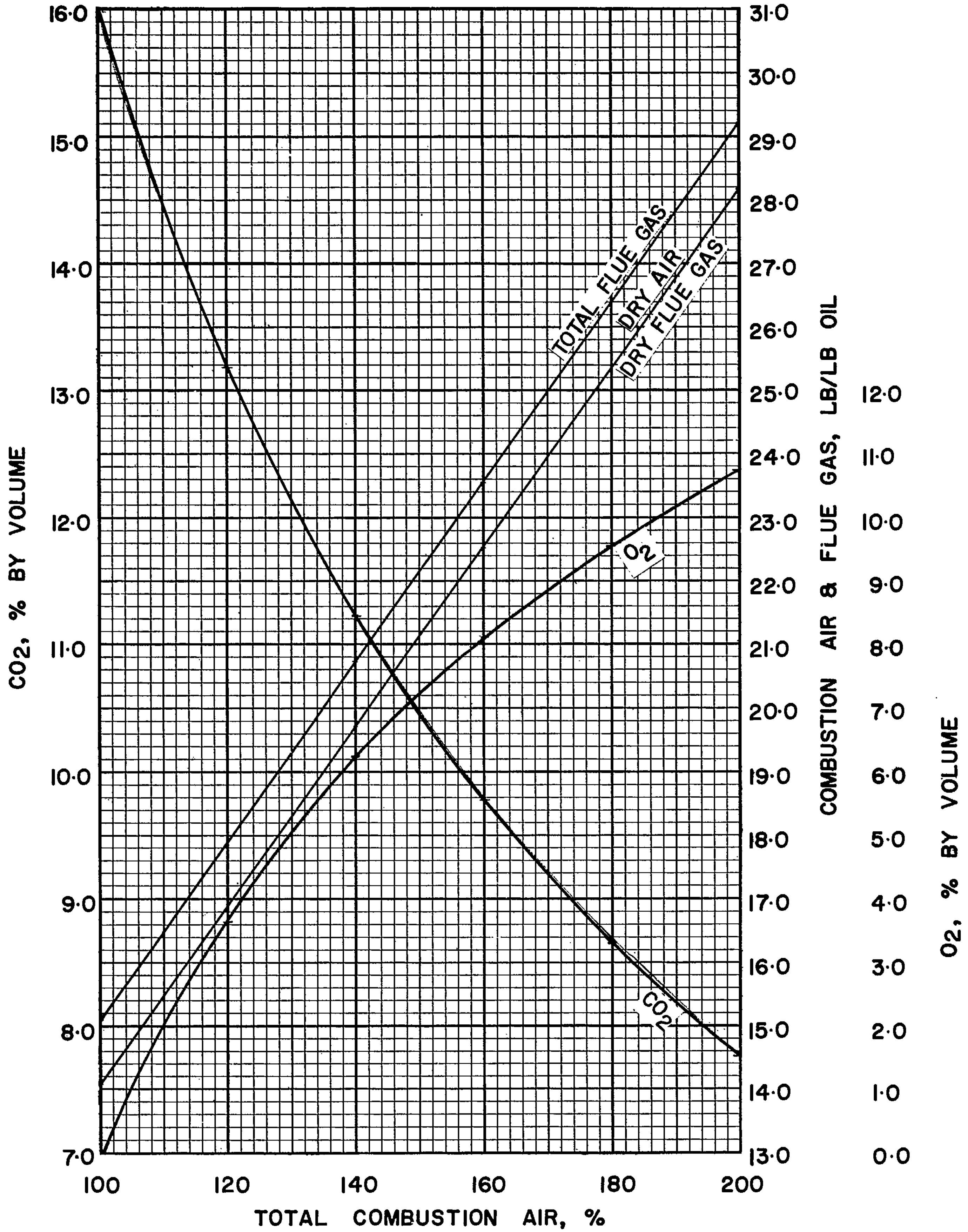


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS 9700

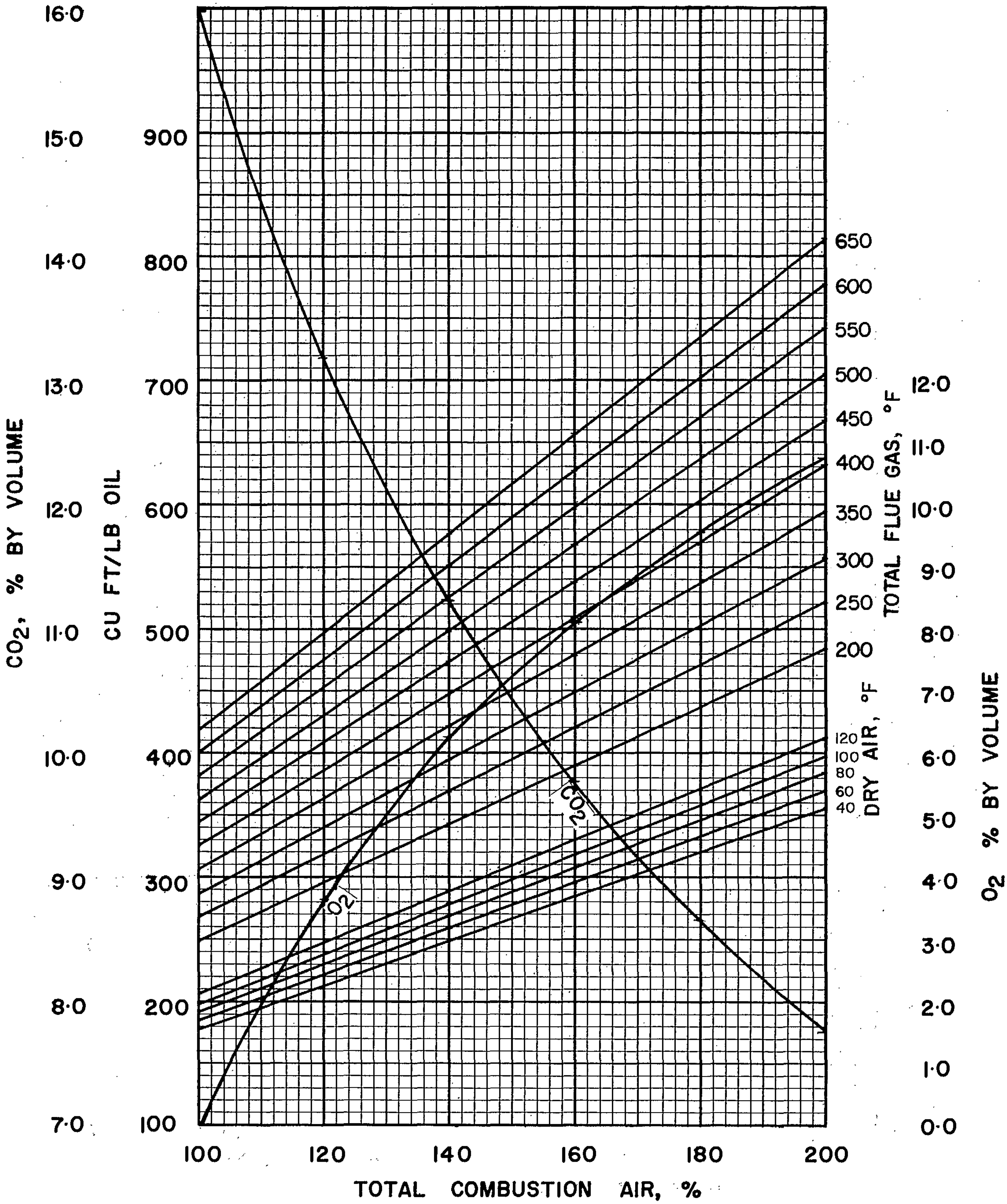


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 9700

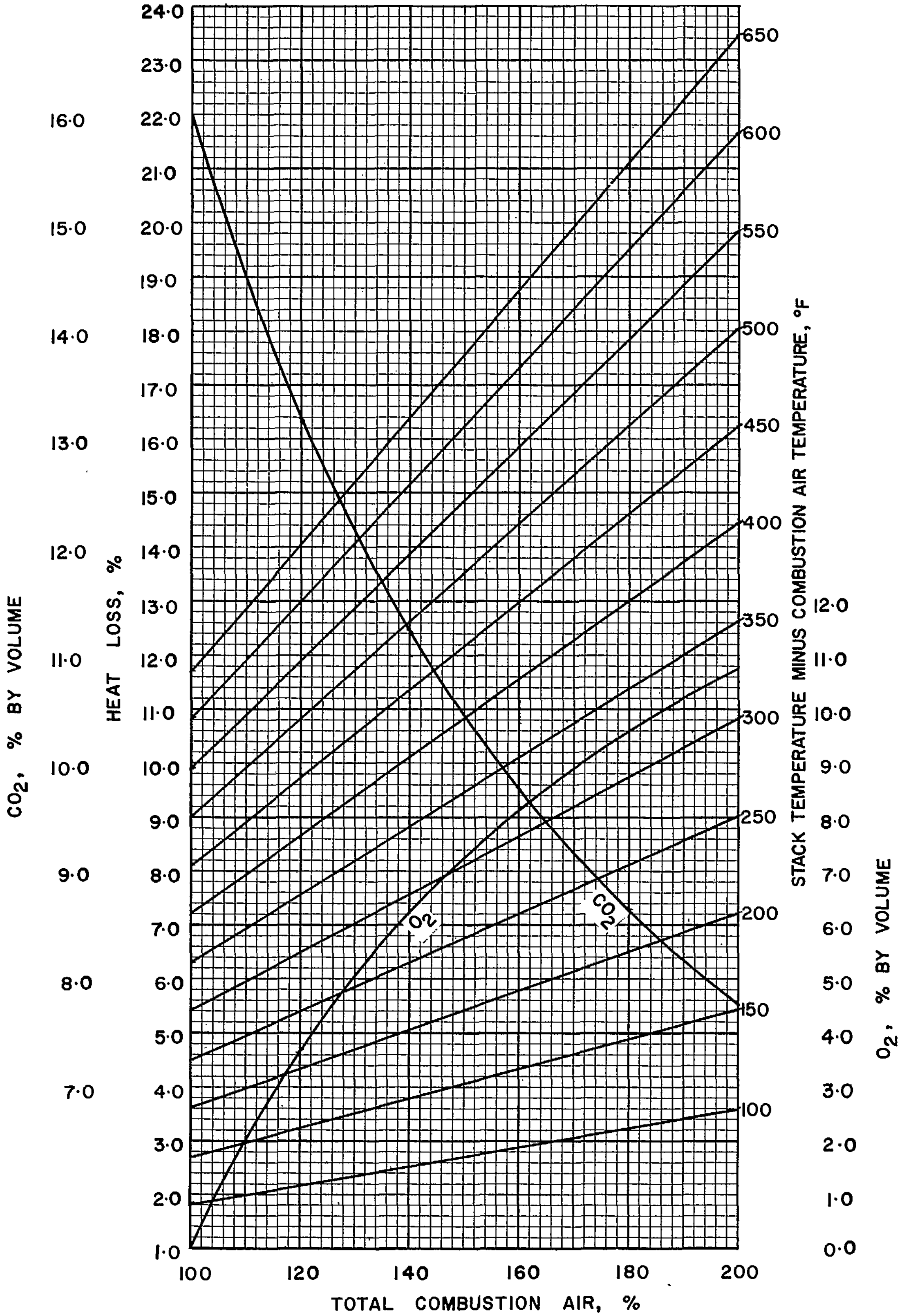


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

9700

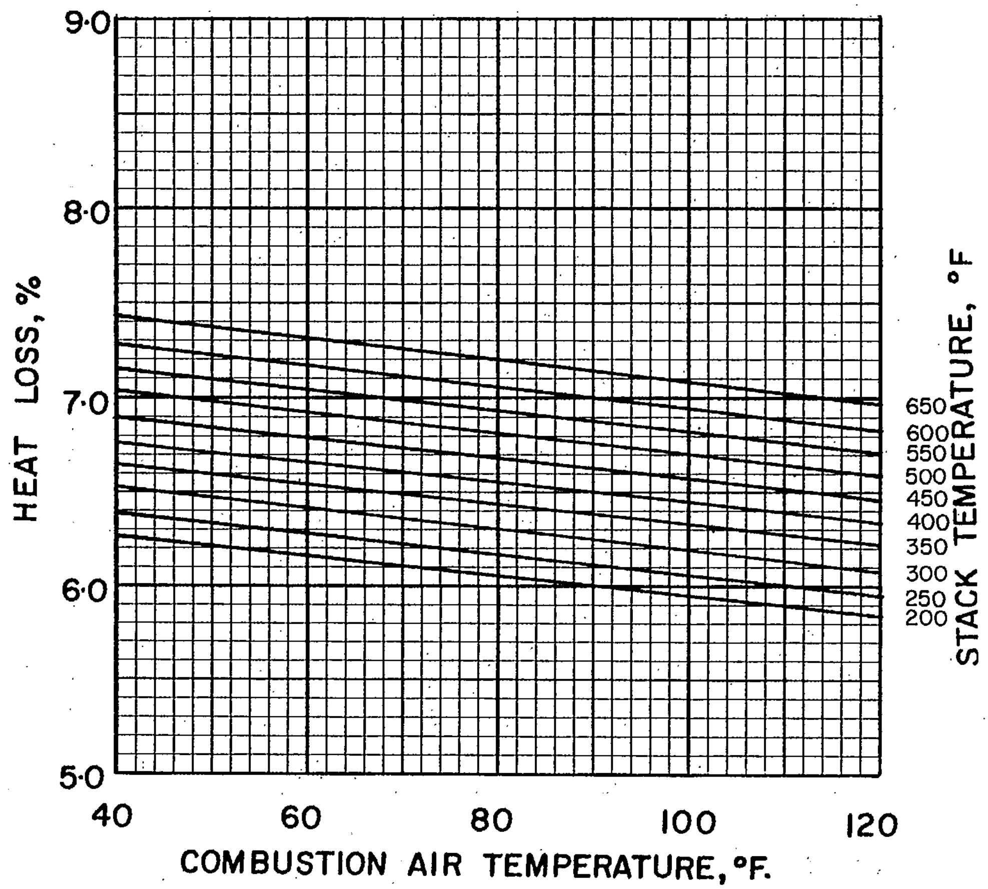


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

9700

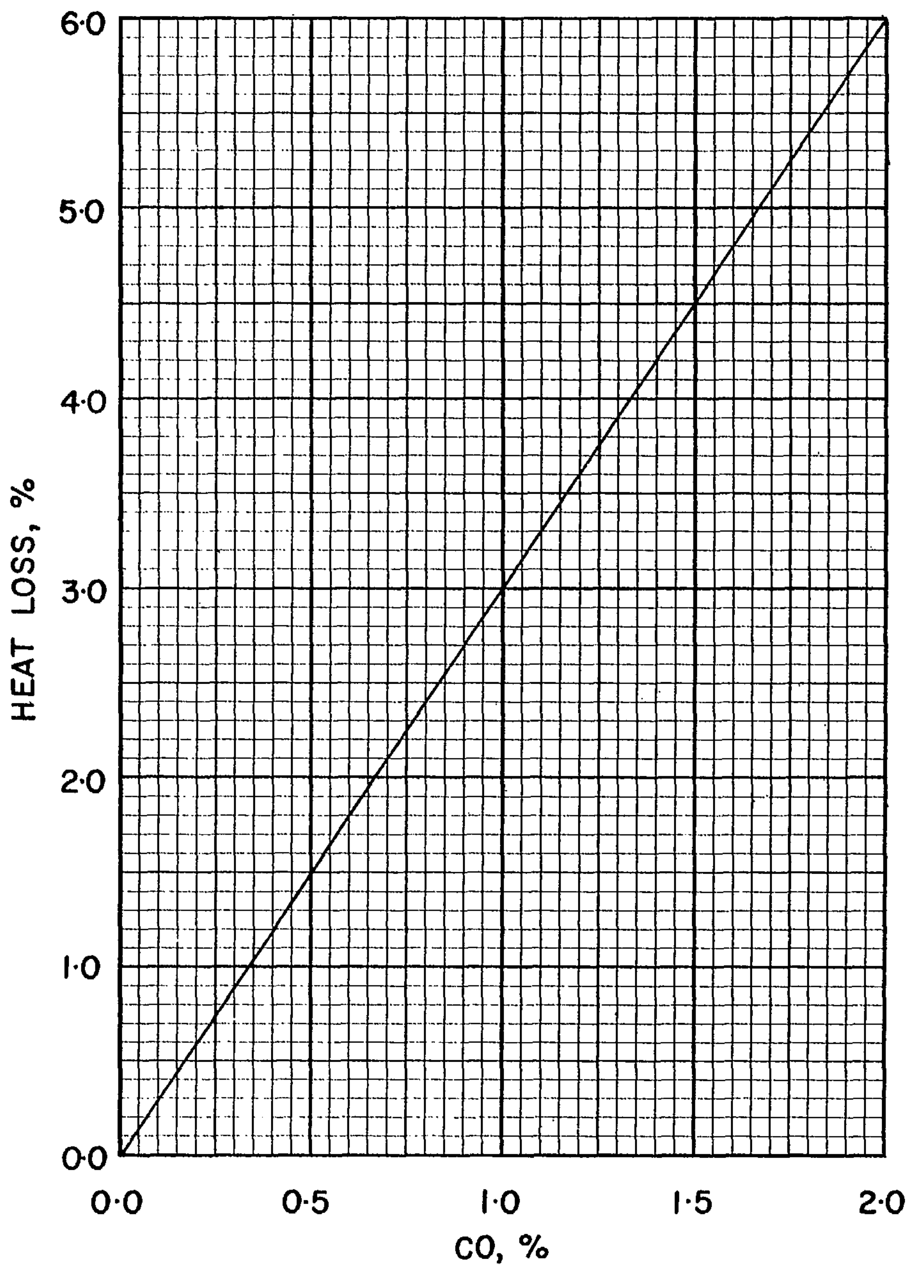


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

9700

FUEL OIL 9710, SPECIFIC GRAVITY 0.970

Ultimate Analysis, lb/lb

Carbon	(C)	0.8766
Hydrogen	(H_2)	0.1134
Sulphur	(S)	0.0100
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,610

Conversion Factors

1 Imp gal oil = 9.70 lb oil
or Imp gal oil × 9.70 = lb oil
or lb oil × 0.1031 = Imp gal oil

1 U.S. gal oil = 9.70 × 0.8337 lb oil
or U.S. gal oil × 8.087 = lb oil
or lb oil × 0.1237 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}610} \text{ lb oil}$$

or Btu × 10^6 × 53.73 = lb oil
or lb oil × 0.0186 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}610 \times 9.70} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.540 = Imp gal oil
or Imp gal oil × 0.1805 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}610 \times 8.087} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.644 = U.S. gal oil
or U.S. gal oil × 0.1505 = Btu × 10^6

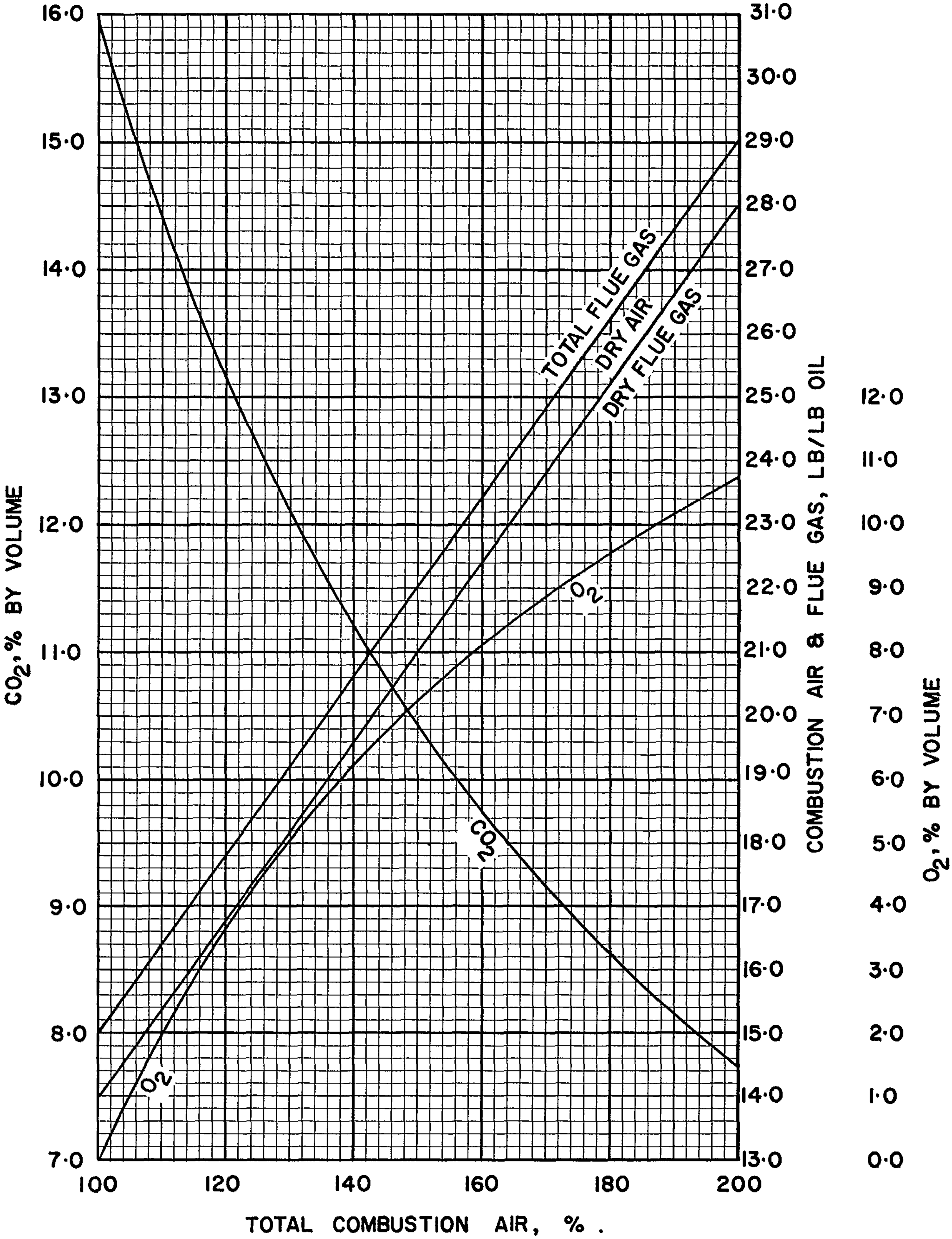


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS.

9710

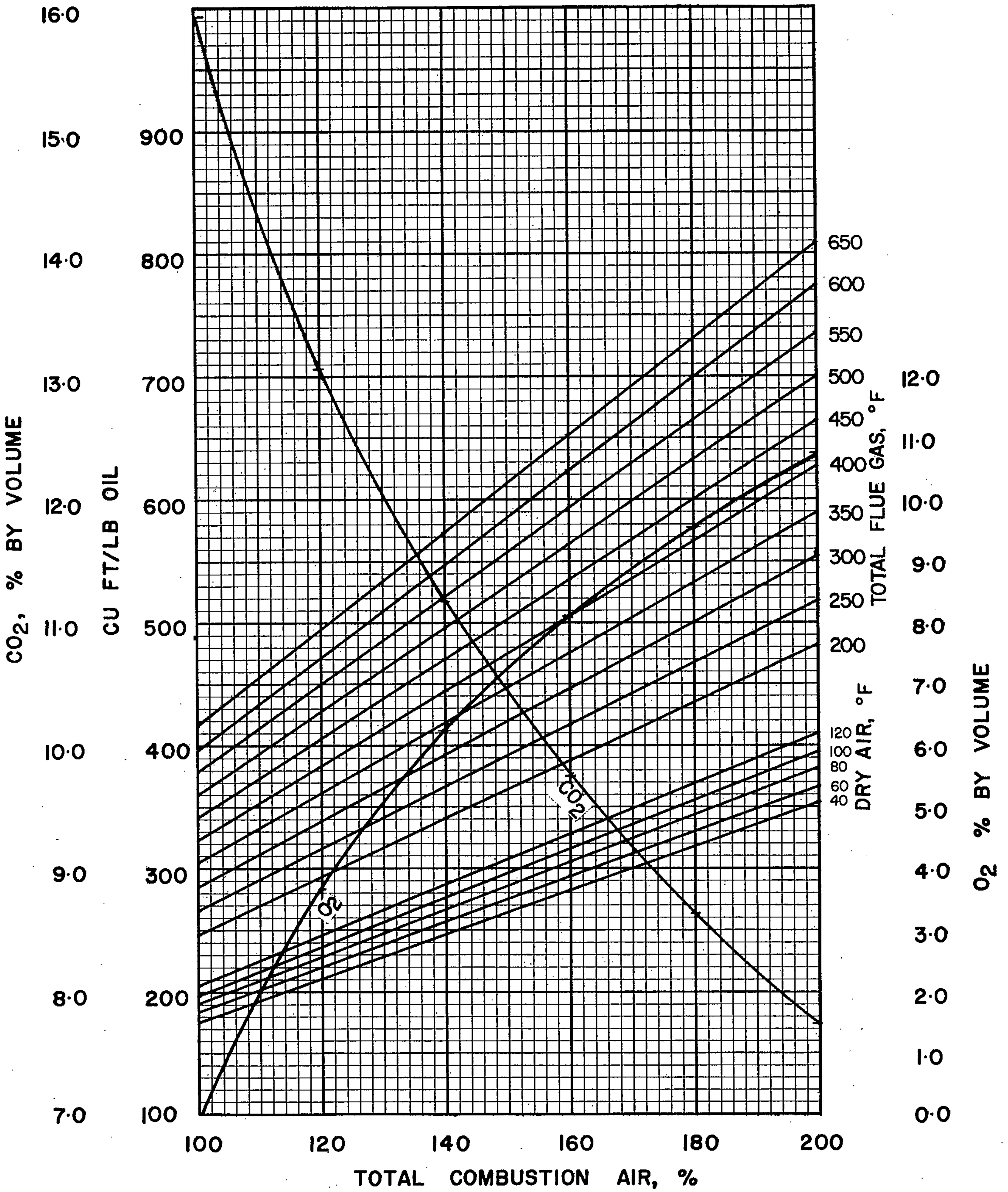


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 9710

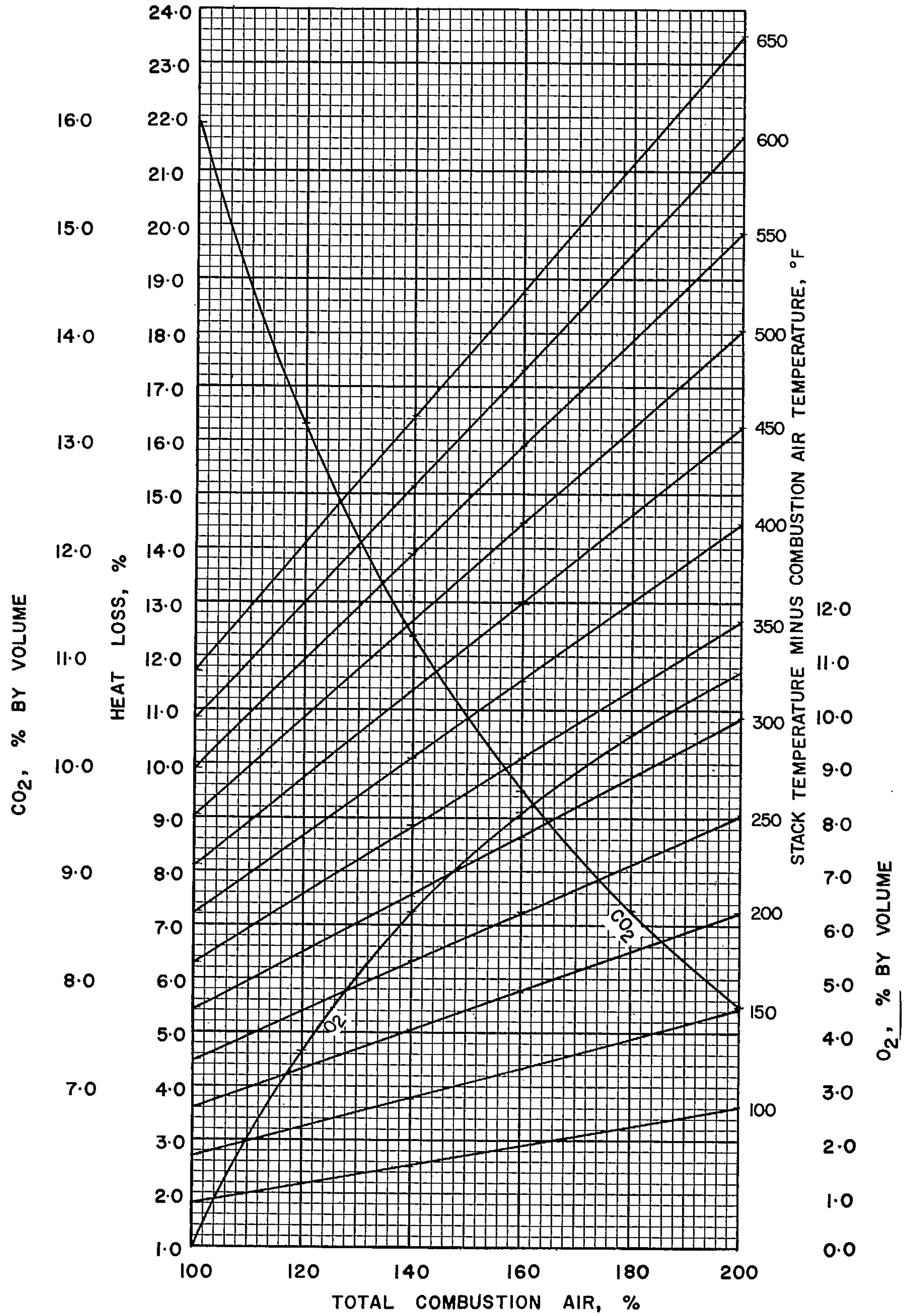


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

9710

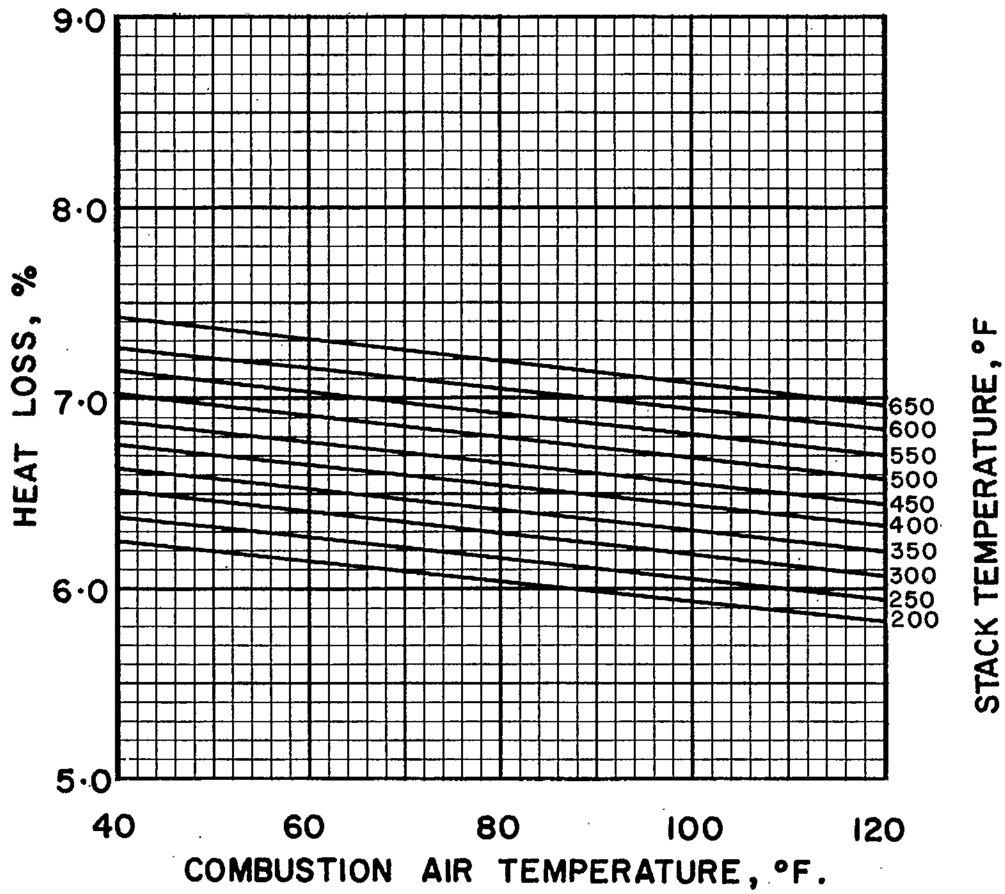


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

9710

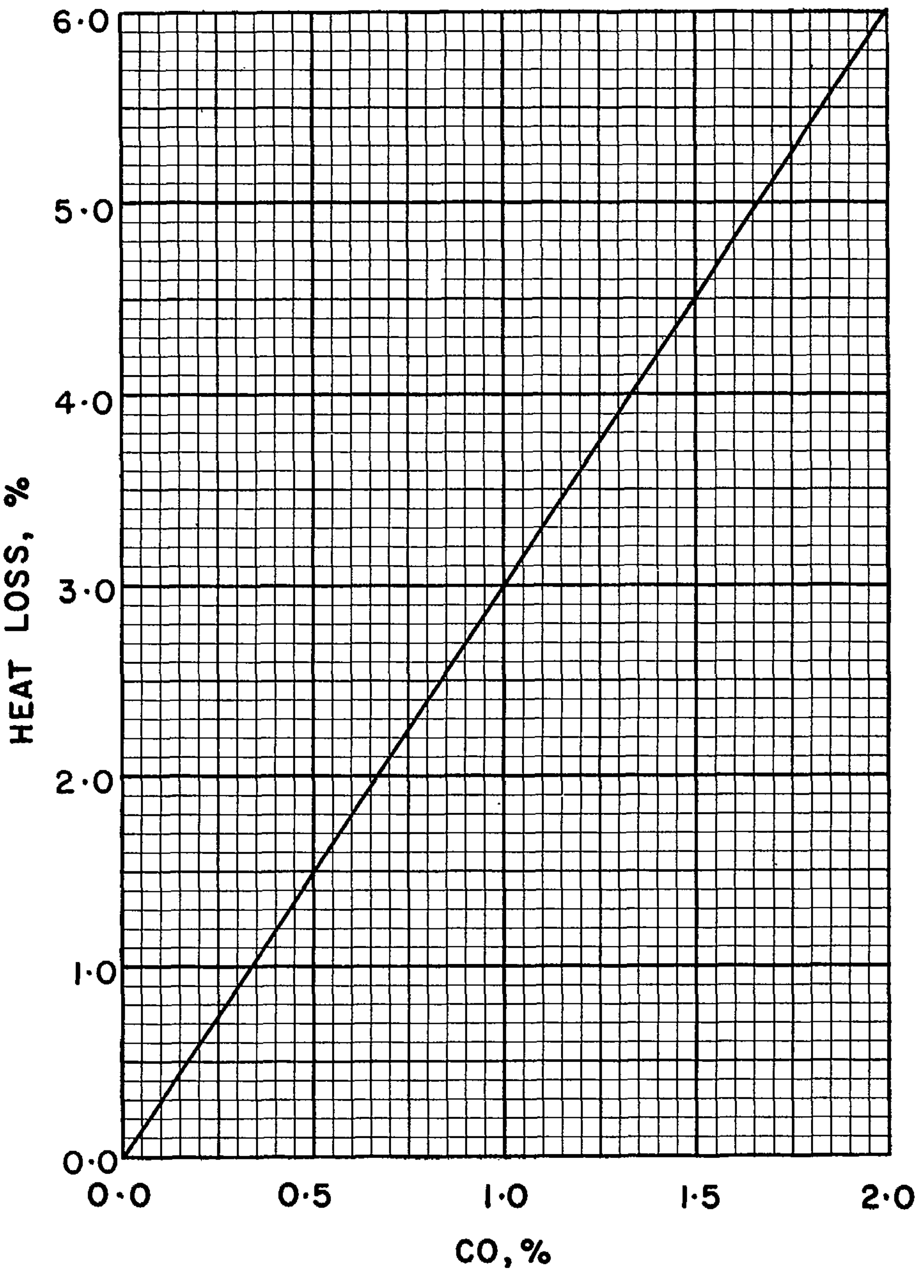


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

9710

FUEL OIL 9720, SPECIFIC GRAVITY 0.970

Ultimate Analysis, lb/lb

Carbon	(C)	0.8678
Hydrogen	(H_2)	0.1122
Sulphur	(S)	0.0200
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,470

Conversion Factors

1 Imp gal oil = 9.70 lb oil
or Imp gal oil × 9.70 = lb oil
or lb oil × 0.1031 = Imp gal oil

1 U.S. gal oil = 9.70 × 0.8337 lb oil
or U.S. gal oil × 8.087 = lb oil
or lb oil × 0.1237 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}470} \text{ lb oil}$$

or Btu × 10^6 × 54.14 = lb oil
or lb oil × 0.0185 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}470 \times 9.70} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.582 = Imp gal oil
or Imp gal oil × 0.1792 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}470 \times 8.087} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.693 = U.S. gal oil
or U.S. gal oil × 0.1494 = Btu × 10^6

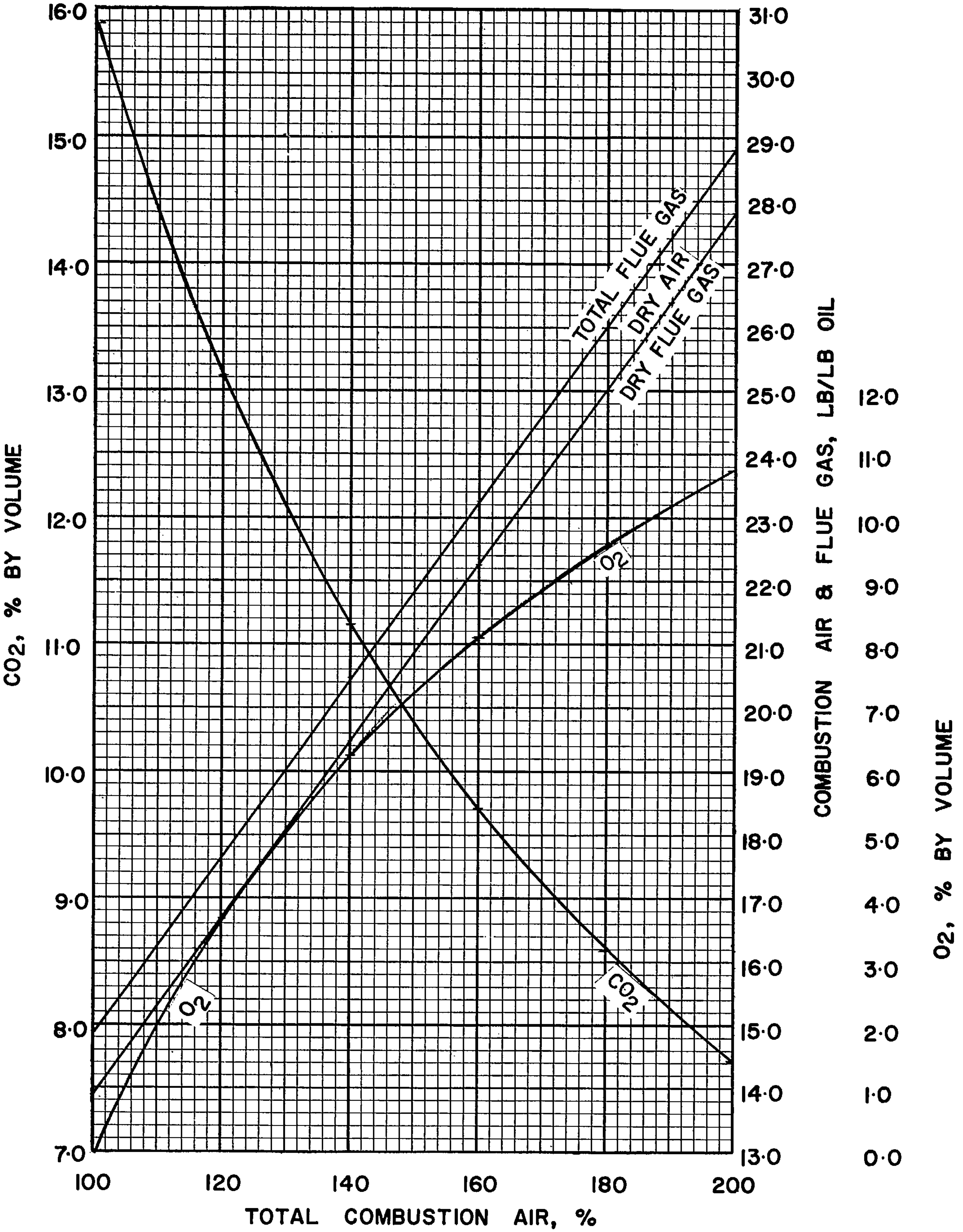


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS

9720

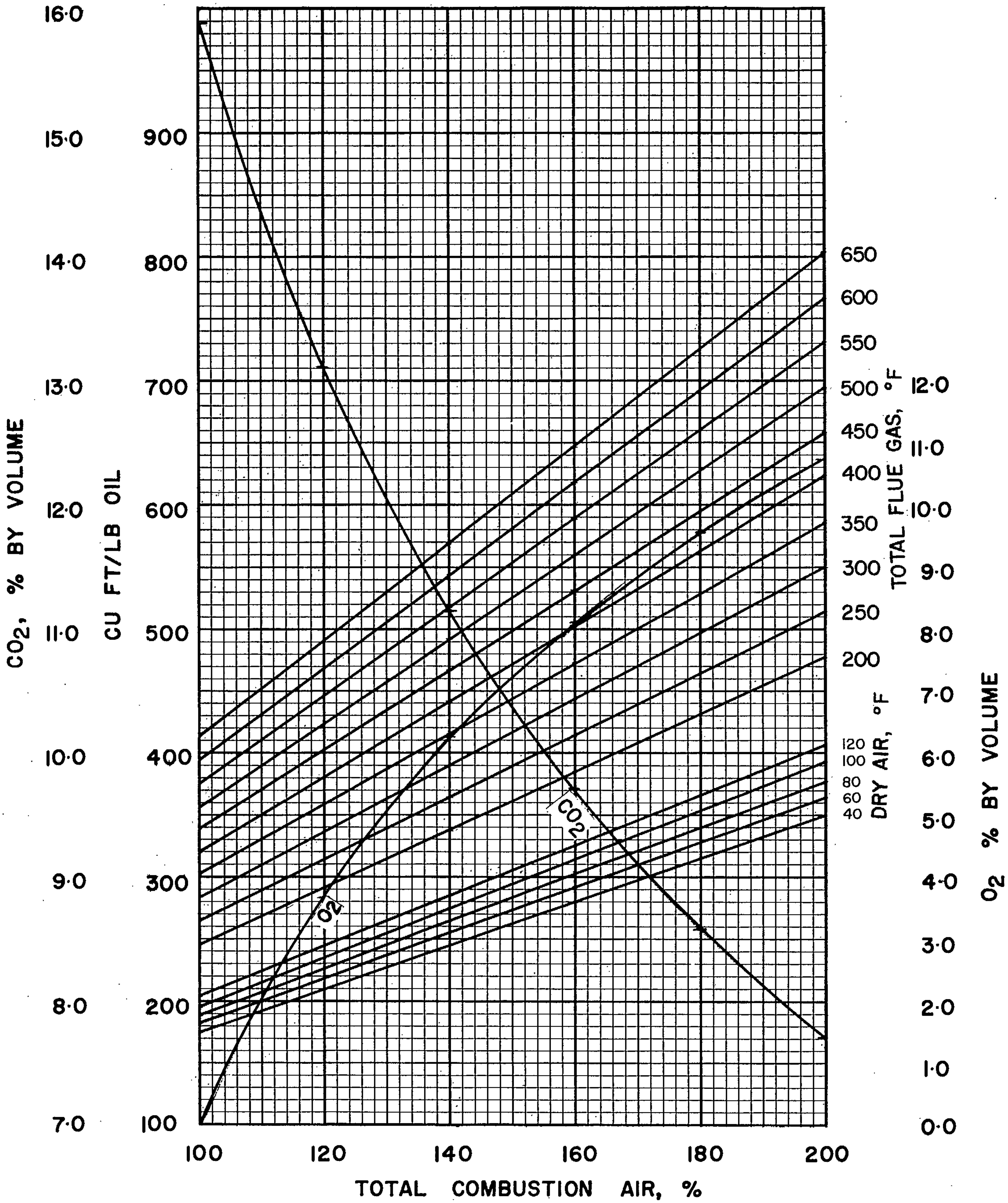


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 9720

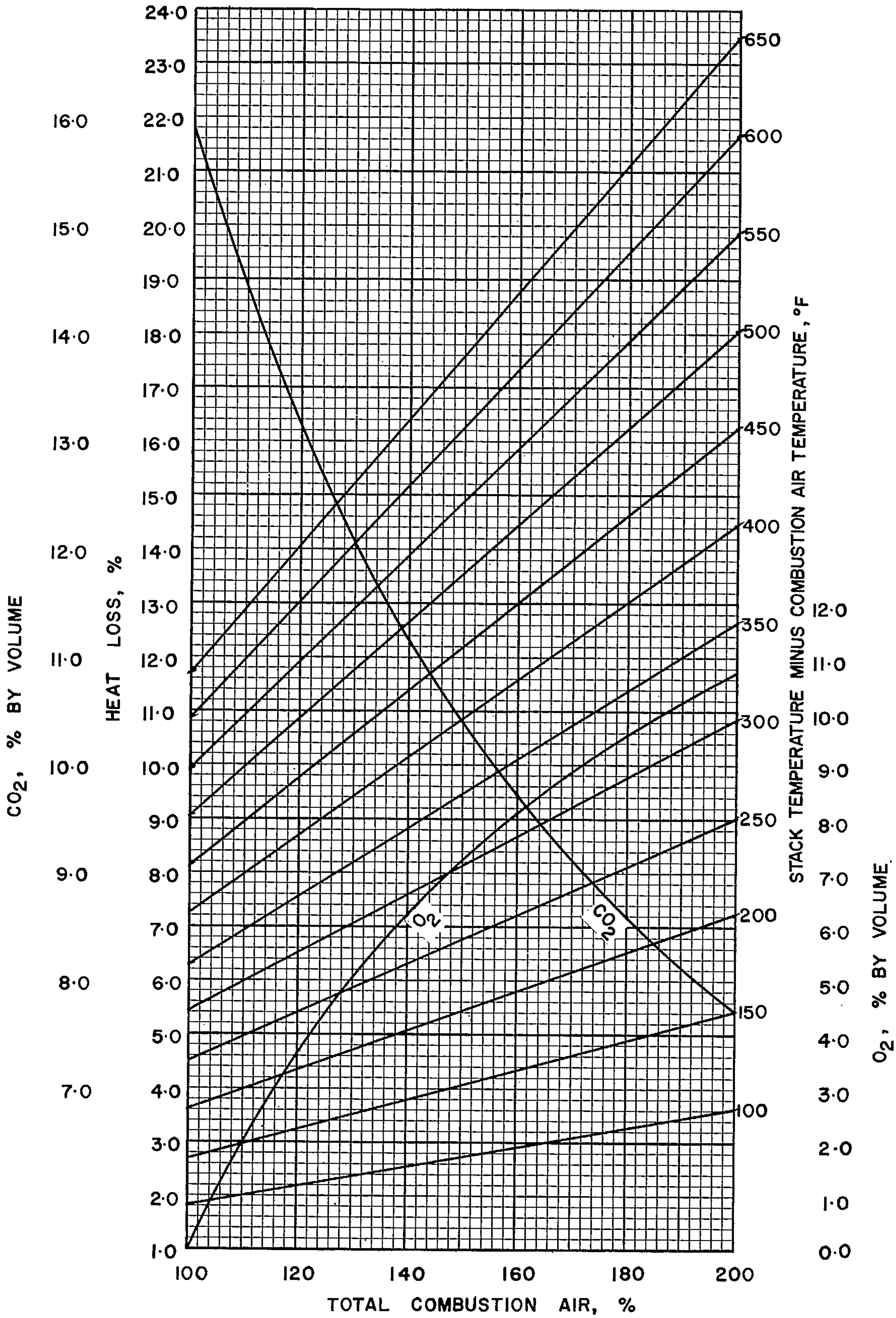


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

9720

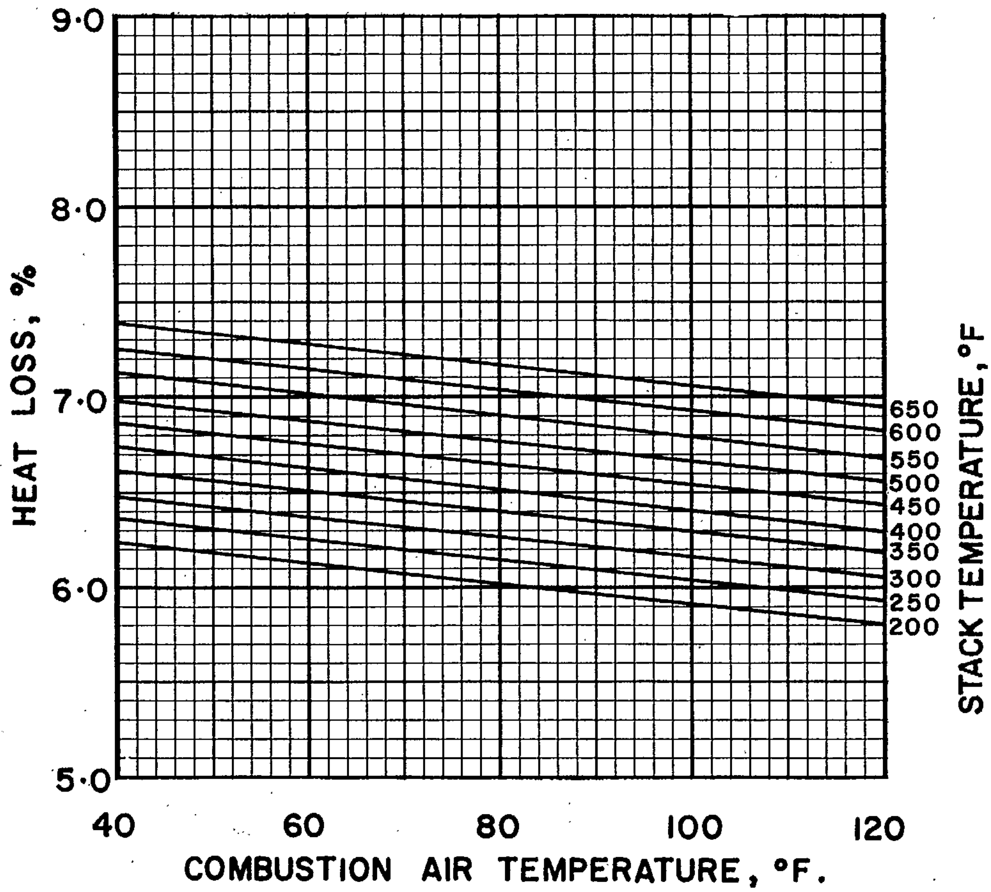


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

9720

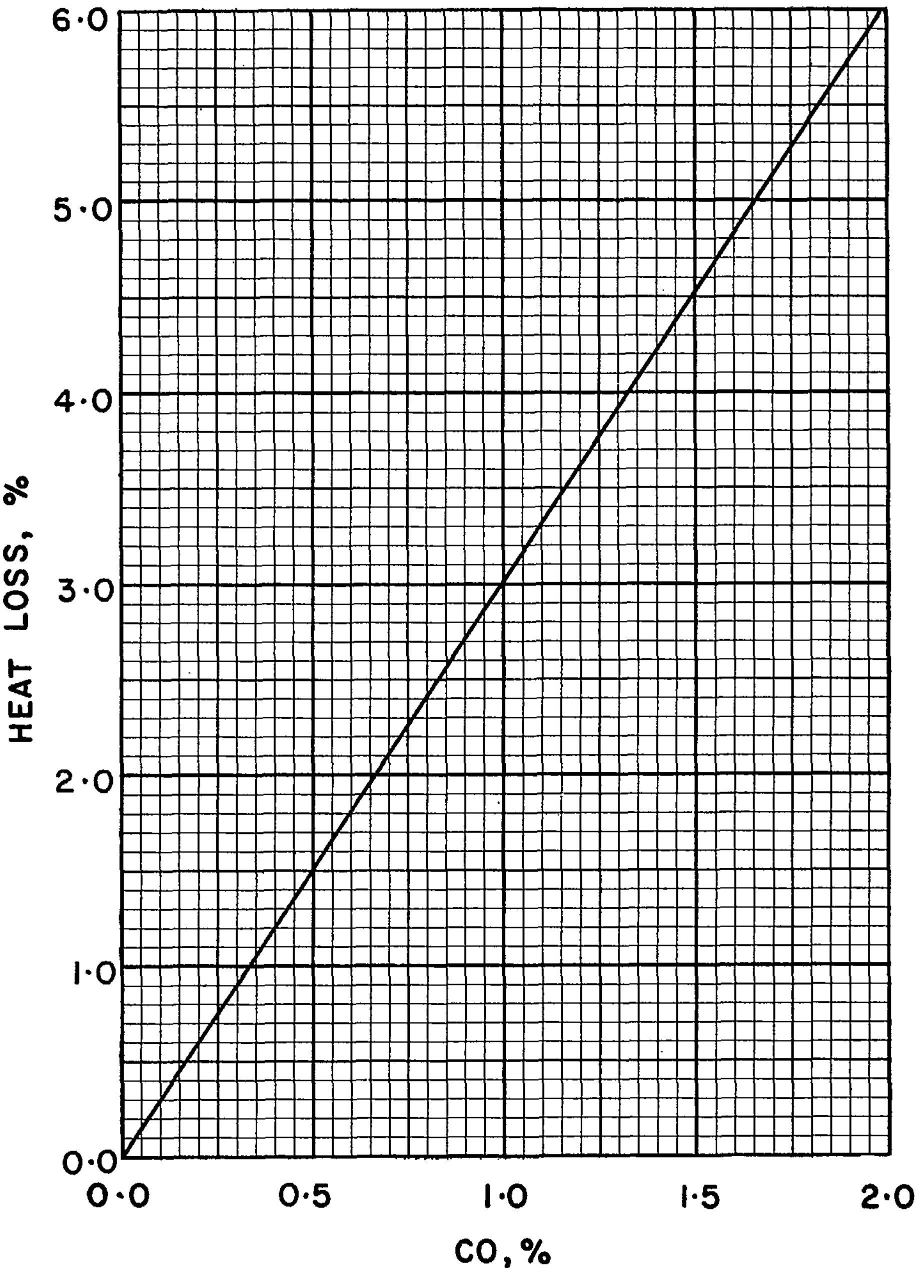


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

9720

FUEL OIL 9730, SPECIFIC GRAVITY 0.970

Ultimate Analysis, lb/lb

Carbon	(C)	0.8589
Hydrogen	(H_2)	0.1111
Sulphur	(S)	0.0300
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,320

Conversion Factors

1 Imp gal oil = 9.70 lb oil
or Imp gal oil × 9.70 = lb oil
or lb oil × 0.1031 = Imp gal oil

1 U.S. gal oil = 9.70 × 0.8337 lb oil
or U.S. gal oil × 8.087 = lb oil
or lb oil × 0.1237 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}320} \text{ lb oil}$$

or Btu × 10^6 × 54.58 = lb oil
or lb oil × 0.0183 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}320 \times 9.70} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.627 = Imp gal oil
or Imp gal oil × 0.1777 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}320 \times 8.087} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.748 = U.S. gal oil
or U.S. gal oil × 0.1482 = Btu × 10^6

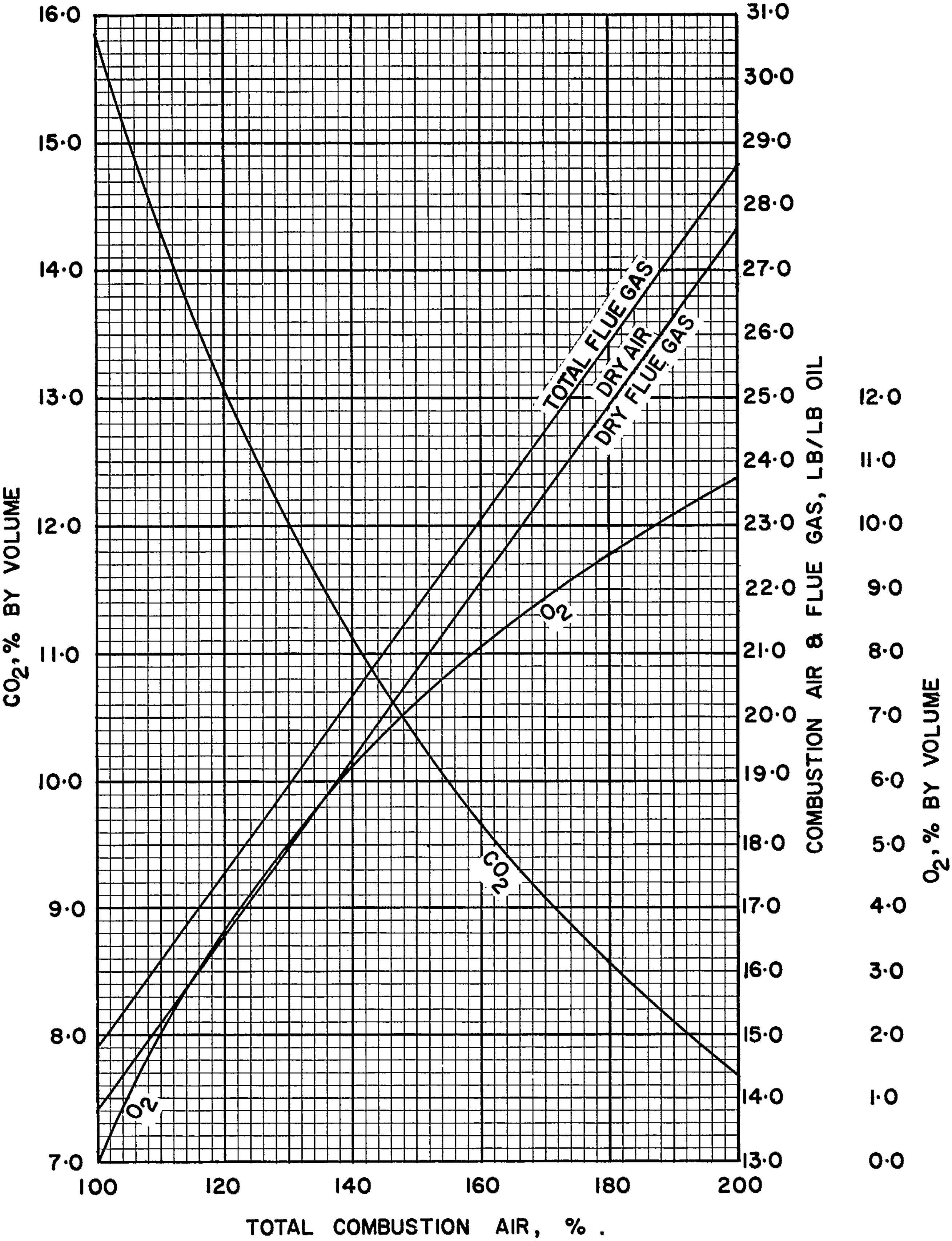


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS.

9730

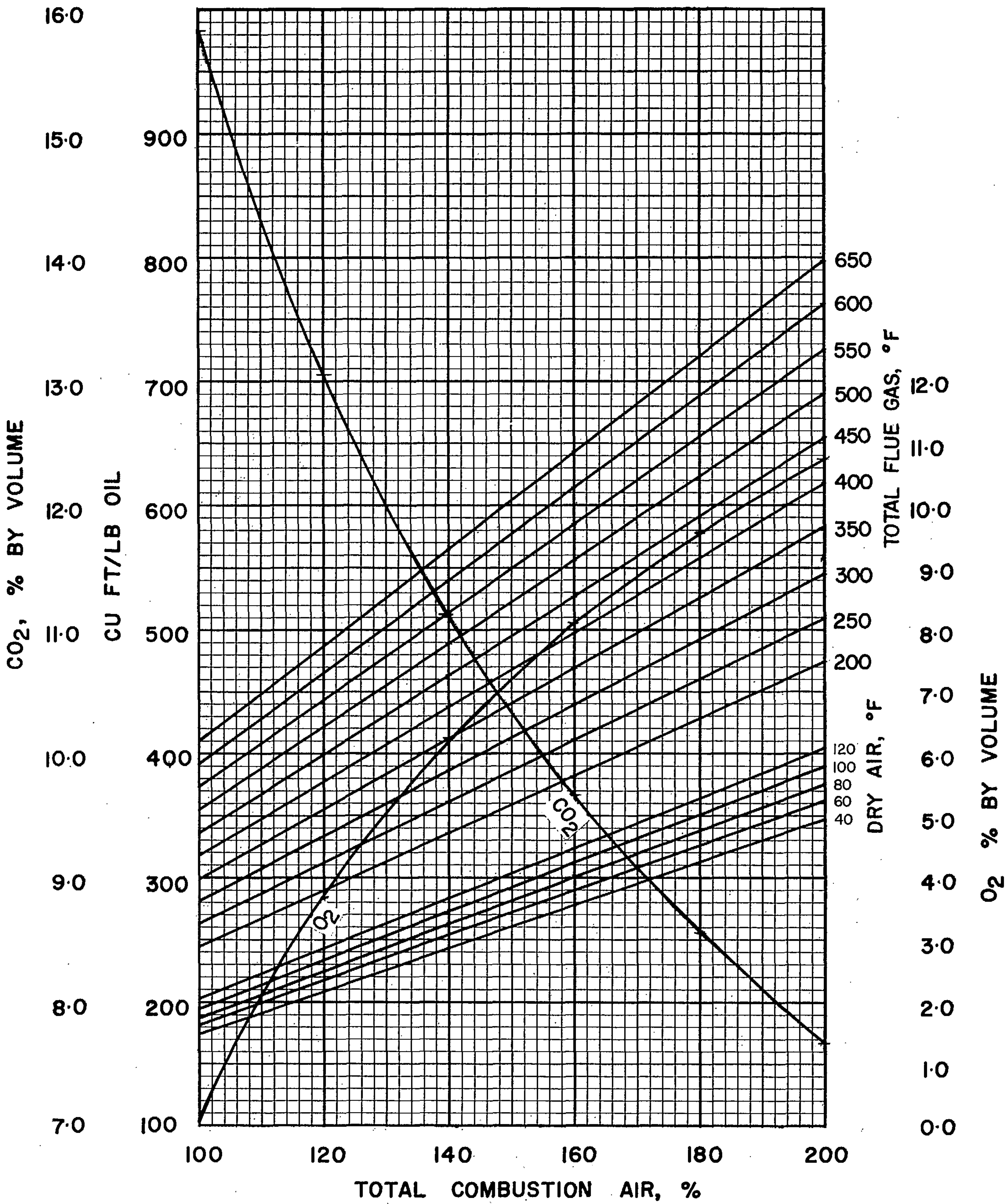


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 9730

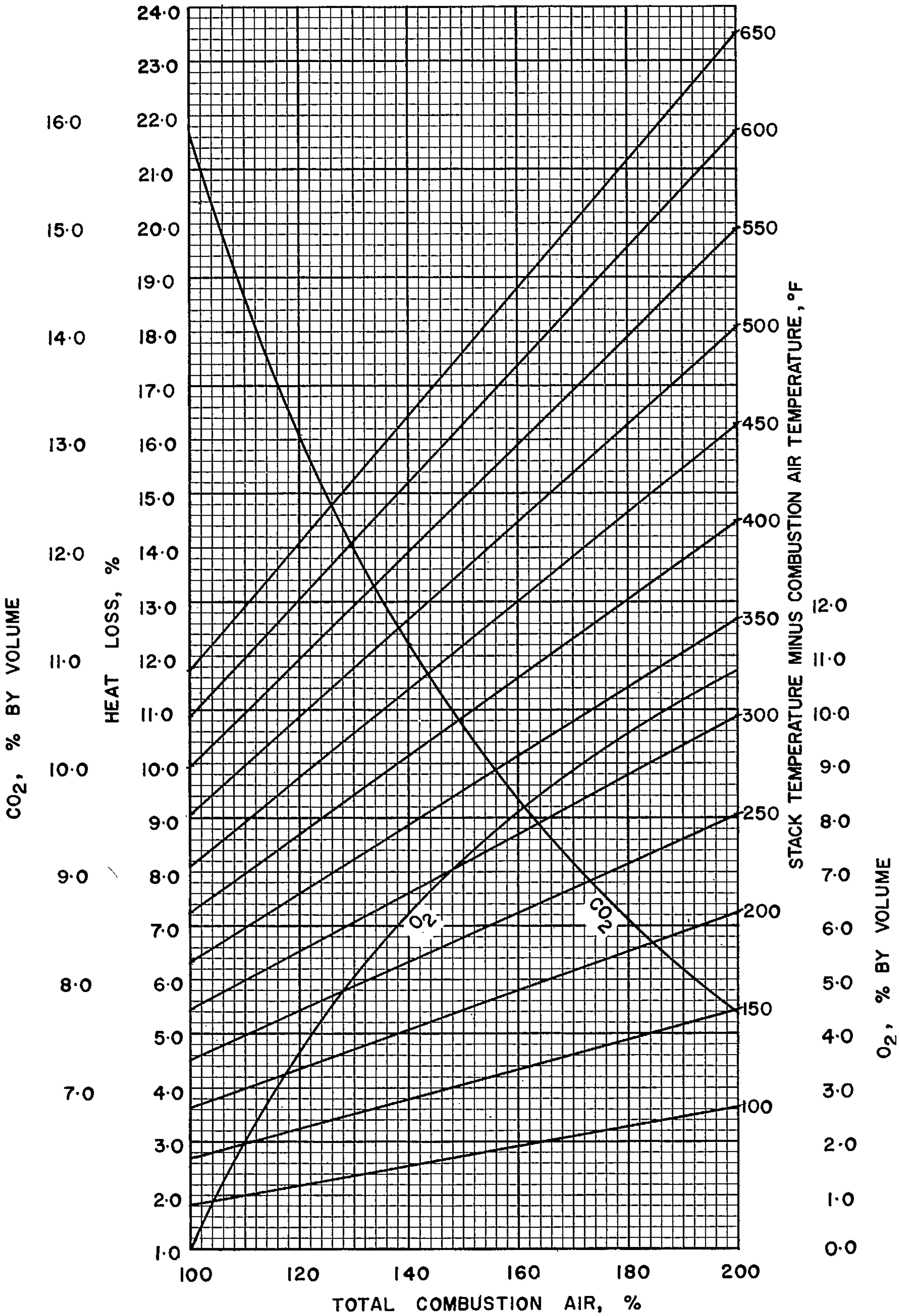


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

9730

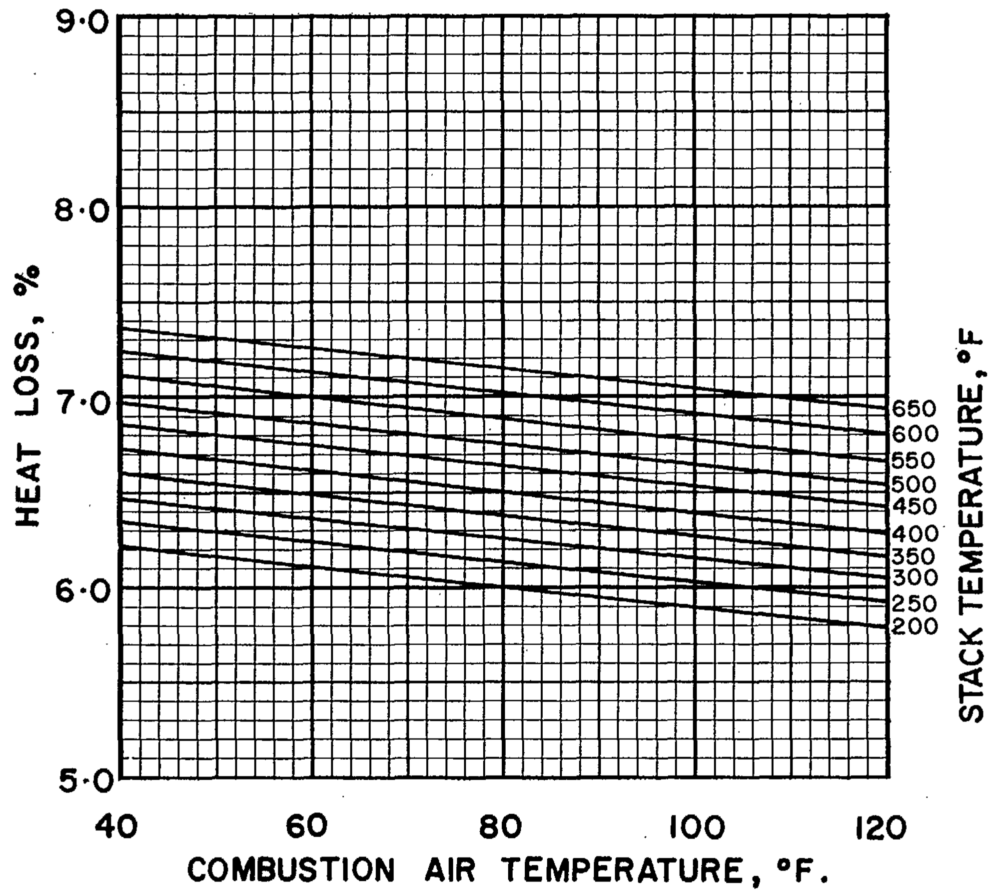


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

9730

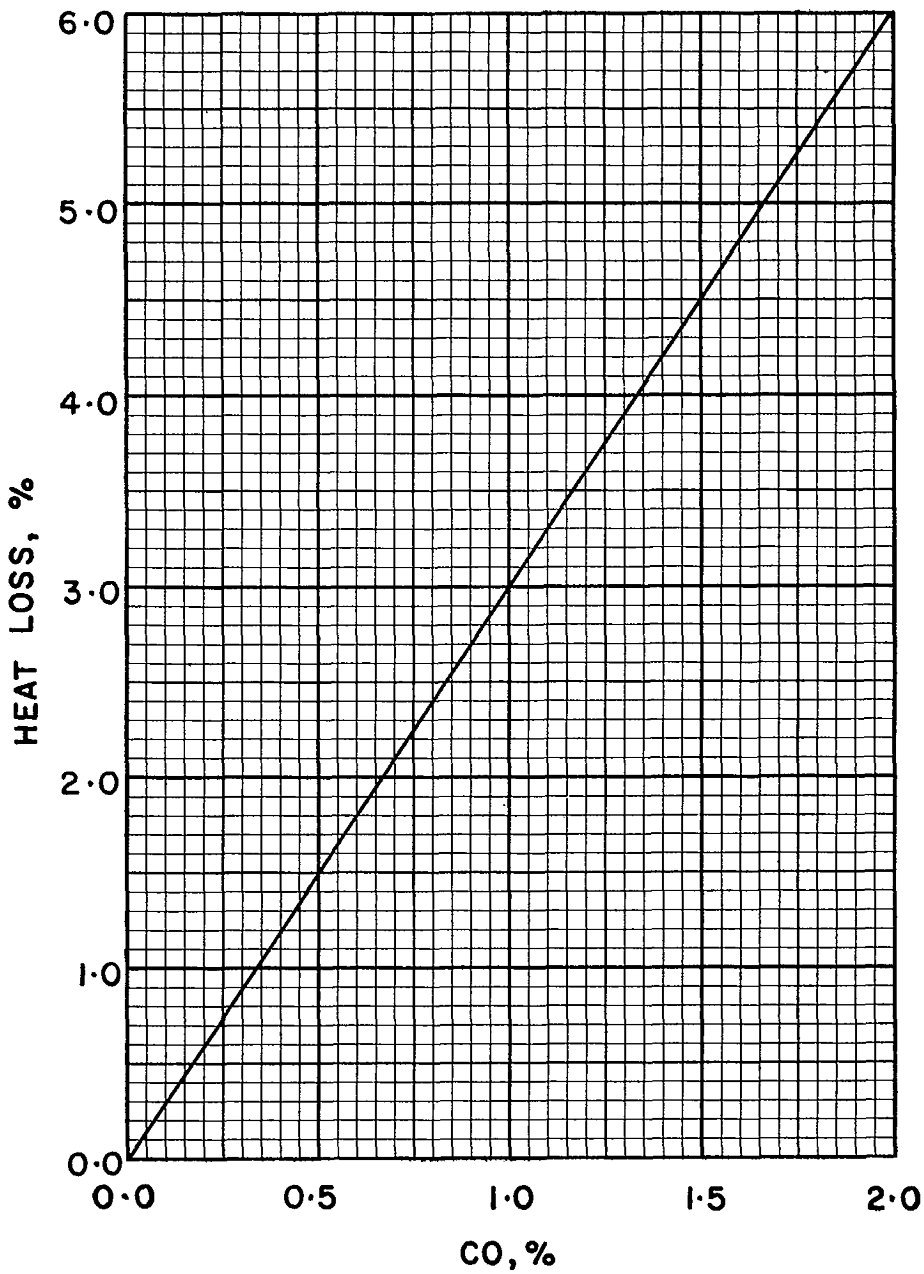


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

9730

FUEL OIL 9740, SPECIFIC GRAVITY 0.970

Ultimate Analysis, lb/lb

Carbon	(C)	0.8501
Hydrogen	(H_2)	0.1099
Sulphur	(S)	0.0400
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,170

Conversion Factors

1 Imp gal oil = 9.70 lb oil
or Imp gal oil × 9.70 = lb oil
or lb oil × 0.1031 = Imp gal oil

1 U.S. gal oil = 9.70 × 0.8337 lb oil
or U.S. gal oil × 8.087 = lb oil
or lb oil × 0.1237 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}170} \text{ lb oil}$$

or Btu × 10^6 × 55.04 = lb oil
or lb oil × 0.0182 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}170 \times 9.70} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.674 = Imp gal oil
or Imp gal oil × 0.1762 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}170 \times 8.087} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.807 = U.S. gal oil
or U.S. gal oil × 0.1469 = Btu × 10^6

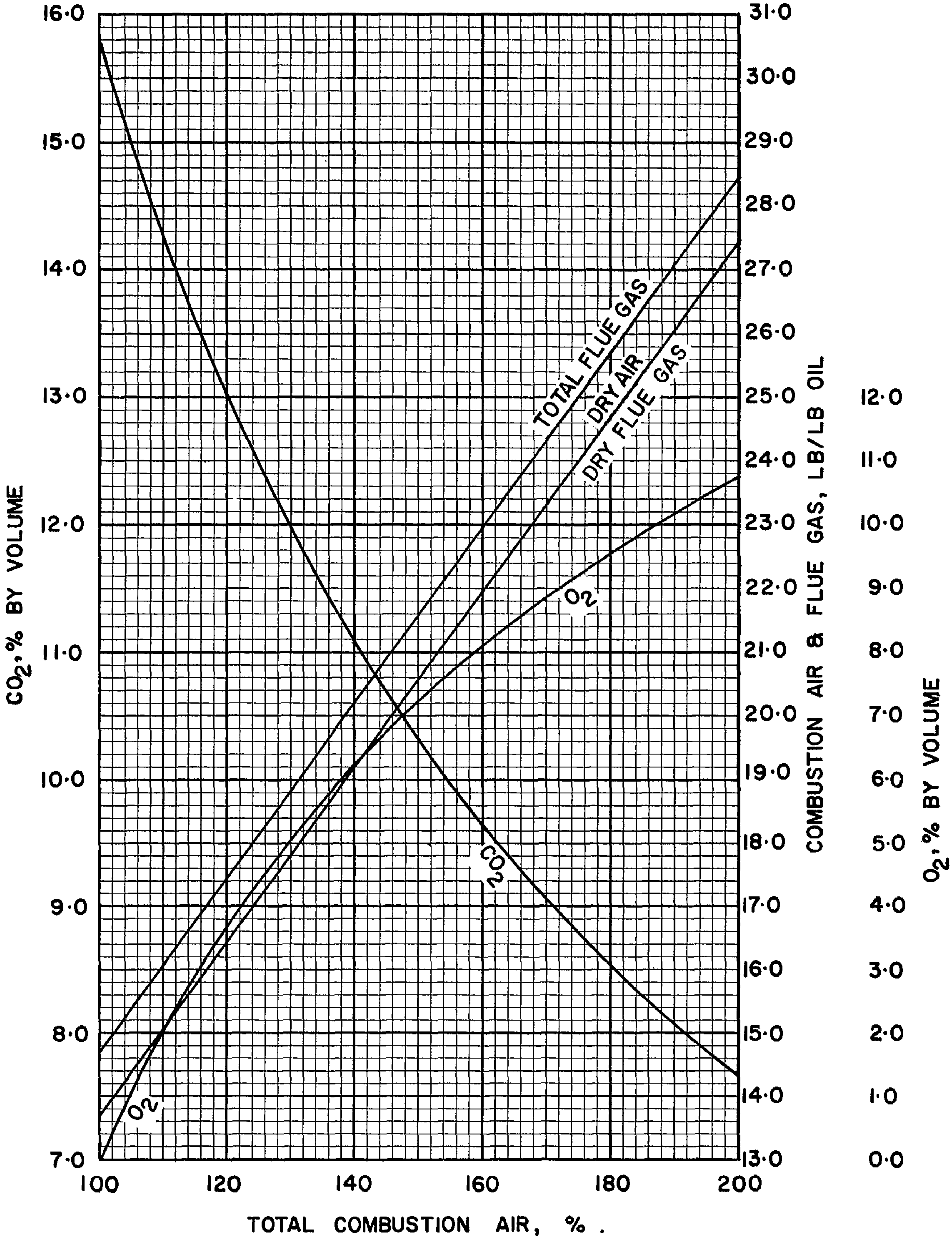


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS.

9740

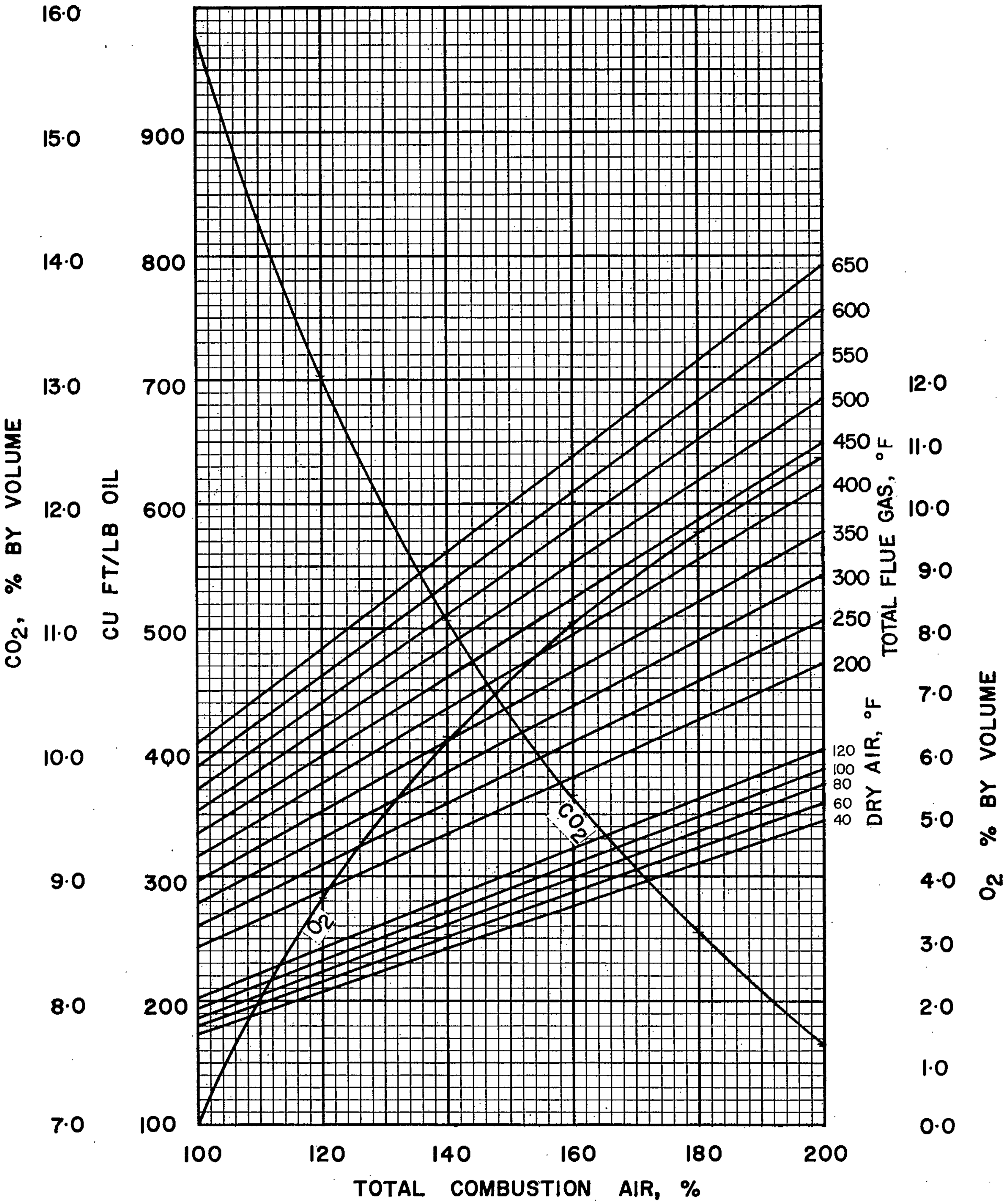


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 9740

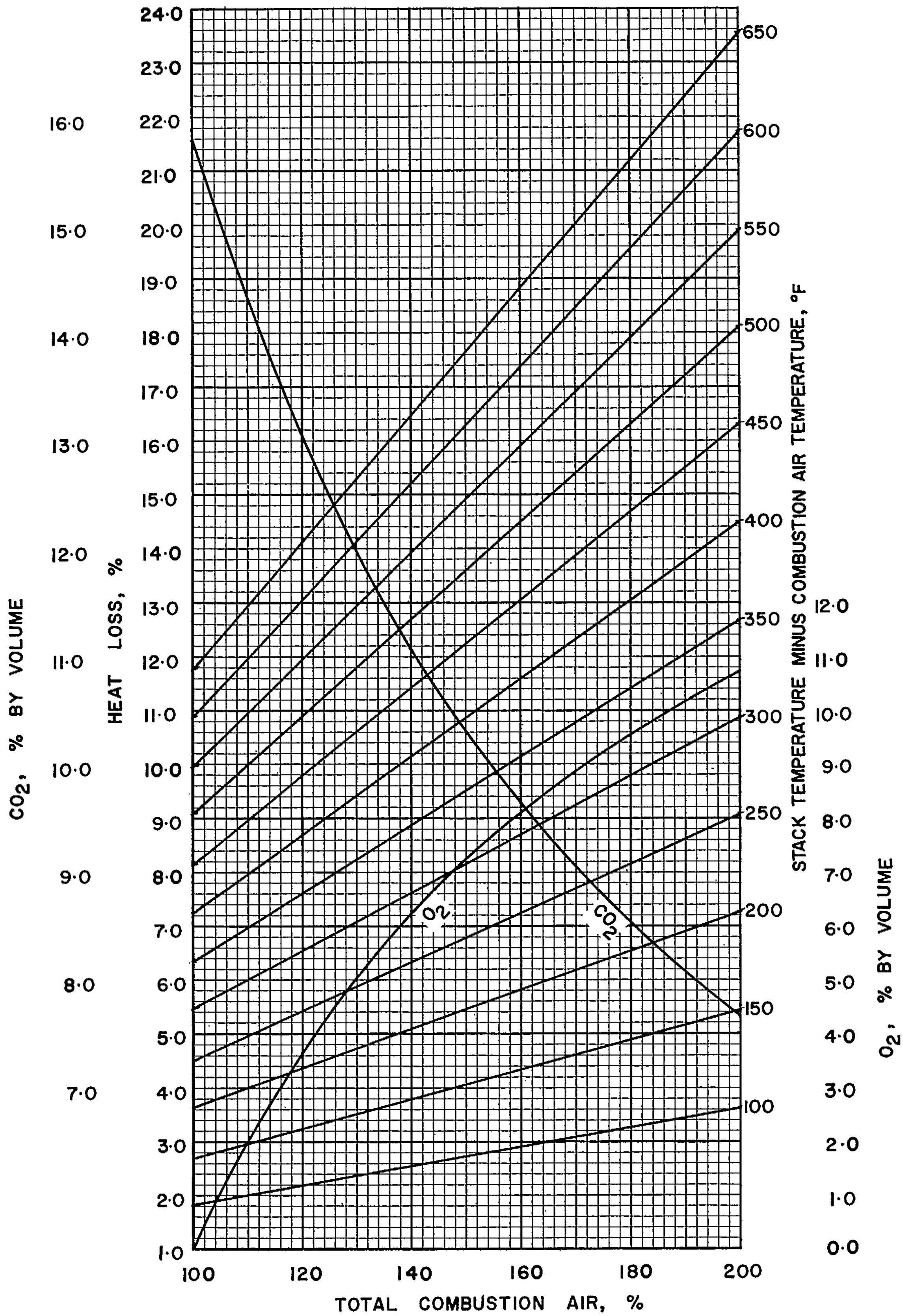


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

9740

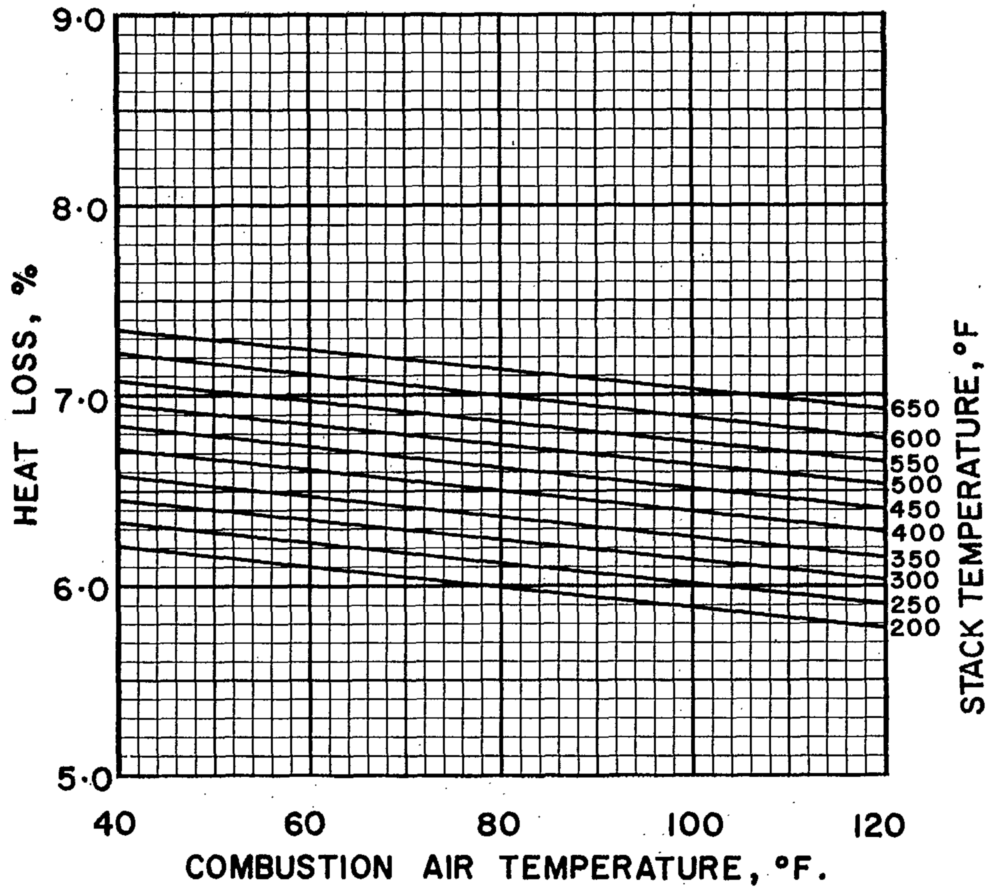


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

9740

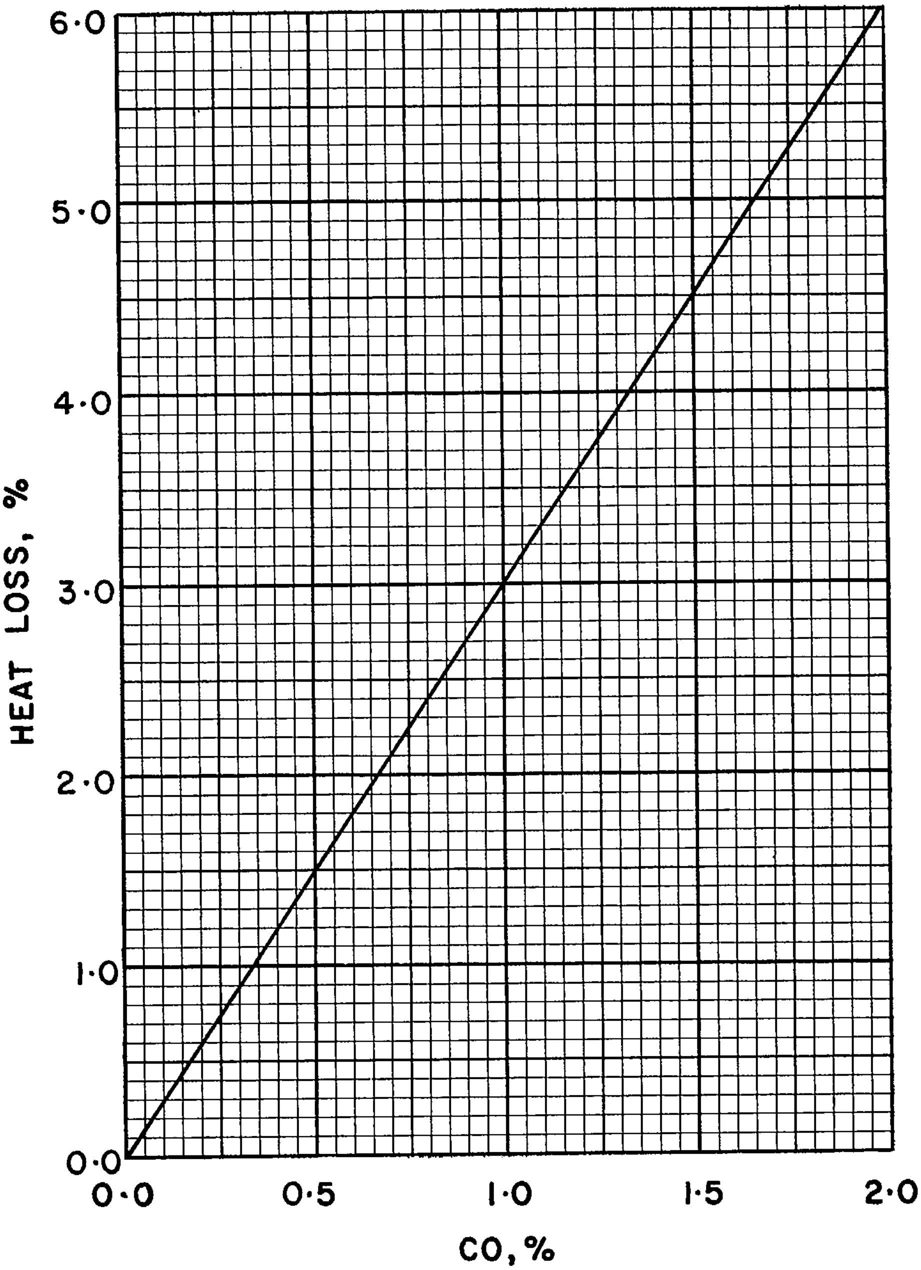


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

9740

FUEL OIL 9800, SPECIFIC GRAVITY 0.980

Ultimate Analysis, lb/lb

Carbon	(C)	0.8870
Hydrogen	(H_2)	0.1130
Sulphur	(S)	–
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,690

Conversion Factors

1 Imp gal oil = 9.80 lb oil
or Imp gal oil × 9.80 lb oil
or lb oil × 0.1020 = Imp gal oil

1 U.S. gal oil = 9.80 × 0.8337 lb oil
or U.S. gal oil × 8.170 = lb oil
or lb oil × 0.1224 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}690} \text{ lb oil}$$

or Btu × 10^6 × 53.51 = lb oil
or lb oil × 0.0187 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}690 \times 9.80} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.460 = Imp gal oil
or Imp gal oil × 0.1832 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}690 \times 8.170} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.549 = U.S. gal oil
or U.S. gal oil × 0.1527 = Btu × 10^6

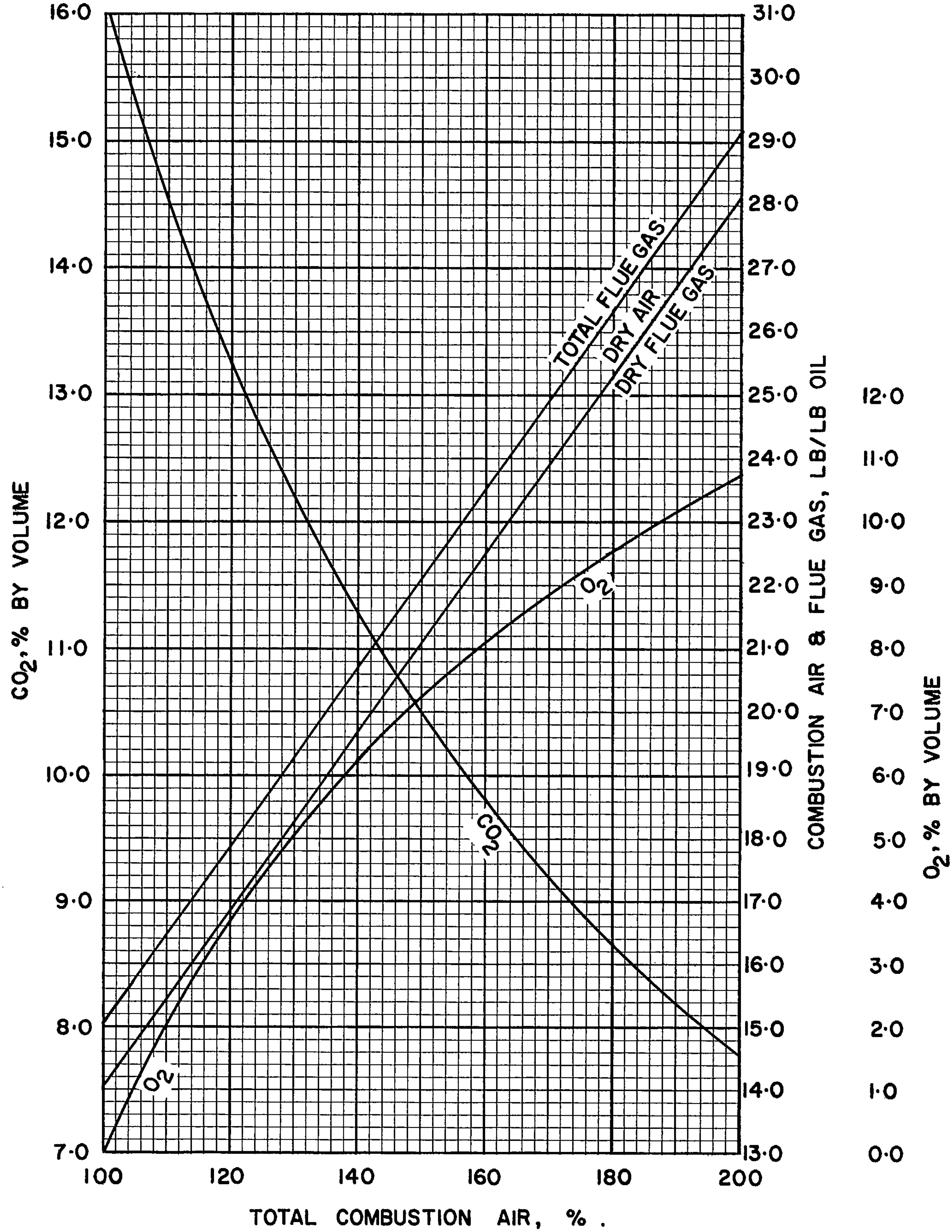


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS.

9800

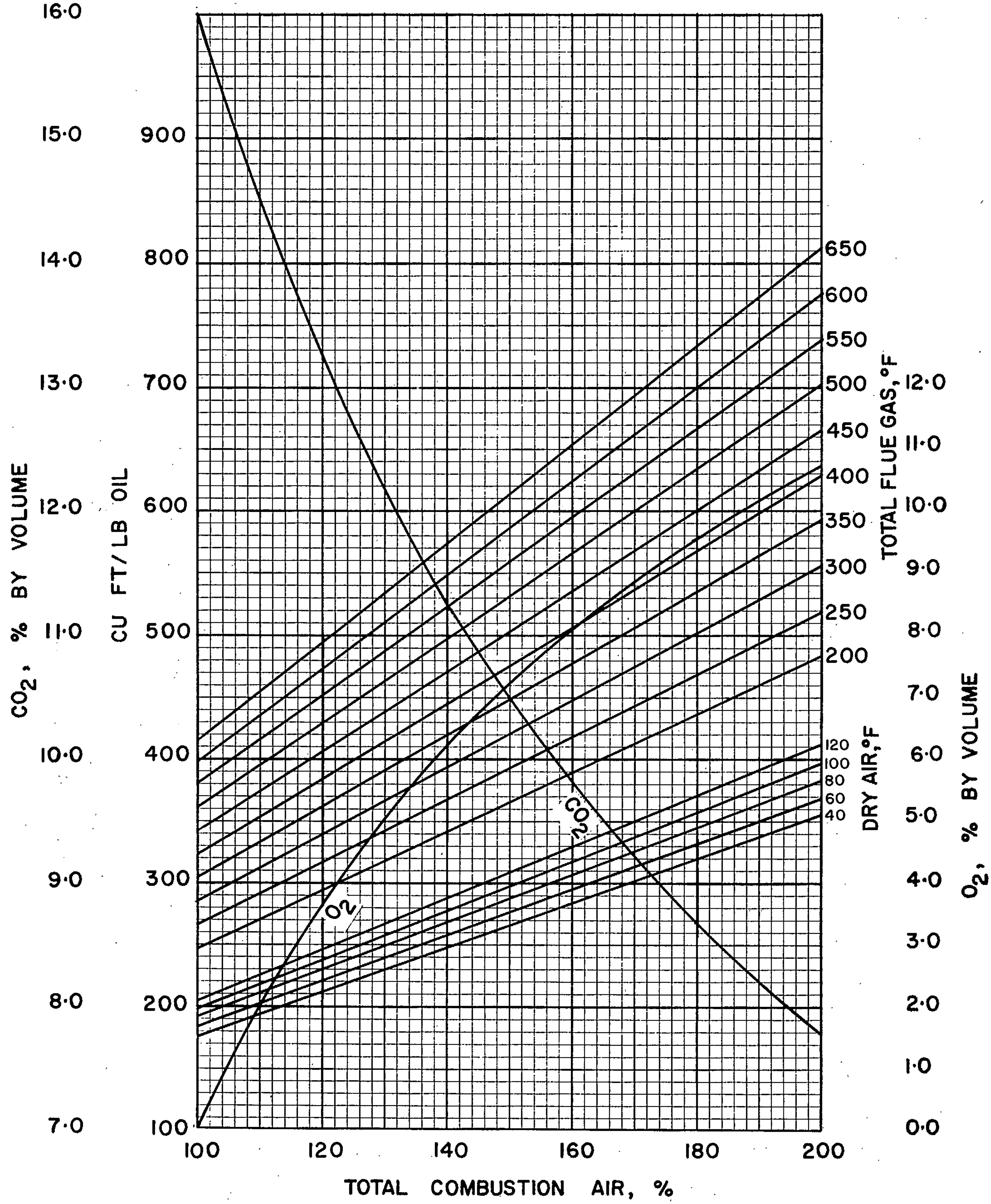


FIGURE 2. COMBUSTION DATA, VOLUME BASIS.

