Appendix VIII: Determination of chimney heights

Appendix VIII: Determination of stack heights and boiler operation

The appendix has been included in the Plan for both compliance with Rules in the Plan (i.e. Rules 3(d), 5(c) and 6(c)) and for guidance to industry, and for general public information and educational purposes. It is advised that users of the Plan should read the rules carefully to determine if compliance with the appendix is required and to contact the Taranaki Regional Council if further clarification is required.

PART I – Introduction

Scope of the Requirements

1 This Appendix provides a method of calculating acceptable chimney heights for discharges of the products of combustion from industrial or trade premises. It also includes an overview of basic boiler management.

2 The Appendix is in two parts. Part I provides an introduction to the appendix by setting out the scope of the requirements and by providing background information on the requirements. Included as background information are relevant technical matters upon which the method of calculation is based. Information is also provided on how compliance with chimney heights and related requirements of the plan can be met.

3 Part II of the Appendix sets out the method of calculating chimney heights. Part II is used in two ways. With respect to discharges covered by Rules 3, 5, and 6, compliance with the conditions of the permitted activity relating to chimney heights, requires that the heights conform to those calculated in compliance with the methods set out in Part II of this Appendix. With respect to Rules 2, 4 and 7, the Taranaki Regional Council in conjunction with the applicant or consent holder, will have regard to Part II of this Appendix when assessing the 'best practicable option' to prevent or minimise the adverse effects of the discharge and/or in setting other conditions relating to adverse effects of the discharge.

Background Information

4 The method of calculation is based on the amount of flue gases which the chimney is expected to emit as a function of the maximum rate of emission of sulphur dioxide. This applies to fuels such as oil and coal. For natural gas/liquefied petroleum gas fired equipment, refer to paragraph 13 (b).

5 Prejudice to health or nuisance from smoke, grit and dust should not occur where chimney heights are so calculated and where the other relevant requirements of the Resource Management Act are given effect to. It should be noted that difficulty with grit and dust cannot be avoided solely by increasing the height of a chimney. Dust arrestment plant may also be necessary in order to achieve compliance with rules in this Plan.

6 For small and medium-sized oil fired combustion sources experience has shown that an insulated stack is necessary to avoid acid smut problems.

7 In the nomograms (Figures 1 to 6 in Part II), the chimney height has been calculated to ensure dispersion of the gases to achieve a theoretical maximum ground level concentration of 400 μg/m³ (about 0.16 ppm by volume) of sulphur dioxide. This is less than the generally accepted threshold of odour for this gas of 1.1 mg/m³ (about 0.5 ppm by volume).

Acceptable chimney heights calculated in accordance with this Appendix will also be taken by the Taranaki Regional Council as achieving compliance with a maximum exposure level at any time for sulphur dioxide of 570 μg/m³ (hourly time-weighted average exposure) and 350 μg/m³ as the hourly average (nine exceedances allowed annually), unless otherwise demonstrated. These figures are the Resource Management (National Environmental Standards [For Air Quality]) Regulations 2004 for air quality for sulphur dioxide in New Zealand.

Efflux velocity

8 The diameter of a chimney top should be as small as possible in order to increase the efflux velocity of the flue gases. If the efflux velocity is insufficient, the plume tends to flow down the outside of the stack on the lee side and the effective chimney height is thus reduced. Efflux velocities of about 15 m/sec will avoid this downwash.

9 Such a velocity is impracticable for small combustion sources. Small furnaces or boilers equipped with forced draught fans only should have a chimney efflux velocity of not less than 6 m/sec at full load. Boilers or furnaces equipped with induced draught fans should have a chimney efflux velocity of not less than 8 m/sec at full load for boilers rated up to 13,600 kg/hour increasing to a maximum of 15 m/sec at full load for boilers rated at 204,000 kg/hour.

10 The method of calculation of final chimney heights set out in Part II of this Appendix assumes that the appropriate efflux velocity will be achieved.

11 Consent holders, and operators of boilers generally, are responsible for maintaining and operating combustion equipment according to good industry practice. Without restricting that obligation, a boiler should be serviced at least once every year, by a person competent in the servicing of such appliances. This servicing should include: visual assessment of the stack emissions under low and full load, inspection of the state of flues, notes on any recent construction of buildings in the vicinity, adjustment if necessary of the fuel-to-air ratio, and testing of the ratio or concentration of

combustion gases discharged i.e., carbon monoxide, carbon dioxide and oxygen, using a suitably calibrated instrument. Service reports shall be prepared and retained, and copies shall be provided to the Taranaki Regional Council on request.

