International Plumbing Design and Installation Standards

A BRIEF OVERVIEW

PRESENTED BY: JOHN LANSING

JUNE 1, 2023

PAE

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A Comparison of British and American Plumbing Engineering Standards and Practices

JOHN LANSING

WORLD PLUMBING COUNCIL

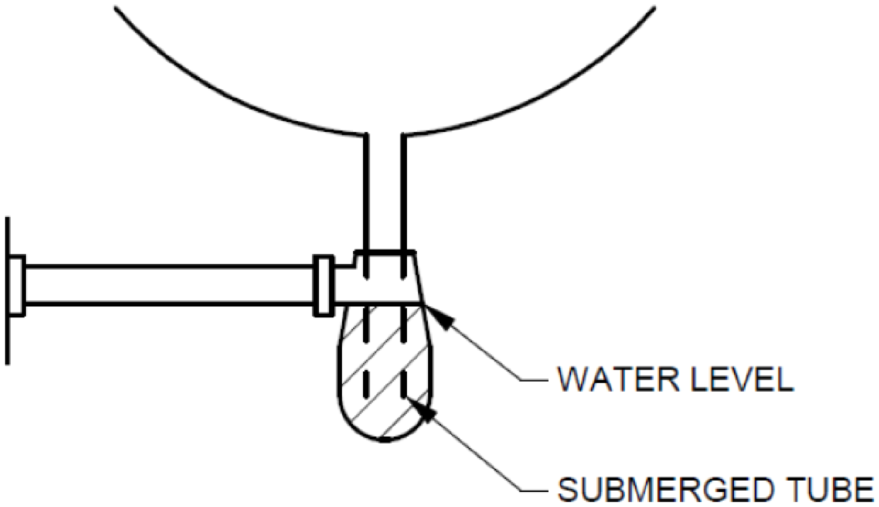
建筑给水排水设计手册 （第三版）（上册）
建筑给水排水设计手册 （第三版）（下册）
Byggvägledning 10 Marko Granroth och Lars Olof Mattsson • VATTEN OCH AVLOPP
TRANSIENT FREE SURFACE FLOWS IN BUILDING DRAINAGE SYSTEMS
John Swaffield with Michael Gormley, Grant B. Wright and Ian McDougal
Transient Airflow in Building Drainage Systems
John Swaffield
Spon Press
FIFTH EDITION
Water, Sanitary & Waste Services for Buildings
WISE SWAFFIELD
Water Regulations Guide
SECOND EDITION
WRAS
Nigel Watson
Competence and Commitment
An Illustrated History of the Institute of Plumbing and Heating Engineering
제4판
설비공학 편람
제5권
위생·소방·환경
SAREK
SHASE-S 206-2019 給排水衛生設備規準・同解説
公益社団法人 空気調和・衛生工学会
Liegenschaftsentwässerung
NTR 3216
RIOLERING VAN BOUWWERKEN
HERZIENE VERSIE 2018
KOMMENTAR
Ermittlung und Berechnung der Rohrdurchmesser
Beuth
KOMMENTAR
Gebäude- und Grundstücksentwässerung
Beuth
Plumbing Engineering Services Design Guide
CIBSE
Public health and plumbing engineering
CIBSE Guide G
2014
2021-2022
ASPE
Fundamentals of Plumbing Engineering
Volume 1

“A complicating factor is the historic roots of current design guides and standards (including the interpretation of the governing fluid mechanics principles and margins of safety), causing many design differences to exist for the same conditions internationally, such as minimum trap seal retention requirements, stack-to-vent cross-vent spacing, and even stack diameter. “

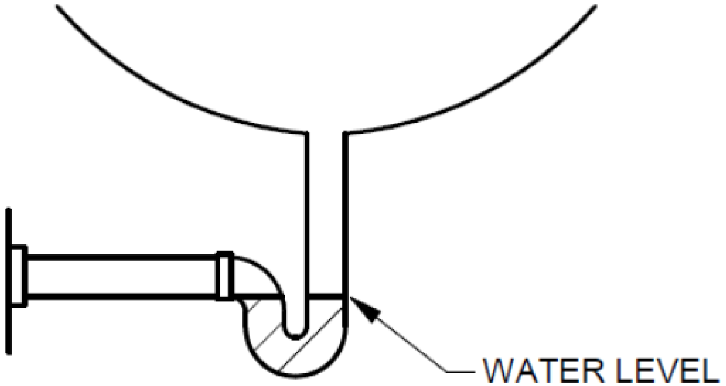
Building Drainage System Design for Tall Buildings: Current Limitations and Public Health Implications