9800

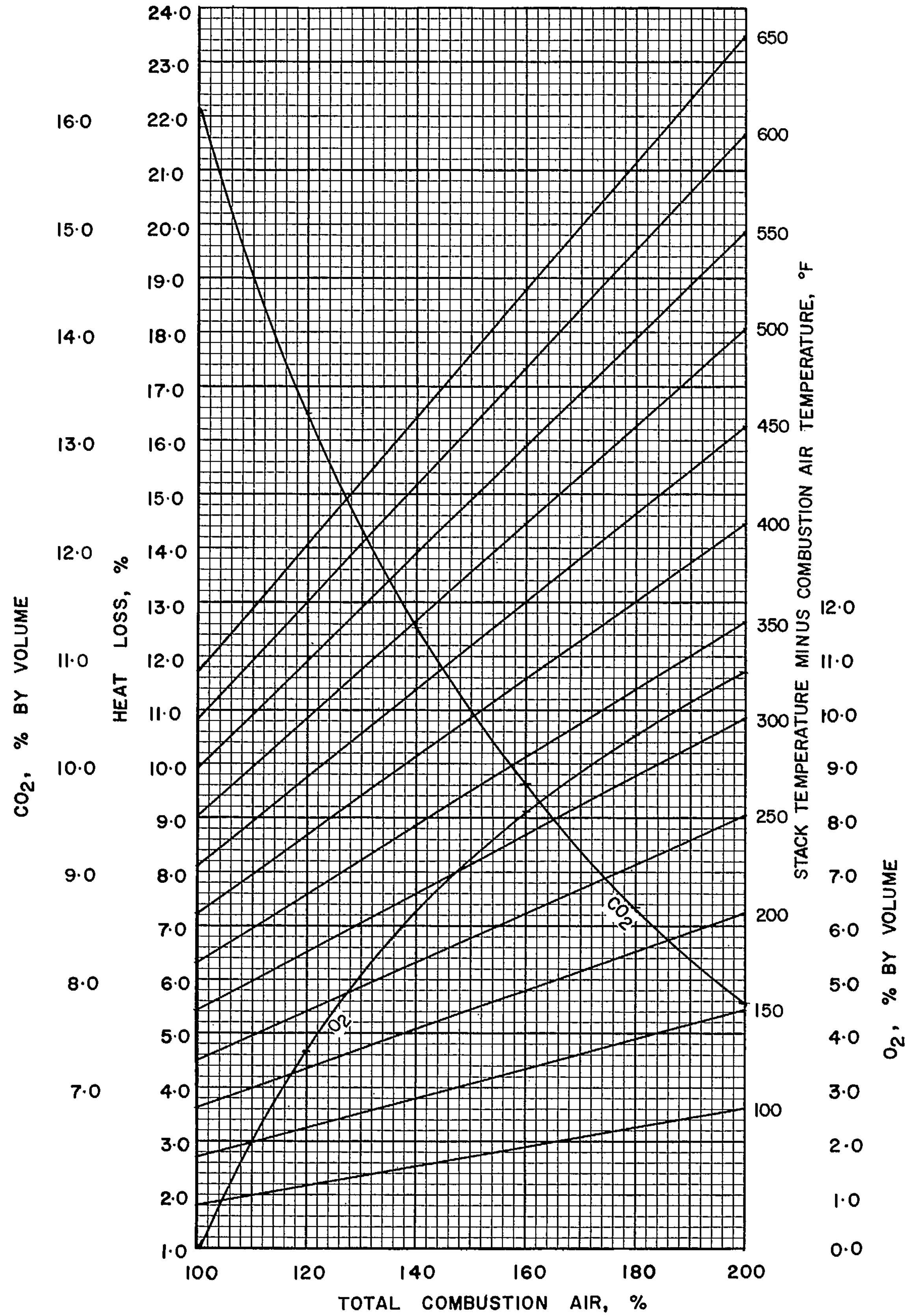


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

9800

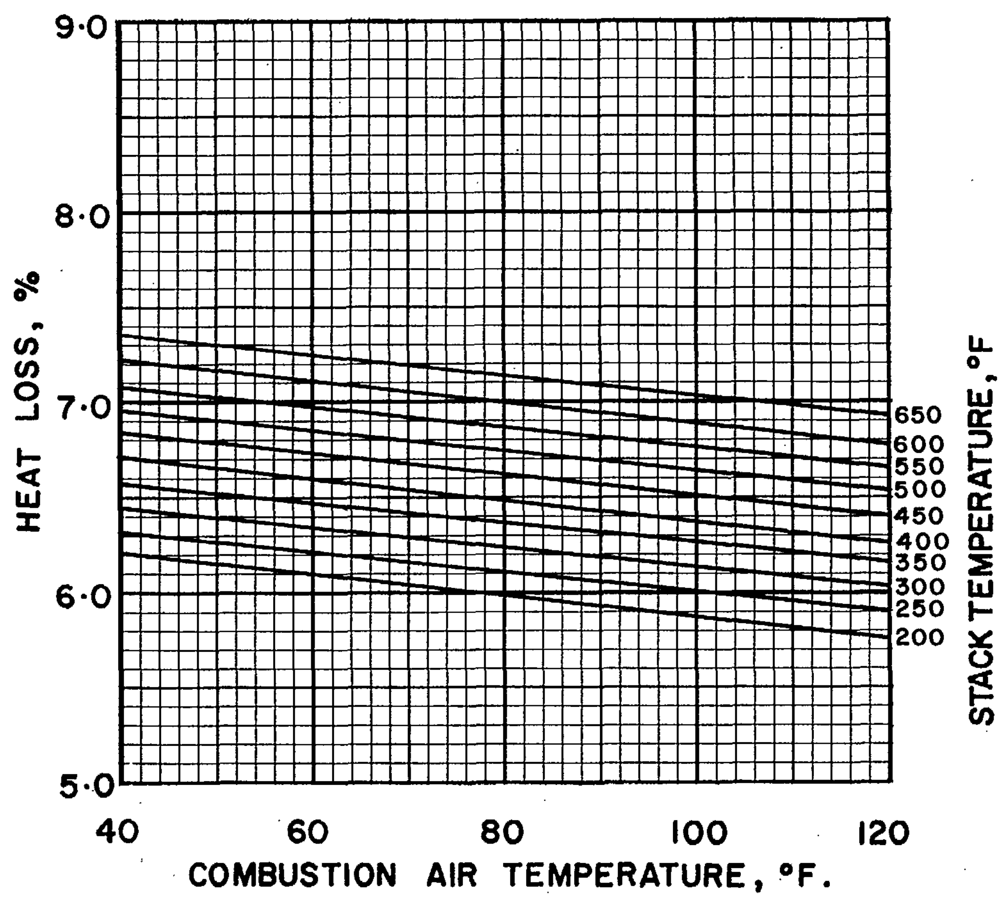


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

9800

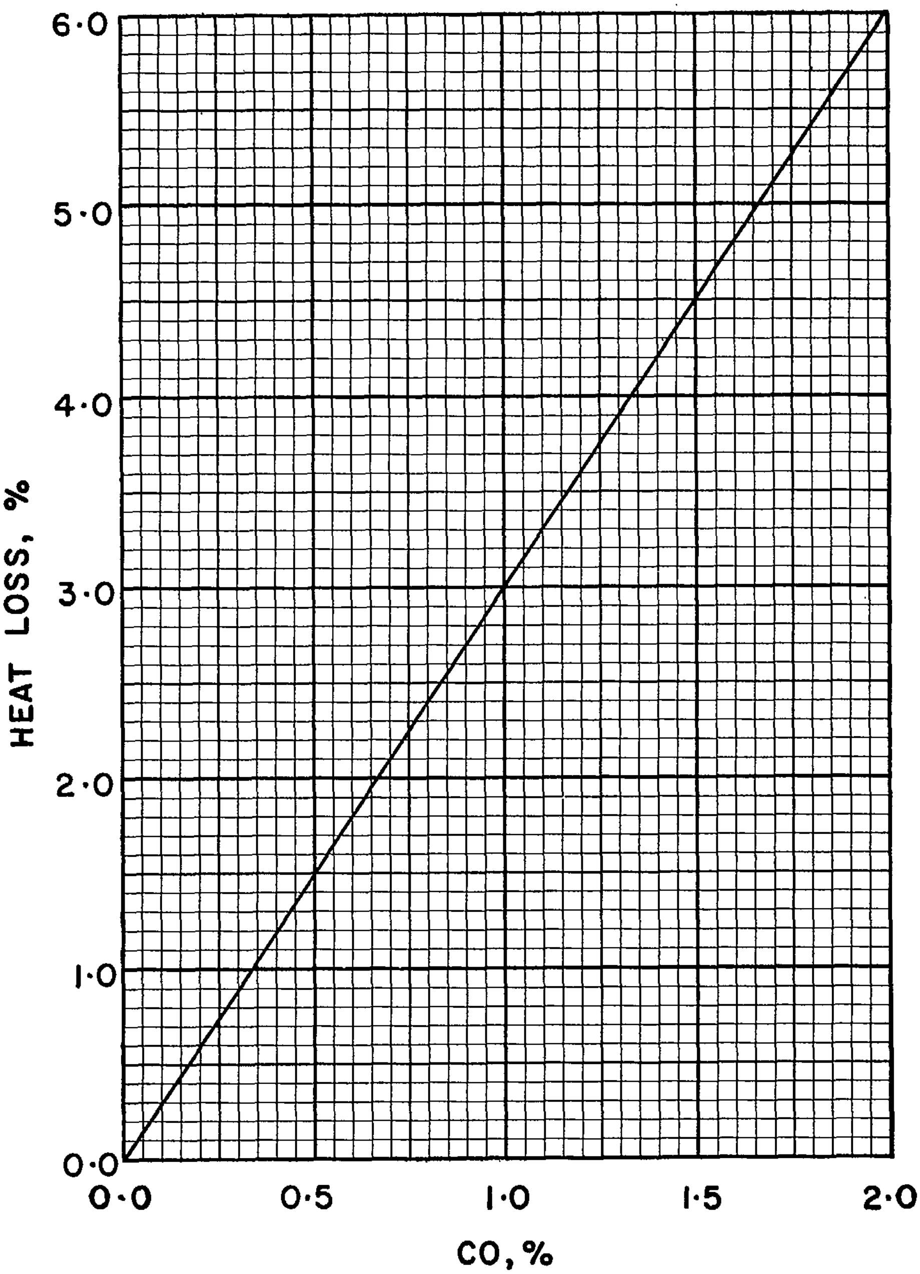


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

9800

FUEL OIL 9810, SPECIFIC GRAVITY 0.980

Ultimate Analysis, lb/lb

Carbon	(C)	0.8781
Hydrogen	(H_2)	0.1119
Sulphur	(S)	0.0100
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,540

Conversion Factors

1 Imp gal oil = 9.80 lb oil
or Imp gal oil × 9.80 = lb oil
or lb oil × 0.1020 = Imp gal oil

1 U.S. gal oil = 9.80 × 0.8337 lb oil
or U.S. gal oil × 8.170 = lb oil
or lb oil × 0.1224 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}540} \text{ lb oil}$$

or Btu × 10^6 × 53.94 = lb oil
or lb oil × 0.0185 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}540 \times 9.80} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.504 = Imp gal oil
or Imp gal oil × 0.1817 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}540 \times 8.170} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.601 = U.S. gal oil
or U.S. gal oil × 0.1515 = Btu × 10^6

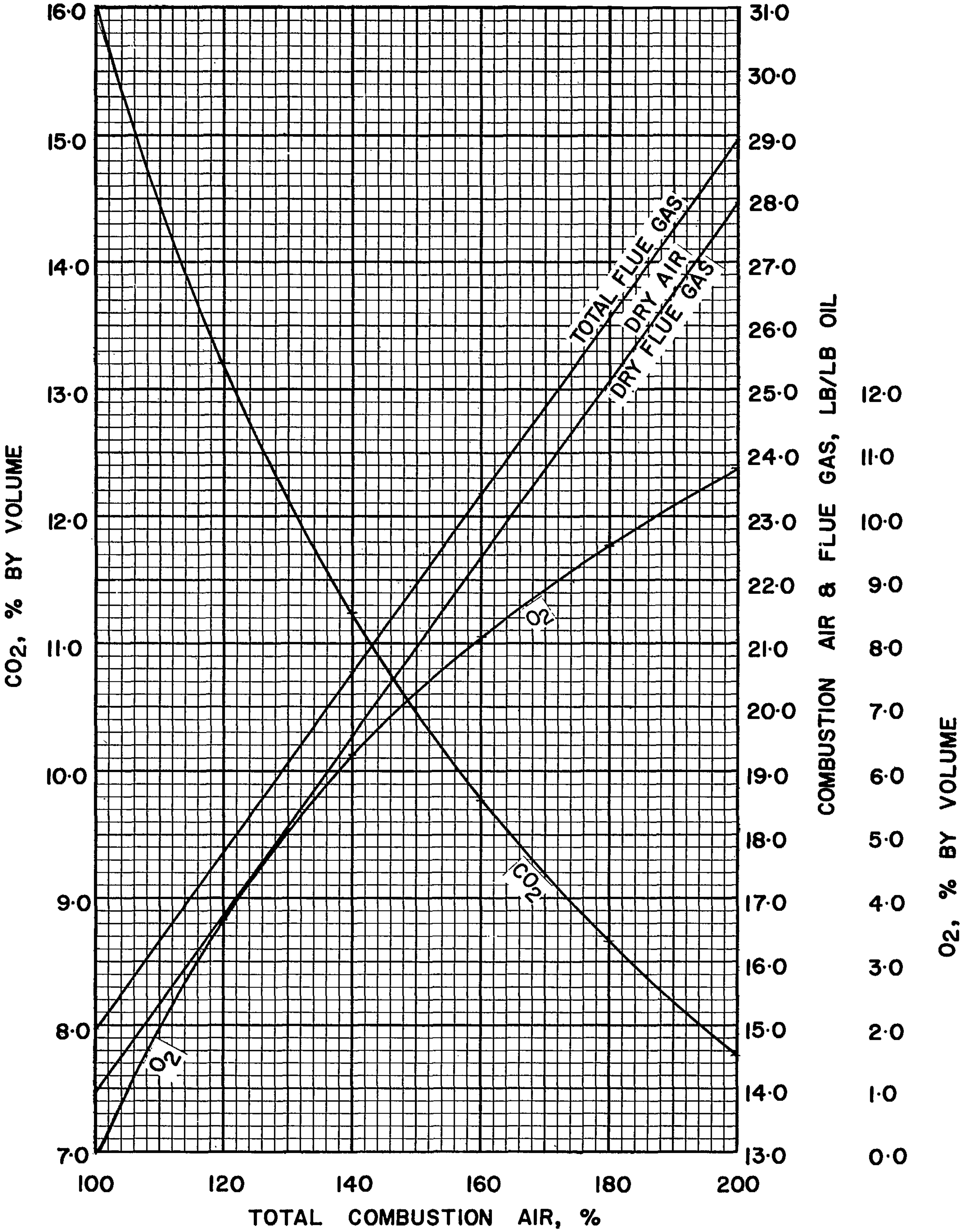


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS

9810

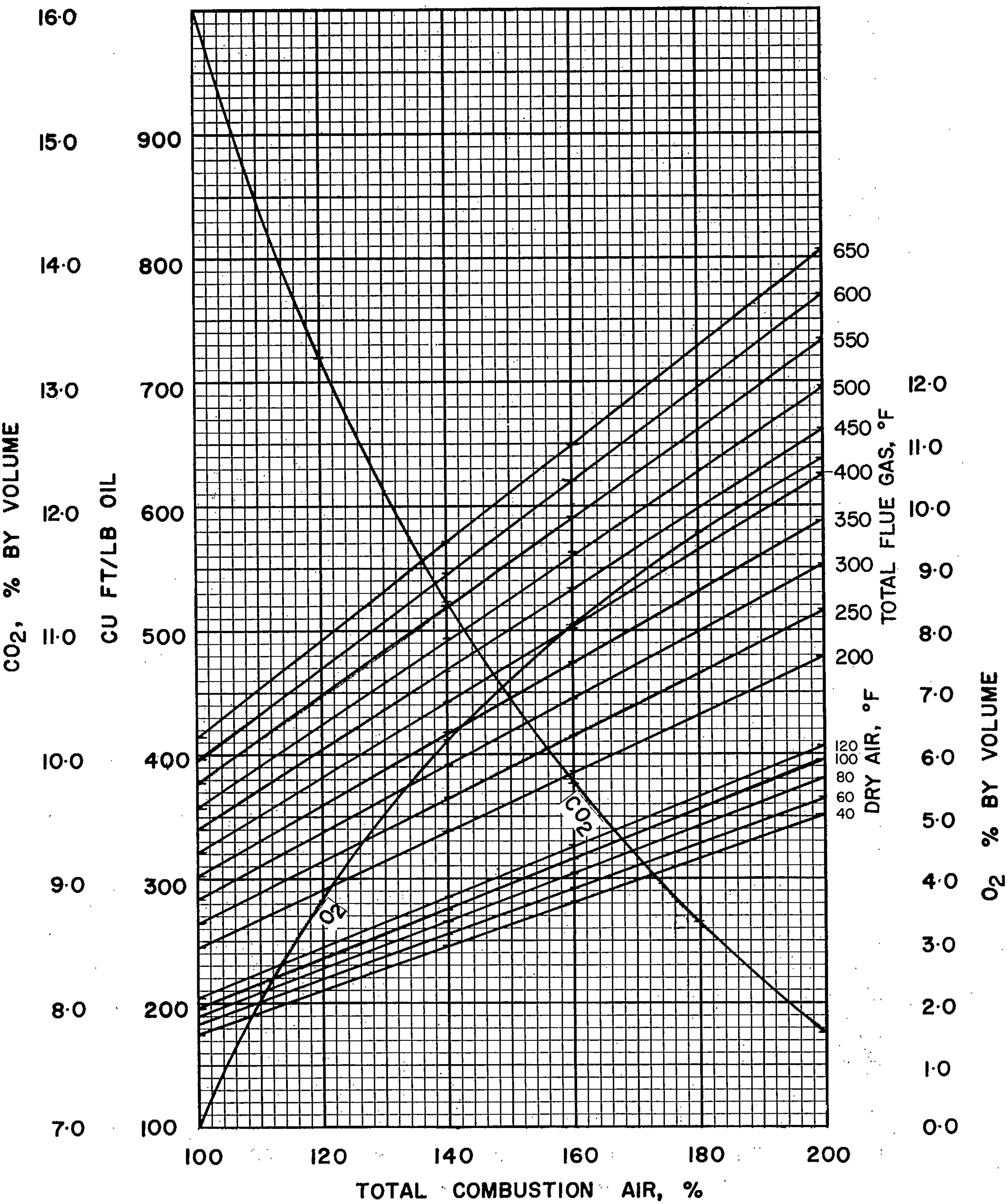


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 9810

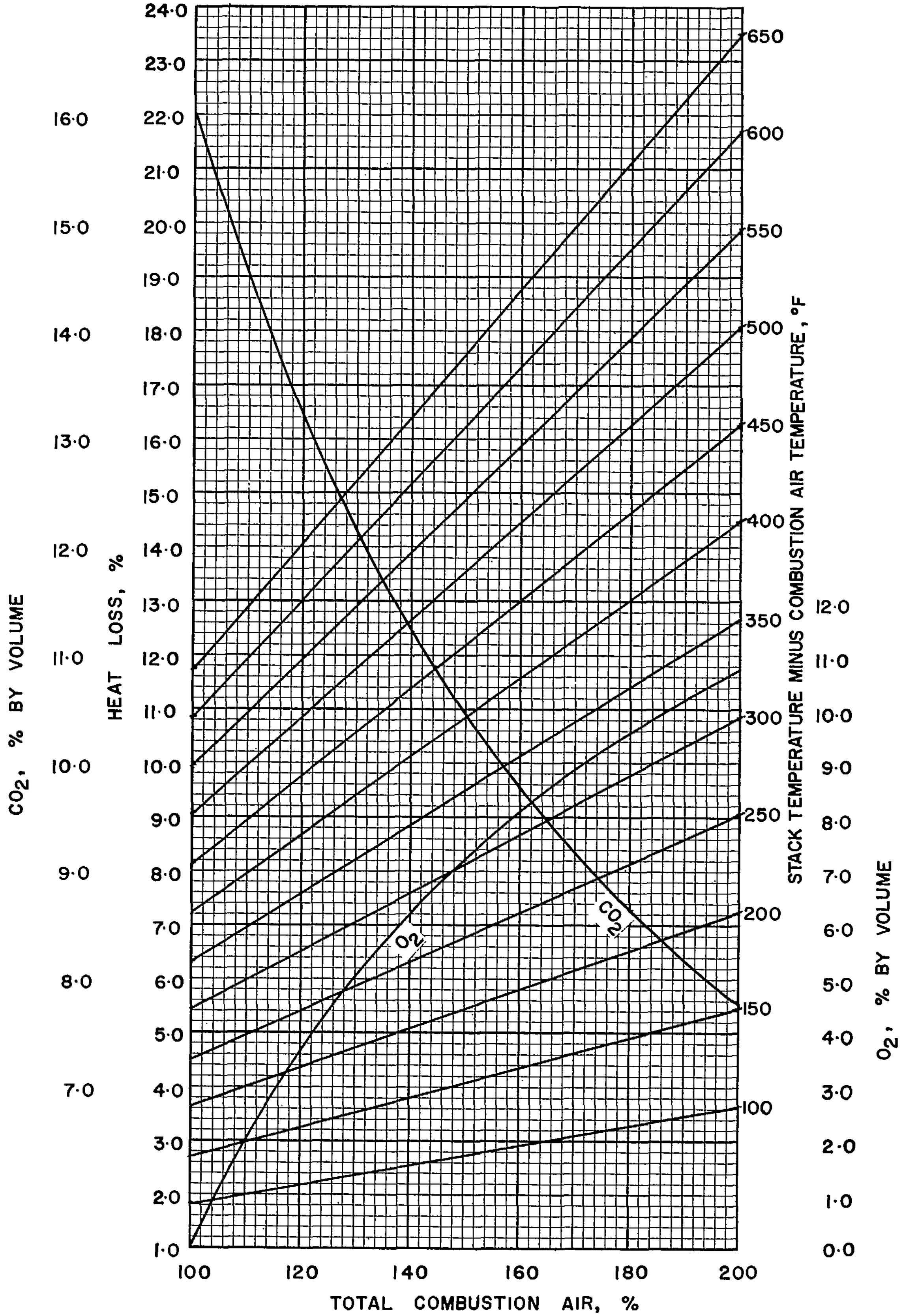


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

9810

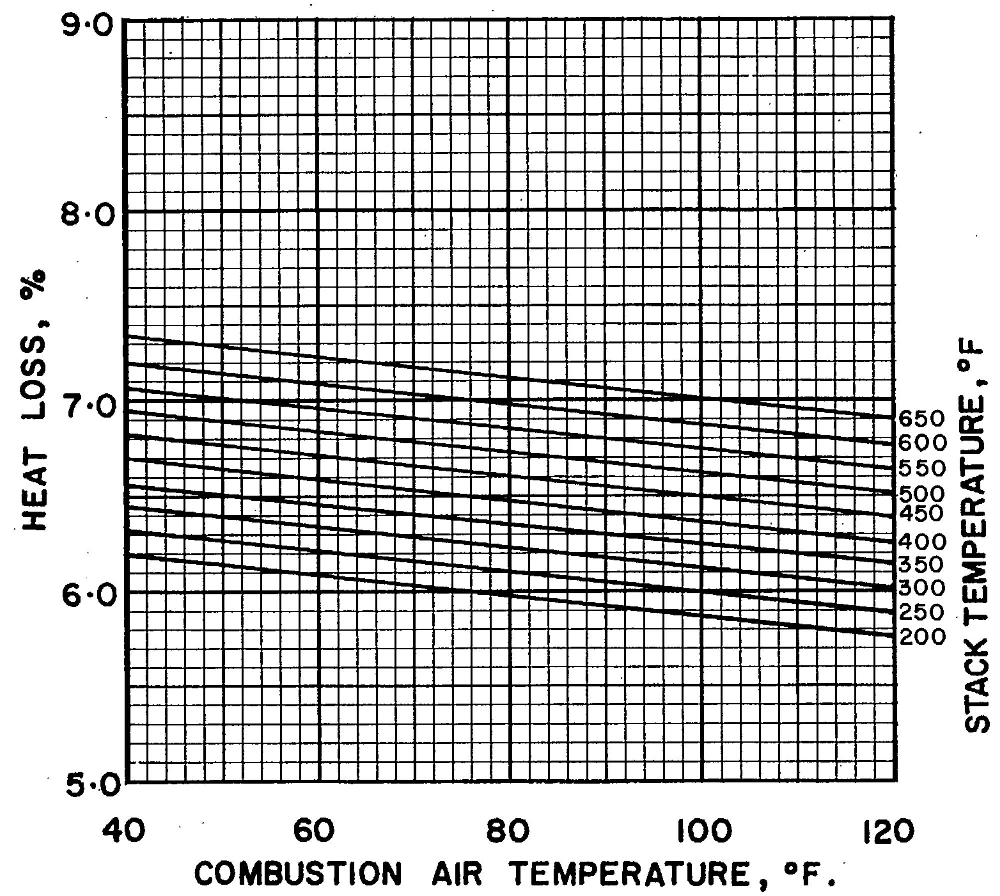


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

9810

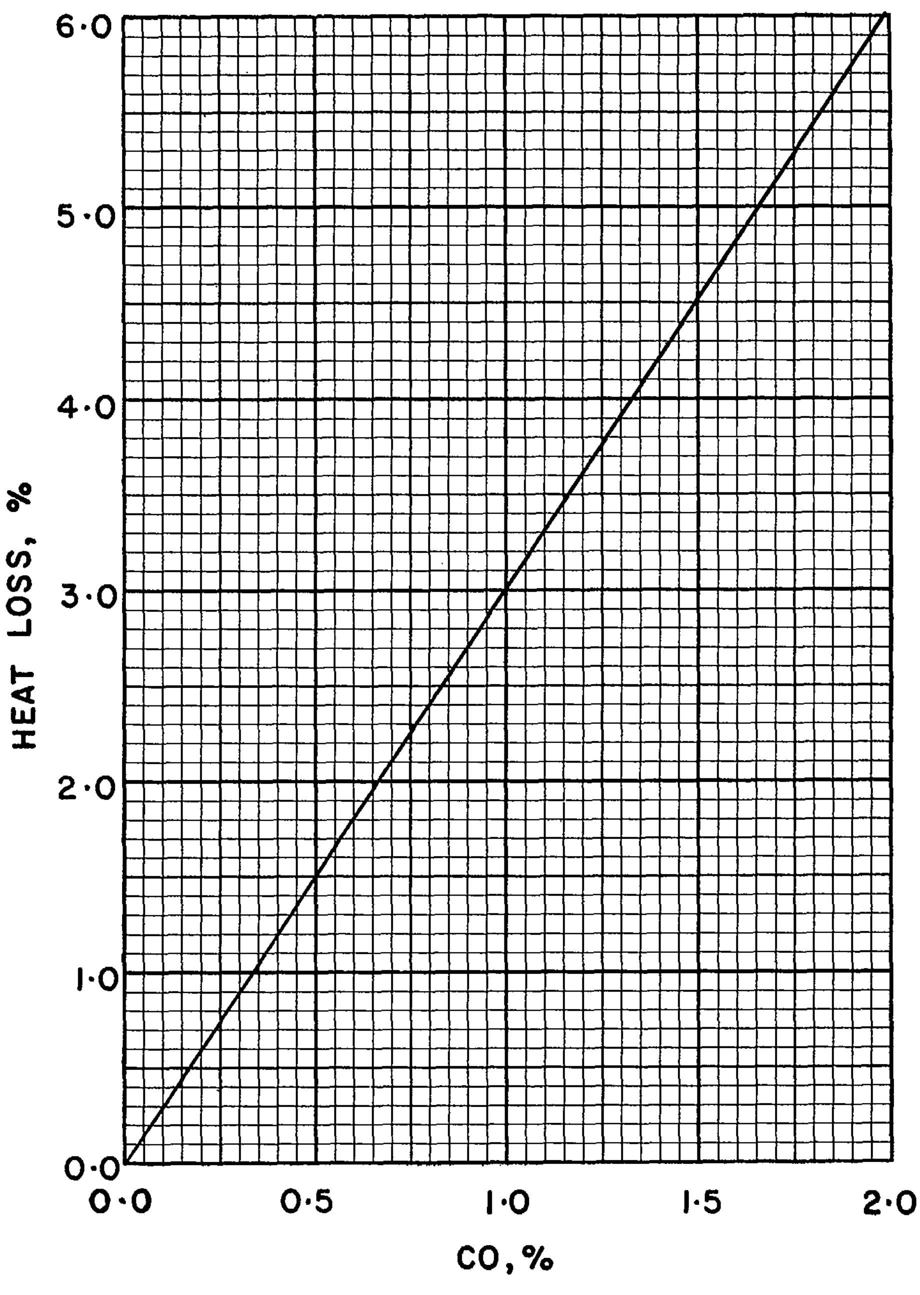


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

9810

FUEL OIL 9820, SPECIFIC GRAVITY 0.980

Ultimate Analysis, lb/lb

Carbon	(C)	0.8693
Hydrogen	(H_2)	0.1107
Sulphur	(S)	0.0200
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,400

Conversion Factors

1 Imp gal oil = 9.80 lb oil
or Imp gal oil × 9.80 = lb oil
or lb oil × 0.1020 = Imp gal oil

1 U.S. gal oil = 9.80 × 0.8337 lb oil
or U.S. gal oil × 8.170 = lb oil
or lb oil × 0.1224 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}400} \text{ lb oil}$$

or Btu × 10^6 × 54.35 = lb oil
or lb oil × 0.01840 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}400 \times 9.80} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.546 = Imp gal oil
or Imp gal oil × 0.1803 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}400 \times 8.170} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.653 = U.S. gal oil
or U.S. gal oil × 0.1503 = Btu × 10^6

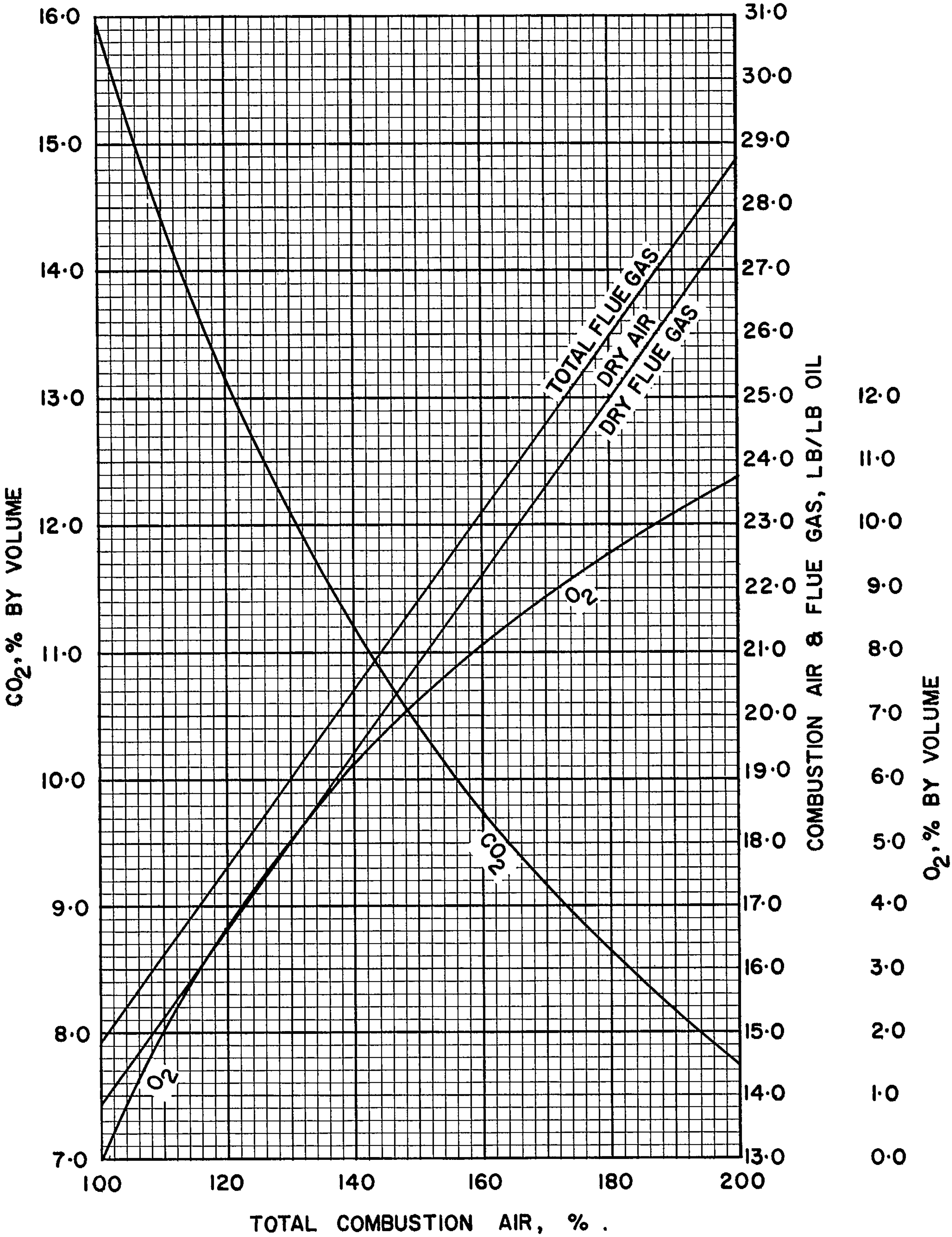


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS.

9820

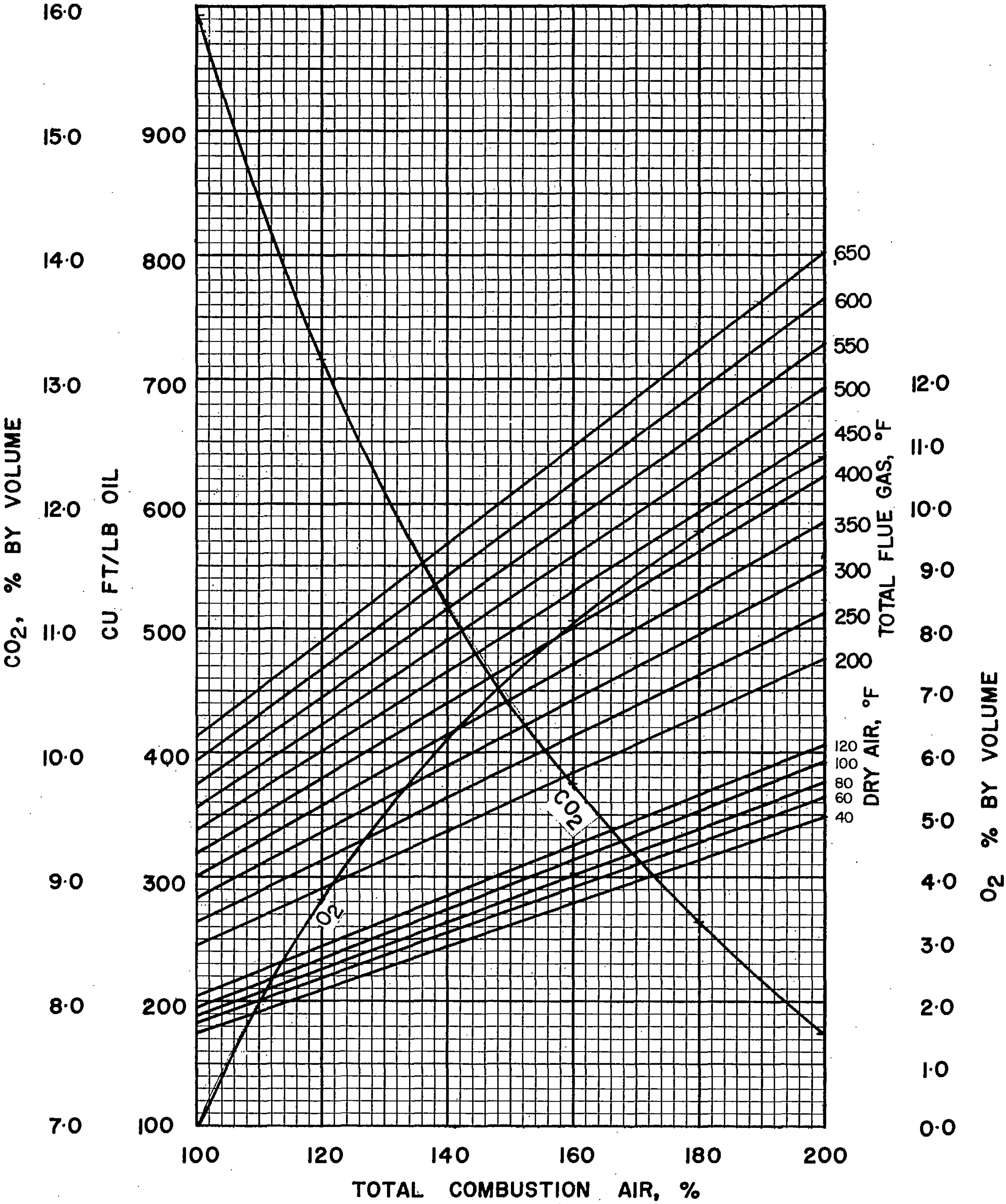


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 9820

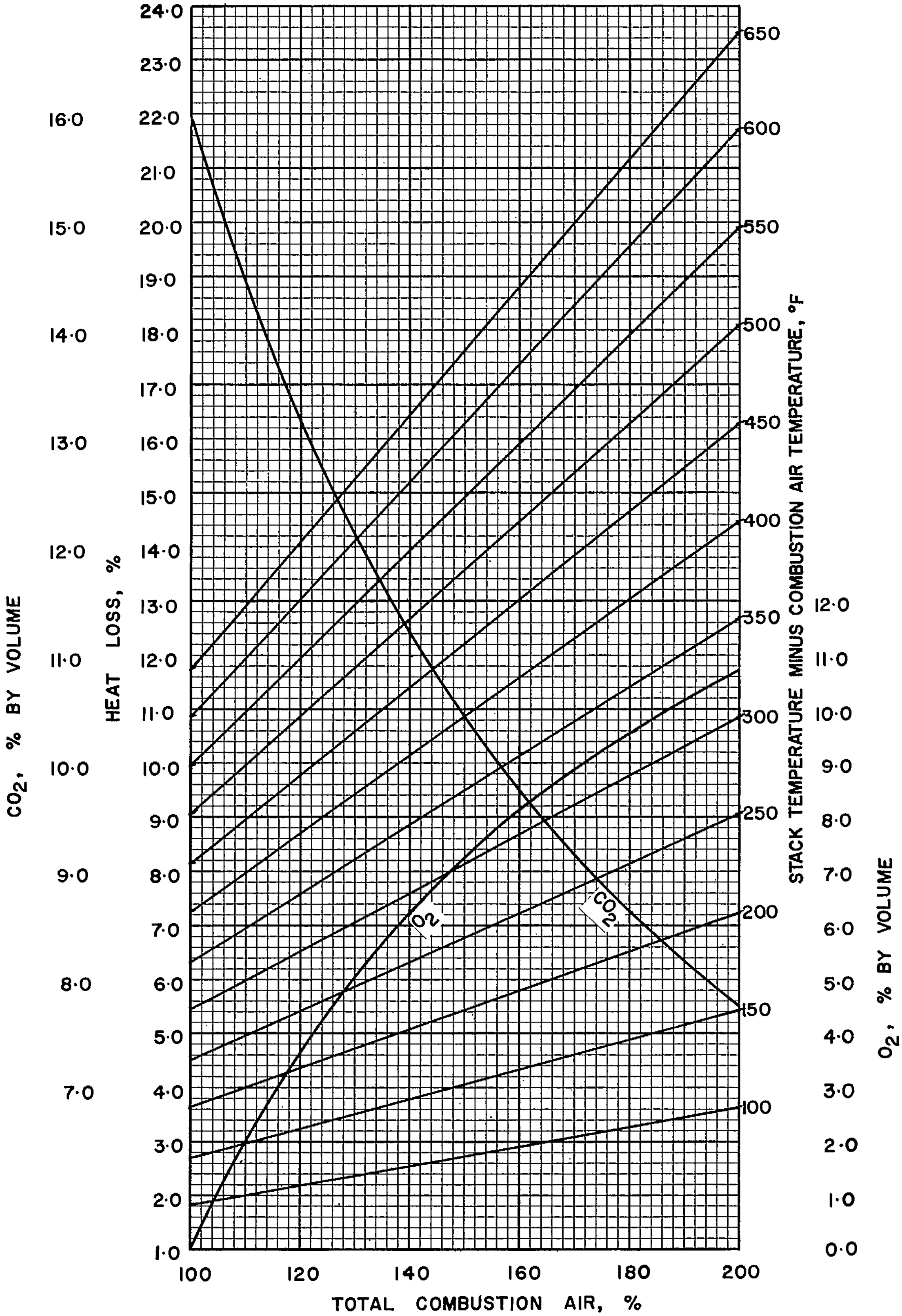


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

9820

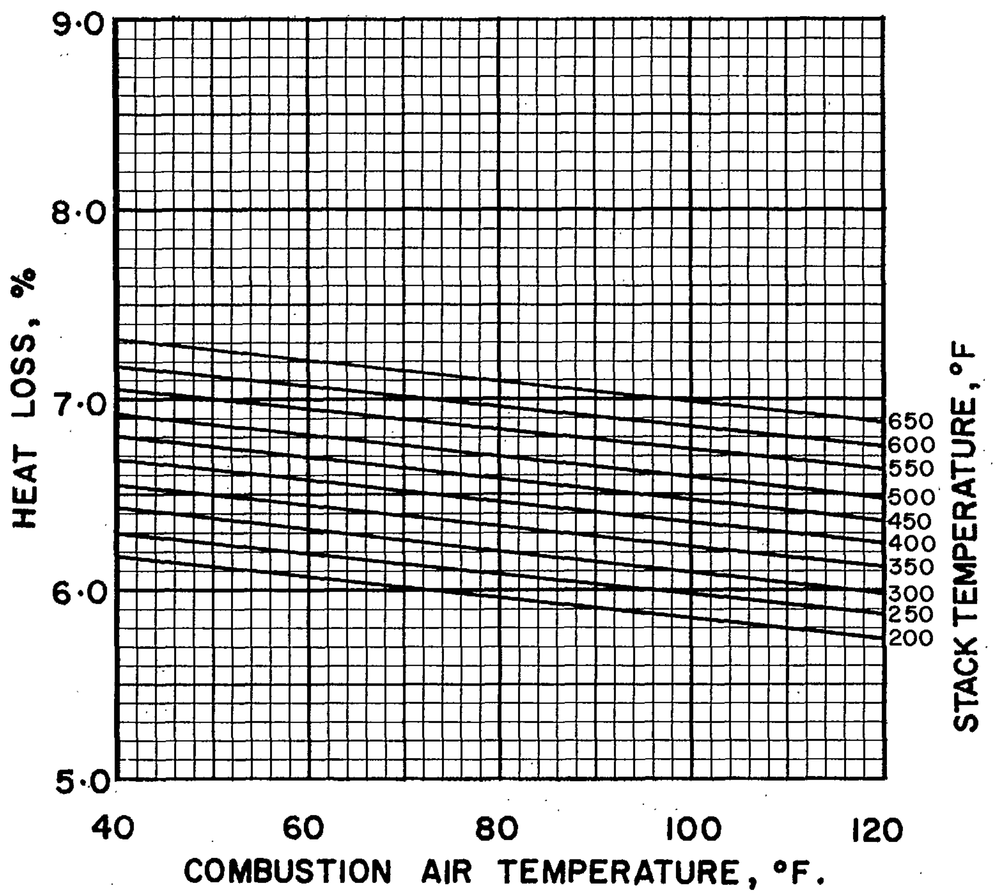


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

9820

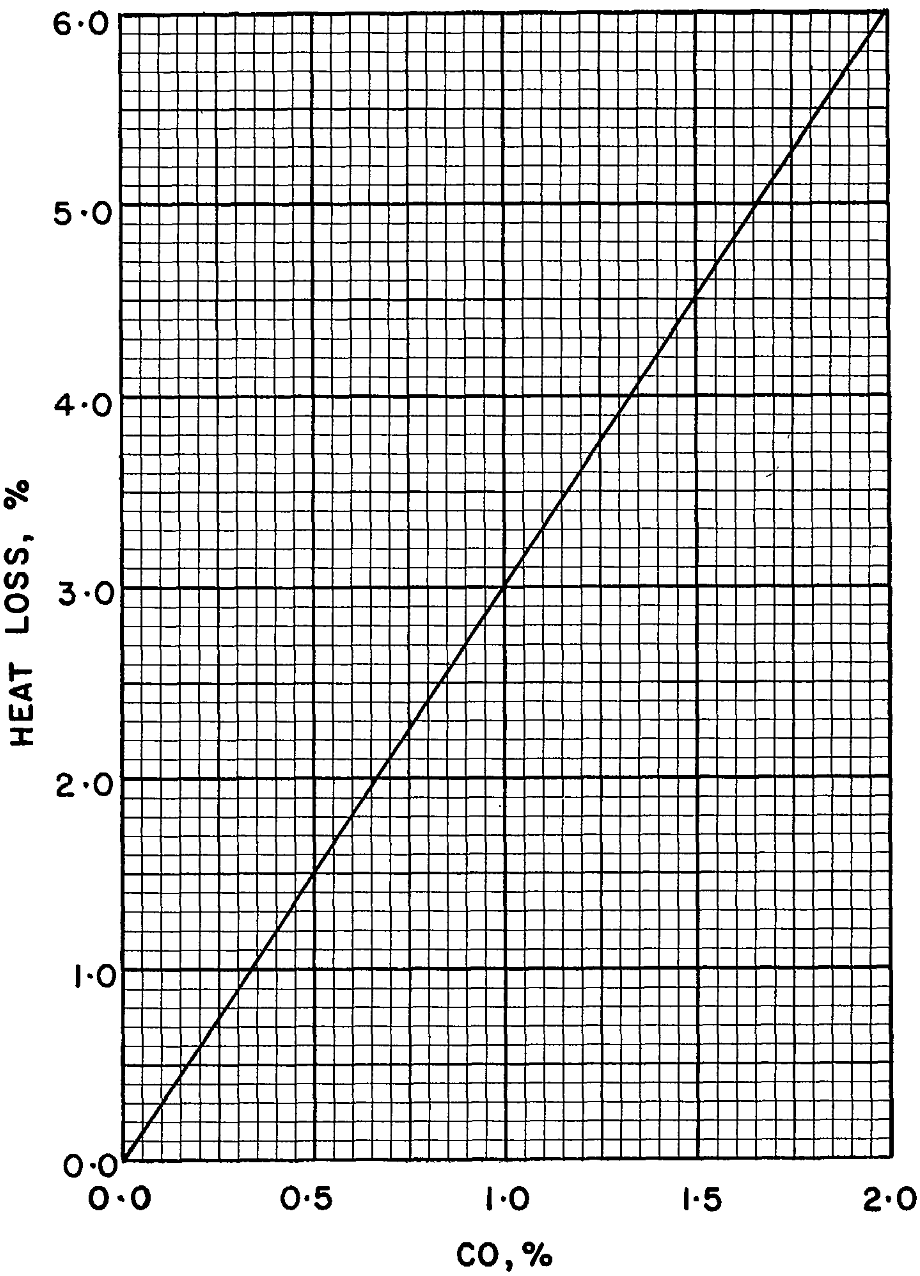


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

9820

FUEL OIL 9830, SPECIFIC GRAVITY 0.980

Ultimate Analysis, lb/lb

Carbon	(C)	0.8604
Hydrogen	(H_2)	0.1096
Sulphur	(S)	0.0300
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,250

Conversion Factors

1 Imp gal oil = 9.80 lb oil
or Imp gal oil × 9.80 = lb oil
or lb oil × 0.1020 = Imp gal oil

1 U.S. gal oil = 9.80 × 0.8337 lb oil
or U.S. gal oil × 8.170 = lb oil
or lb oil × 0.1224 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}250} \text{ lb oil}$$

or Btu × 10^6 × 54.80 = lb oil
or lb oil × 0.01825 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}250 \times 9.80} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.591 = Imp gal oil
or Imp gal oil × 0.1789 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}250 \times 8.170} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.707 = U.S. gal oil
or U.S. gal oil × 0.1491 = Btu × 10^6

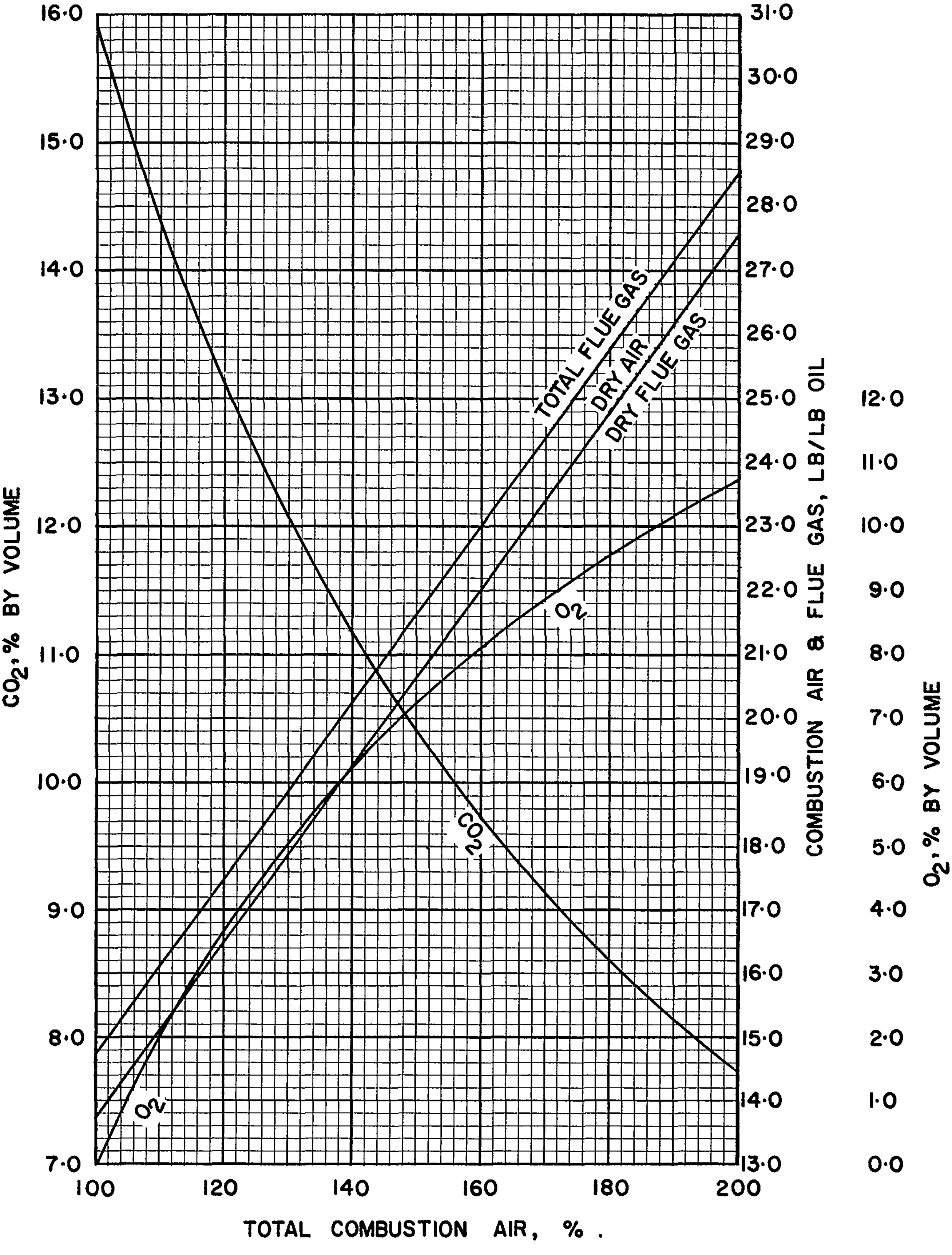


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS.

9830

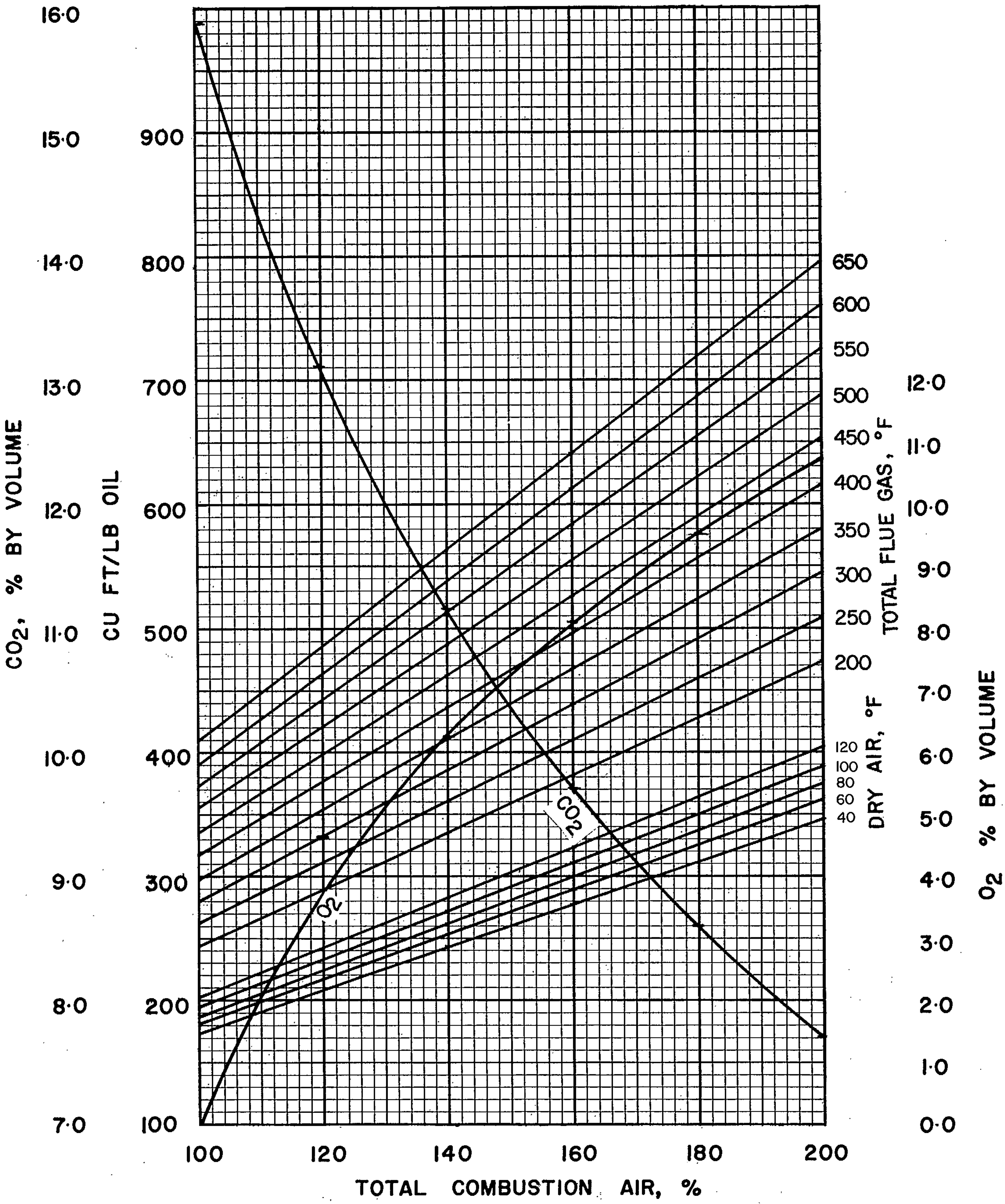


FIGURE 2 COMBUSTION DATA, VOLUME BASIS 9830

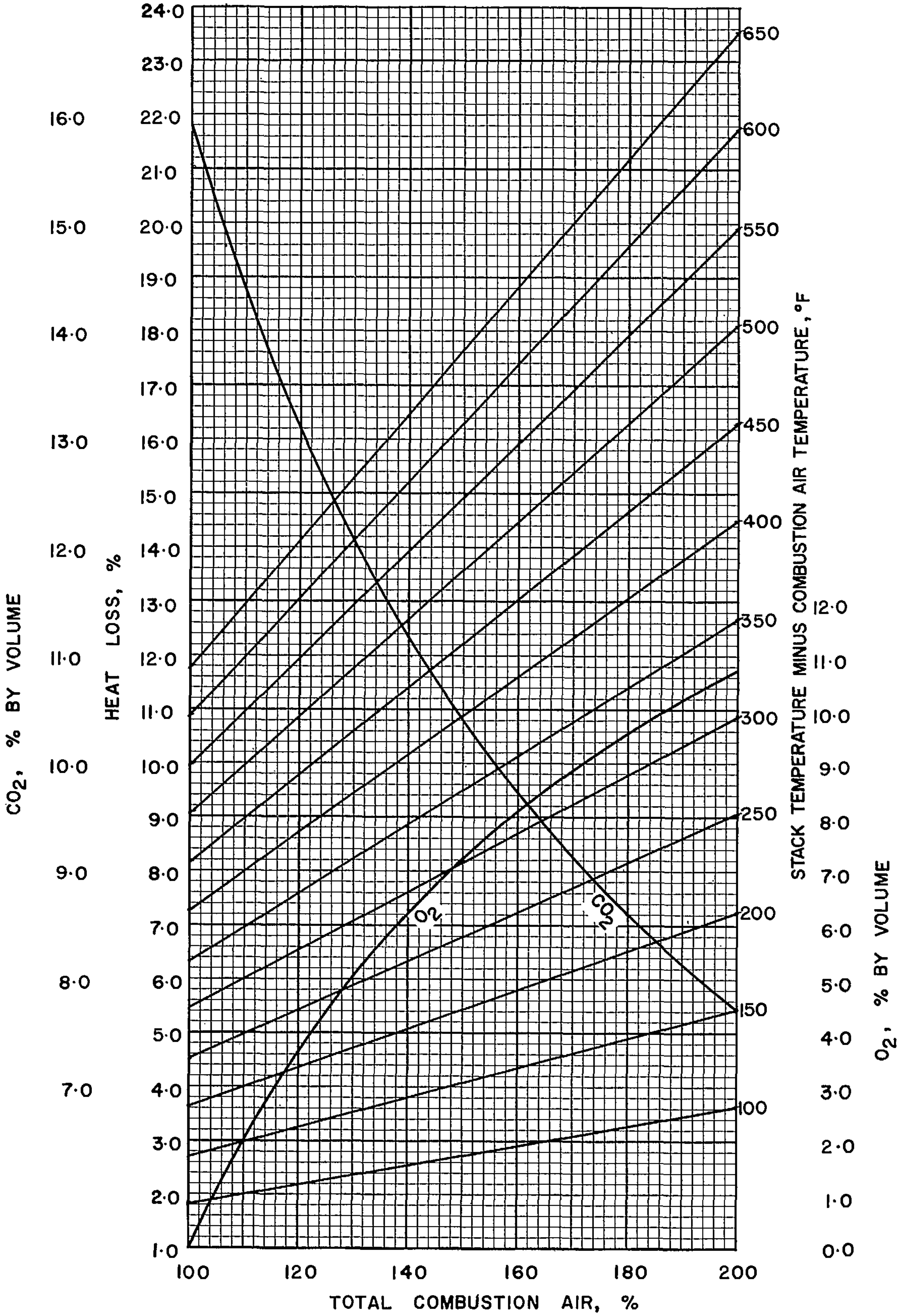


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

9830

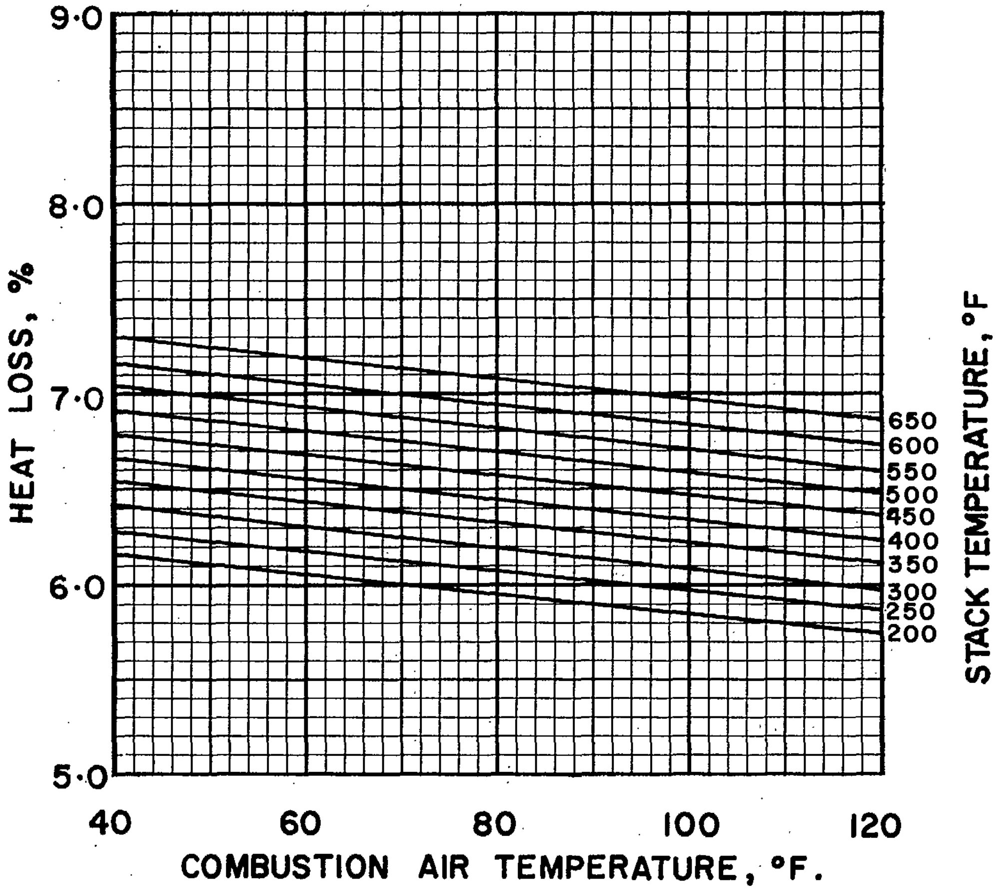


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

9830

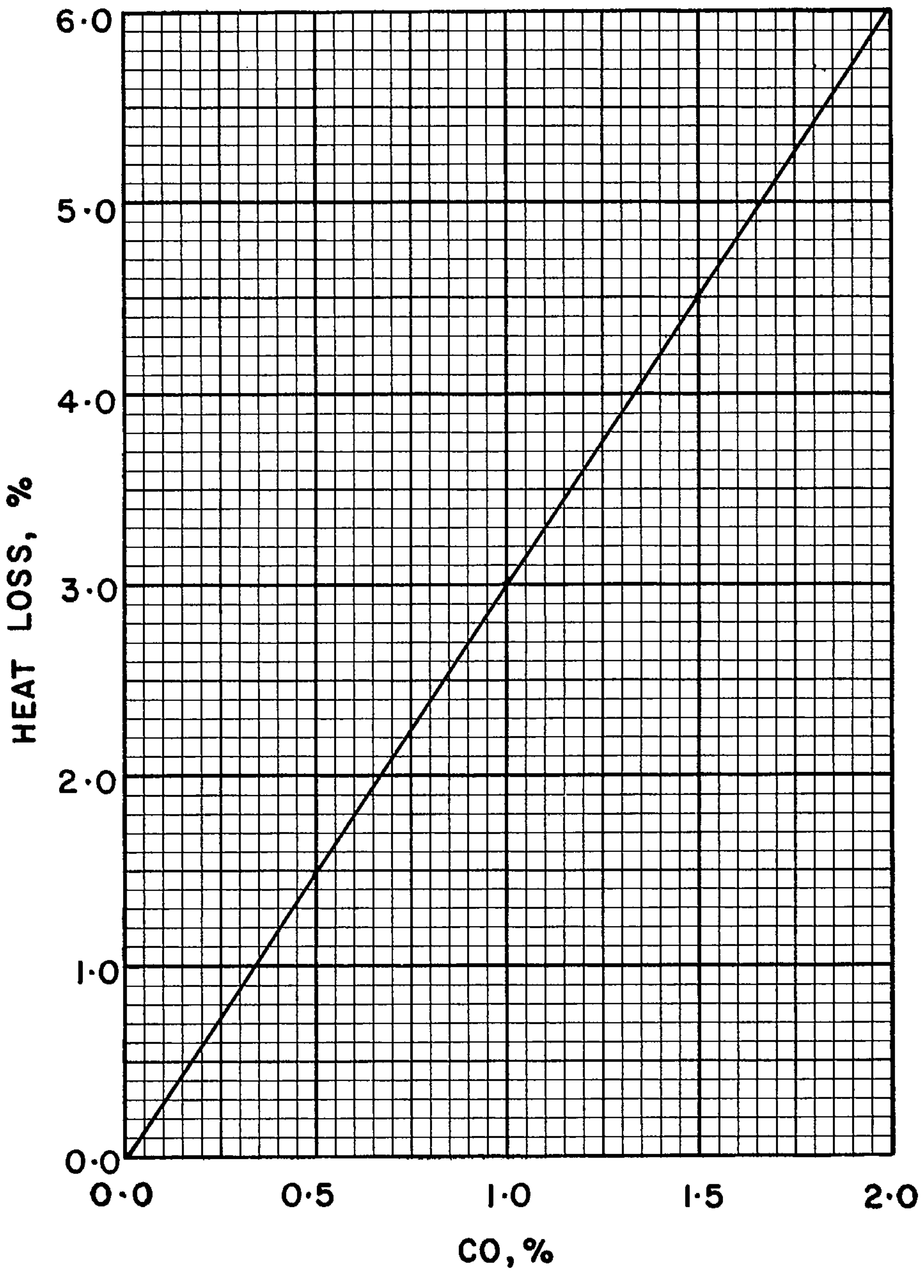


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

9830

FUEL OIL 9840, SPECIFIC GRAVITY 0.980

Ultimate Analysis, lb/lb

Carbon	(C)	0.8515
Hydrogen	(H_2)	0.1085
Sulphur	(S)	0.0400
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,100

Conversion Factors

1 Imp gal oil = 9.80 lb oil
or Imp gal oil × 9.80 = lb oil
or lb oil × 0.1020 = Imp gal oil

1 U.S. gal oil = 9.80 × 0.8337 lb oil
or U.S. gal oil × 8.170 = lb oil
or lb oil × 0.1224 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}100} \text{ lb oil}$$

or Btu × 10^6 × 55.25 = lb oil
or lb oil × 0.0181 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}100 \times 9.80} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.638 = Imp gal oil
or Imp gal oil × 0.1774 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}100 \times 8.170} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.761 = U.S. gal oil
or U.S. gal oil × 0.1479 = Btu × 10^6

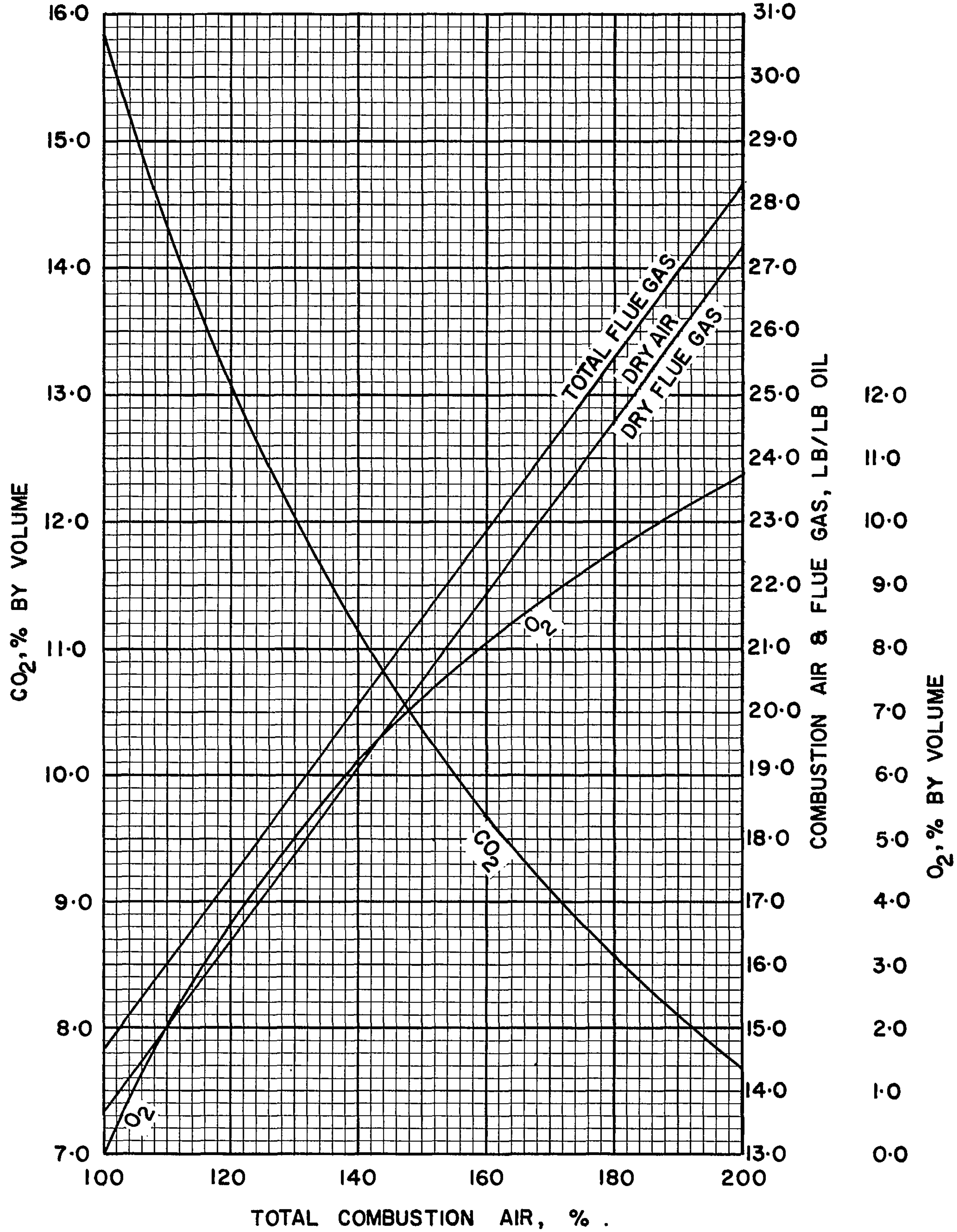


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS.

9840

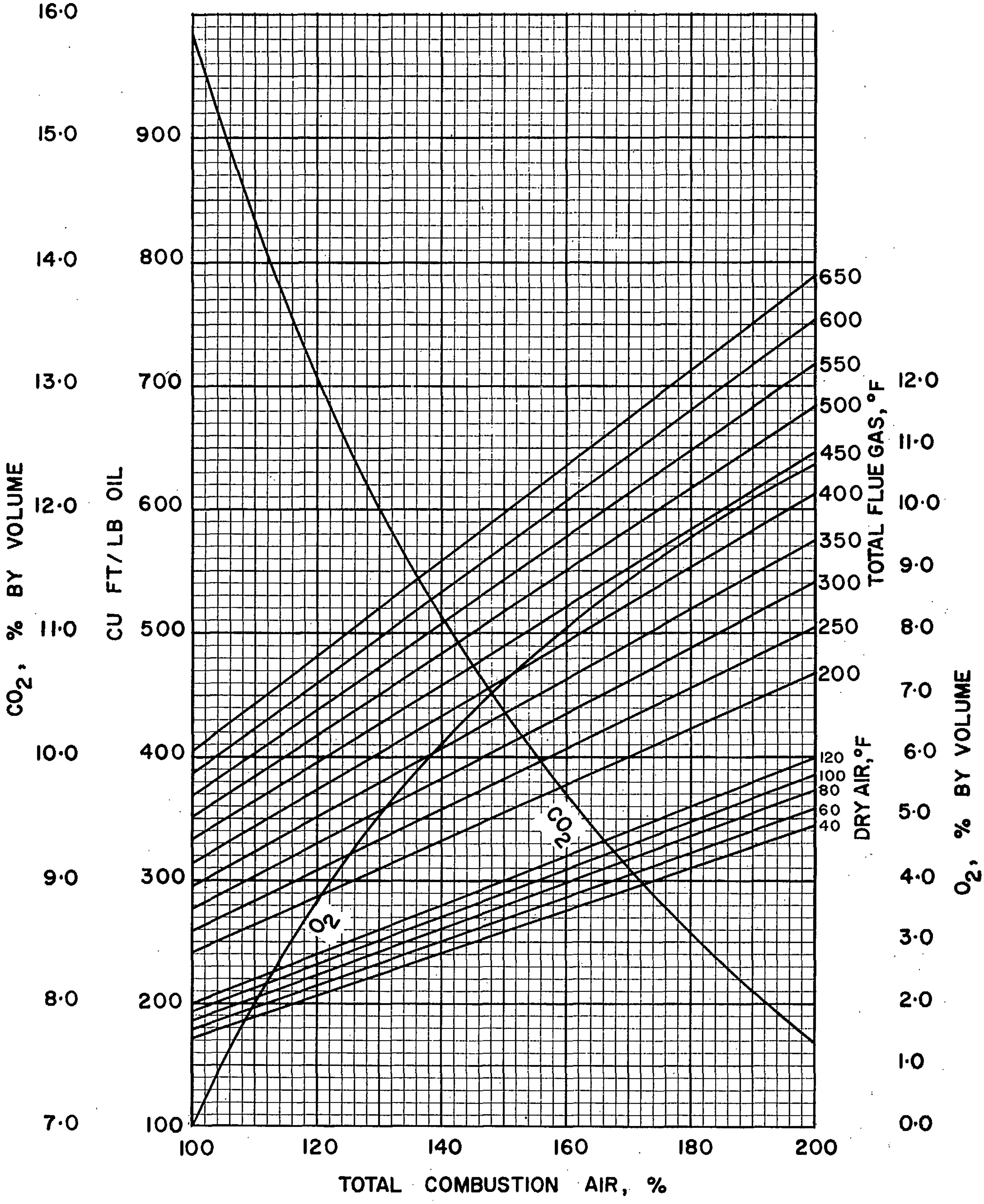


FIGURE 2. COMBUSTION DATA, VOLUME BASIS.

9840

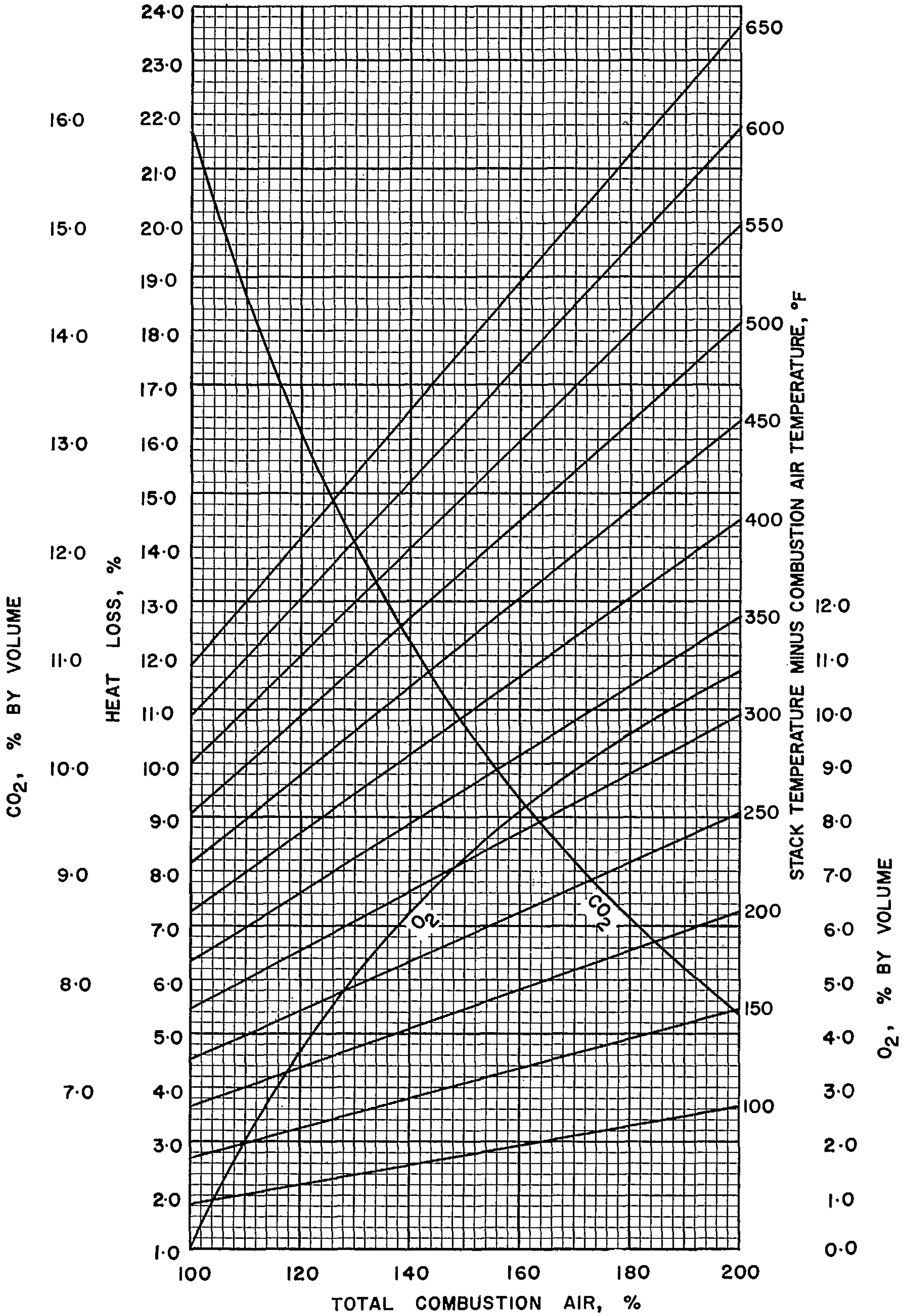


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

9840

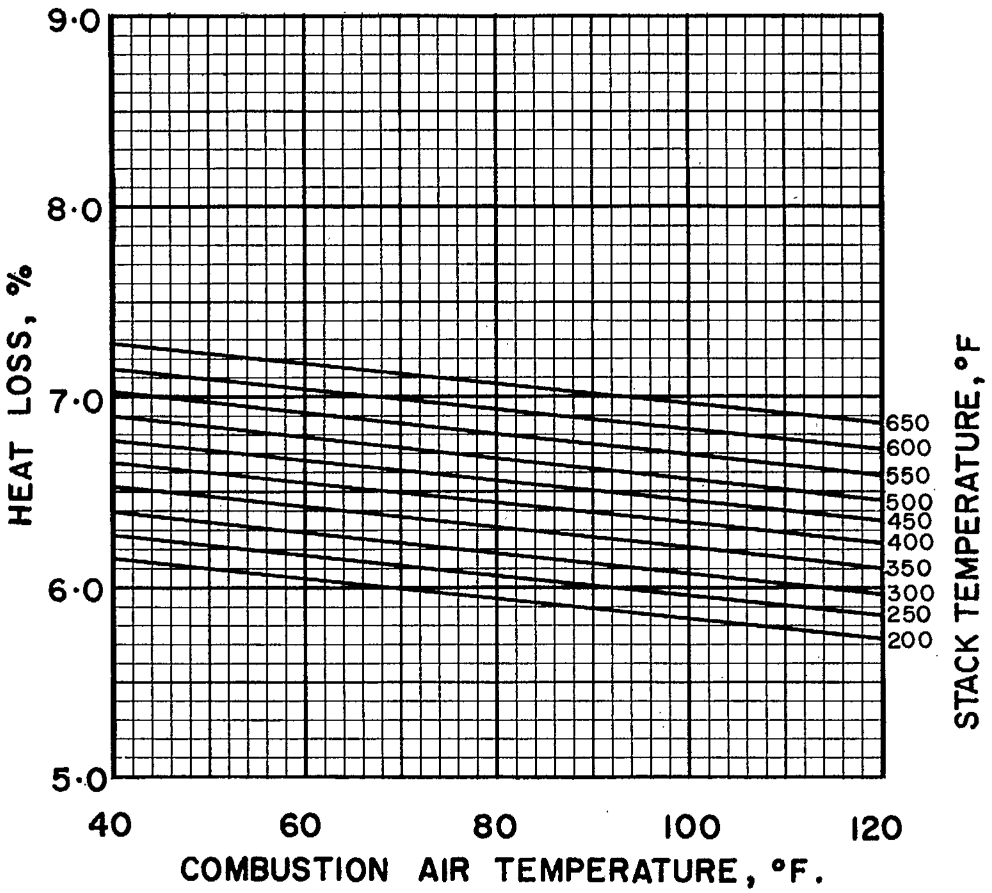


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

9840

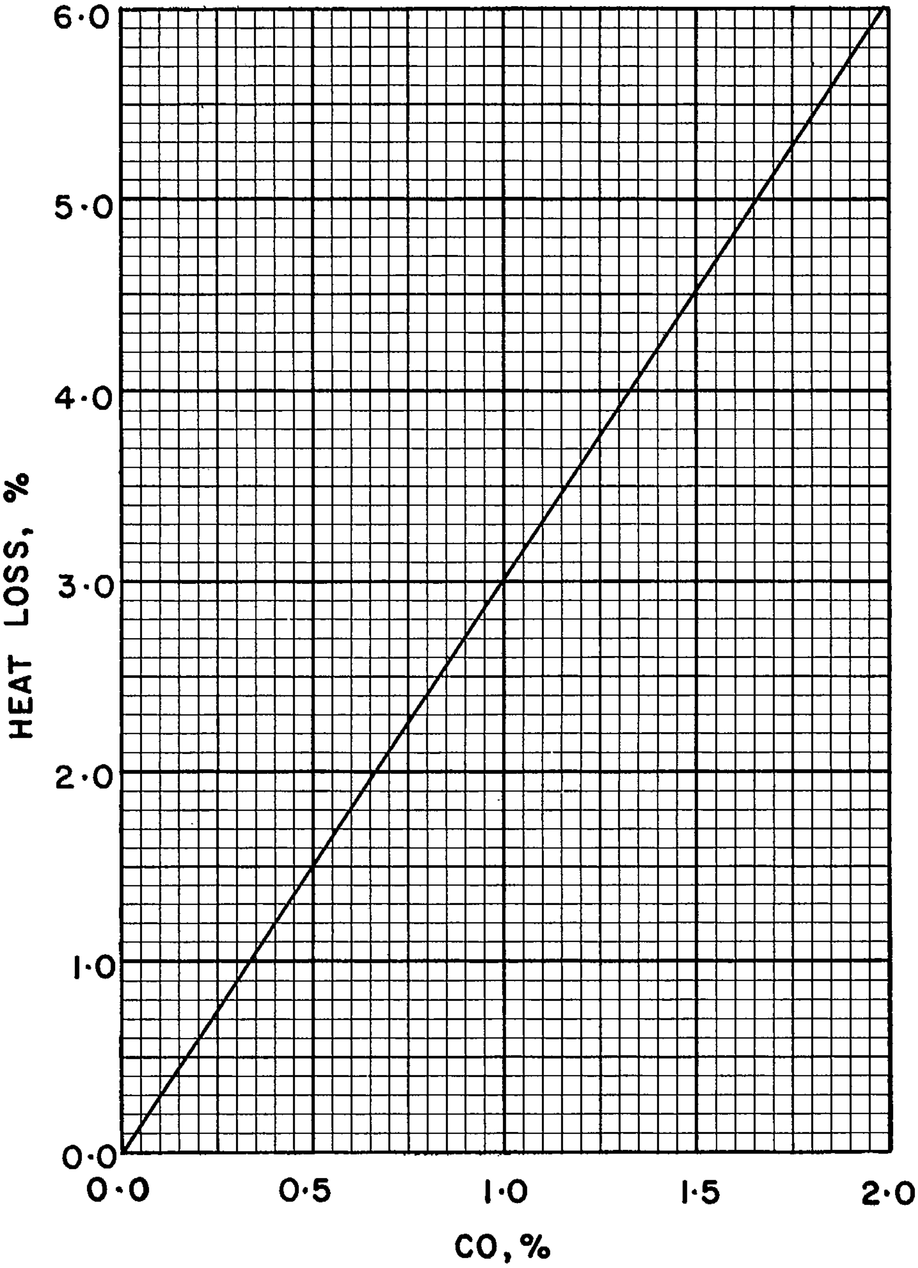


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

9840

FUEL OIL 9900, SPECIFIC GRAVITY 0.990

Ultimate Analysis, lb/lb

Carbon	(C)	0.8885
Hydrogen	(H_2)	0.1115
Sulphur	(S)	–
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,610

Conversion Factors

1 Imp gal oil = 9.90 lb oil
or Imp gal oil × 9.90 = lb oil
or lb oil × 0.1010 = Imp gal oil

1 U.S. gal oil = 9.90 × 0.8337 lb oil
or U.S. gal oil × 8.254 = lb oil
or lb oil × 0.1212 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}610} \text{ lb oil}$$

or Btu × 10^6 × 53.74 = lb oil
or lb oil × 0.0186 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}610 \times 9.90} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.428 = Imp gal oil
or Imp gal oil × 0.1842 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}610 \times 8.254} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.510 = U.S. gal oil
or U.S. gal oil × 0.1536 = Btu × 10^6

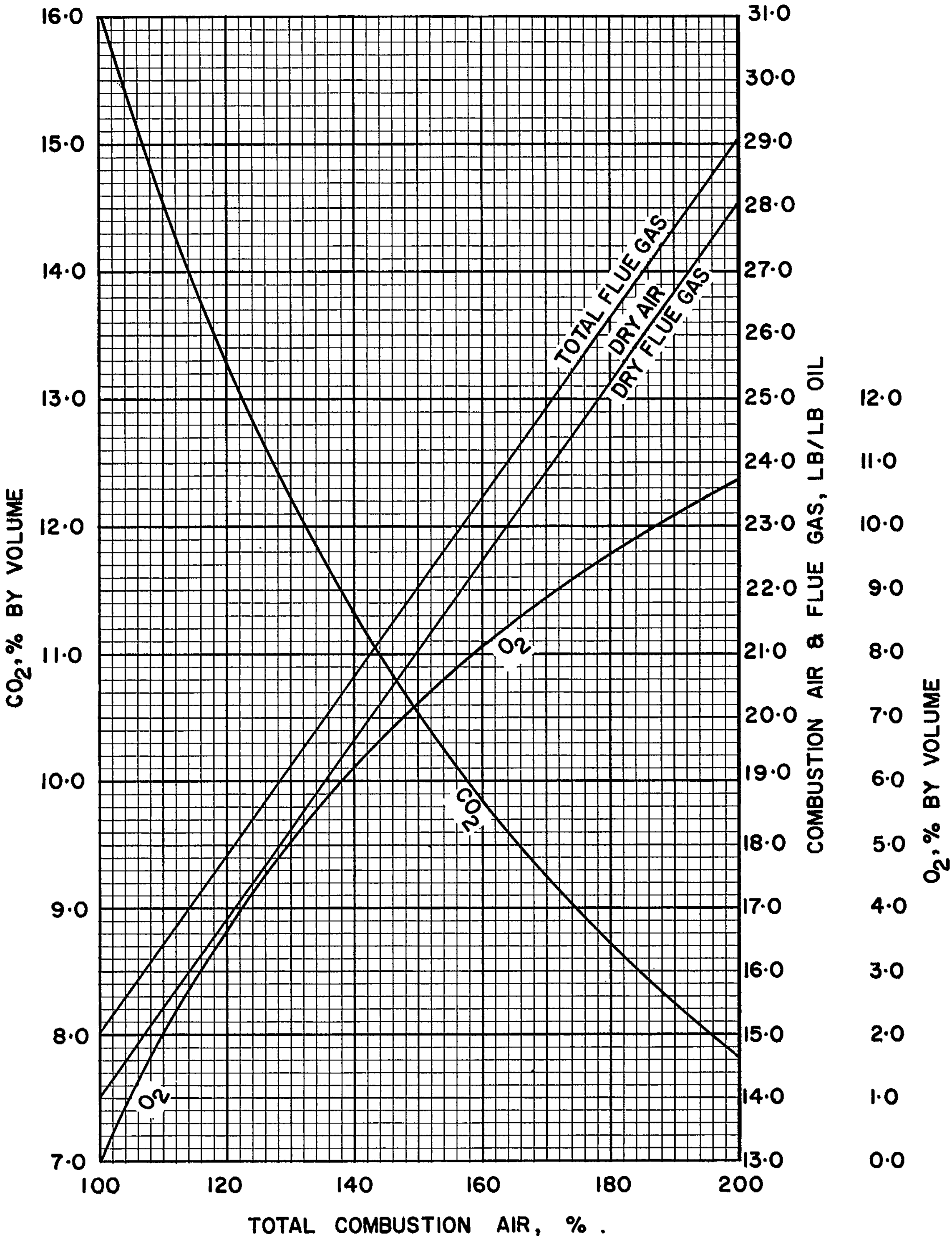


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS.

9900

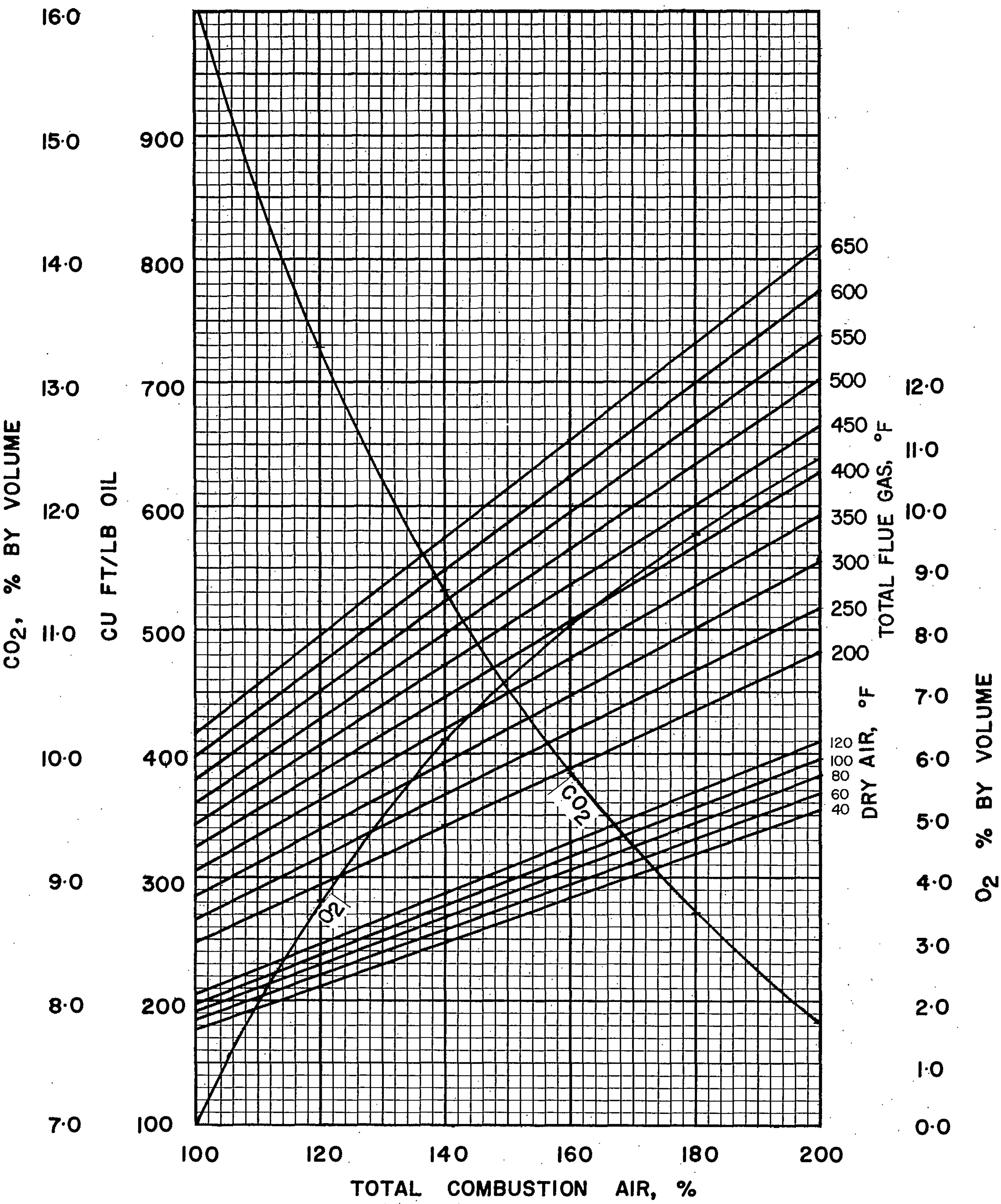


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 9900

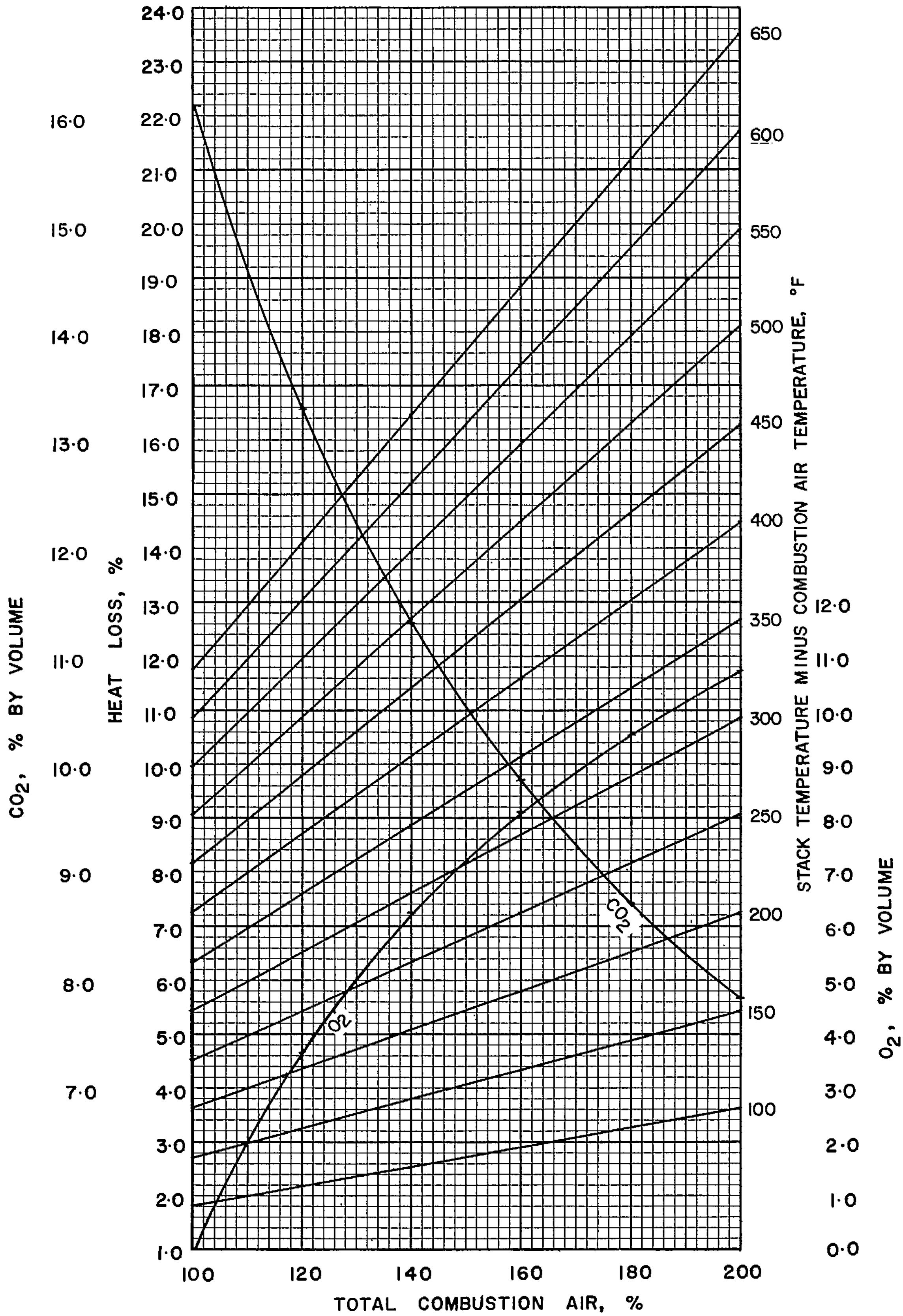


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

9900

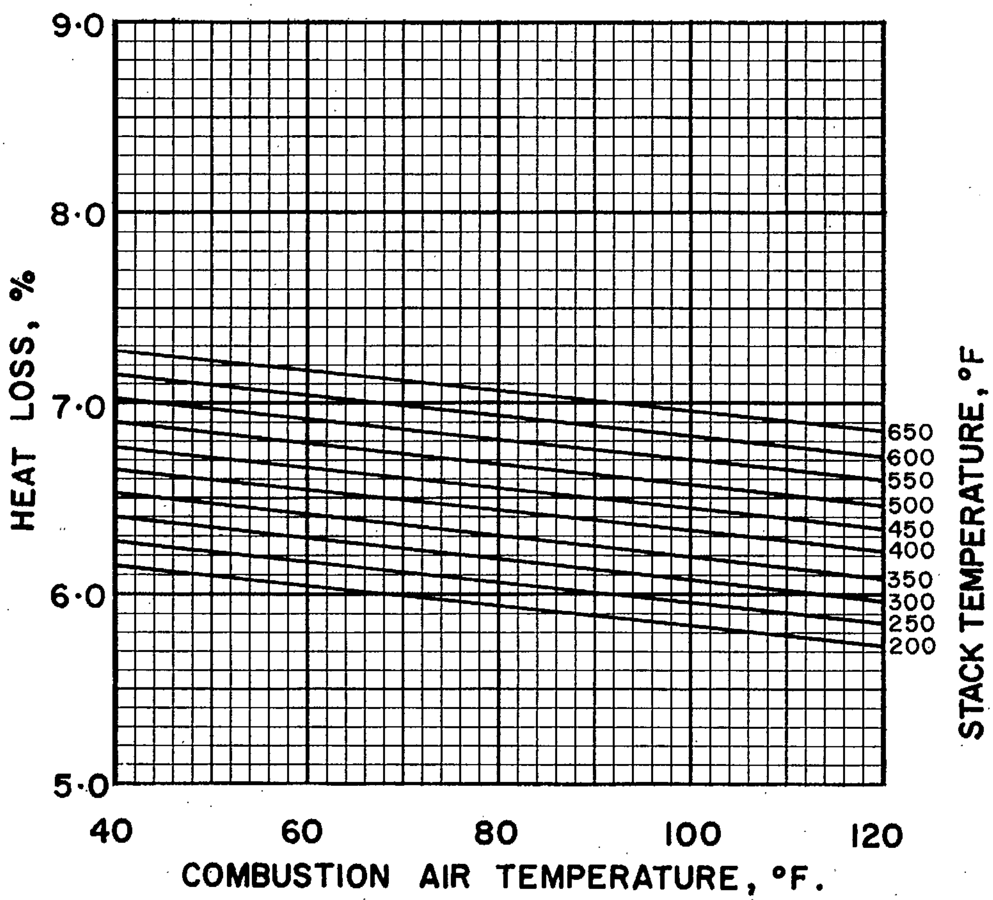


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

9900

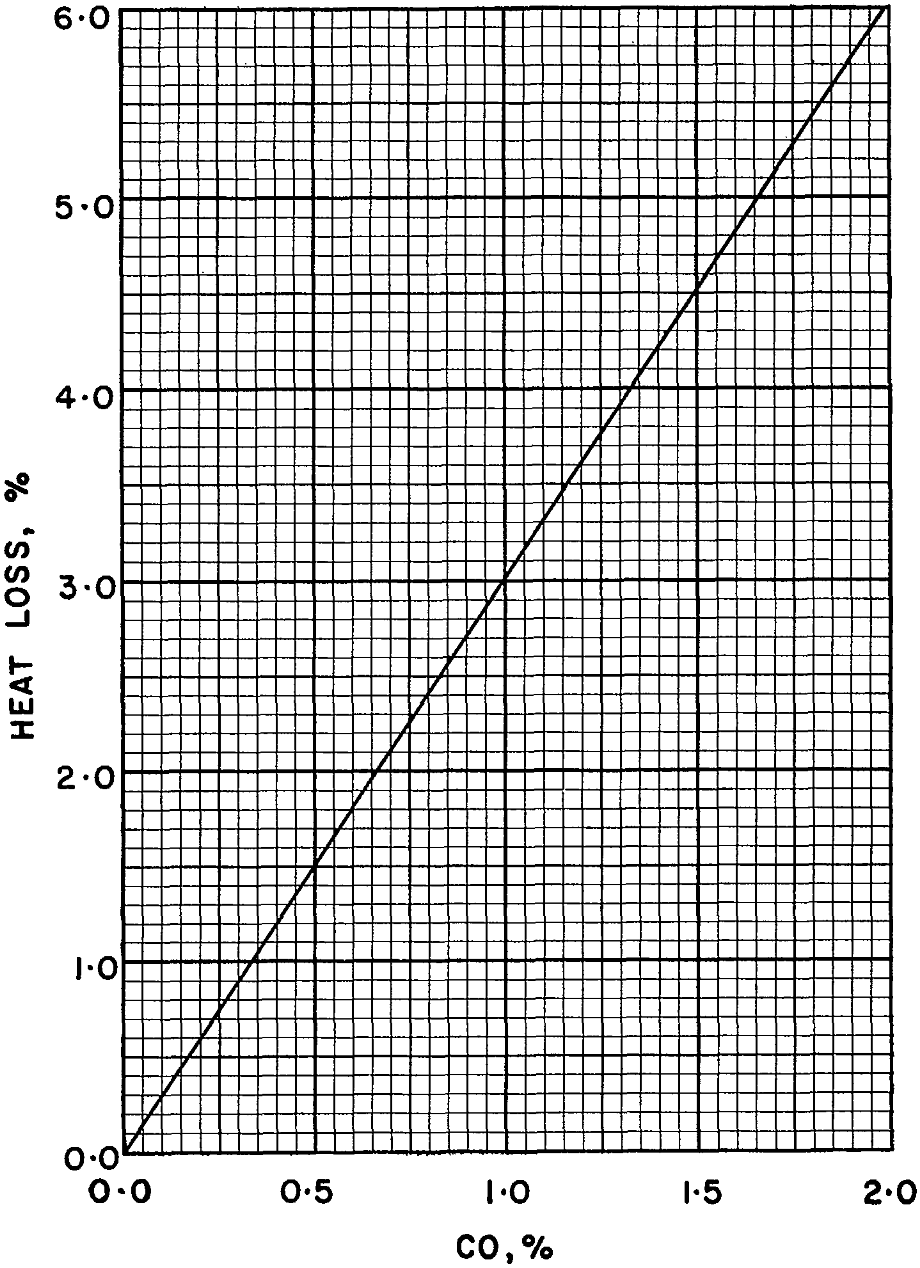


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

9900

FUEL OIL 9910, SPECIFIC GRAVITY 0.990

Ultimate Analysis, lb/lb

Carbon	(C)	0.8796
Hydrogen	(H_2)	0.1104
Sulphur	(S)	0.0100
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,460

Conversion Factors

1 Imp gal oil = 9.90 lb oil
or Imp gal oil × 9.90 = lb oil
or lb oil × 0.1010 = Imp gal oil

1 U.S. gal oil = 9.90 × 0.8337 lb oil
or U.S. gal oil × 8.254 = lb oil
or lb oil × 0.1212 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}460} \text{ lb oil}$$

or Btu × 10^6 × 54.17 = lb oil
or lb oil × 0.0185 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}460 \times 9.90} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.472 = Imp gal oil
or Imp gal oil × 0.1827 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}460 \times 8.254} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.562 = U.S. gal oil
or U.S. gal oil × 0.1524 = Btu × 10^6

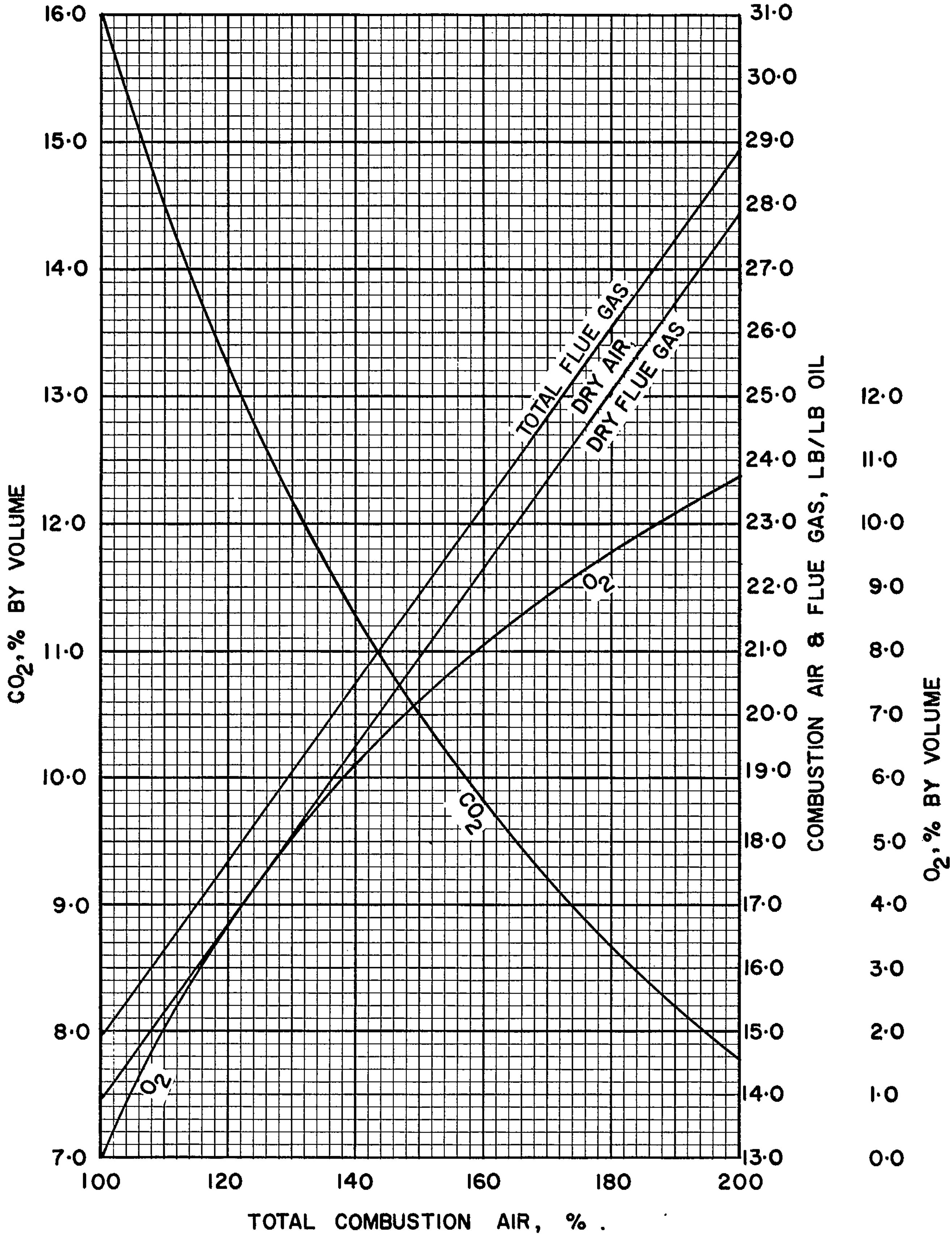


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS.