Combining of emissions

12 Where there are several adjacent furnaces in the same works, there are advantages in combining the waste gases, if possible, and discharging them through a common chimney. The larger volume from the combined emissions has a higher thermal rise than the discharges from separate chimneys and the concentration of the flue gases reaching the ground is smaller.

Fuel types

13 (a) For combustion processes using liquid or solid or mixed fuels, the materials to be combusted will contain varying amounts of sulphur. The proportions of sulphur content used in the calculation of the amount of sulphur dioxide emission from the combustion process are set out in paragraph 18 of Part II.

(b) For natural gas and manufactured gas (with zero or very low sulphur content) it is recognised that the process of combustion generates low levels of nitrogen oxides, which have much the same degree of offensiveness as sulphur dioxide. For combustion sources using gas fuel, the main consideration is to avoid local down-draught effects. The determination of uncorrected chimney heights is made in accordance with paragraph 21 of Part II. Final chimney heights are calculated in accordance with paragraphs 22 to 25 of Part II, and Figure 6.

(c) A special category of furnaces is those where the flue gases are used directly to dry or heat various materials. In these cases the height of the stack required may be related more to the material exposed to the flue gases rather than the nature of the fuel. Additional measures to manage ground level effects may also apply. Such cases require individual assessment. Consultation with the Taranaki Regional Council is recommended.

Dust emissions

14 The stack height is also based on the assumption that little dust or grit is produced in combustion or that an effective grit arrestor is fitted. It should be noted that when grit arrestors are fitted to wood-burning plants, performance is likely to be less effective than on solid fuels because of the lower density of the material to be collected.

PART II - Method of Calculating Chimney Heights

"Uncorrected chimney height" and "final chimney height"

15 The first stage is the calculation of the "uncorrected chimney height". For fuels other than natural gas and manufactured gas, the uncorrected chimney height is the height appropriate for the relevant maximum rate of sulphur dioxide emission when account has been taken of neighbouring sources of pollution, and the general character of the locality (paragraphs 17 to 20). For combustion sources using natural gas and manufactured gas, uncorrected chimney heights are set out under paragraph 21.

16 The second stage is the calculation of the "final chimney height". This is the uncorrected chimney height amended if necessary to allow for the dispersion from the chimney being affected by the supporting building and by neighbouring buildings.

Calculation of uncorrected chimney height

<u>Consideration of locality</u>

17 The initial step is to consider the character of the surrounding district which for this purpose will be regarded as falling into one of the following categories:

A a rural area, and no other comparable industrial emissions within 1 kilometre of the chimney under consideration;

B a partially developed area with scattered houses, and no other comparable industrial emissions within 1 kilometre of the chimney under consideration;

C a built-up residential area and no other comparable industrial emissions within half a kilometre of the chimney under consideration;

D an urban area of mixed industrial and residential development and with other comparable industrial emissions within half a kilometre of the chimney under consideration;

E an area where existing air quality is of significance, namely, those areas defined in Policy 2.3 and Section 6 of the Act as requiring special recognition.

Note: of the categories listed above, categories A, C, and D are those considered to be generally applicable in Taranaki, covering rural, urban, residential, and industrialised areas respectively. Category E is applicable in the vicinity of areas where it is appropriate to give particular regard to maintaining or enhancing ambient air quality to a high level.

With respect to Rules 2, 4, 7 in situations of existing significant air quality degradation, the Taranaki

Regional Council may choose to apply the more stringent requirements of category E to prevent or minimise further degradation.

Amount of sulphur dioxide emissions

18 For liquid or solid fuels, including untreated wood, the calculations of chimney height are based on the maximum sulphur content of any fuel to be burned. The minimum sulphur content allowed will be 0.5%. For processes receiving mixed fuels, the calculations of chimney height are based on 1% sulphur in the absence of further consideration of fuel types.

19 The amount of sulphur dioxide likely to be emitted will be calculated as follows.

Where the maximum rate at which coal or other solid fuel is burnt is W thousand kg/hour and the sulphur content of the fuel is S percent, the weight of sulphur dioxide emitted in the flue gas should be taken as 18 WS kg/hour, since about 10 per cent of the sulphur is retained in the ash. As an example, the average sulphur content of coal is 1.6 per cent. A plant burning coal of sulphur content 1.6 per cent at a maximum rate of 4,000 kg/hour emits 115 kg/hour sulphur dioxide.

Where the maximum rate at which oil is burnt is W thousand kg/hour and its sulphur content is S per cent, the weight of sulphur dioxide emitted in the flue gas should be taken as 20 WS kg/hour. The average sulphur content of residual fuel oil used in boiler plant is about 3 per cent. One tonne of oil may be taken to contain 1050 litres.