Bottle Trap

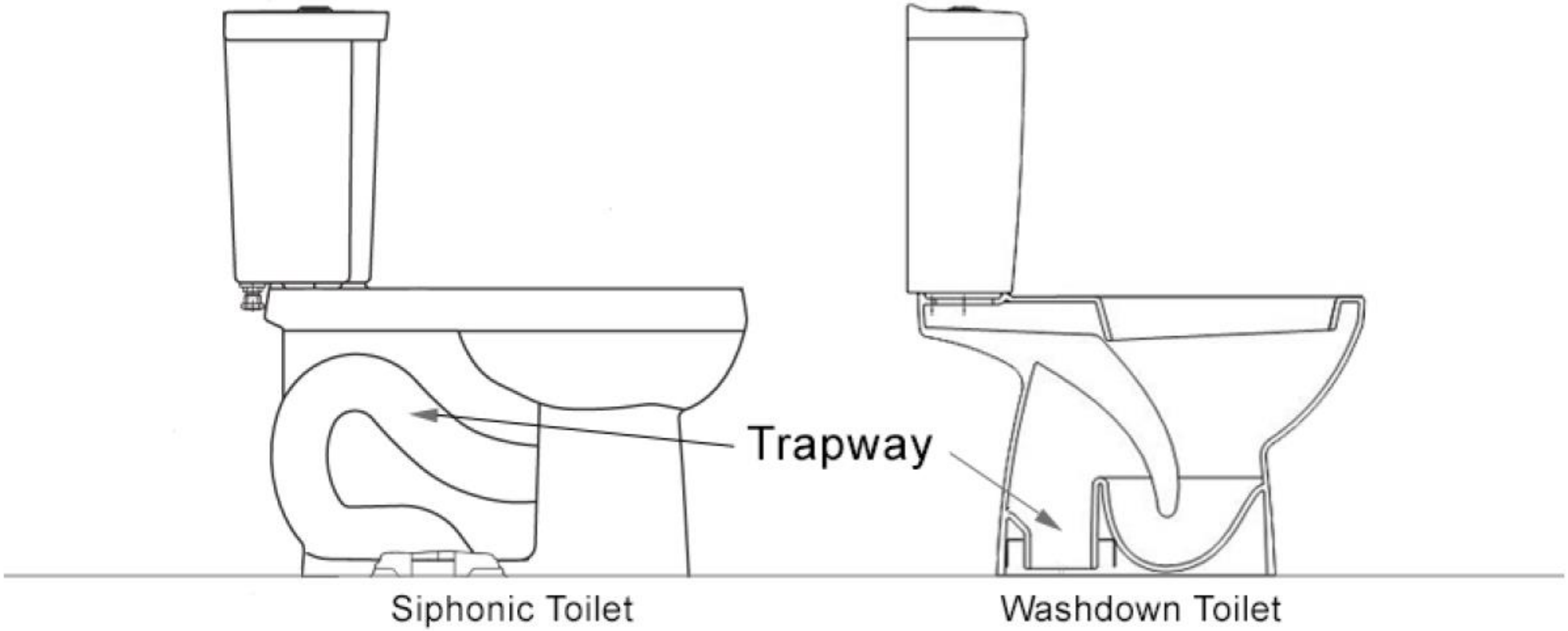
P-Trap



BOTTLE TRAP

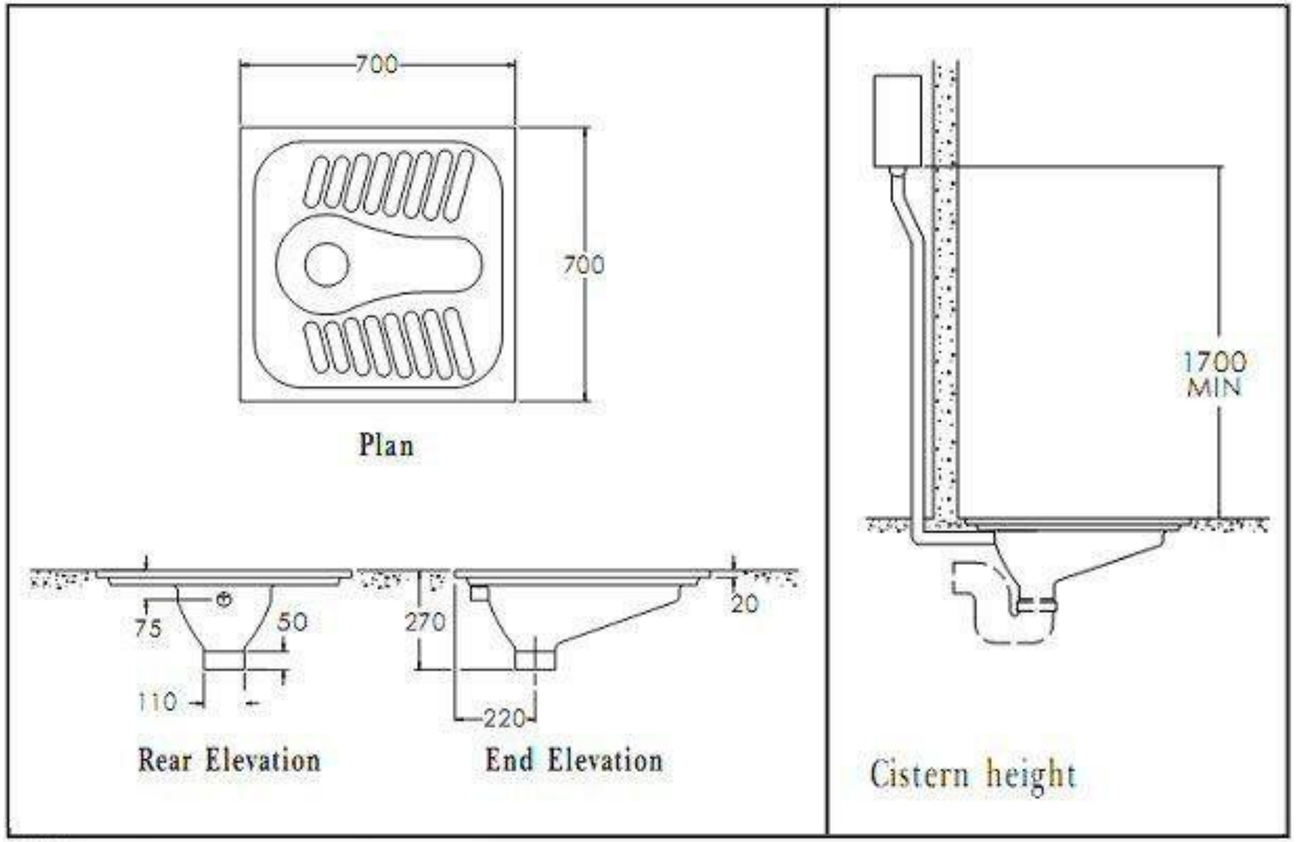


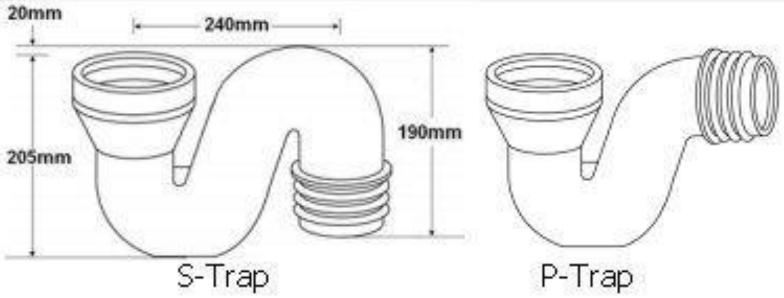
P-TRAP

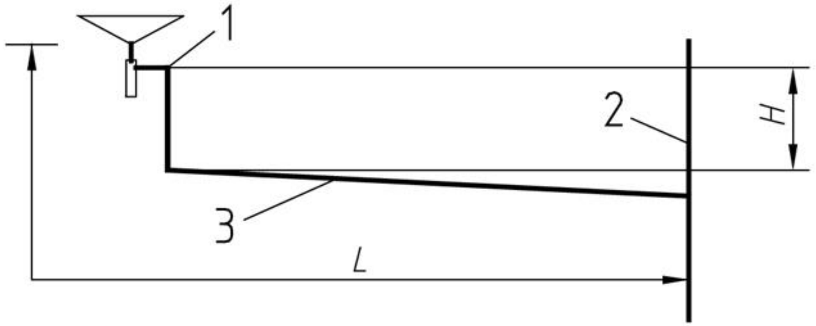


Pedestal Water Closet: Siphonic vs washdown

Squatting Water Closet