9910

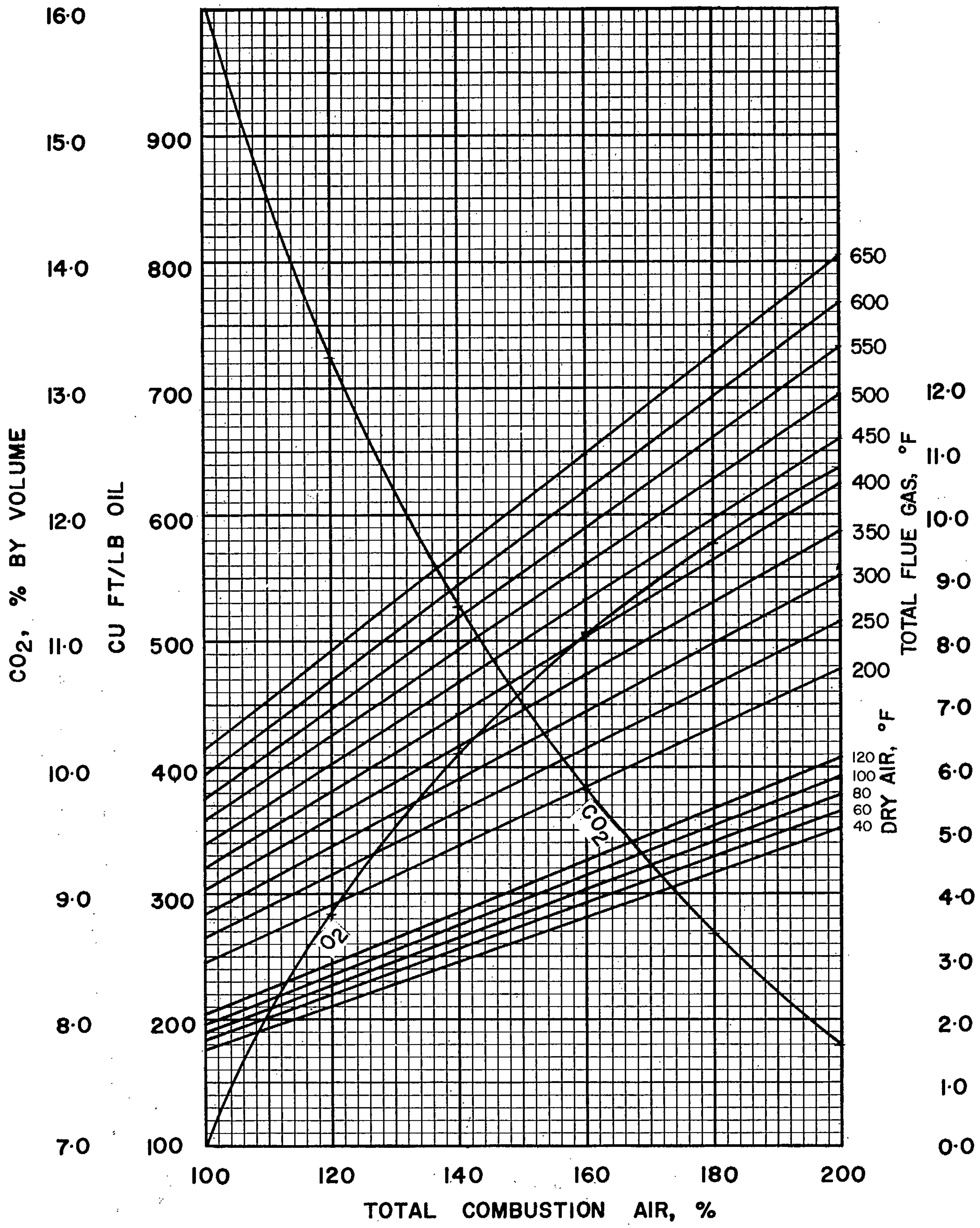


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 9910

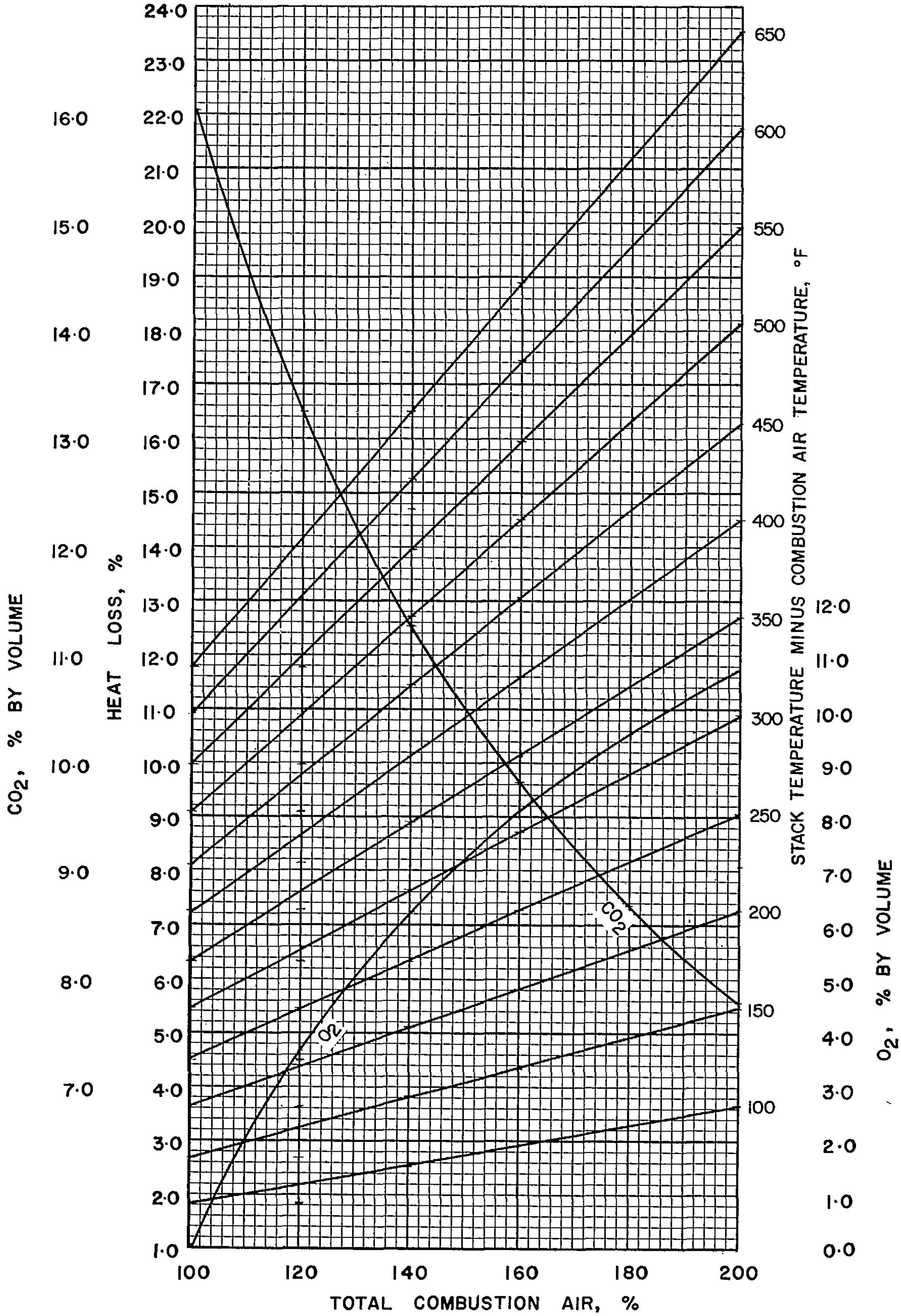


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

9910

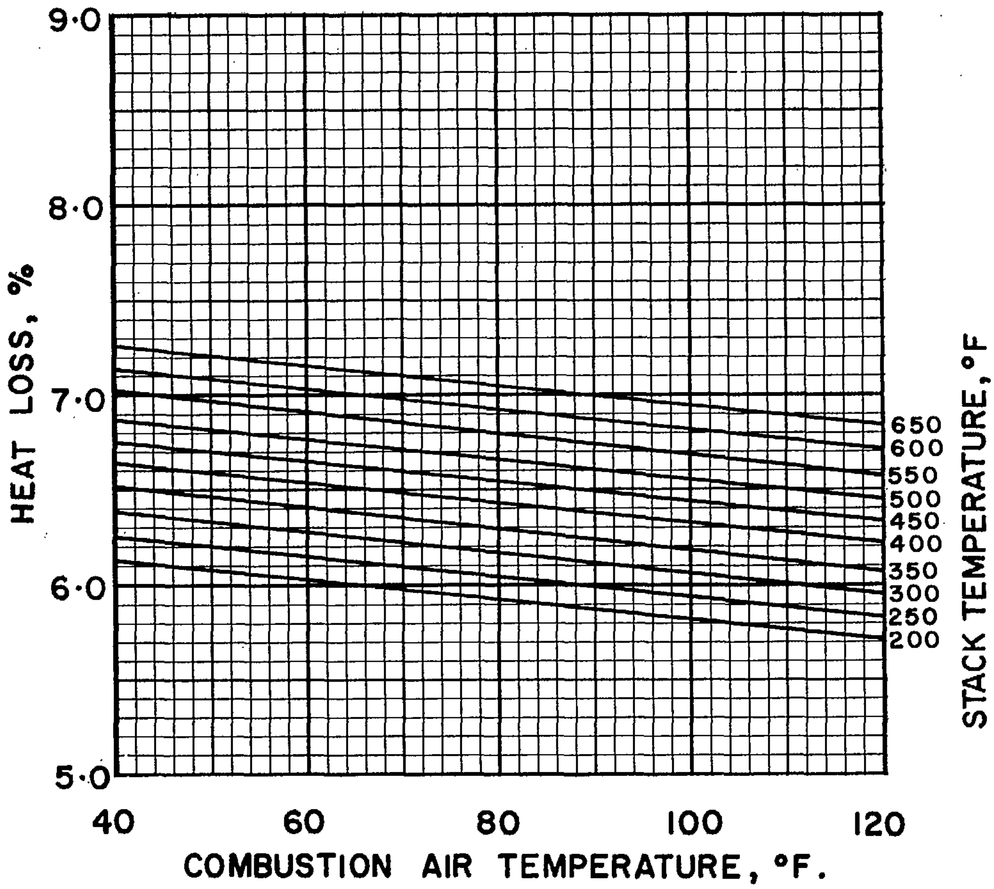


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

9910

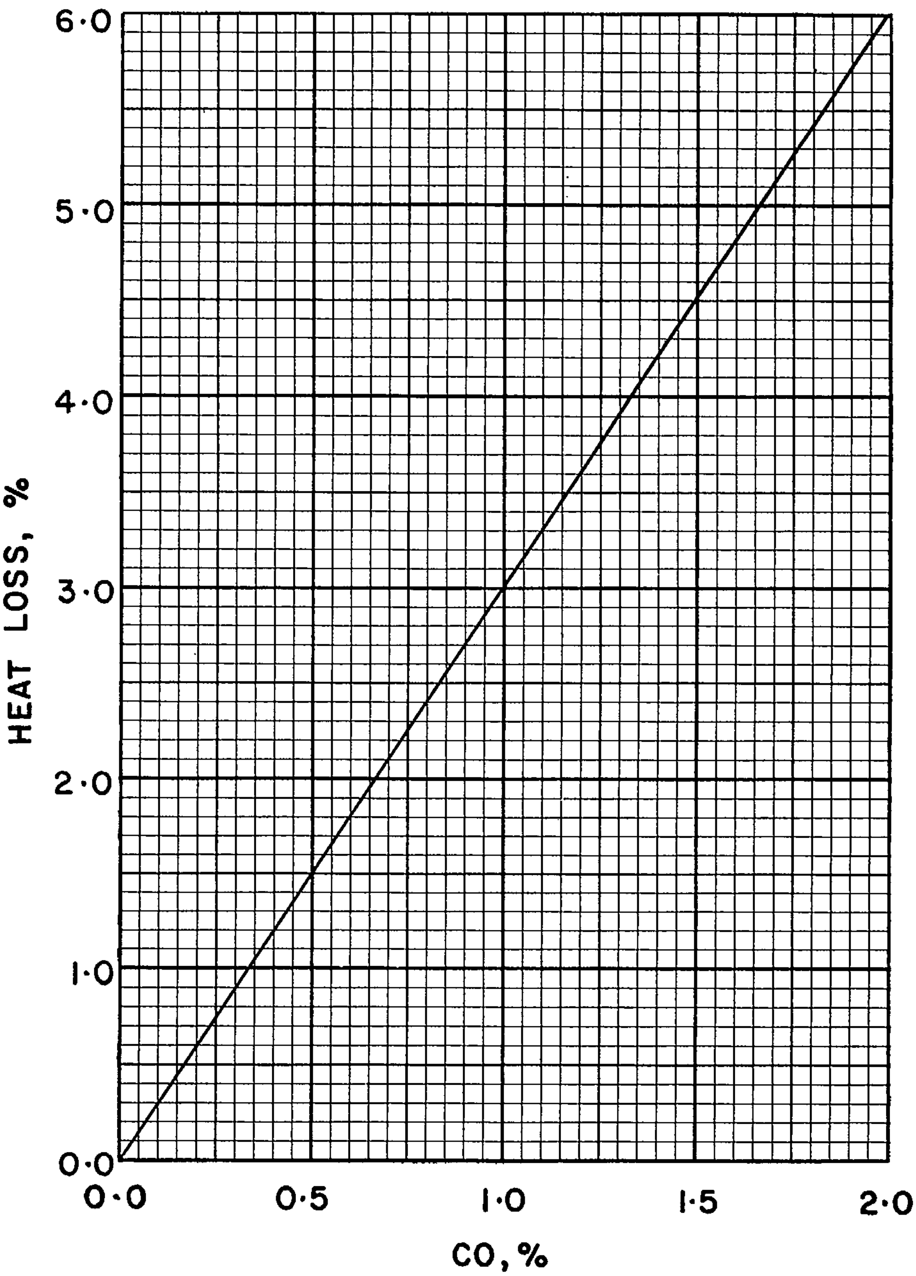


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

9910

FUEL OIL 9920, SPECIFIC GRAVITY 0.990

Ultimate Analysis, lb/lb

Carbon	(C)	0.8707
Hydrogen	(H_2)	0.1093
Sulphur	(S)	0.0200
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,320

Conversion Factors

1 Imp gal oil = 9.90 lb oil
or Imp gal oil × 9.90 = lb oil
or lb oil × 0.1010 = Imp gal oil

1 U.S. gal oil = 9.90 × 0.8337 lb oil
or U.S. gal oil × 8.254 = lb oil
or lb oil × 0.1212 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}320} \text{ lb oil}$$

or Btu × 10^6 × 54.59 = lb oil
or lb oil × 0.0183 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}320 \times 0.99} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.514 = Imp gal oil
or Imp gal oil × 0.1814 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}320 \times 8.254} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.614 = U.S. gal oil
or U.S. gal oil × 0.1512 = Btu × 10^6

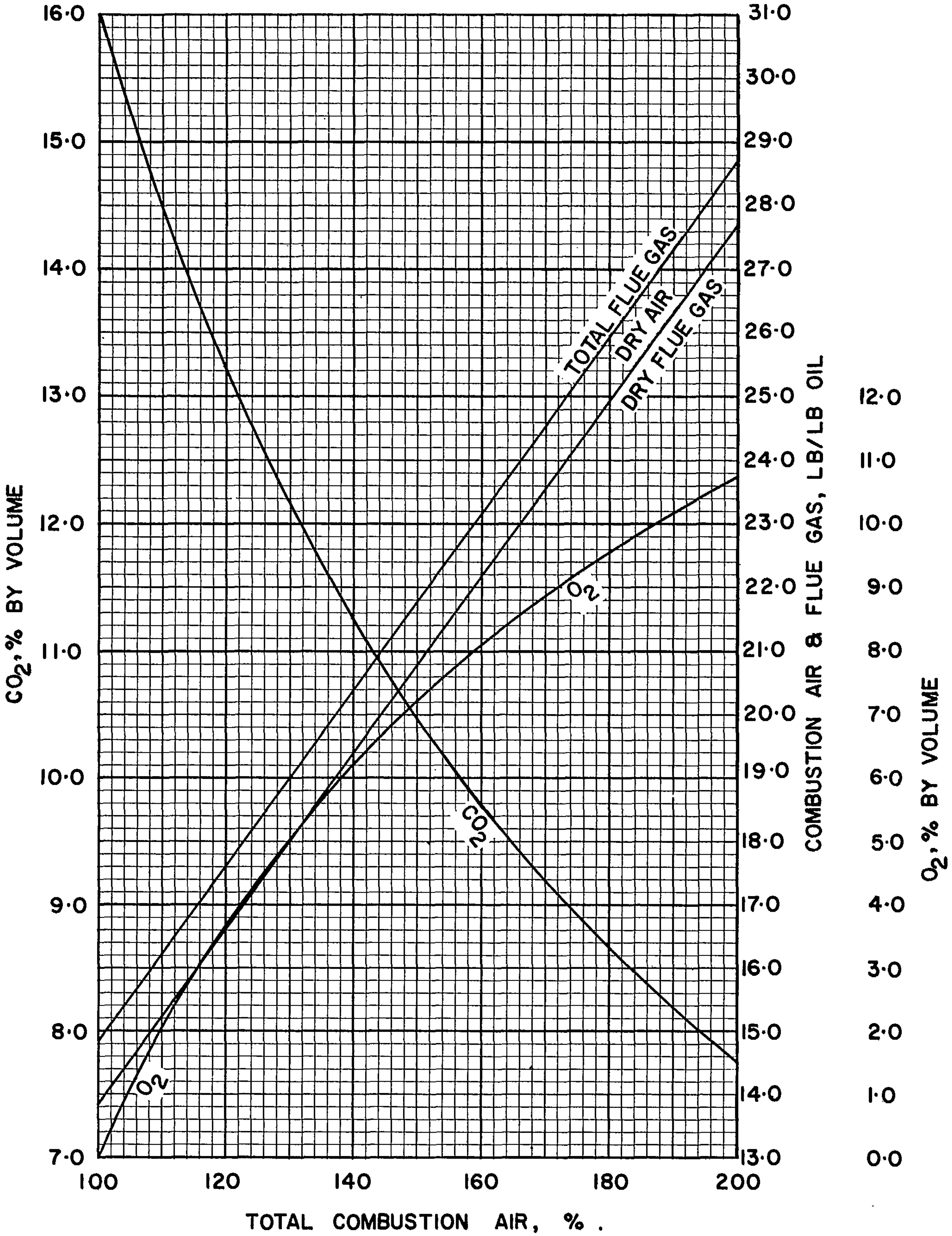


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS.

9920

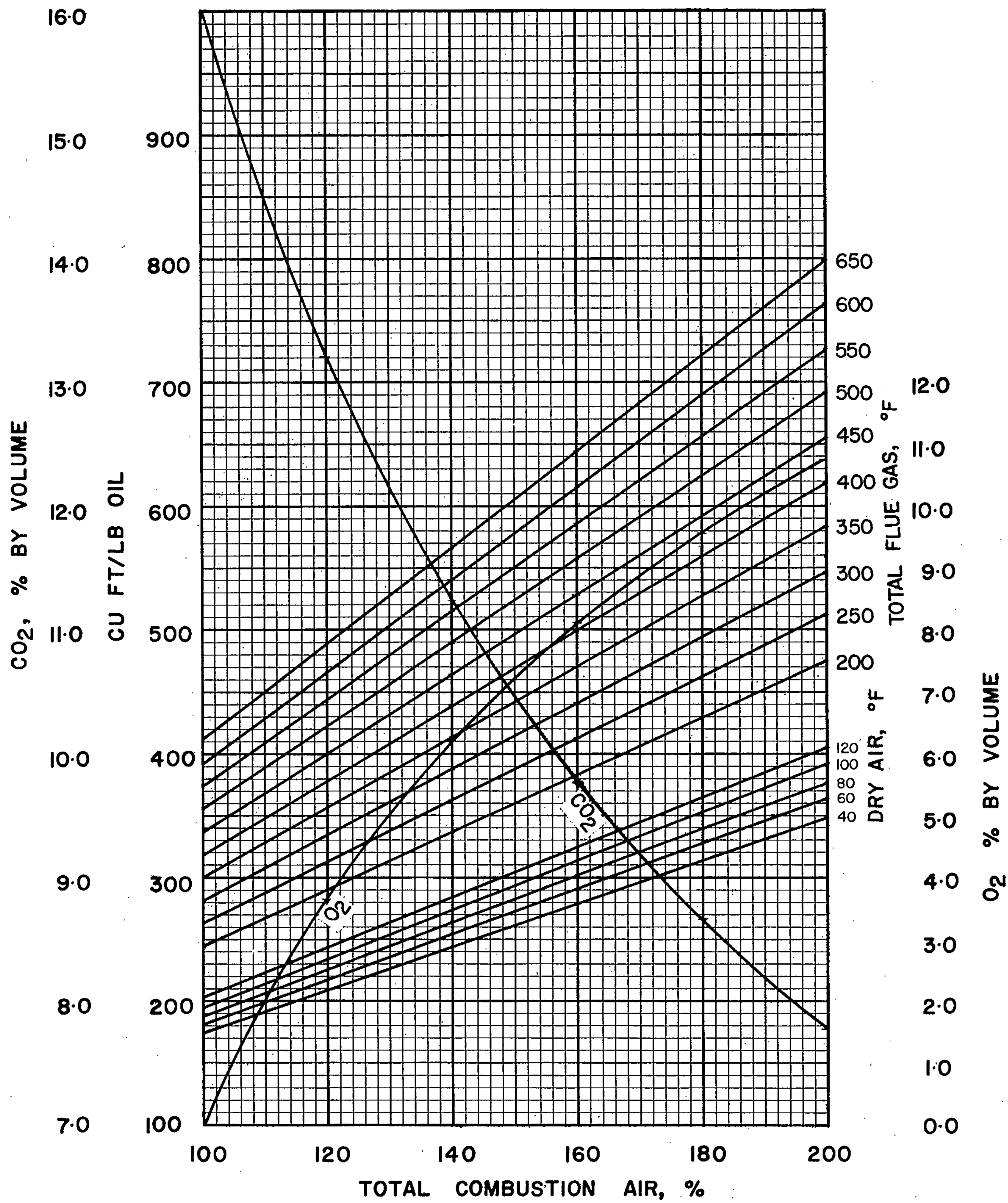


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 9920

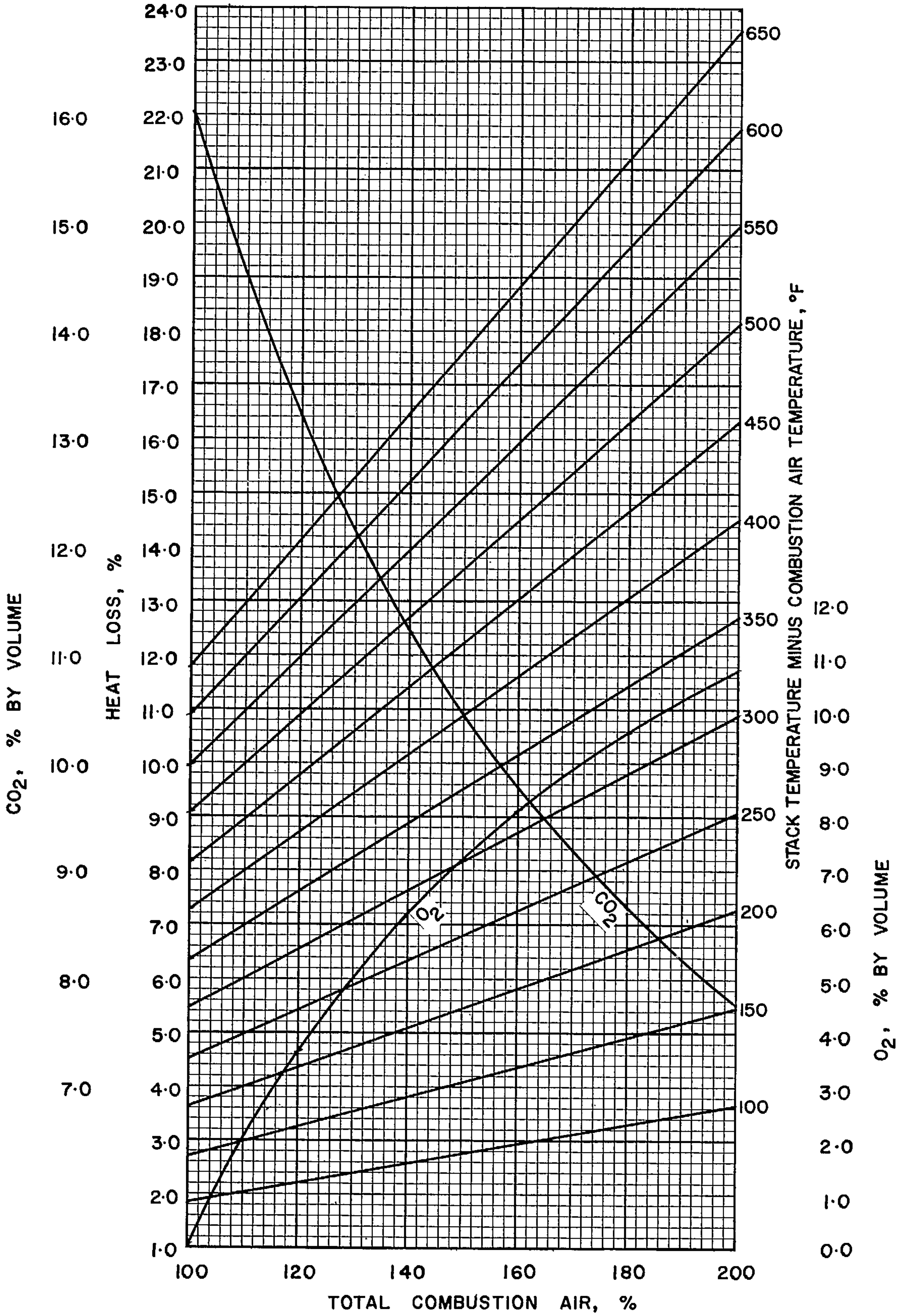


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

9920

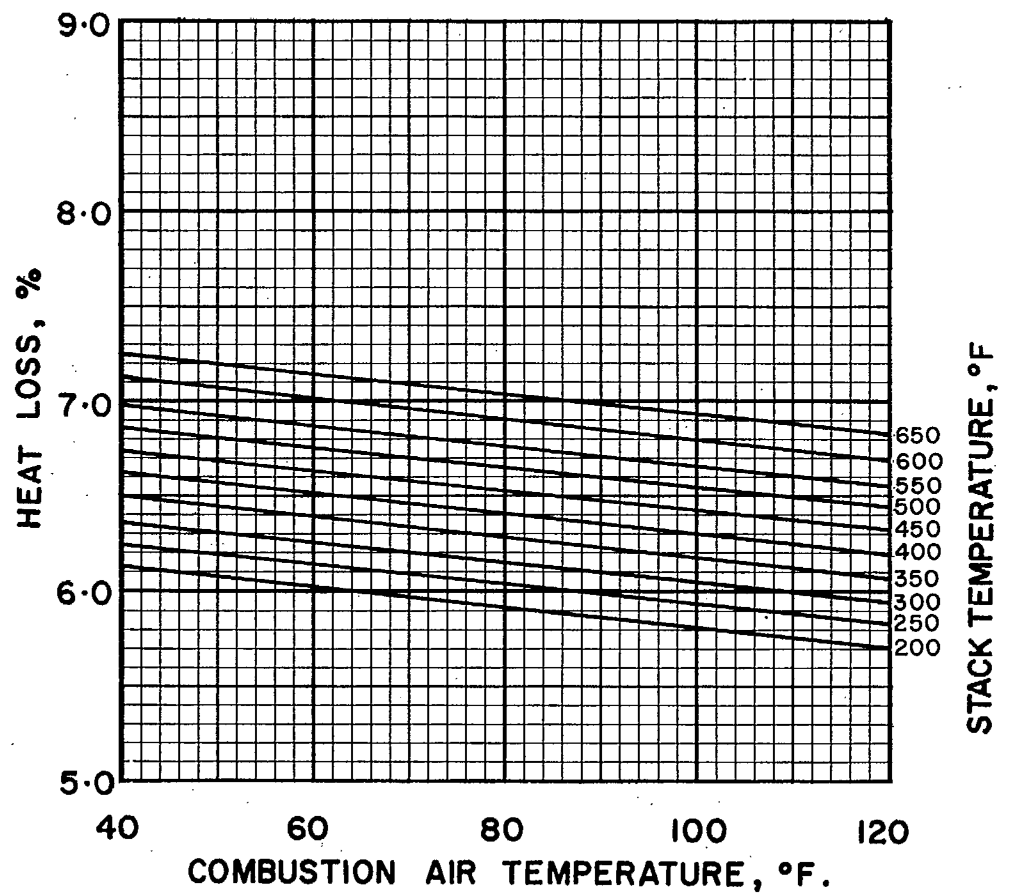


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

9920

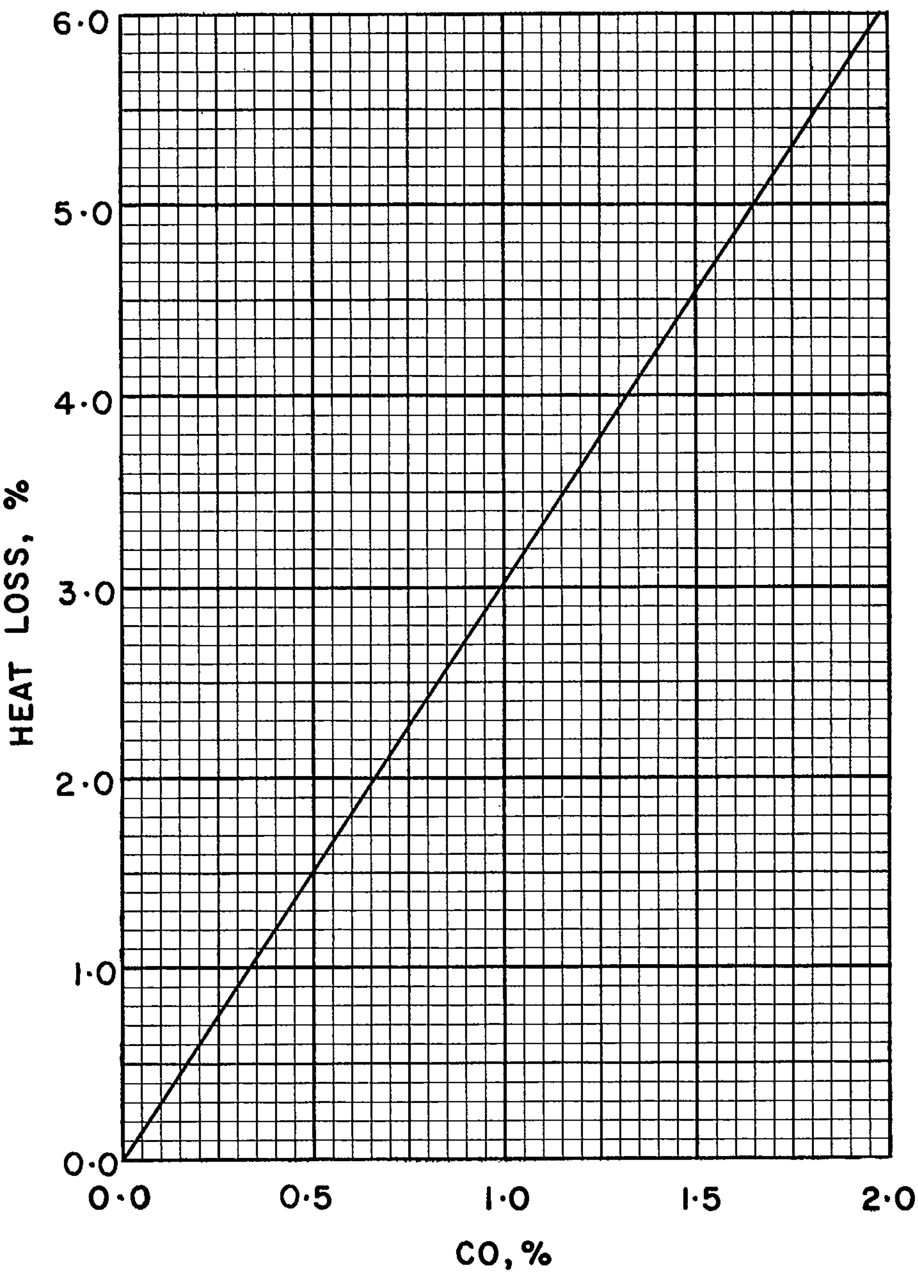


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

9920

FUEL OIL 9930, SPECIFIC GRAVITY 0.990

Ultimate Analysis, lb/lb

Carbon	(C)	0.8618
Hydrogen	(H_2)	0.1082
Sulphur	(S)	0.0300
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,170

Conversion Factors

1 Imp gal oil = 9.90 lb oil
or Imp gal oil × 9.90 = lb oil
or lb oil × 0.1010 = Imp gal oil

1 U.S. gal oil = 9.90 × 0.8337 lb oil
or U.S. gal oil × 8.254 = lb oil
or lb oil × 0.1212 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}170} \text{ lb oil}$$

or Btu × 10^6 × 55.04 = lb oil
or lb oil × 0.0182 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}170 \times 9.90} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.559 = Imp gal oil
or Imp gal oil × 0.1799 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}170 \times 8.254} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.667 = U.S. gal oil
or U.S. gal oil × 0.1500 = Btu × 10^6

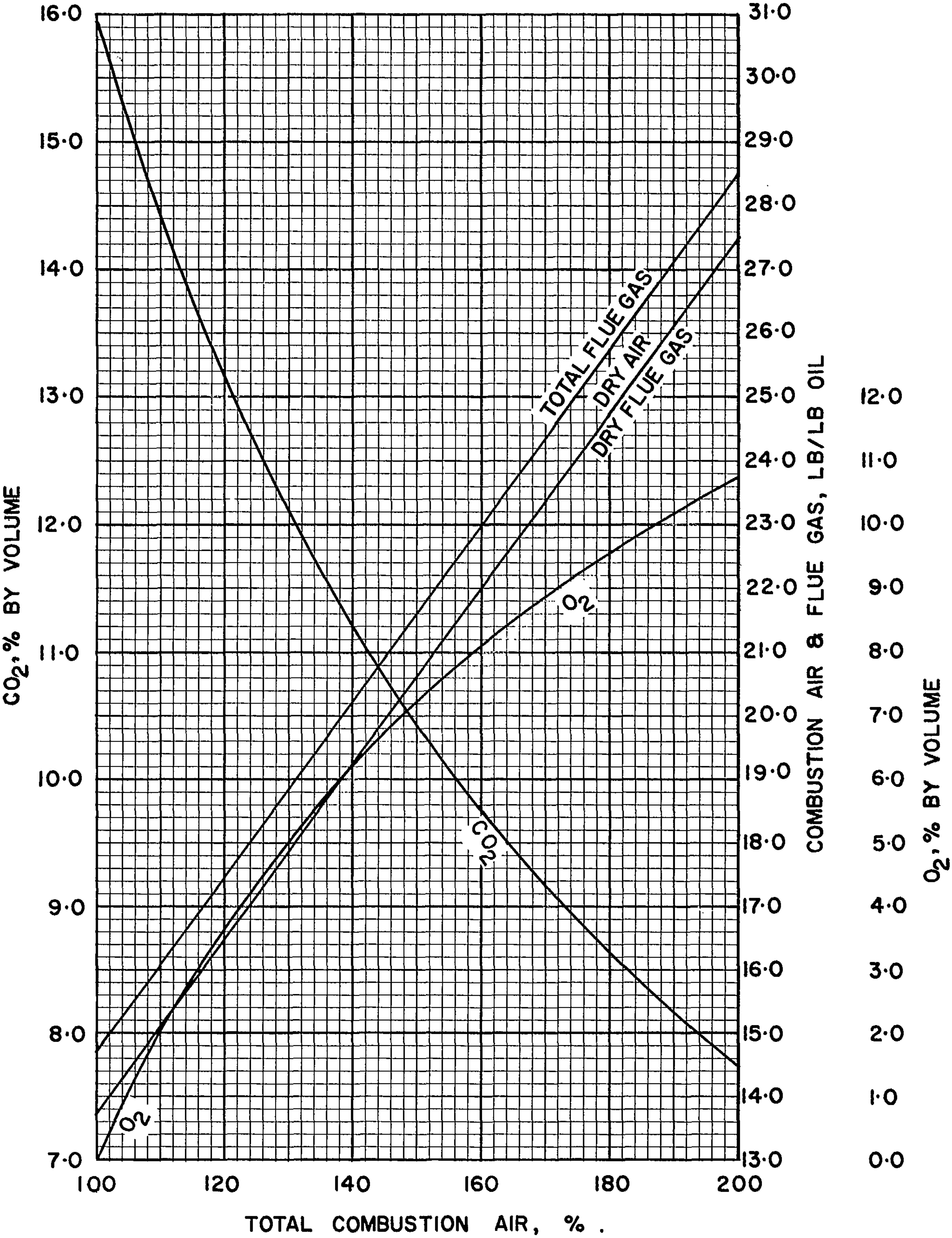


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS.

9930

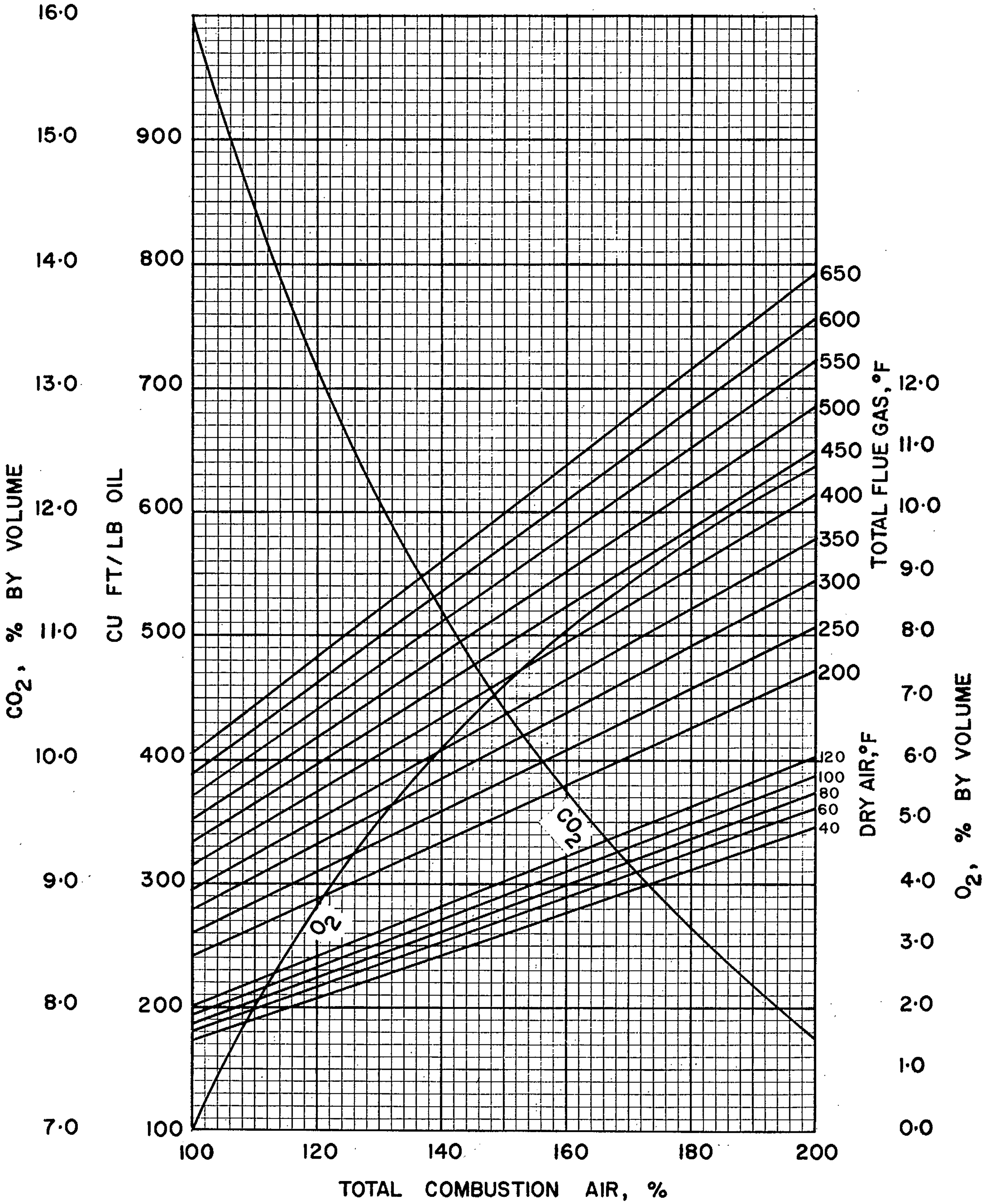


FIGURE 2. COMBUSTION DATA, VOLUME BASIS.

9930

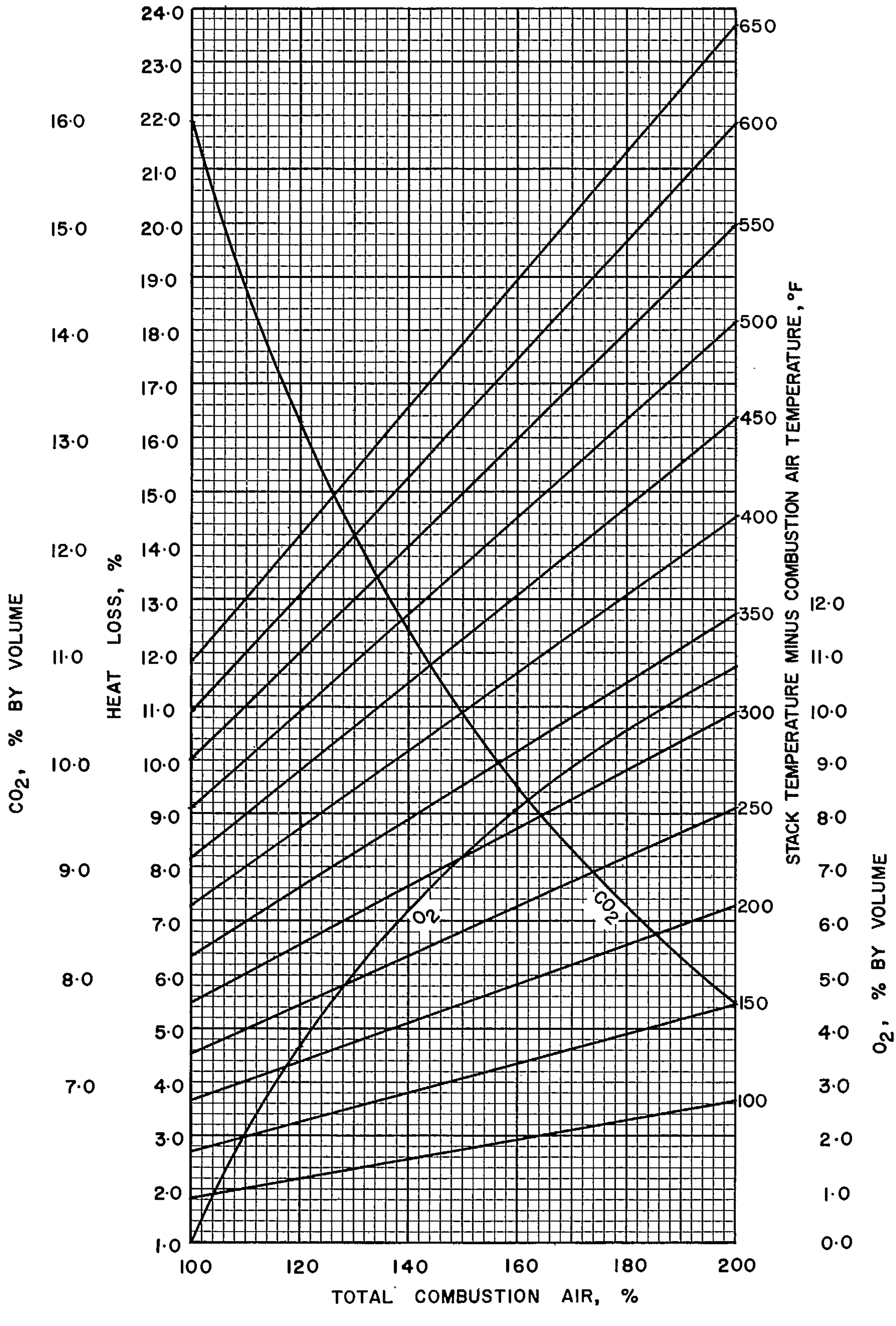


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

9930

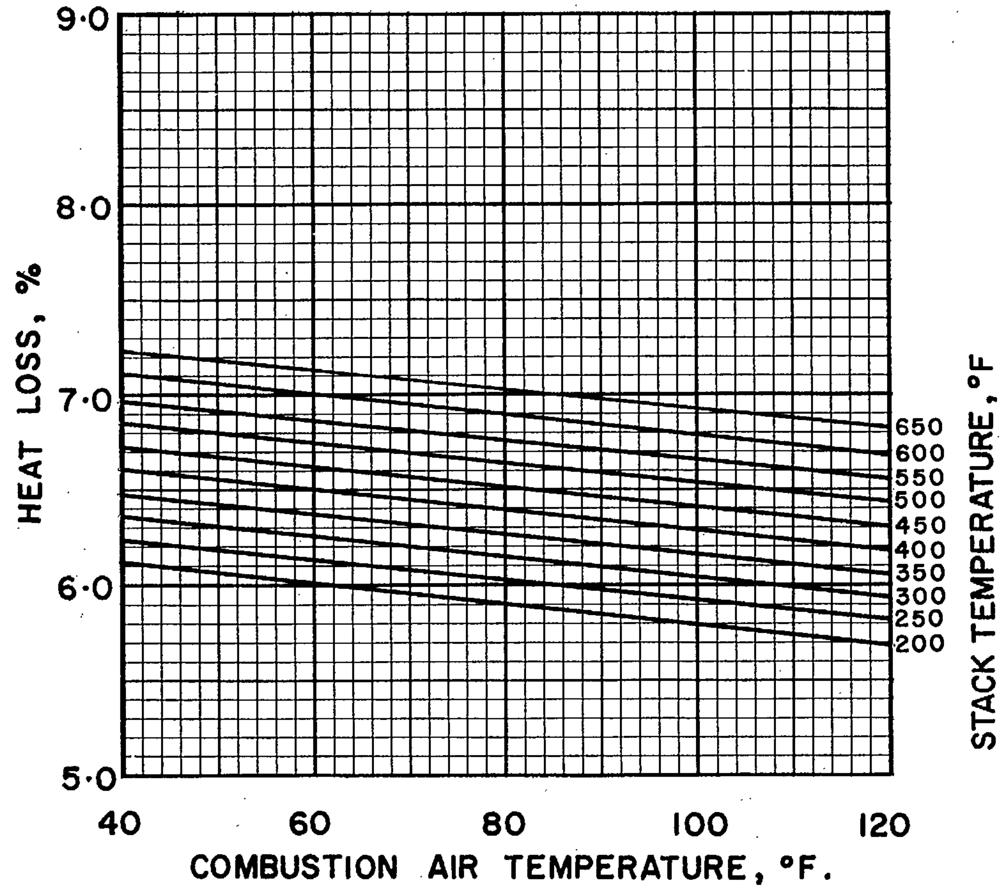


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

9930

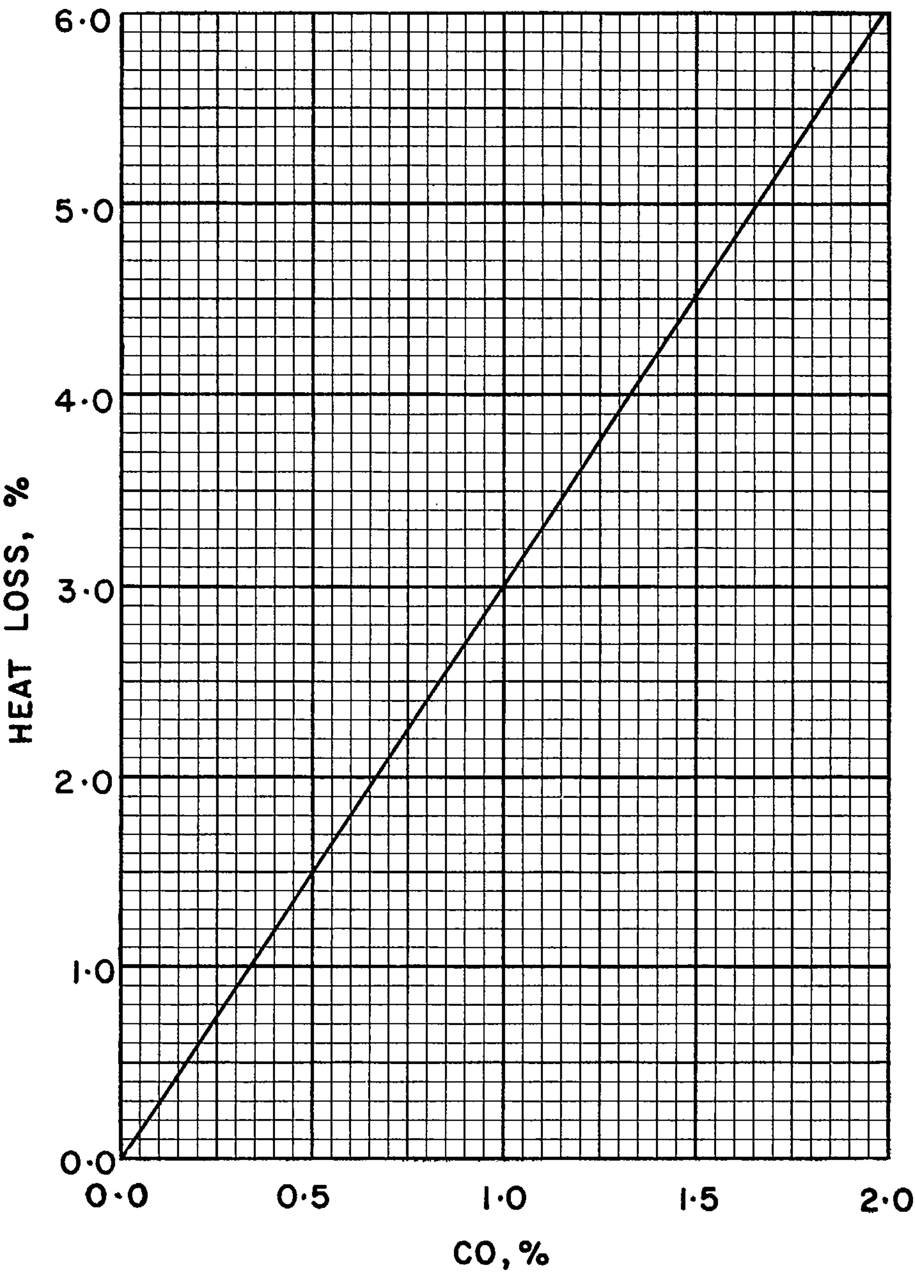


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

9930

FUEL OIL 9940, SPECIFIC GRAVITY 0.990

Ultimate Analysis, lb/lb

Carbon	(C)	0.8530
Hydrogen	(H_2)	0.1070
Sulphur	(S)	0.0400
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,030

Conversion Factors

1 Imp gal oil = 9.90 lb oil
or Imp gal oil × 9.90 = lb oil
or lb oil × 0.1010 = Imp gal oil

1 U.S. gal oil = 9.90 × 0.8337 lb oil
or U.S. gal oil × 8.254 = lb oil
or lb oil × 0.1212 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}030} \text{ lb oil}$$

or Btu × 10^6 × 55.46 = lb oil
or lb oil × 0.0180 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}030 \times 9.90} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.602 = Imp gal oil
or Imp gal oil × 0.1785 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}030 \times 8.254} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.720 = U.S. gal oil
or U.S. gal oil × 0.1488 = Btu × 10^6

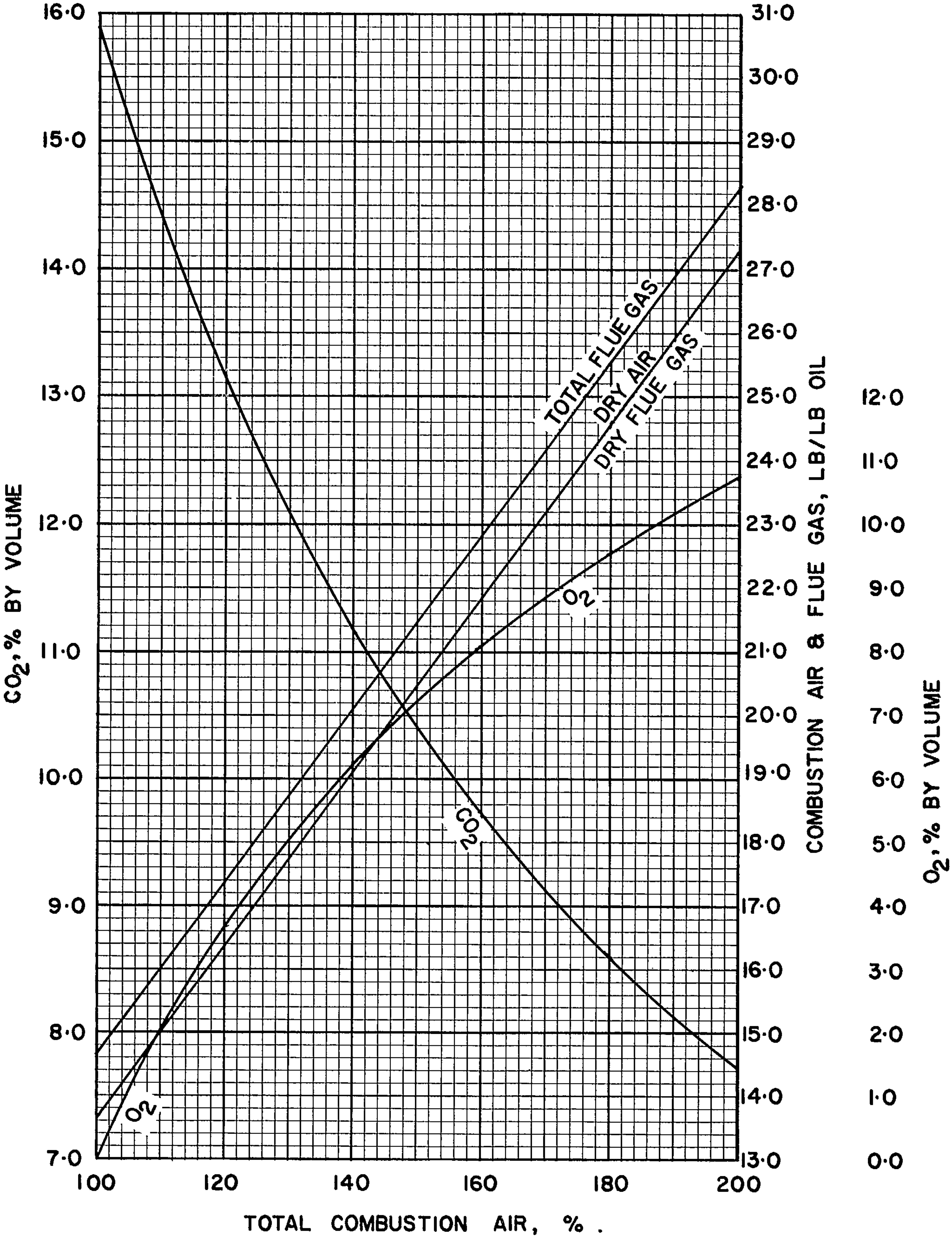


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS.

9940

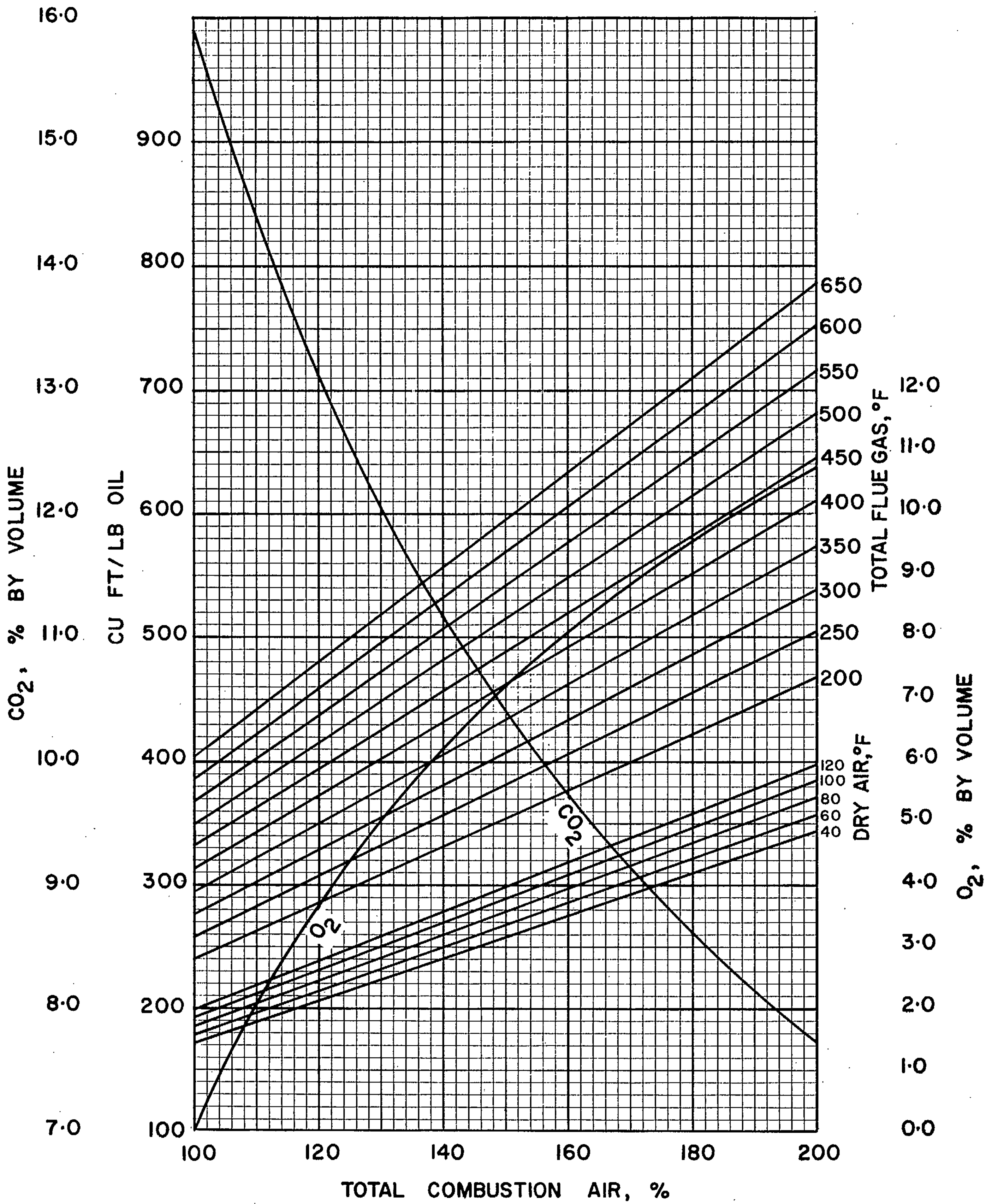


FIGURE 2. COMBUSTION DATA, VOLUME BASIS.

9940

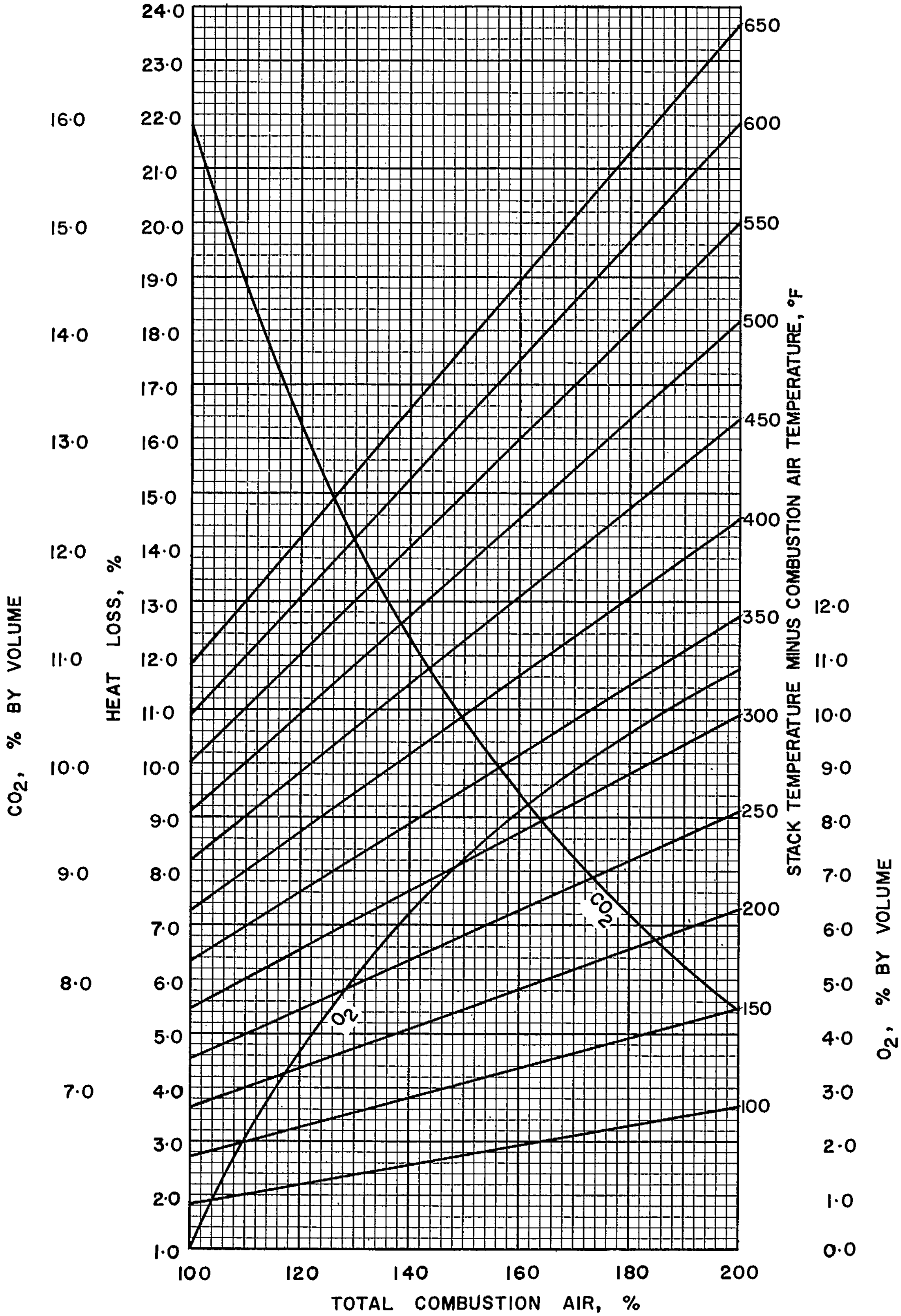


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

9940

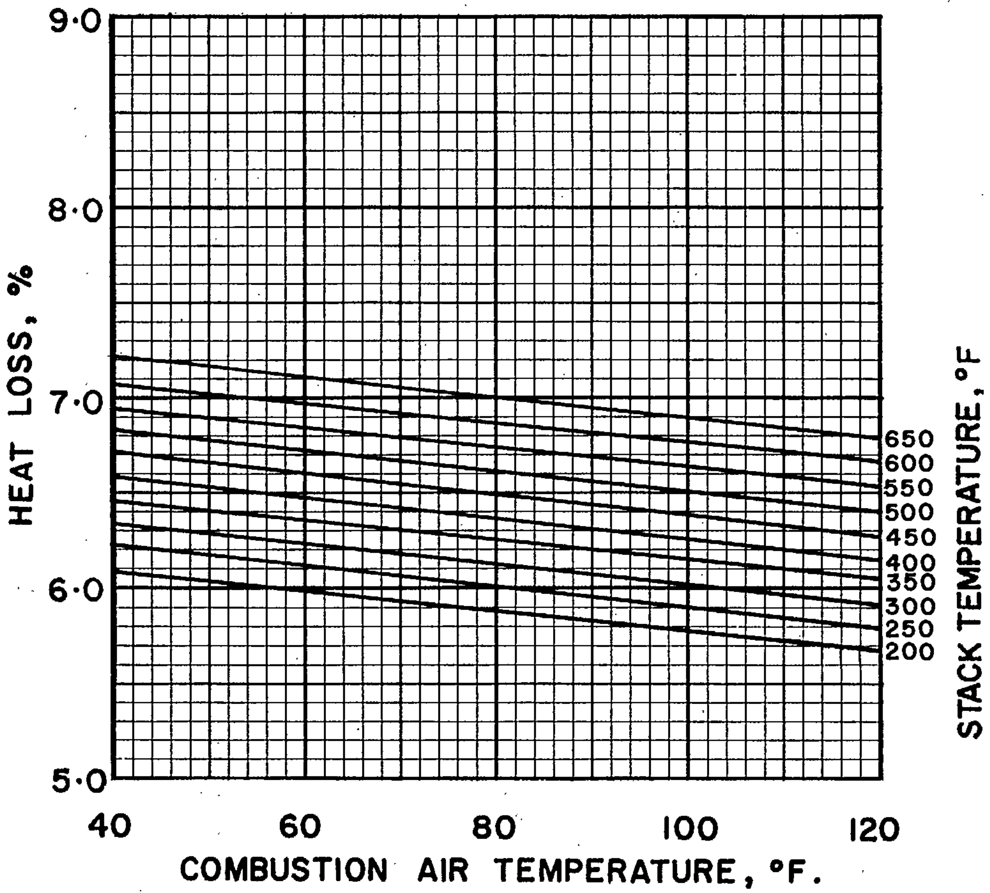


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

9940

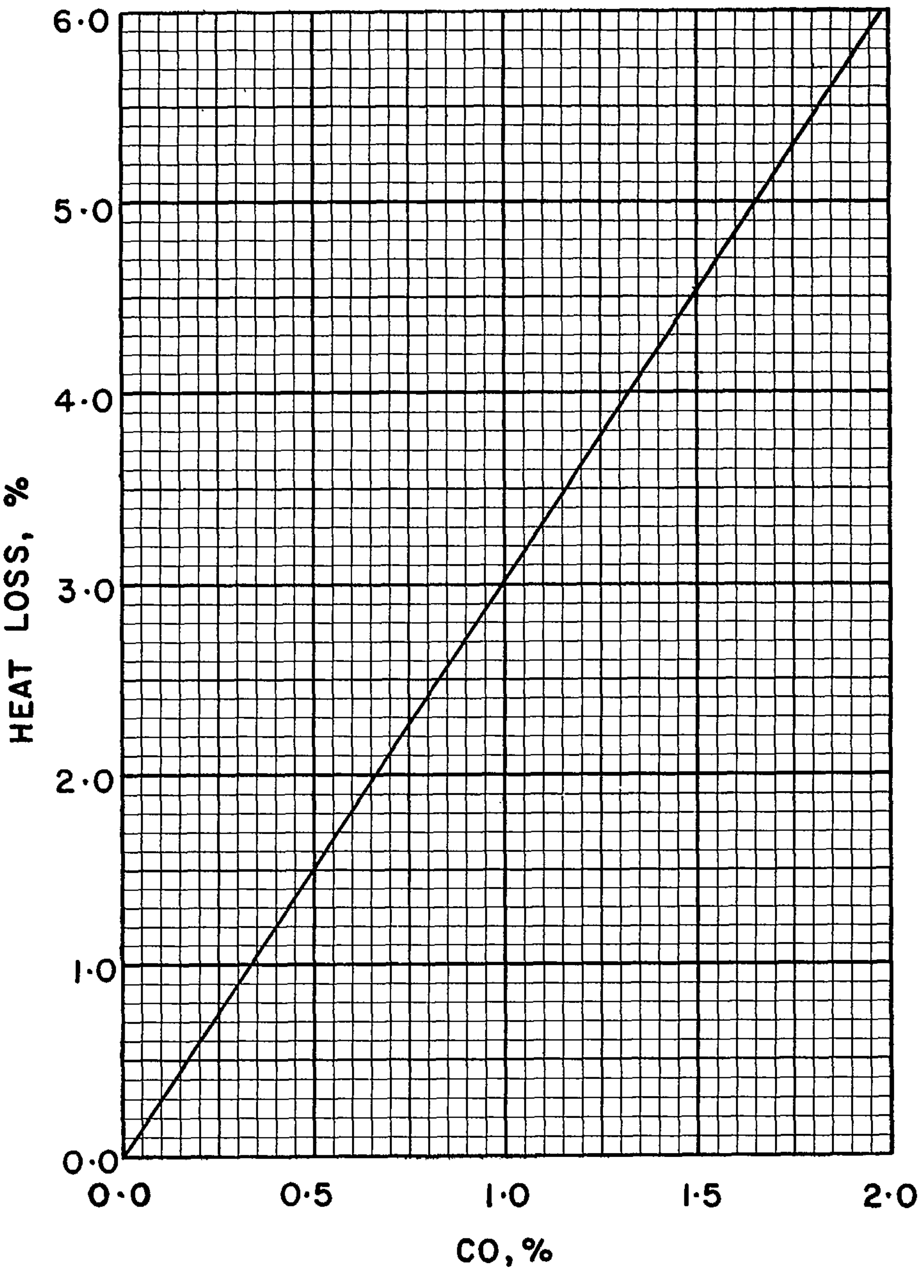


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

9940

FUEL OIL 10000, SPECIFIC GRAVITY 1.000

Ultimate Analysis, lb/lb

Carbon	(C)	0.8900
Hydrogen	(H_2)	0.1100
Sulphur	(S)	–
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,540

Conversion Factors

1 Imp gal oil = 10.00 lb oil
or Imp gal oil × 10.00 = lb oil
or lb oil × 0.1000 = Imp gal oil

1 U.S. gal oil = 10.00 × 0.8337 lb oil
or U.S. gal oil × 8.337 = lb oil
or lb oil × 0.1200 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}540} \text{ lb oil}$$

or Btu × 10^6 × 53.94 = lb oil
or lb oil × 0.0185 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}540 \times 10.0} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.394 = Imp gal oil
or Imp gal oil × 0.1854 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}540 \times 8.337} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.468 = U.S. gal oil
or U.S. gal oil × 0.1546 = Btu × 10^6

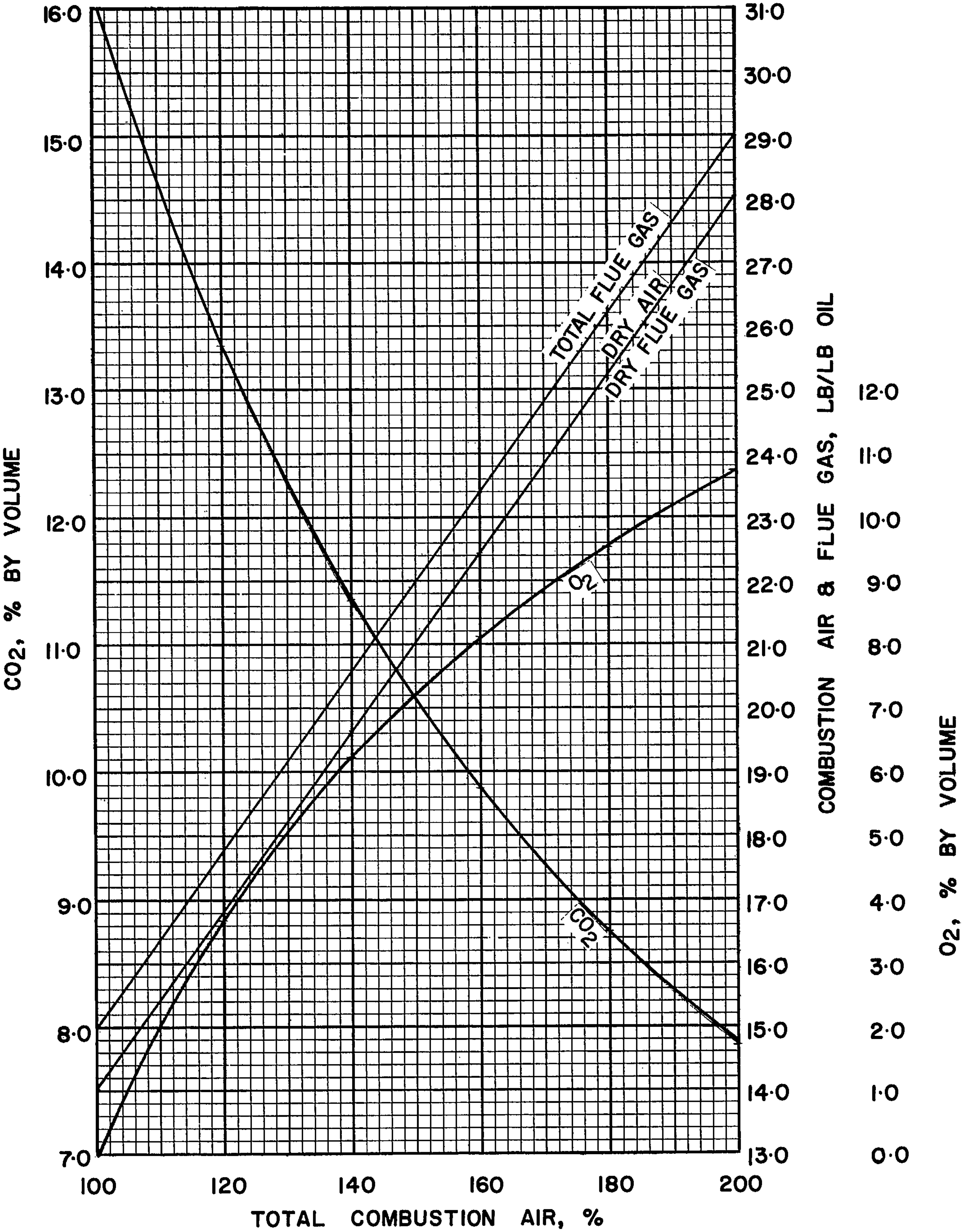


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS

10000

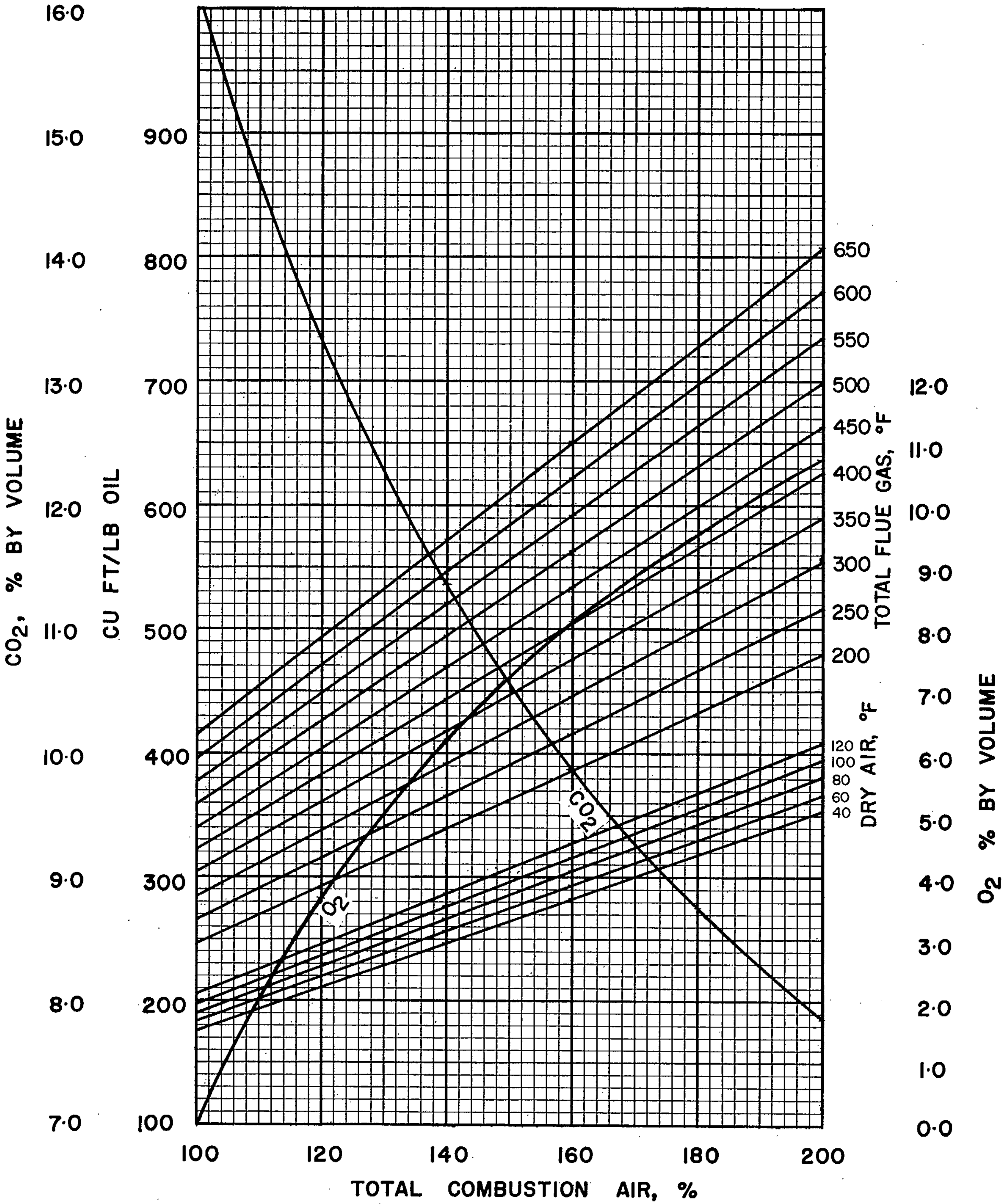


FIGURE 2· COMBUSTION DATA, VOLUME BASIS

10000

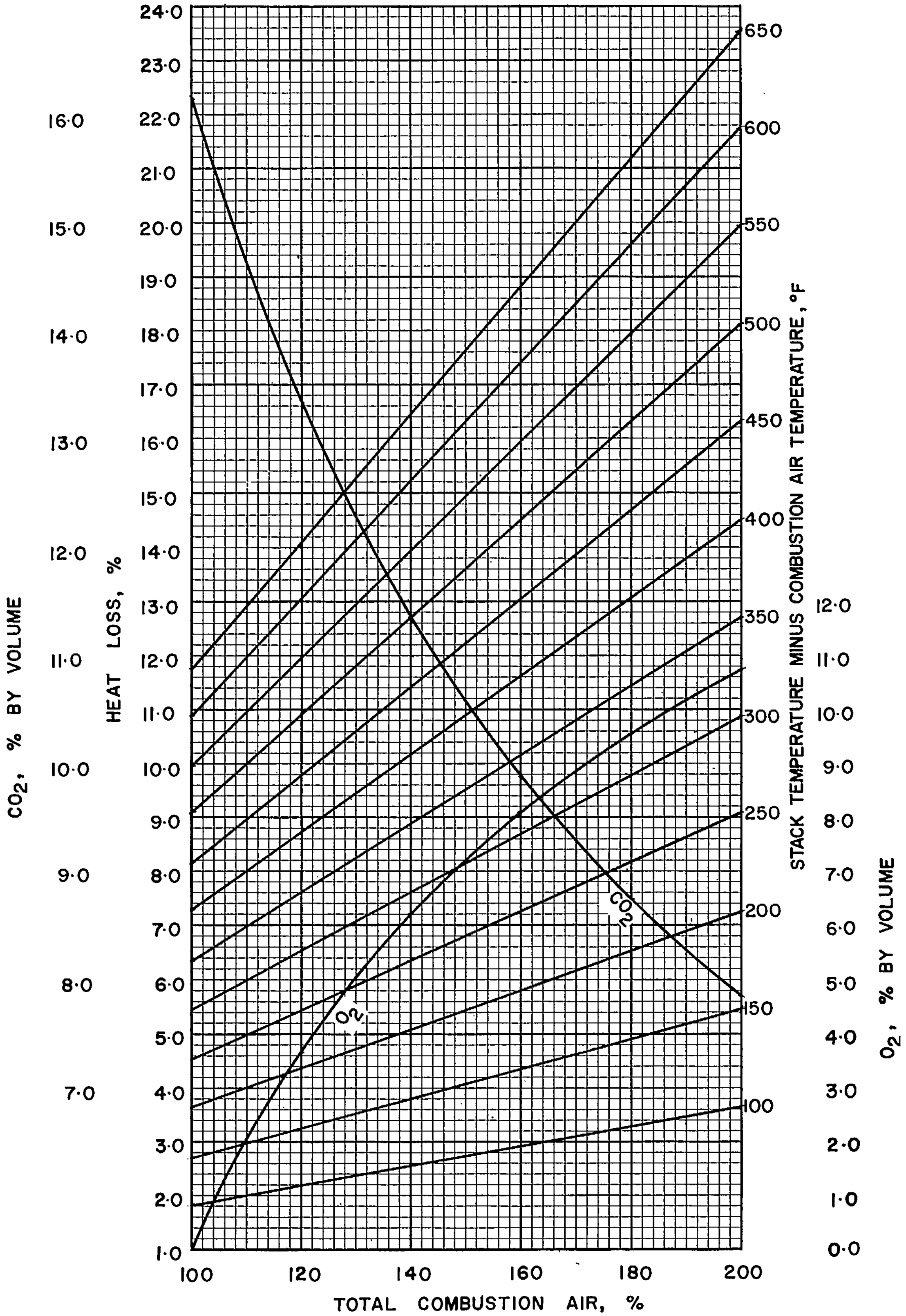


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

10 000

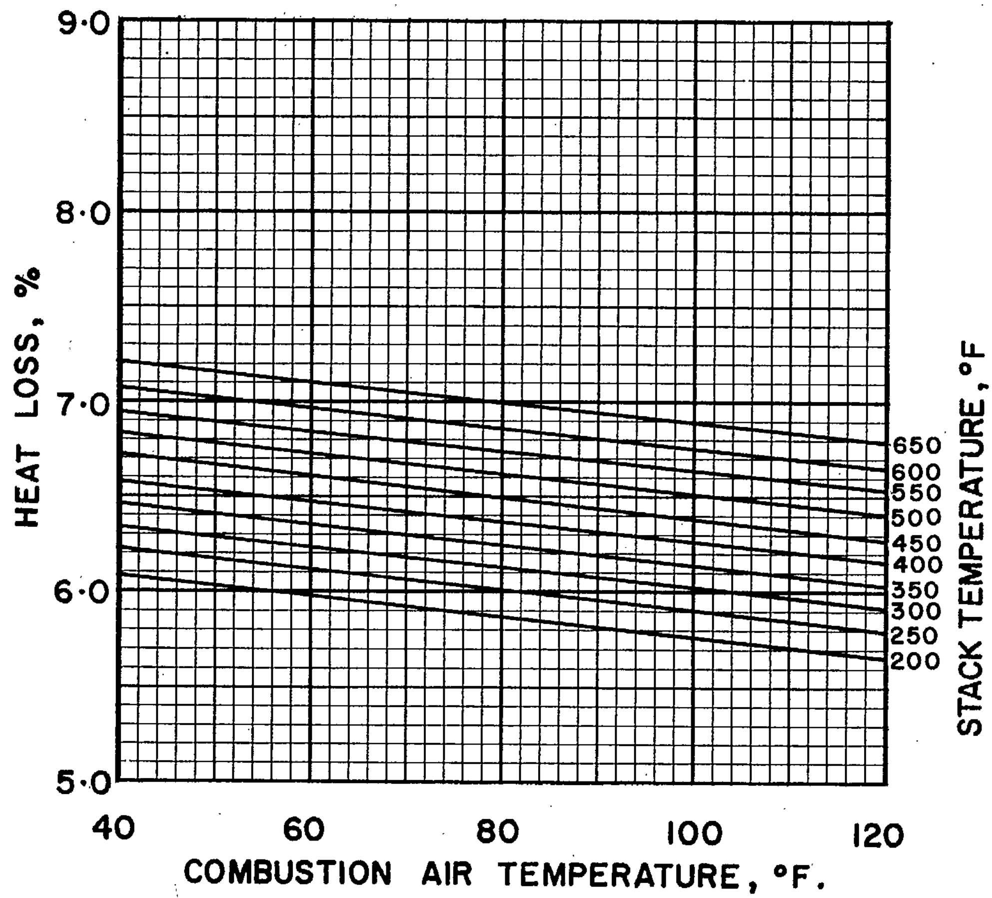


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

10000

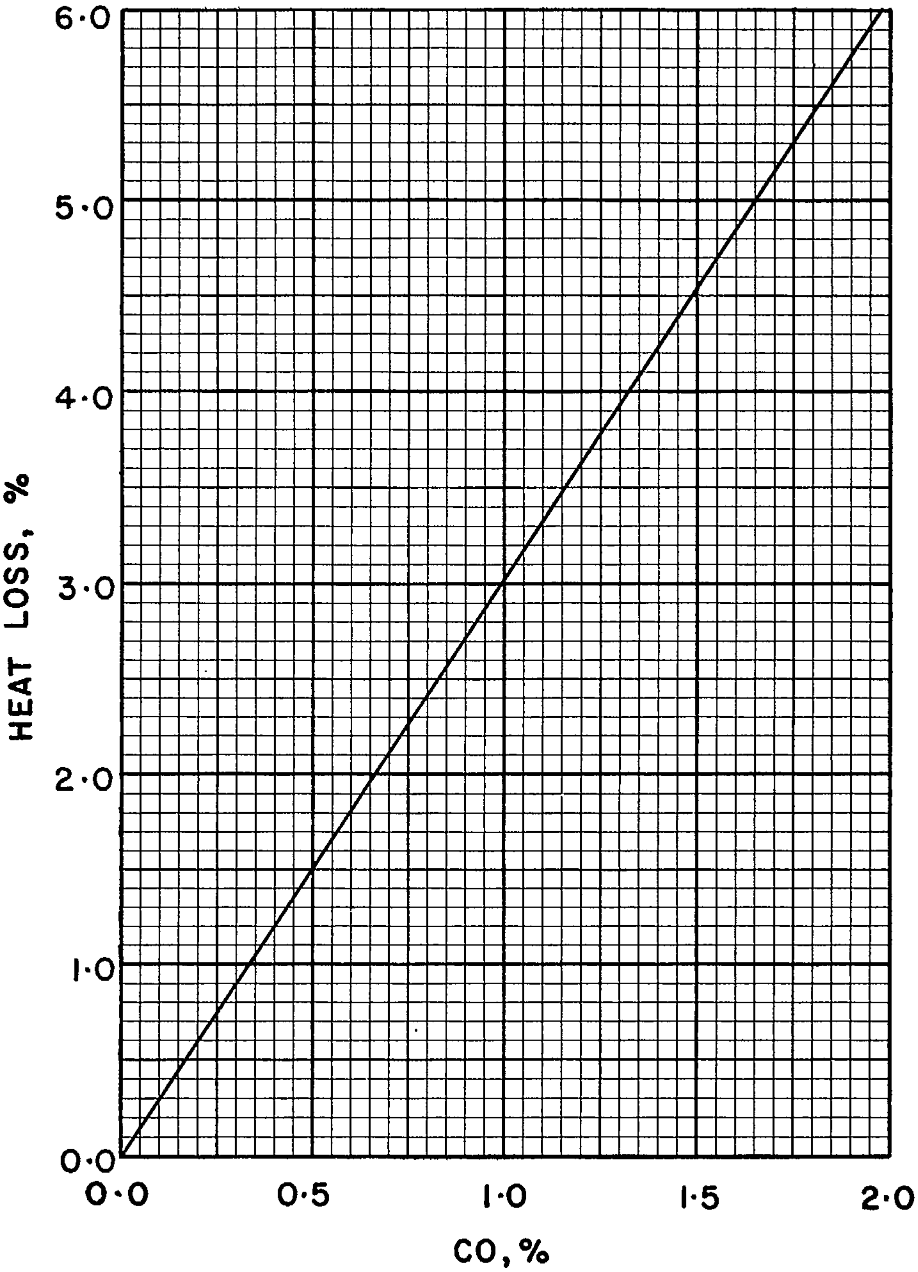


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

10000

FUEL OIL 10010, SPECIFIC GRAVITY 1.000

Ultimate Analysis, lb/lb

Carbon	(C)	0.8811
Hydrogen	(H_2)	0.1089
Sulphur	(S)	0.0100
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,400

Conversion Factors

1 Imp gal oil = 10.00 lb oil
or Imp gal oil × 10.00 = lb oil
or lb oil × 0.100 = Imp gal oil

1 U.S. gal oil = 10.00 × 0.8337 lb oil
or U.S. gal oil × 8.337 = lb oil
or lb oil × 0.1200 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}400} \text{ lb oil}$$

or Btu × 10^6 × 54.35 = lb oil
or lb oil × 0.0184 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}400 \times 10.0} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.435 = Imp gal oil
or Imp gal oil × 0.1840 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}400 \times 8.337} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.519 = U.S. gal oil
or U.S. gal oil × 0.1534 = Btu × 10^6

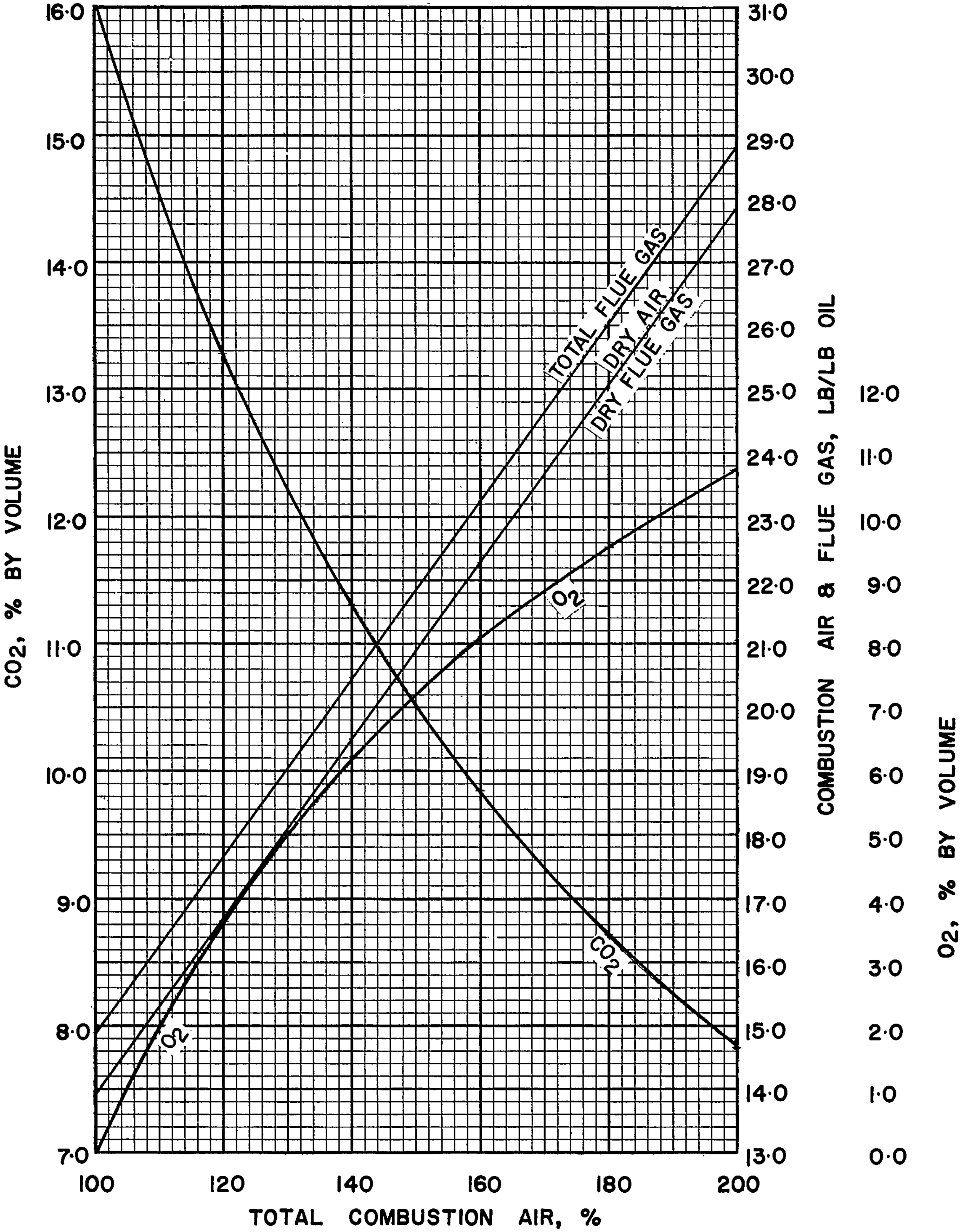


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS

10010

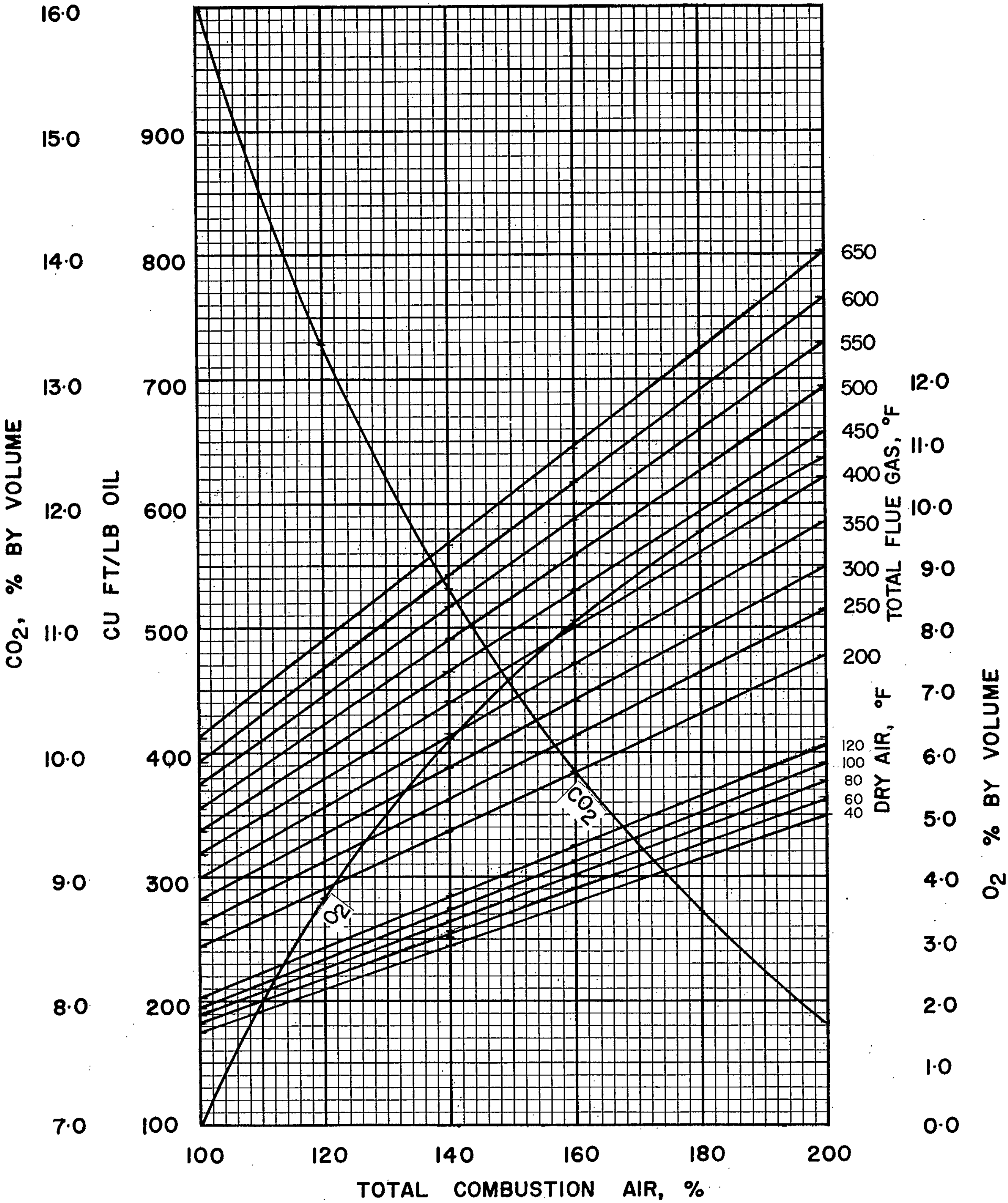


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 10010

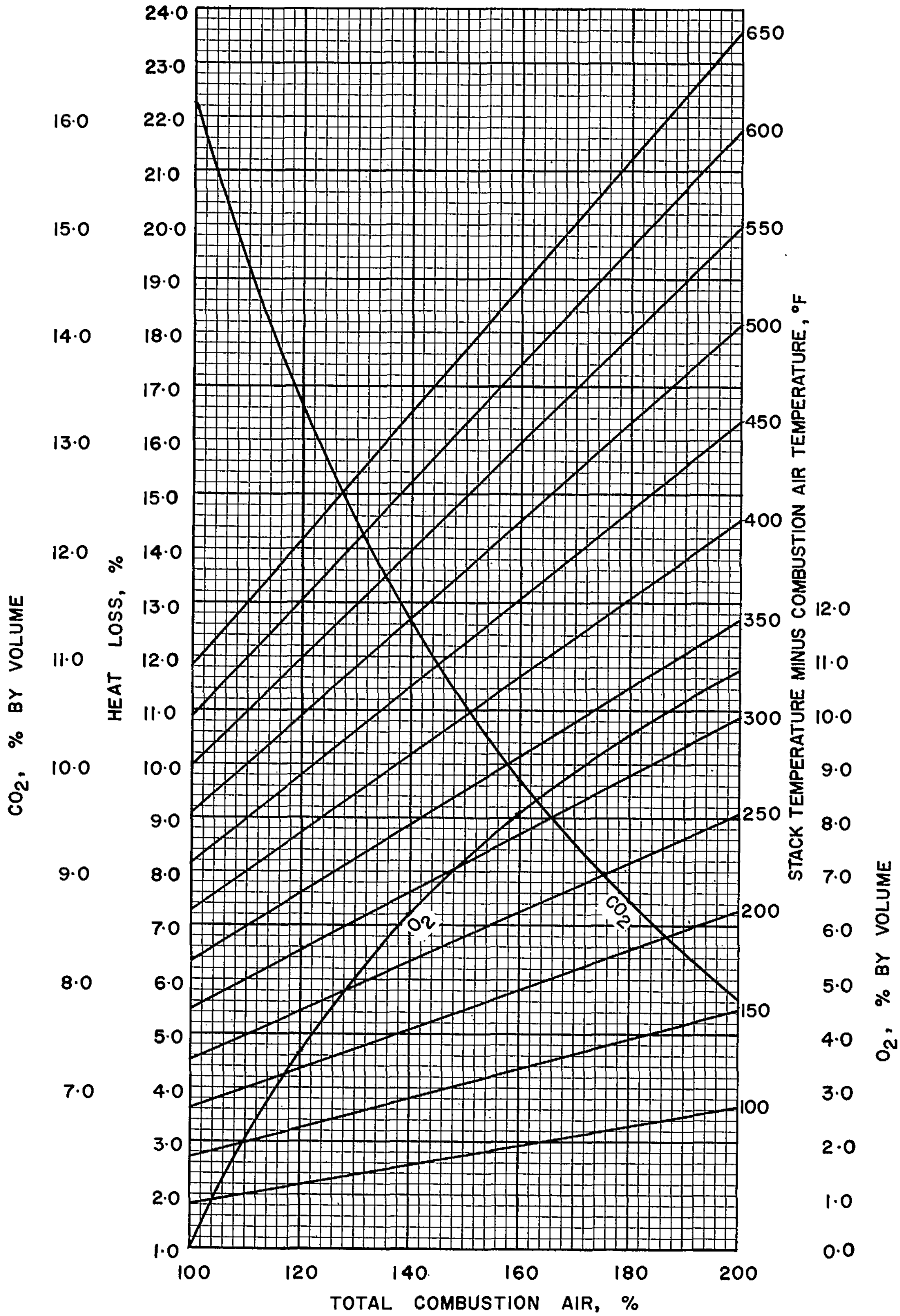


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

10010

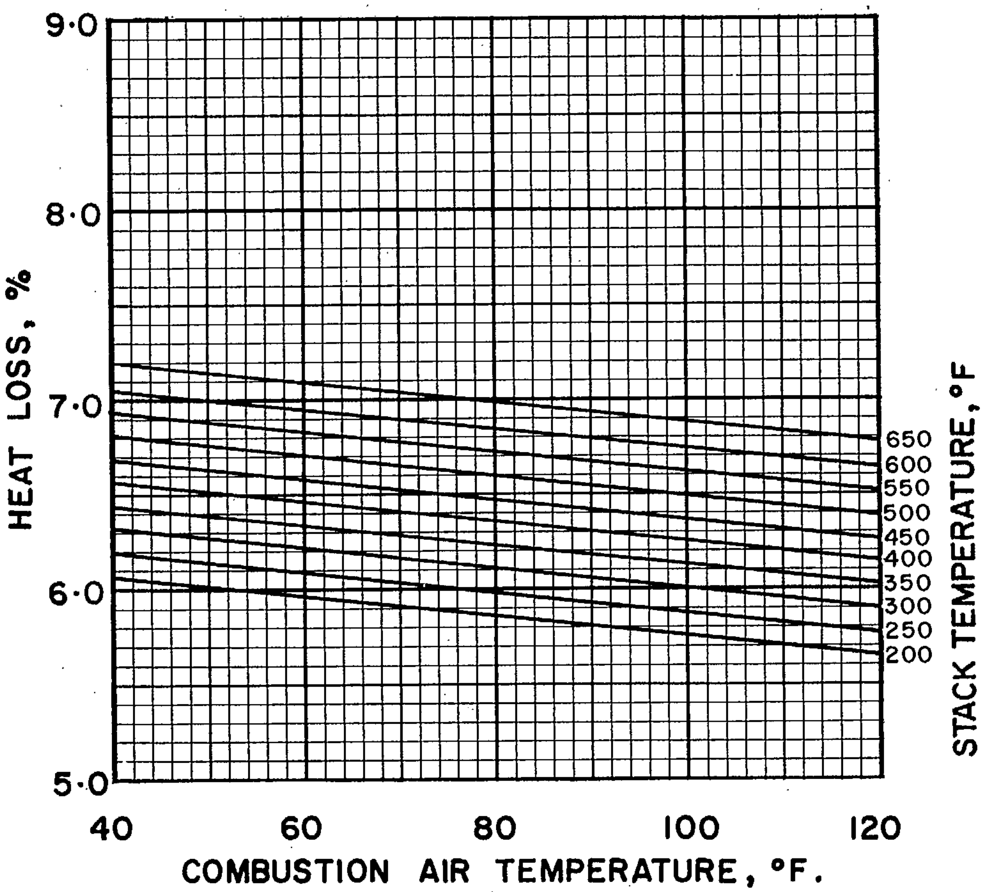


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

10010

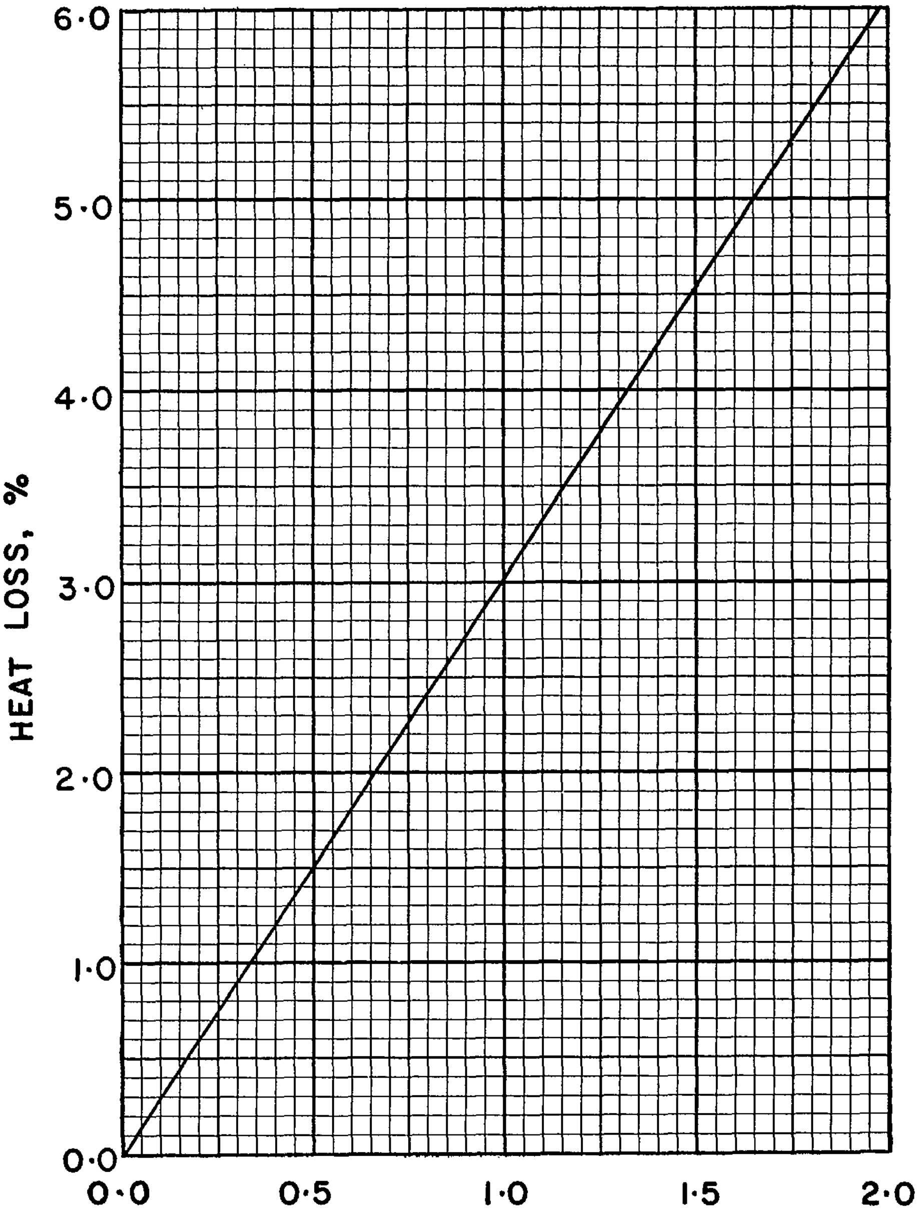


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

10010

FUEL OIL 10020, SPECIFIC GRAVITY 1.000

Ultimate Analysis, lb/lb

Carbon	(C)	0.8722
Hydrogen	(H_2)	0.1078
Sulphur	(S)	0.0200
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,250

Conversion Factors

1 Imp gal oil = 10.00 lb oil
or Imp gal oil × 10.00 = lb oil
or lb oil × 0.100 = Imp gal oil

1 U.S. gal oil = 10.00 × 0.8337 lb oil
or U.S. gal oil × 8.337 = lb oil
or lb oil × 0.1200 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}250} \text{ lb oil}$$

or Btu × 10^6 × 54.80 = lb oil
or lb oil × 0.0183 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}250 \times 10} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.480 = Imp gal oil
or Imp gal oil × 0.1825 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}250 \times 8.337} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.570 = U.S. gal oil
or U.S. gal oil × 0.1522 = Btu × 10^6