Calculation of uncorrected chimney heights (excluding combustion sources using natural gas and manufactured gas)

20 When it has been decided into which of the categories the surrounding district falls, reference is then made to the relevant chart in Figures 1-4 which relate to various mass emission rates of sulphur dioxide in discharges. A line starting from the relevant sulphur dioxide emission on the left hand side of the appropriate chart and projected through the points A, B, C, D, or E (representing the category into which the district falls) will indicate on the right hand side of the chart the appropriate uncorrected chimney height. In case of an oil-fired plant, 10% should be added to the uncorrected chimney height in order to allow for the average reduction in thermal lift compared with that of a similar emission of sulphur dioxide from coal firing.

Example 1

A new chimney is needed for a plant burning coal and emitting 127 kg sulphur dioxide per hour. What is the uncorrected chimney height in a district category C and district category E?

Reference to Figure 3 will show that the respective uncorrected chimney heights are 33 metres and 38.5 metres.

Calculation of uncorrected chimney heights for combustion sources using natural gas and manufactured gas

21 For combustion processes using gas fuel at a rate less than 5MW, the height of the building containing the furnace, or buildings within 30 metres will be taken as the "uncorrected chimney height", and the nomograph of Figure 6 or 3 metres (whichever is the greater) will be used to reach the "final chimney height", as described in paragraph 25 below. No correction will be required for taller buildings 30 metres or more distant.

For combustion sources or aggregates of sources of 5 MW or more, uncorrected chimney heights are as follows:

Heat Release (MW)	Uncorrected Chimney Height (Metres)
5-6	5
>6-8	7
>8-10	9
>10-12	12
>12-15	15

Calculation of final chimney height

22 The calculation of final chimney height may involve a ‘correction' of the uncorrected chimney height. The correction is partly based on the ratio between the greatest length and the height of the building to the roof ridge, since the relationship between the greatest length and height influences the effect of downdraughts.

23 An uncorrected chimney height that is not less than 2.5 times the height of the building to which the chimney is attached or of any other building that is within the immediate vicinity ie: within a distance of less than 5 times the roof ridge height of that building, does not need to be corrected to allow for the effect of the building(s). In that case, the final chimney height is the same as the uncorrected chimney height, and no further calculation is necessary.

24 Corrections for the effects of buildings are, however, necessary when the uncorrected height is less than 2.5 times the height of such buildings. In these cases, the chimney should be regarded as being attached to an infinitely long building whose height is the average level of the roof tops in the immediate vicinity (as defined in paragraph 23).

25 Reference is then made to the chart in Figure 5, or in the case of gas fired processes, to Figure 6. A line starting from the relevant uncorrected chimney height on the left hand side is produced through the point representing the building height to the reference line. From this point on the reference line, another line produced through a point representing the height of the building or its greatest length, whichever is lower, will indicate on the right hand side of the chart the final chimney height, subject to any adjustment that may be necessary to ensure that this is

never less than 3 metres above the ridge of the building, nor less than the uncorrected chimney height.

Example II

A chimney whose uncorrected height is 37 metres is attached to a building 31 metres in height to the ridge of the roof; what will the final chimney height have to be if the maximum width of the building is (a) 31 metres or more, (b) 15 metres, and (c) 6 metres? Reference to Figure 5 will show the three cases represented by dotted lines and the corresponding final heights are 52 metres, 43 metres and 38 metres.

Example III

A chimney whose uncorrected height is calculated as 18 metres is associated with a building 24 metres in height to the ridge of the roof; what should the final chimney height be if the maximum width of the building is (a) more than 24 metres, (b) 9 metres? Reference to Figure 5 will show the corresponding final heights to be 34 metres and 25 metres. The final heights are therefore 34 metres and 27 metres respectively, since they must be at least 3 metres above the ridge of the roof.

Note: *Any height controls or restrictions contained in District Plans will also need to be complied with.*