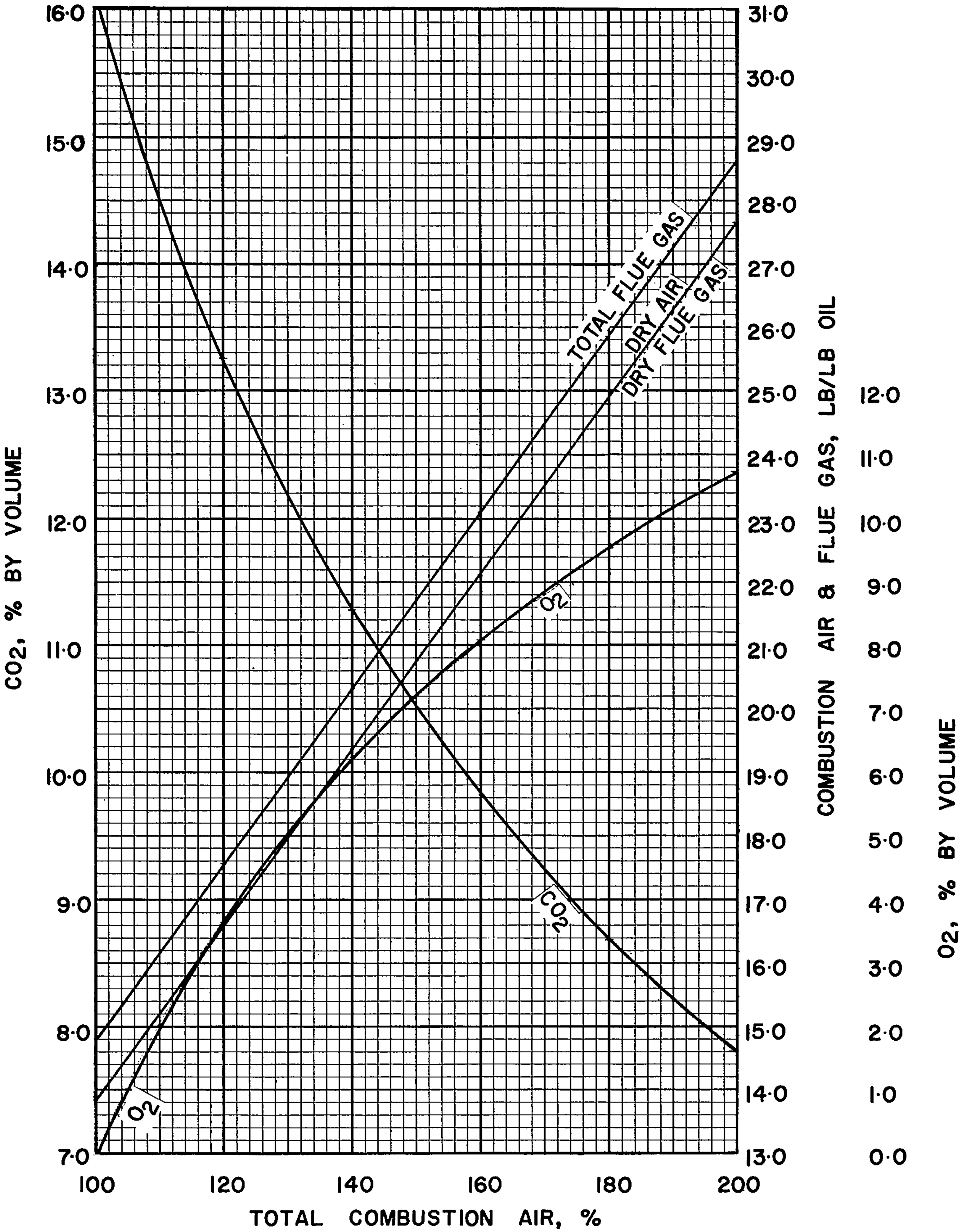


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS

10020

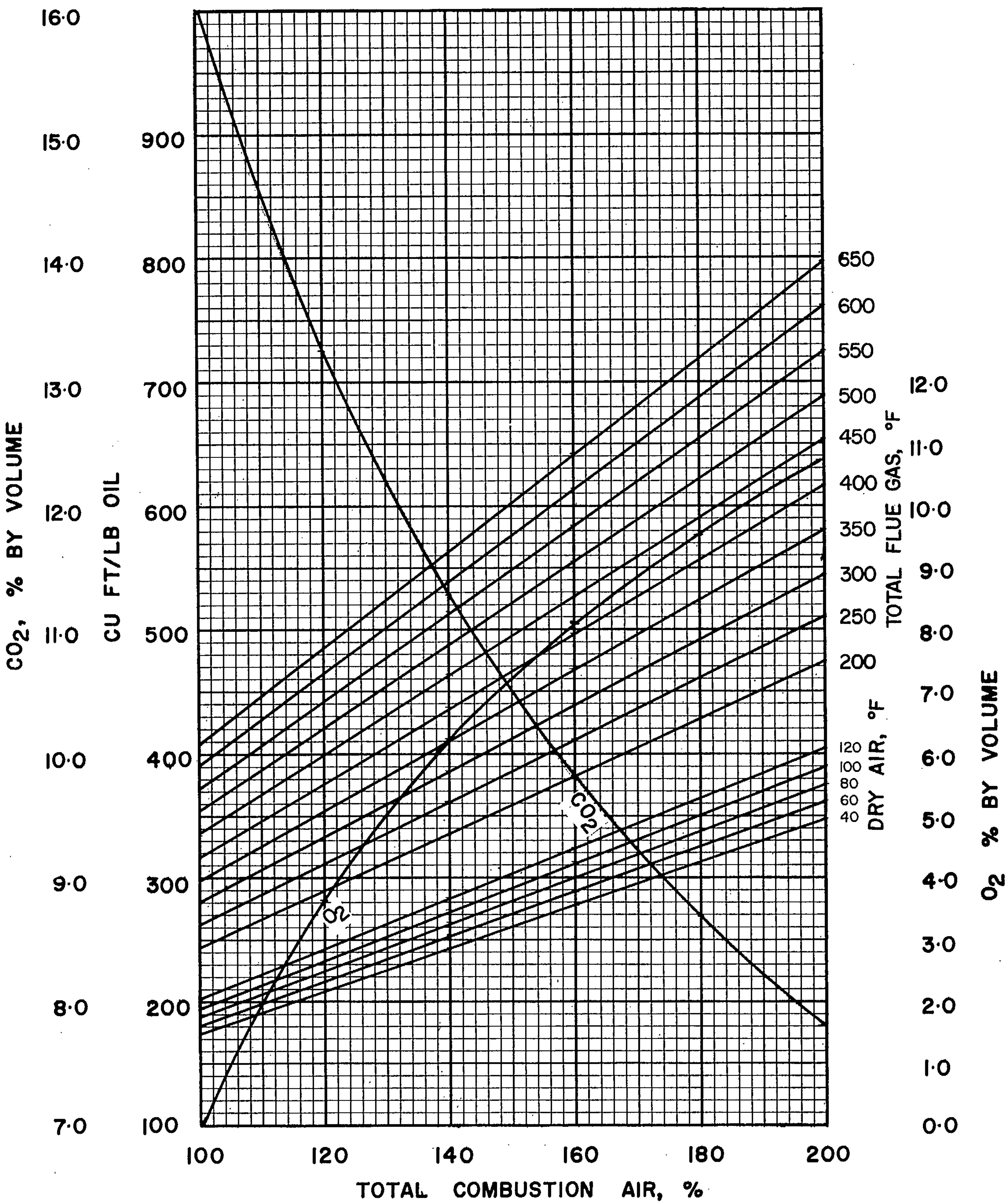


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 10020

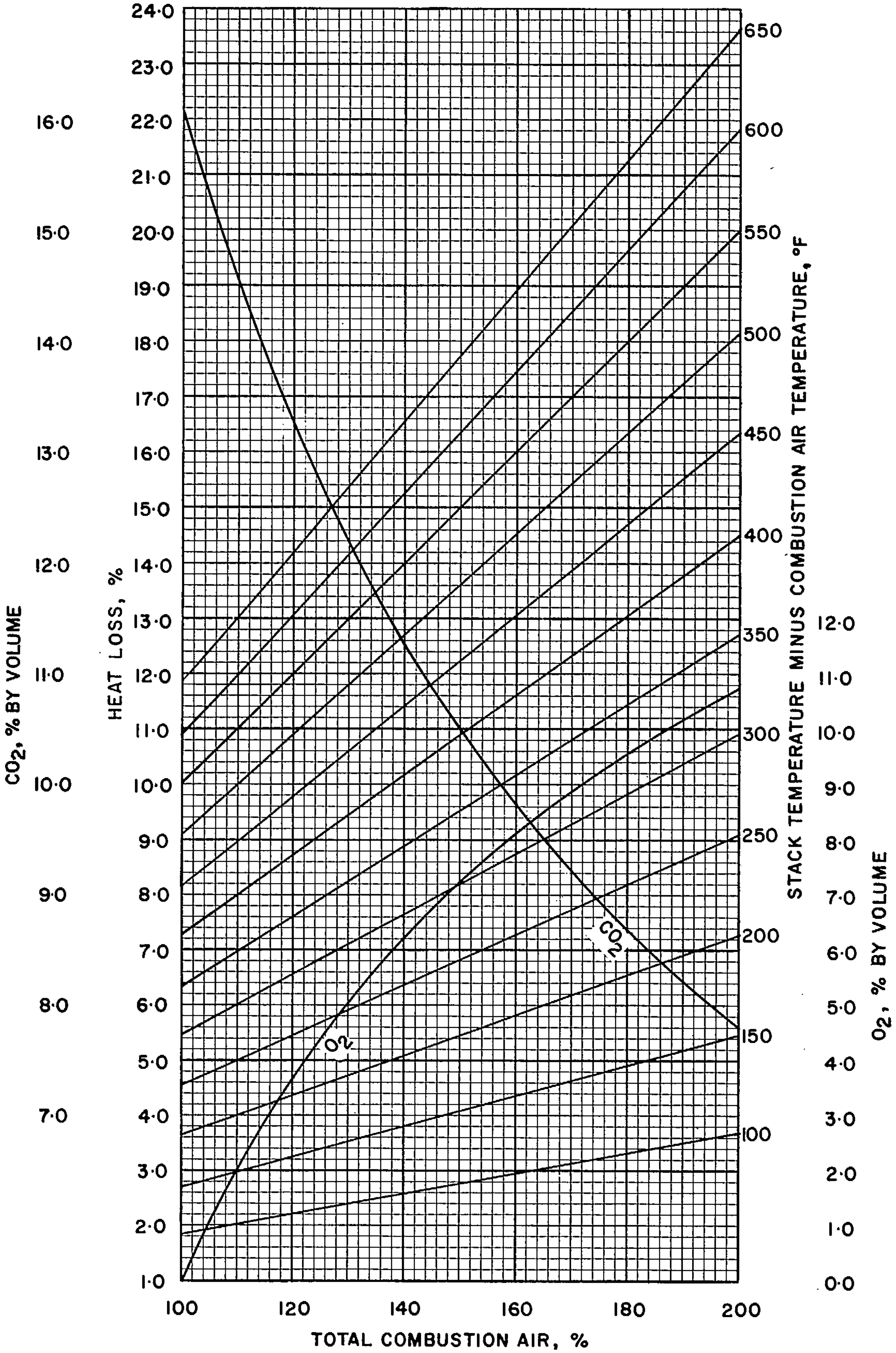


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS·

10020

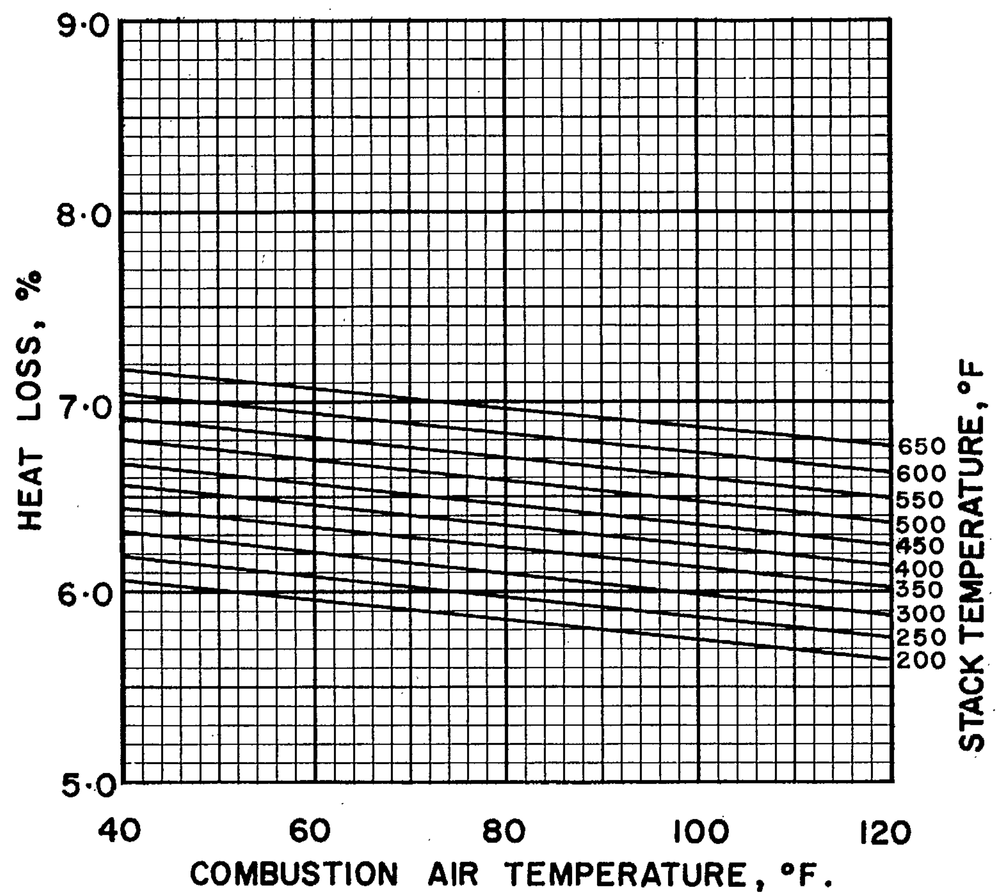


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

10020

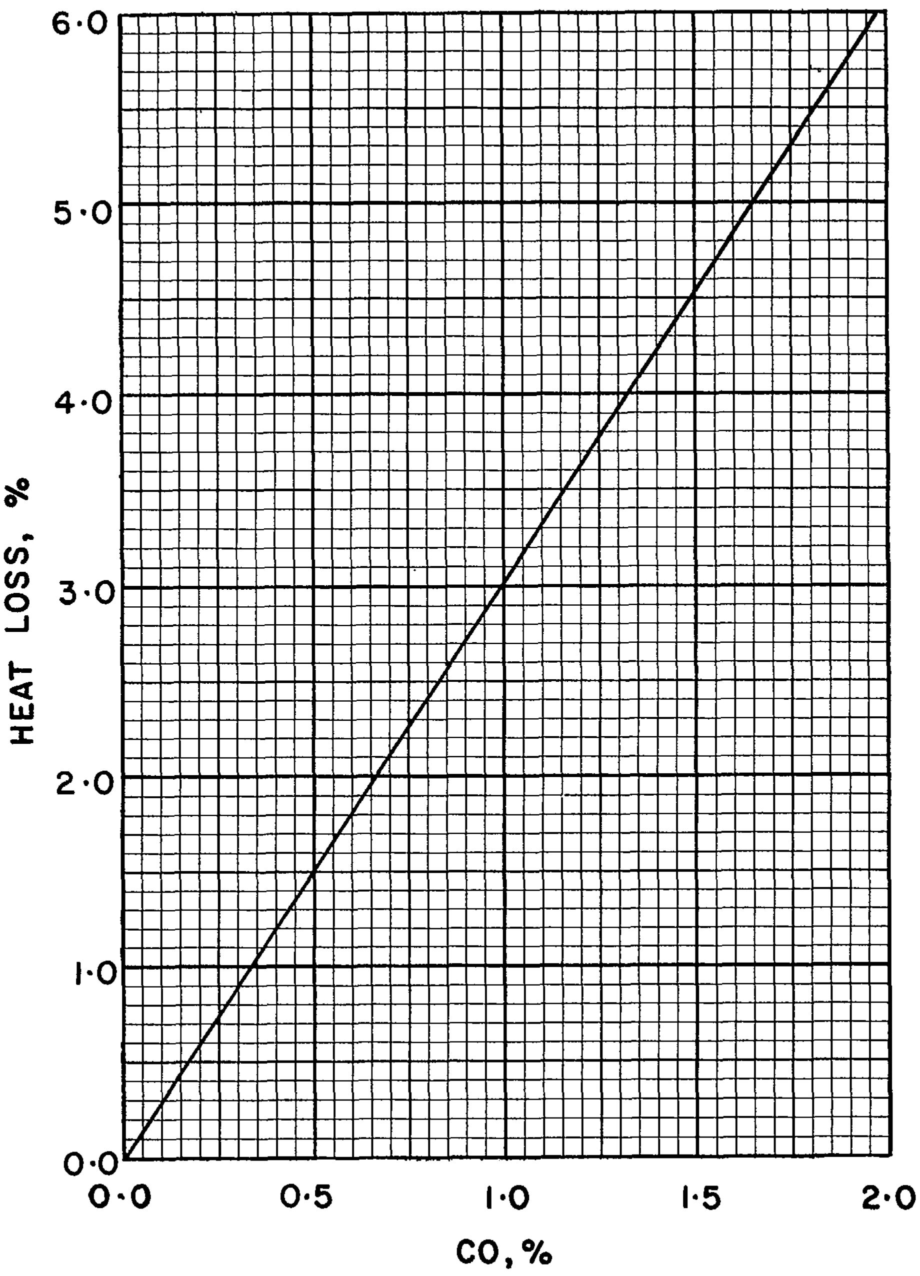


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

10020

FUEL OIL 10030, SPECIFIC GRAVITY 1.000

Ultimate Analysis, lb/lb

Carbon	(C)	0.8633
Hydrogen	(H_2)	0.1067
Sulphur	(S)	0.0300
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,110

Conversion Factors

1 Imp gal oil = 10.00 lb oil
or Imp gal oil × 10.00 = lb oil
or lb oil × 0.100 = Imp gal oil

1 U.S. gal oil = 10.00 × 0.8337 lb oil
or U.S. gal oil × 8.337 = lb oil
or lb oil × 0.1200 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}110} \text{ lb oil}$$

or Btu × 10^6 × 55.22 = lb oil
or lb oil × 0.0181 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}110 \times 10.00} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.522 = Imp gal oil
or Imp gal oil × 0.1811 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}110 \times 8.337} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.622 = U.S. gal oil
or U.S. gal oil × 0.1510 = Btu × 10^6

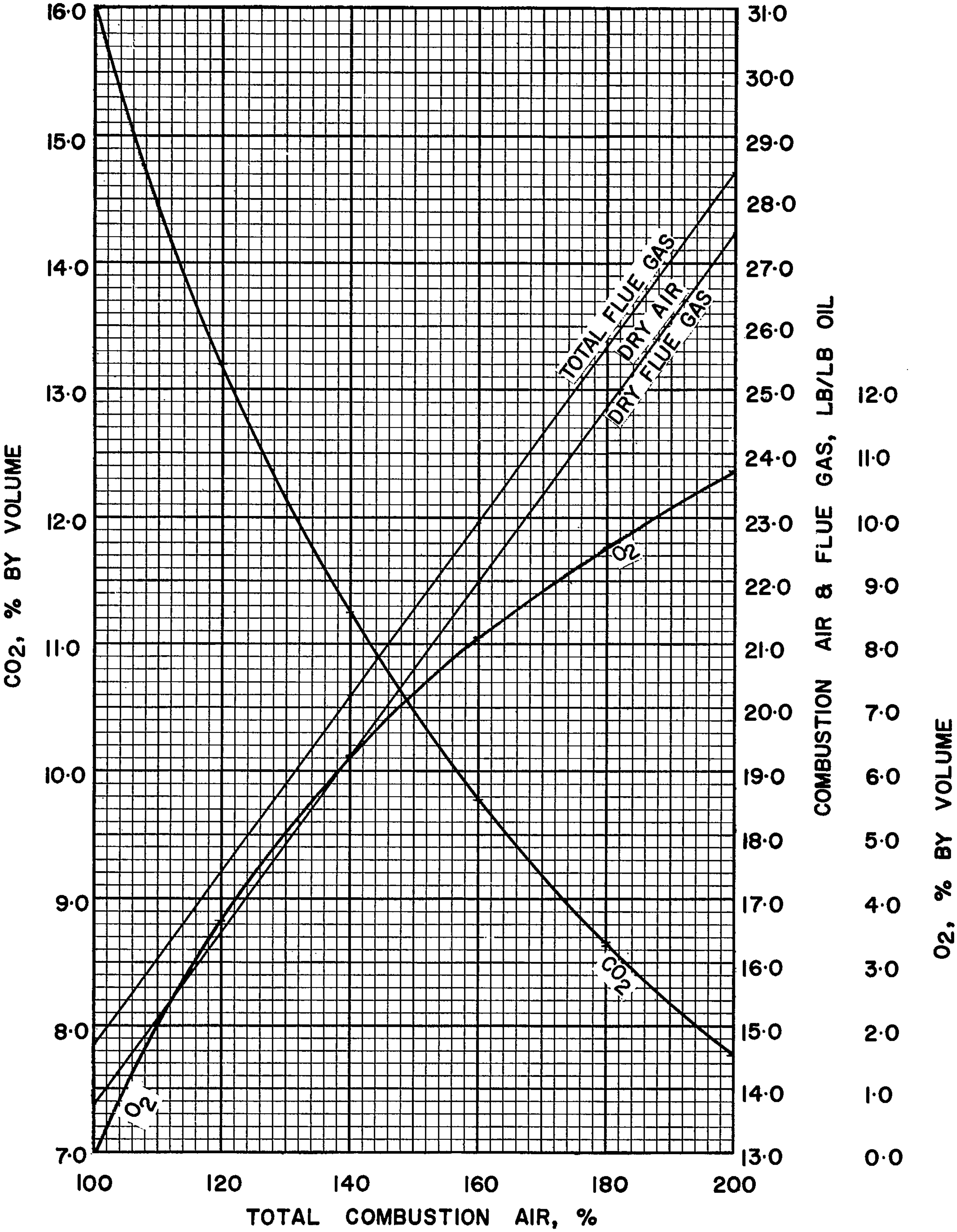


FIGURE I· COMBUSTION DATA, WEIGHT BASIS 10030

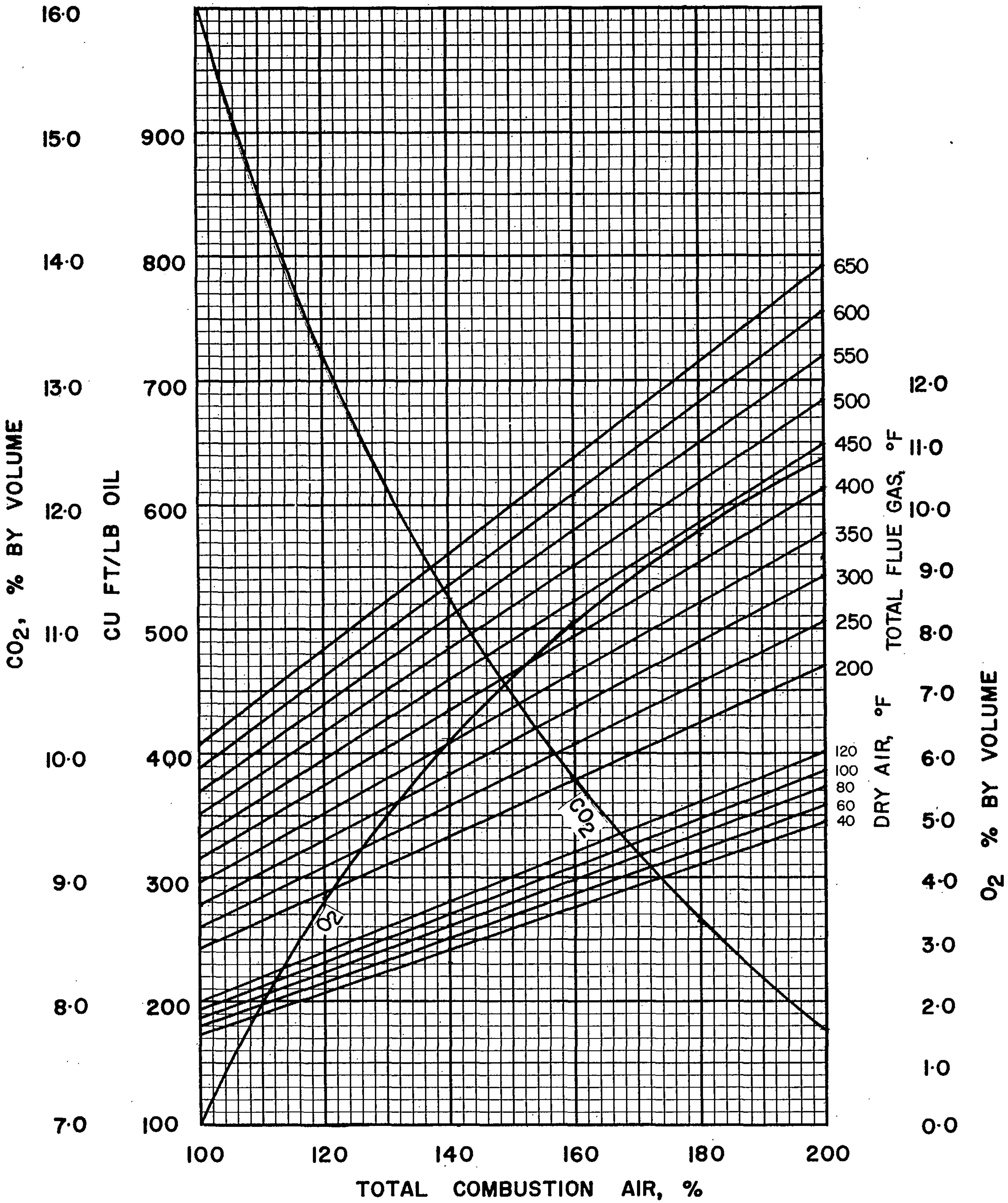


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 10030

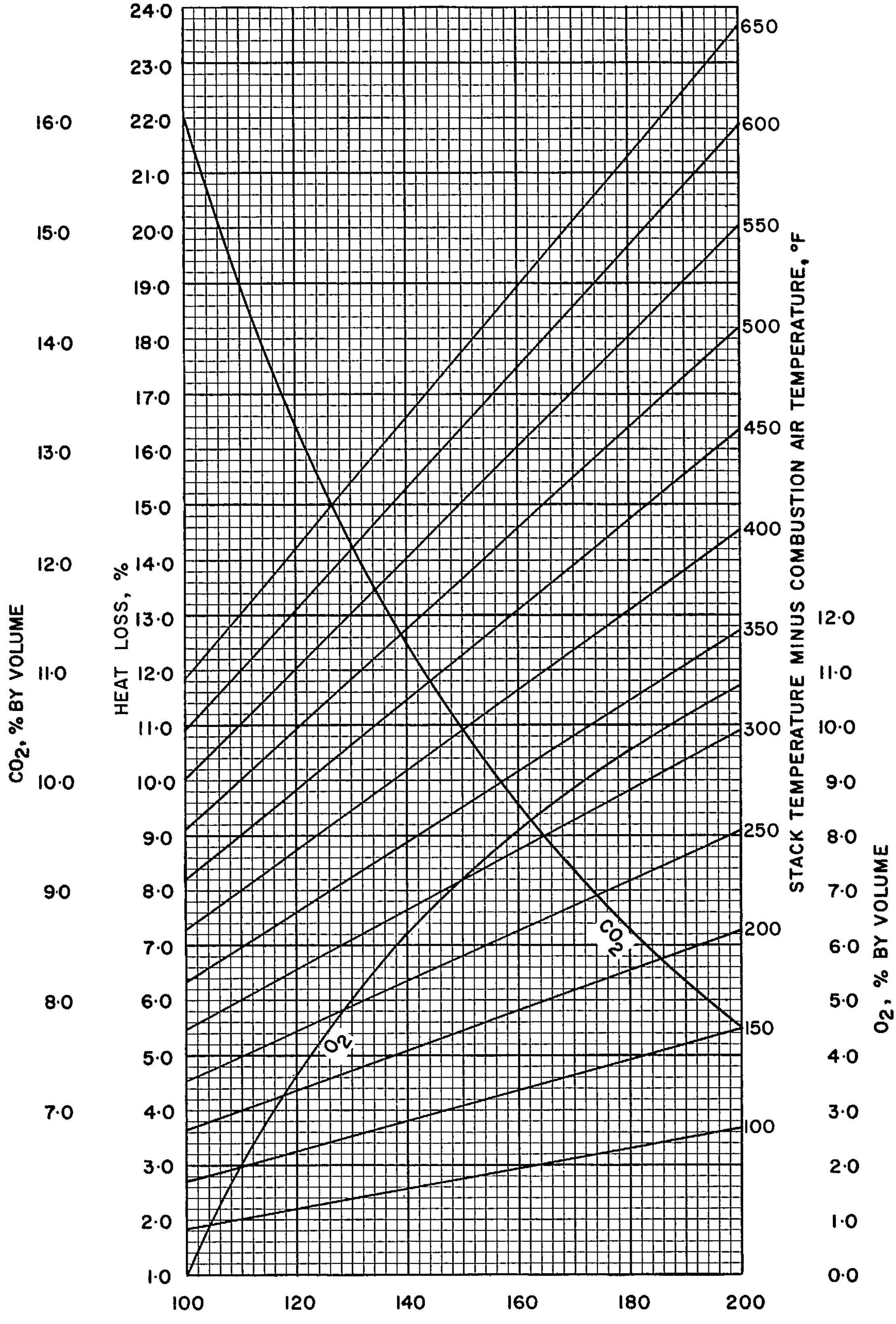


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS·

10030

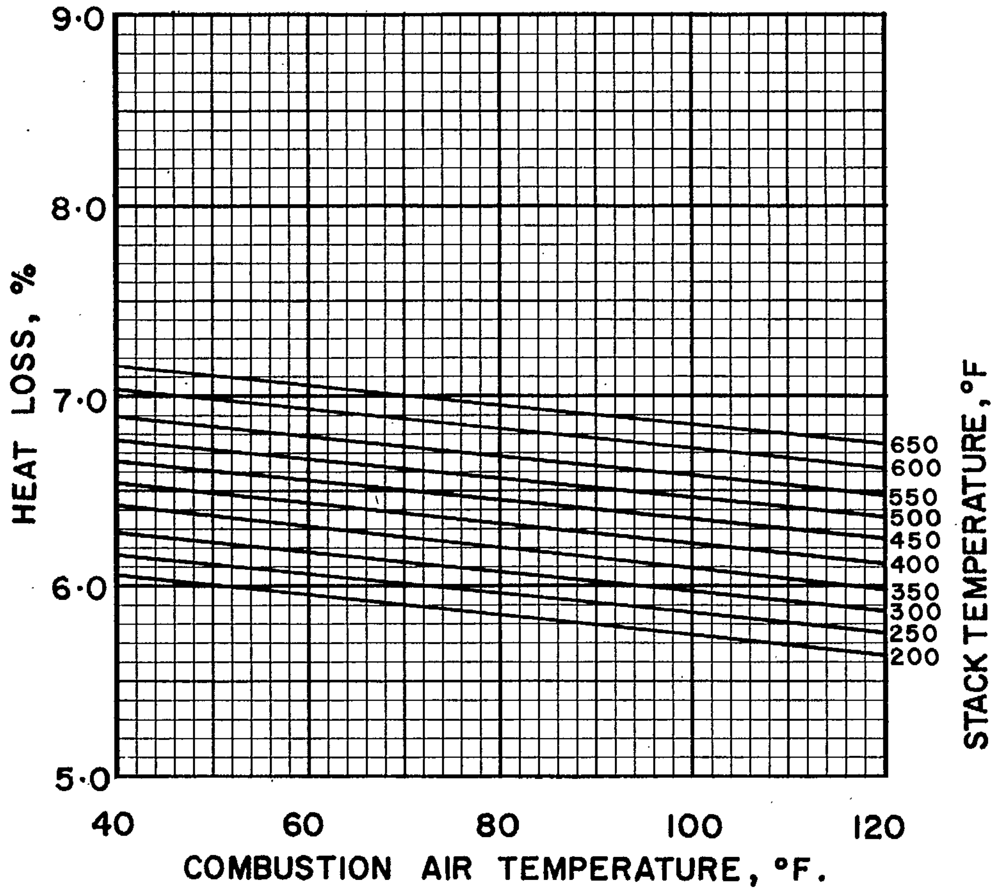


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

10030

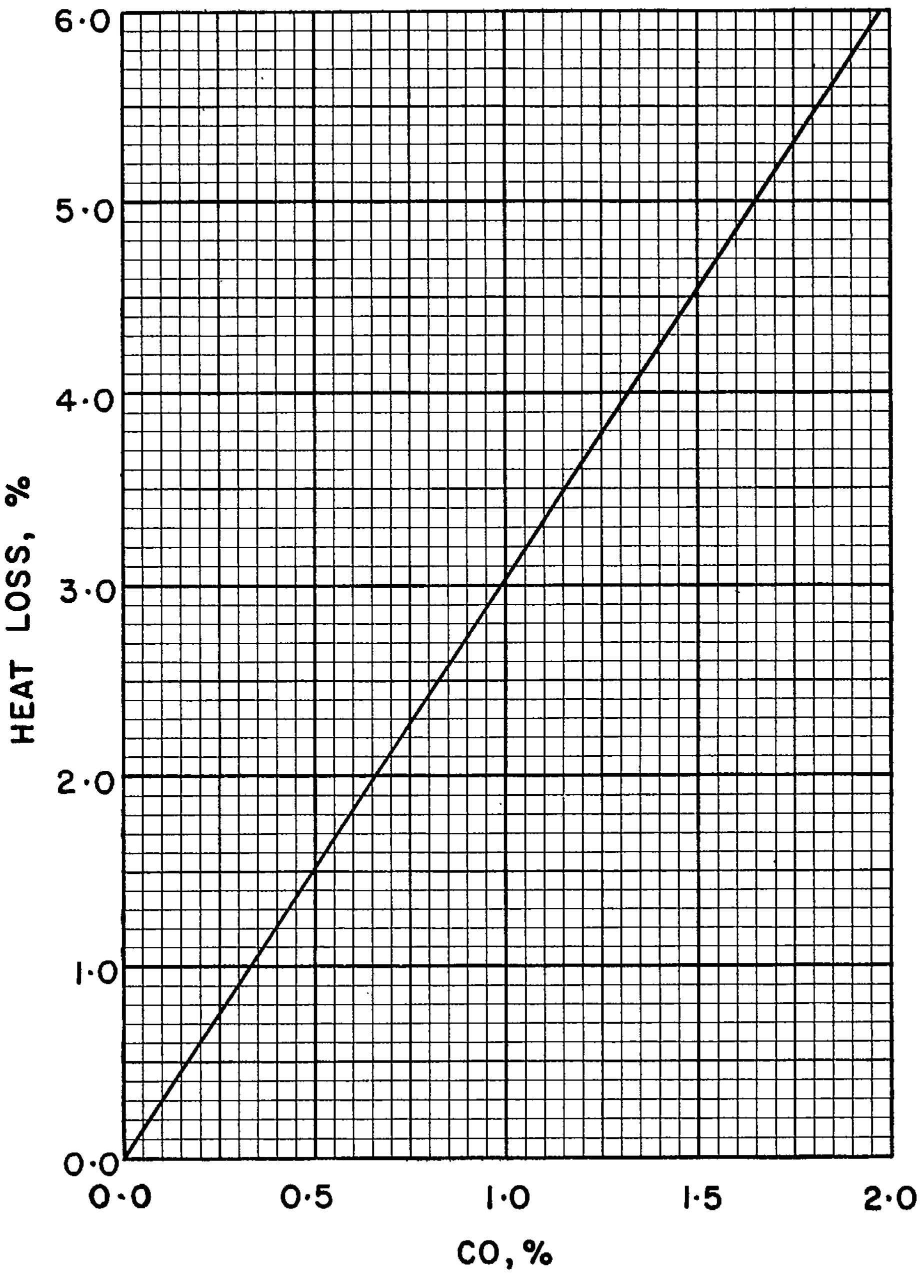


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

10030

FUEL OIL 10040, SPECIFIC GRAVITY 1.000

Ultimate Analysis, lb/lb

Carbon	(C)	0.8544
Hydrogen	(H_2)	0.1056
Sulphur	(S)	0.0400
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		17,960

Conversion Factors

1 Imp gal oil = 10.00 lb oil
or Imp gal oil × 10.00 = lb oil
or lb oil × 0.100 = Imp gal oil

1 U.S. gal oil = 10.00 × 0.8337 lb oil
or U.S. gal oil × 8.337 = lb oil
or lb oil × 0.1200 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{17{,}960} \text{ lb oil}$$

or Btu × 10^6 × 55.68 = lb oil
or lb oil × 0.0180 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{17{,}960 \times 10.00} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.568 = Imp gal oil
or Imp gal oil × 0.1796 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{17{,}960 \times 8.337} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.680 = U.S. gal oil
or U.S. gal oil × 0.1497 = Btu × 10^6

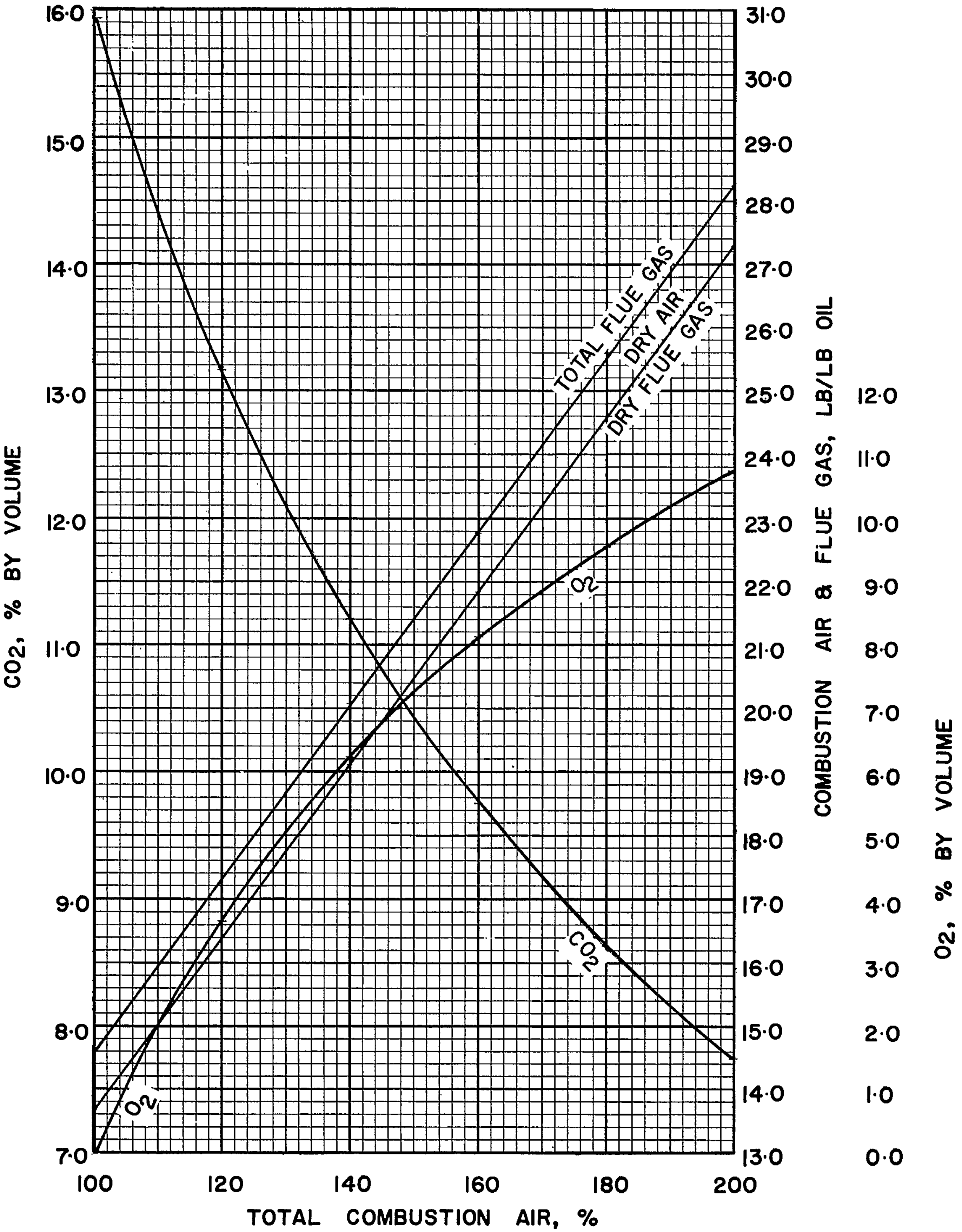


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS

10040

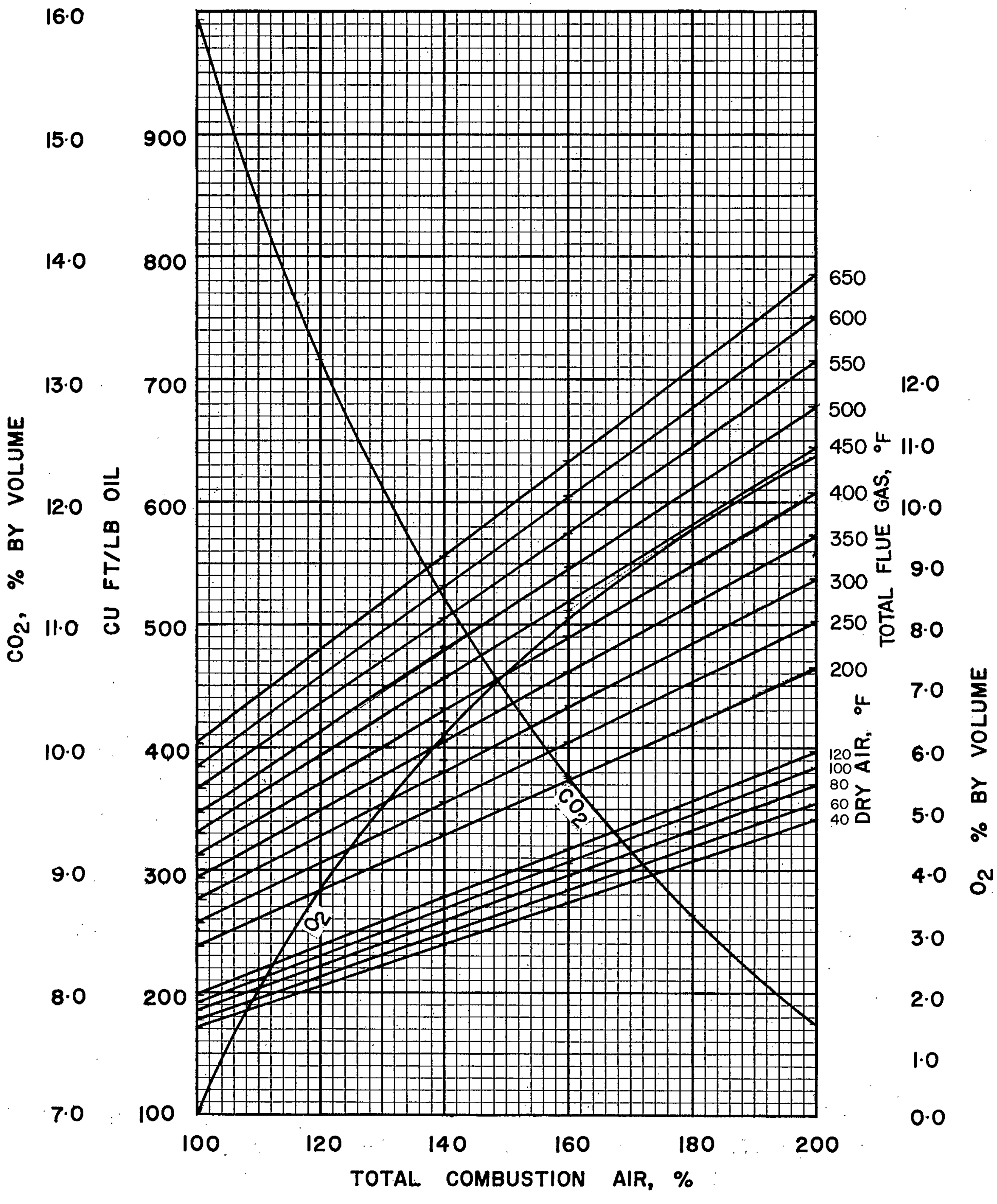


FIGURE 2. COMBUSTION DATA, VOLUME BASIS 10040

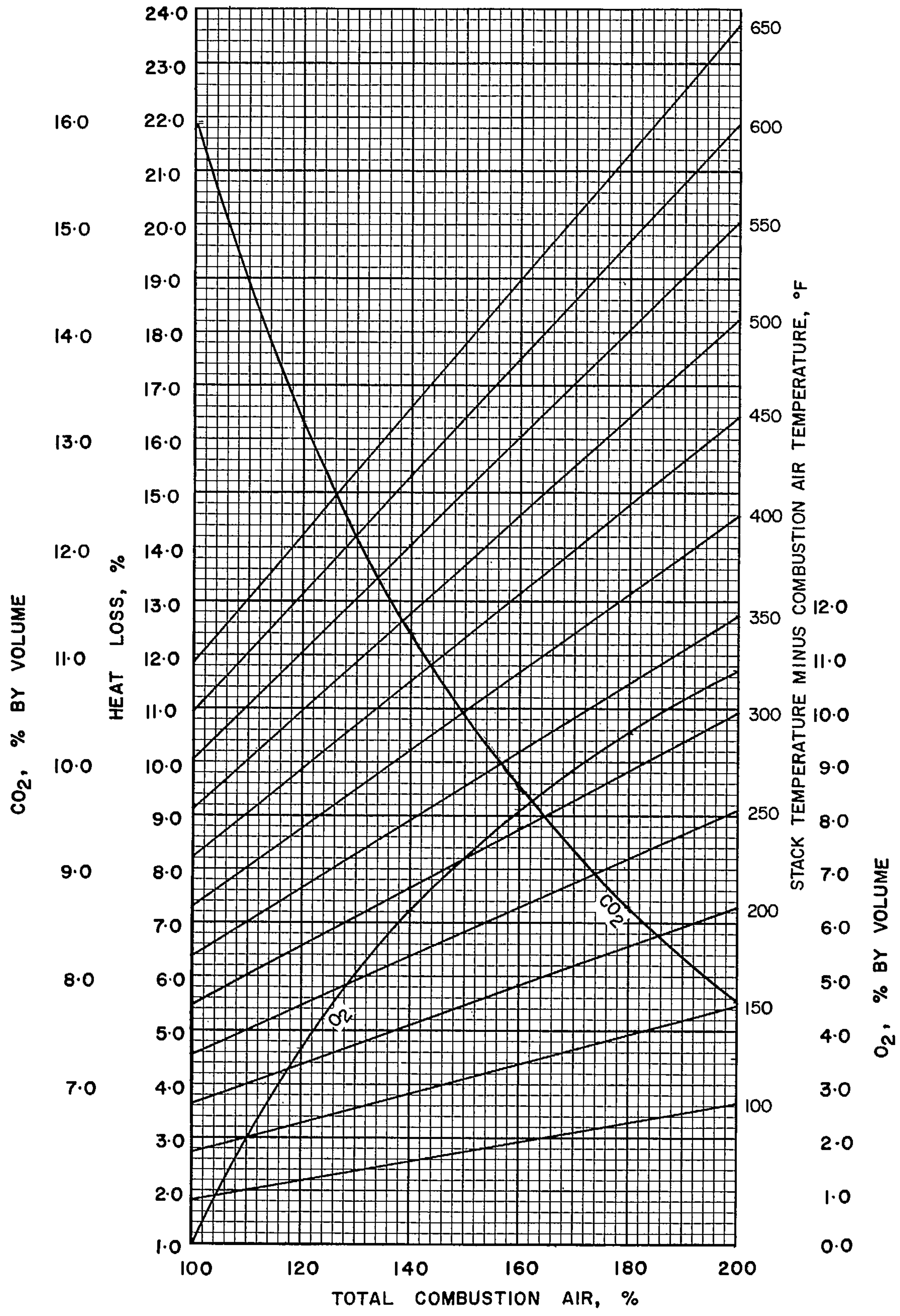


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

10040

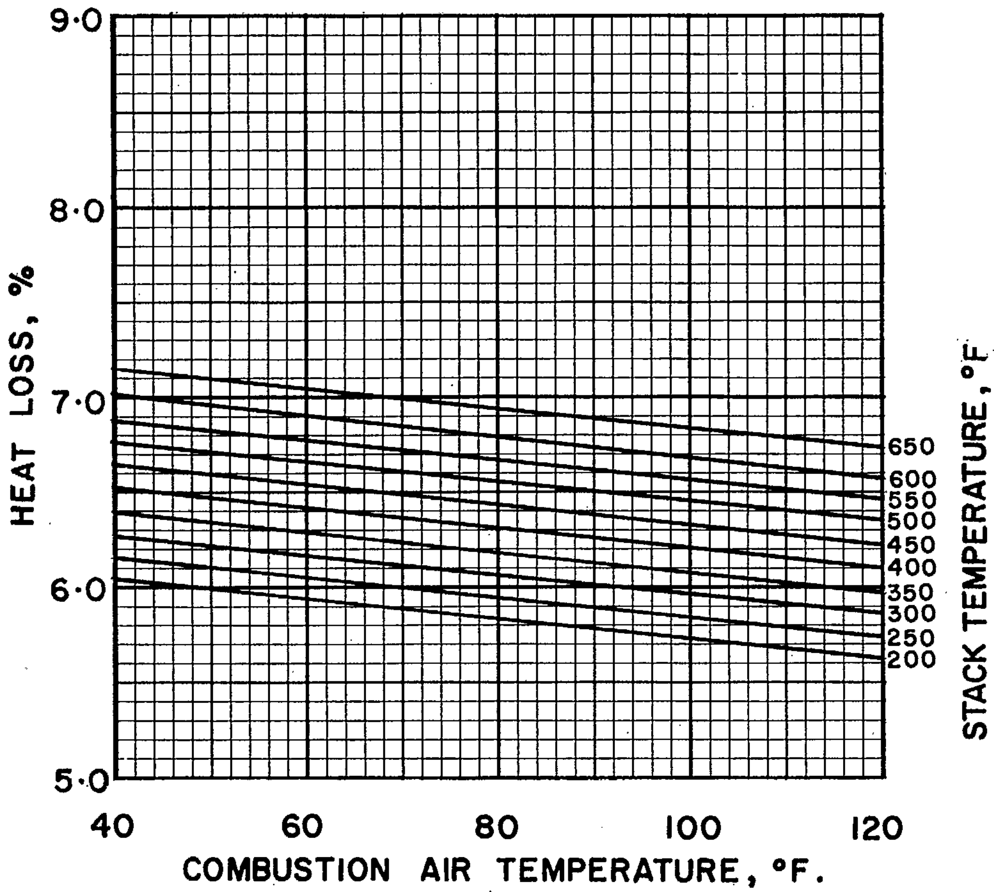


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

10040

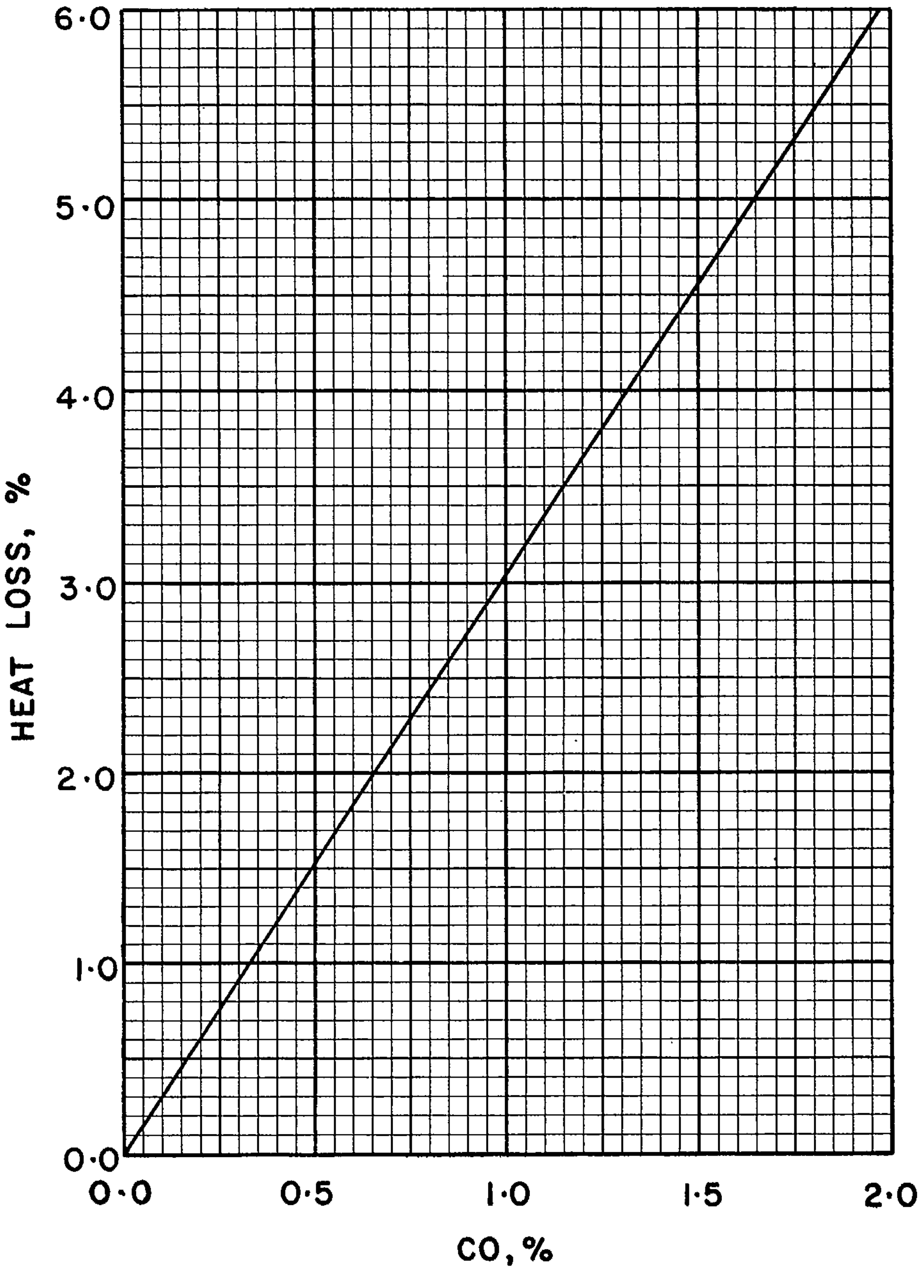


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

10040

FUEL OIL 10100, SPECIFIC GRAVITY 1.010

Ultimate Analysis, lb/lb

Carbon	(C)	0.8915
Hydrogen	(H_2)	0.1085
Sulphur	(S)	–
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,460

Conversion Factors

1 Imp gal oil = 10.10 lb oil
or Imp gal oil × 10.10 = lb oil
or lb oil × 0.0990 = Imp gal oil

1 U.S. gal oil = 10.10 × 0.8337 lb oil
or U.S. gal oil × 8.420 = lb oil
or lb oil × 0.1188 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}460} \text{ lb oil}$$

or Btu × 10^6 × 54.17 = lb oil
or lb oil × 0.0185 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}460 \times 10.10} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.364 = Imp gal oil
or Imp gal oil × 0.1864 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}460 \times 8.420} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.435 = U.S. gal oil
or U.S. gal oil × 0.1554 = Btu × 10^6

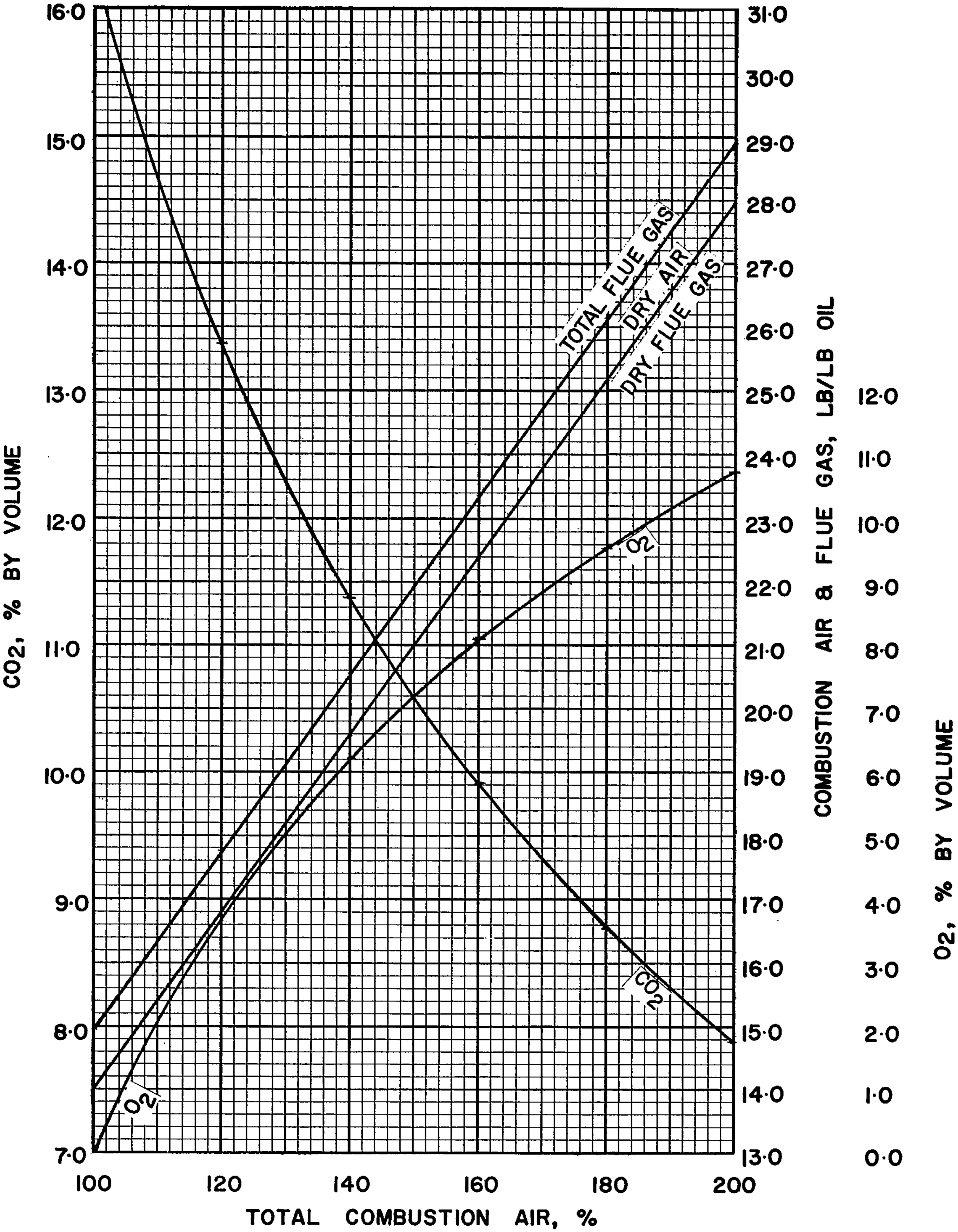


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS

10100

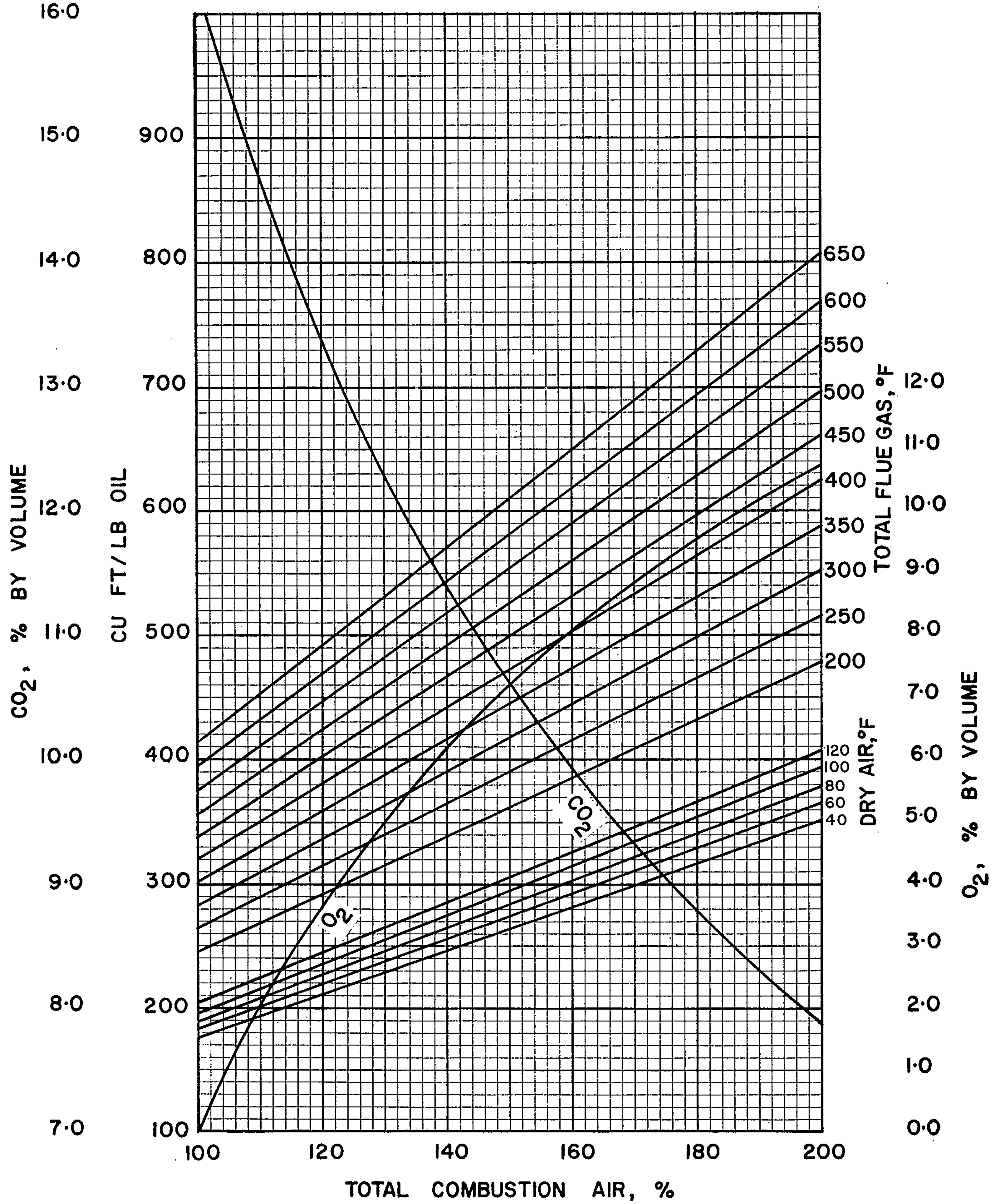


FIGURE 2. COMBUSTION DATA, VOLUME BASIS.

10100

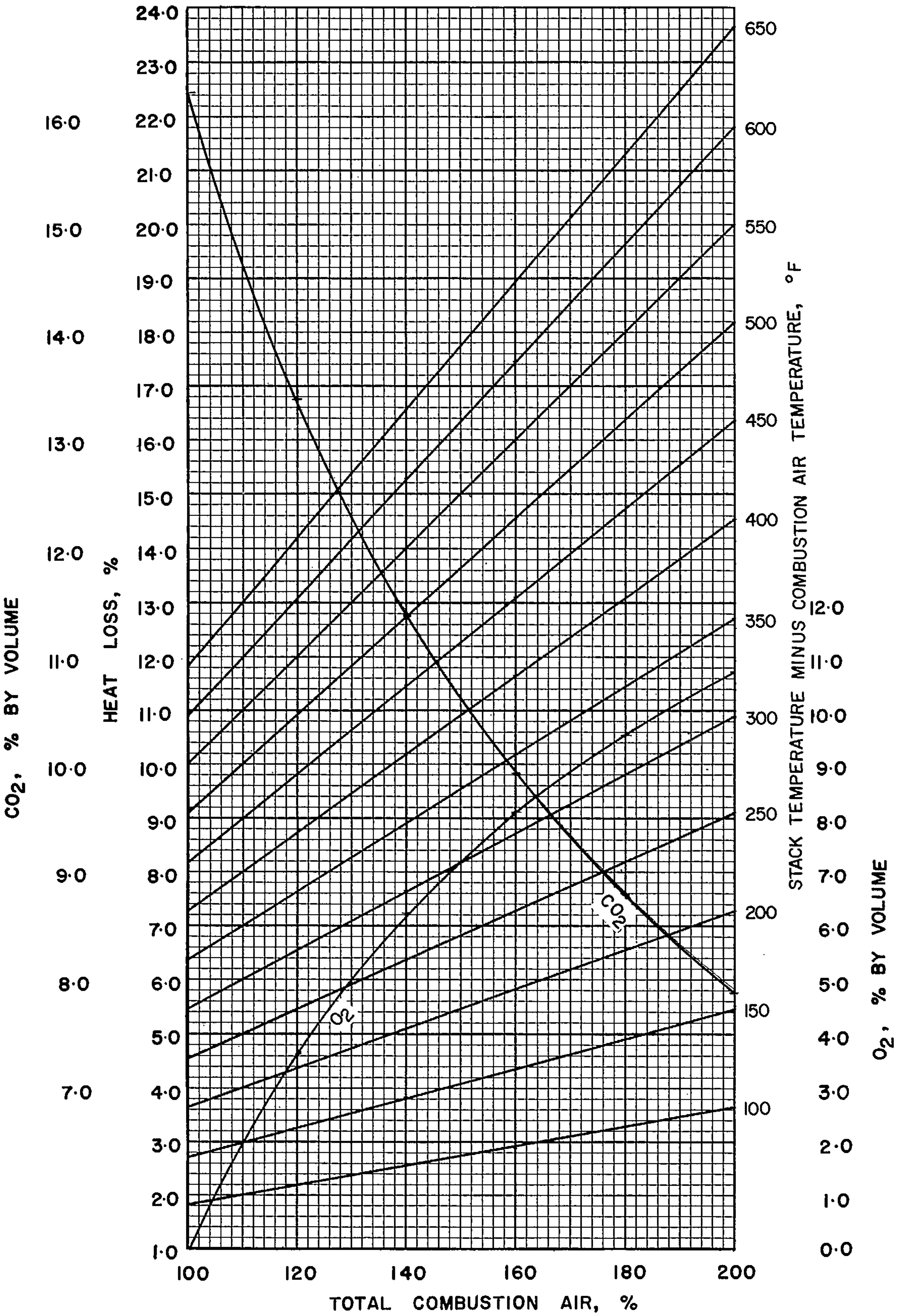


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

10100

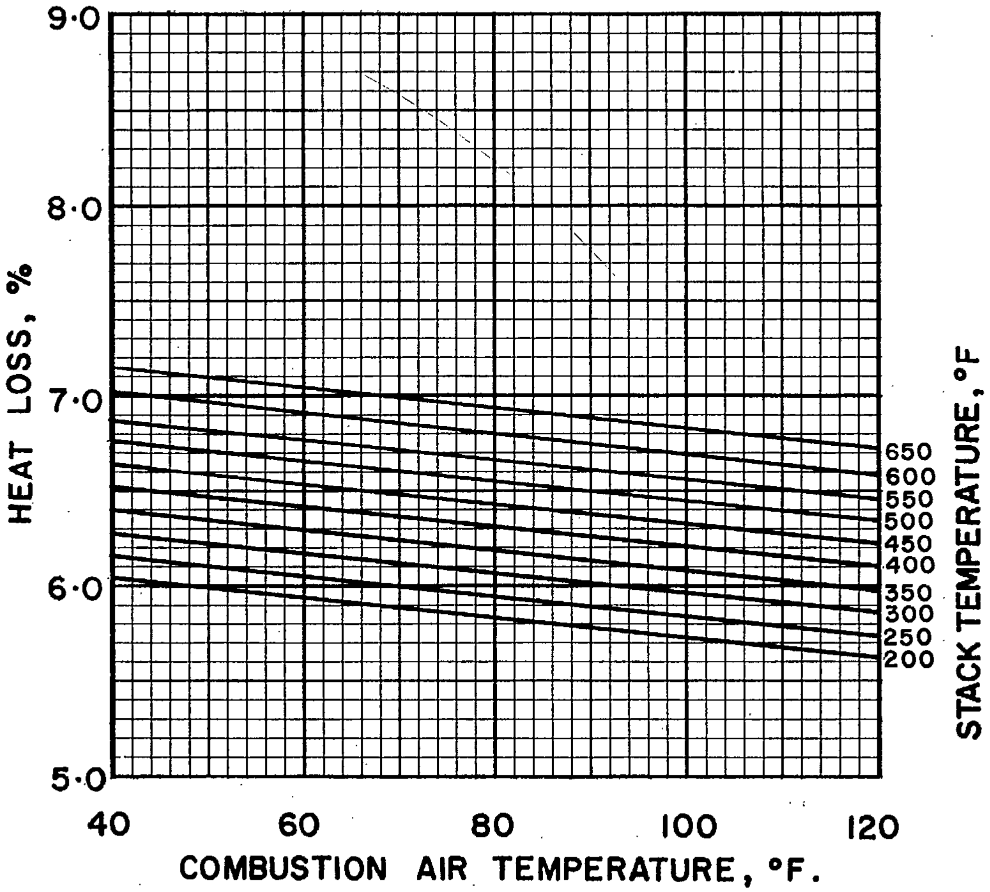


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

10100

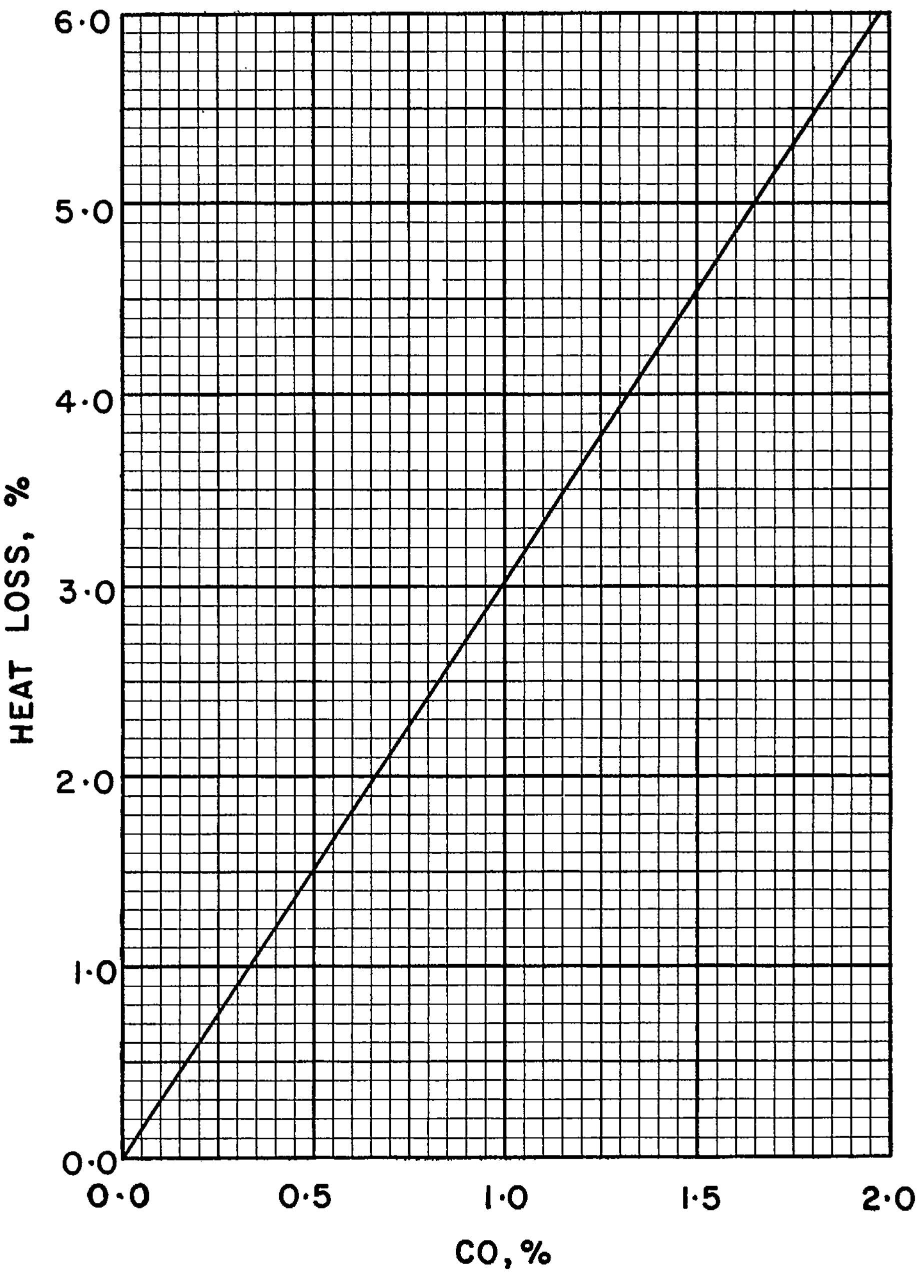


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

10100

FUEL OIL 10110, SPECIFIC GRAVITY 1.010

Ultimate Analysis, lb/lb

Carbon	(C)	0.8826
Hydrogen	(H_2)	0.1074
Sulphur	(S)	0.0100
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,320

Conversion Factors

1 Imp gal oil = 10.10 lb oil
or Imp gal oil × 10.10 = lb oil
or lb oil × 0.0990 = Imp gal oil

1 U.S. gal oil = 10.10 × 0.8337 lb oil
or U.S. gal oil × 8.420 = lb oil
or lb oil × 0.1188 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}320} \text{ lb oil}$$

or Btu × 10^6 × 54.59 = lb oil
or lb oil × 0.0183 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}320 \times 10.10} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.405 = Imp gal oil
or Imp gal oil × 0.1850 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}320 \times 8.420} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.485 = U.S. gal oil
or U.S. gal oil × 0.1542 = Btu × 10^6

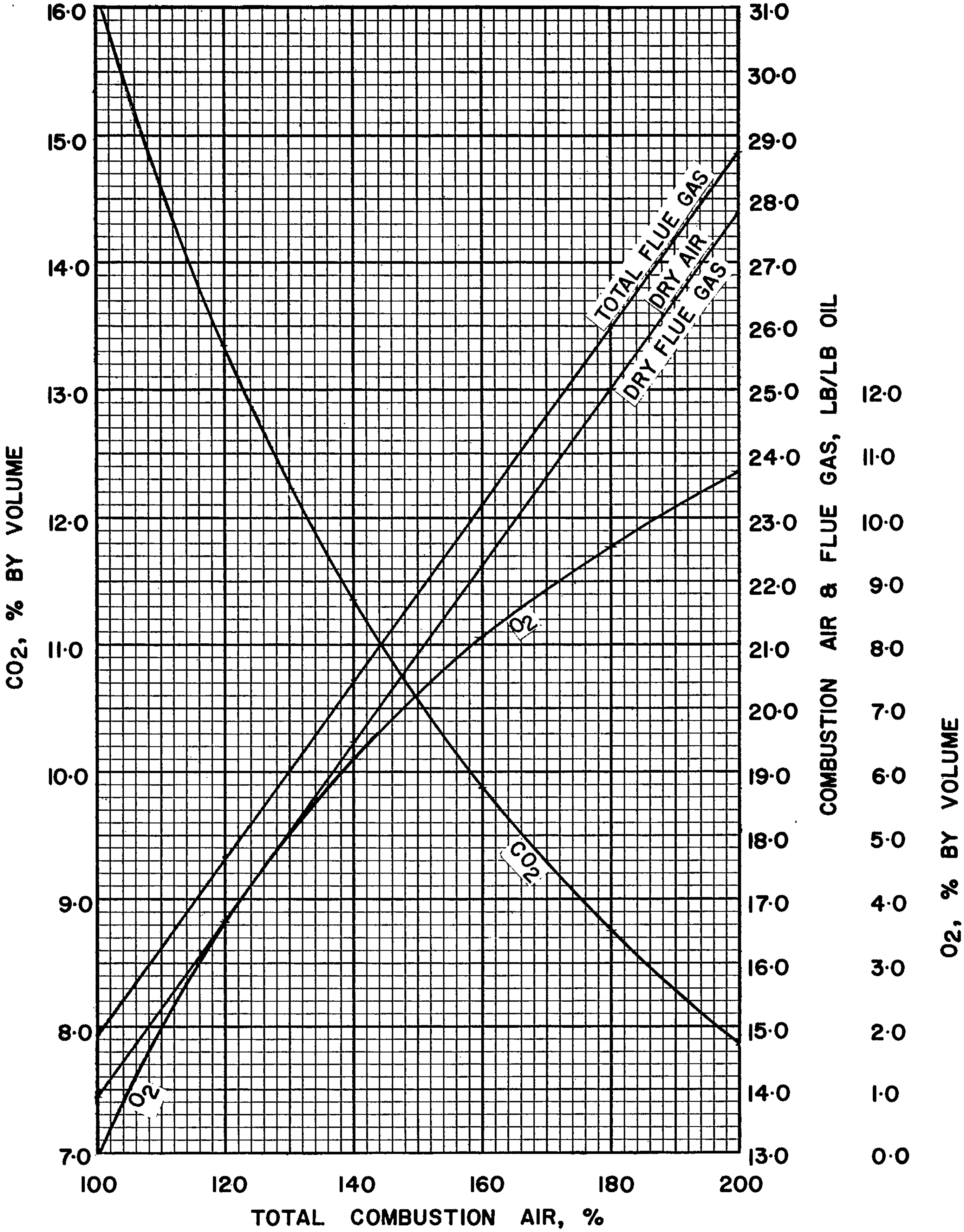


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS 10110

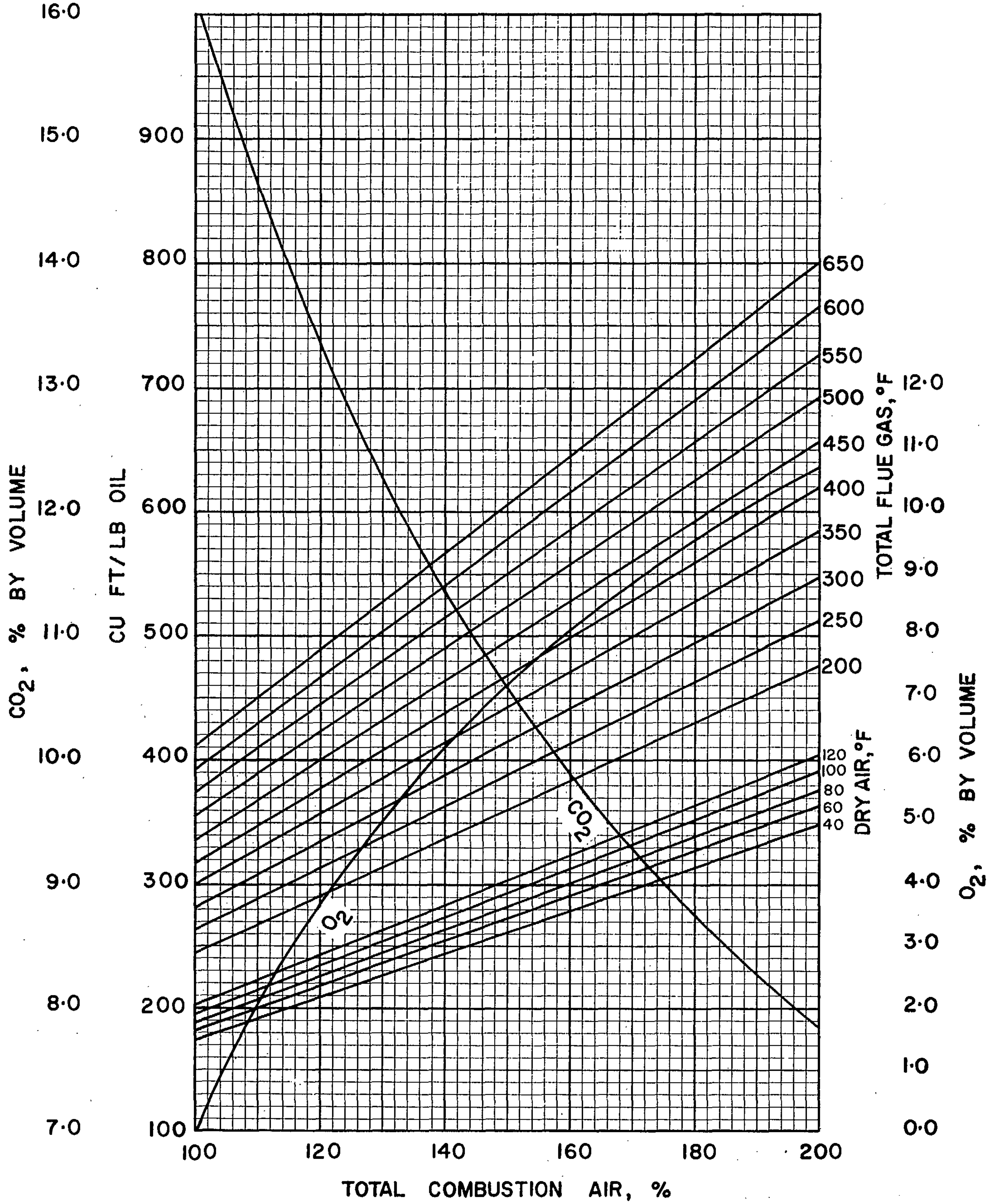


FIGURE 2. COMBUSTION DATA, VOLUME BASIS.

10110

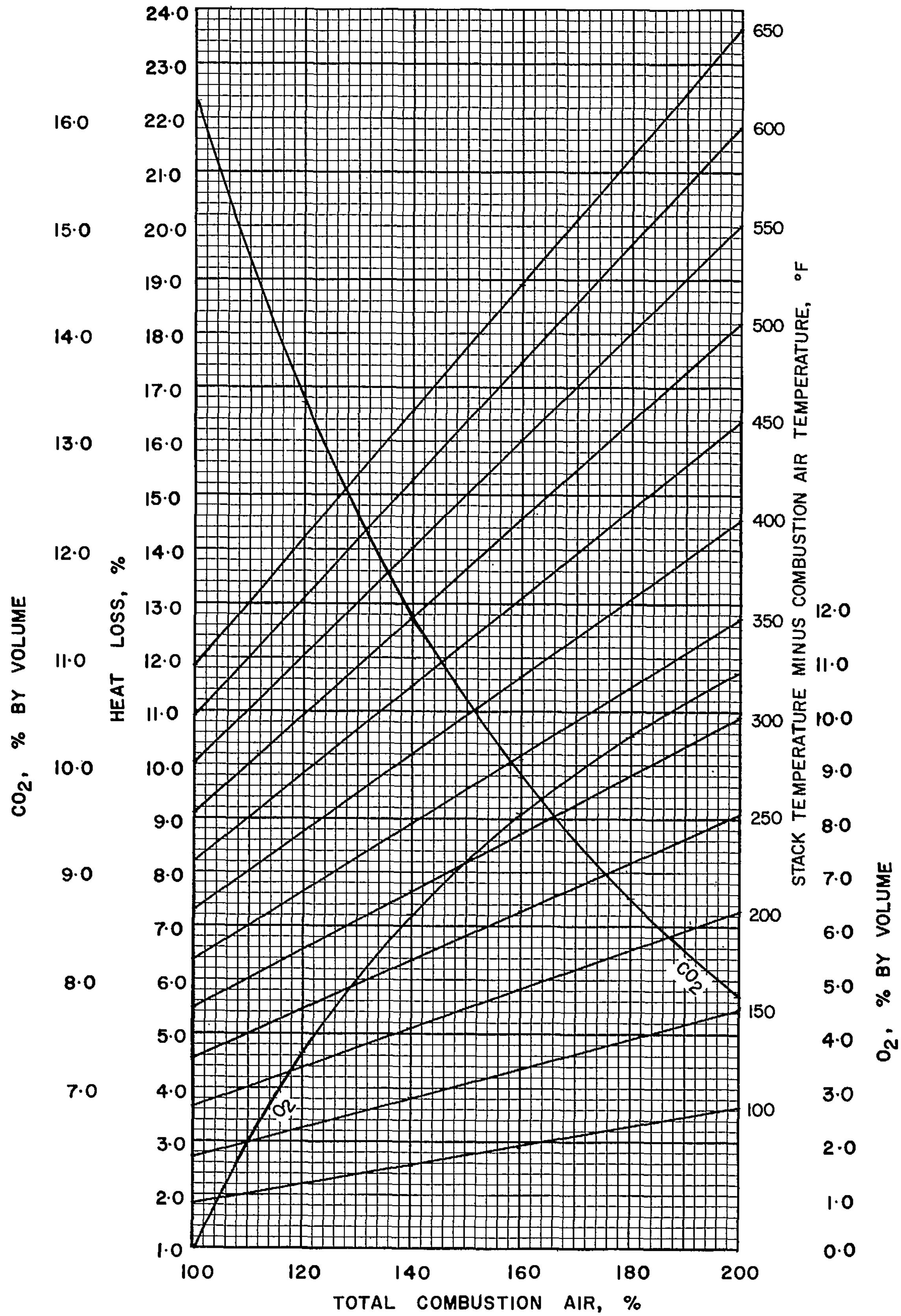


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

10110

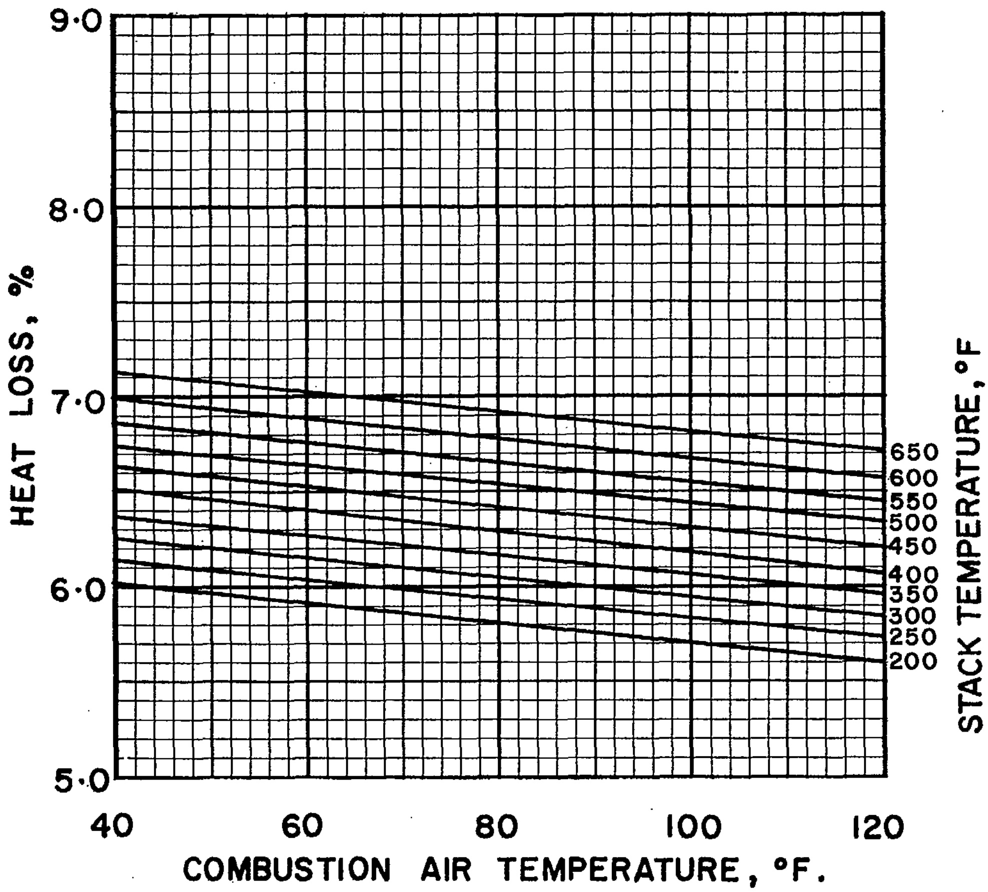


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

10110

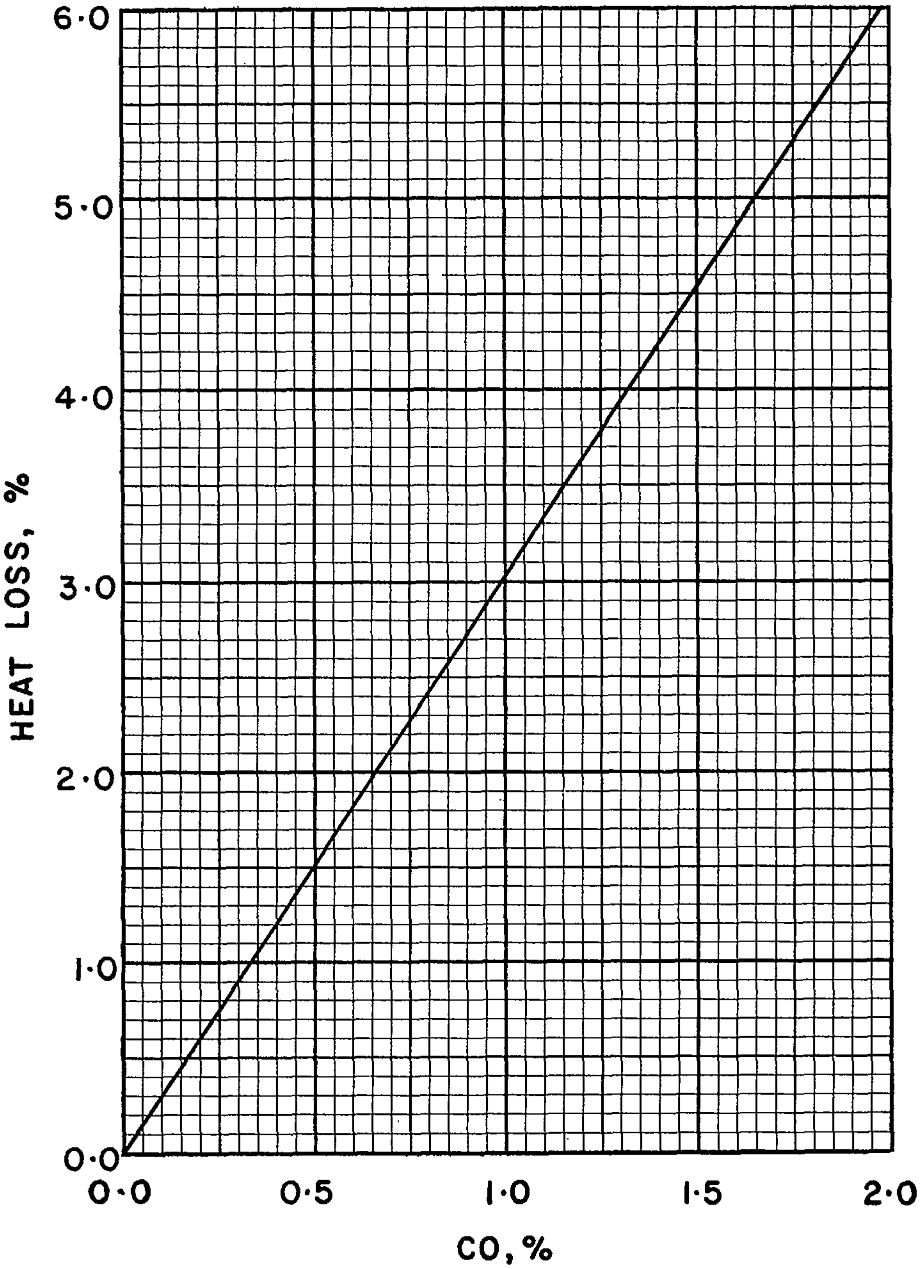


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

10110

FUEL OIL 10120, SPECIFIC GRAVITY 1.010

Ultimate Analysis, lb/lb

Carbon	(C)	0.8737
Hydrogen	(H_2)	0.1063
Sulphur	(S)	0.0200
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,170

Conversion Factors

1 Imp gal oil = 10.10 lb oil
or Imp gal oil × 10.10 = lb oil
or lb oil × 0.0990 = Imp gal oil

1 U.S. gal oil = 10.10 × 0.8337 lb oil
or U.S. gal oil × 8.420 = lb oil
or lb oil × 0.1188 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}170} \text{ lb oil}$$

or Btu × 10^6 × 55.04 = lb oil
or lb oil × 0.0182 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}170 \times 10.10} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.449 = Imp gal oil
or Imp gal oil × 0.1835 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}170 \times 8.420} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.536 = U.S. gal oil
or U.S. gal oil × 0.1530 = Btu × 10^6

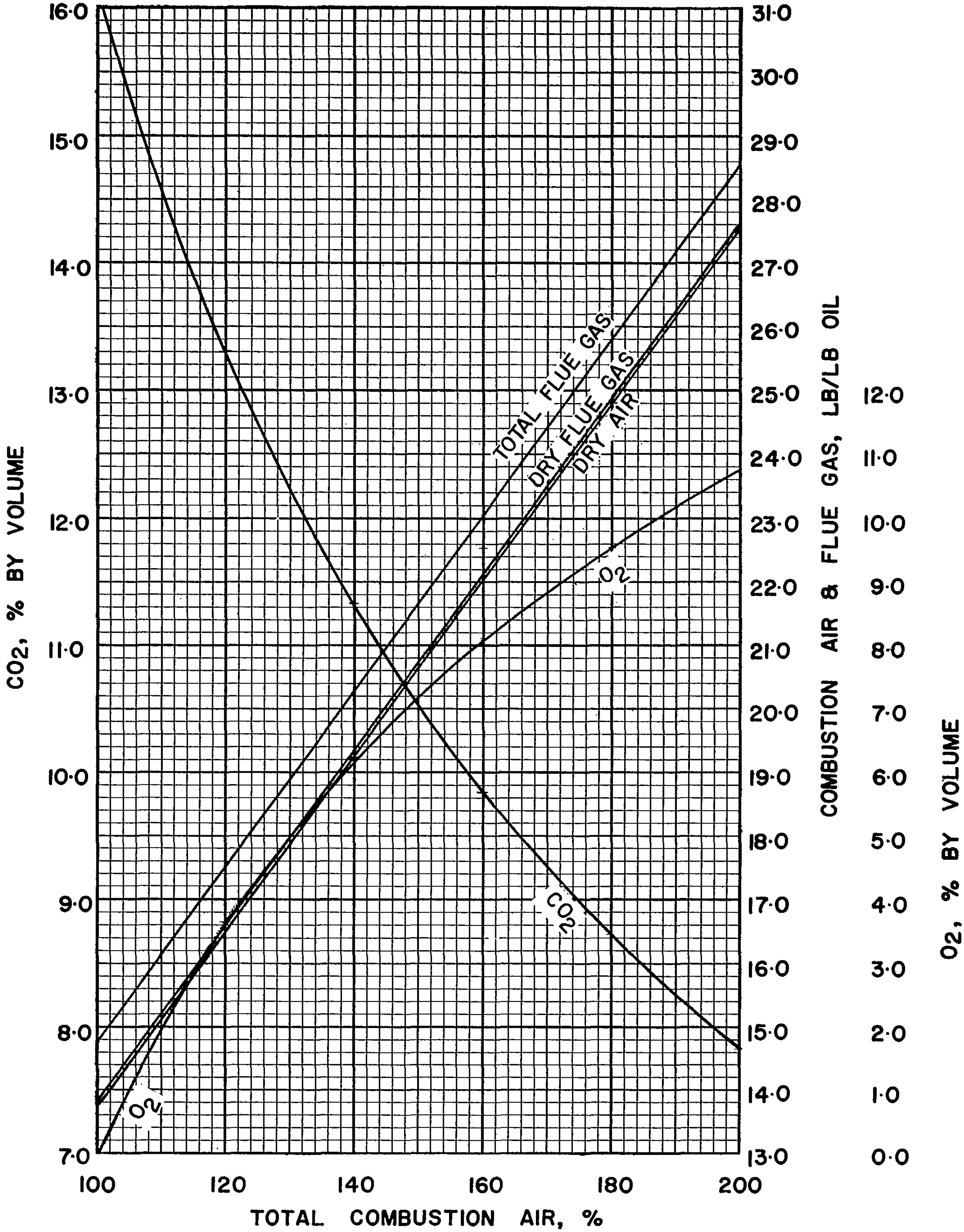


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS 10120

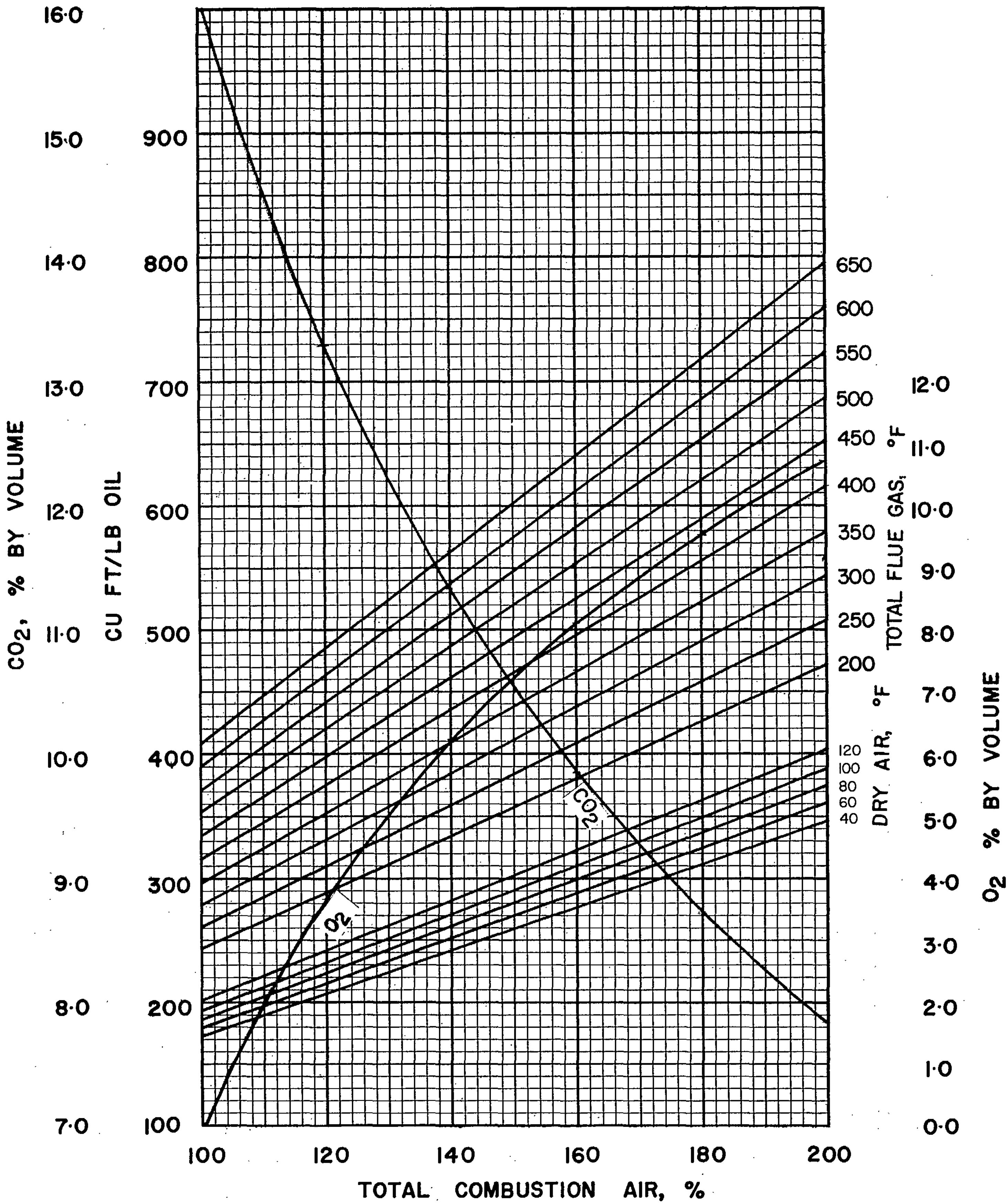


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 10120

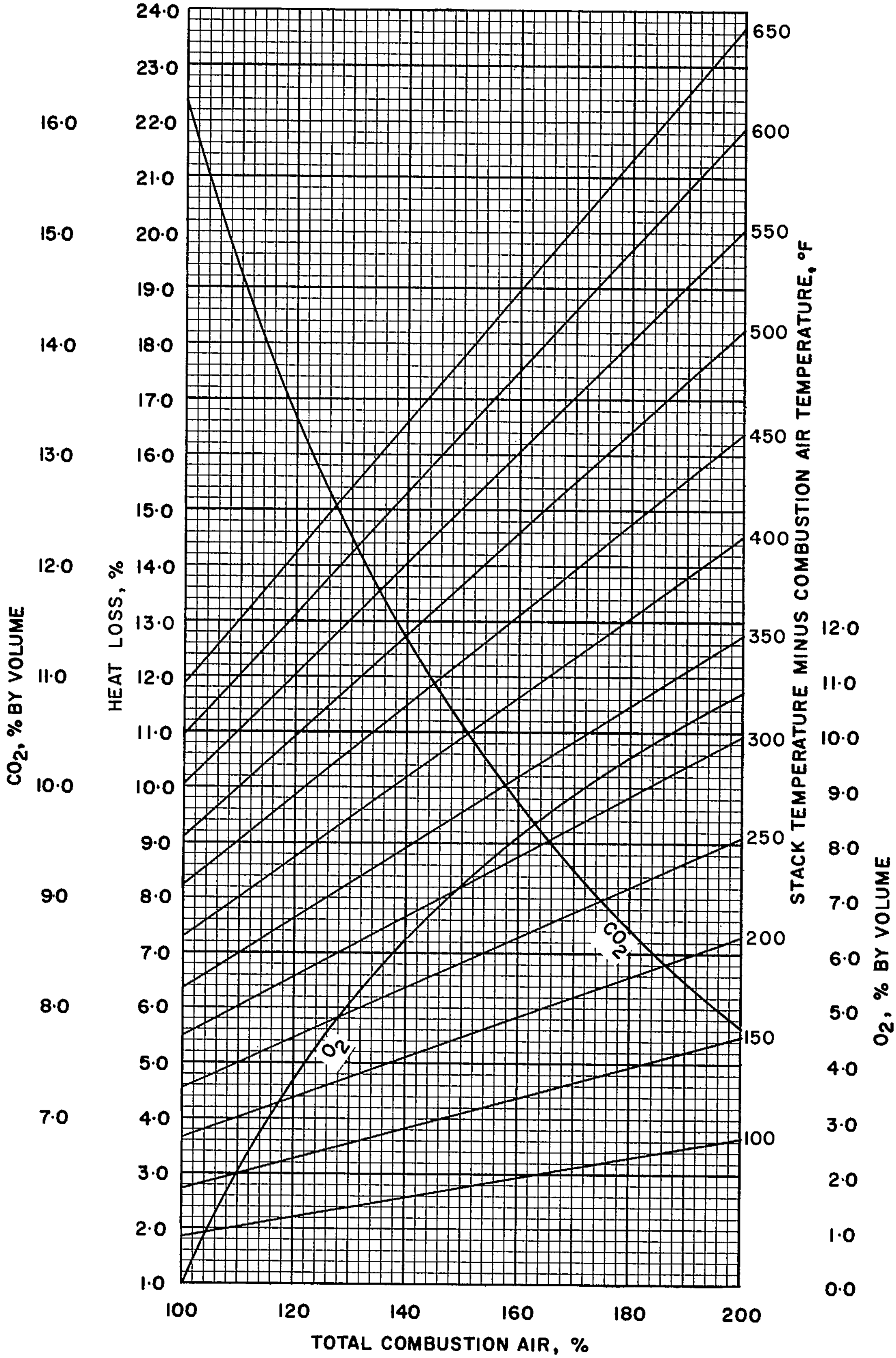


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS·

10120

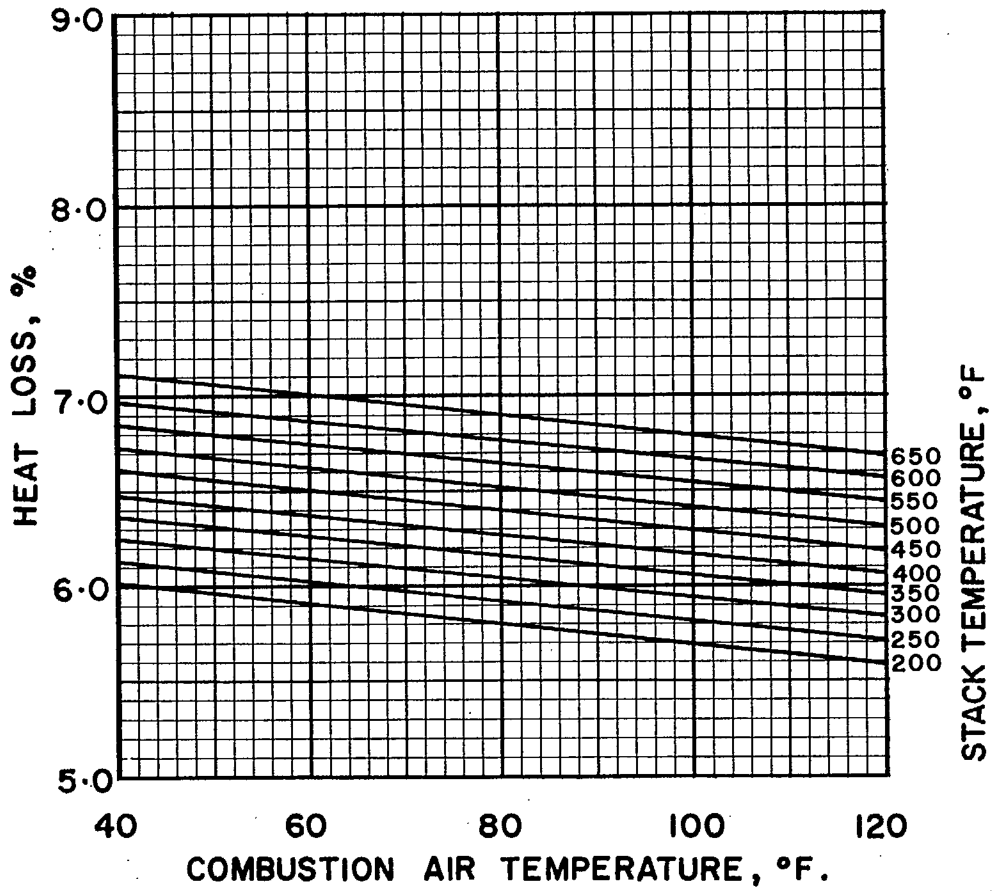


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

10120

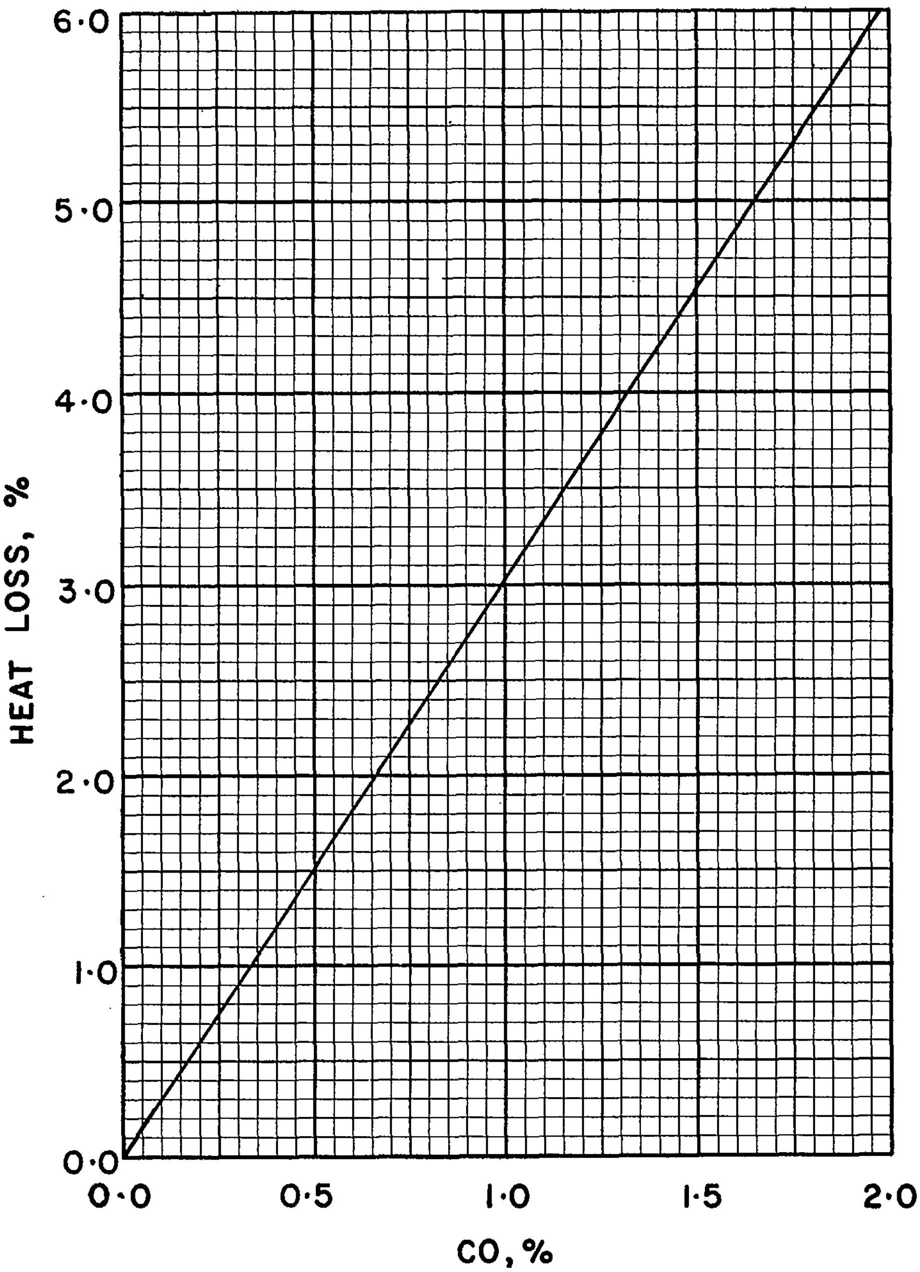


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

10120

FUEL OIL 10130, SPECIFIC GRAVITY 1.010

Ultimate Analysis, lb/lb

Carbon	(C)	0.8648
Hydrogen	(H_2)	0.1052
Sulphur	(S)	0.0300
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,030

Conversion Factors

1 Imp gal oil = 10.10 lb oil
or Imp gal oil × 10.10 = lb oil
or lb oil × 0.0990 = Imp gal oil

1 U.S. gal oil = 10.10 × 0.8337 lb oil
or U.S. gal oil × 8.420 = lb oil
or lb oil × 0.1188 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}030} \text{ lb oil}$$

or Btu × 10^6 × 55.46 = lb oil
or lb oil × 0.0180 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}030 \times 10.10} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.491 = Imp gal oil
or Imp gal oil × 0.1821 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}030 \times 8.420} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.588 = U.S. gal oil
or U.S. gal oil × 0.1518 = Btu × 10^6

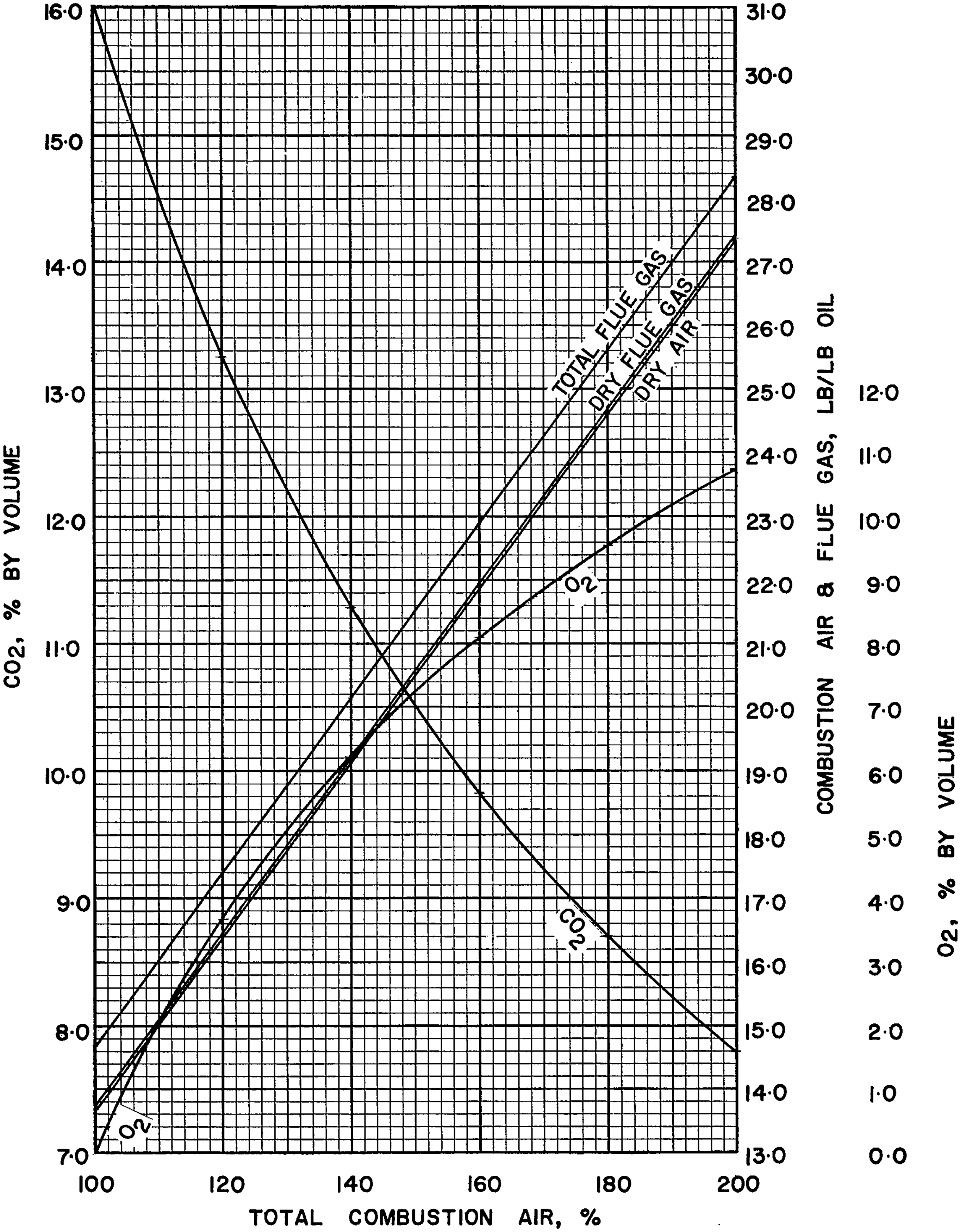


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS

10130

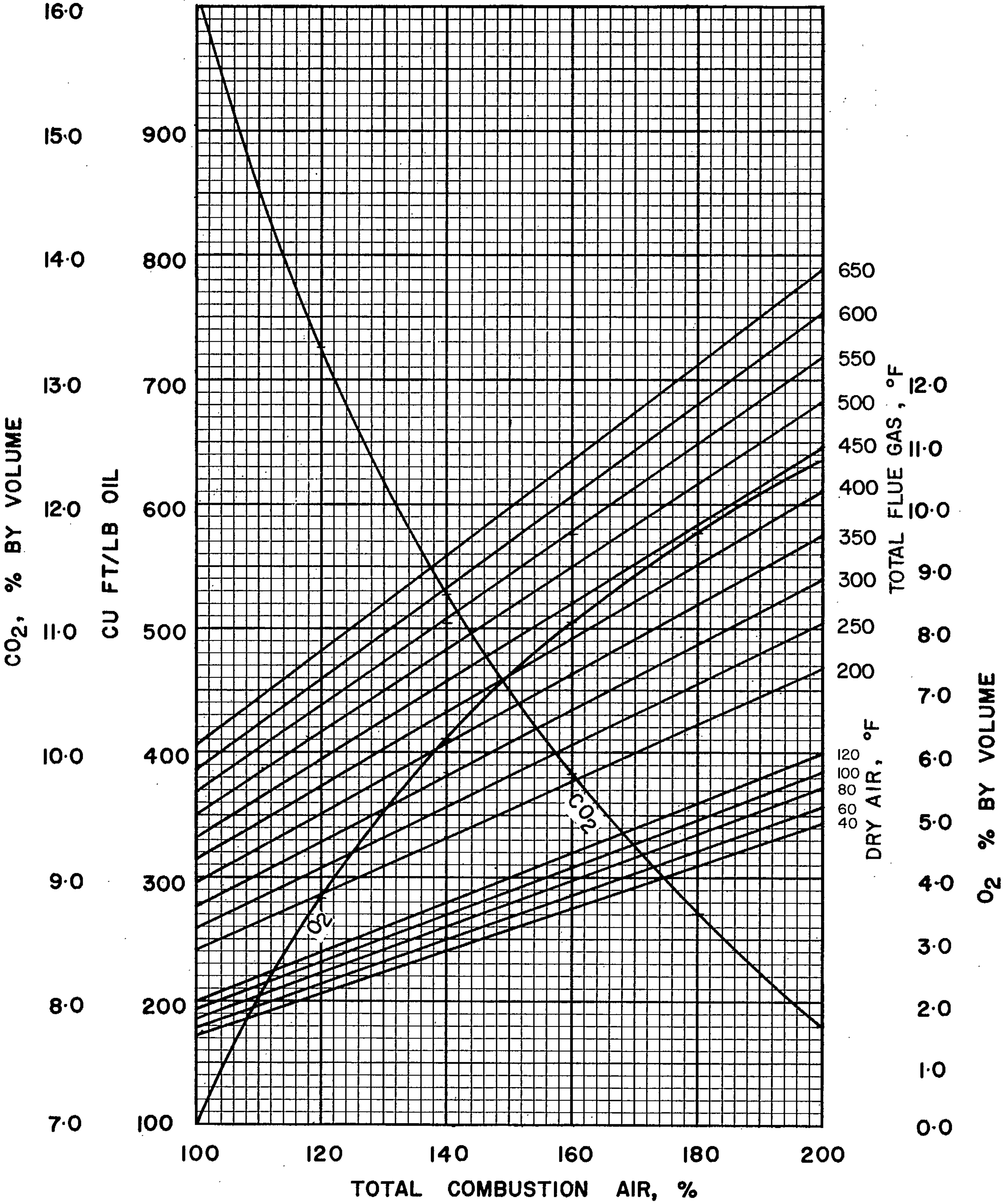


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 10130

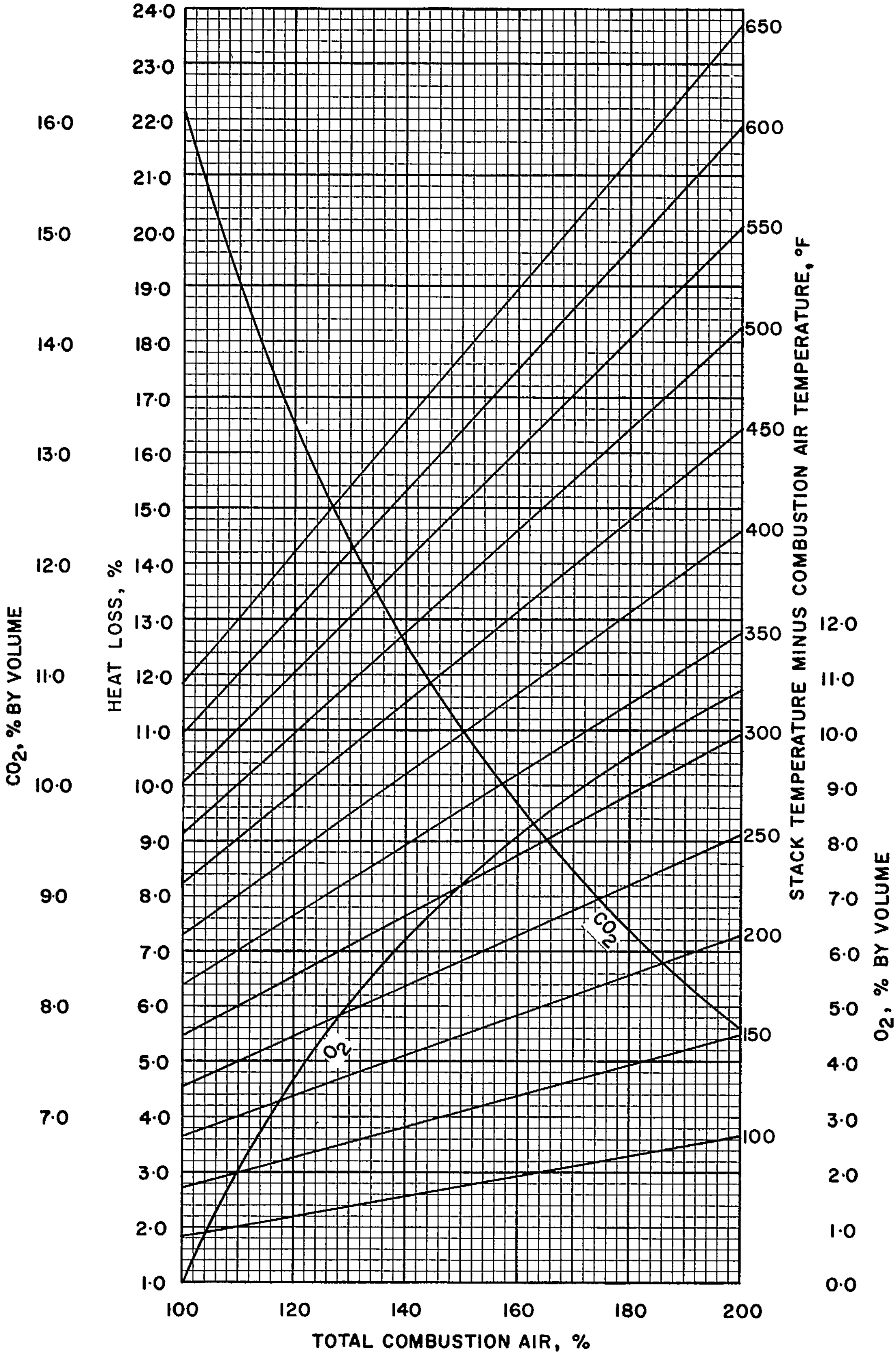


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS·

10130

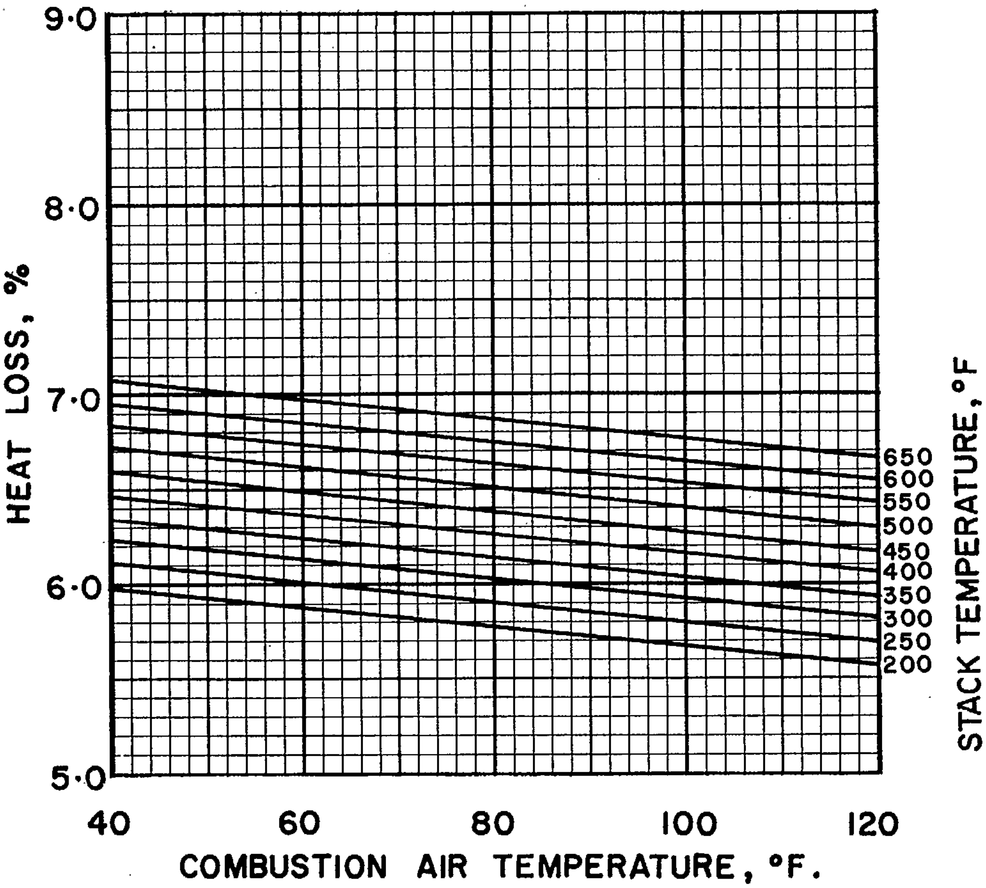


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

10130

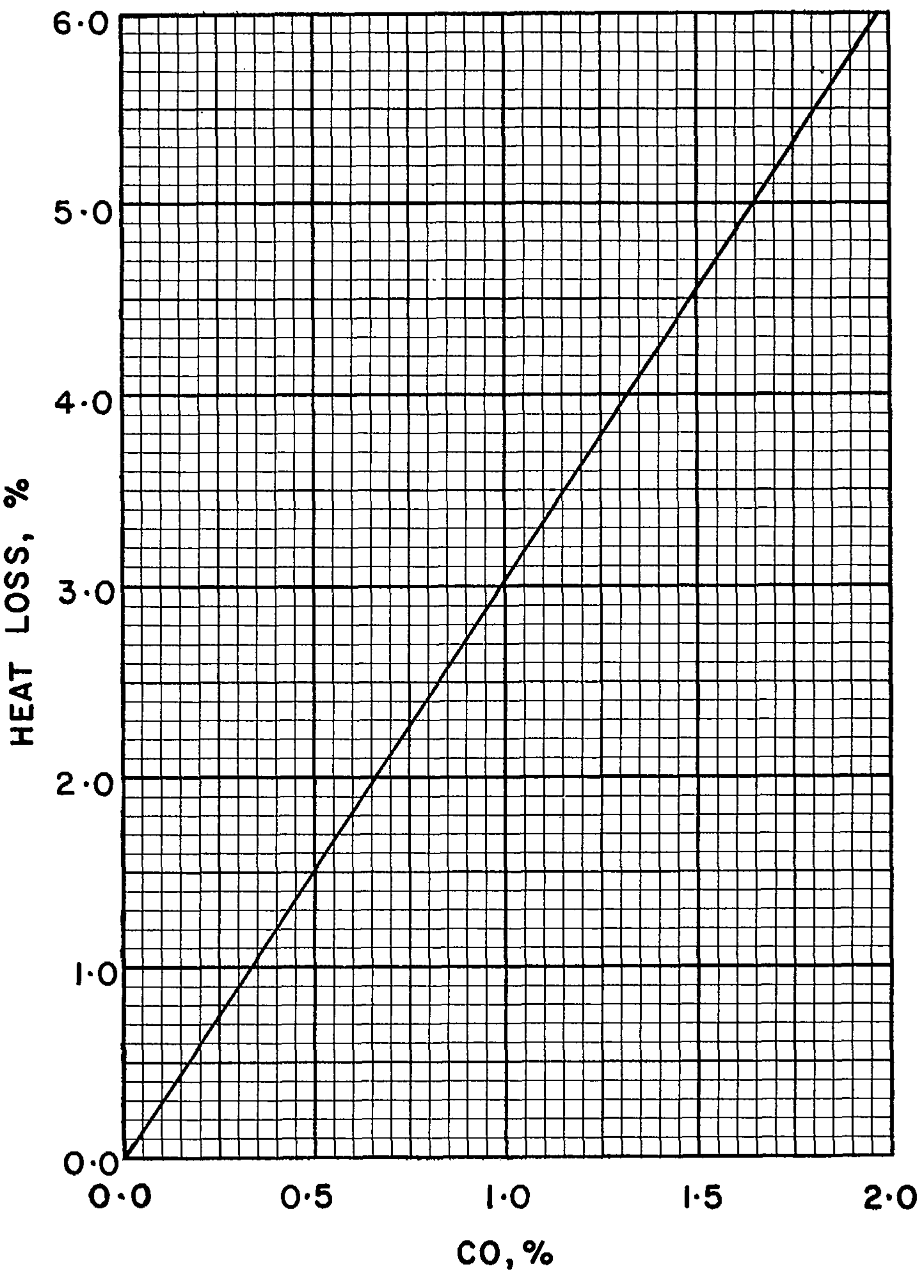


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

10130

FUEL OIL 10140, SPECIFIC GRAVITY 1.010

Ultimate Analysis, lb/lb

Carbon	(C)	0.8558
Hydrogen	(H_2)	0.1042
Sulphur	(S)	0.0400
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		17,880

Conversion Factors

1 Imp gal oil = 10.10 lb oil
or Imp gal oil × 10.10 = lb oil
or lb oil × 0.0990 = Imp gal oil

1 U.S. gal oil = 10.10 × 0.8337 lb oil
or U.S. gal oil × 8.420 = lb oil
or lb oil × 0.1188 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{17{,}880} \text{ lb oil}$$

or Btu × 10^6 × 55.93 = lb oil
or lb oil × 0.0179 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{17{,}880 \times 10.10} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.538 = Imp gal oil
or Imp gal oil × 0.1806 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{17{,}880 \times 8.420} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.640 = U.S. gal oil
or U.S. gal oil × 0.1506 = Btu × 10^6

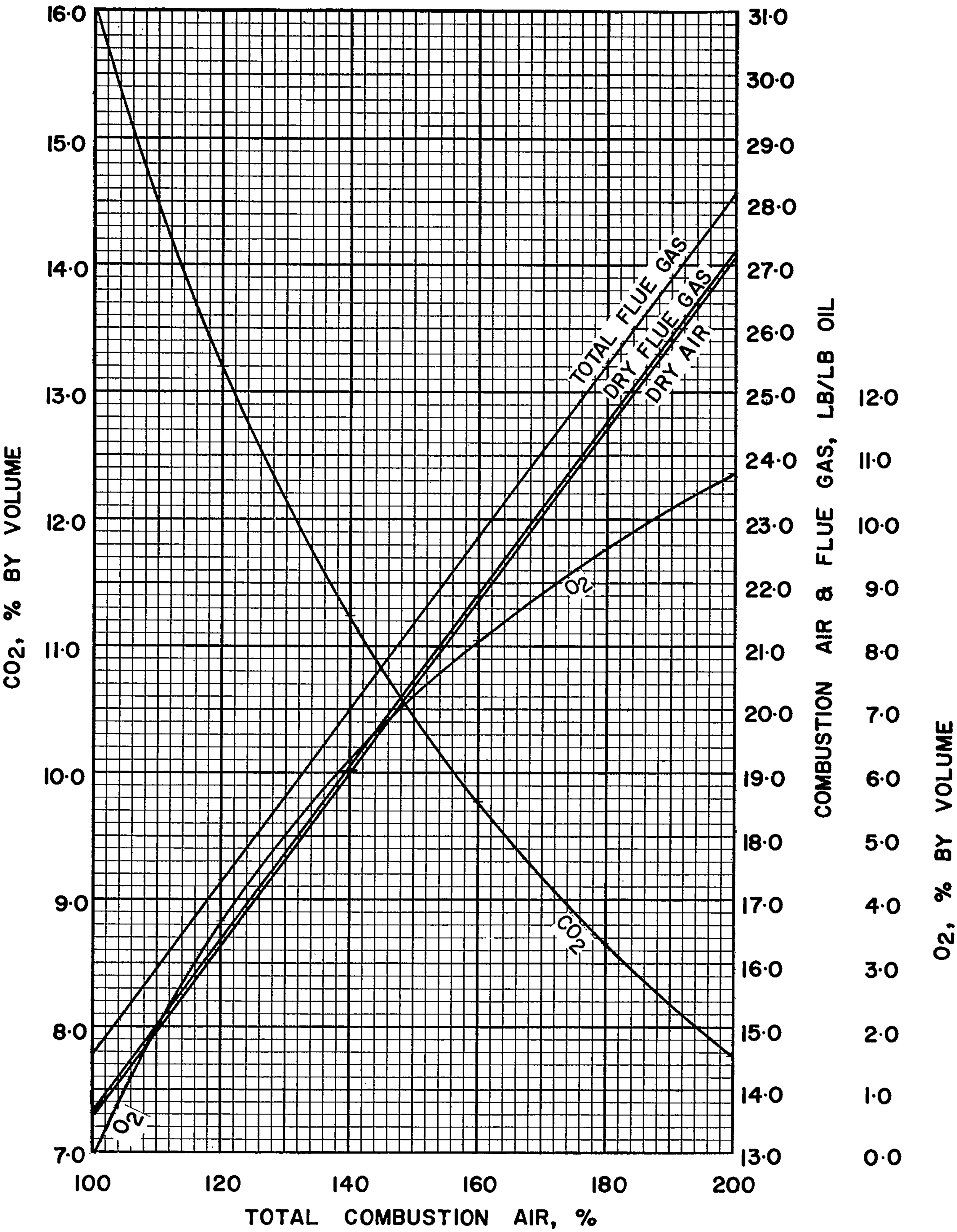


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS

10140

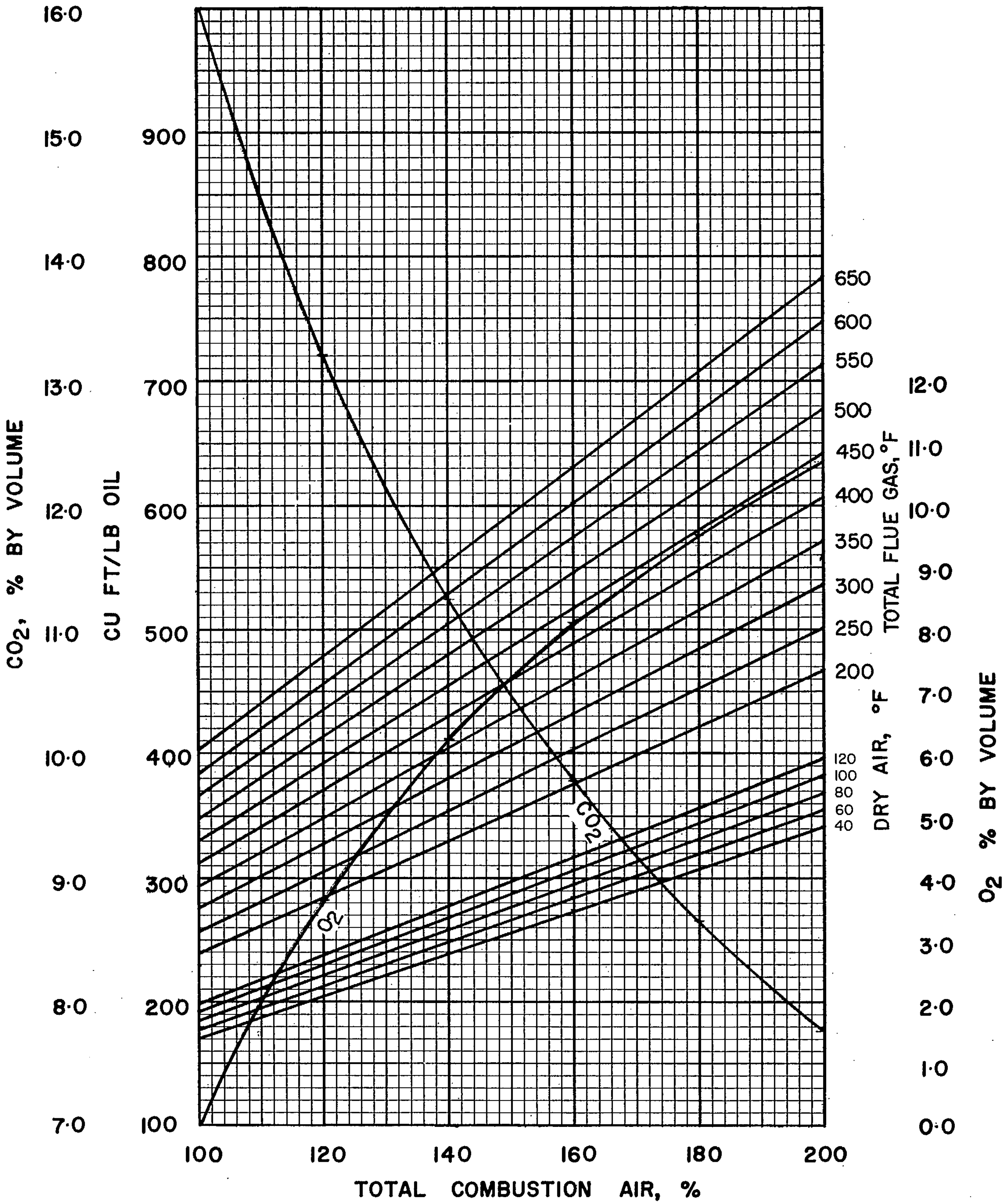


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 10140

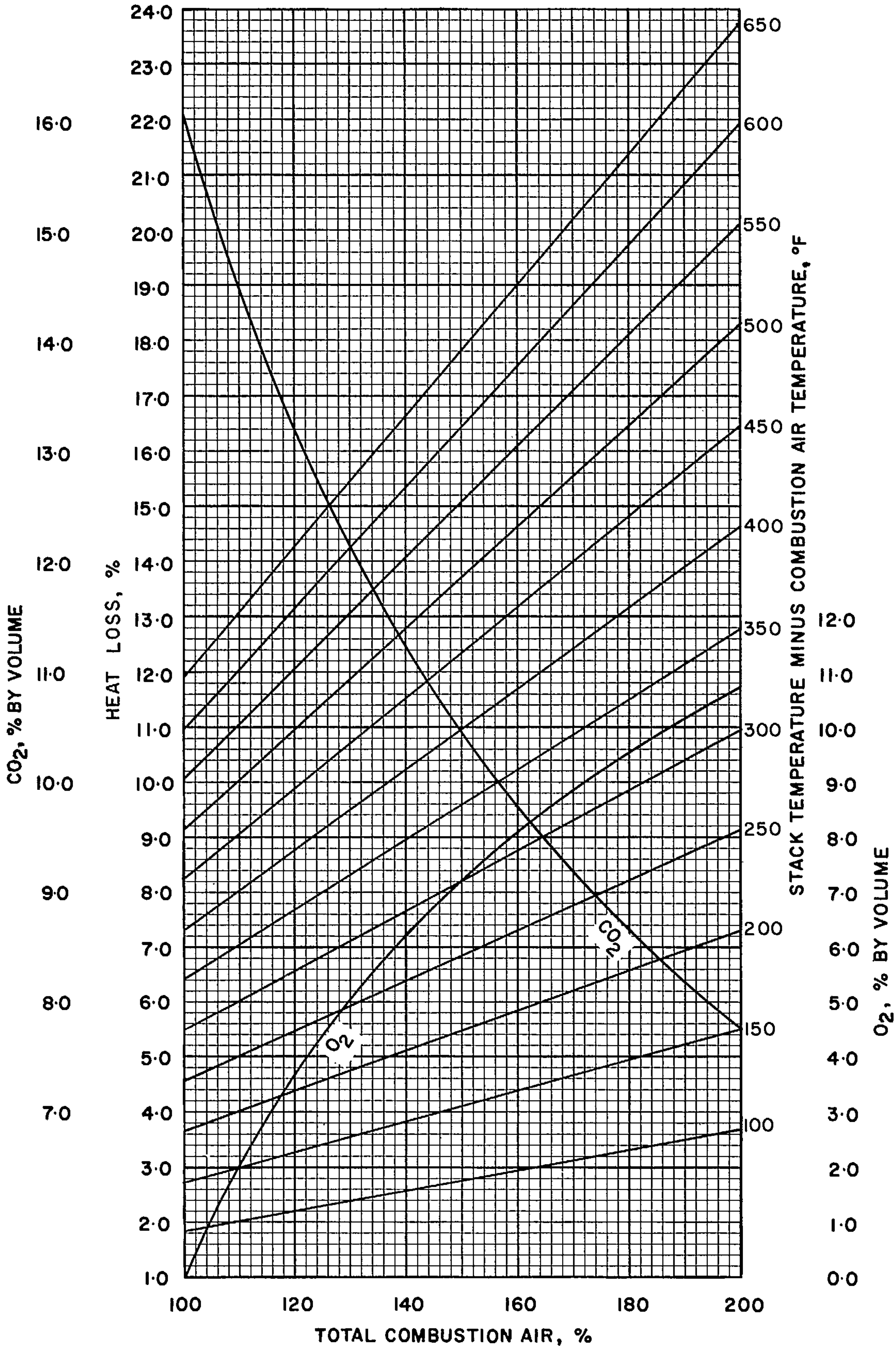


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS·

10140

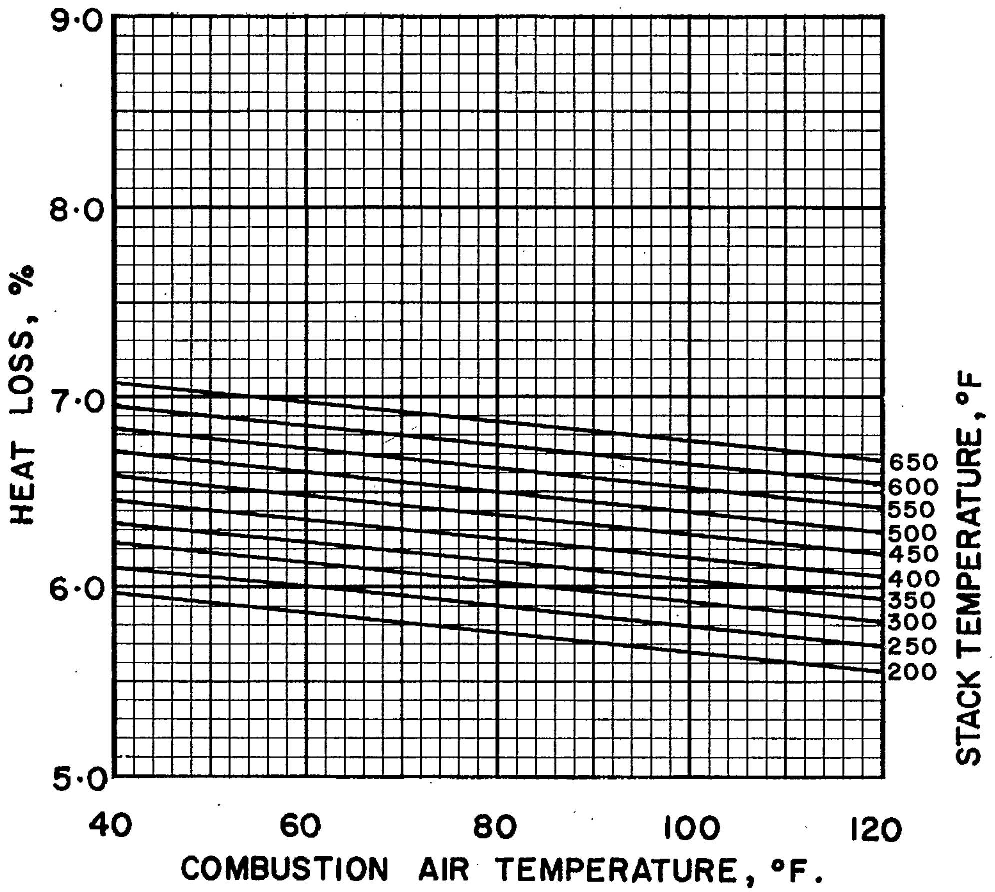


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

10140

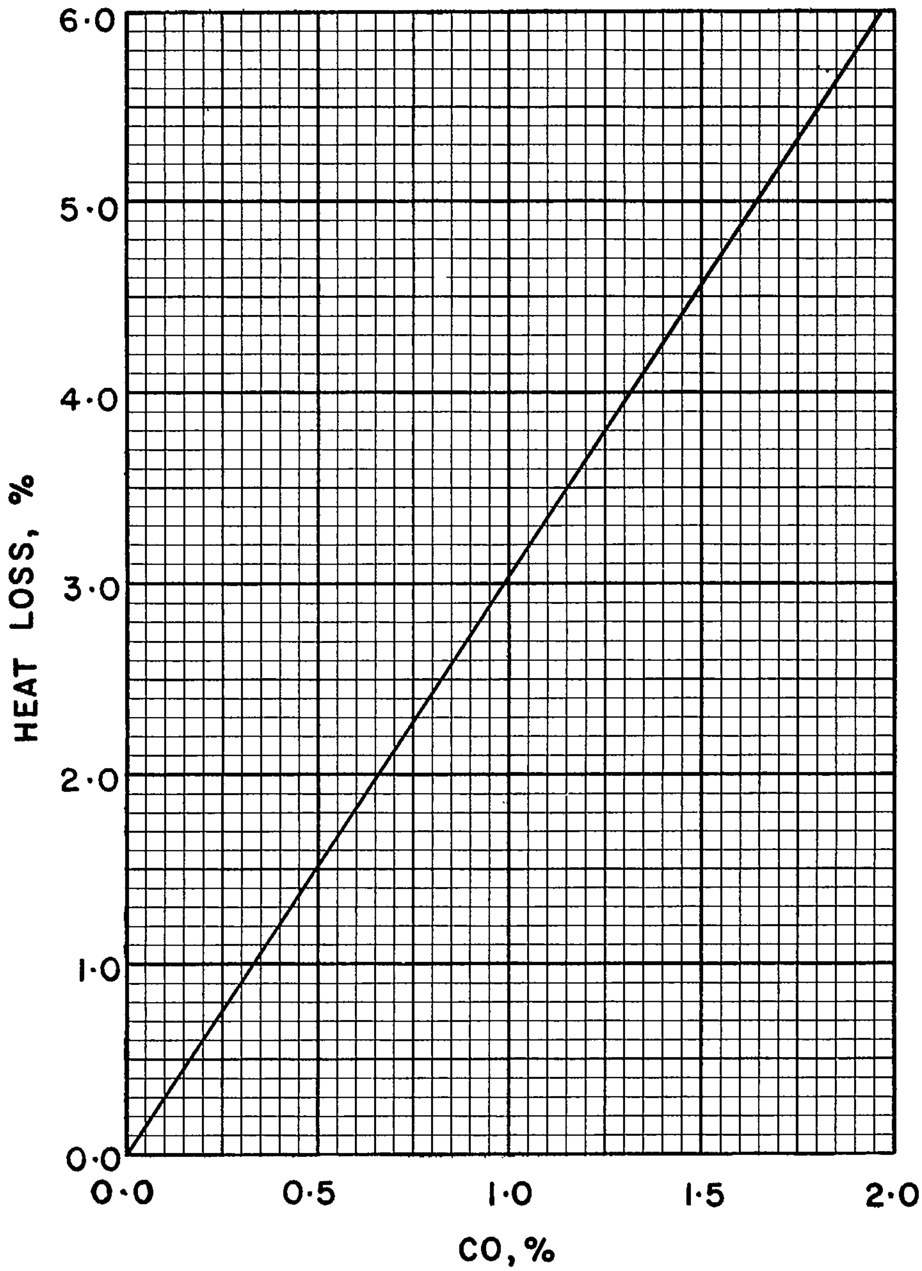


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

10140

FUEL OIL 10200, SPECIFIC GRAVITY 1.020

Ultimate Analysis, lb/lb

Carbon (C)	0.8930
Hydrogen (H_2)	0.1070
Sulphur (S)	–
Nitrogen (N_2)	–
Oxygen (O_2)	–
Ash	–
Moisture	–
Total	1.0000
Calorific Value, Btu/lb	18,390

Conversion Factors

1 Imp gal oil = 10.20 lb oil
or Imp gal oil × 10.20 = lb oil
or lb oil × 0.0980 = Imp gal oil

1 U.S. gal oil = 10.20 × 0.8337 lb oil
or U.S. gal oil × 8.504 = lb oil
or lb oil × 0.1176 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}390} \text{ lb oil}$$

or Btu × 10^6 × 54.38 = lb oil
or lb oil × 0.0184 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}390 \times 10.20} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.331 = Imp gal oil
or Imp gal oil × 0.1876 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}390 \times 8.504} \text{ U.S. gal}$$

or Btu × 10^6 × 6.394 = U.S. gal oil
or U.S. gal oil × 0.1564 = Btu × 10^6

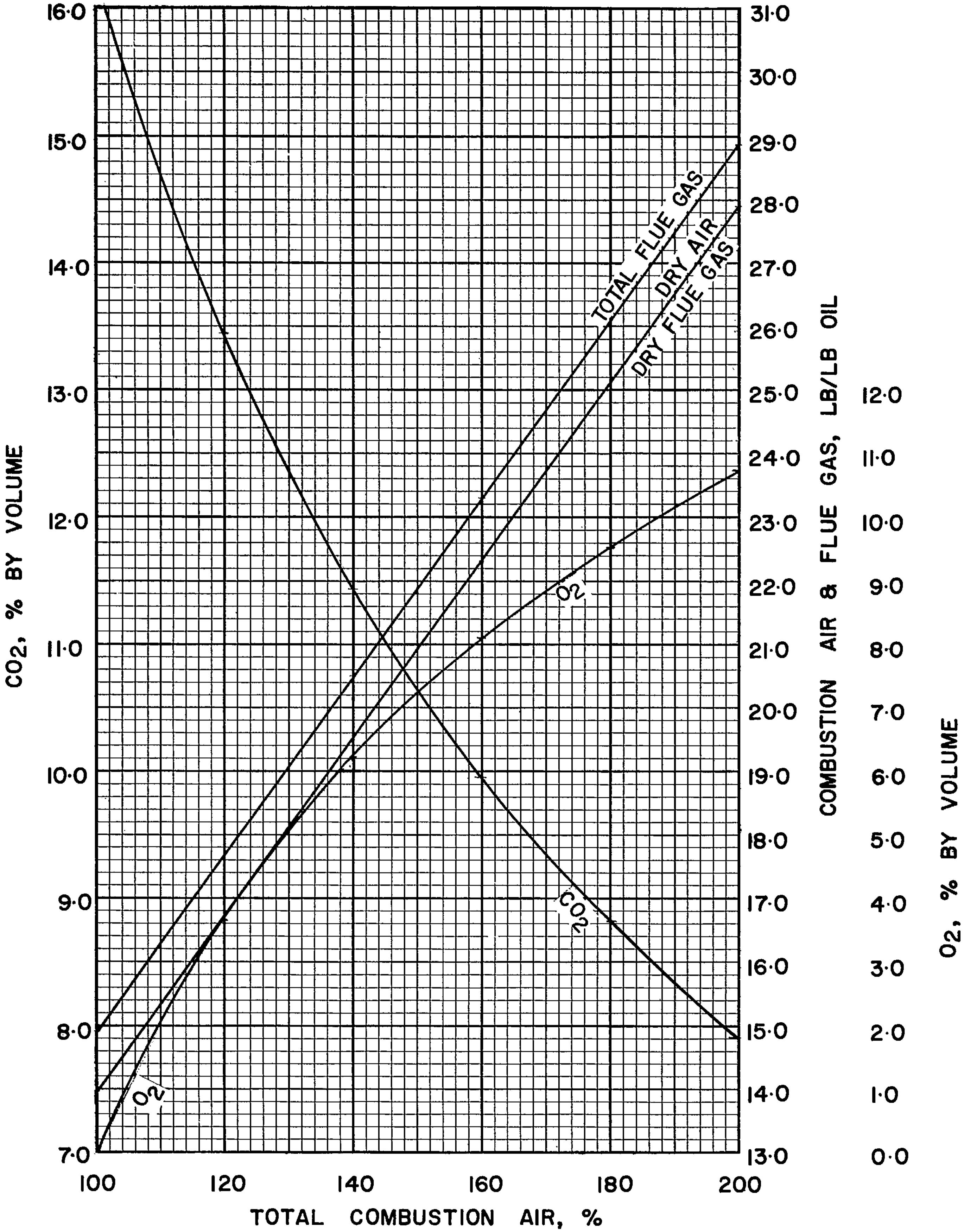


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS

10200

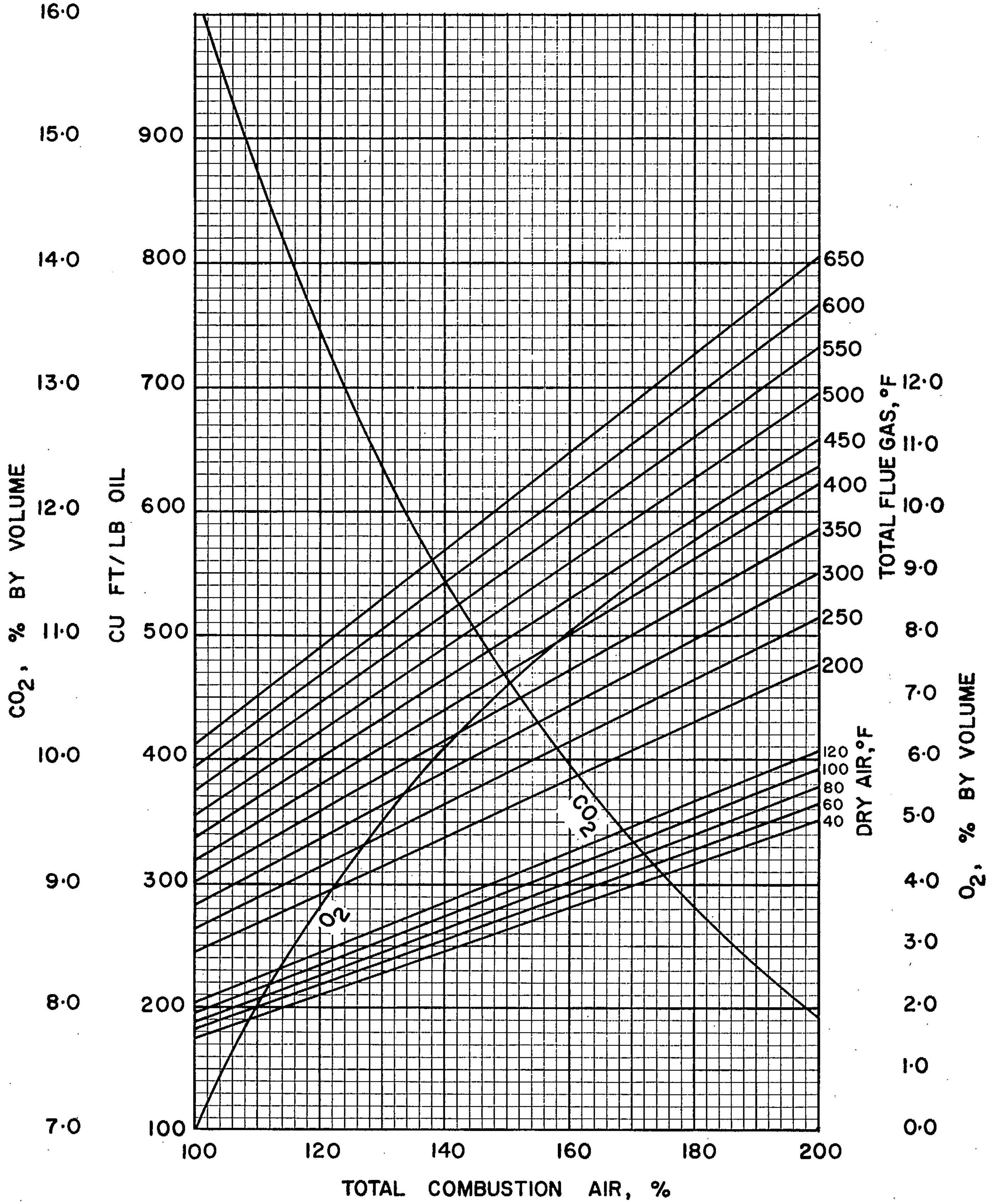


FIGURE 2. COMBUSTION DATA, VOLUME BASIS.

10200

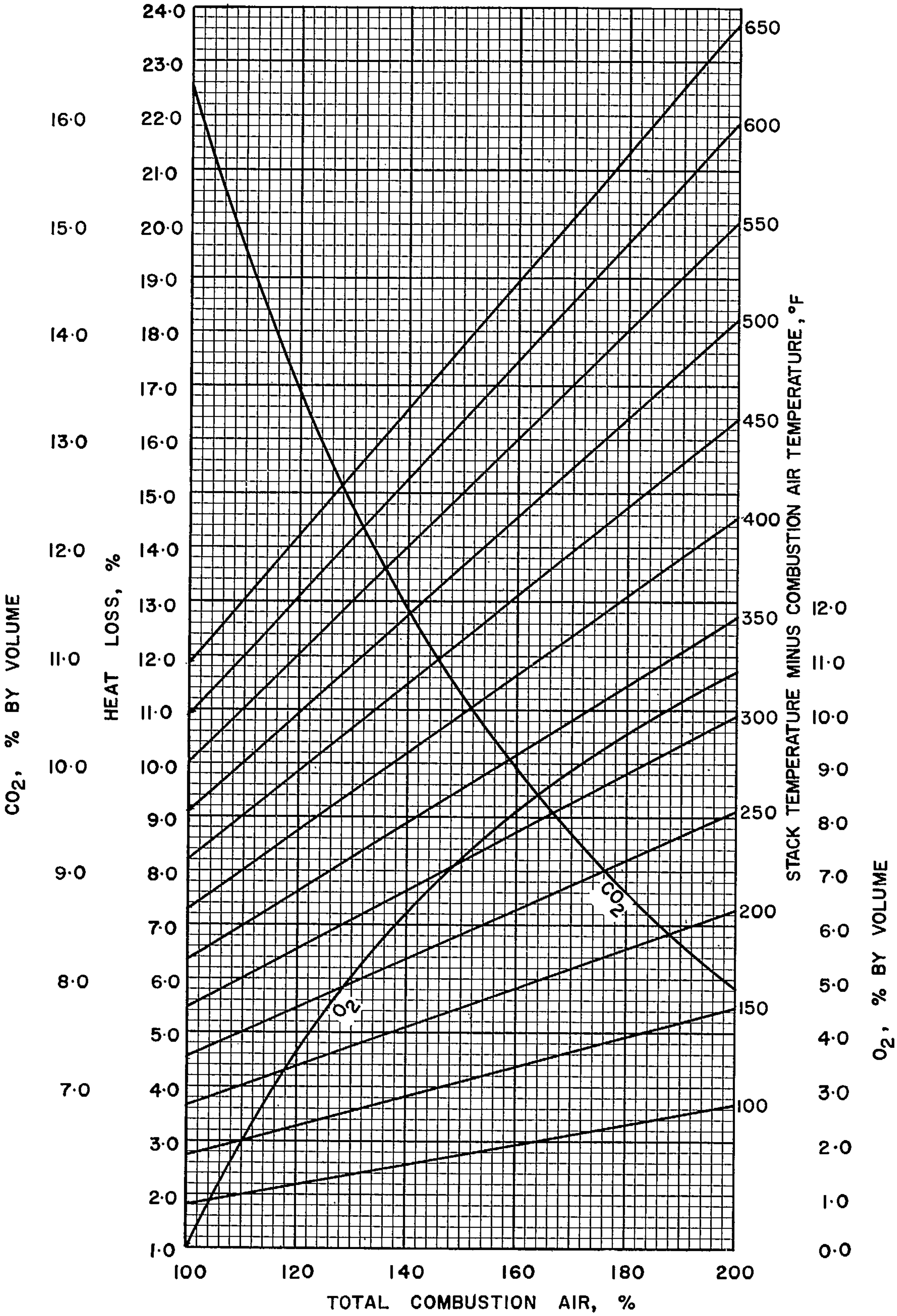


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

10200

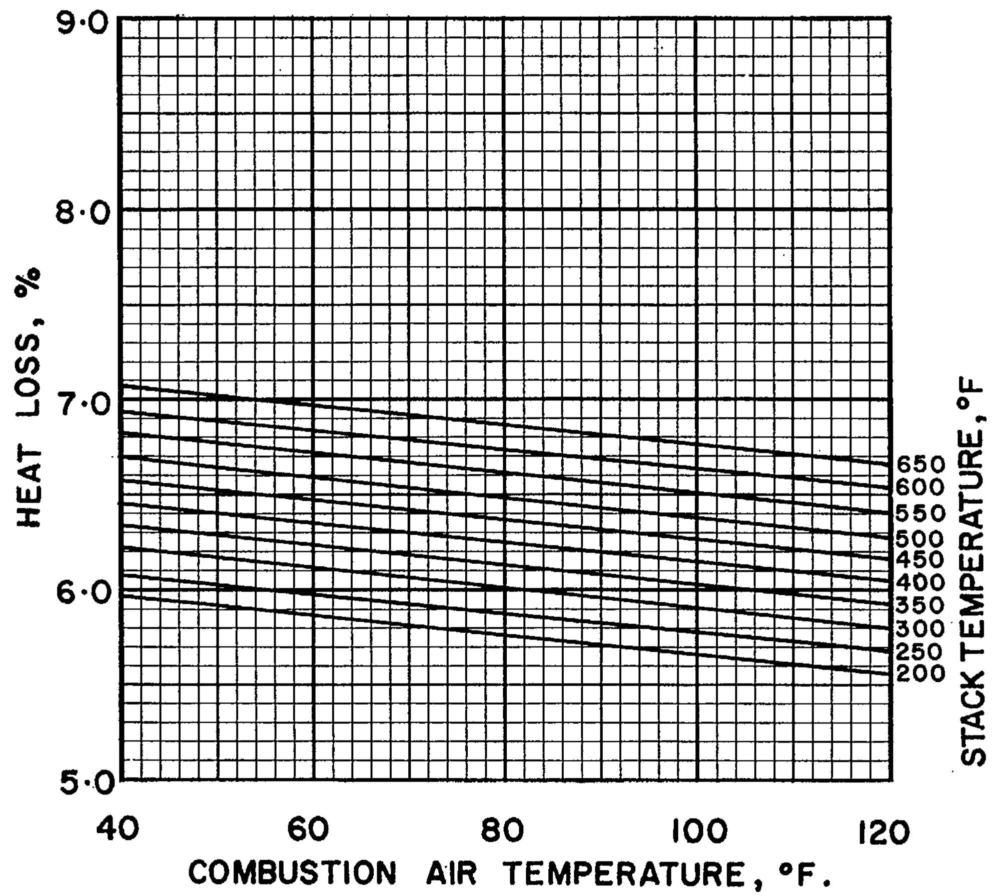


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

10200

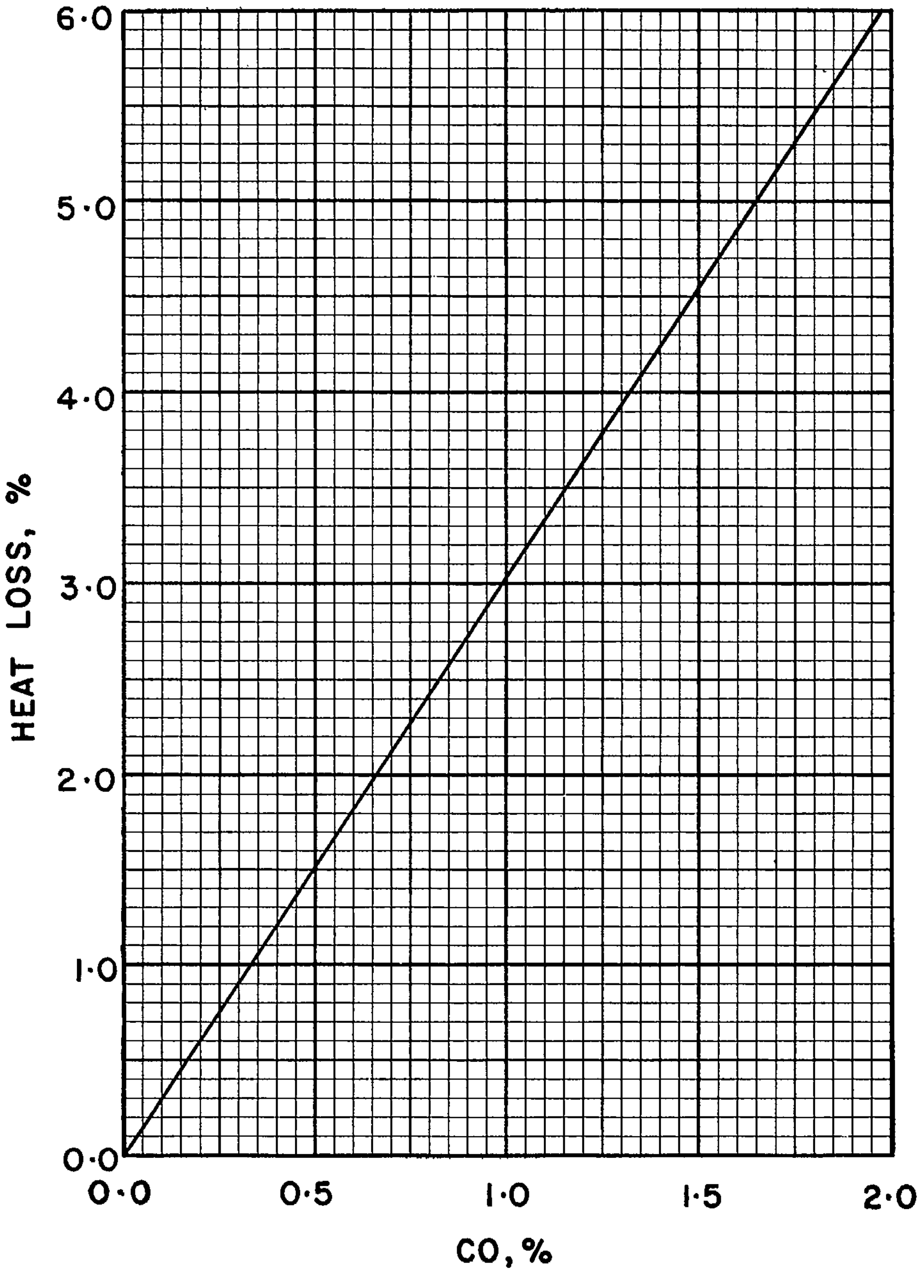


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

10200

FUEL OIL 10210, SPECIFIC GRAVITY 1.020

Carbon	(C)	0.8841
Hydrogen	(H_2)	0.1059
Sulphur	(S)	0.0100
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,250

Conversion Factors

1 Imp gal oil = 10.20 lb oil
or Imp gal oil × 10.20 = lb oil
or lb oil × 0.0980 = Imp gal oil

1 U.S. gal oil = 10.20 × 0.8337 lb oil
or U.S. gal oil × 8.504 = lb oil
or lb oil × 0.1176 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}250} \text{ lb oil}$$

or Btu × 10^6 × 54.80 = lb oil
or lb oil × 0.0183 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}250 \times 10.20} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.372 = Imp gal oil
or Imp gal oil × 0.1862 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}250 \times 8.504} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.443 = U.S. gal oil
or U.S. gal oil × 0.1552 = Btu × 10^6

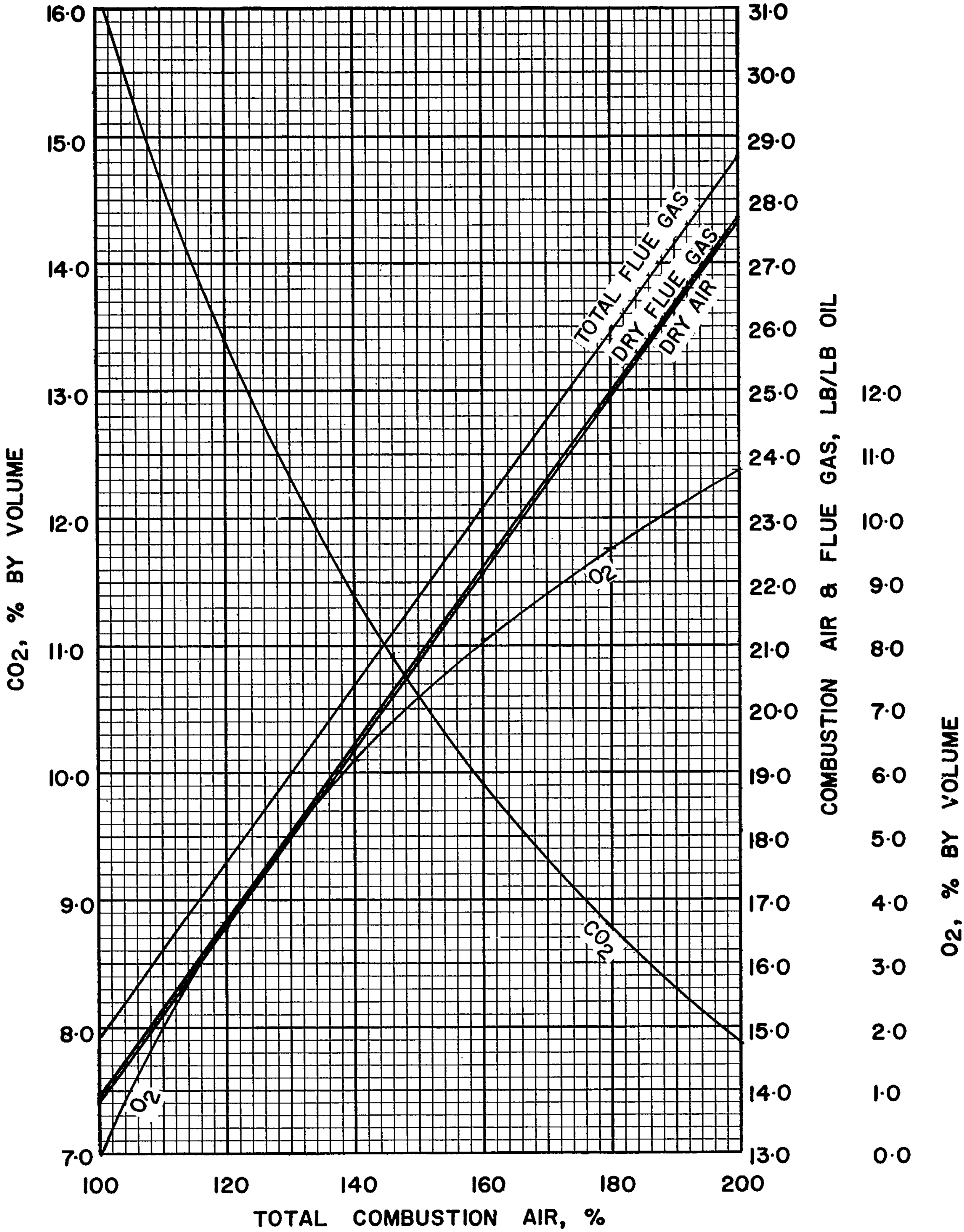


FIGURE I· COMBUSTION DATA, WEIGHT BASIS 10210

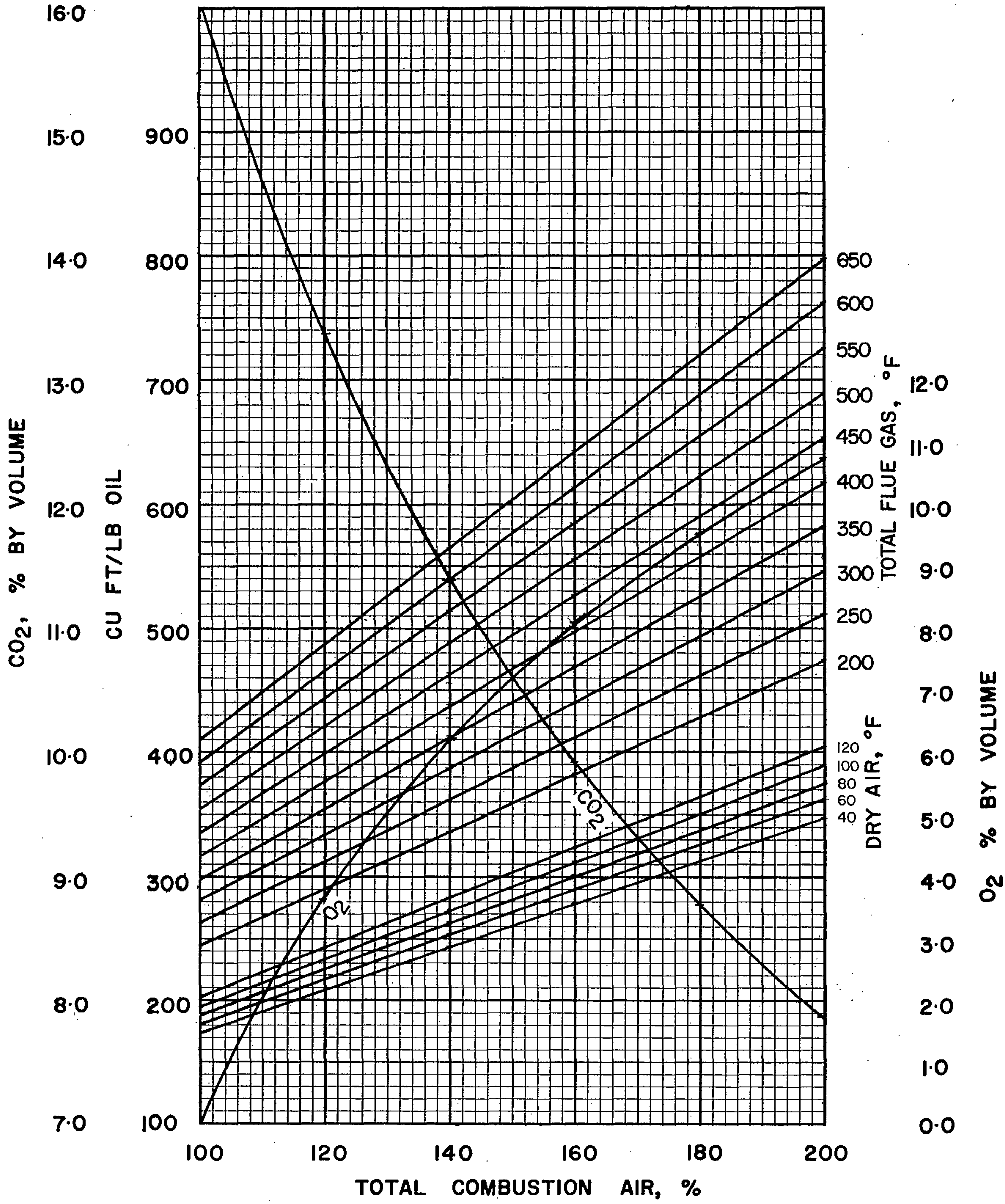


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 10210

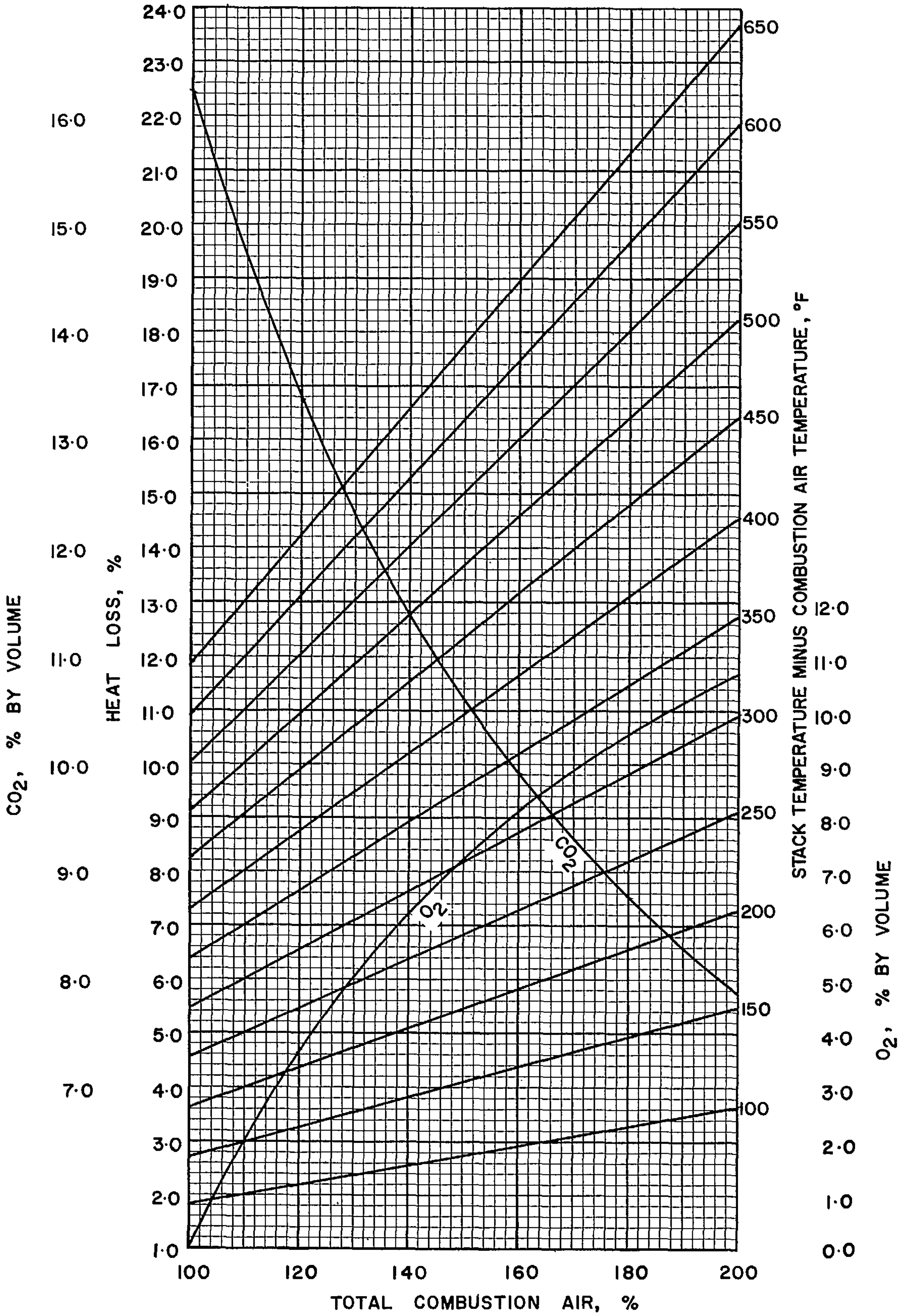


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

10210

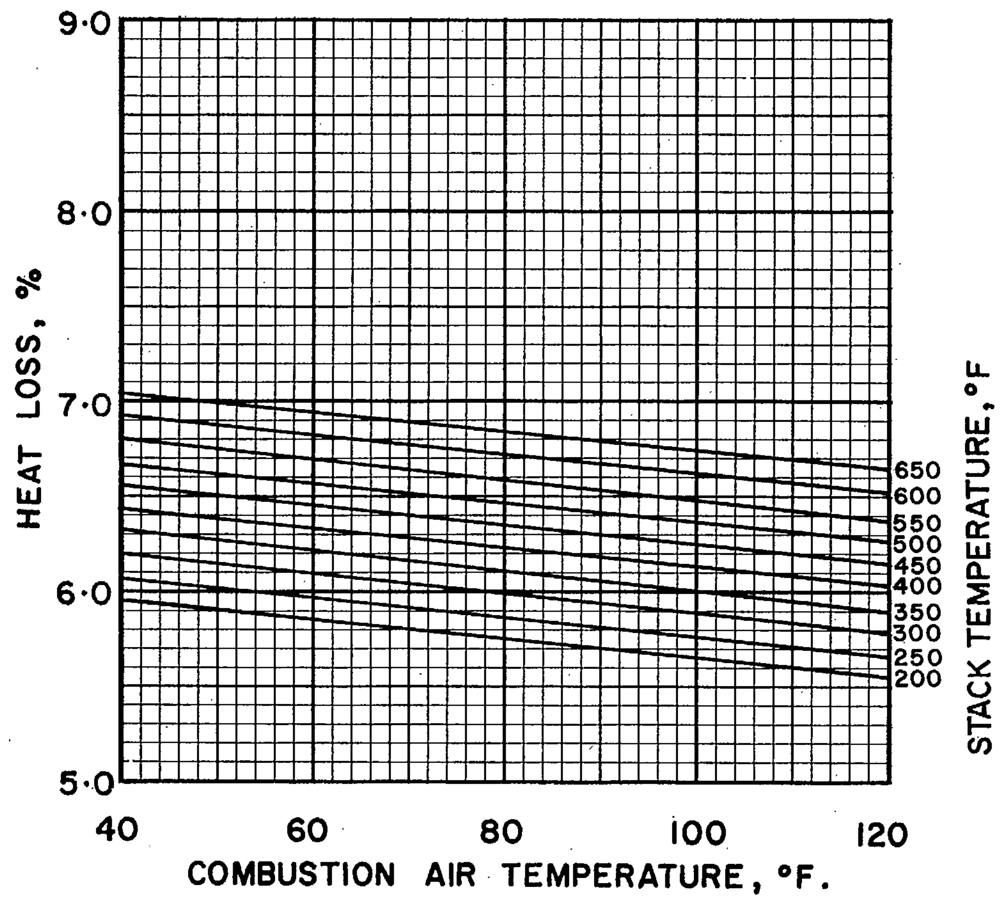


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

10210

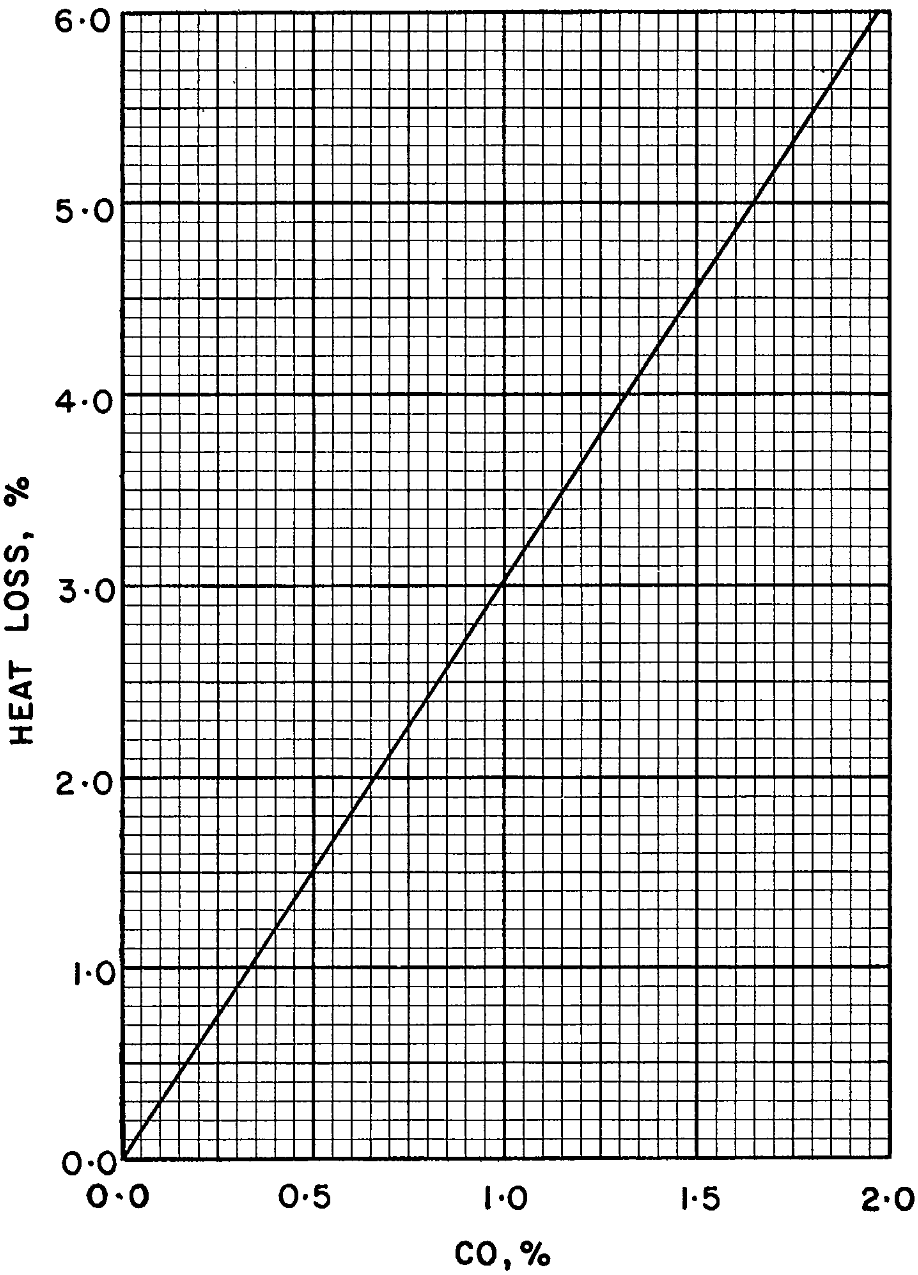


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR·

10210

FUEL OIL 10220, SPECIFIC GRAVITY 1.020

Ultimate Analysis, lb/lb

Carbon	(C)	0.8751
Hydrogen	(H_2)	0.1049
Sulphur	(S)	0.0200
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,100

Conversion Factors

1 Imp gal oil = 10.20 lb oil
or Imp gal oil × 10.20 = lb oil
or lb oil × 0.0980 = Imp gal oil

1 U.S. gal oil = 10.20 × 0.8337 lb oil
or U.S. gal oil × 8.504 = lb oil
or lb oil × 0.1176 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}100} \text{ lb oil}$$

or Btu × 10^6 × 55.25 = lb oil
or lb oil × 0.0181 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}100 \times 10.20} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.417 = Imp gal oil
or Imp gal oil × 0.1846 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}100 \times 8.504} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.498 = U.S. gal oil
or U.S. gal oil × 0.1539 = Btu × 10^6

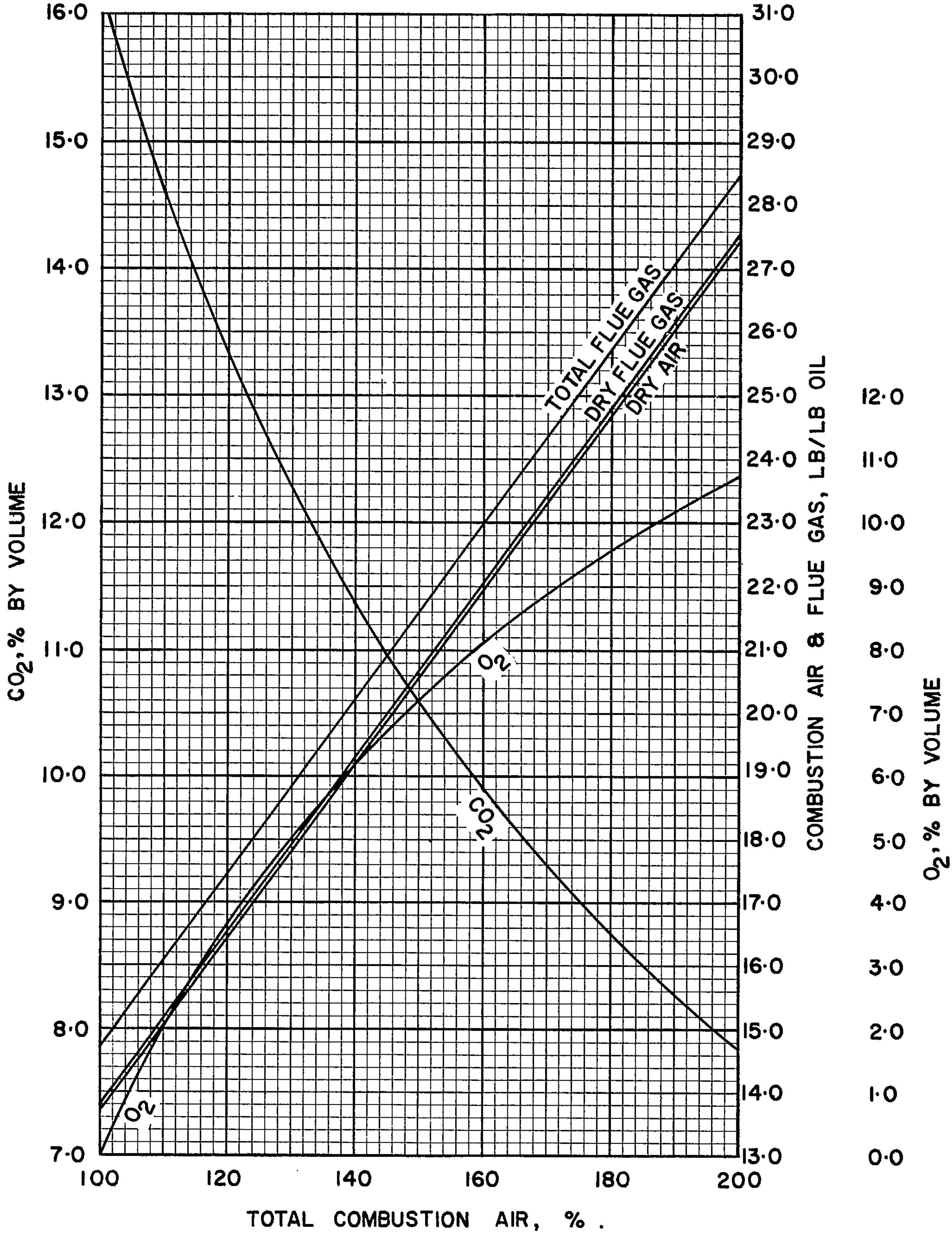


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS.

10220

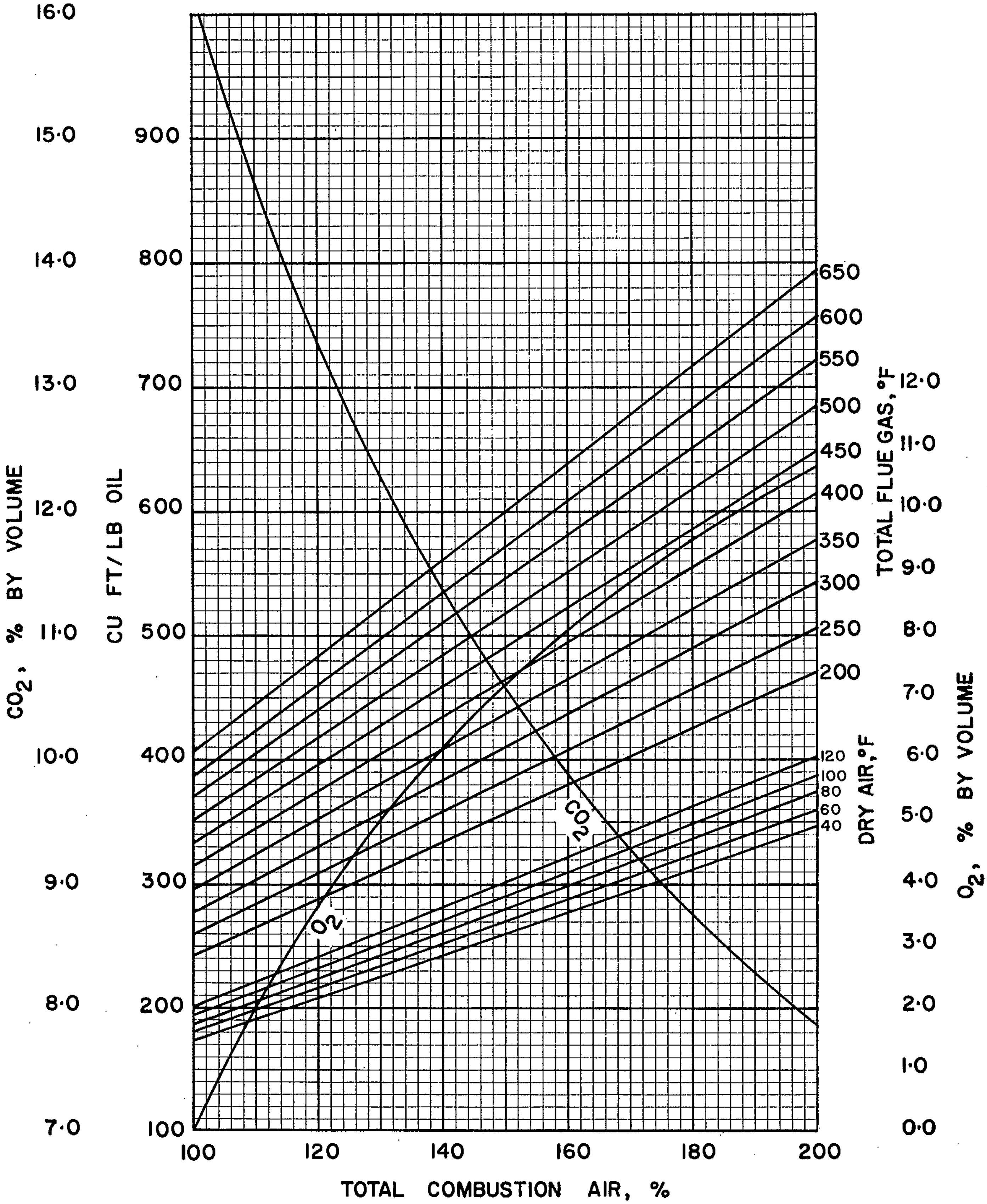


FIGURE 2. COMBUSTION DATA, VOLUME BASIS.

10220

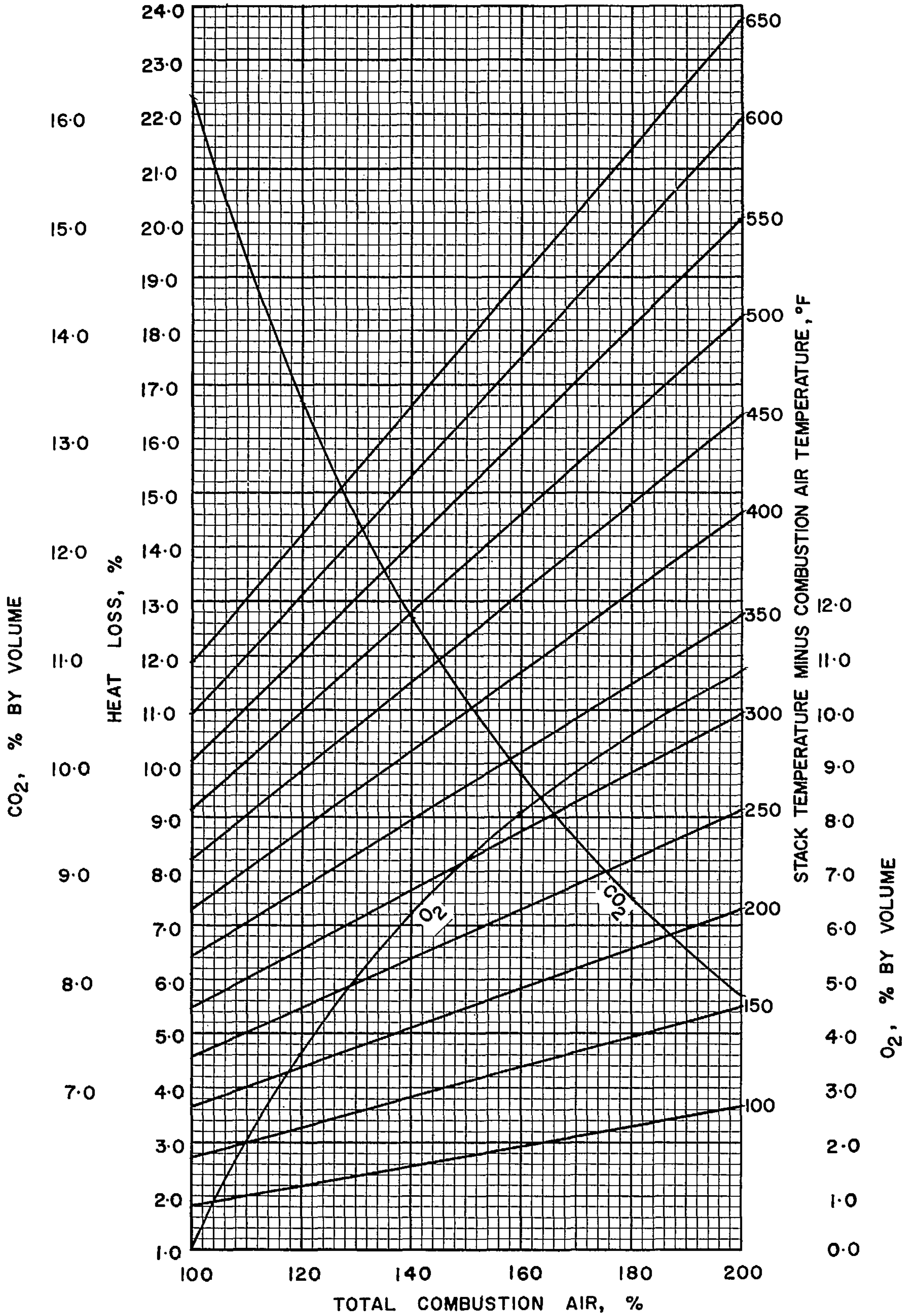


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

10220

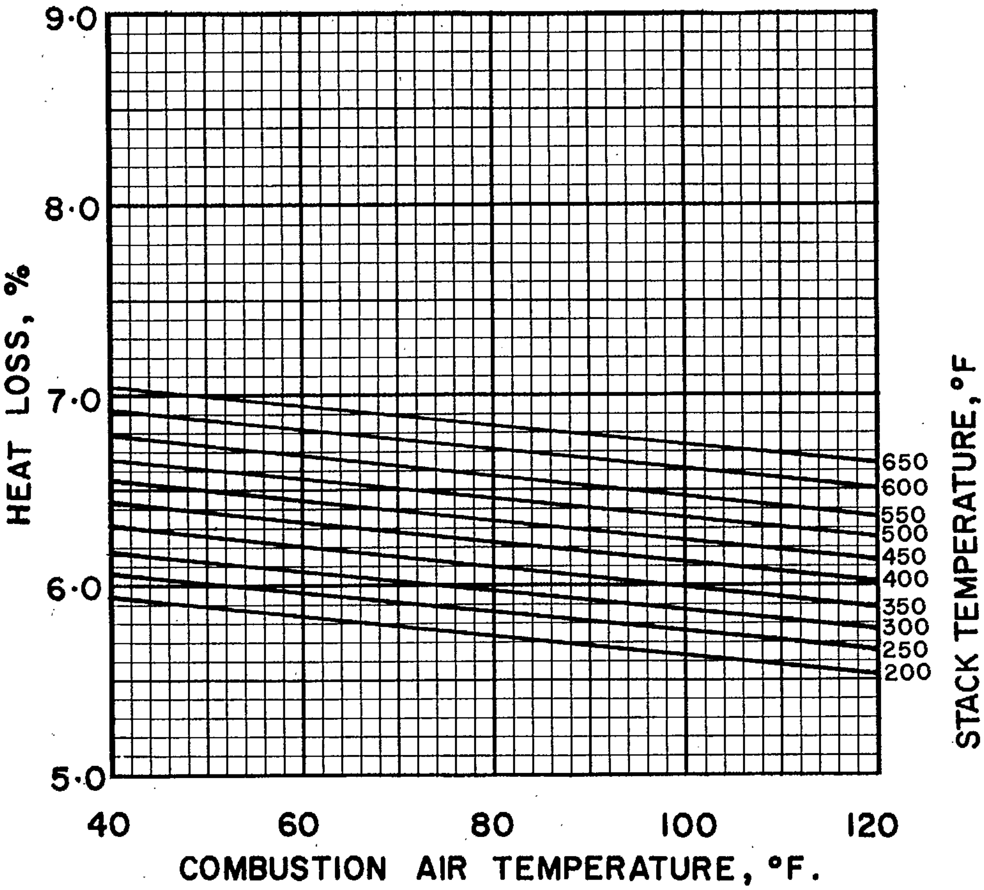


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

10220

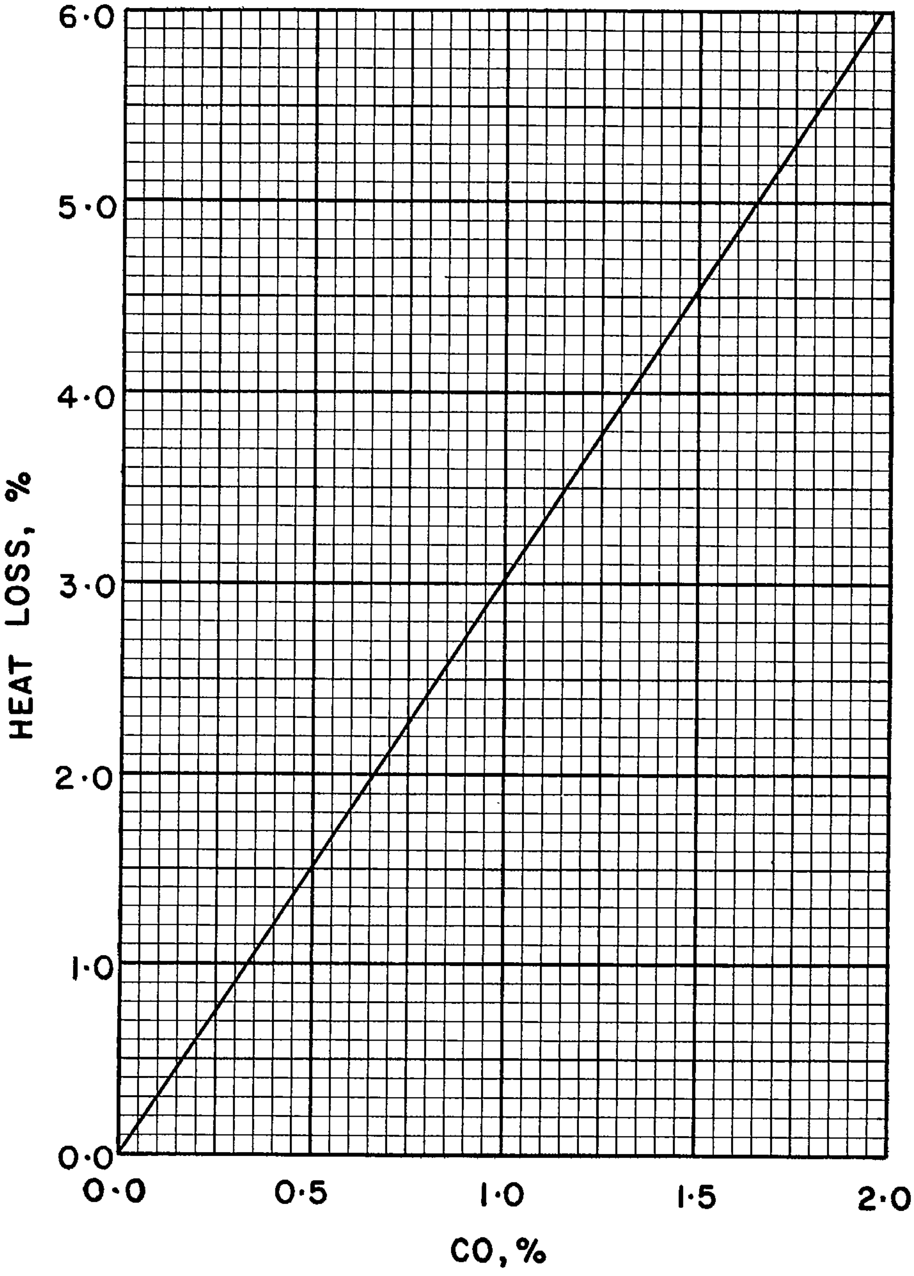


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

10220

FUEL OIL 10230, SPECIFIC GRAVITY 1.020

Ultimate Analysis, lb/lb

Carbon	(C)	0.8662
Hydrogen	(H_2)	0.1038
Sulphur	(S)	0.0300
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		17,960

Conversion Factors

1 Imp gal oil = 10.20 lb oil
or Imp gal oil × 10.20 = lb oil
or lb oil × 0.0980 = Imp gal oil

1 U.S. gal oil = 10.20 × 0.8337 lb oil
or U.S. gal oil × 8.504 = lb oil
or lb oil × 0.1176 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{17{,}960} \text{ lb oil}$$

or Btu × 10^6 × 55.68 = lb oil
or lb oil × 0.0180 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{17{,}960 \times 10.20} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.459 = Imp gal oil
or Imp gal oil × 0.1832 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{17{,}960 \times 8.504} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.549 = U.S. gal oil
or U.S. gal oil × 0.1527 = Btu × 10^6