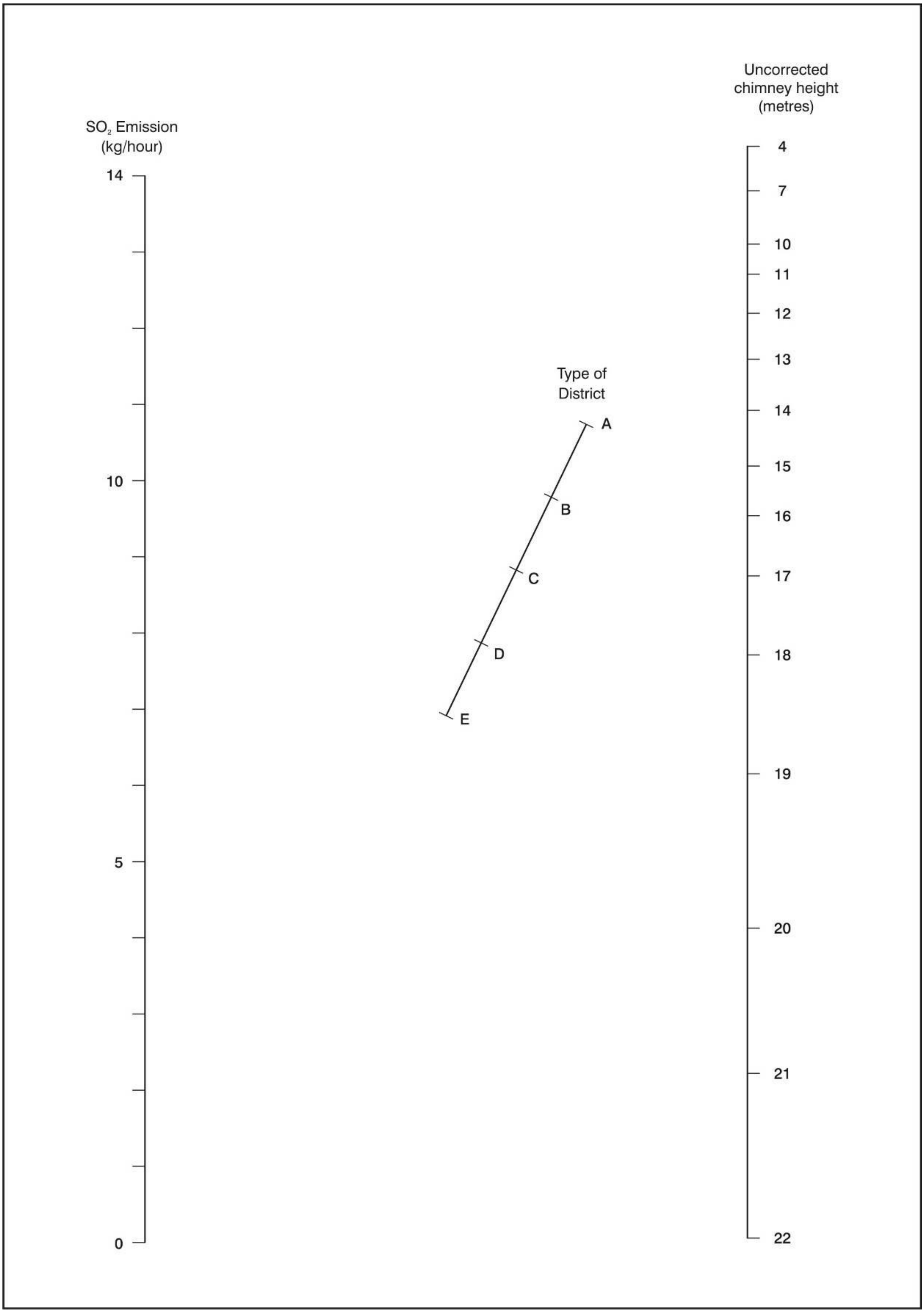

Figure 1: Uncorrected chimney heights for very small discharges of sulphur dioxide (up to 14 kg / hour)