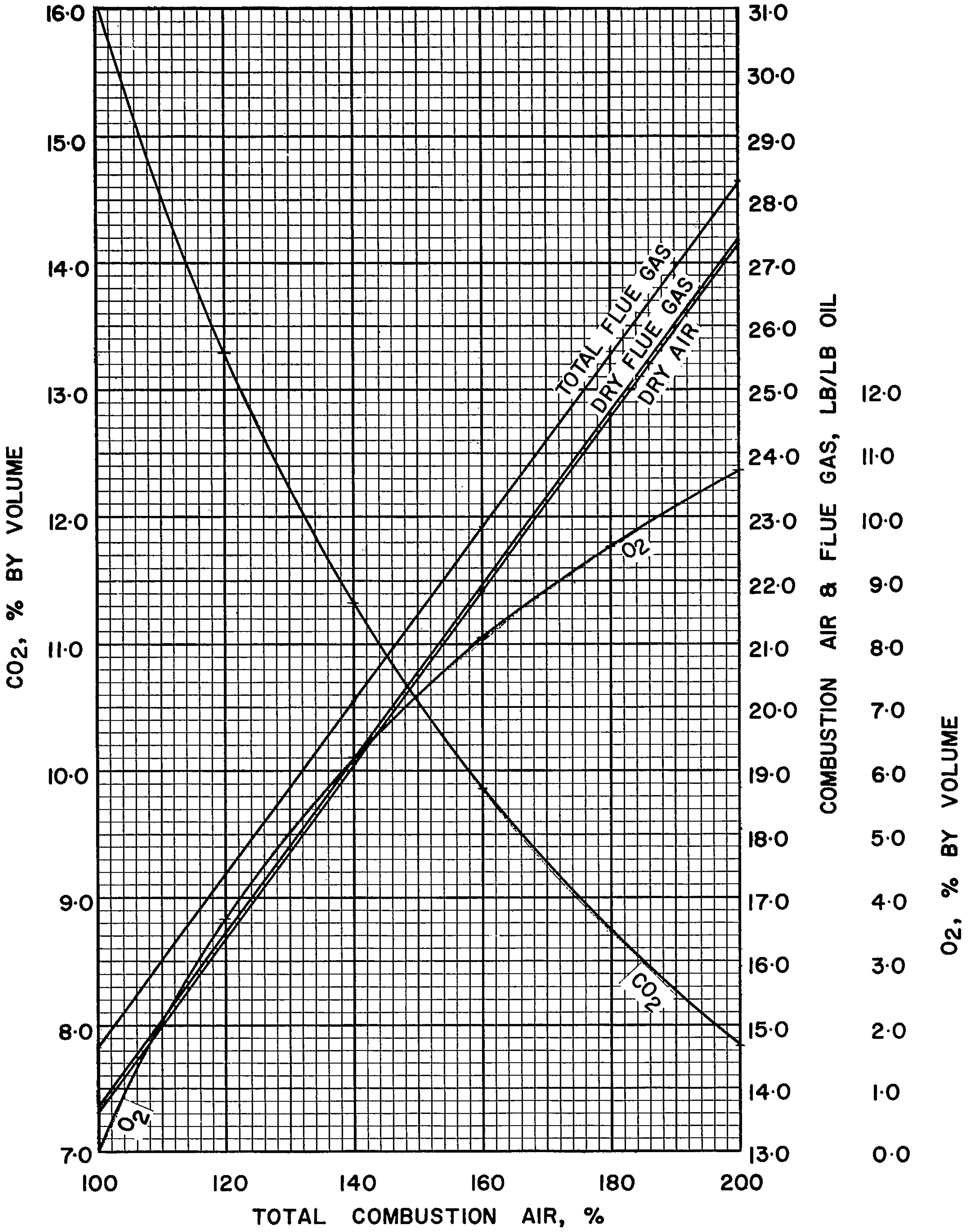


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS

10230

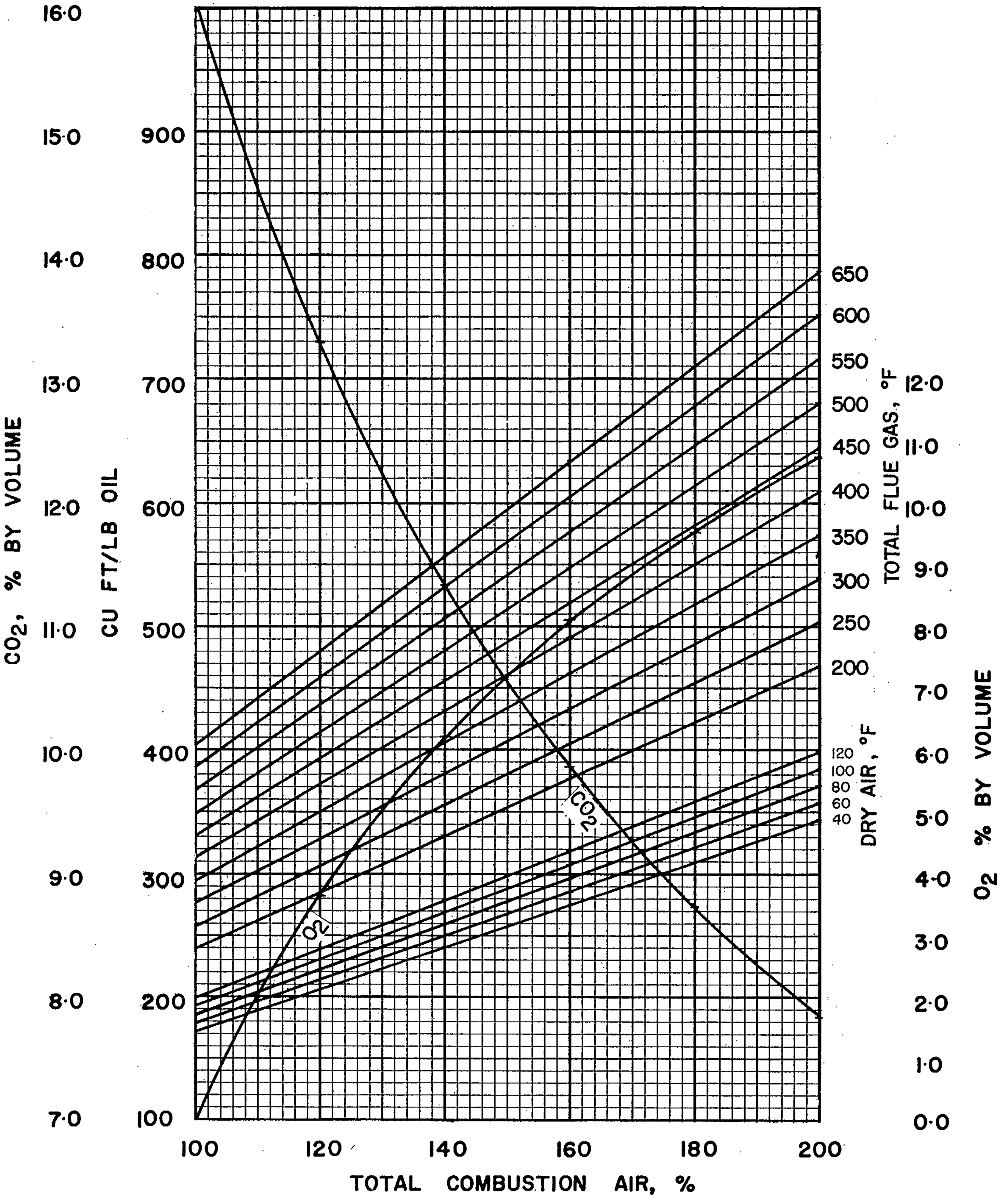


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 10230

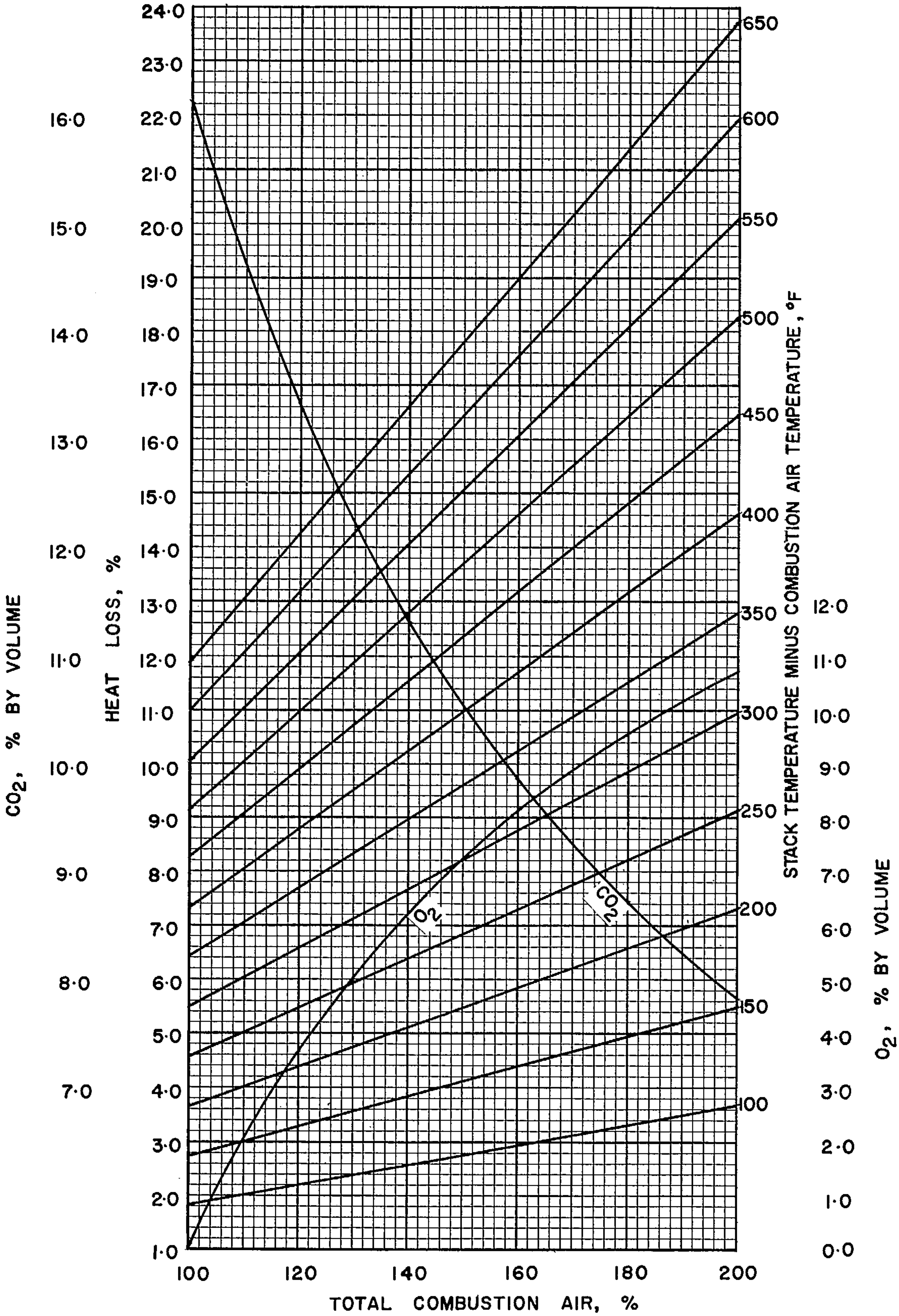


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

10230

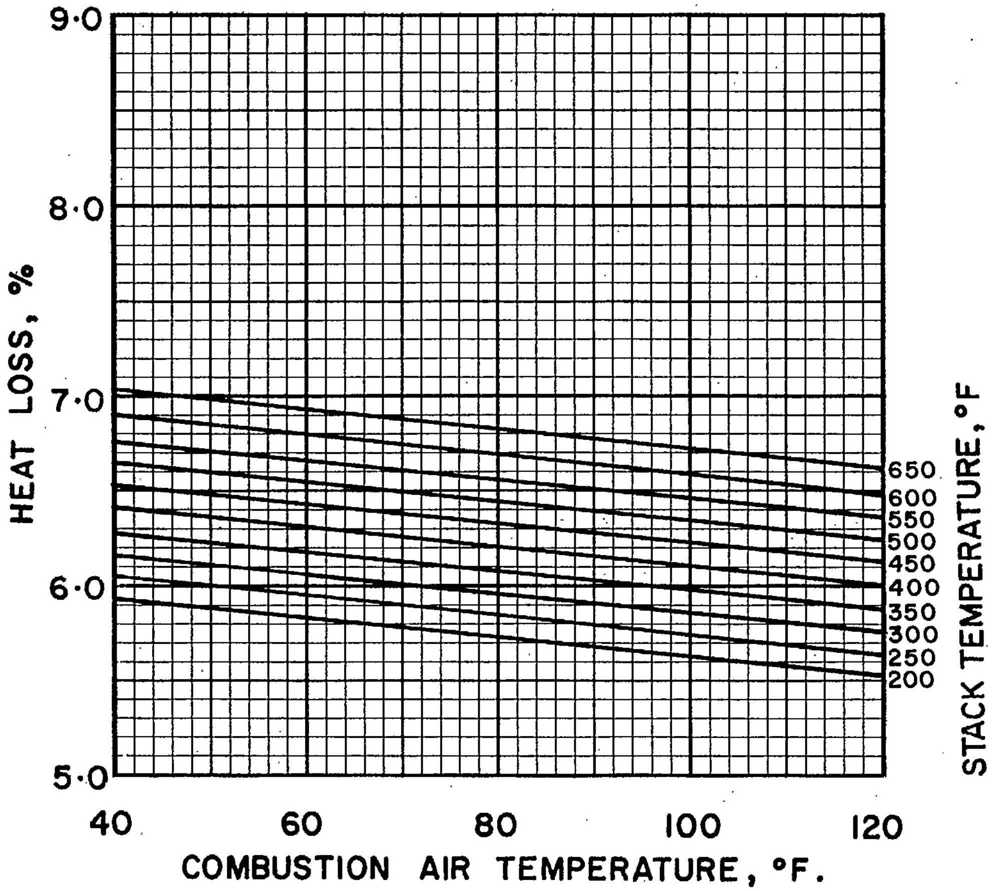


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

10230

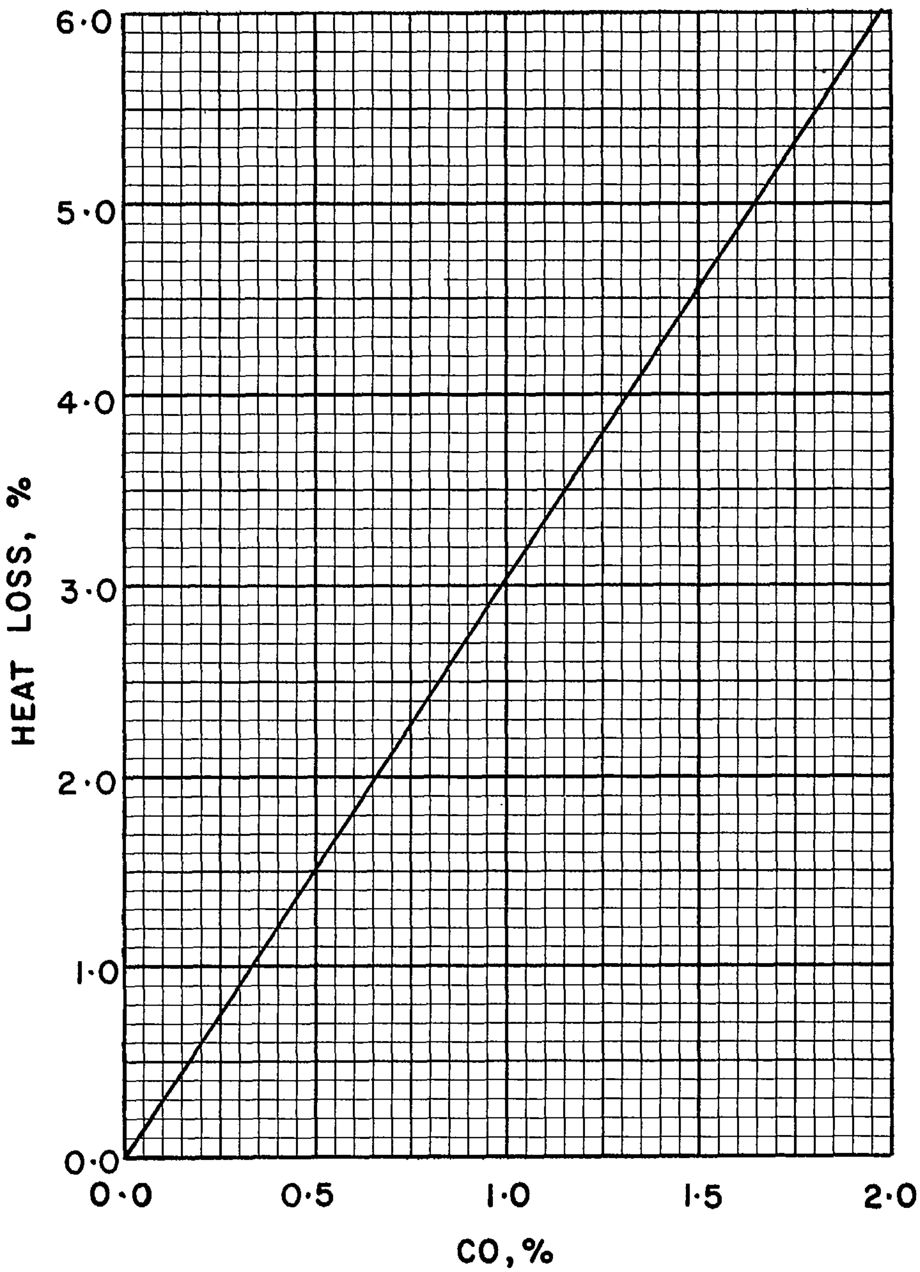


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

10230

FUEL OIL 10240, SPECIFIC GRAVITY 1.020

Ultimate Analysis, lb/lb

Carbon	(C)	0.8573
Hydrogen	(H_2)	0.1027
Sulphur	(S)	0.0400
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		17,820

Conversion Factors

1 Imp gal oil = 10.20 lb oil
or Imp gal oil × 10.20 = lb oil
or lb oil × 0.0980 = Imp gal oil

1 U.S. gal oil = 10.20 × 0.8337 lb oil
or U.S. gal oil × 8.504 = lb oil
or lb oil × 0.1176 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{17{,}820} \text{ lb oil}$$

or Btu × 10^6 × 56.12 = lb oil
or lb oil × 0.0178 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{17.820 \times 10.20} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.502 = Imp gal oil
or Imp gal oil × 0.1818 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{17{,}820 \times 8.504} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.601 = U.S. gal oil
or U.S. gal oil × 0.1515 = Btu × 10^6

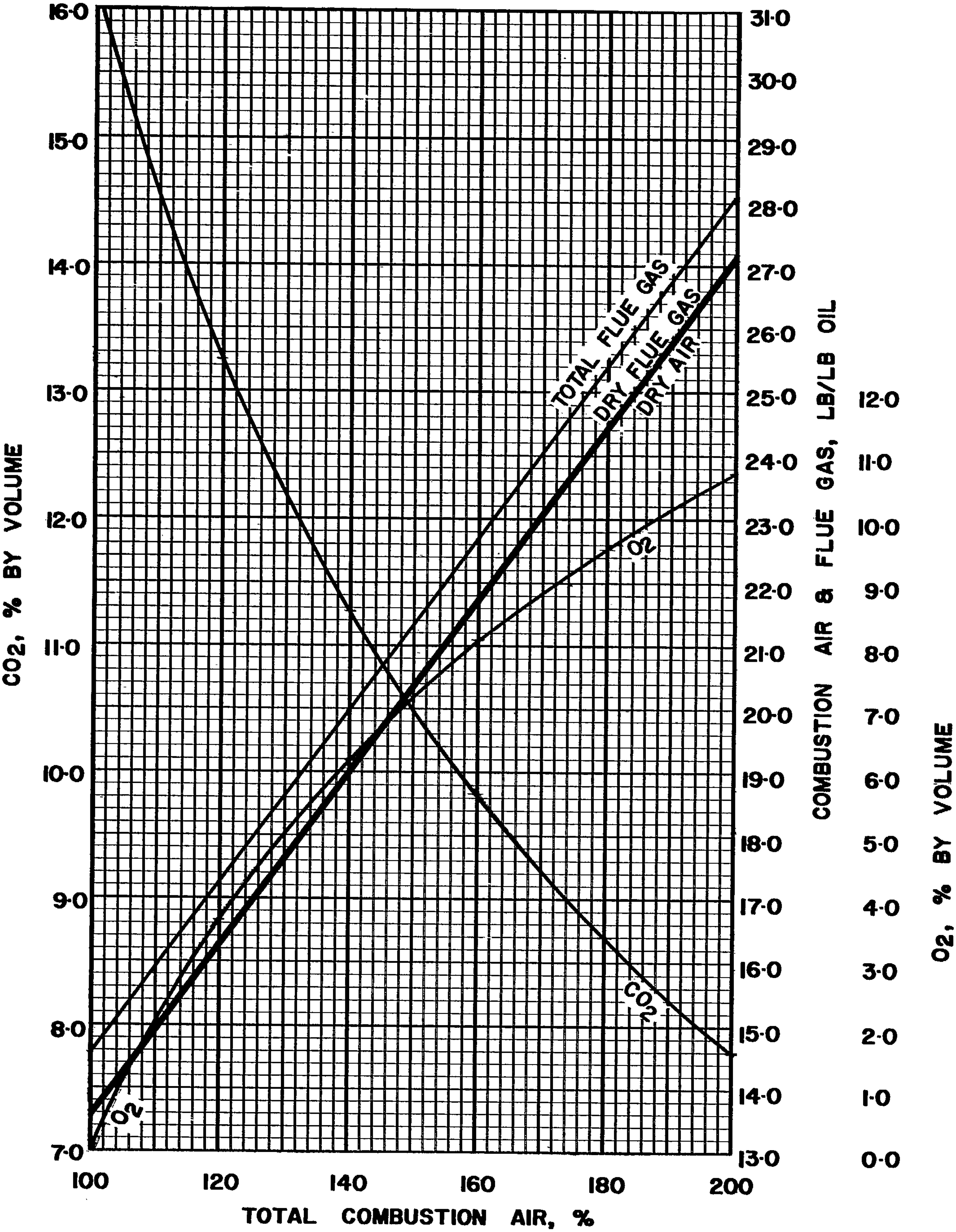


FIGURE I- COMBUSTION DATA, WEIGHT BASIS 10240

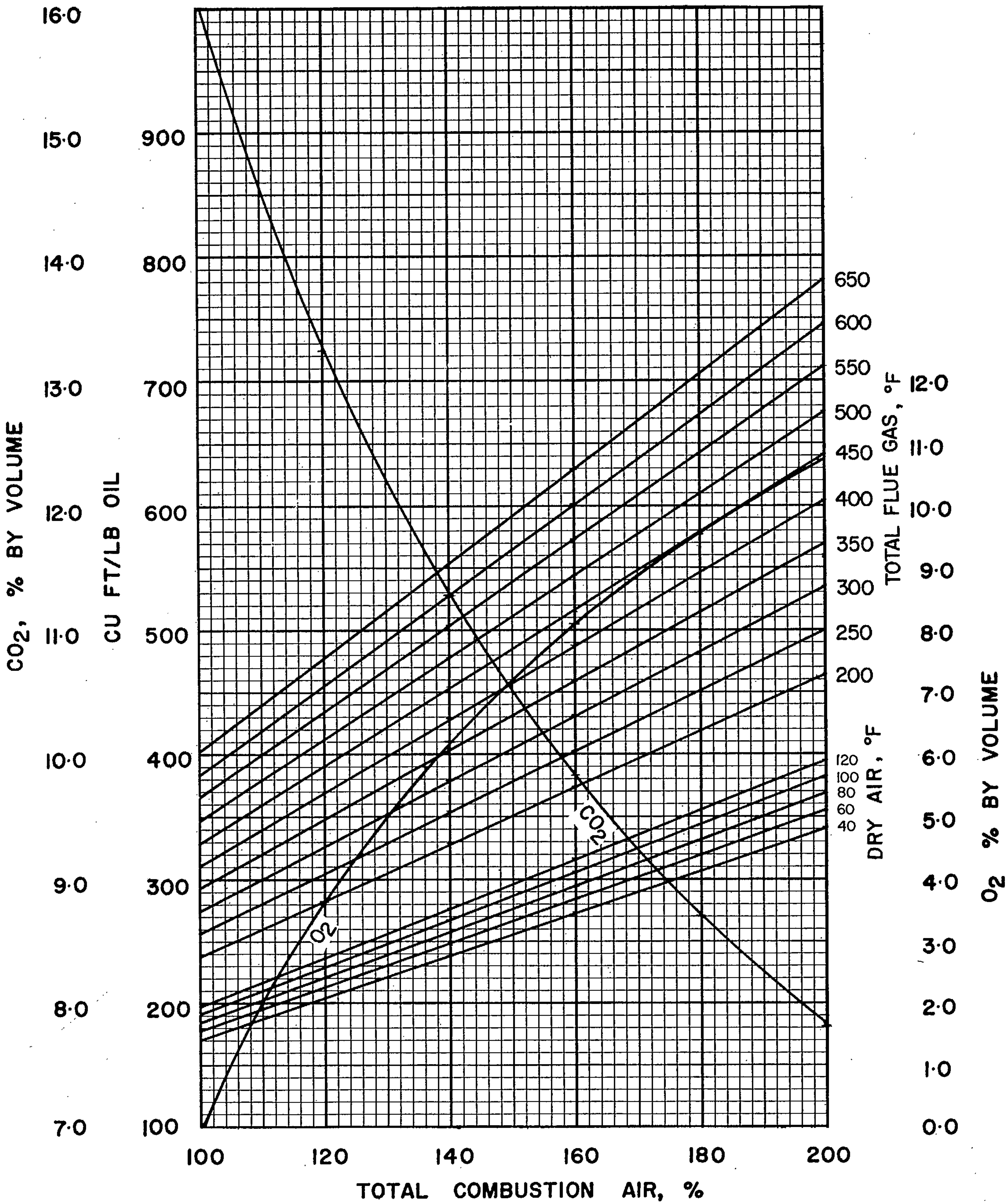


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 10240

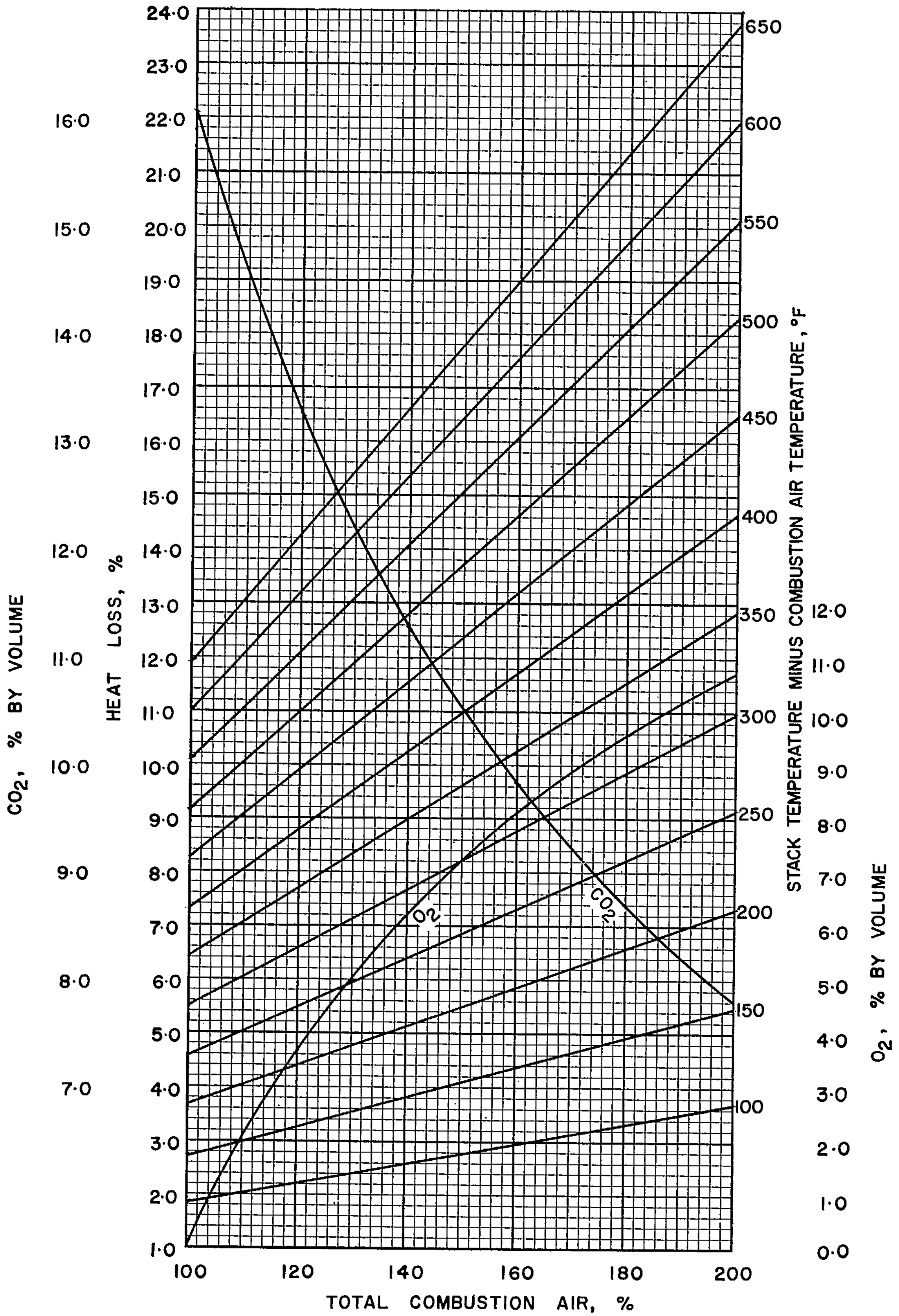


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

10240

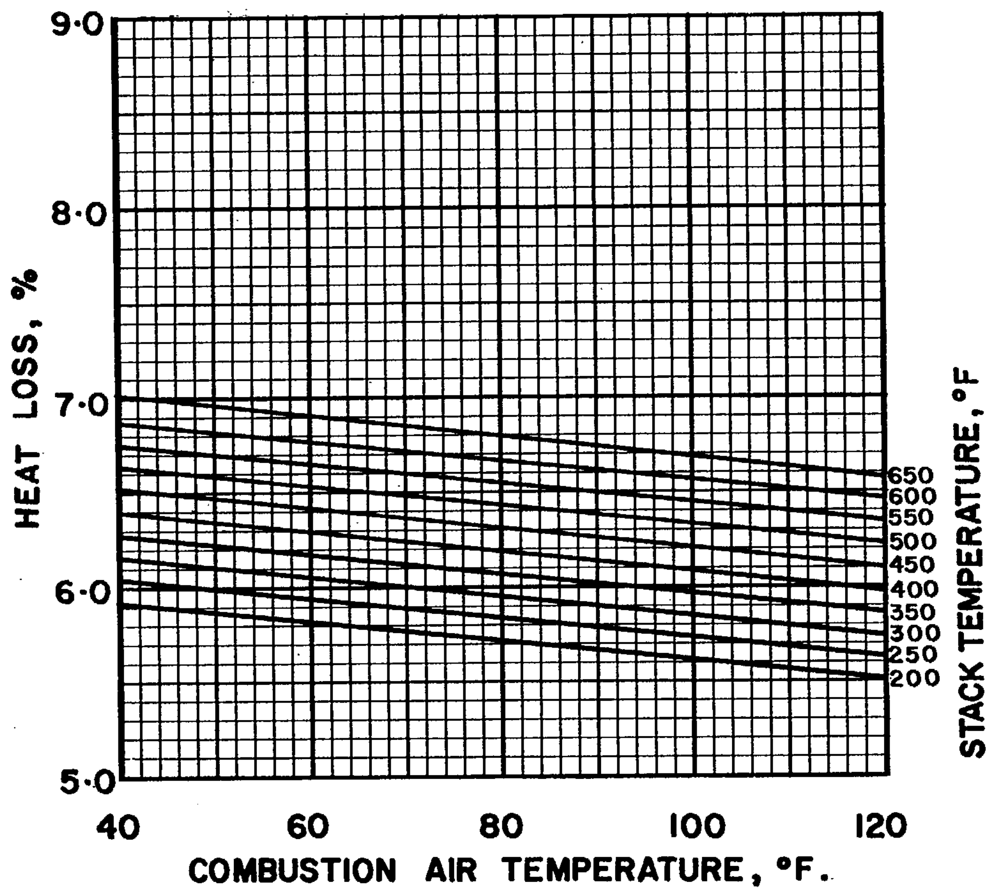


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

10240

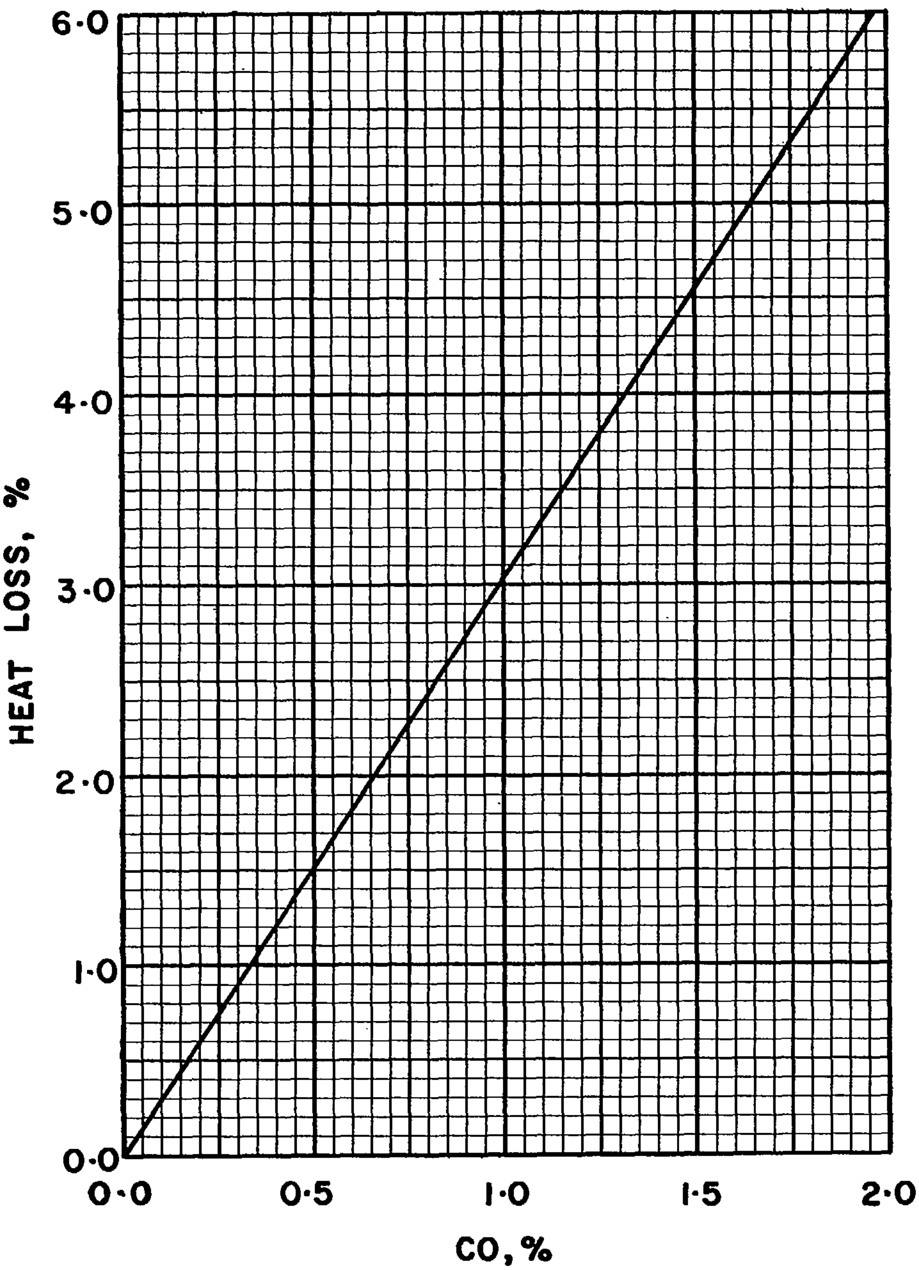


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

10240

FUEL OIL 10300, SPECIFIC GRAVITY 1.030

Ultimate Analysis, lb/lb

Carbon	(C)	0.8945
Hydrogen	(H_2)	0.1055
Sulphur	(S)	–
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,310

Conversion Factors

1 Imp gal oil = 10.30 lb oil
or Imp gal oil × 10.30 = lb oil
or lb oil × 0.0971 = Imp gal oil

1 U.S. gal oil = 10.30 × 0.8337 lb oil
or U.S. gal oil × 8.587 = lb oil
or lb oil × 0.1165 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}310} \text{ lb oil}$$

or Btu × 10^6 × 54.62 = lb oil
or lb oil × 0.0183 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}310 \times 10.30} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.302 = Imp gal oil
or Imp gal oil × 0.1886 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}310 \times 8.587} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.361 = U.S. gal oil
or U.S. gal oil × 0.1572 = Btu × 10^6

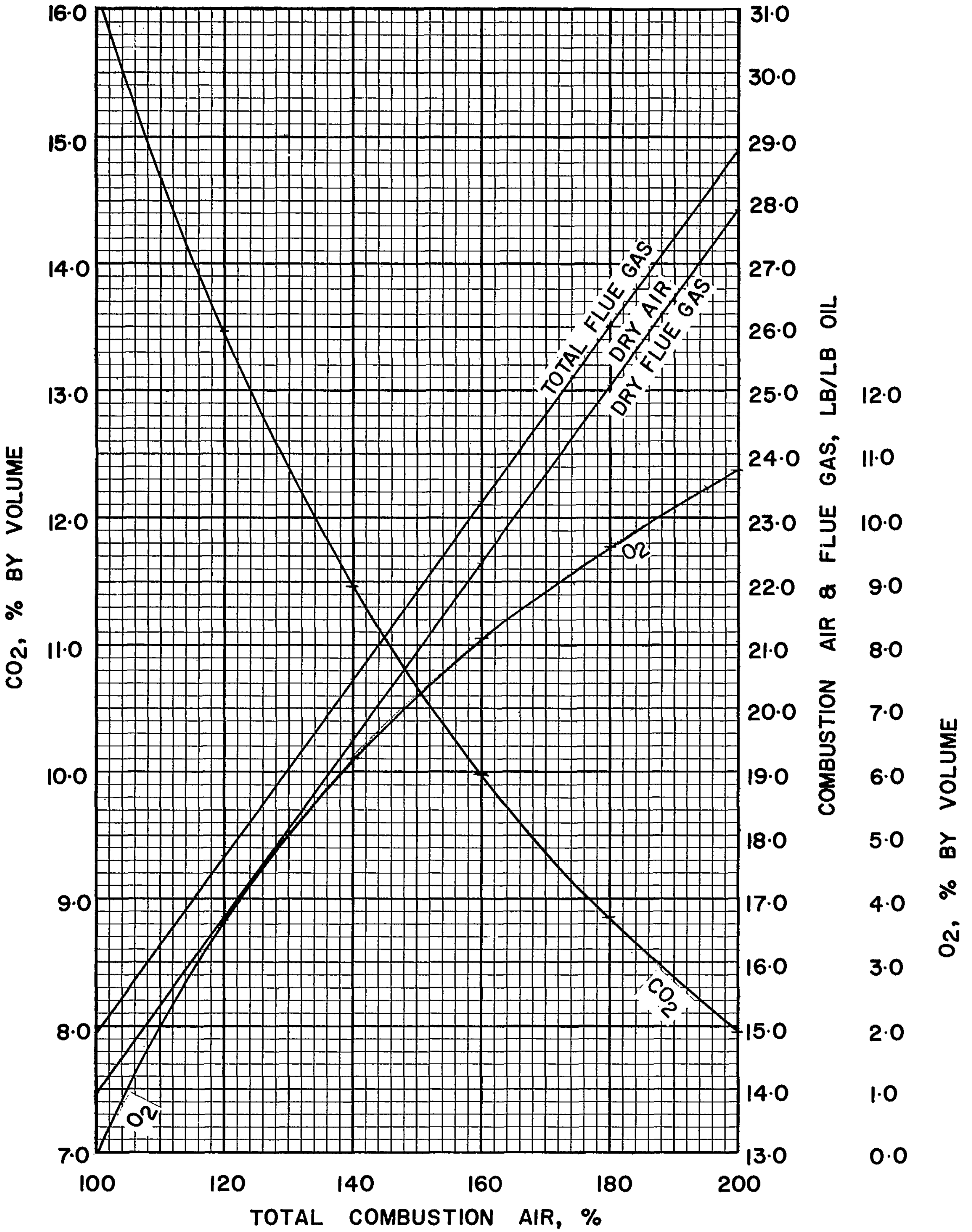


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS 10300

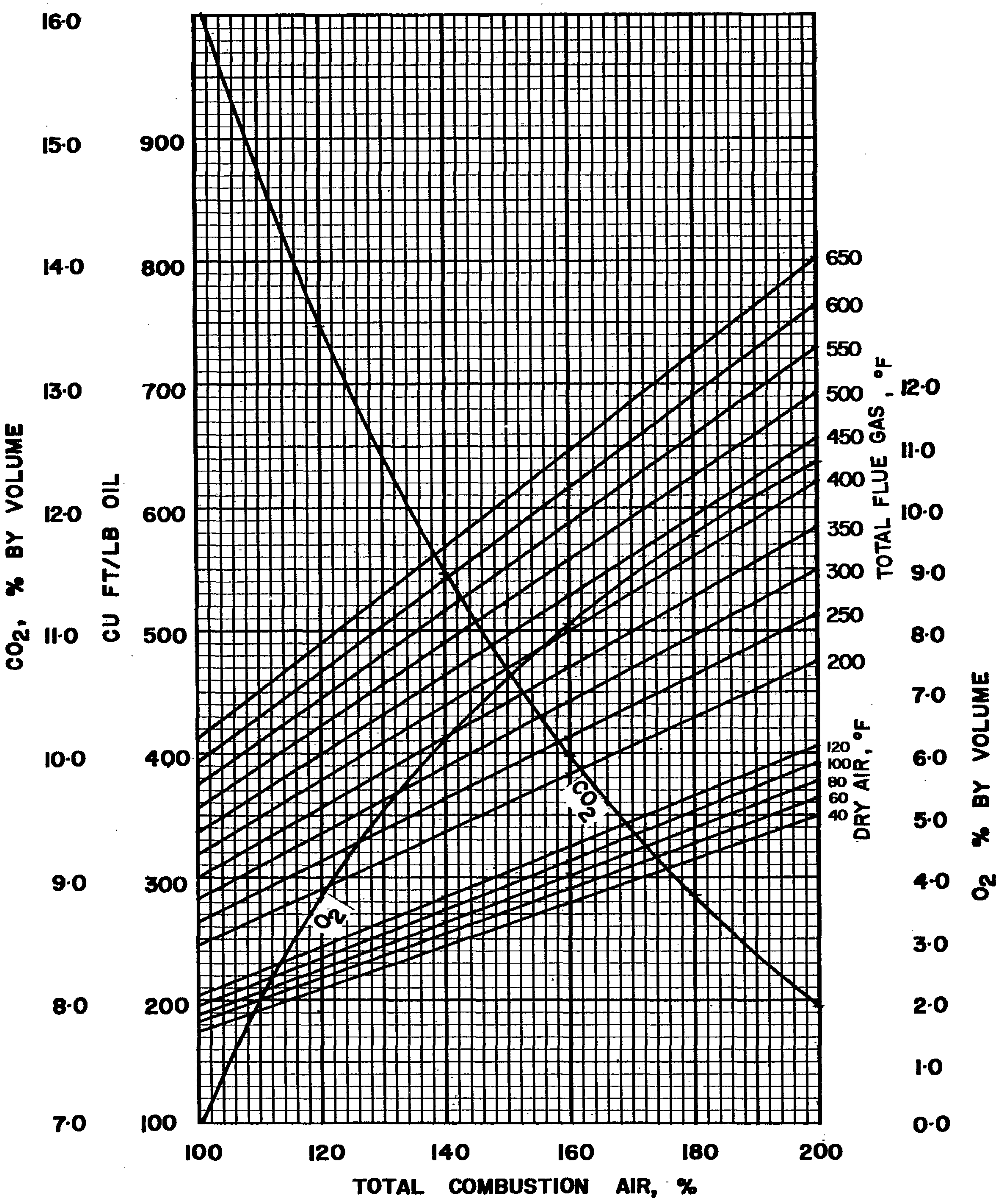


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 10300

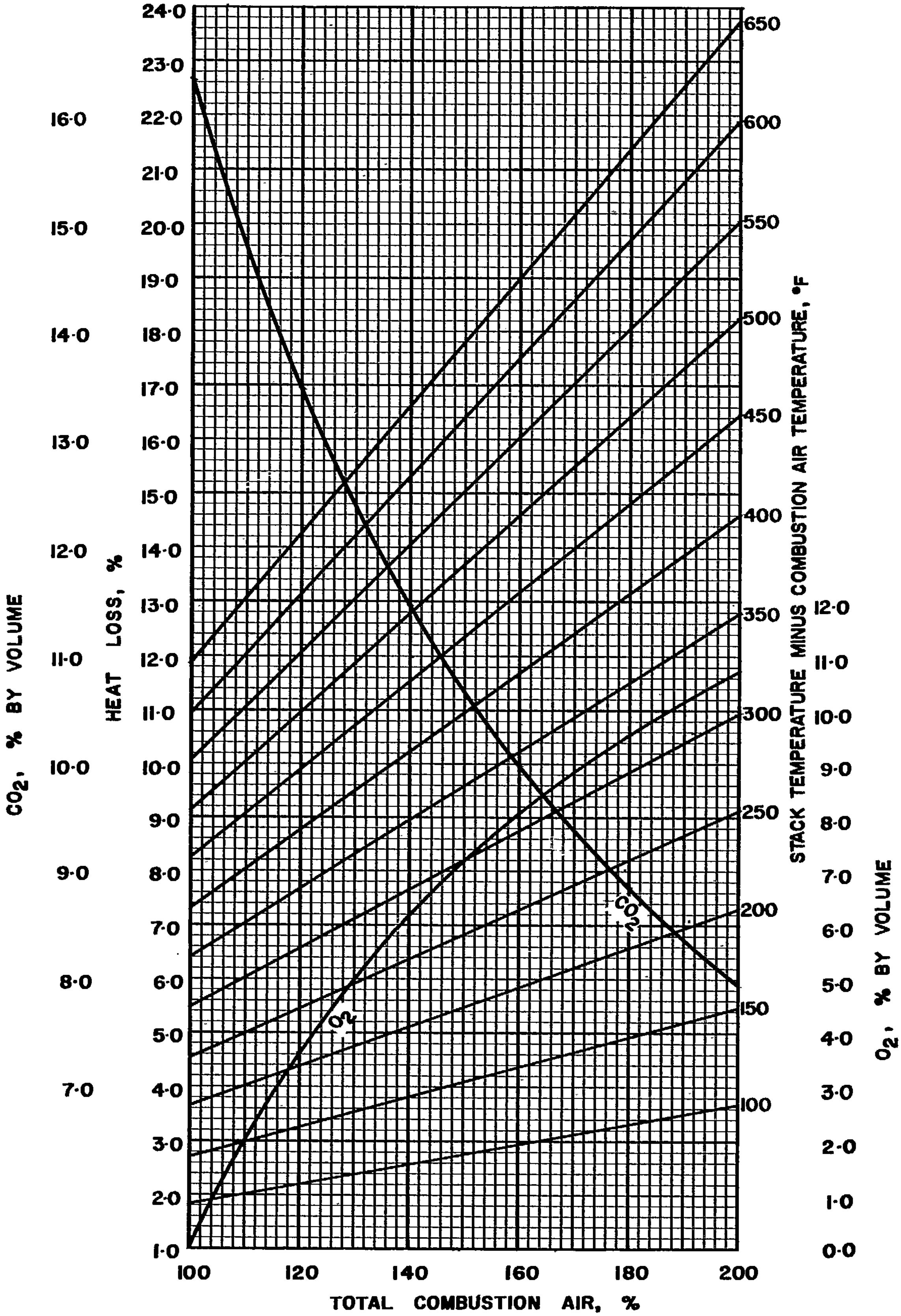


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

10300

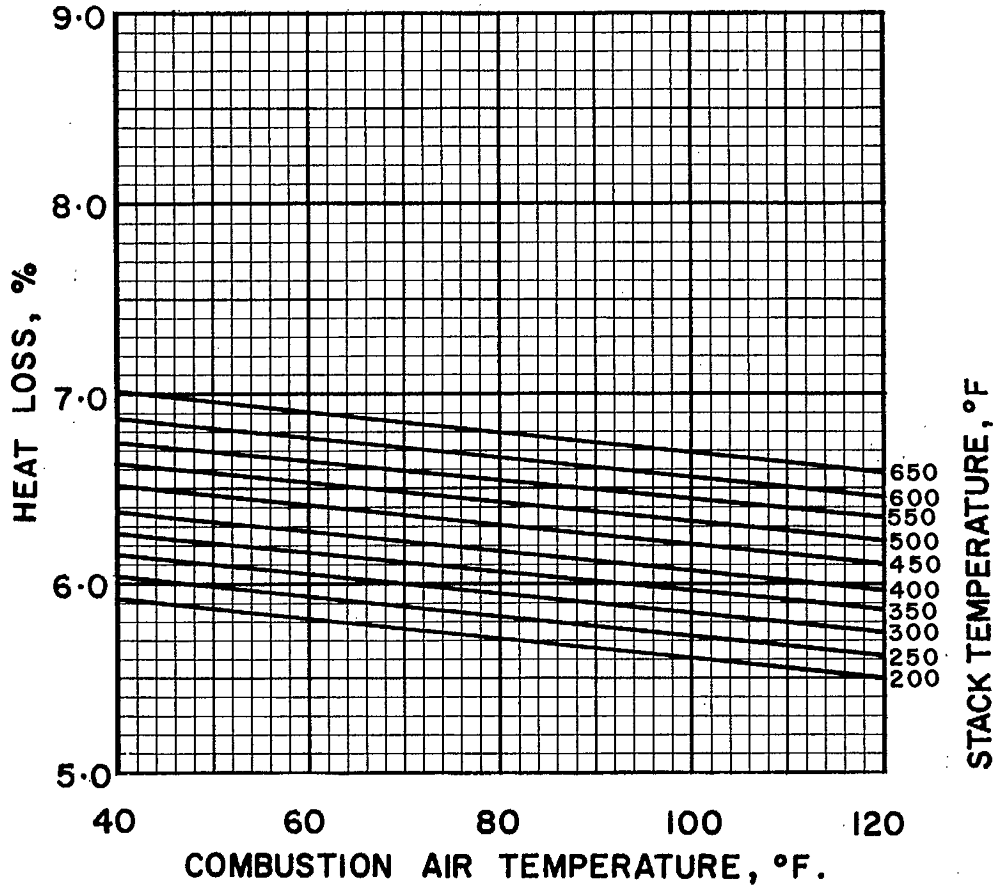


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

10300

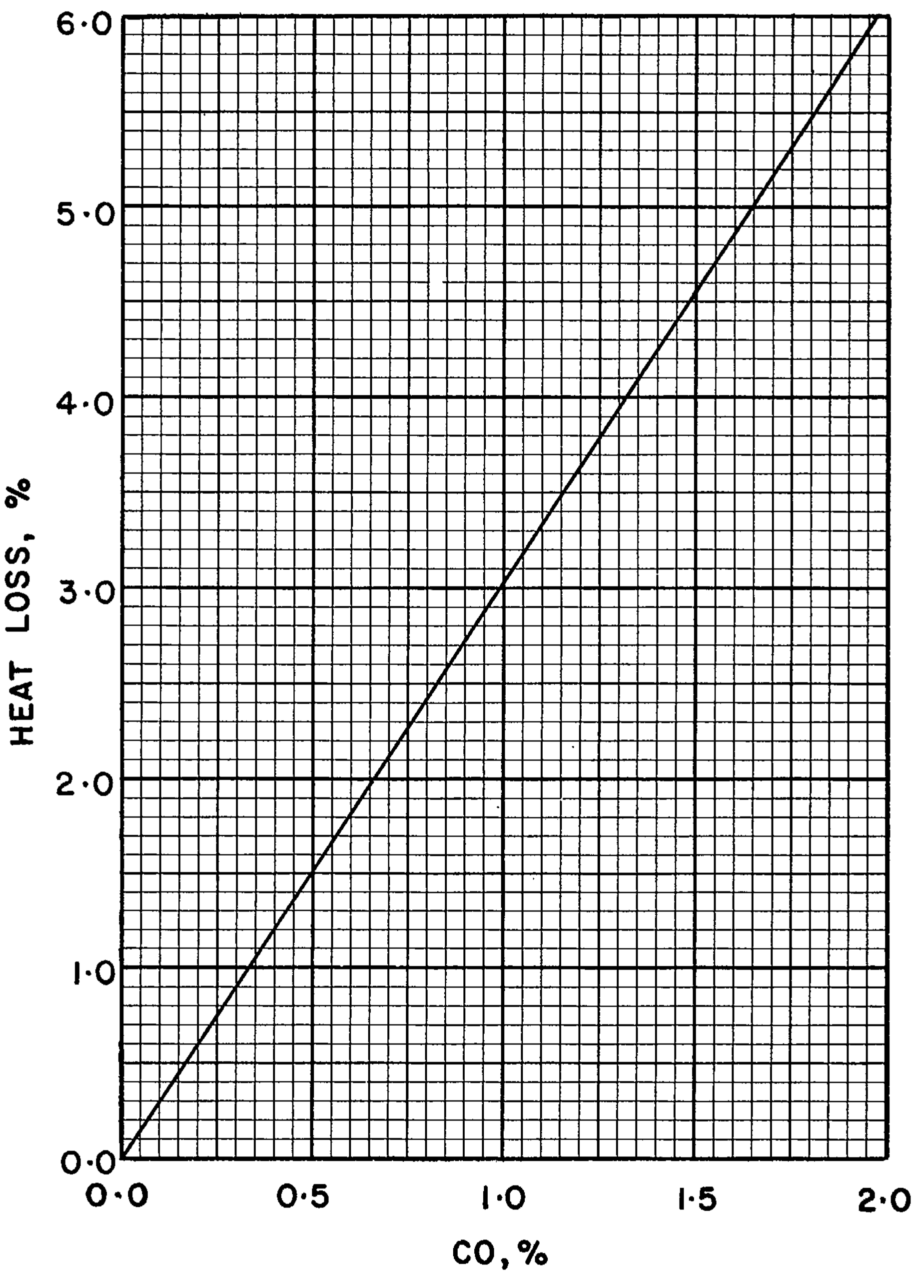


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

10300

FUEL OIL 10310, SPECIFIC GRAVITY 1.030

Ultimate Analysis, lb/lb

Carbon (C)	0.8856
Hydrogen (H_2)	0.1044
Sulphur (S)	0.0100
Nitrogen (N_2)	–
Oxygen (O_2)	–
Ash	–
Moisture	–
Total	1.0000
Calorific Value, Btu/lb	18,170

Conversion Factors

1 Imp gal oil = 10.30 lb oil
or Imp gal oil × 10.30 = lb oil
or lb oil × 0.0971 = Imp gal oil

1 U.S. gal oil = 10.30 × 0.8337 lb oil
or U.S. gal oil × 8.587 = lb oil
or lb oil × 0.1165 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}170} \text{ lb oil}$$

or Btu × 10^6 × 55.04 = lb oil
or lb oil × 0.0182 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}170 \times 10.30} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.343 = Imp gal oil
or Imp gal oil × 0.1872 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}170 \times 8.587} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.410 = U.S. gal oil
or U.S. gal oil × 0.1560 = Btu × 10^6

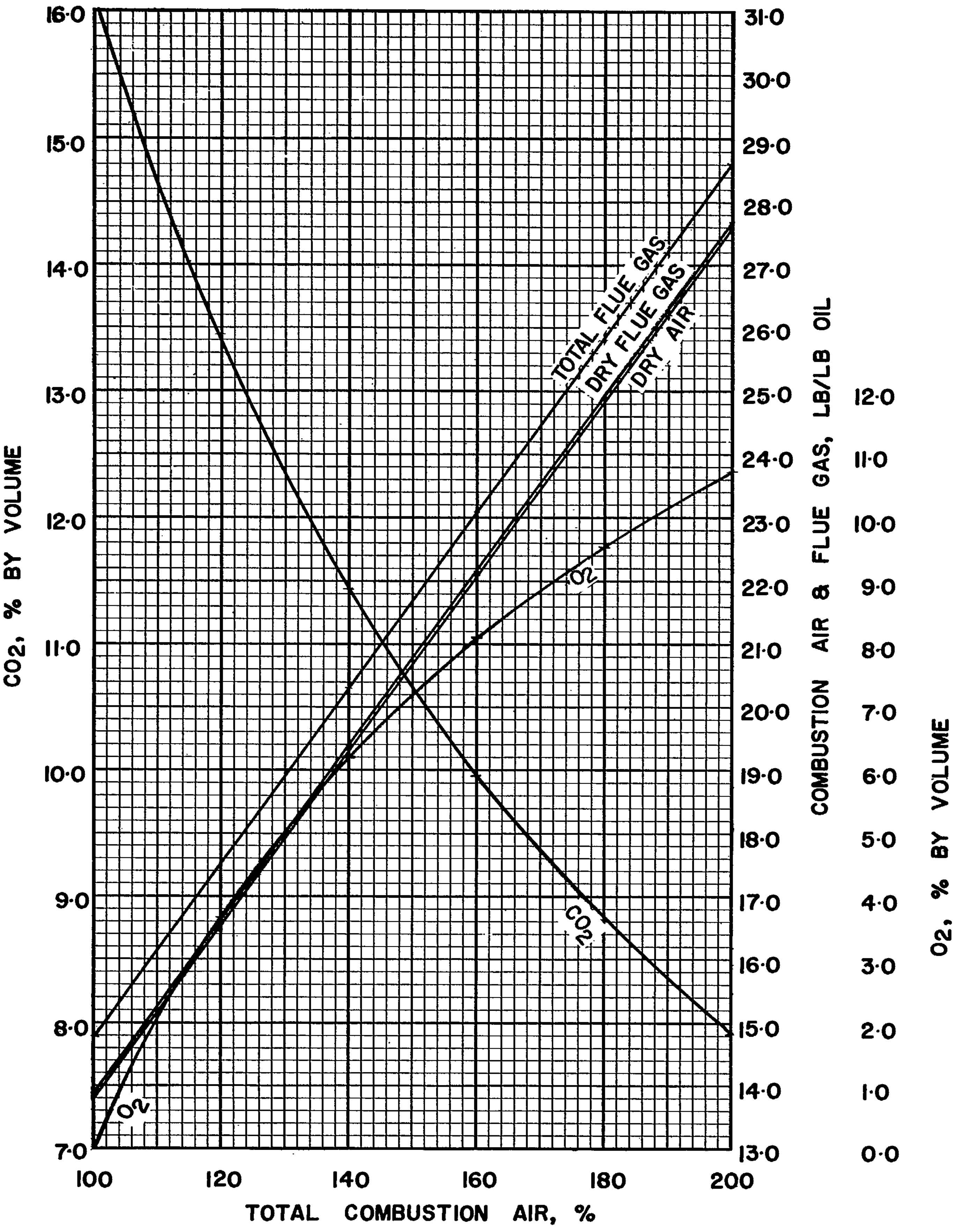


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS

10310

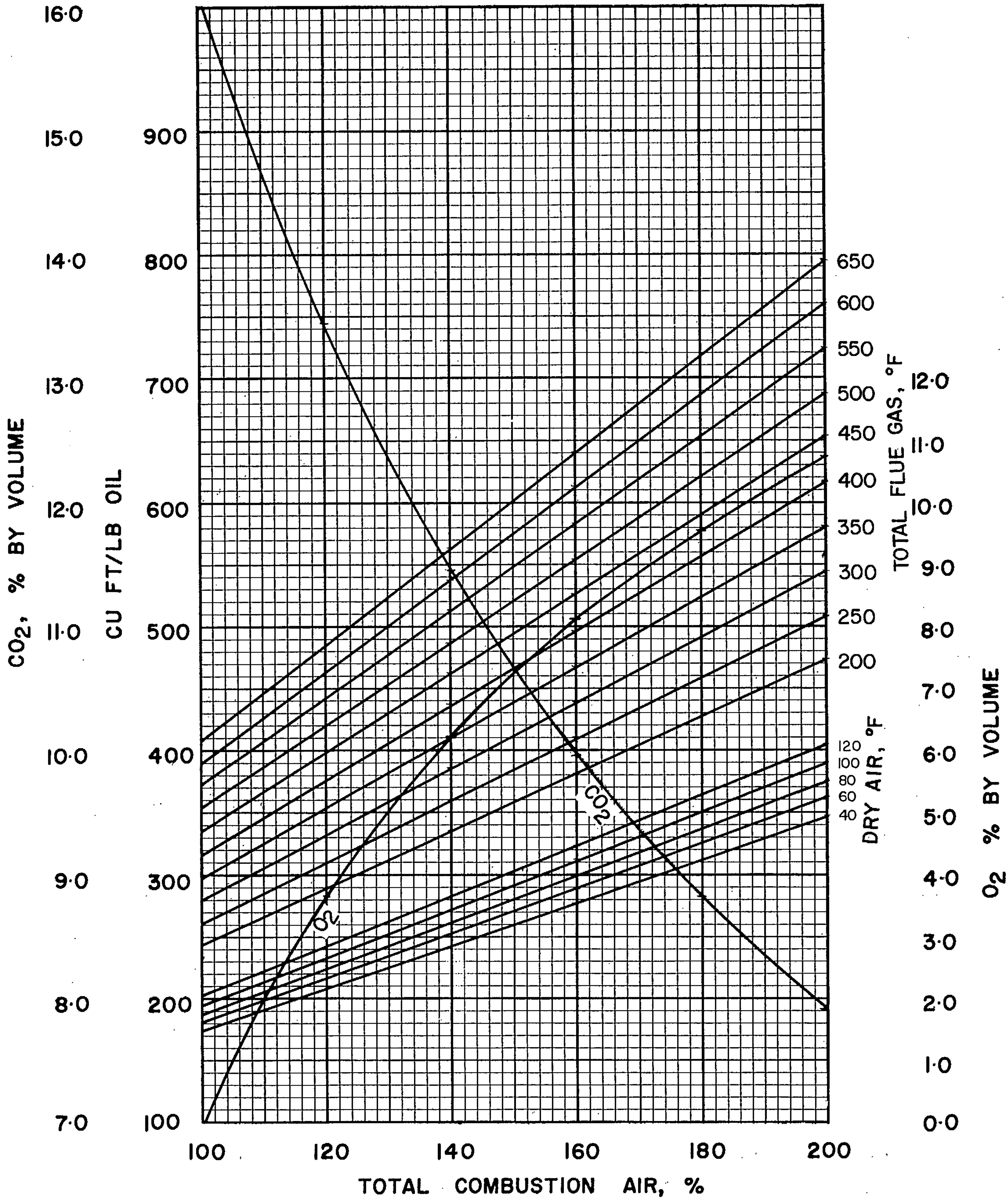


FIGURE 2· COMBUSTION DATA, VOLUME BASIS

10310

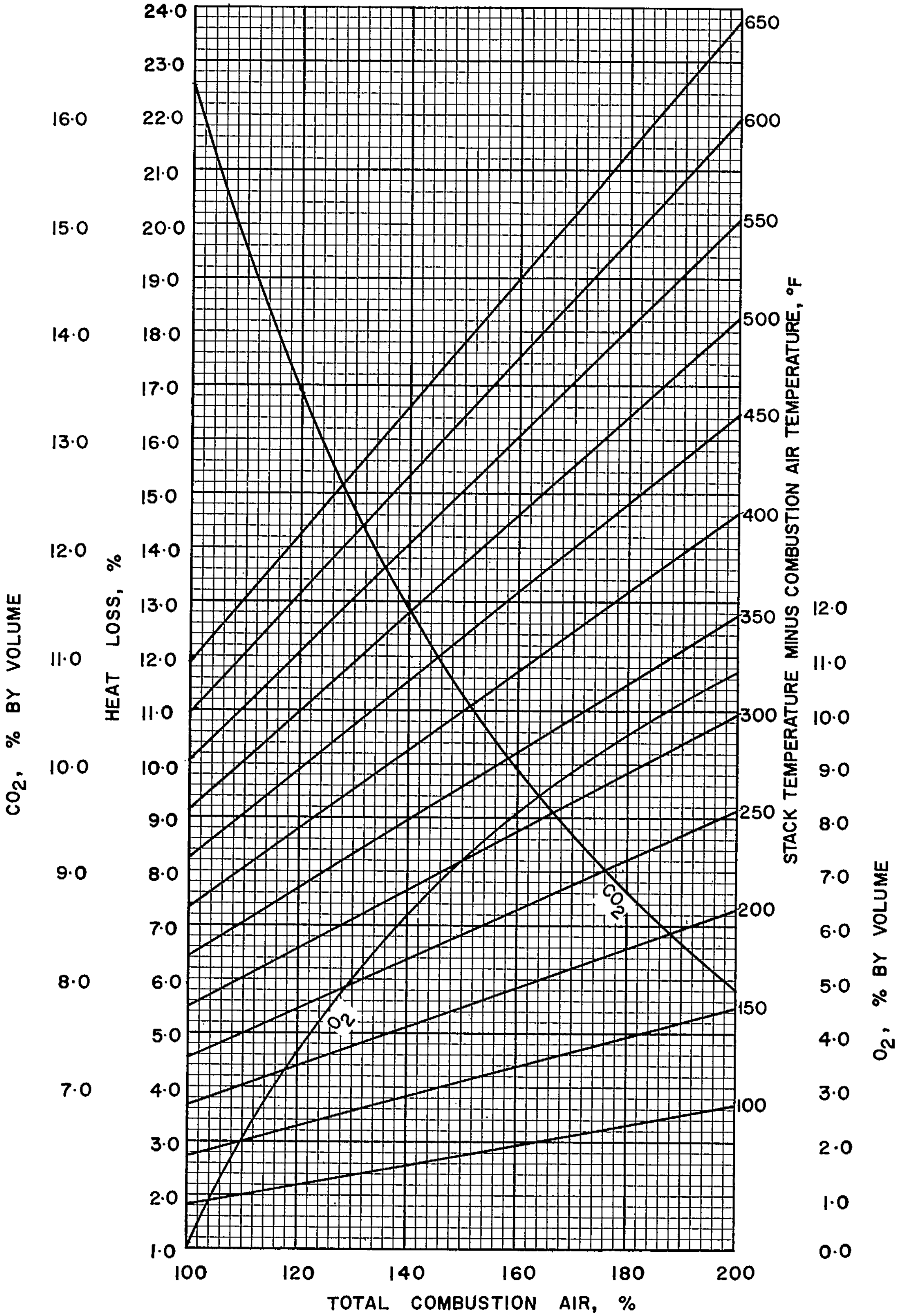


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

10310

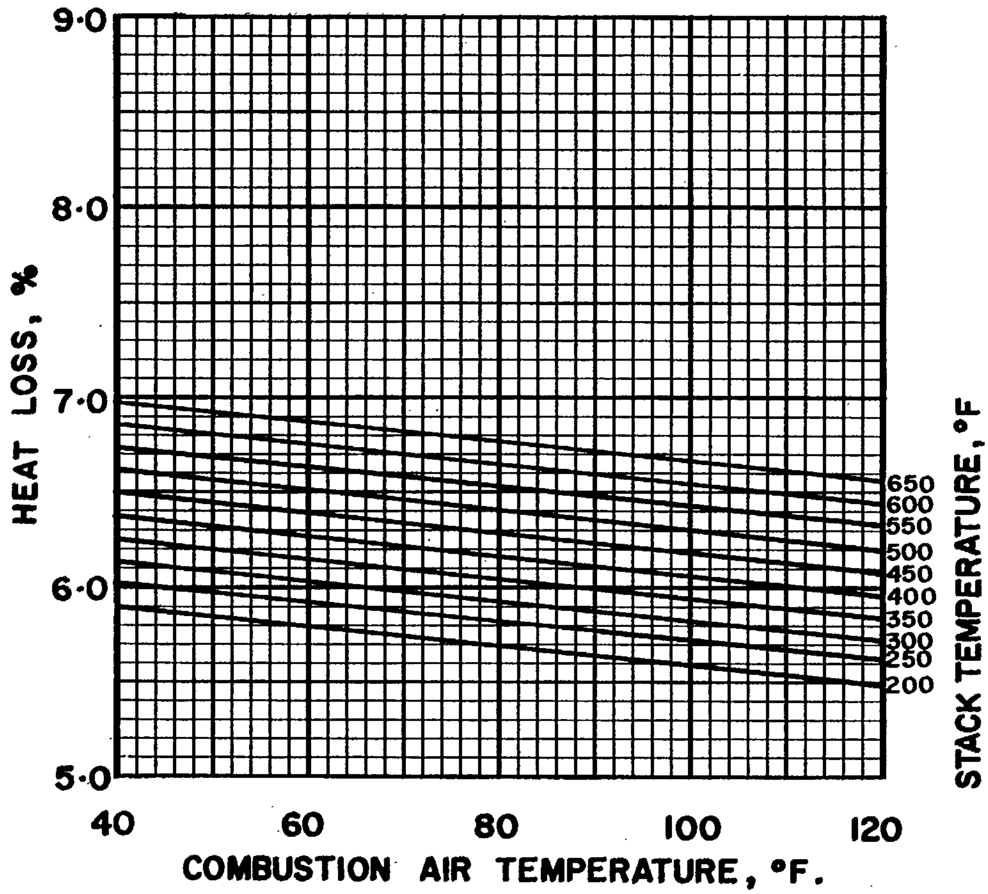


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

10310

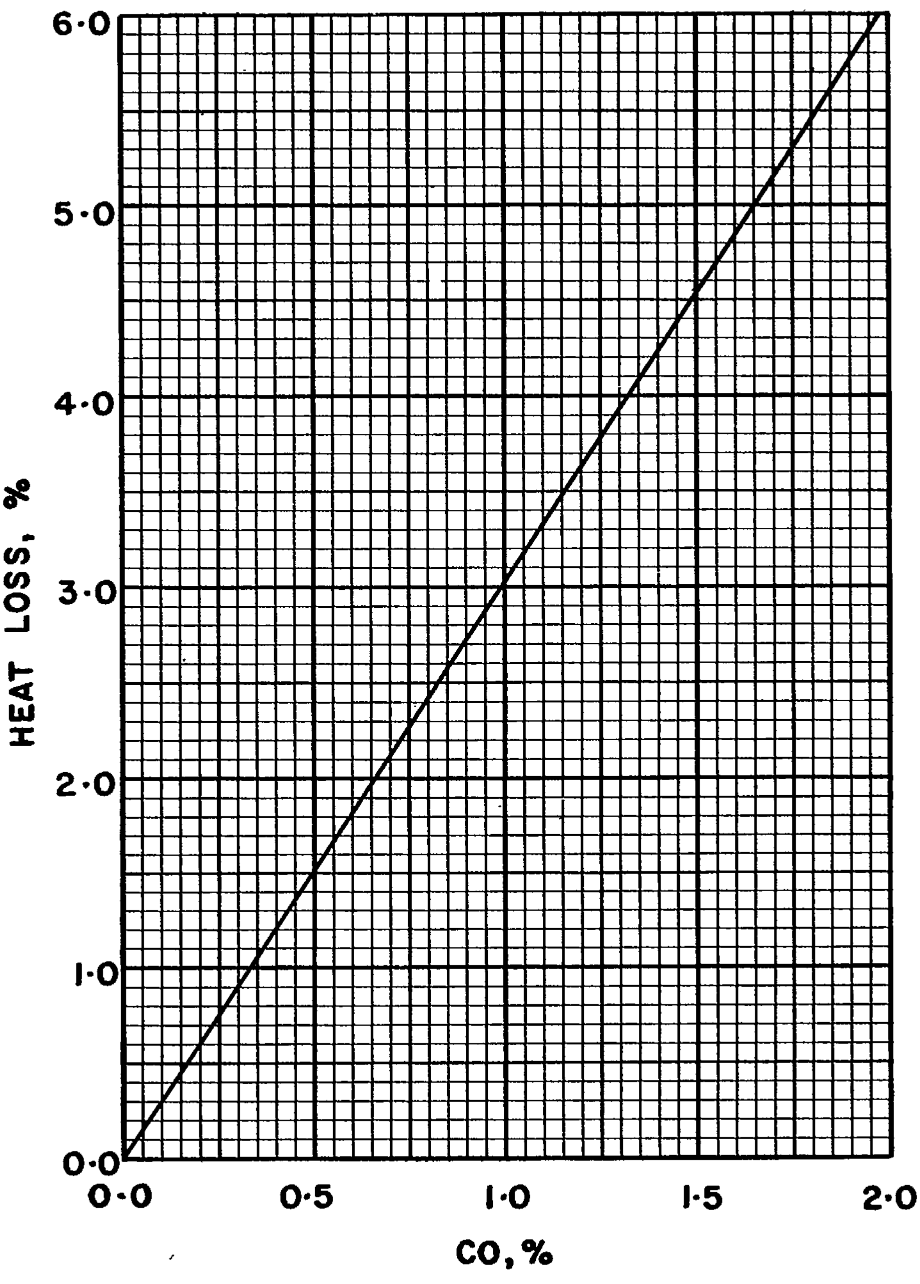


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

10310

FUEL OIL 10320, SPECIFIC GRAVITY 1.030

Ultimate Analysis, lb/lb

Carbon	(C)	0.8766
Hydrogen	(H_2)	0.1034
Sulphur	(S)	0.0200
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,020

Conversion Factors

1 Imp gal oil = 10.30 lb oil
or Imp gal oil × 10.30 = lb oil
or lb oil × 0.0971 = Imp gal oil

1 U.S. gal oil = 10.30 × 0.8337 lb oil
or U.S. gal oil × 8.587 = lb oil
or lb oil × 0.1165 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}020} \text{ lb oil}$$

or Btu × 10^6 × 55.49 = lb oil
or lb oil × 0.0180 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}020 \times 10.30} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.388 = Imp gal oil
or Imp gal oil × 0.1856 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}020 \times 8.587} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.464 = U.S. gal oil
or U.S. gal oil × 0.1547 = Btu × 10^6

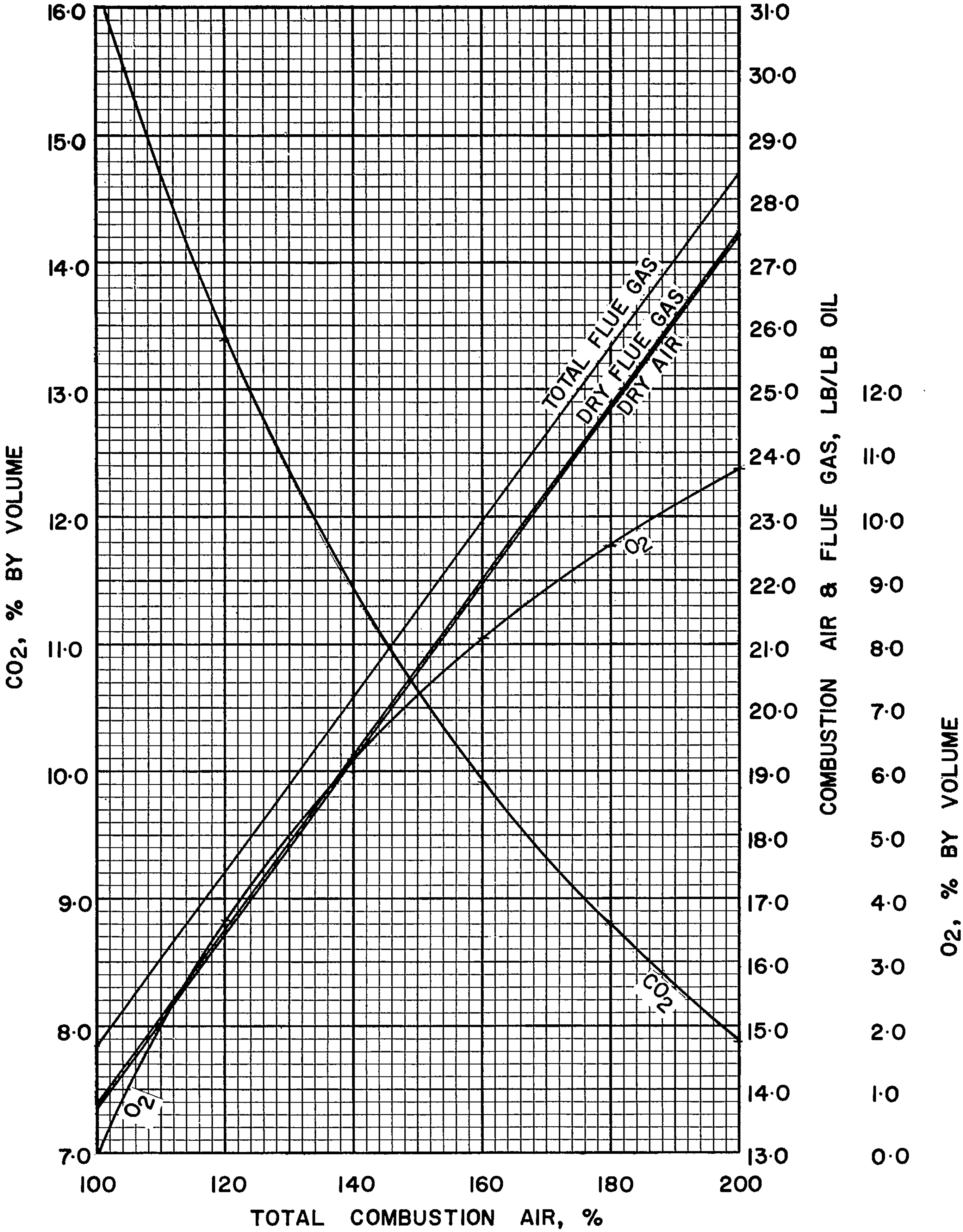


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS

10320

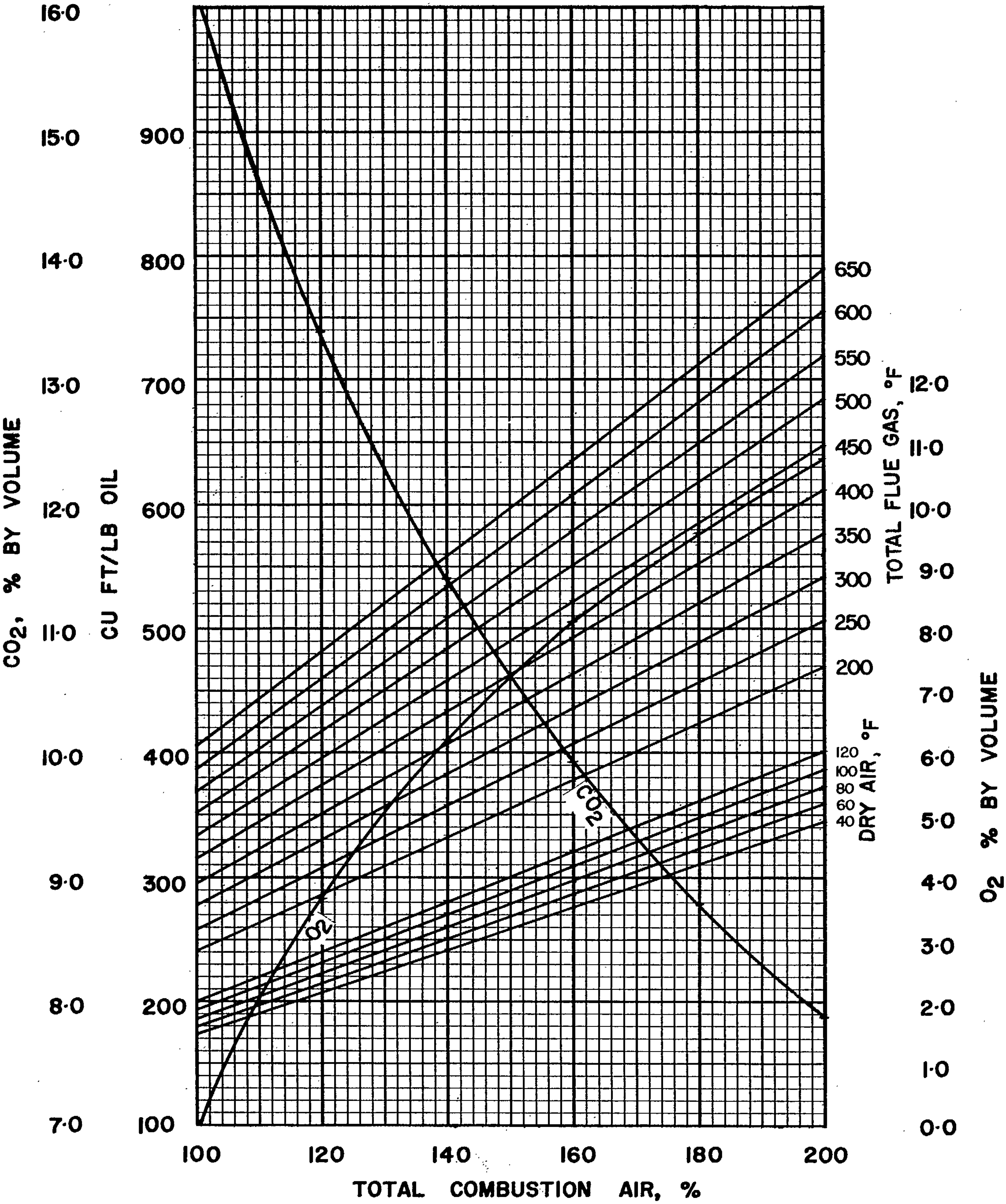


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 10320

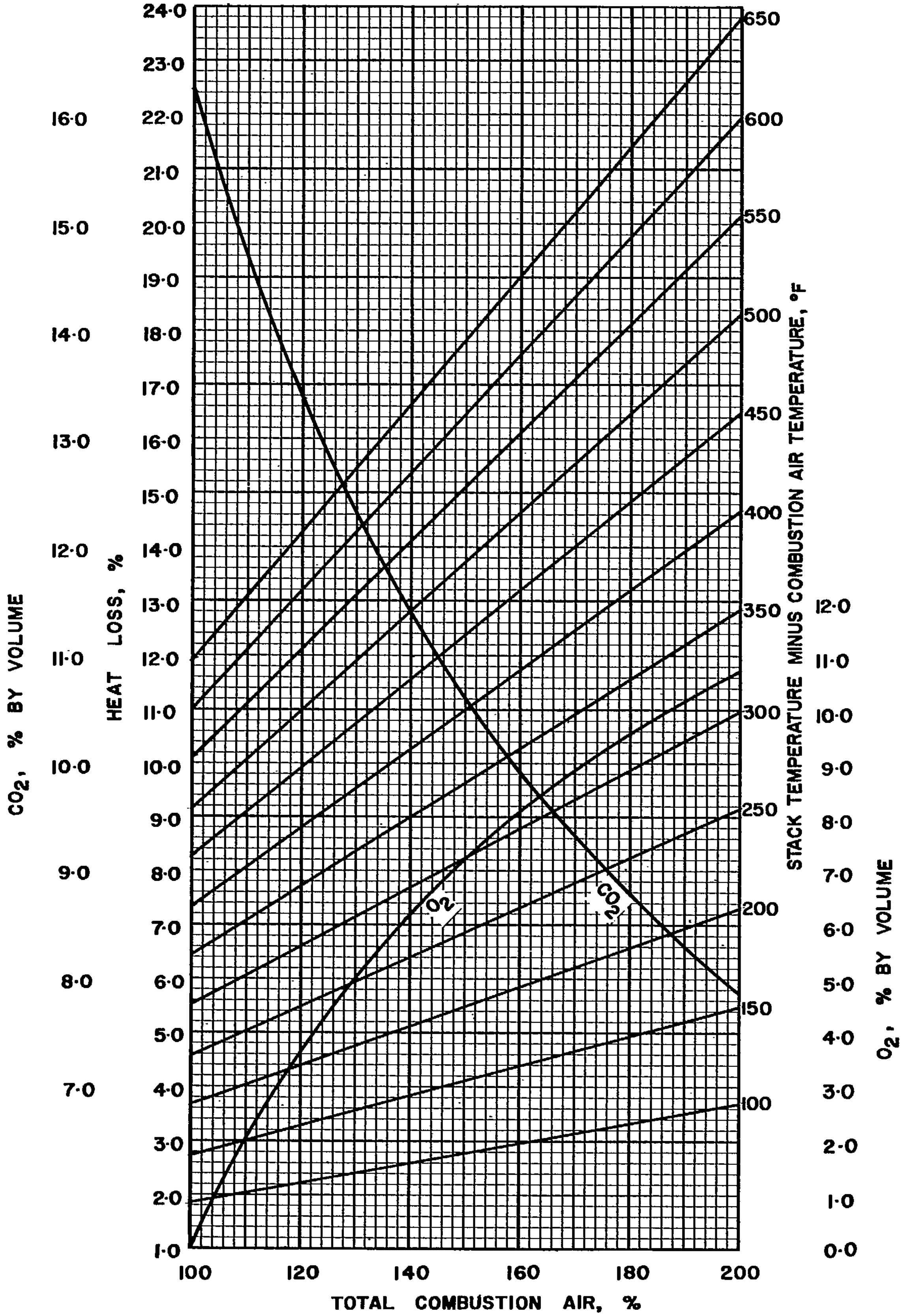


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

10320

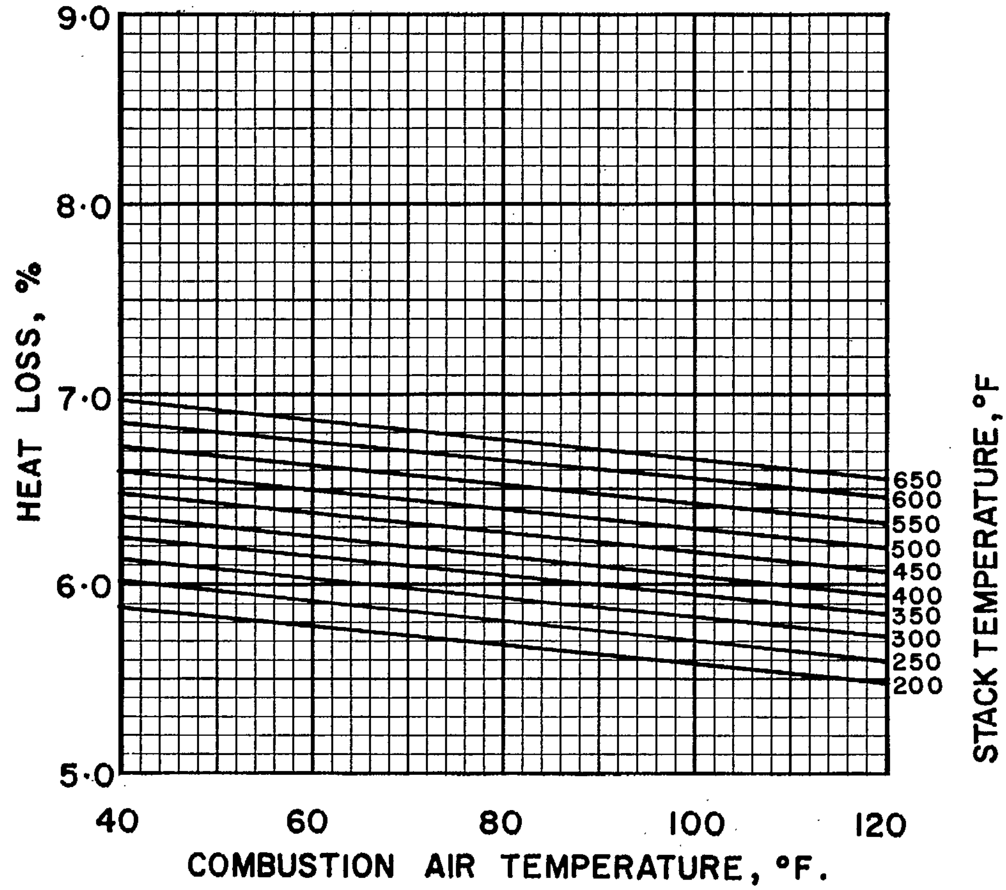


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

10320

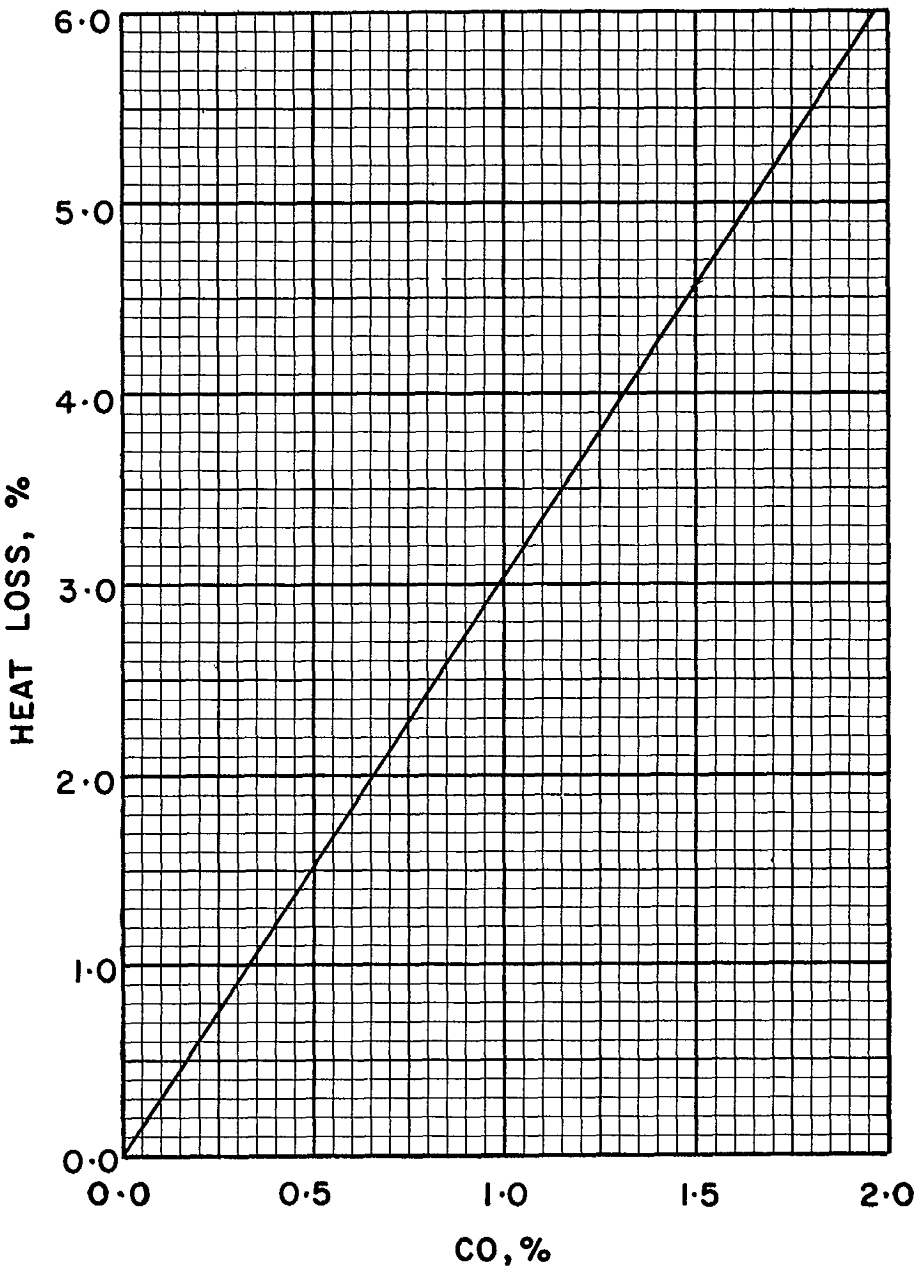


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

10320

FUEL OIL 10330, SPECIFIC GRAVITY 1.030

Ultimate Analysis, lb/lb

Carbon (C)	0.8677
Hydrogen (H_2)	0.1023
Sulphur (O_2)	0.0300
Nitrogen (N_2)	–
Oxygen (O_2)	–
Ash	–
Moisture	–
Total	1.0000
Calorific Value, Btu/lb	17,880

Conversion Factors

1 Imp gal oil = 10.30 lb oil
or Imp gal oil X 10.30 = lb oil
or lb oil X 0.0971 = Imp gal oil

1 U.S. gal oil = 10.30 X 0.8337 lb oil
or U.S. gal oil X 8.587 = lb oil
or lb oil X 0.1165 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal X 0.8327 = Imp gal
or Imp gal X 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{17{,}880} \text{ lb oil}$$

or Btu X 10^6 X 55.93 = lb oil
or lb oil X 0.0179 = Btu X 10^6

$$10^6 \text{ Btu} = \frac{10^6}{17{,}880 \times 10.30} \text{ Imp gal oil}$$

or Btu X 10^6 X 5.430 = Imp gal oil
or Imp gal oil X 0.1842 = Btu X 10^6

$$10^6 \text{ Btu} = \frac{10^6}{17{,}880 \times 8.587} \text{ U.S. gal oil}$$

or Btu X 10^6 X 6.515 = U.S. gal oil
or U.S. gal oil X 0.1535 = Btu X 10^6

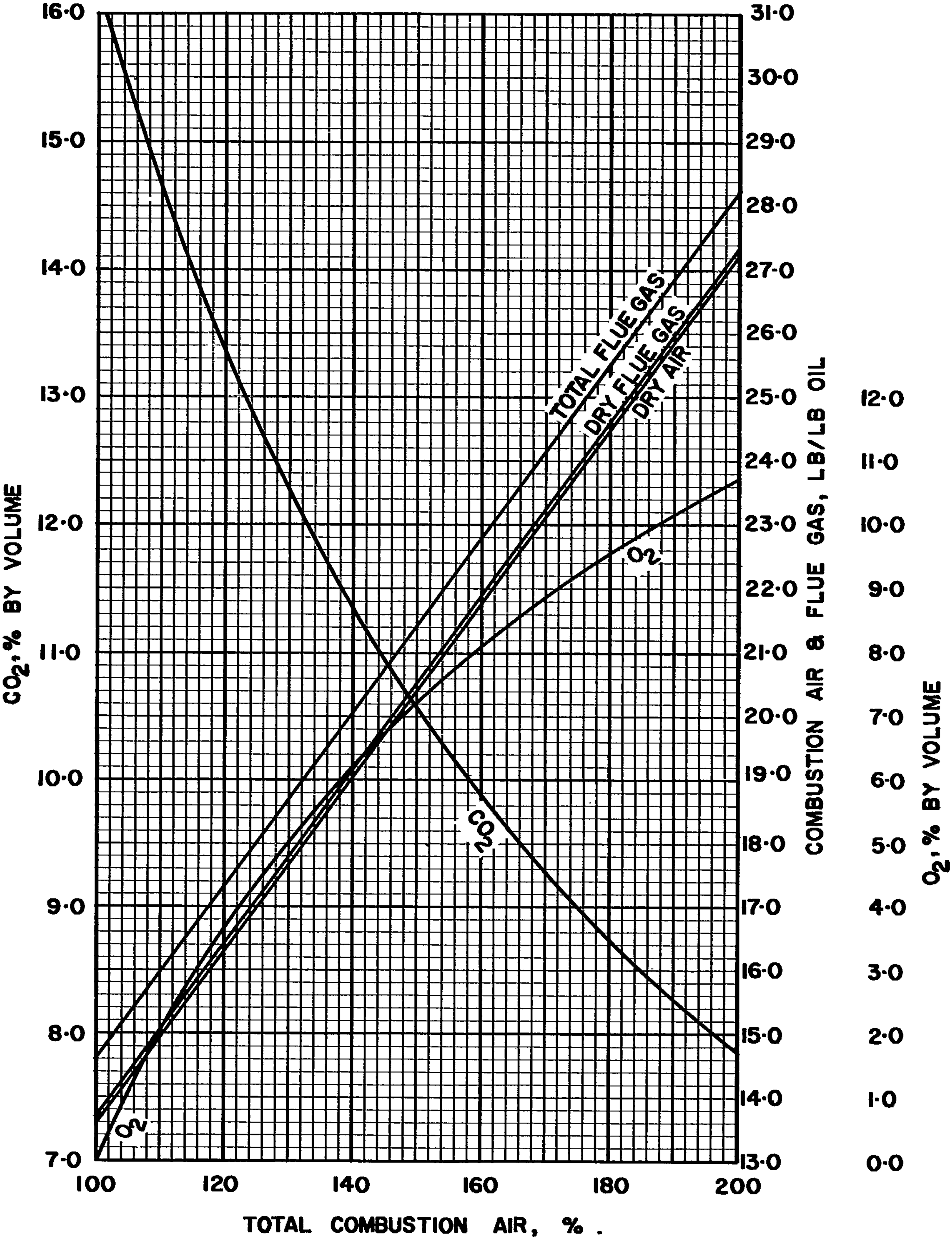


FIGURE I· COMBUSTION DATA, WEIGHT BASIS.

10330

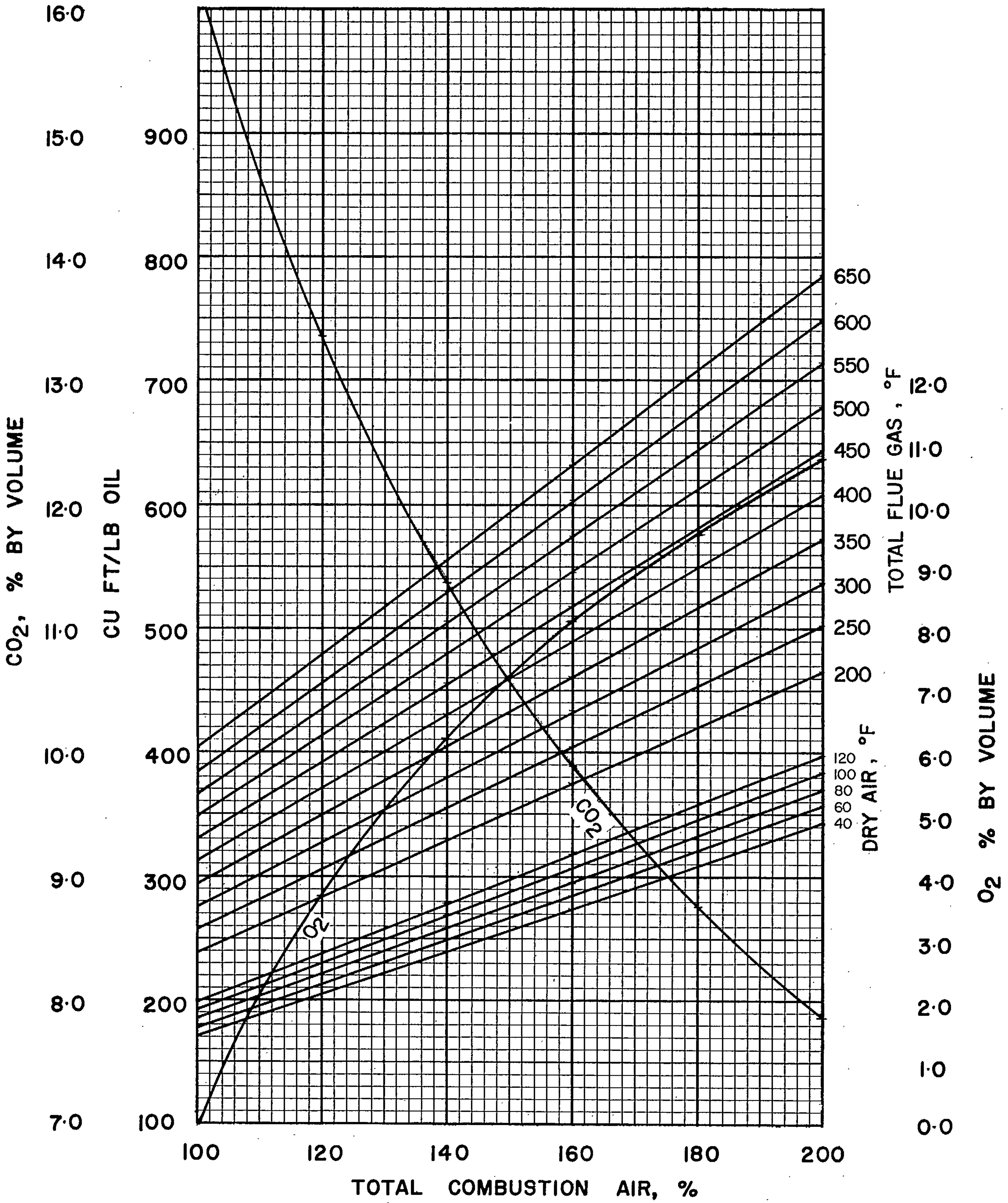


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 10330

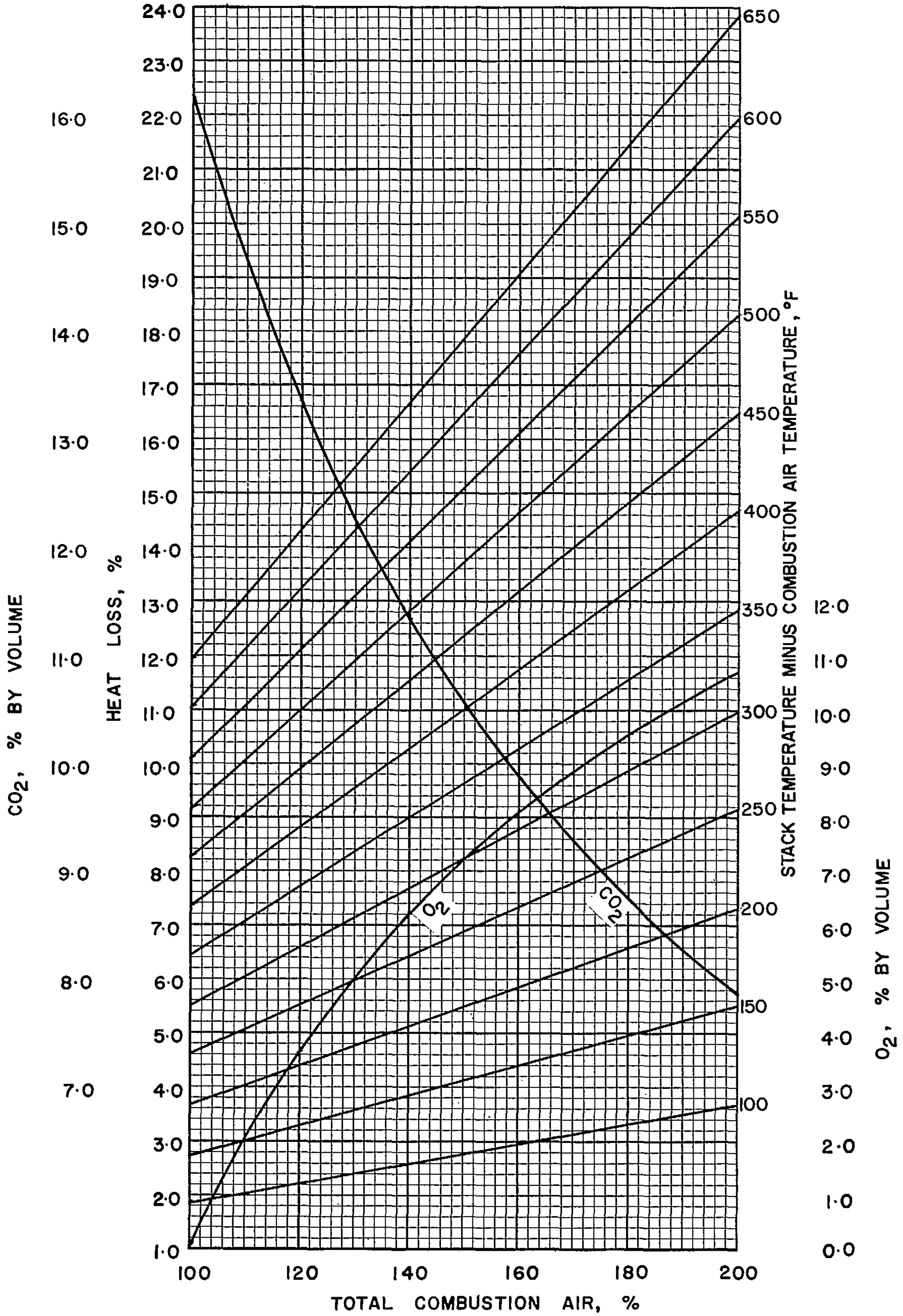


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

10330

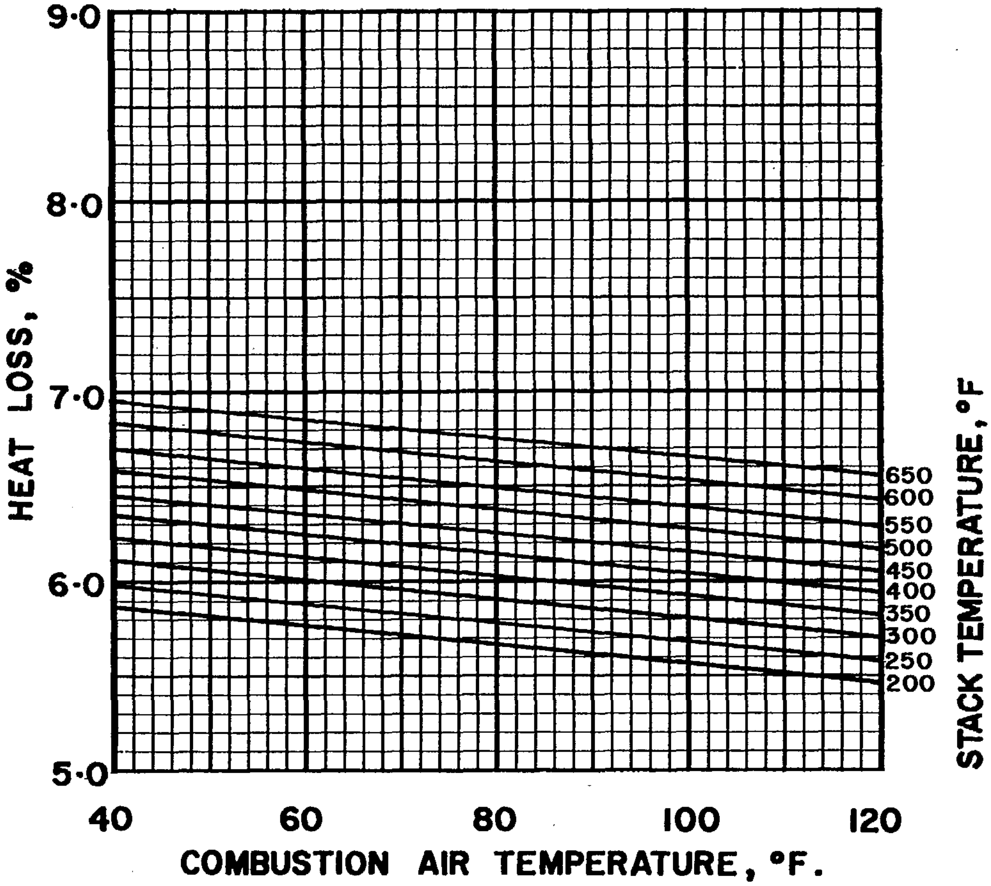


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

10330

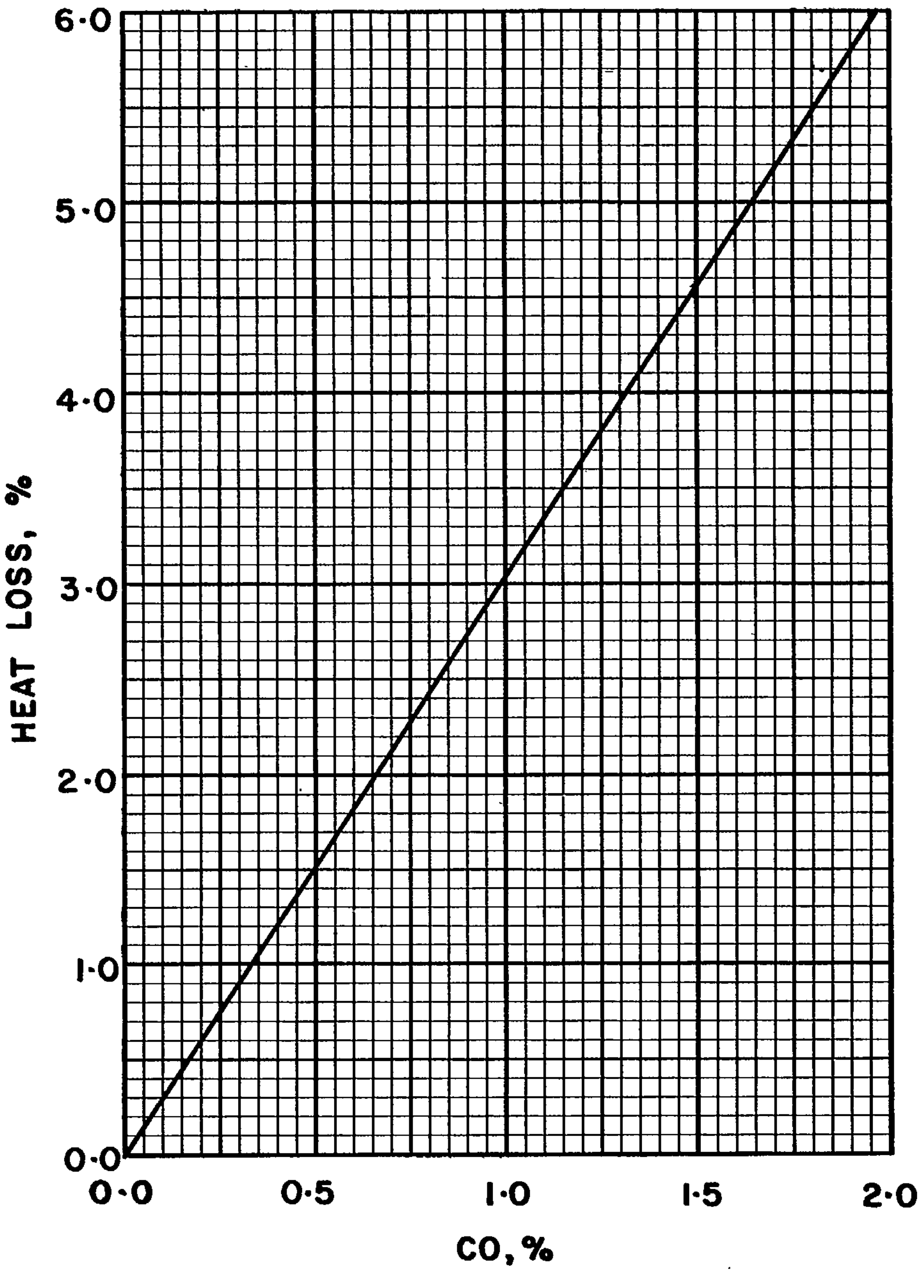


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

10330

FUEL OIL 10340, SPECIFIC GRAVITY 1.030

Ultimate Analysis, lb/lb

Carbon	(C)	0.8587
Hydrogen	(H_2)	0.1013
Sulphur	(S)	0.0400
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		17,740

Conversion Factors

1 Imp gal oil = 10.30 lb oil
or Imp gal oil × 10.30 = lb oil
or lb oil × 0.0971 = Imp gal oil

1 U.S. gal oil = 10.30 × 0.8337 lb oil
or U.S. gal oil × 8.587 = lb oil
or lb oil × 0.1165 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{17{,}740} \text{ lb oil}$$

or Btu × 10^6 × 56.37 = lb oil
or lb oil × 0.01774 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{17{,}740 \times 10.30} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.473 = Imp gal oil
or Imp gal oil × 0.1827 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{17{,}740 \times 8.587} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.566 = U.S. gal oil
or U.S. gal oil × 0.1523 = Btu × 10^6

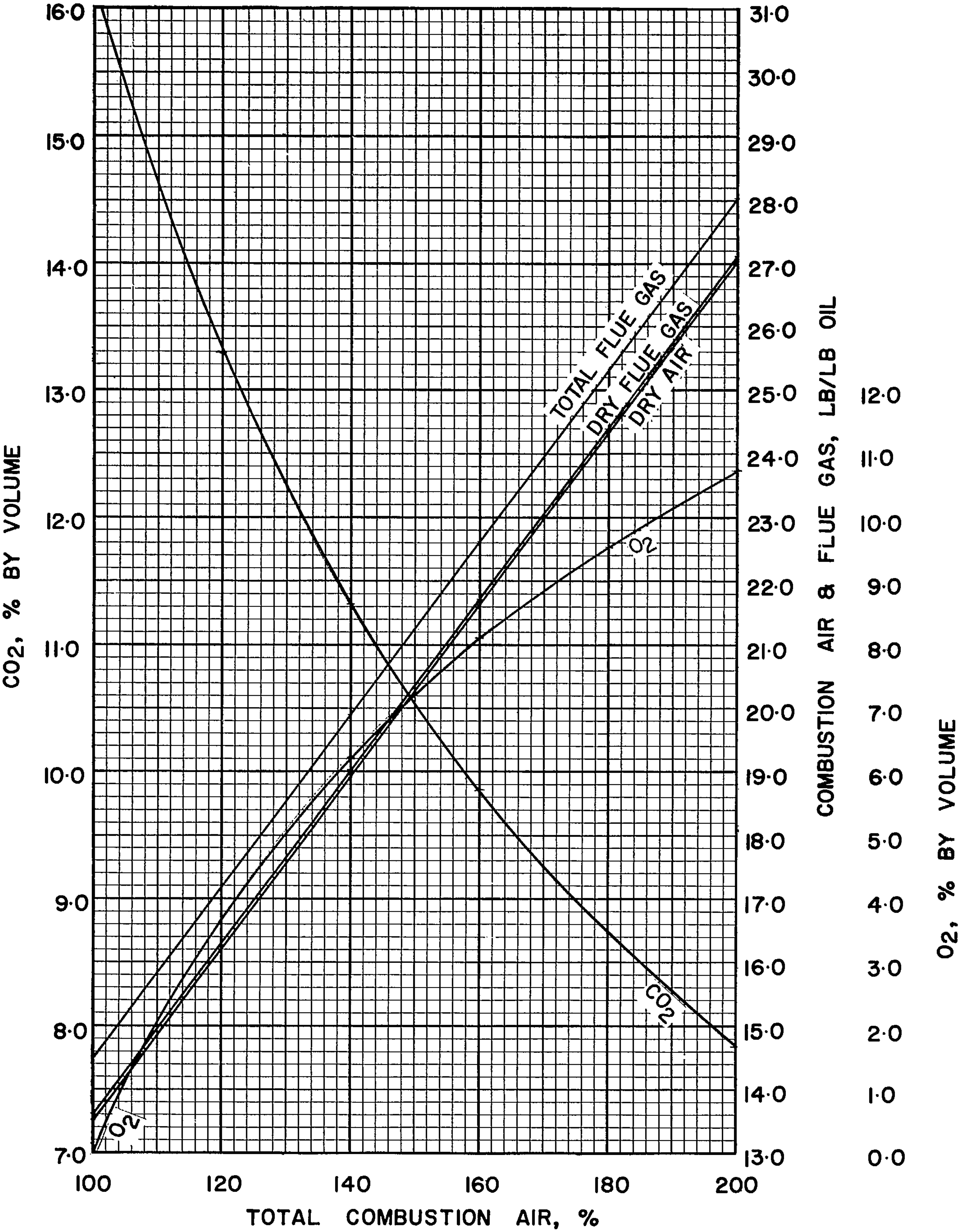


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS 10340

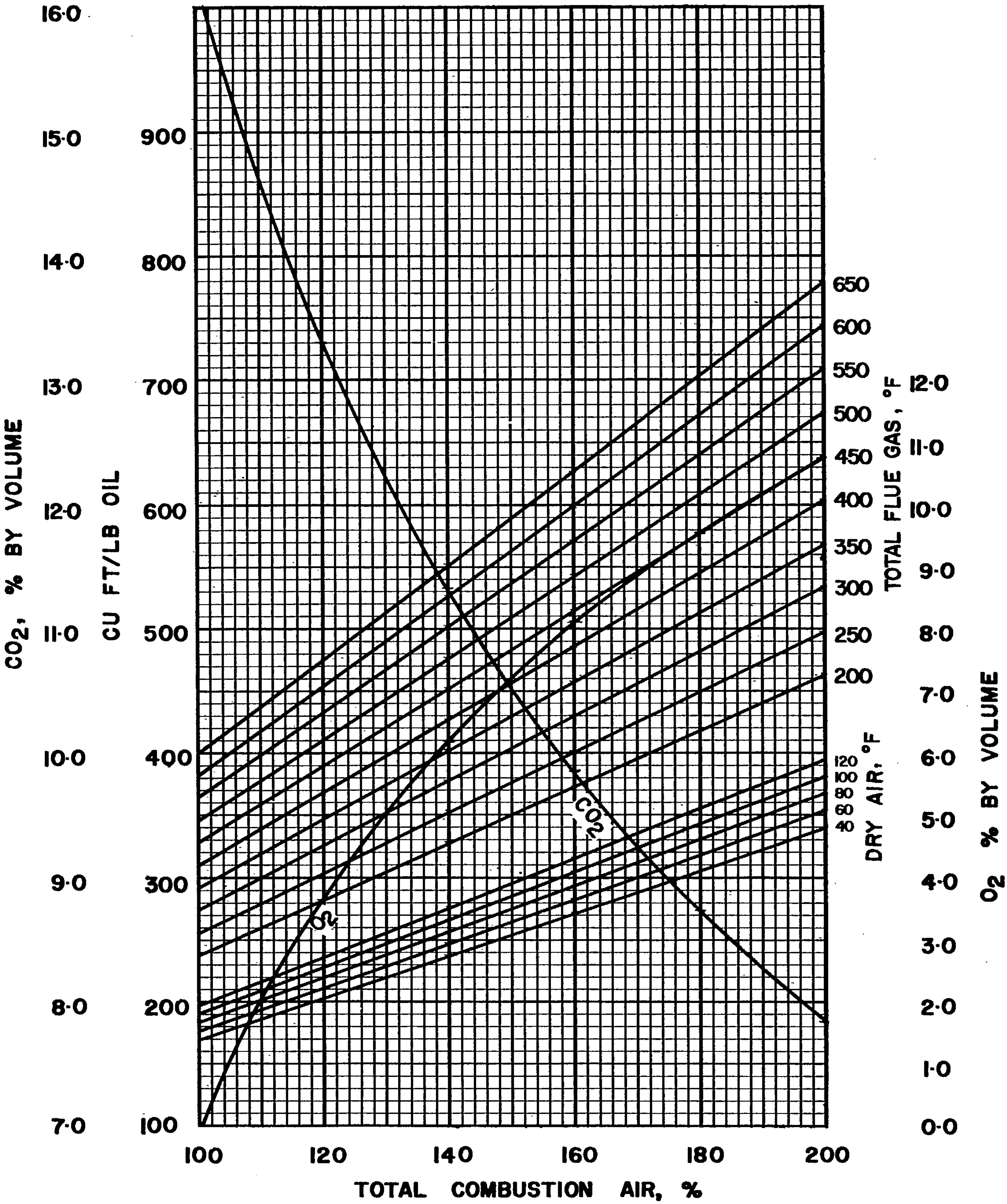


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 10340

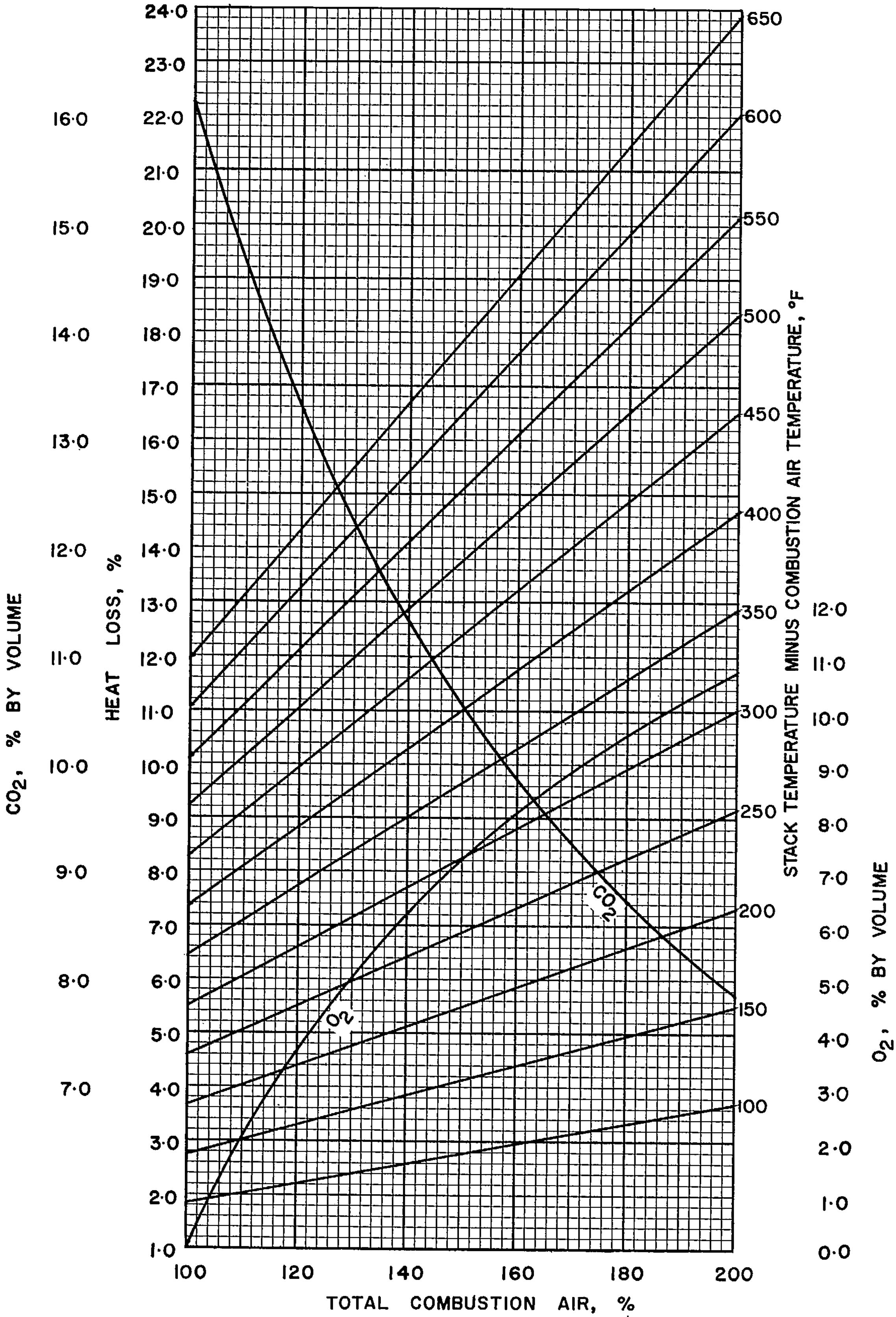


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

10340

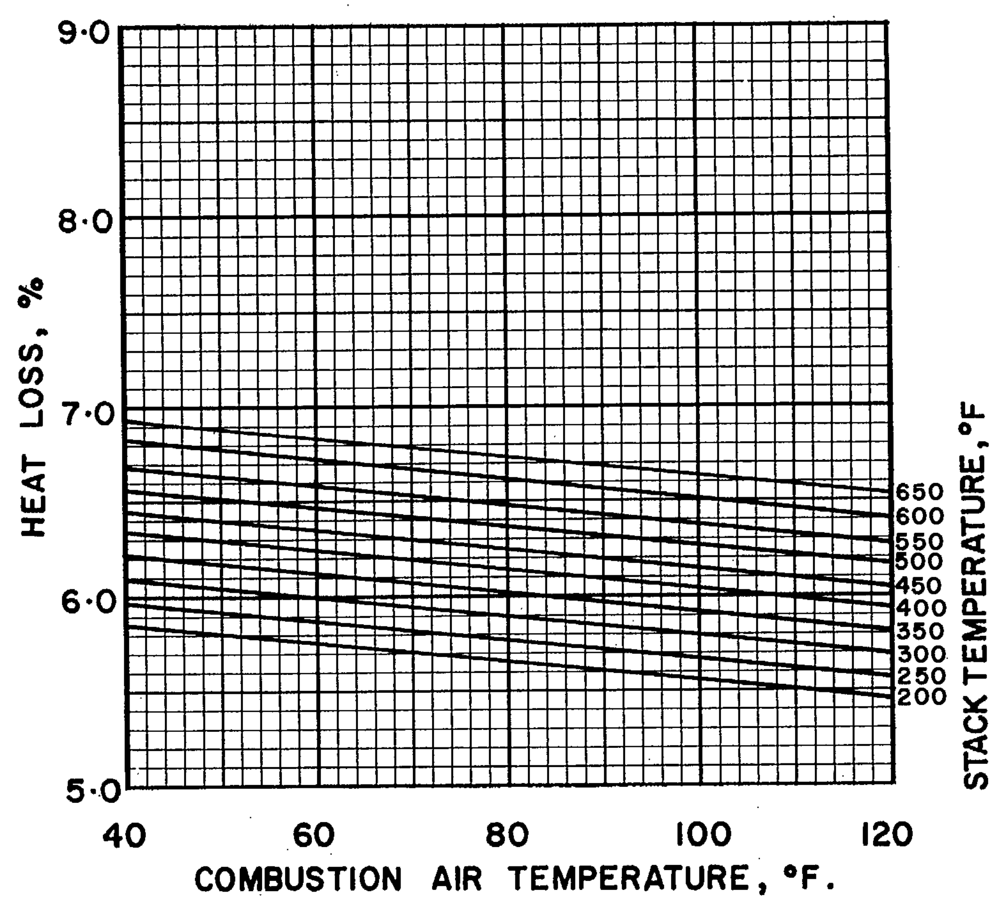


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

10340

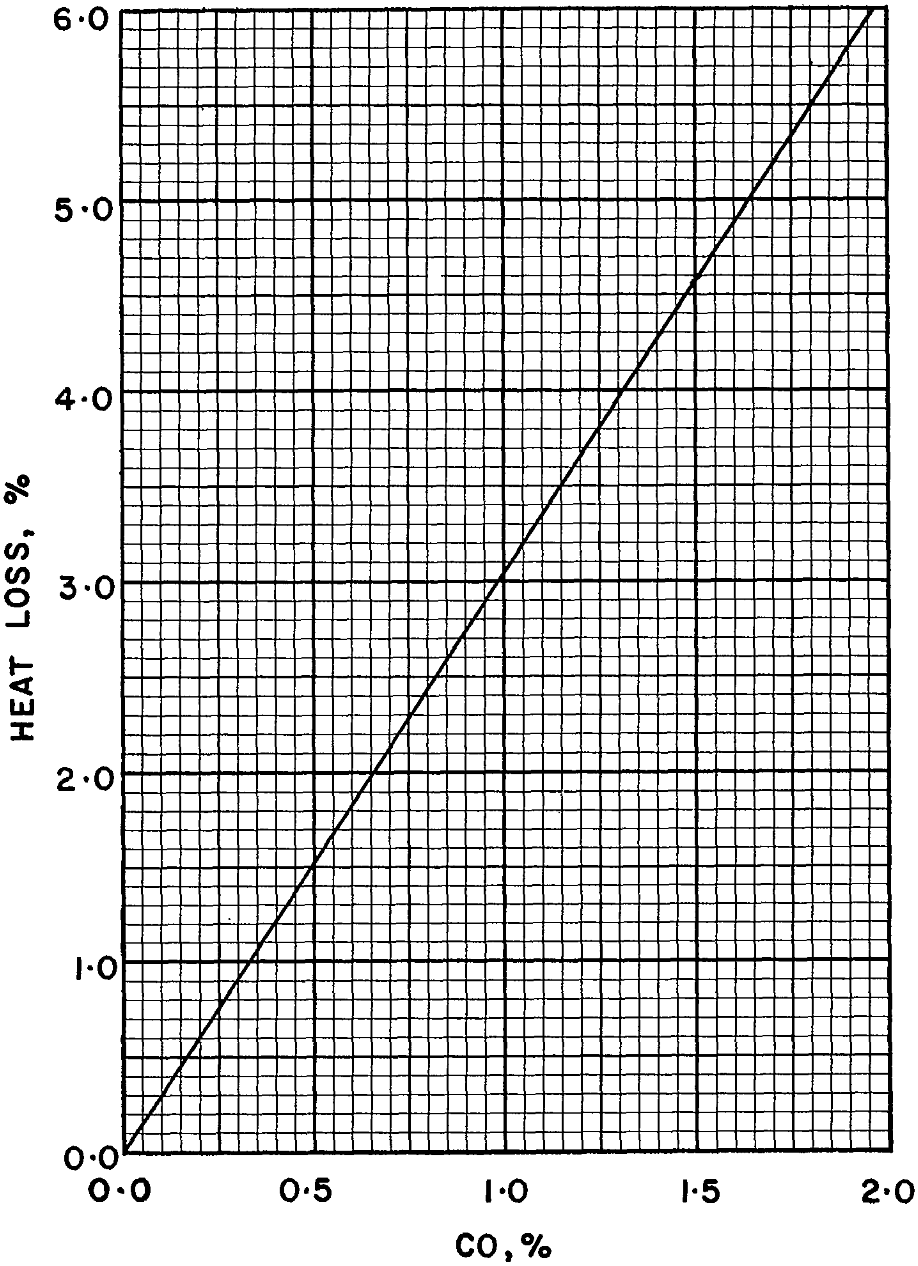


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

10340

FUEL OIL 10400, SPECIFIC GRAVITY 1.040

Ultimate Analysis, lb/lb

Carbon	(C)	0.8960
Hydrogen	(H_2)	0.1040
Sulphur	(S)	–
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,230

Conversion Factors

1 Imp gal oil = 10.40 lb oil
or Imp gal oil × 10.40 = lb oil
or lb oil × 0.0962 = Imp gal oil

1 U.S. gal oil = 10.40 × 0.8337 lb oil
or U.S. gal oil × 8.670 = lb oil
or lb oil × 0.1153 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}230} \text{ lb oil}$$

or Btu × 10^6 × 54.86 = lb oil
or lb oil × 0.0182 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}230 \times 10.40} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.275 = Imp gal oil
or Imp gal oil × 0.1896 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}230 \times 8.670} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.329 = U.S. gal oil
or U.S. gal oil × 0.1580 = Btu × 10^6

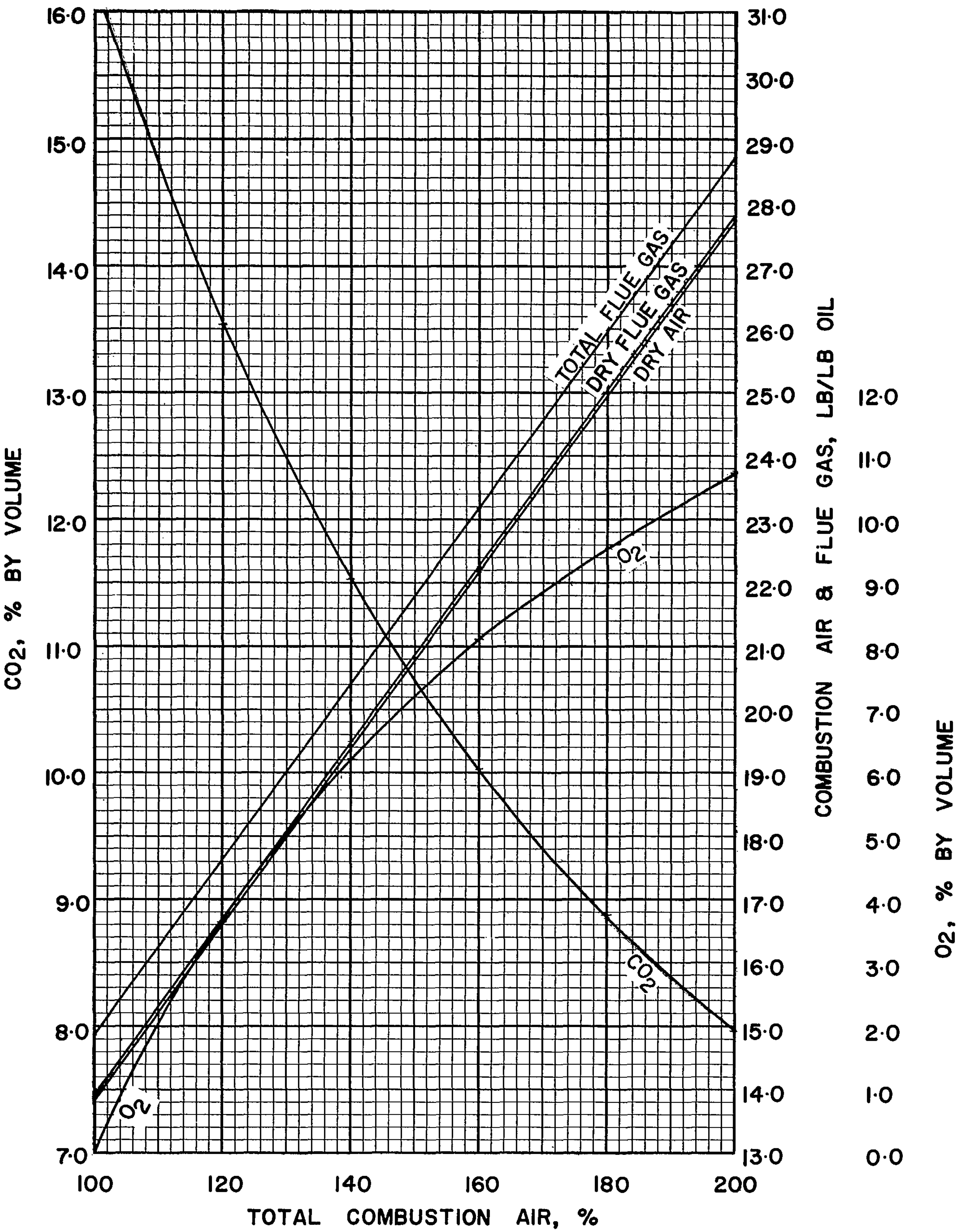


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS

10400

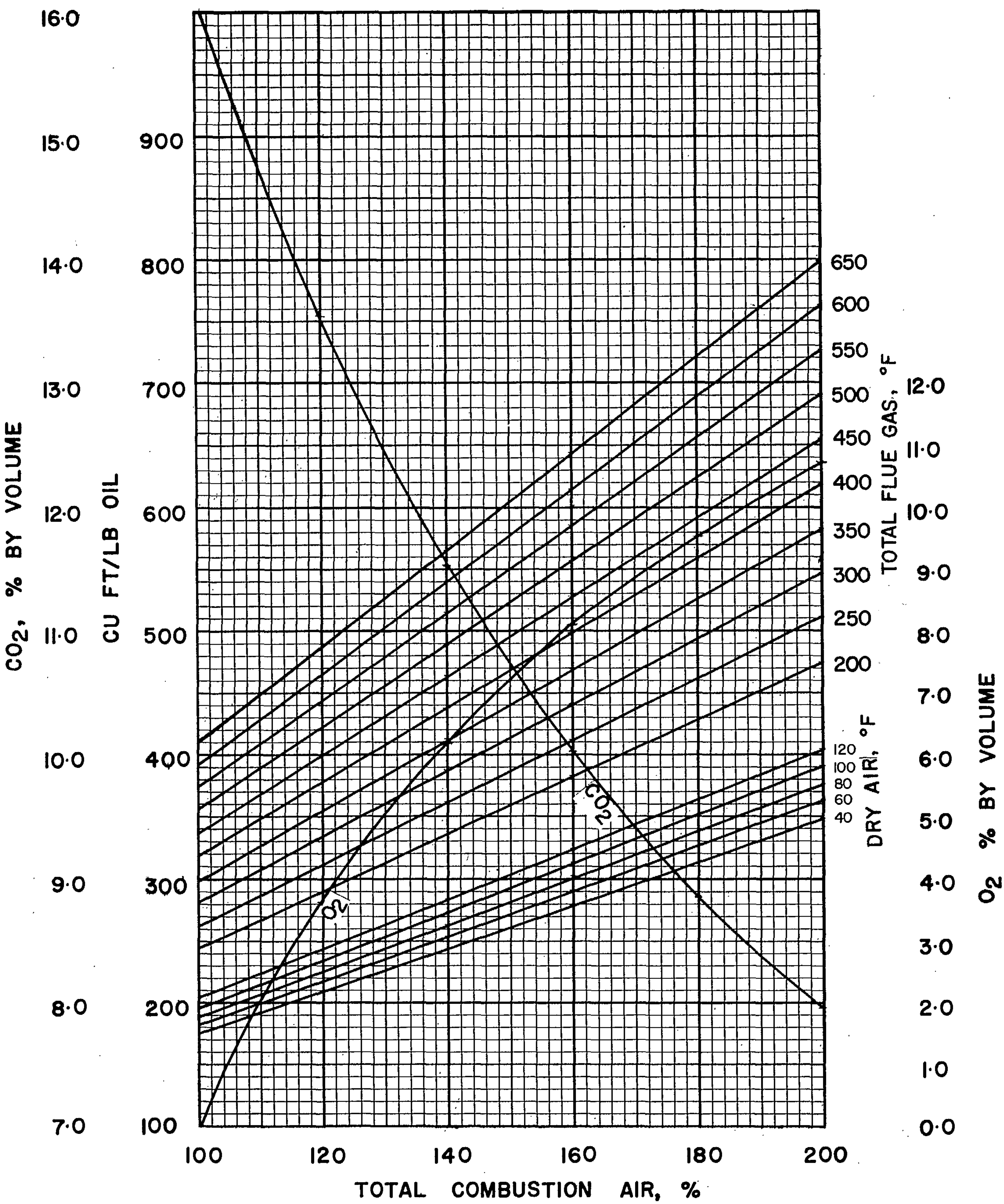


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 10400

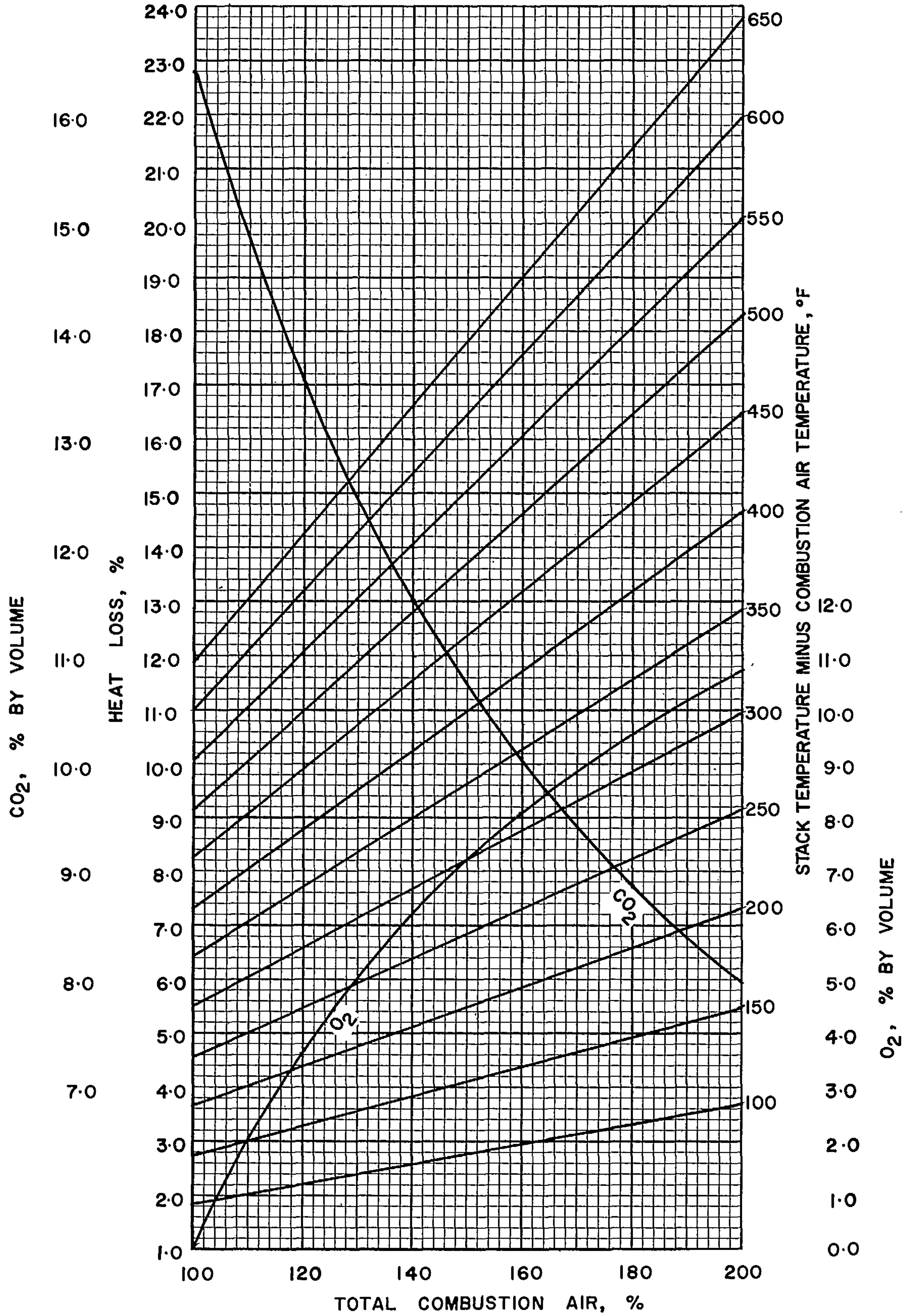


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

10400

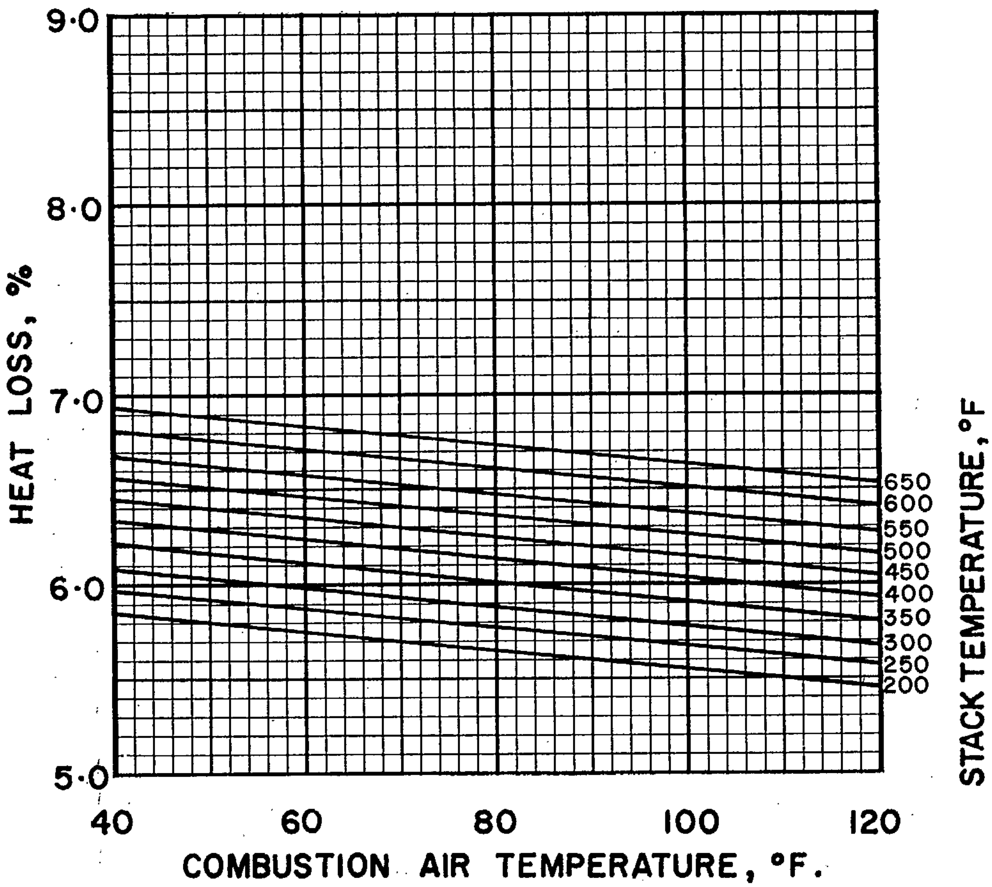


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

10400

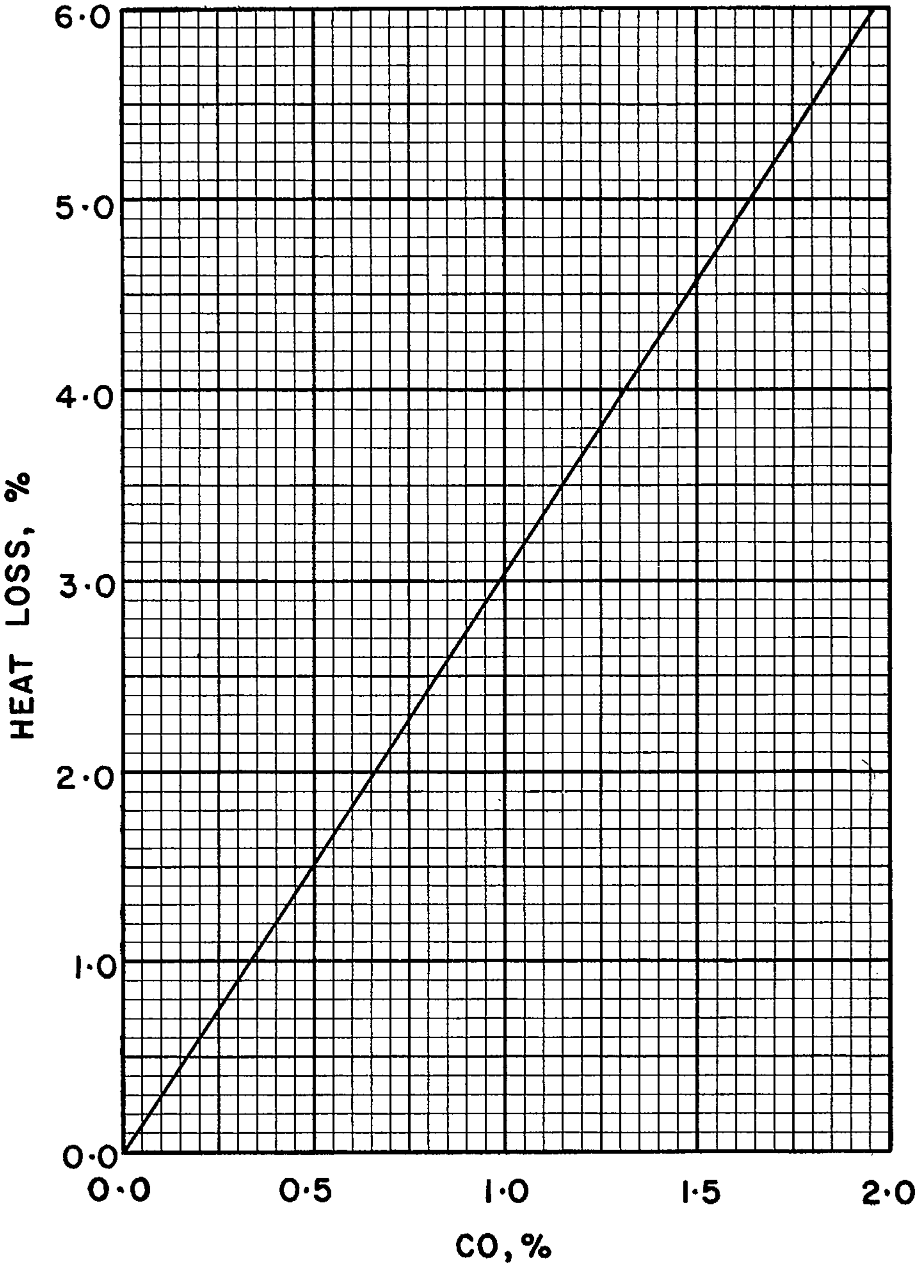


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

10400

FUEL OIL 10410, SPECIFIC GRAVITY 1.040

Ultimate Analysis, lb/lb

Carbon	(C)	0.8870
Hydrogen	(H_2)	0.1030
Sulphur	(S)	0.0100
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,090

Conversion Factors

1 Imp gal oil = 10.40 lb oil
or Imp gal oil × 10.40 = lb oil
or lb oil × 0.0962 = Imp gal oil

1 U.S. gal oil = 10.40 × 0.8337 lb oil
or U.S. gal oil × 8.670 = lb oil
or lb oil × 0.1153 = U.S. gal

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}090} \text{ lb oil}$$

or Btu × 10^6 × 55.28 = lb oil
or lb oil × 0.0181 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}090 \times 10.40} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.315 = Imp gal oil
or Imp gal oil × 0.1882 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}090 \times 8.670} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.378 = U.S. gal oil
or U.S. gal oil × 0.1568 = Btu × 10^6

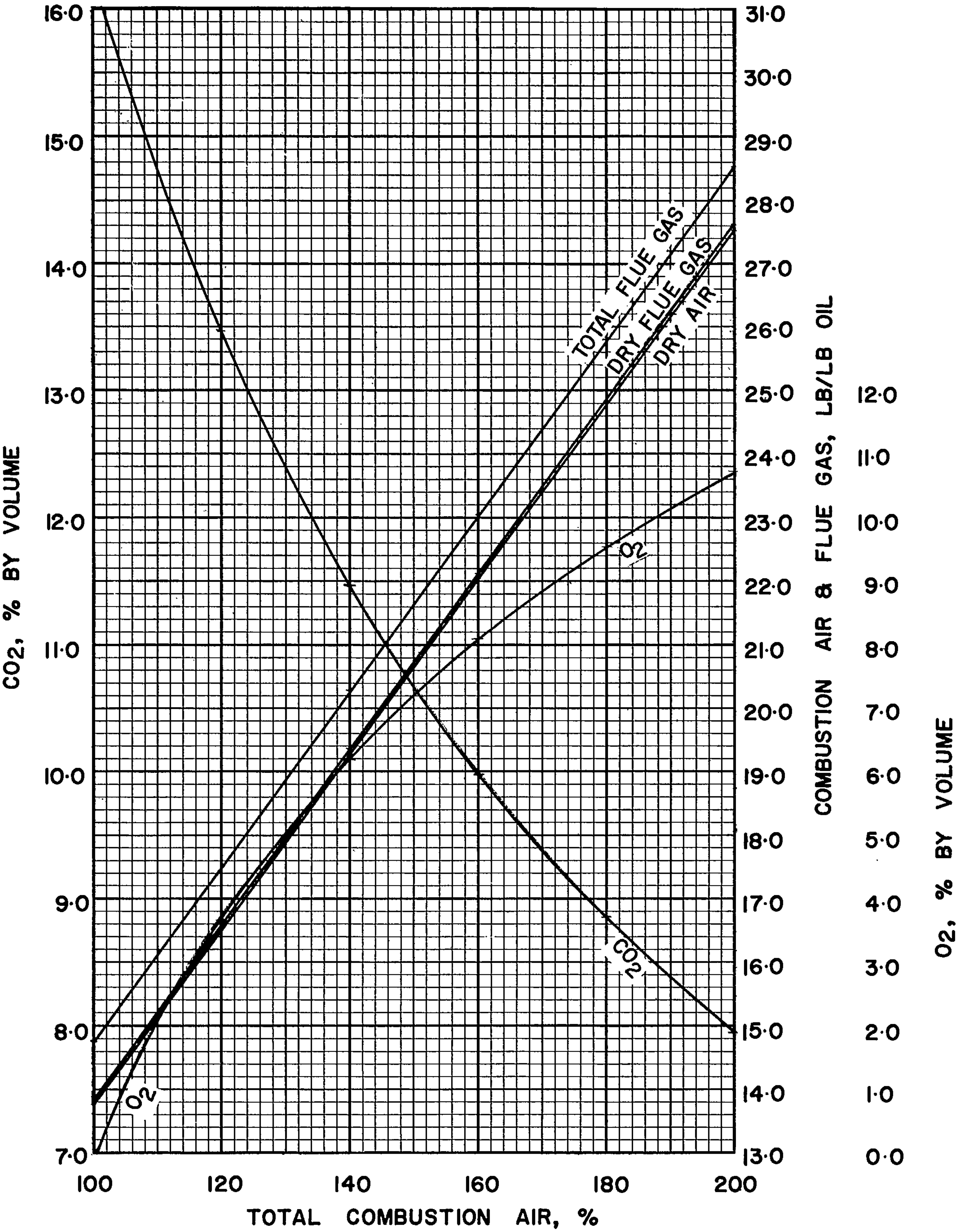


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS

10410

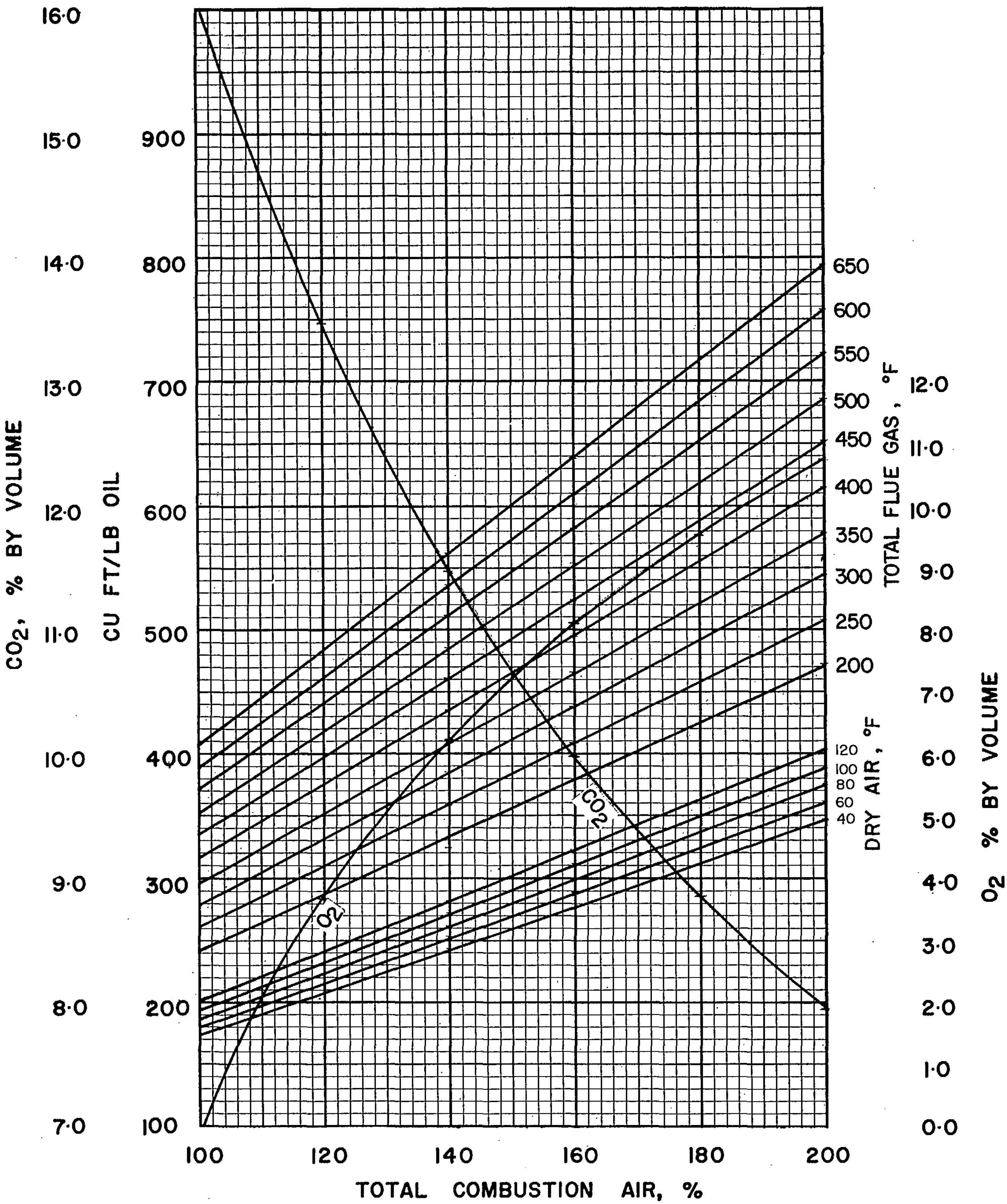


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 10410

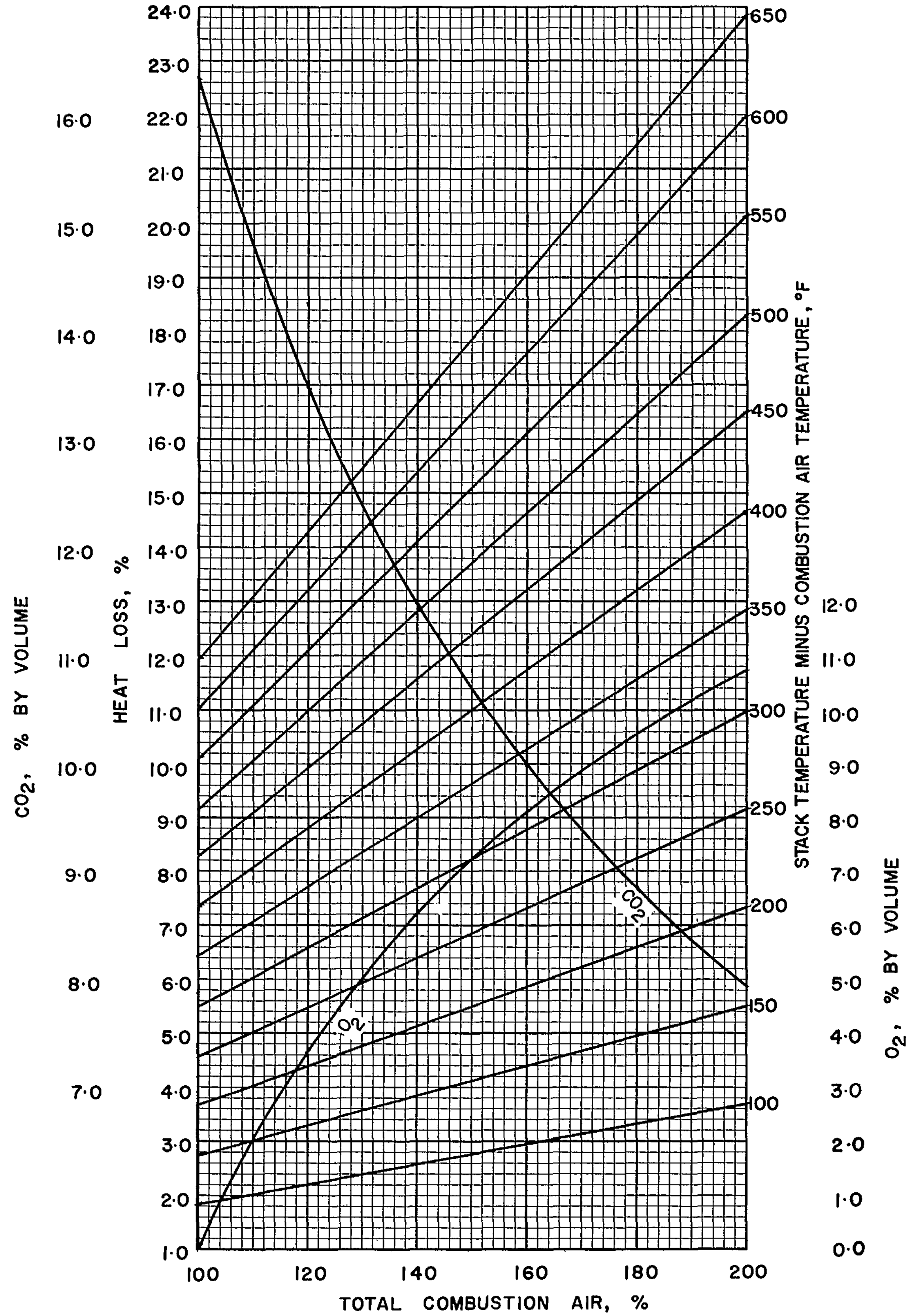


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

10410

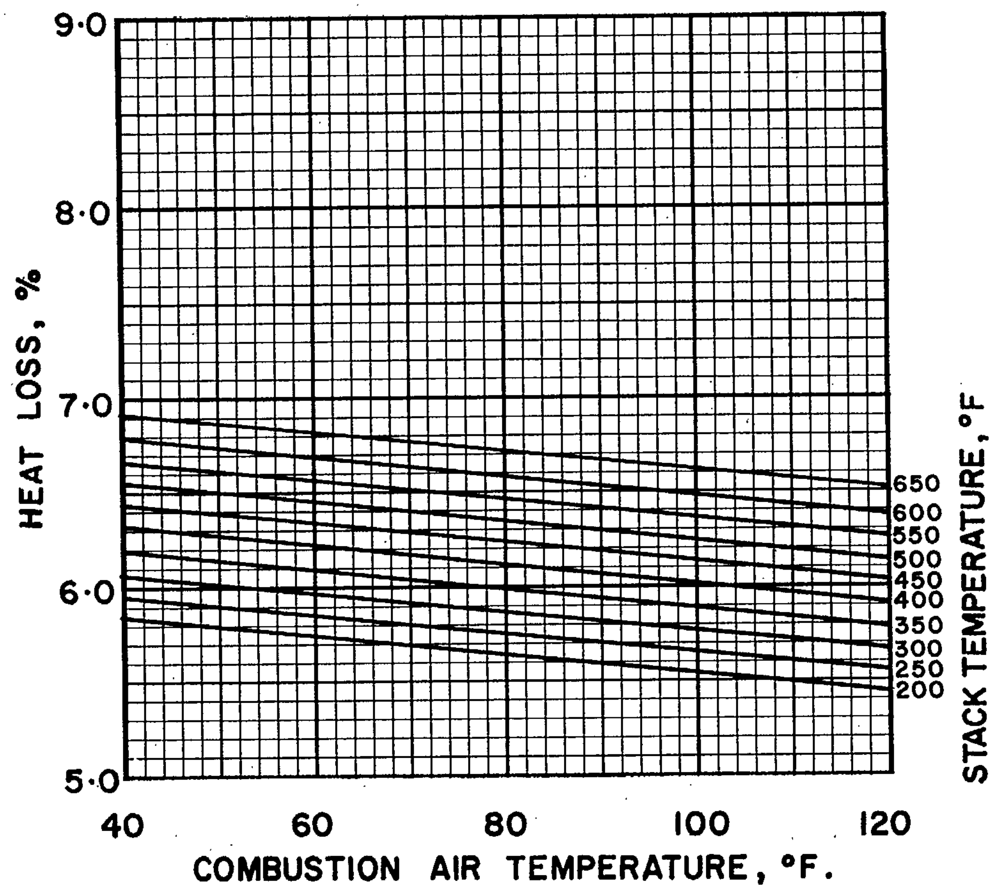


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

10410

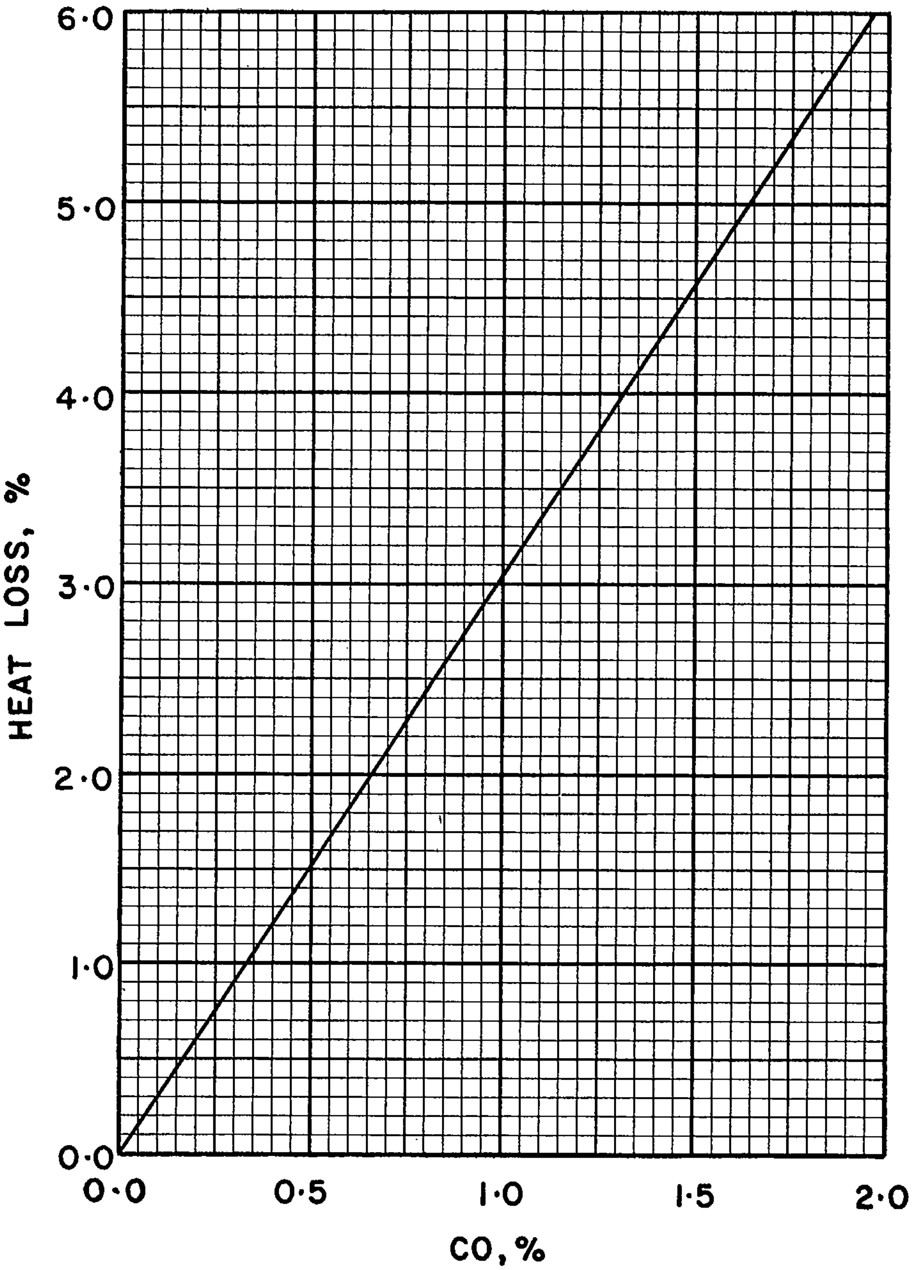


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

10410

FUEL OIL 10420, SPECIFIC GRAVITY 1.040

Ultimate Analysis, lb/lb

Carbon	(C)	0.8781
Hydrogen	(H_2)	0.1019
Sulphur	(S)	0.0200
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		17,950

Conversion Factors

1 Imp gal oil = 10.40 lb oil
or Imp gal oil × 10.40 = lb oil
or lb oil × 0.0962 = Imp gal oil

1 U.S. gal oil = 10.40 × 0.8337 lb oil
or U.S. gal oil × 8.670 = lb oil
or lb oil × 0.1153 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{17{,}950} \text{ lb oil}$$

or Btu × 10^6 × 55.71 = lb oil
or lb oil × 0.0180 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{17{,}950 \times 10.40} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.357 = Imp gal oil
or Imp gal oil × 0.1867 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{17{,}950 \times 8.670} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.427 = U.S. gal oil
or U.S. gal oil × 0.1556 = Btu × 10^6

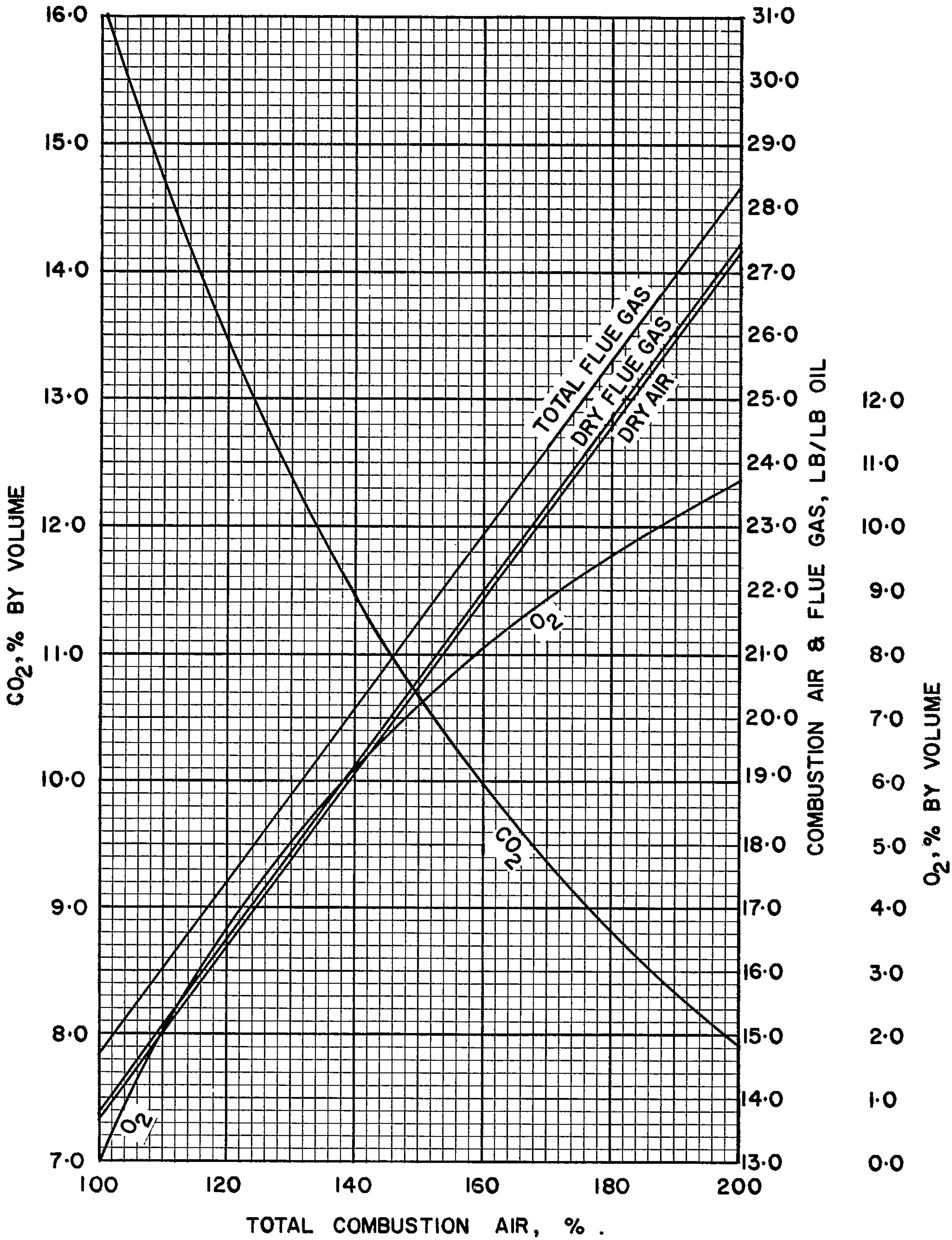


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS.

10420

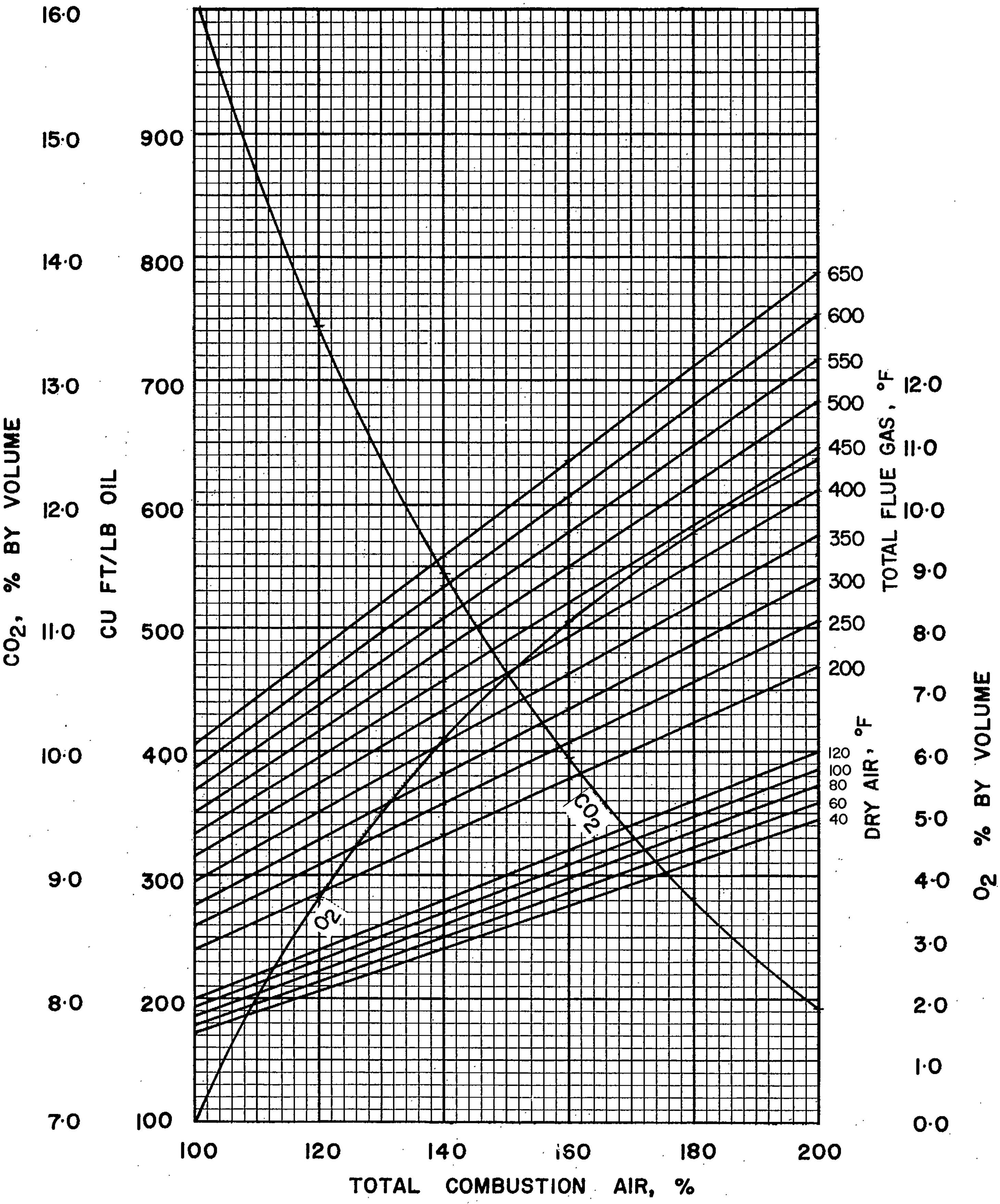


FIGURE 2 COMBUSTION DATA, VOLUME BASIS 10420

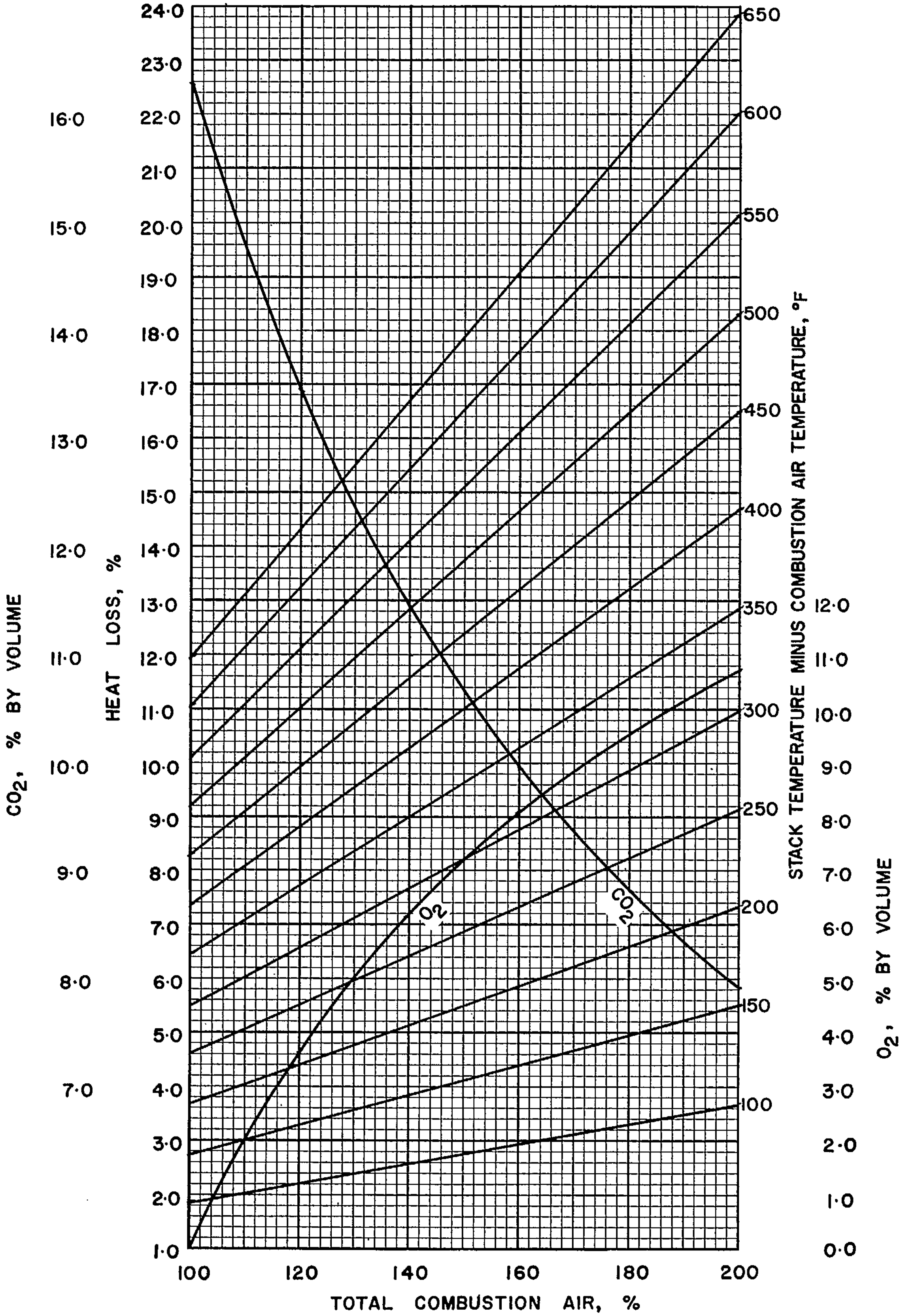


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

10420

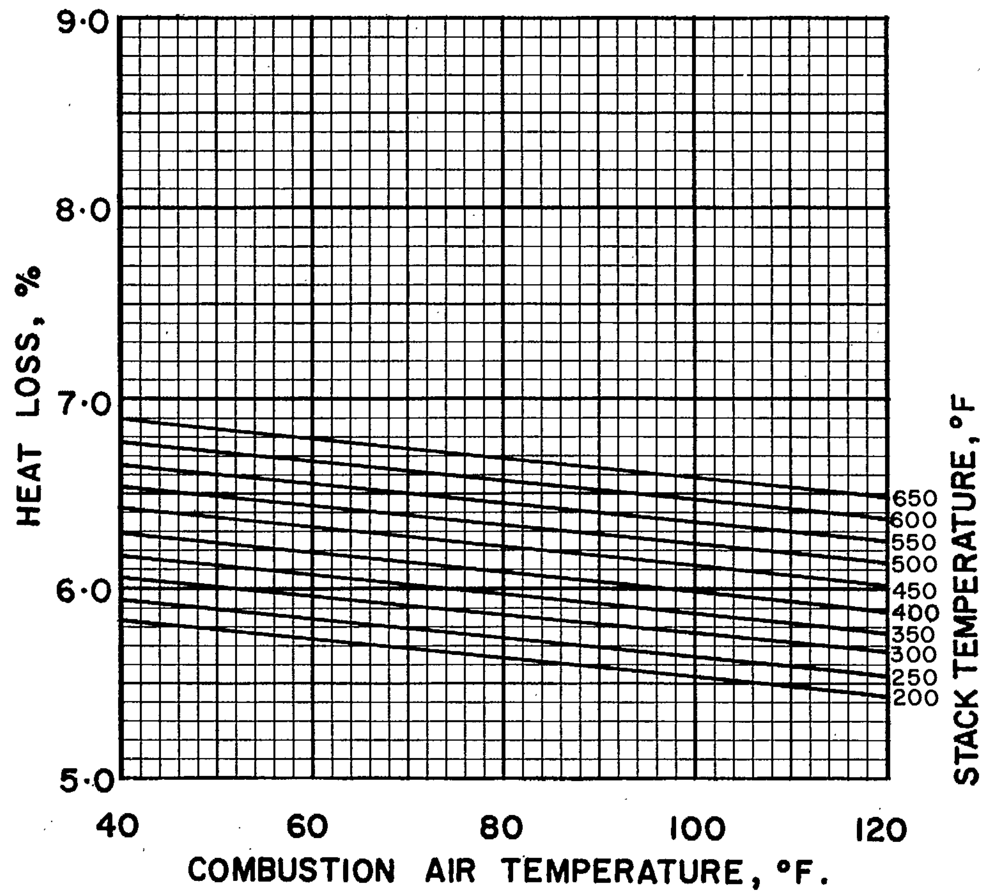


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

10420

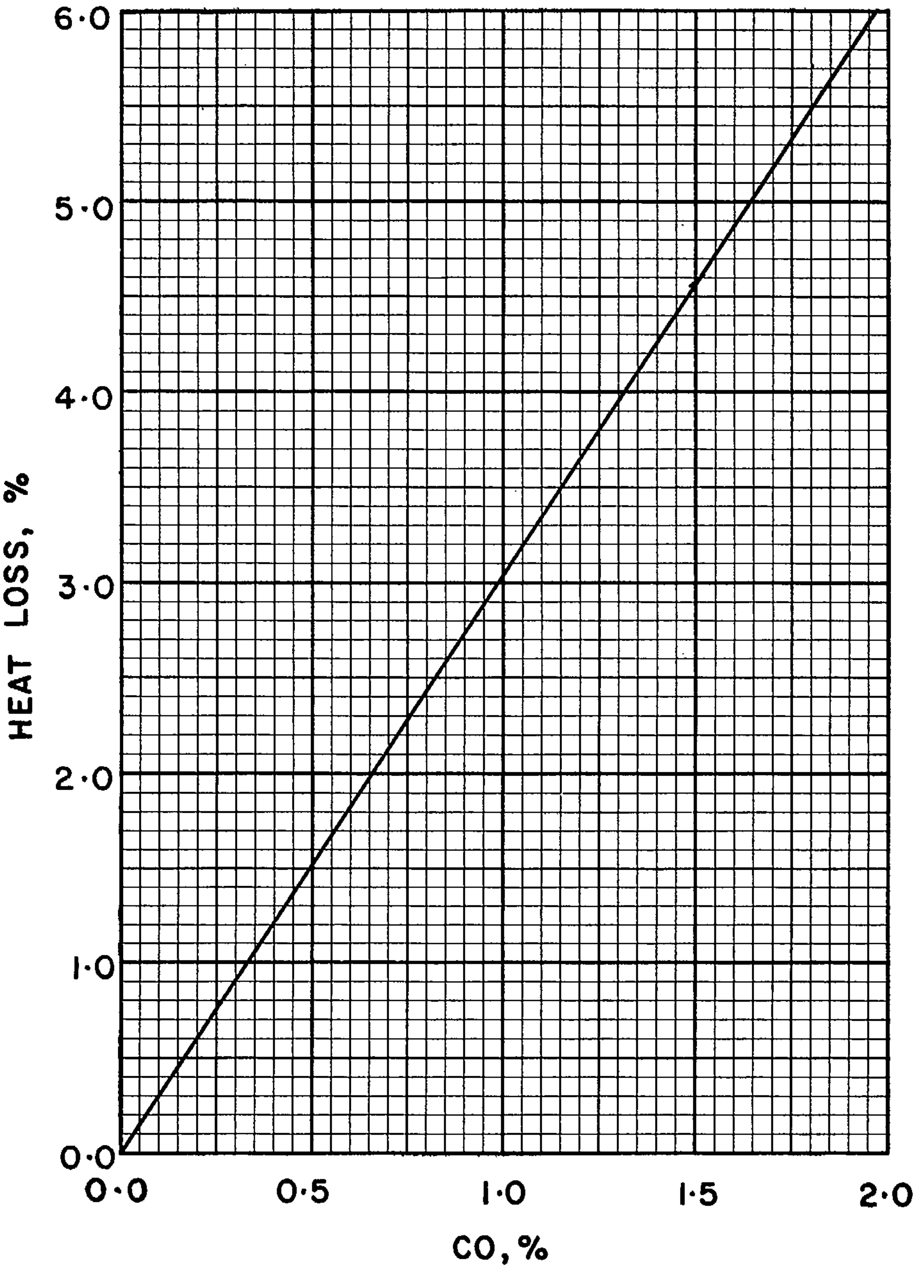


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

10420

FUEL OIL 10430, SPECIFIC GRAVITY 1.040

Ultimate Analysis, lb/lb

Carbon (C)	0.8691
Hydrogen (H_2)	0.1009
Sulphur (S)	0.0300
Nitrogen (N_2)	–
Oxygen (O_2)	–
Ash	–
Moisture	–
Total	1.0000
Calorific Value, Btu/lb	17,800

Conversion Factors

1 Imp gal oil = 10.40 lb oil
or Imp gal oil × 10.40 = lb oil
or lb oil × 0.0962 = Imp gal oil

1 U.S. gal oil = 10.40 × 0.8337 lb oil
or U.S. gal oil × 8.670 = lb oil
or lb oil × 0.1153 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{17{,}800} \text{ lb oil}$$

or Btu × 10^6 × 56.18 = lb oil
or lb oil × 0.0178 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{17{,}800 \times 10.40} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.402 = Imp gal oil
or Imp gal oil × 0.1851 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{17{,}800 \times 8.670} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.481 = U.S. gal oil
or U.S. gal oil × 0.1543 = Btu × 10^6

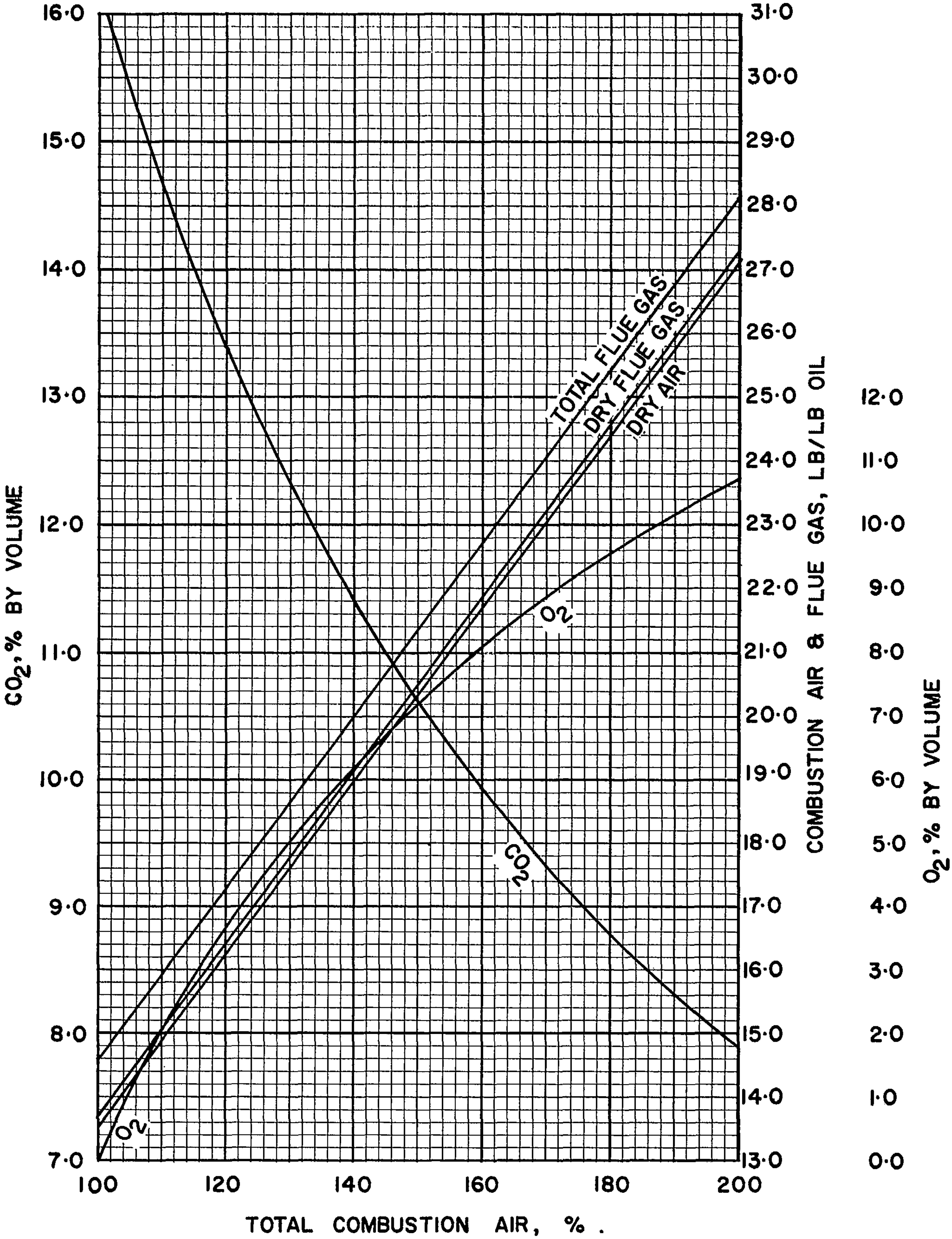


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS.

10430

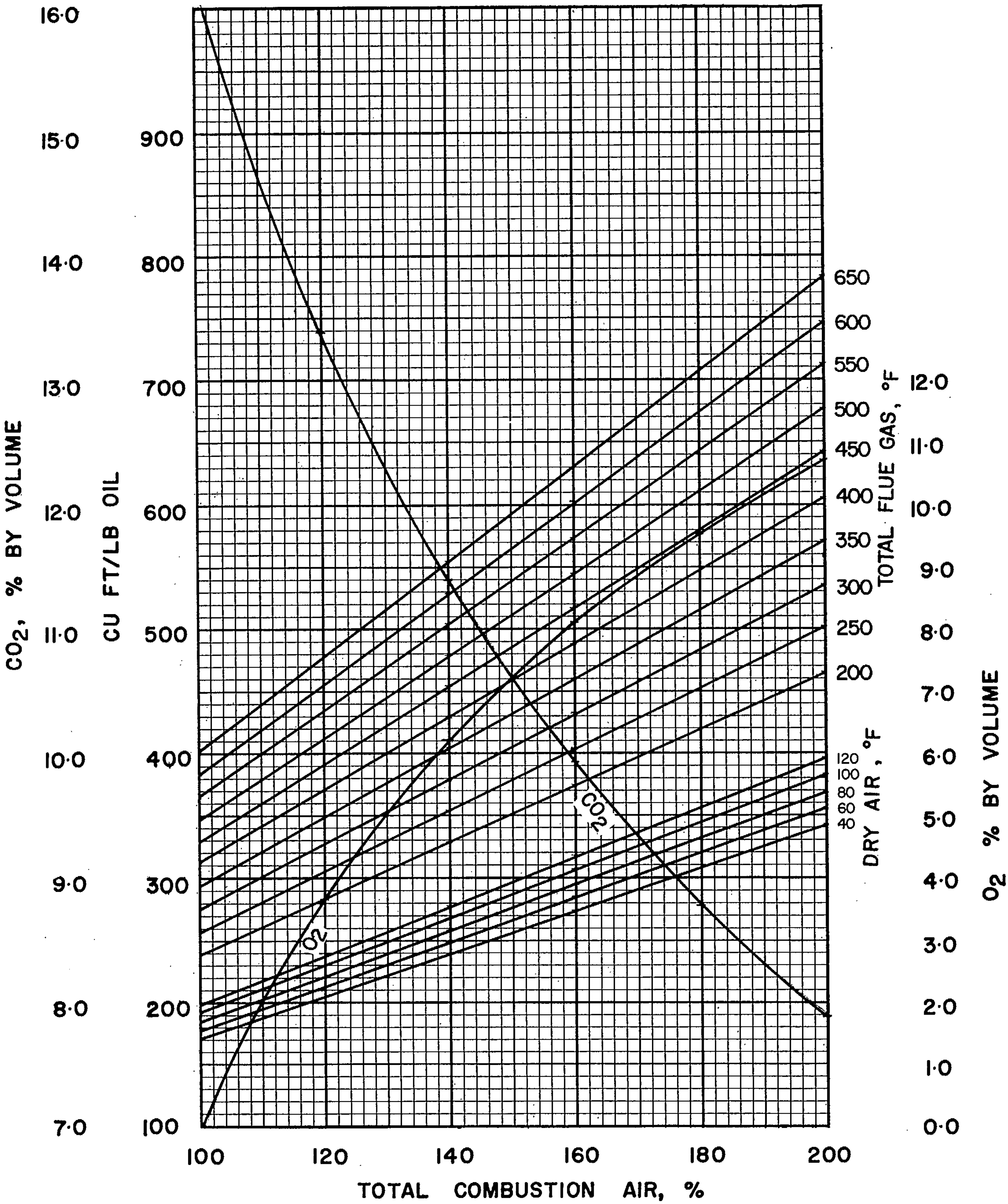


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 10430

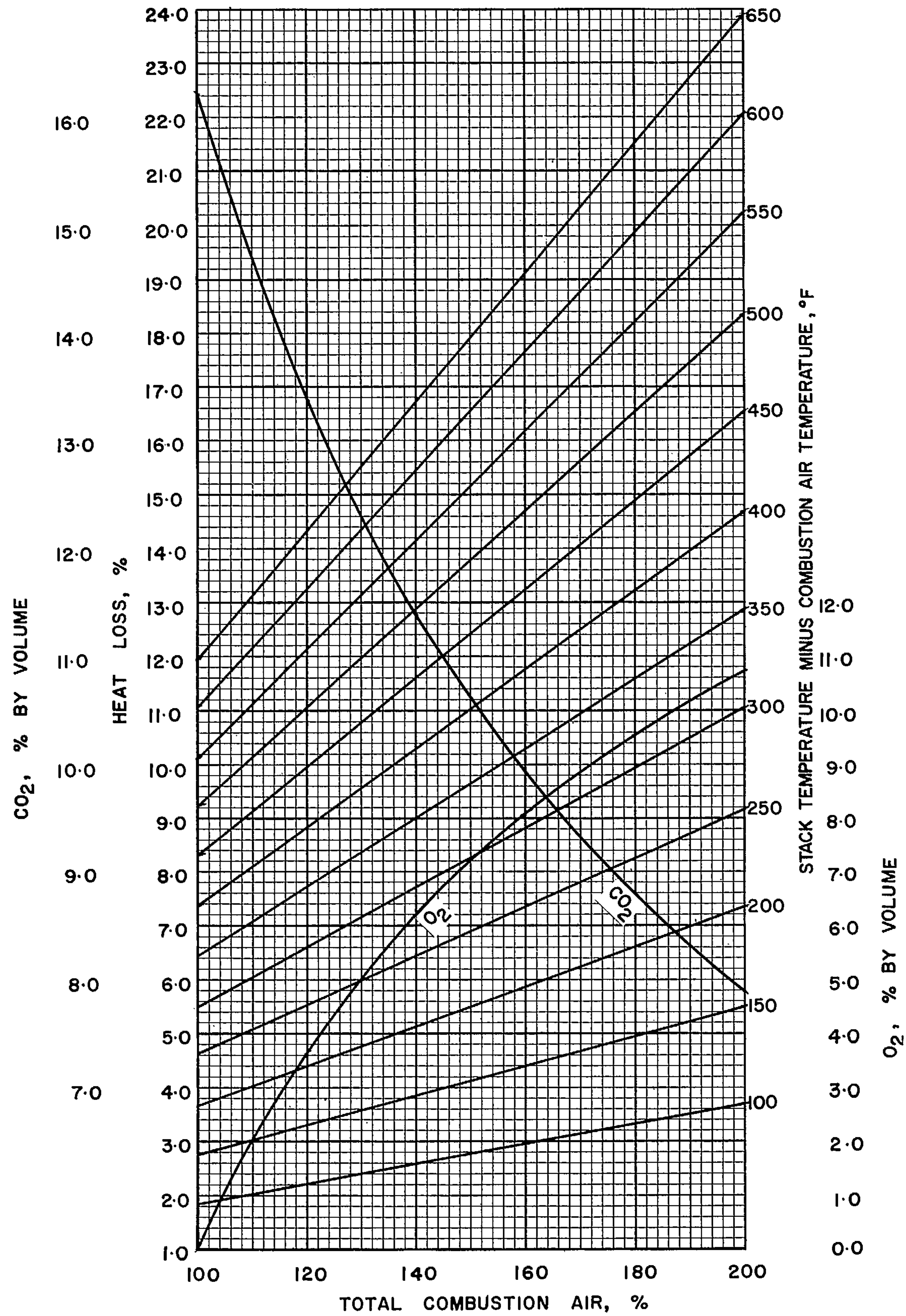


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

10430

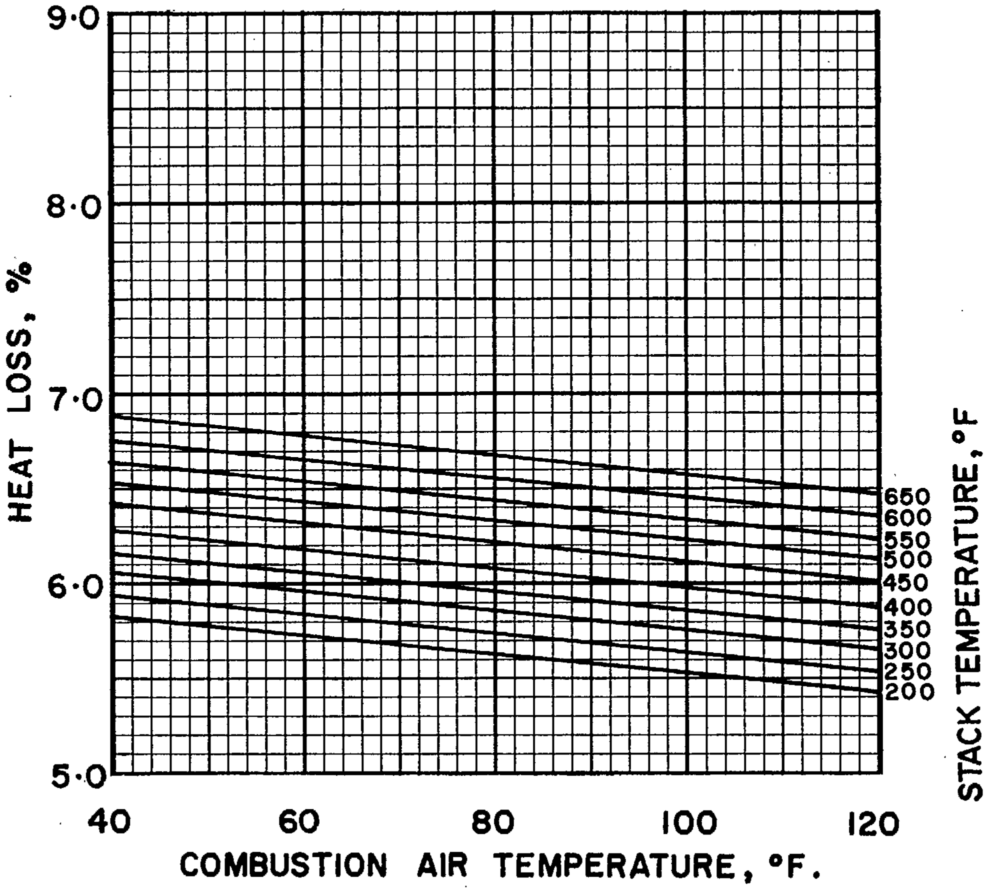


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

10430

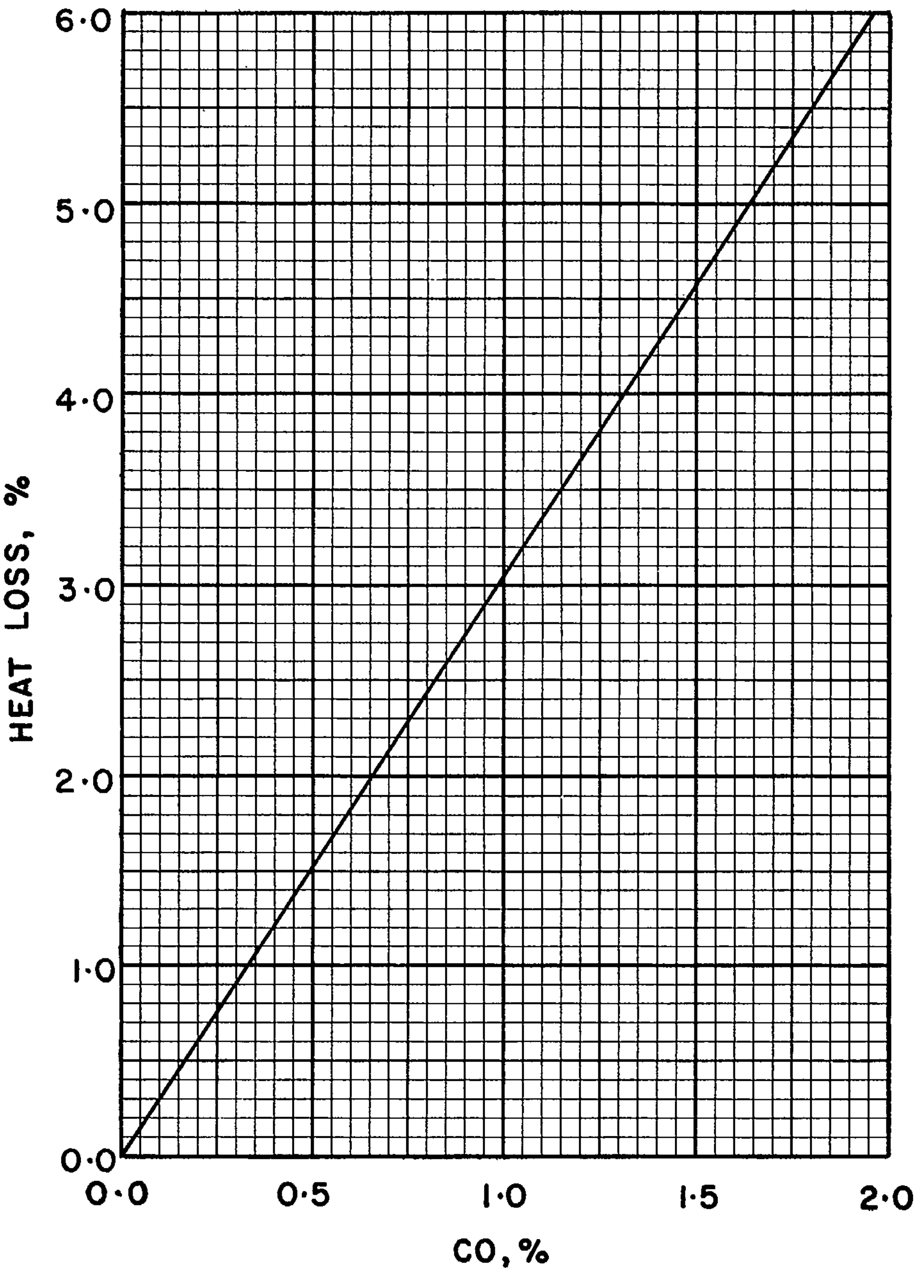


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

10430

FUEL OIL 10440, SPECIFIC GRAVITY 1.040

Ultimate Analysis, lb/lb

Carbon	(C)	0.8602
Hydrogen	(H_2)	0.0998
Sulphur	(S)	0.0400
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		17,660

Conversion Factors

1 Imp gal oil = 10.40 lb oil
or Imp gal oil × 10.40 = lb oil
or lb oil × 0.0962 = Imp gal oil

1 U.S. gal oil = 10.40 × 0.8337 lb oil
or U.S. gal oil × 8.670 = lb oil
or lb oil × 0.1153 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{17{,}660} \text{ lb oil}$$

or Btu × 10^6 × 56.63 = lb oil
or lb oil × 0.0177 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{17{,}660 \times 10.40} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.445 = Imp gal oil
or Imp gal oil × 0.1837 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{17{,}660 \times 0.867} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.532 = U.S. gal oil
or U.S. gal oil × 0.1531 = Btu × 10^6

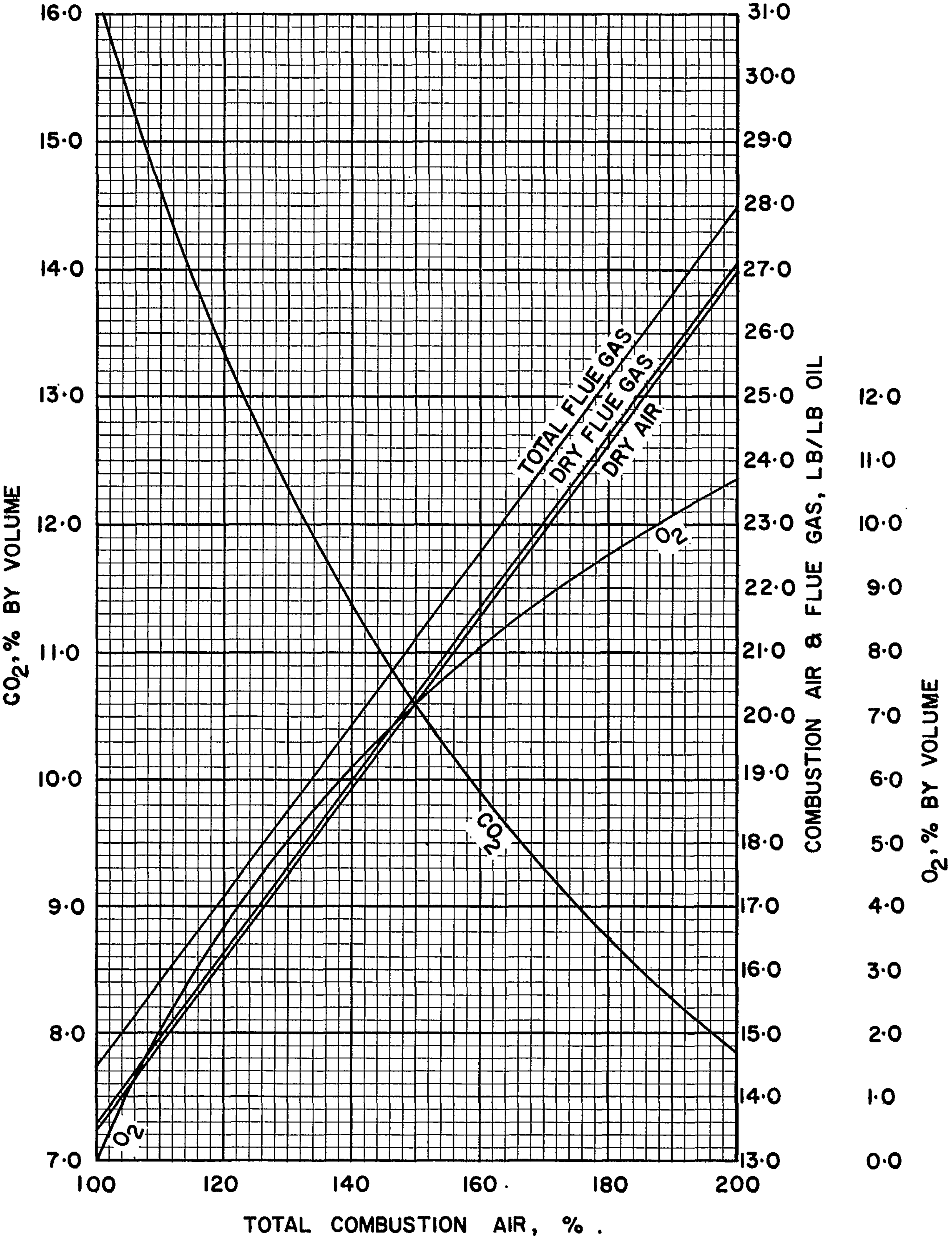


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS.