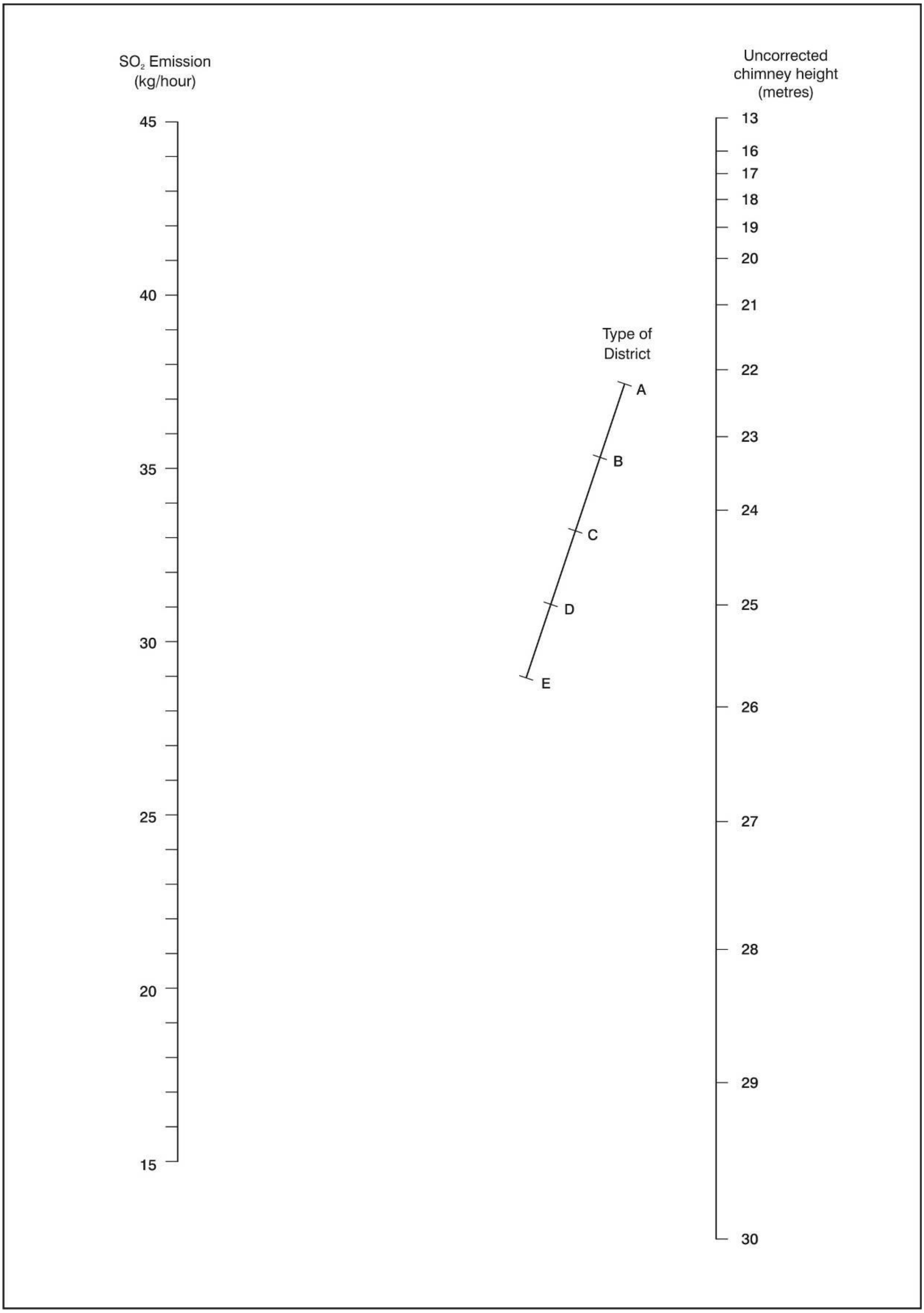

Figure 2: Uncorrected chimney heights for small discharges of sulphur dioxide (15 – 45 kg / hour)

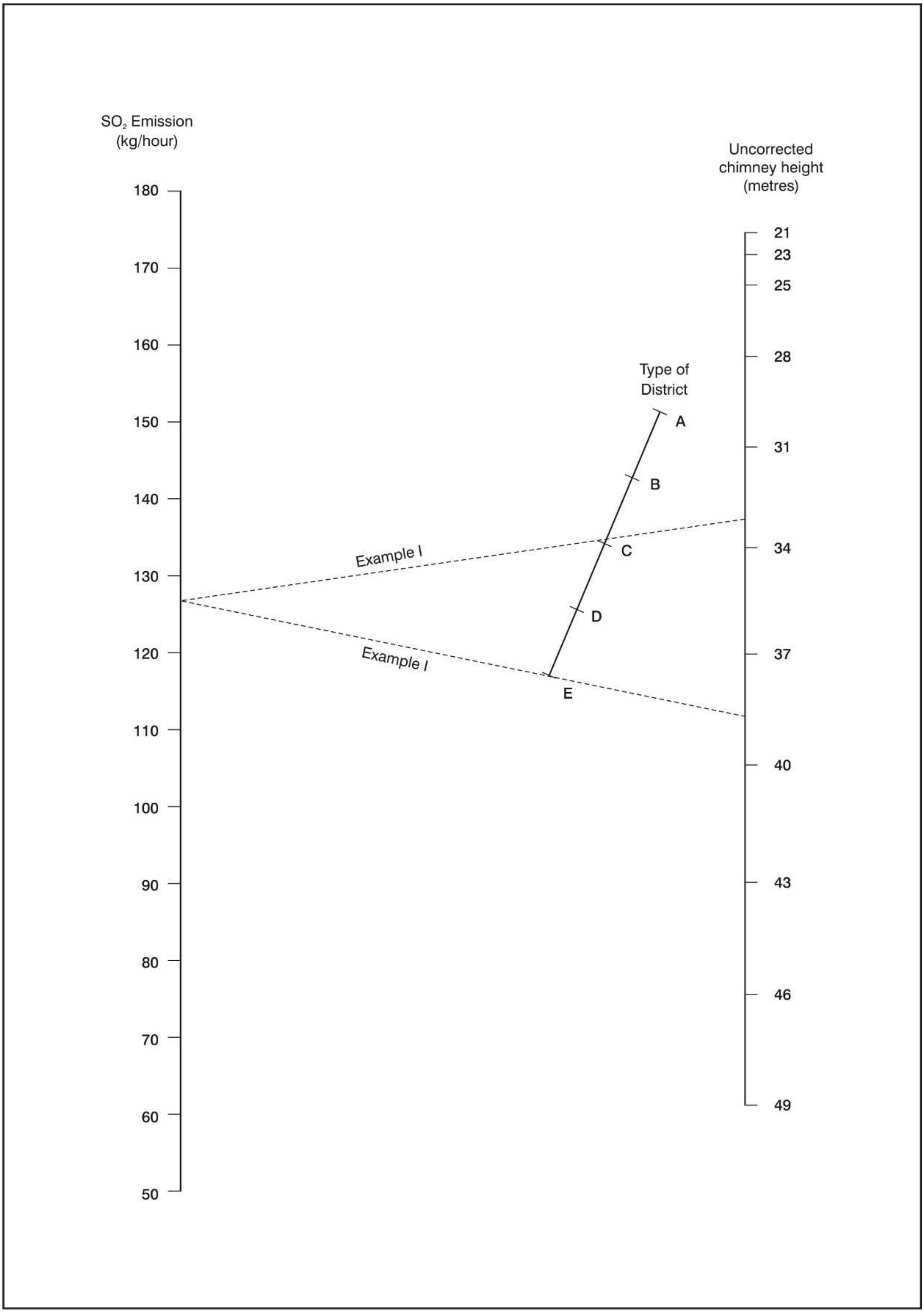

Figure 3: Uncorrected chimney heights for medium discharges of sulphur dioxide (50 – 180 kg / hour)