10440

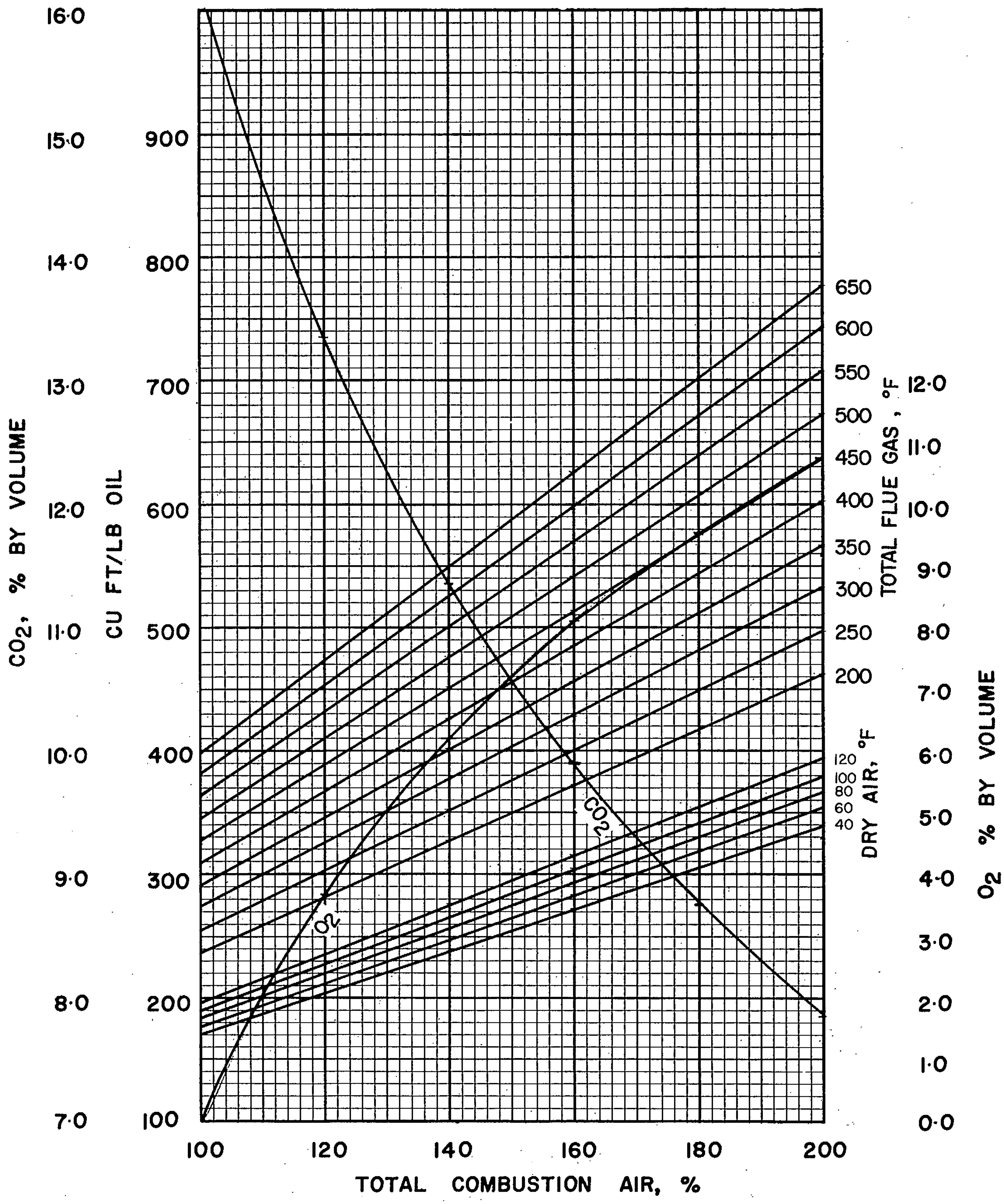


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 10440

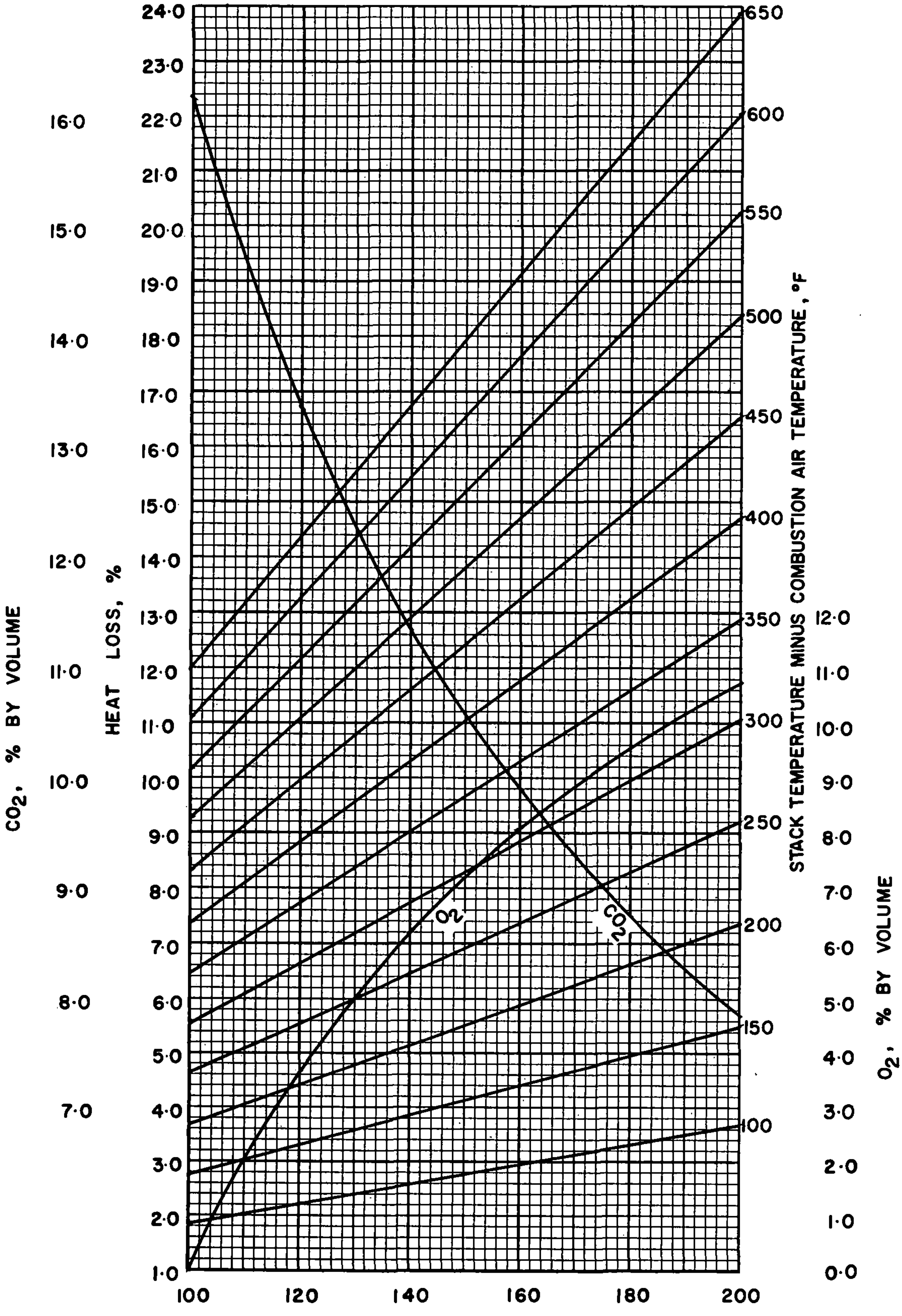


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

10440

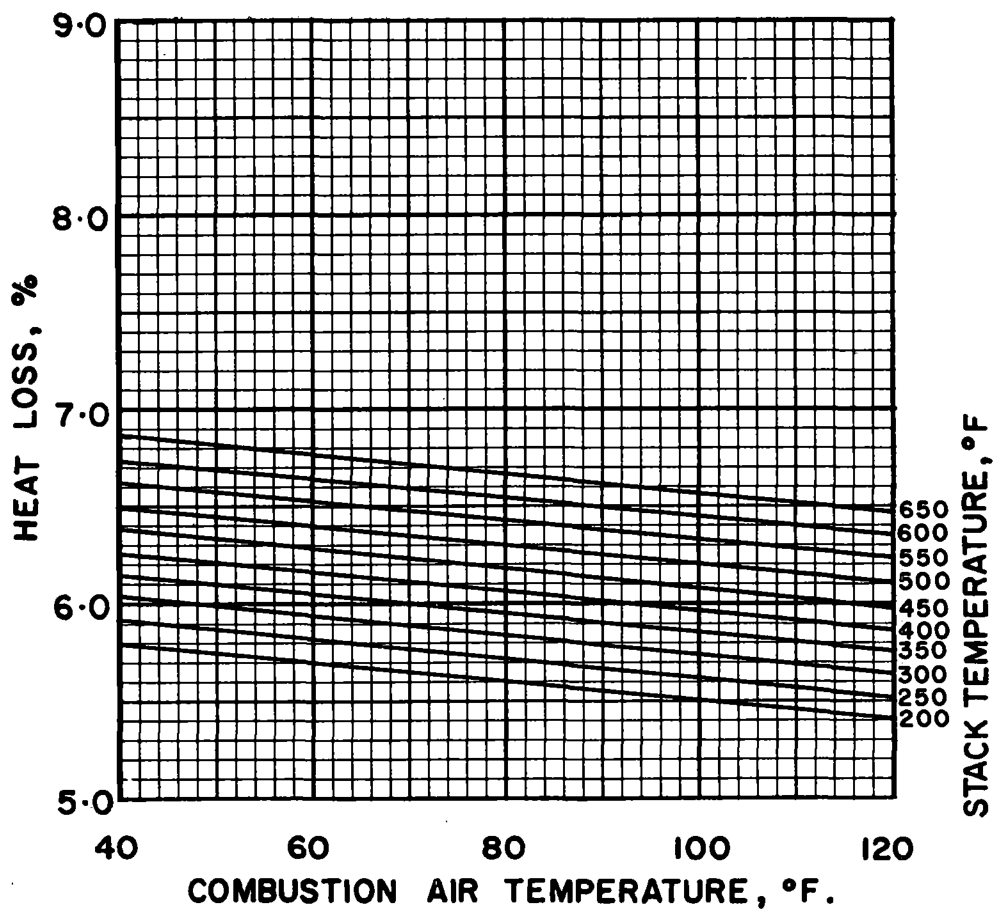


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

10440

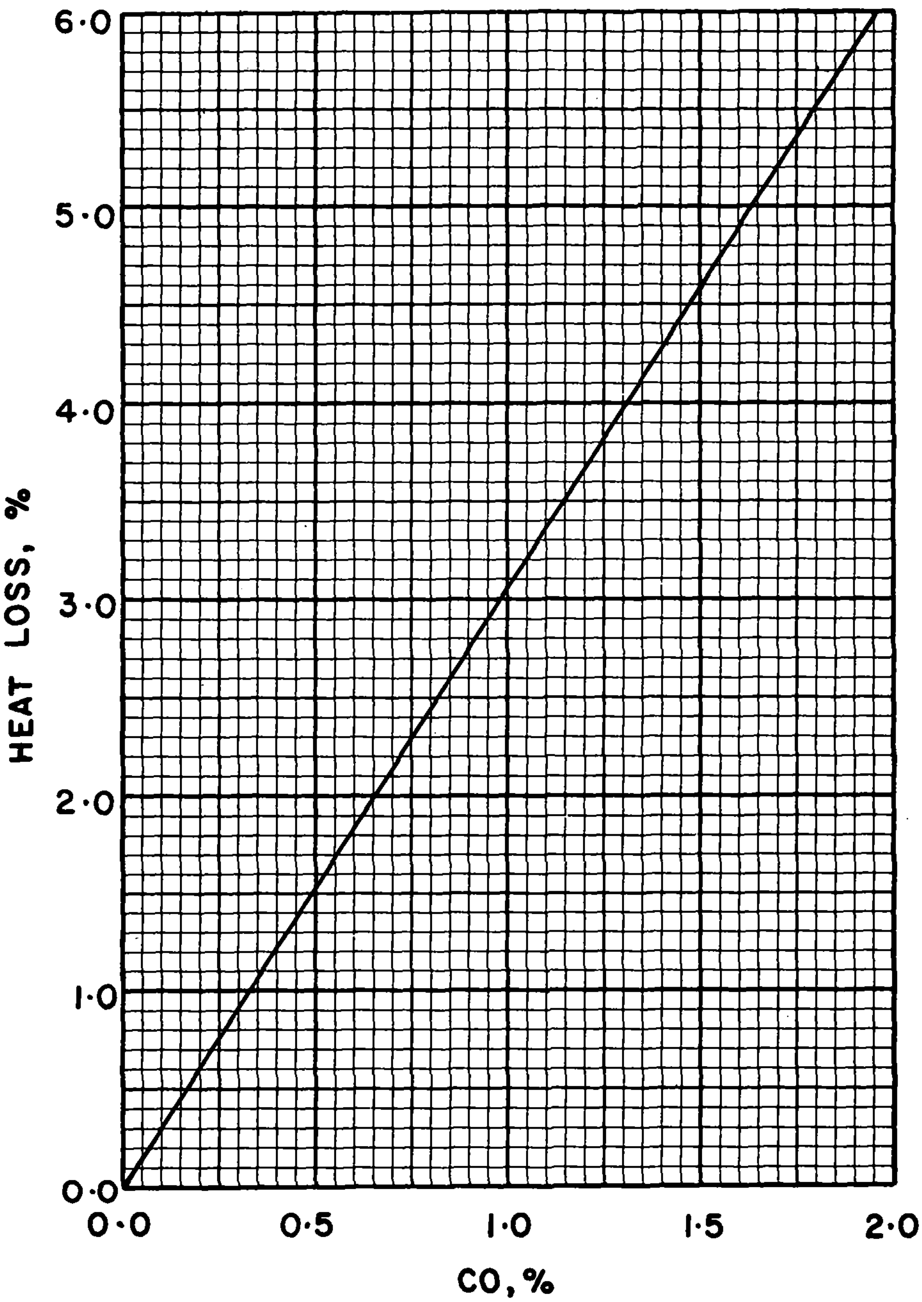


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

10440

FUEL OIL 10500, SPECIFIC GRAVITY 1.050

Ultimate Analysis, lb/lb

Carbon	(C)	0.8975
Hydrogen	(H_2)	0.1025
Sulphur	(S)	–
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,150

Conversion Factors

1 Imp gal oil = 10.50 lb oil
or Imp gal oil × 10.50 = lb oil
or lb oil × 0.0952 = Imp gal oil

1 U.S. gal oil = 10.50 × 0.8337 lb oil
or U.S. gal oil × 8.754 = lb oil
or lb oil × 0.1142 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}150} \text{ lb oil}$$

or Btu × 10^6 × 55.10 = lb oil
or lb oil × 0.0182 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}150 \times 10.50} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.247 = Imp gal oil
or Imp gal oil × 0.1906 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}150 \times 8.754} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.293 = U.S. gal oil
or U.S. gal oil × 0.1589 = Btu × 10^6

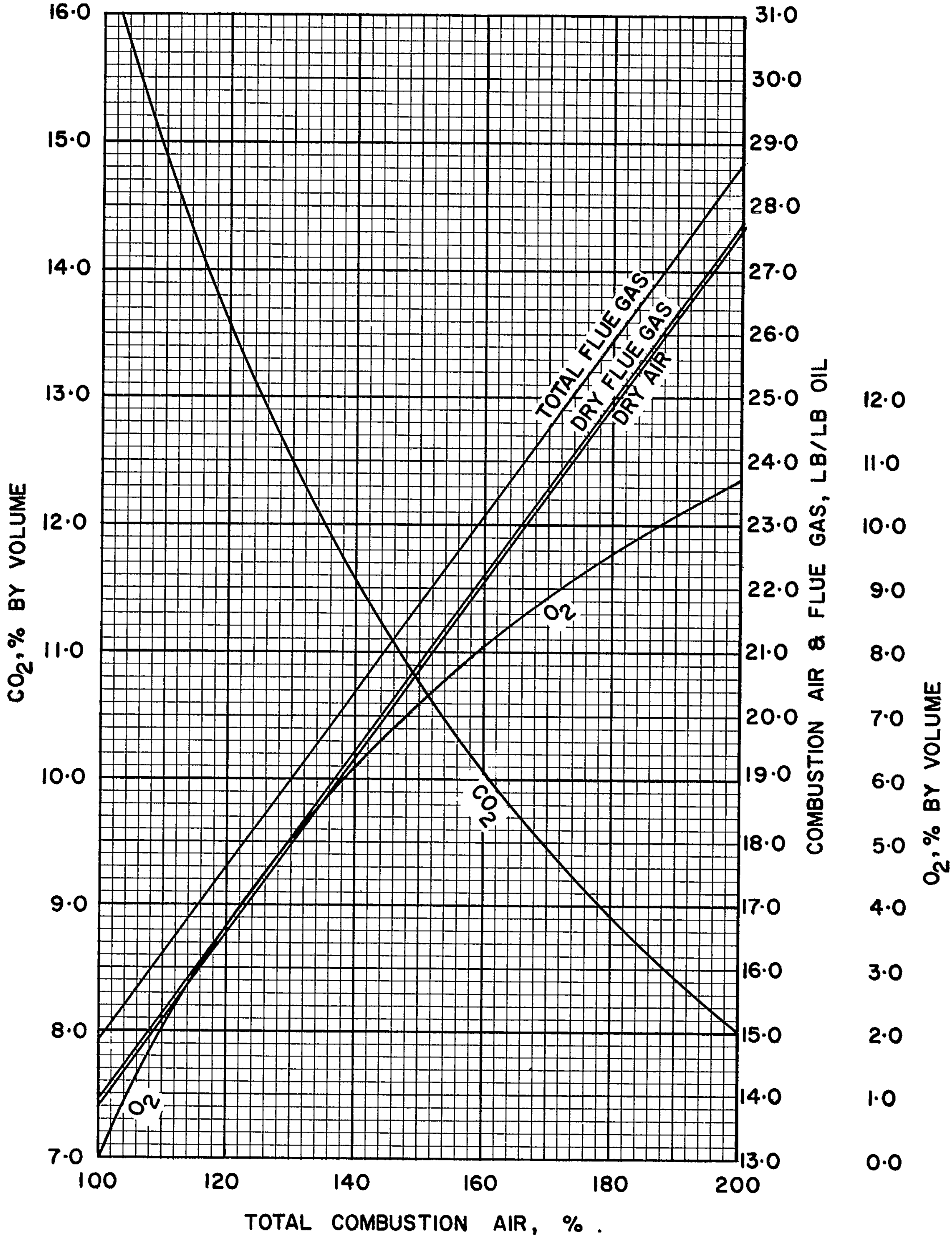


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS.

10500

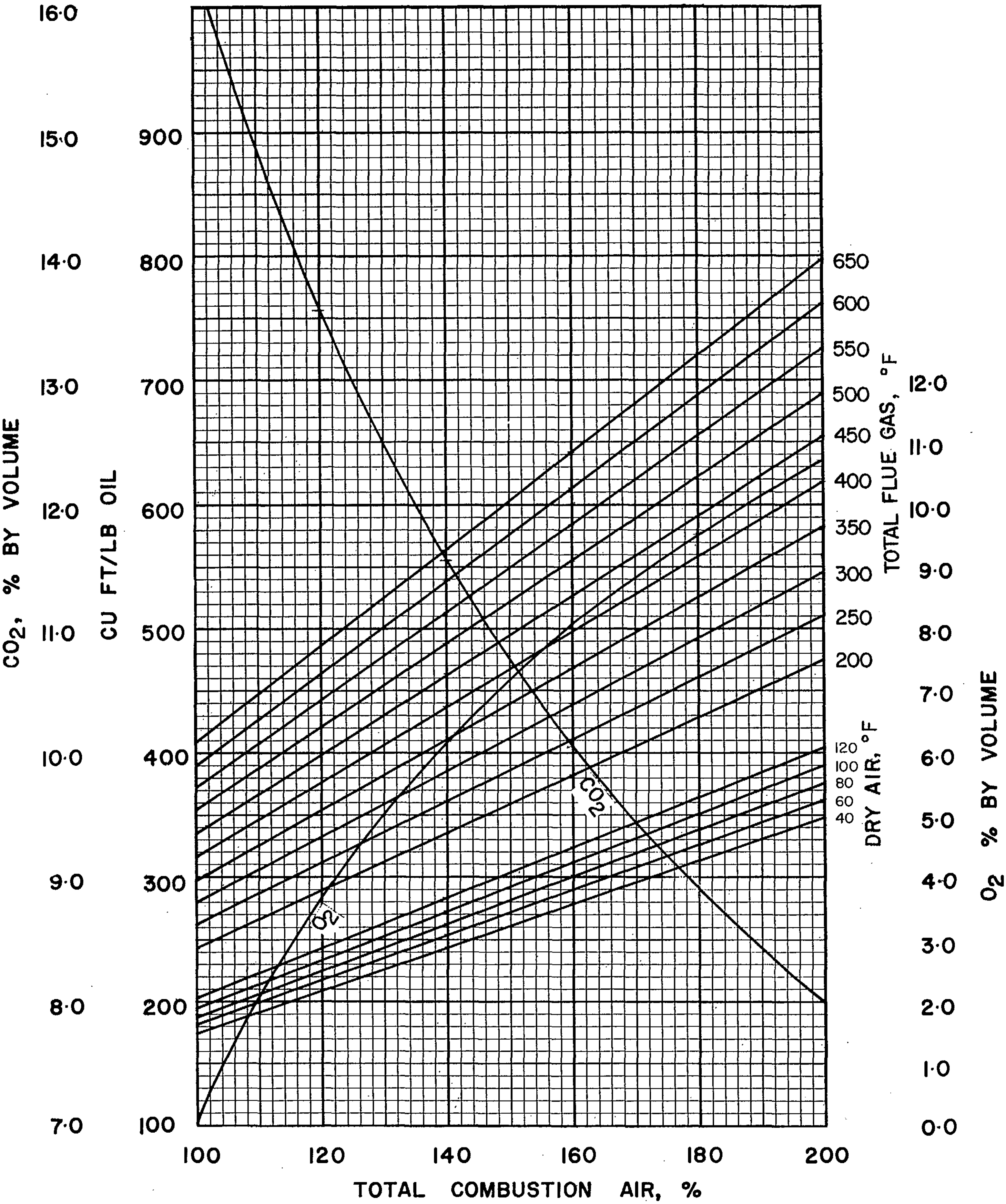


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 10500

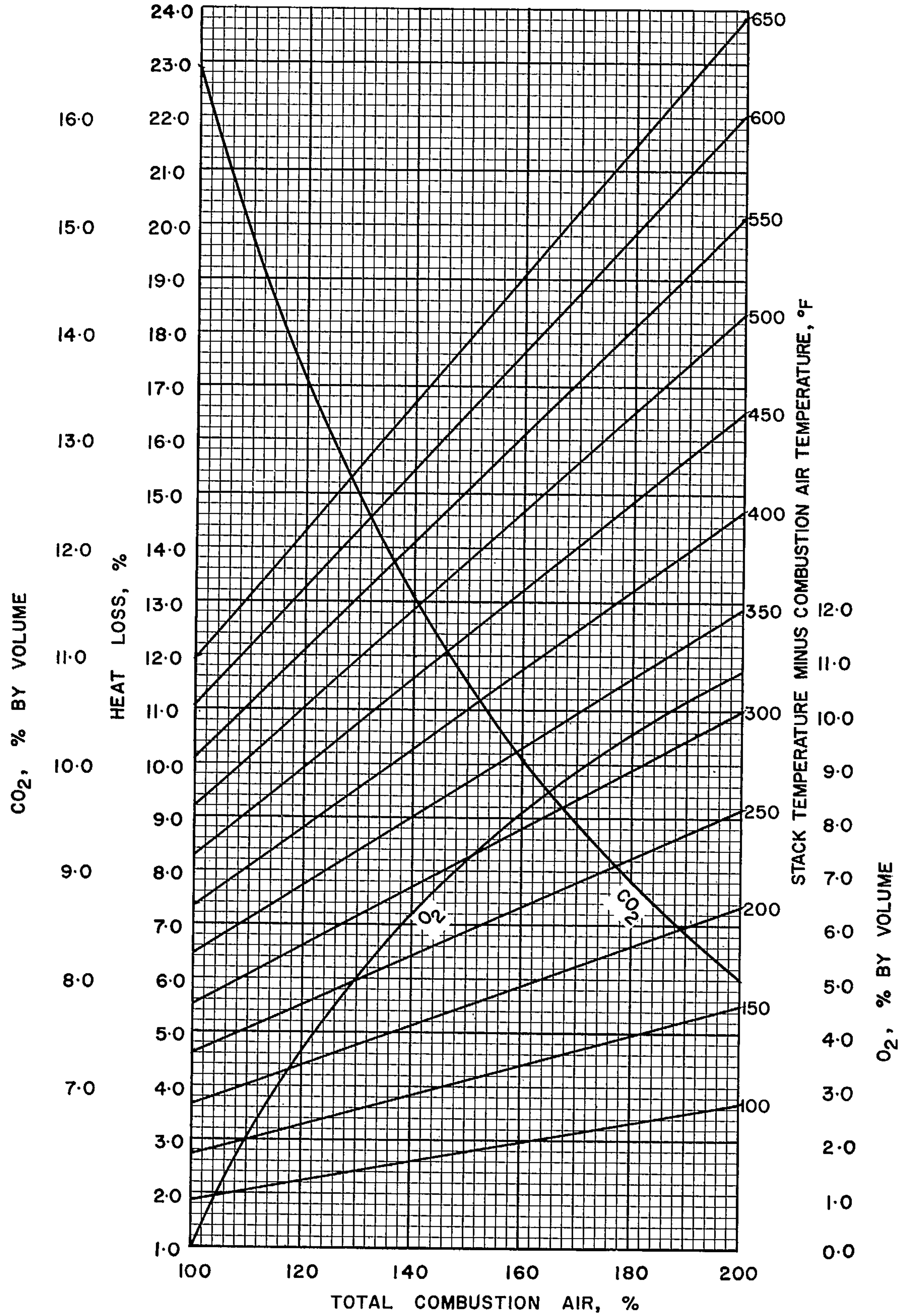


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

10500

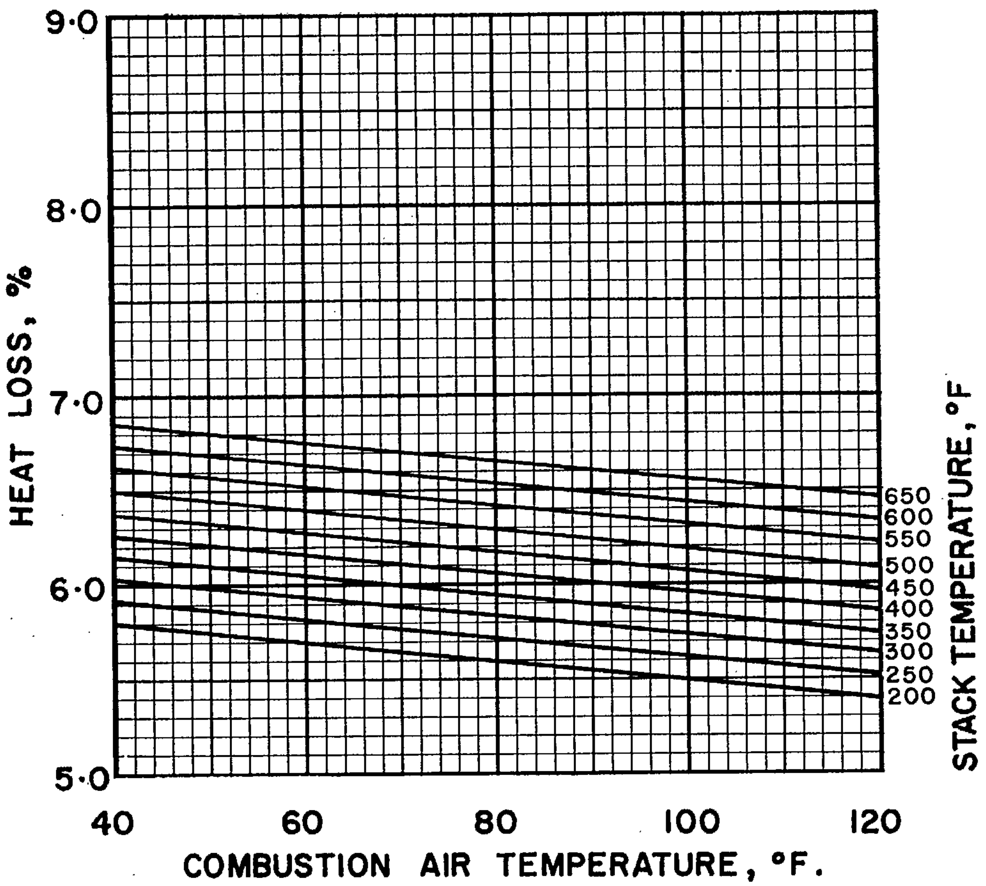


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

10500

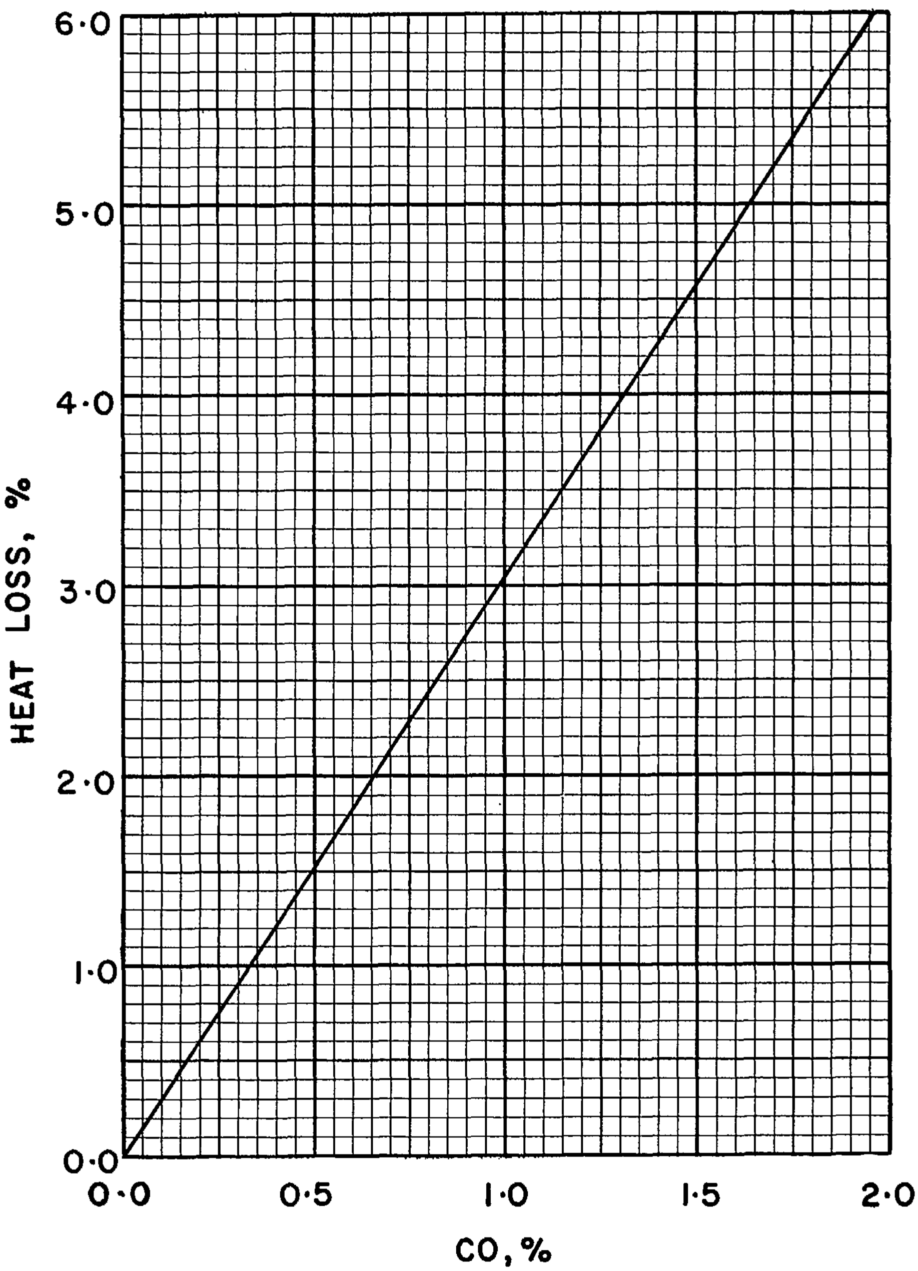


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

10500

FUEL OIL 10510, SPECIFIC GRAVITY 1.050

Ultimate Analysis, lb/lb

Carbon	(C)	0.8885
Hydrogen	(H_2)	0.1015
Sulphur	(S)	0.0100
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		18,100

Conversion Factors

1 Imp gal oil = 10.50 lb oil
or Imp gal oil × 10.50 = lb oil
or lb oil × 0.0952 = Imp gal oil

1 U.S. gal oil = 10.50 × 0.8337 lb oil
or U.S. gal oil × 8.754 = lb oil
or lb oil × 0.1142 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{18{,}100} \text{ lb oil}$$

or Btu × 10^6 × 55.25 = lb oil
or lb oil × 0.0181 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}100 \times 10.50} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.262 = Imp gal oil
or Imp gal oil × 0.1900 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{18{,}100 \times 8.754} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.313 = U.S. gal oil
or U.S. gal oil × 0.1584 = Btu × 10^6

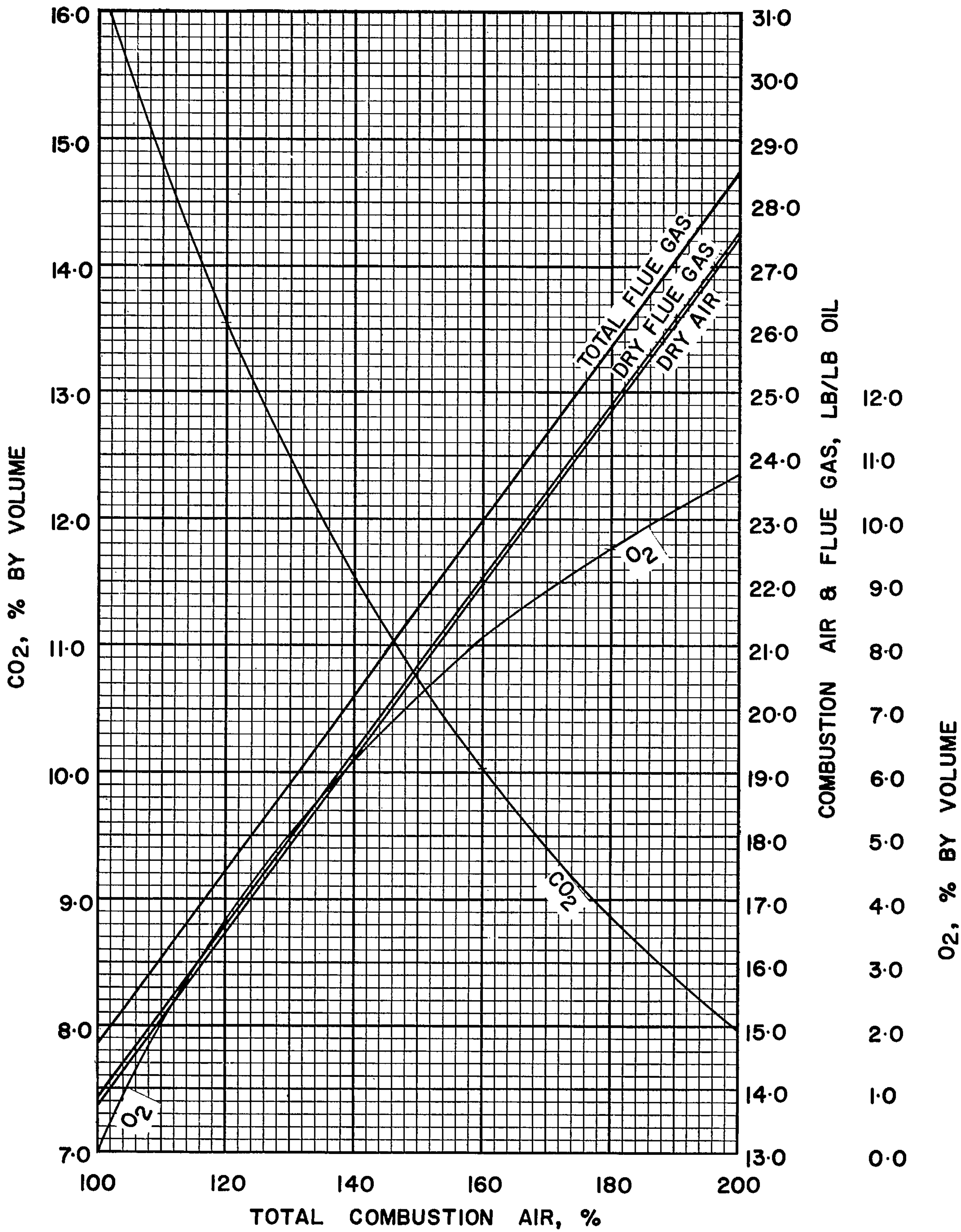


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS

10510

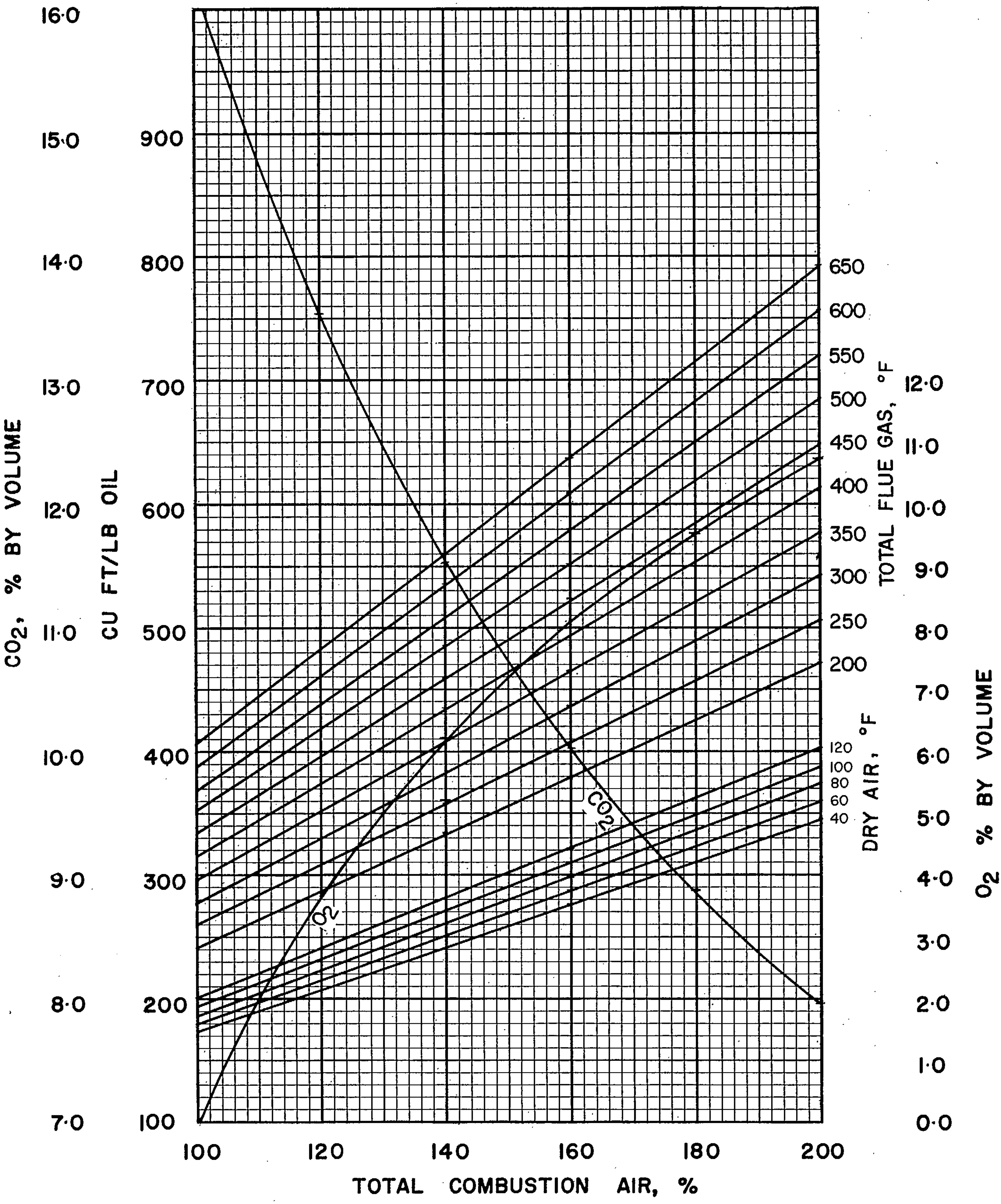


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 10510

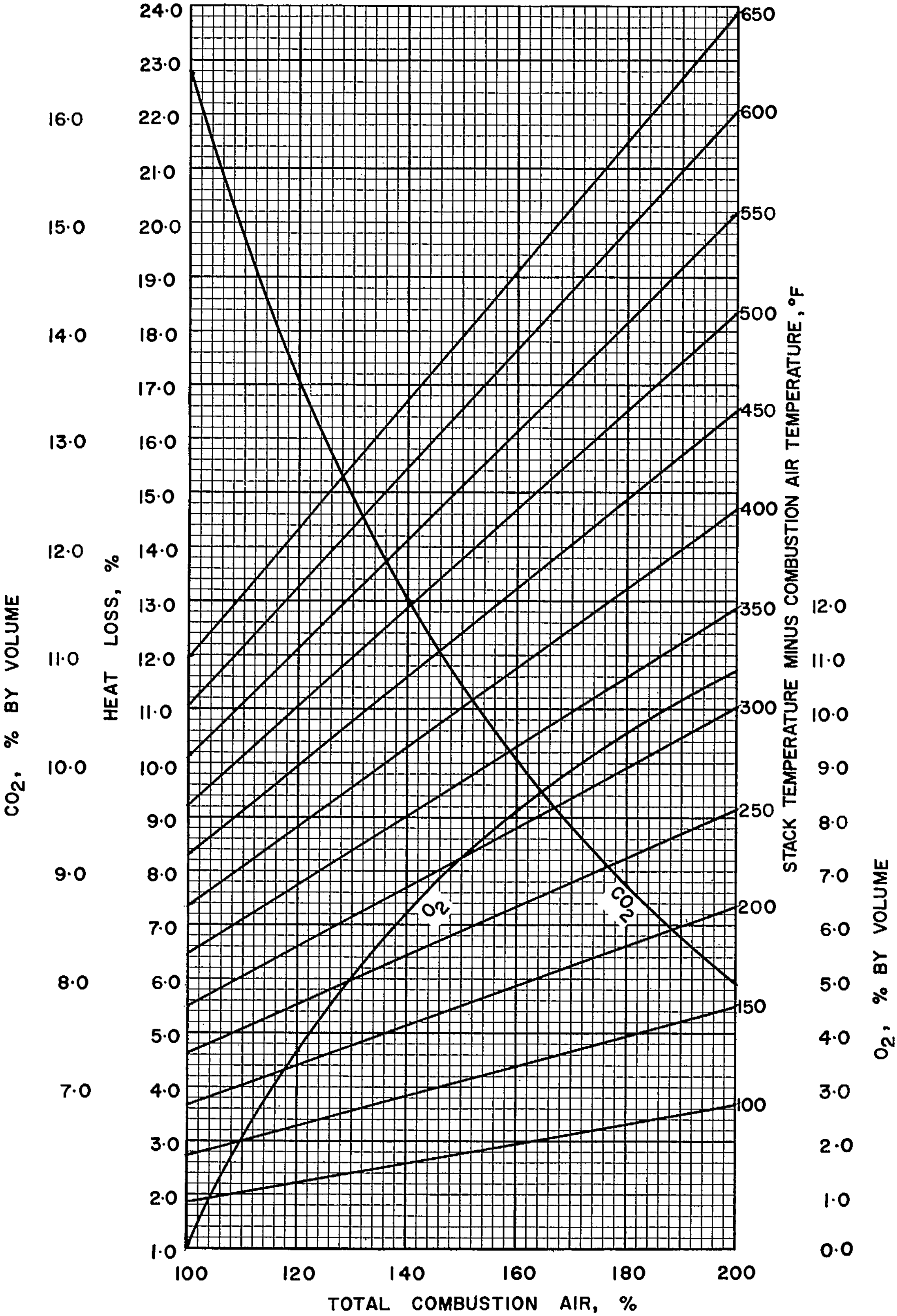


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

10510

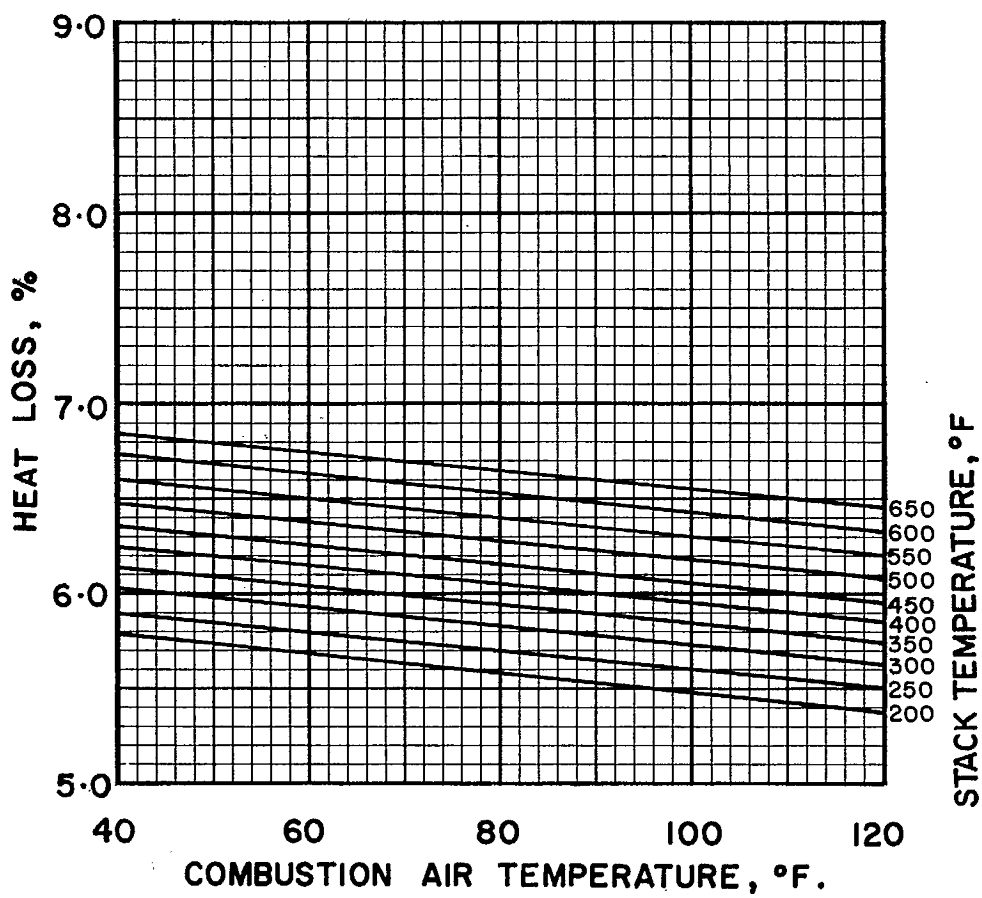


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

10510

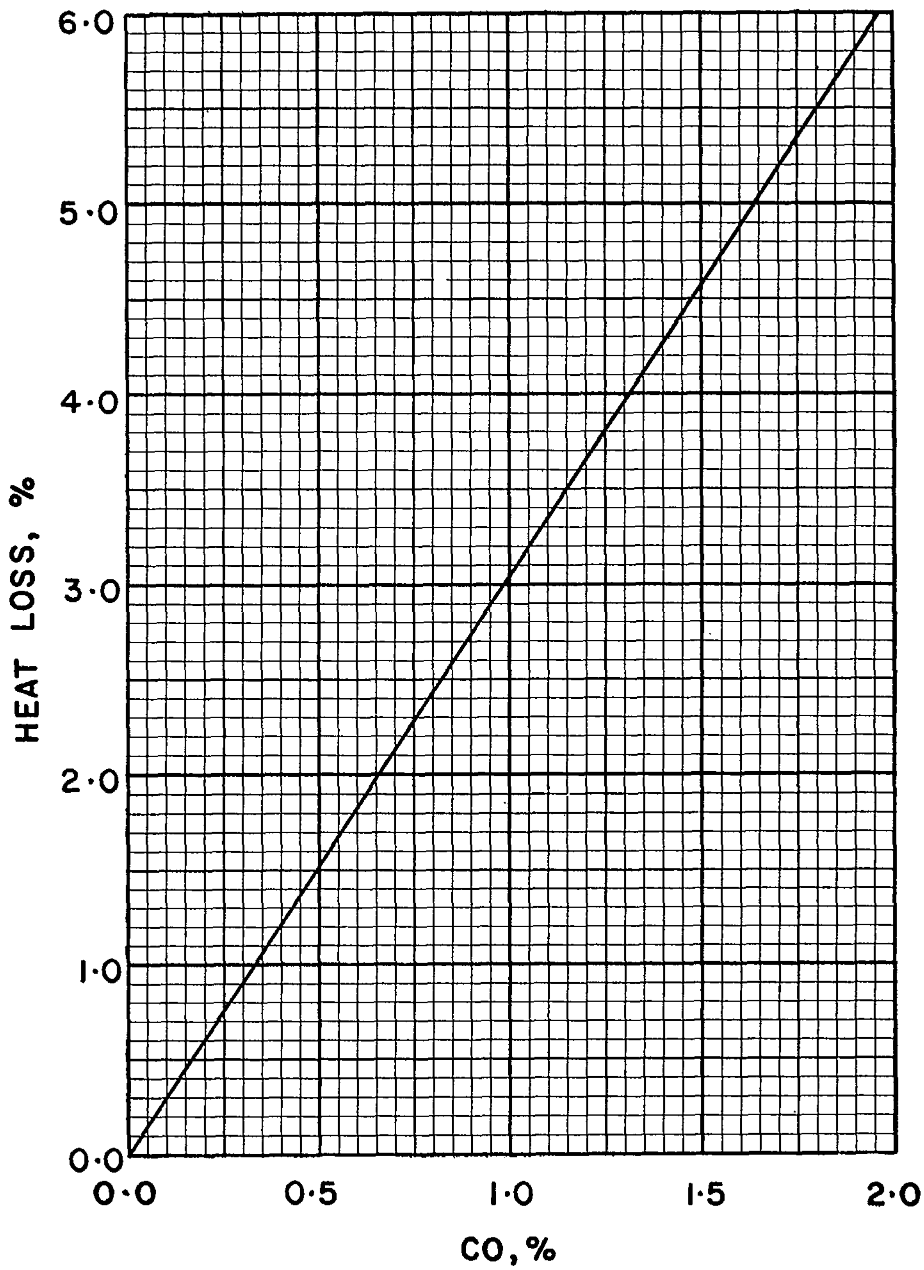


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

10510

FUEL OIL 10520, SPECIFIC GRAVITY 1.050

Ultimate Analysis, lb/lb

Carbon	(C)	0.8796
Hydrogen	(H_2)	0.1004
Sulphur	(S)	0.0200
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		17,870

Conversion Factors

1 Imp gal oil = 10.50 lb oil
or Imp gal oil × 10.50 = lb oil
or lb oil × 0.0952 = Imp gal oil

1 U.S. gal oil = 10.50 × 0.8337 lb oil
or U.S. gal oil × 8.754 = lb oil
or lb oil × 0.1142 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{17{,}870} \text{ lb oil}$$

or Btu × 10^6 × 55.96 = lb oil
or lb oil × 0.0179 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{17{,}870 \times 10.50} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.330 = Imp gal oil
or Imp gal oil × 0.1876 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{17{,}870 \times 8.754} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.394 = U.S. gal oil
or U.S. gal oil × 0.1564 = Btu × 10^6

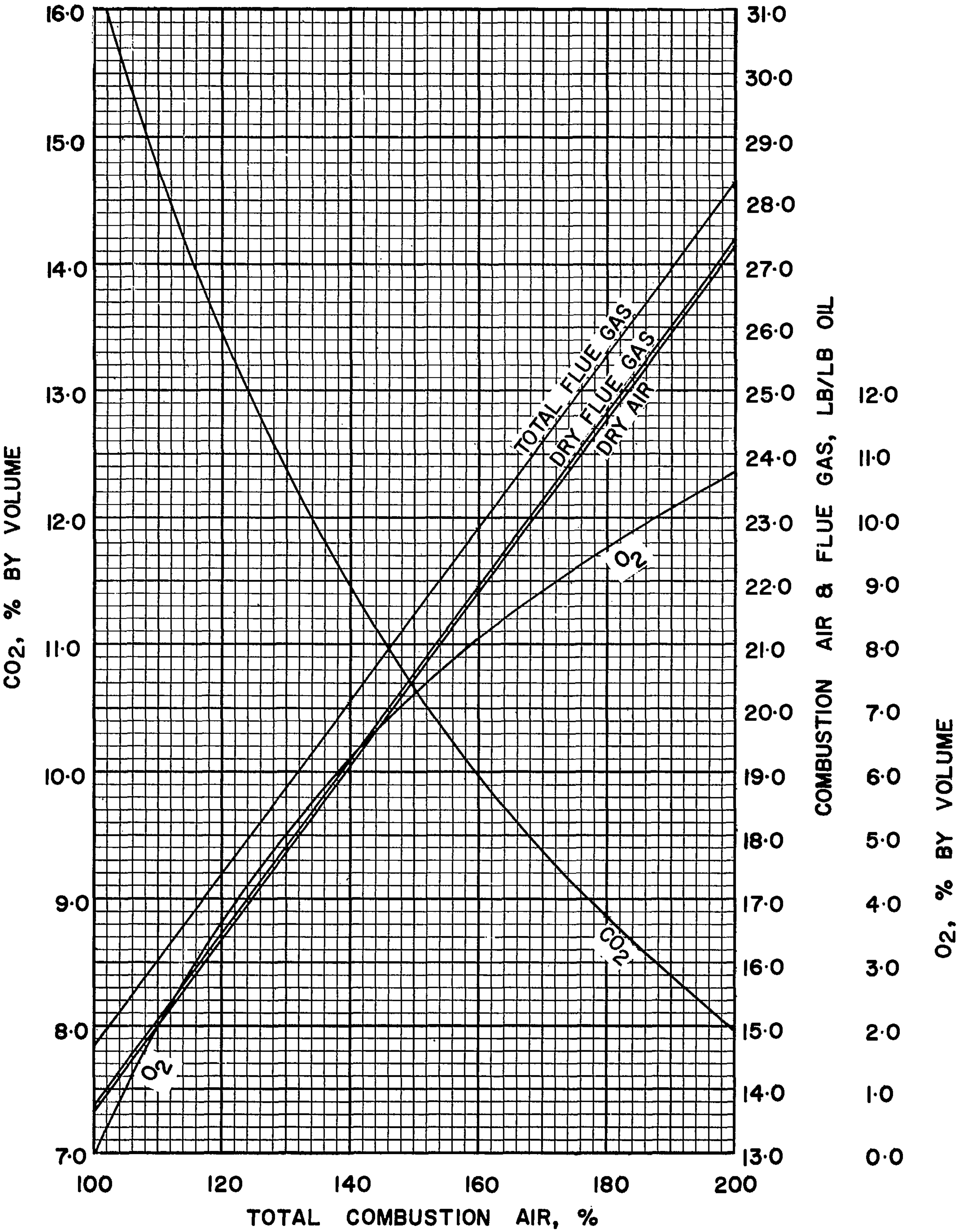


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS

10520

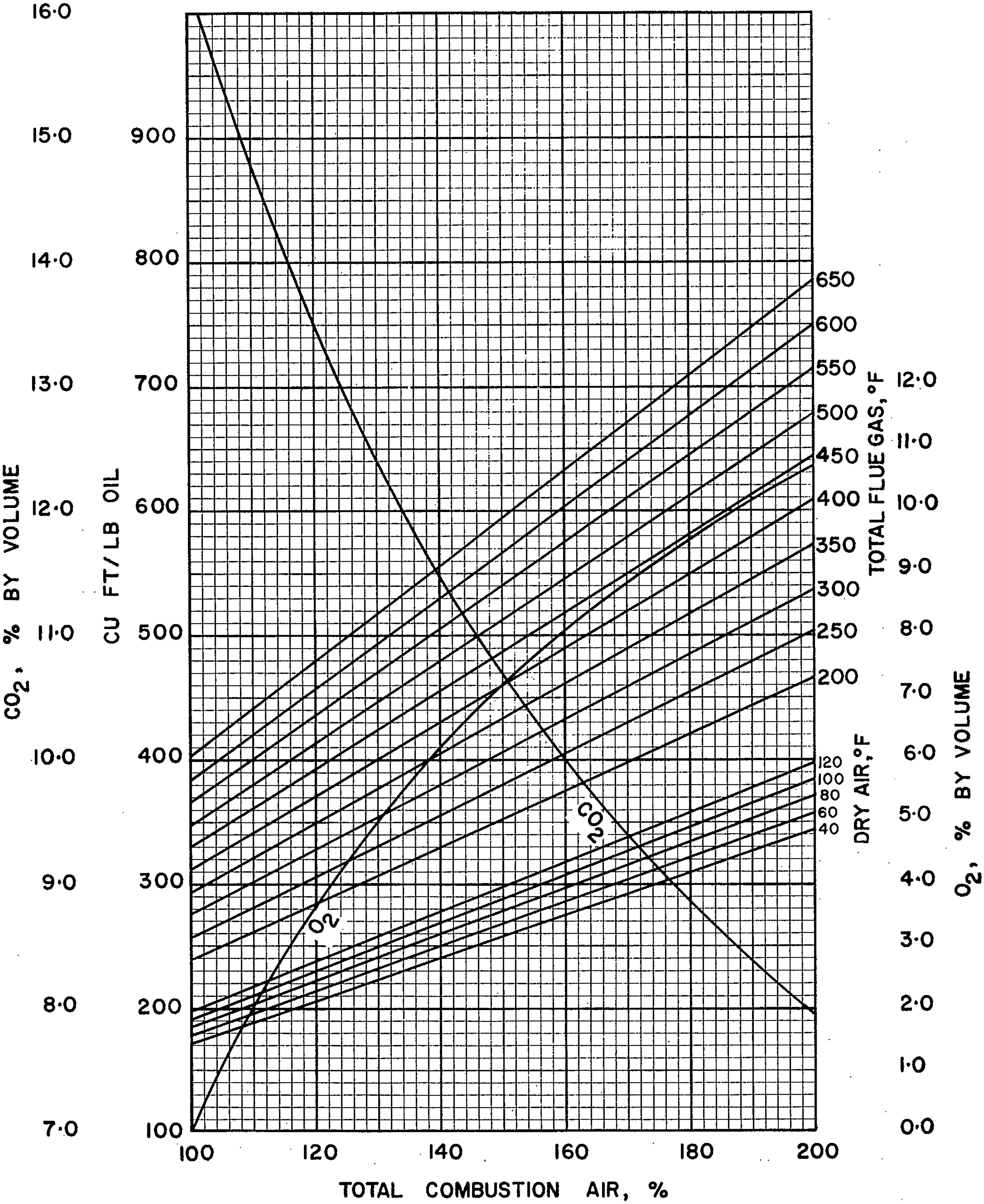


FIGURE 2. COMBUSTION DATA, VOLUME BASIS.

10520

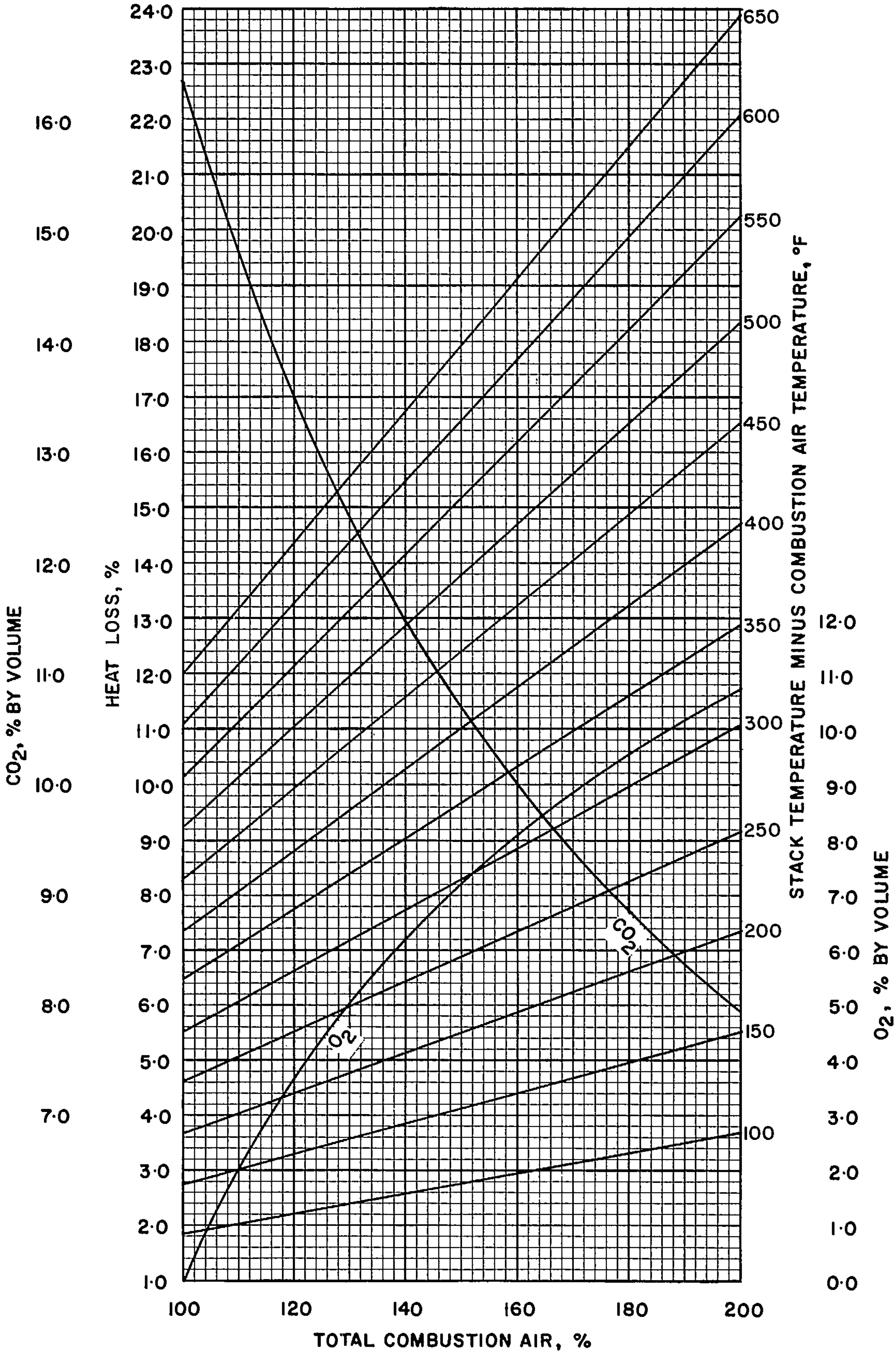


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS.

10520

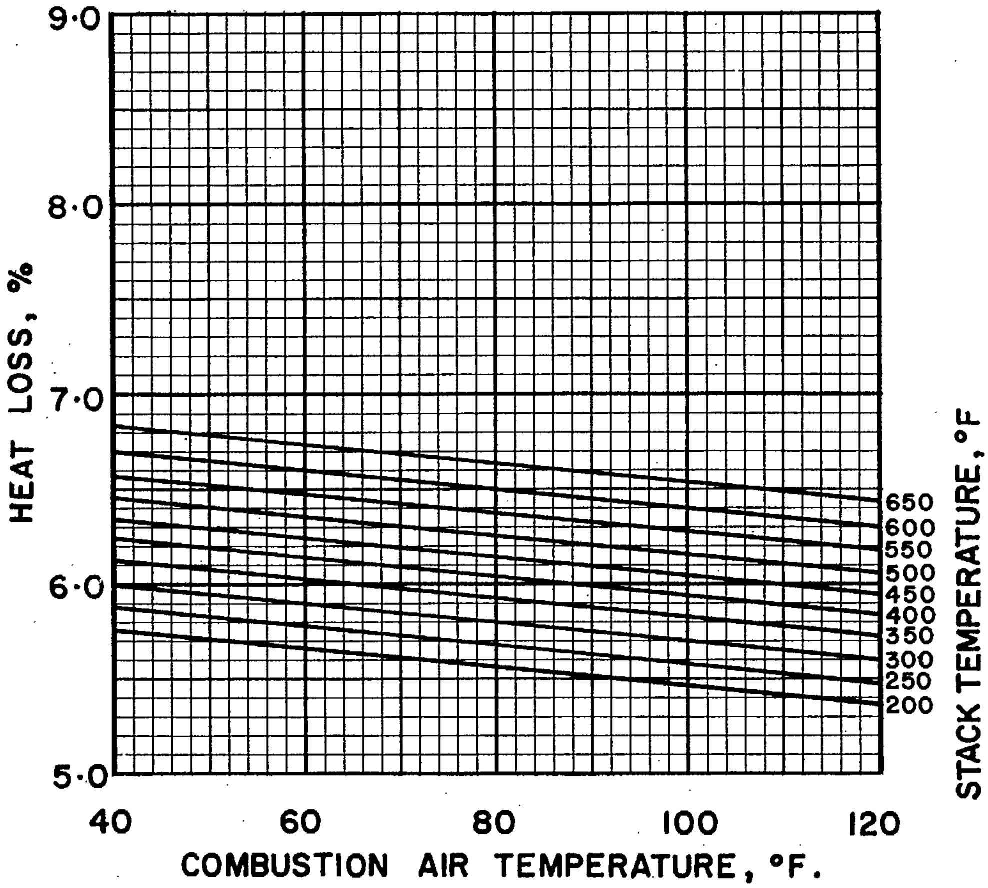


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

10520

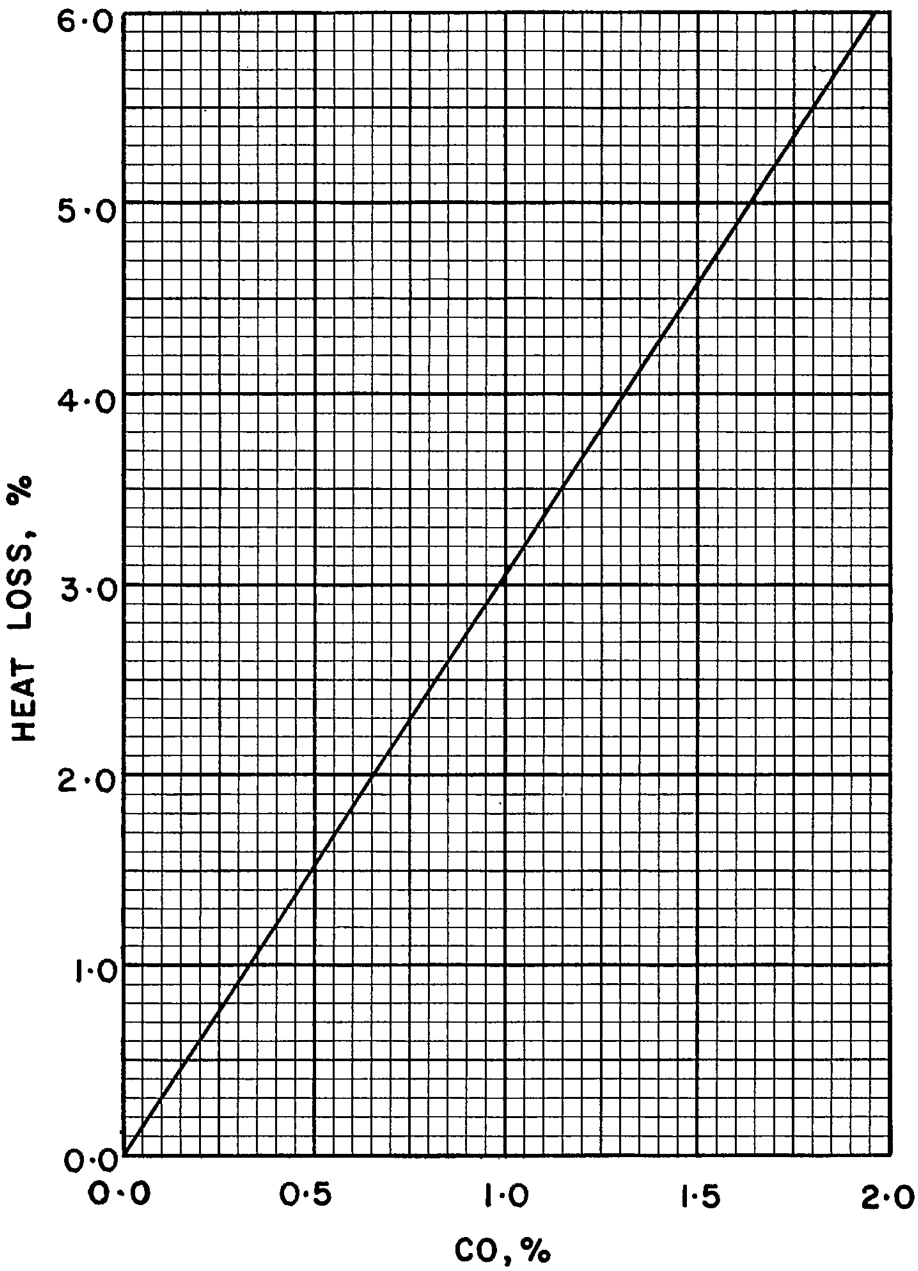


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

10520

FUEL OIL 10530, SPECIFIC GRAVITY 1.050

Ultimate Analysis, lb/lb

Carbon	(C)	0.8706
Hydrogen	(H_2)	0.0994
Sulphur	(S)	0.0300
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		17,730

Conversion Factors

1 Imp gal oil = 10.50 lb oil
or Imp gal oil × 10.50 = lb oil
or lb oil × 0.0952 = Imp gal oil

1 U.S. gal oil = 10.50 × 0.8337 lb oil
or U.S. gal oil × 8.754 = lb oil
or lb oil × 0.1142 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{17{,}730} \text{ lb oil}$$

or Btu × 10^6 × 56.40 = lb oil
or lb oil × 0.0177 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{17{,}730 \times 10.50} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.372 = Imp gal oil
or Imp gal oil × 0.1862 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{17{,}730 \times 8.754} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.443 = U.S. gal oil
or U.S. gal oil × 0.1552 = Btu × 10^6

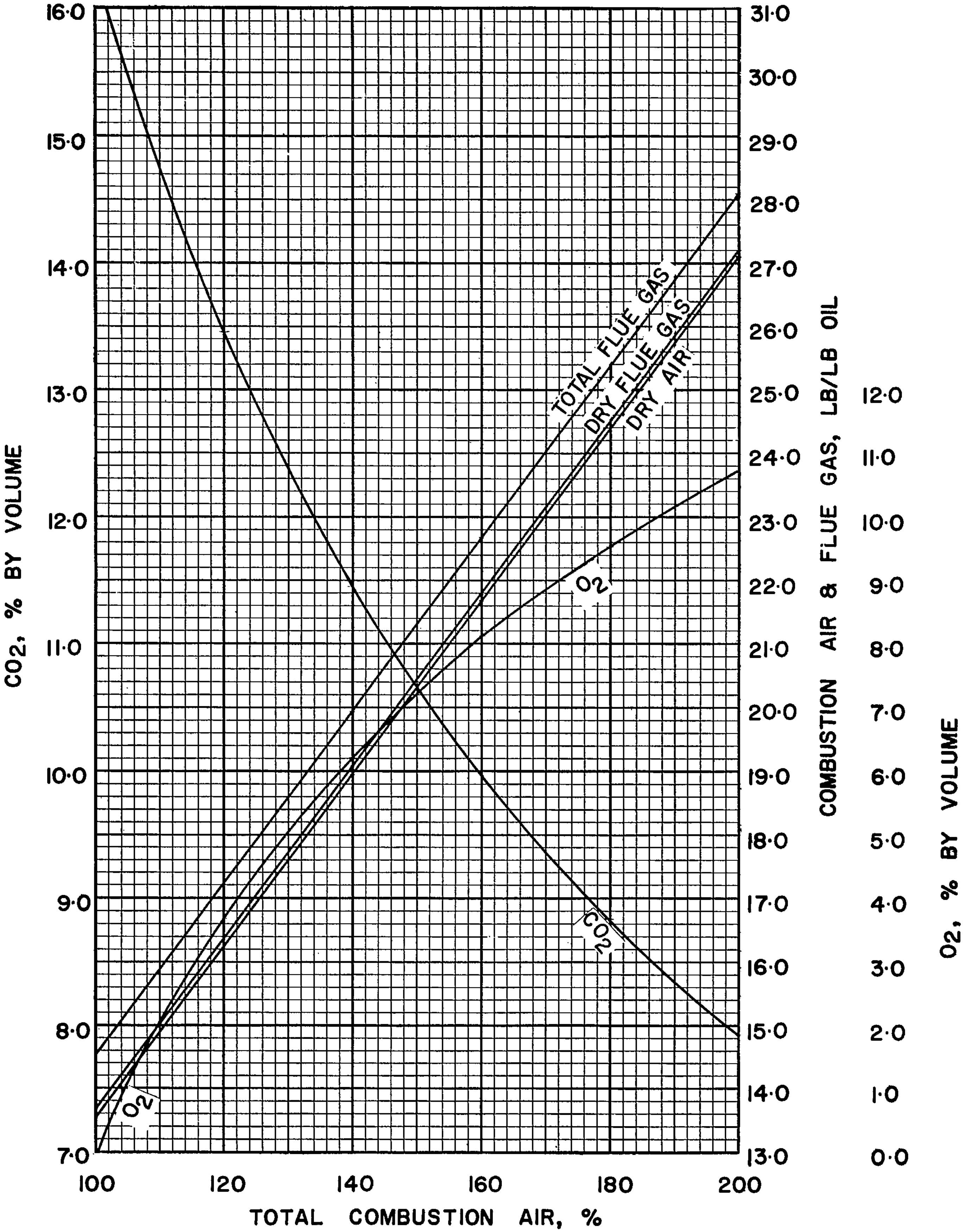


FIGURE 1· COMBUSTION DATA, WEIGHT BASIS 10530

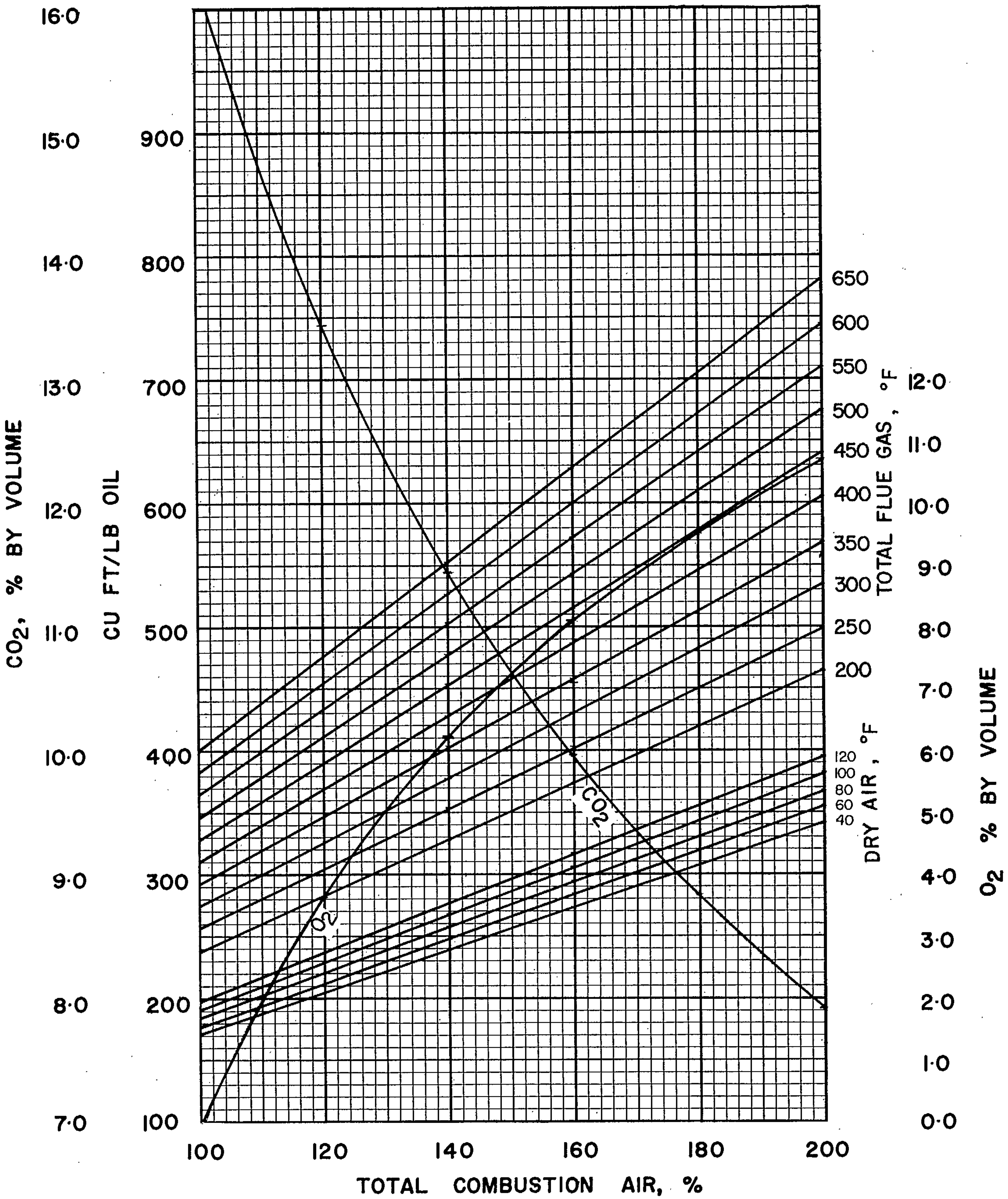


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 10530

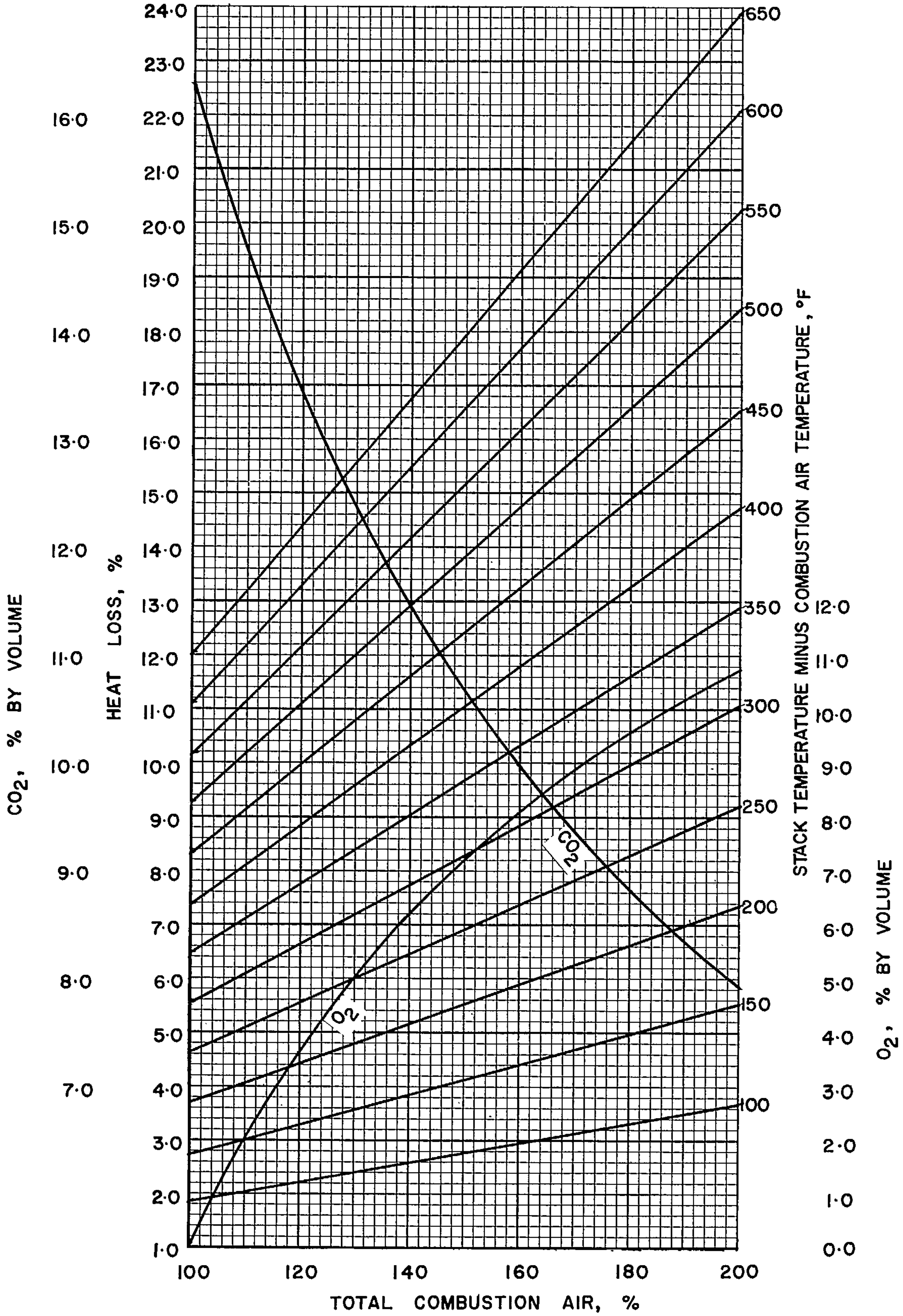


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

10530

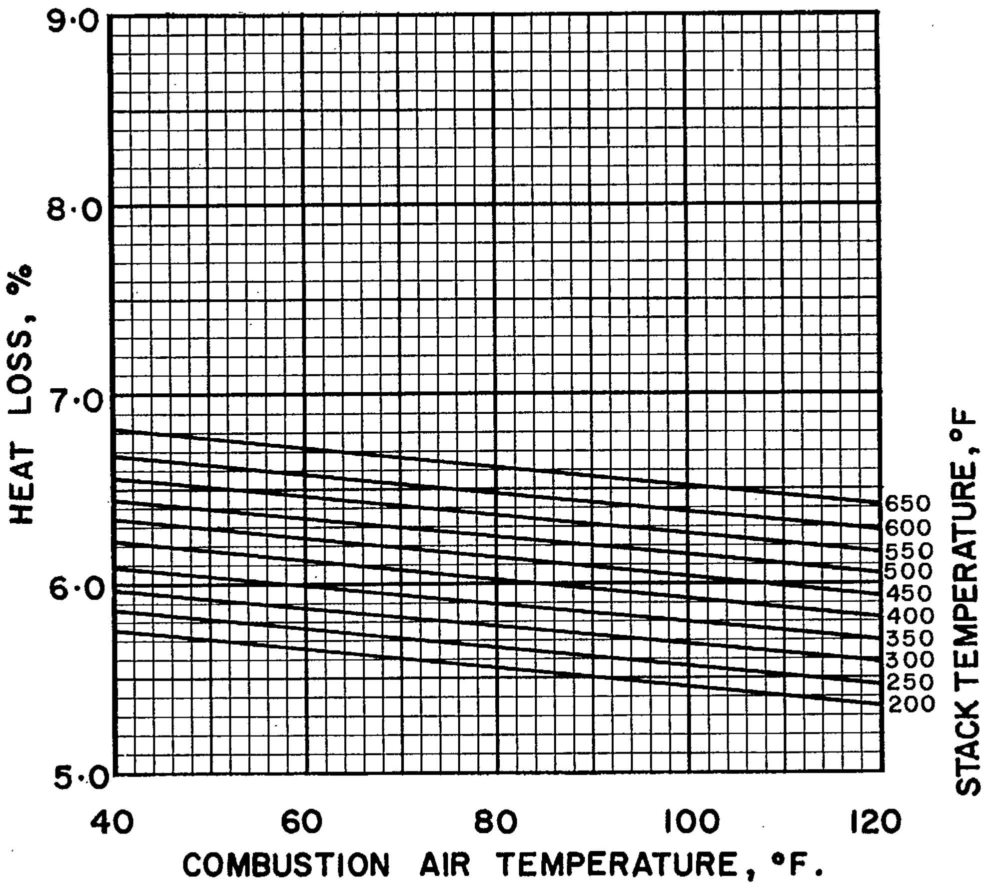


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

10530

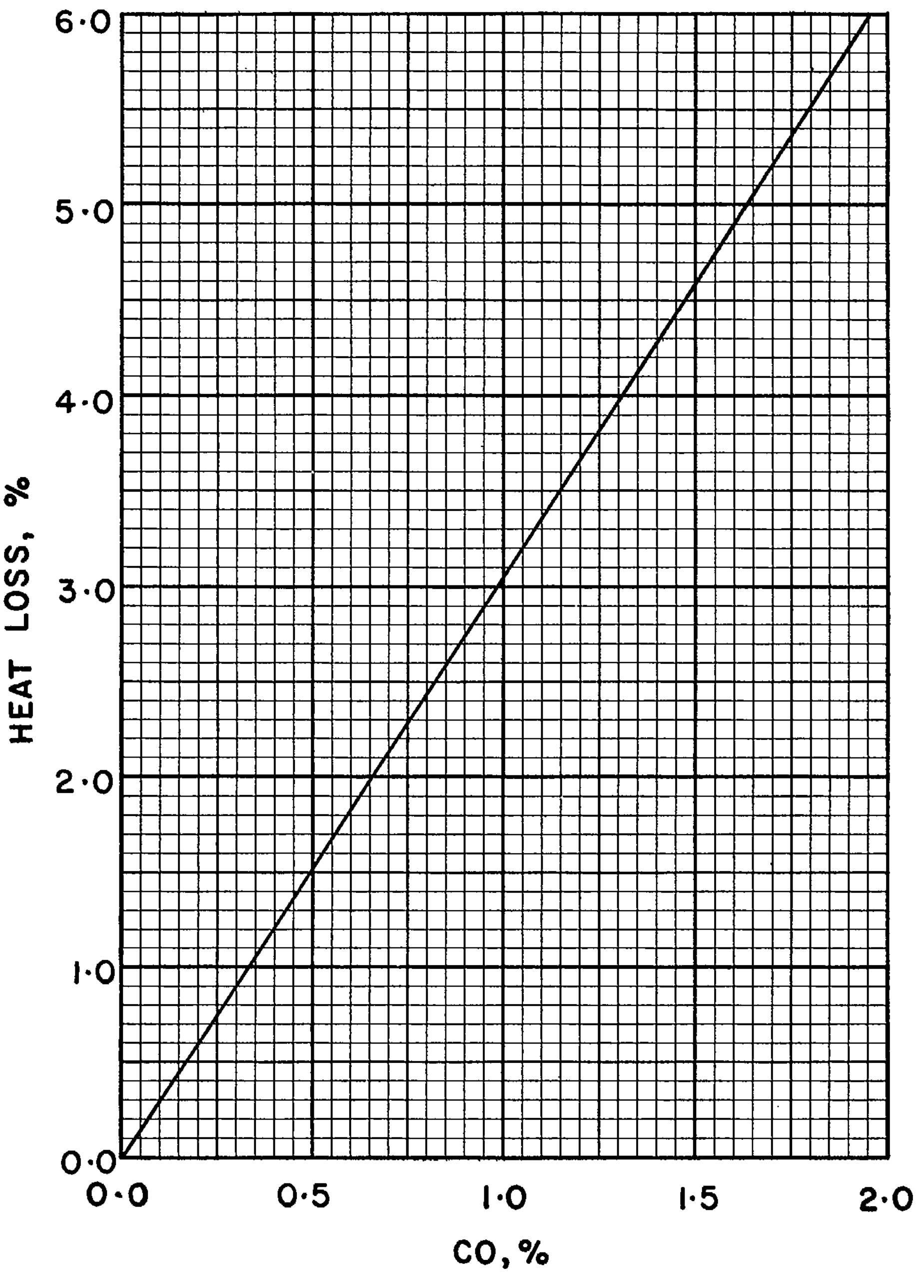


FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

10530

FUEL OIL 10540, SPECIFIC GRAVITY 1.050

Ultimate Analysis, lb/lb

Carbon	(C)	0.8616
Hydrogen	(H_2)	0.0984
Sulphur	(S)	0.0400
Nitrogen	(N_2)	–
Oxygen	(O_2)	–
Ash		–
Moisture		–
	Total	1.0000
Calorific Value, Btu/lb		17,590

Conversion Factors

1 Imp gal oil = 10.50 lb oil
or Imp gal oil × 10.50 = lb oil
or lb oil × 0.0952 = Imp gal oil

1 U.S. gal oil = 10.50 × 0.8337 lb oil
or U.S. gal oil × 8.754 = lb oil
or lb oil × 0.1142 = U.S. gal oil

1 U.S. gal = 0.8327 Imp gal
or U.S. gal × 0.8327 = Imp gal
or Imp gal × 1.201 = U.S. gal

$$10^6 \text{ Btu} = \frac{10^6}{17{,}590} \text{ lb oil}$$

or Btu × 10^6 × 56.85 = lb oil
or lb oil × 0.0176 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{17{,}590 \times 10.50} \text{ Imp gal oil}$$

or Btu × 10^6 × 5.414 = Imp gal oil
or Imp gal oil × 0.1847 = Btu × 10^6

$$10^6 \text{ Btu} = \frac{10^6}{17{,}590 \times 8.754} \text{ U.S. gal oil}$$

or Btu × 10^6 × 6.494 = U.S. gal oil
or U.S. gal oil × 0.1540 = Btu × 10^6

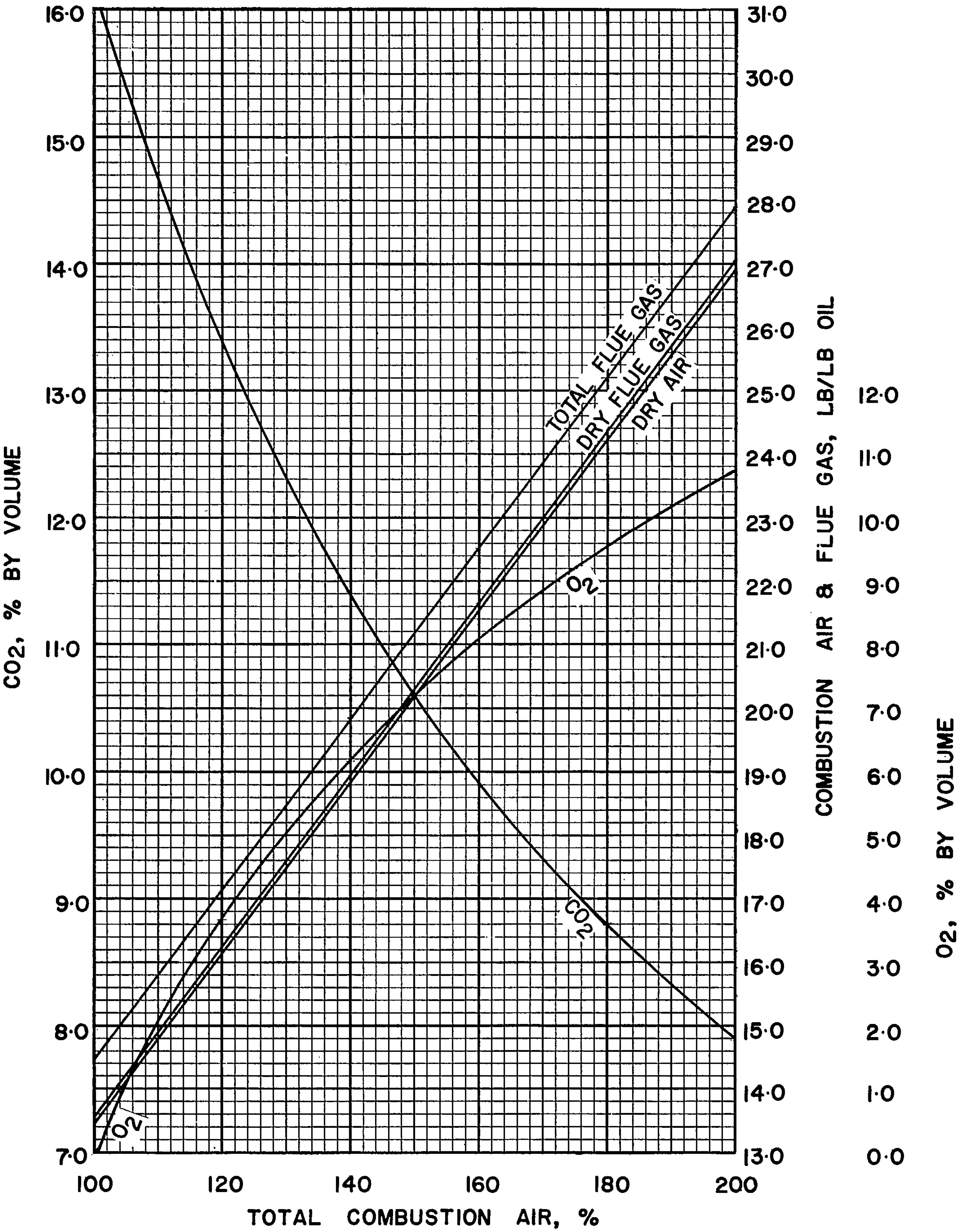


FIGURE I· COMBUSTION DATA, WEIGHT BASIS 10540

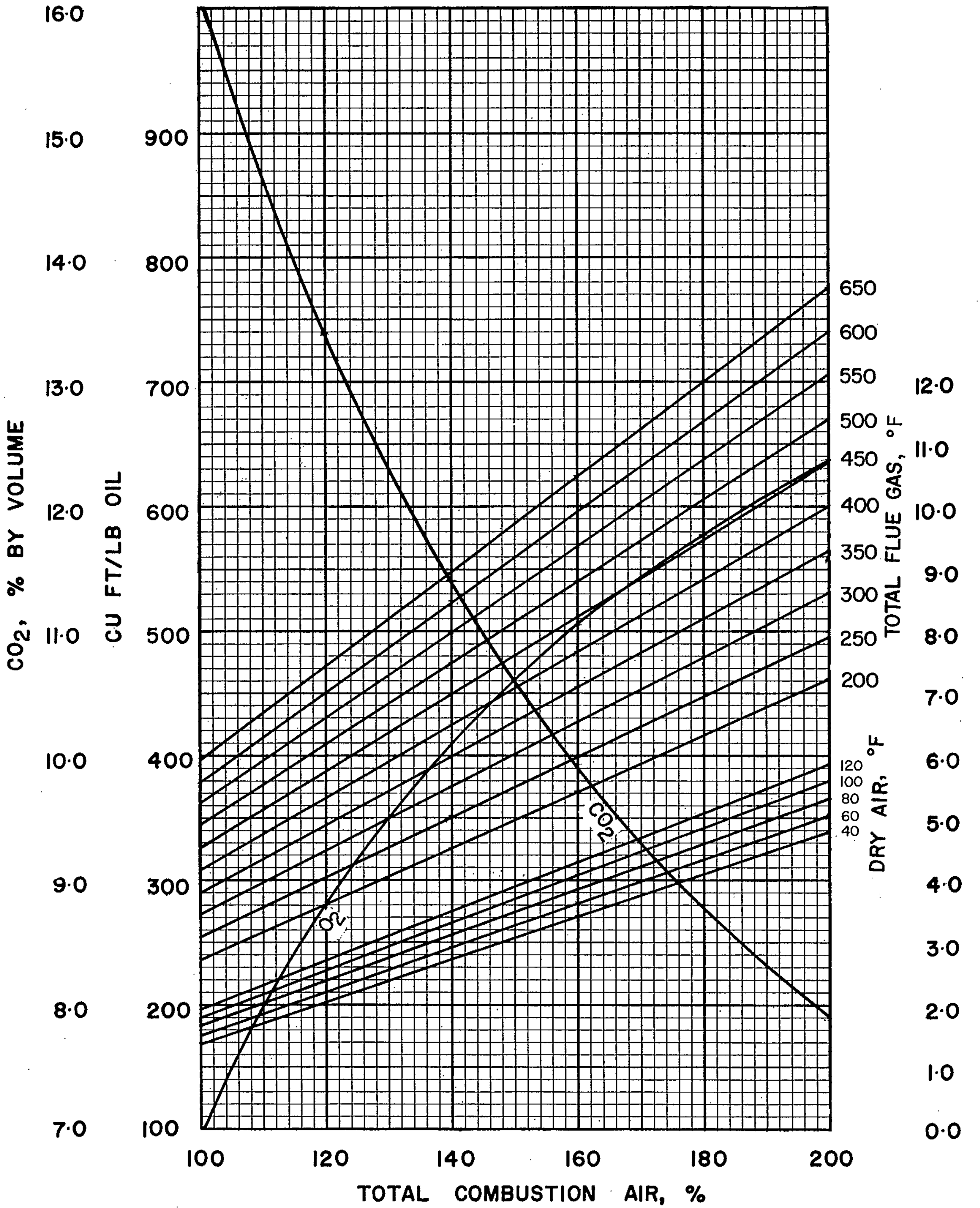


FIGURE 2· COMBUSTION DATA, VOLUME BASIS 10540

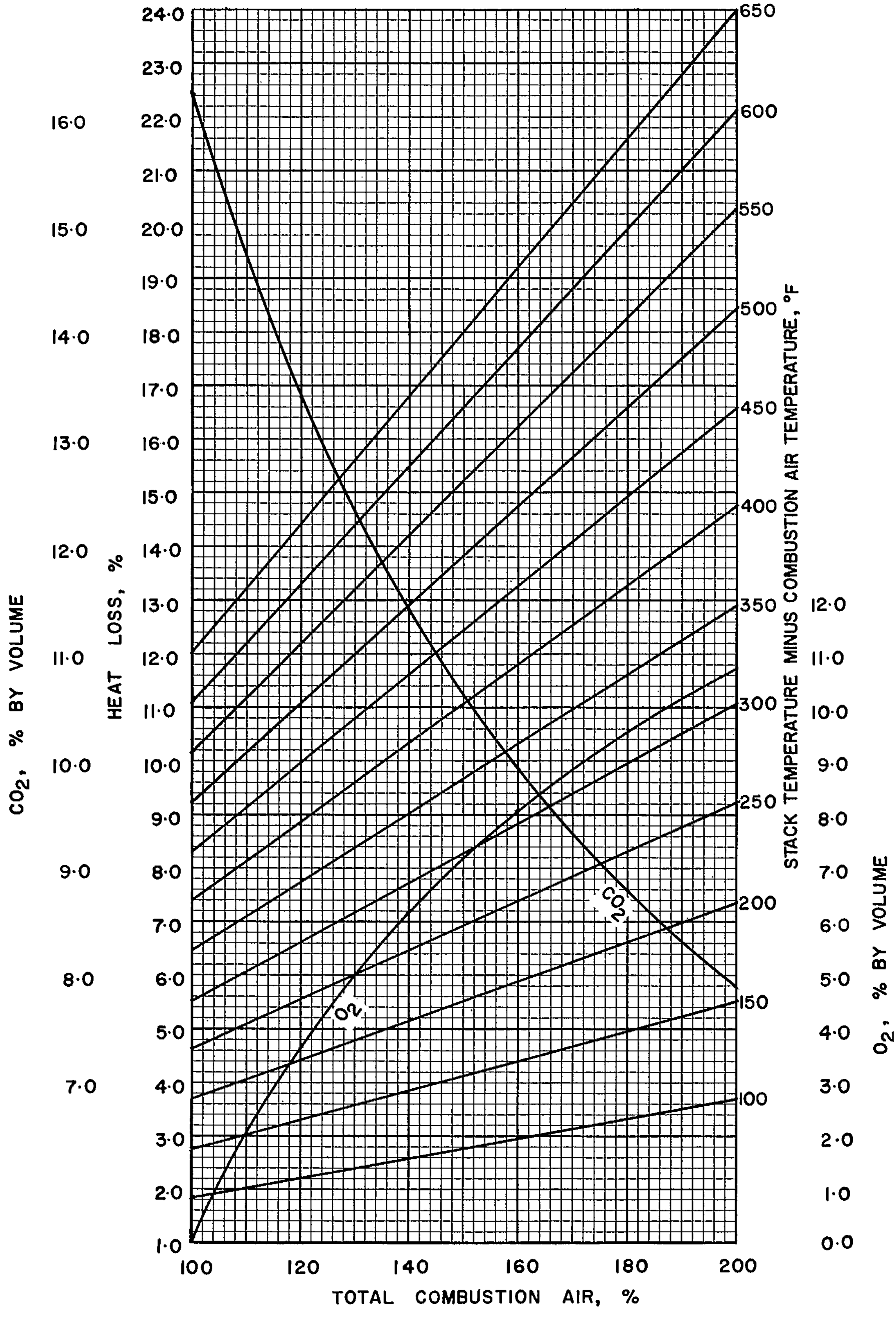


FIGURE 3· DRY FLUE GAS LOSS FOR A RANGE OF TEMPERATURE DIFFERENTIALS

10540

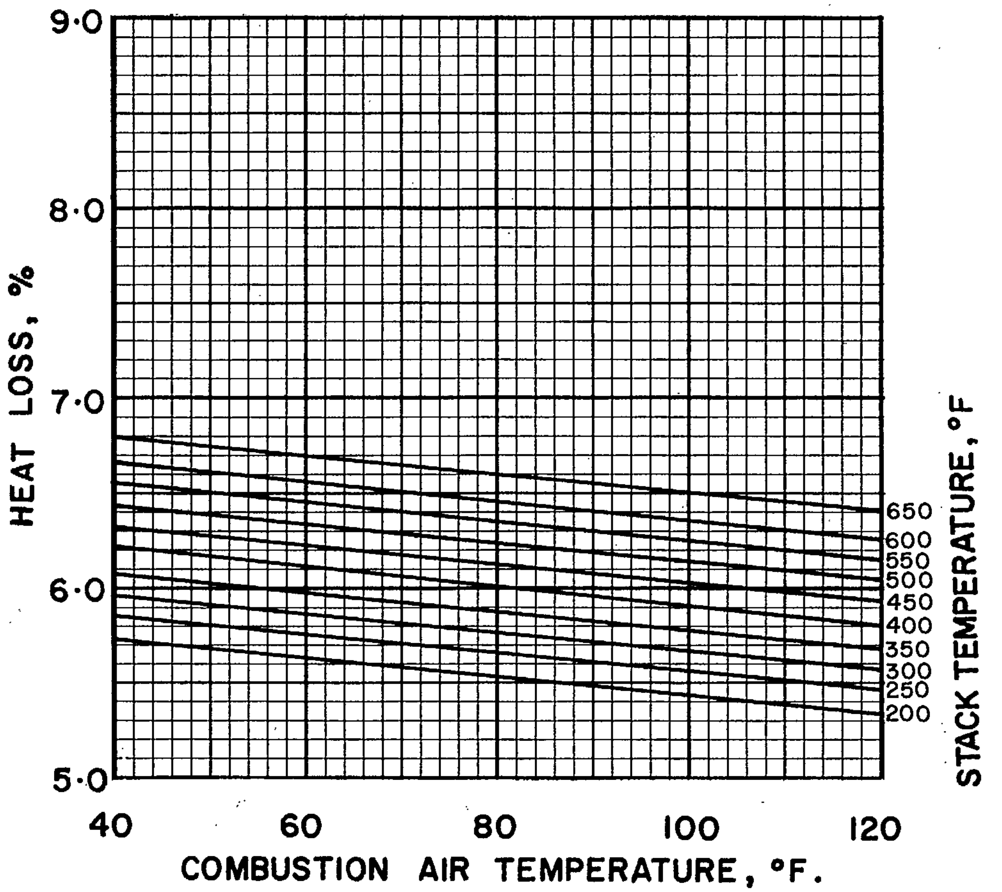


FIGURE 4. HYDROGEN LOSS FOR A RANGE OF STACK TEMPERATURES.

10540

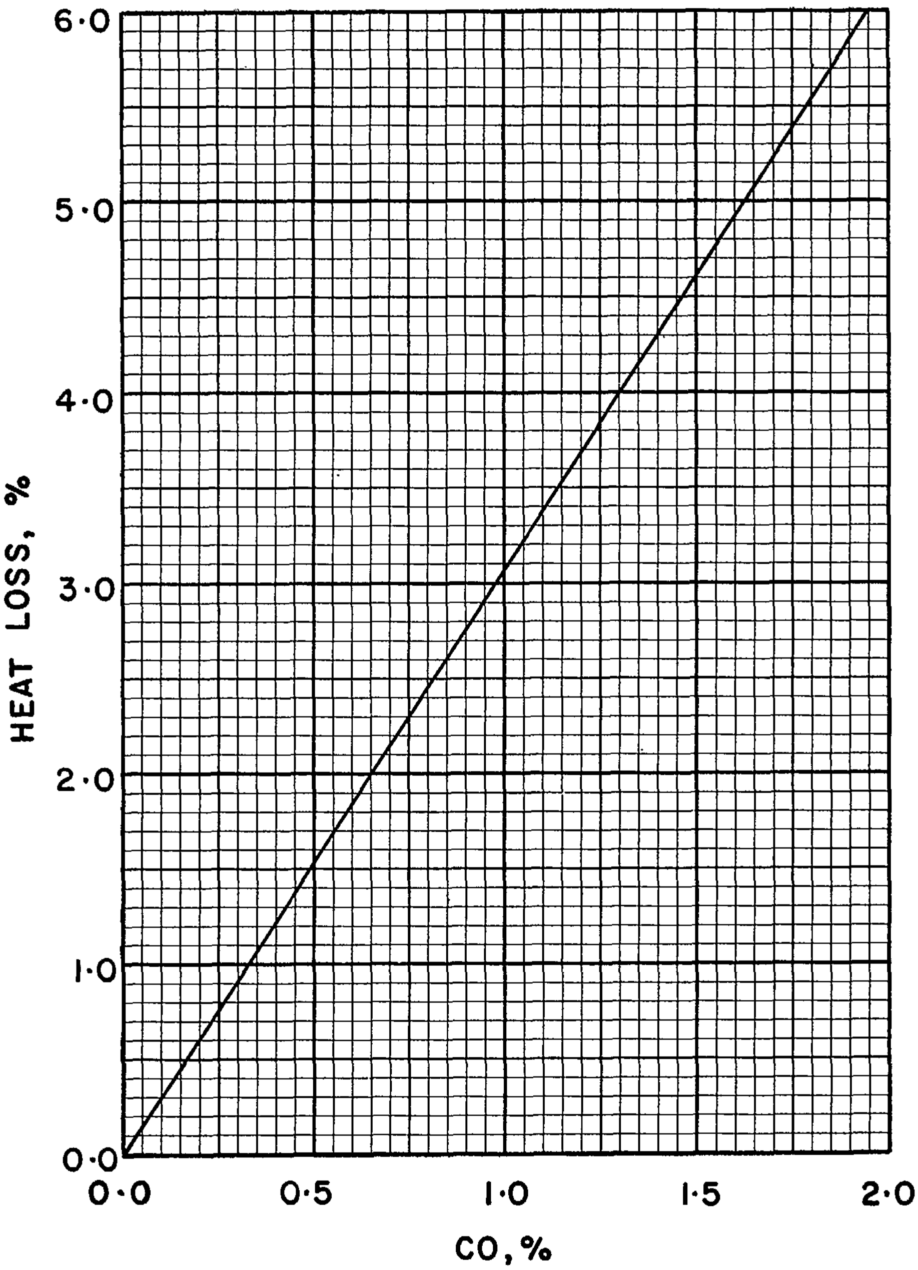


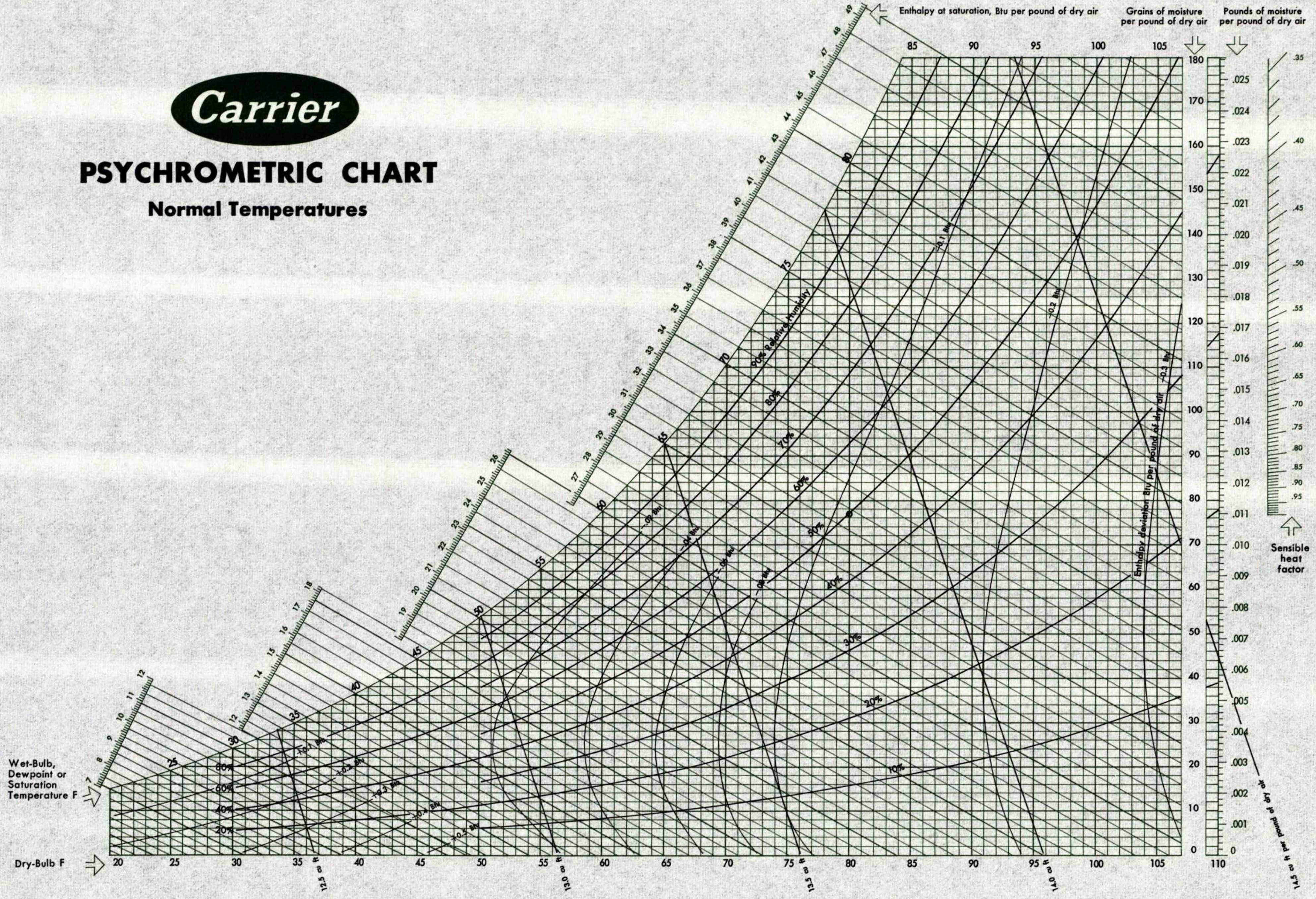
FIGURE 5. HEAT LOSS FOR A RANGE OF CO CONCENTRATIONS, ASSUMING NEGLIGIBLE EXCESS AIR.

10540

Carrier

PSYCHROMETRIC CHART

Normal Temperatures



Below 32 F, properties and enthalpy deviation lines are for ice.

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