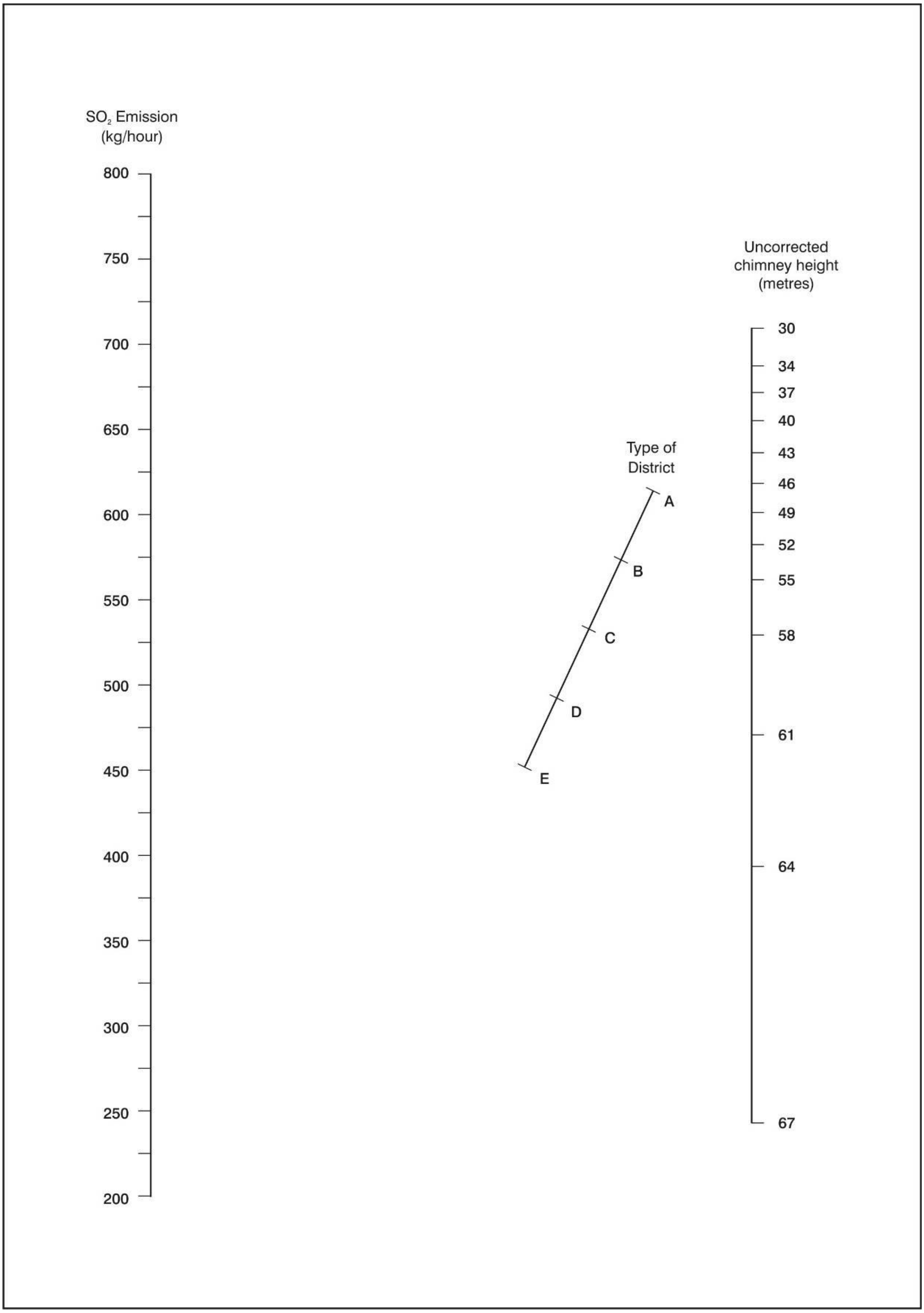

Figure 4: Uncorrected chimney heights for large discharges of sulphur dioxide (200 – 800 kg / hour)

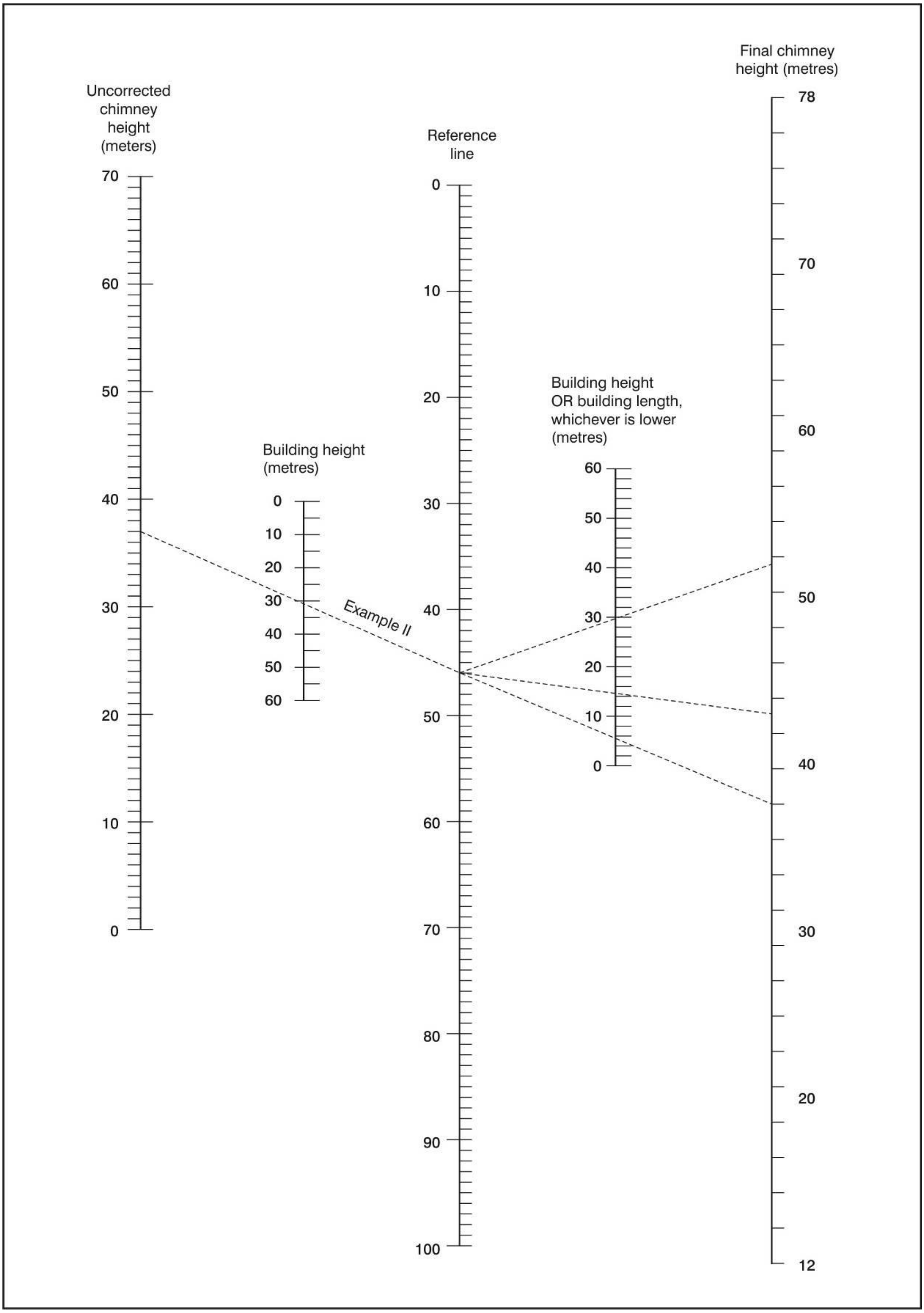

Figure 5: Final chimney heights

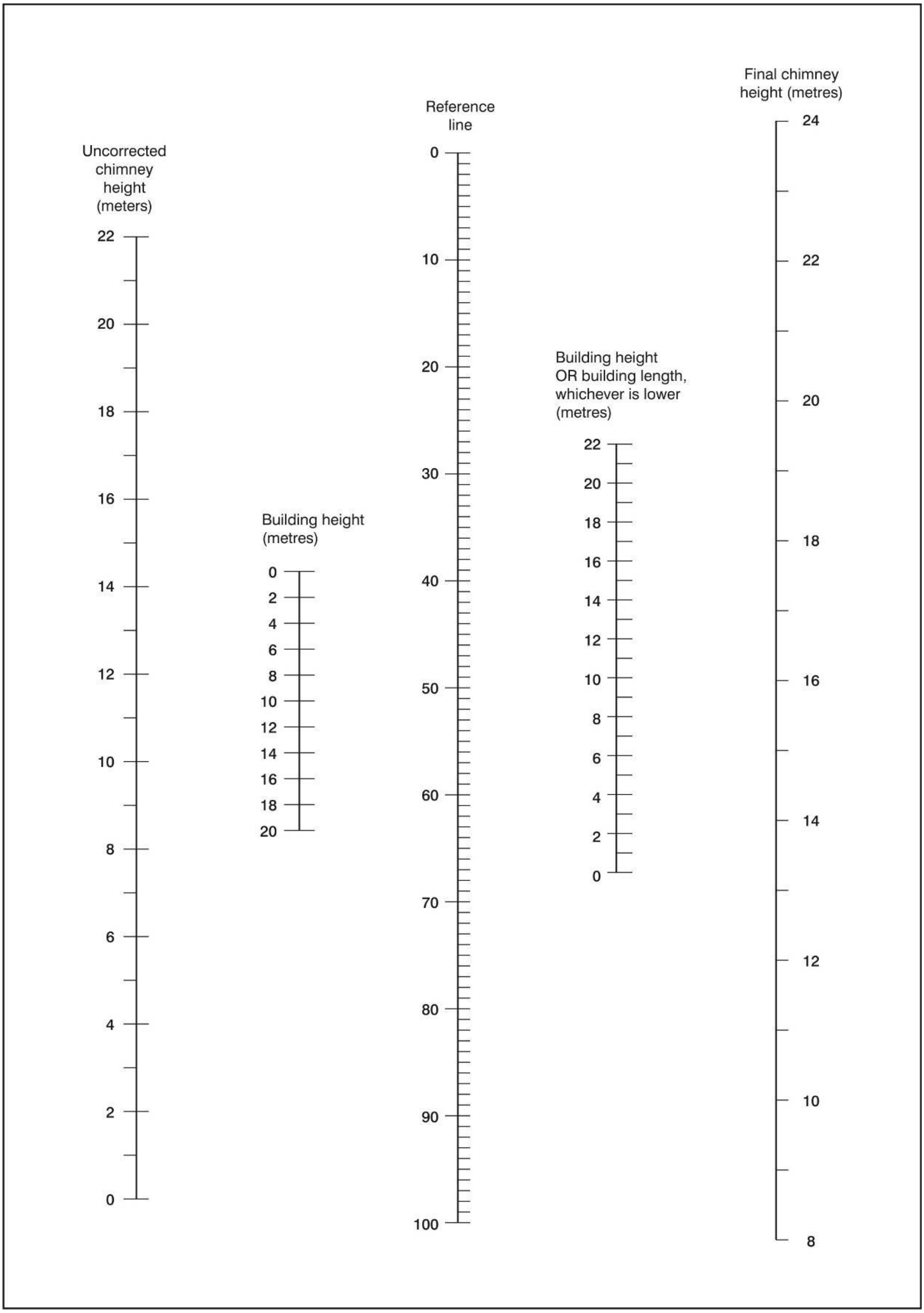

Figure 6: Final chimney heights for gas-fired processes