1 Connecting bend 2 Stack 3 Branch ventilating pipe

Figure 6 — Limitations for unventilated discharge branches in system I, II, IV

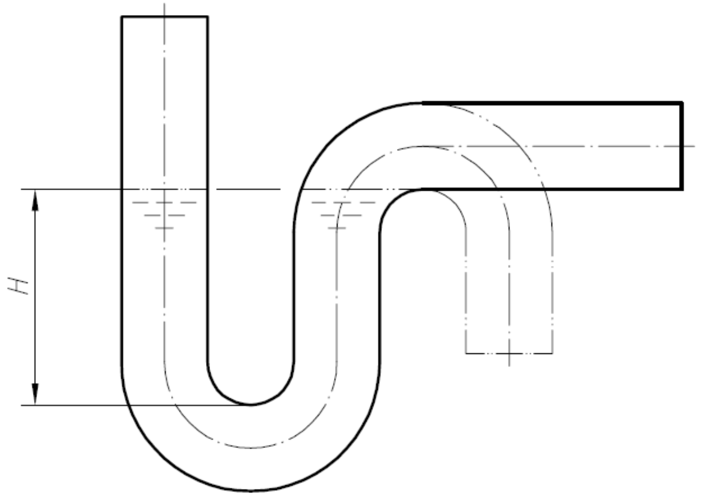
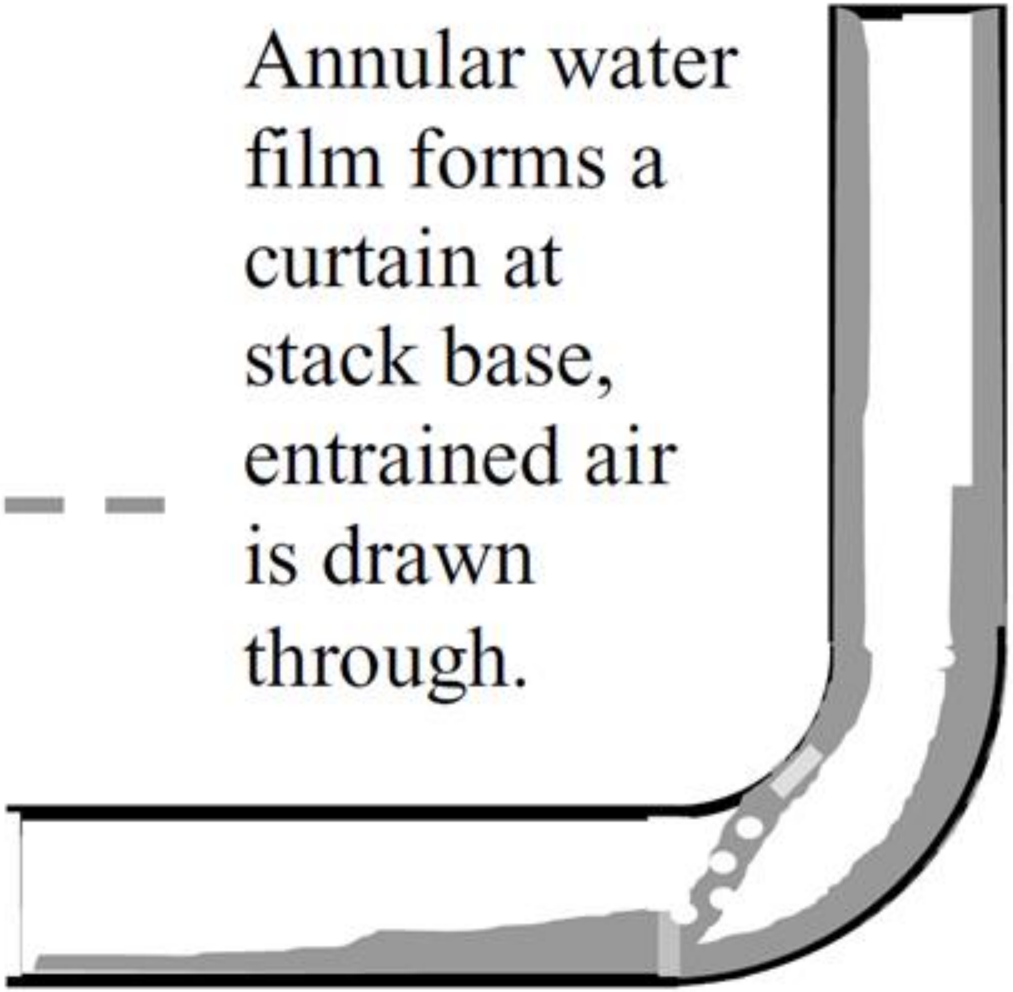


Figure 1: Water depth in trap

A majority of drainage standards around the world are based on incorrect assumptions of a simple correlation between drainage and airflow in stacks from the National Bureau of Standards in the mid 20th century


Annular water film forms a curtain at stack base, entrained air is drawn through.

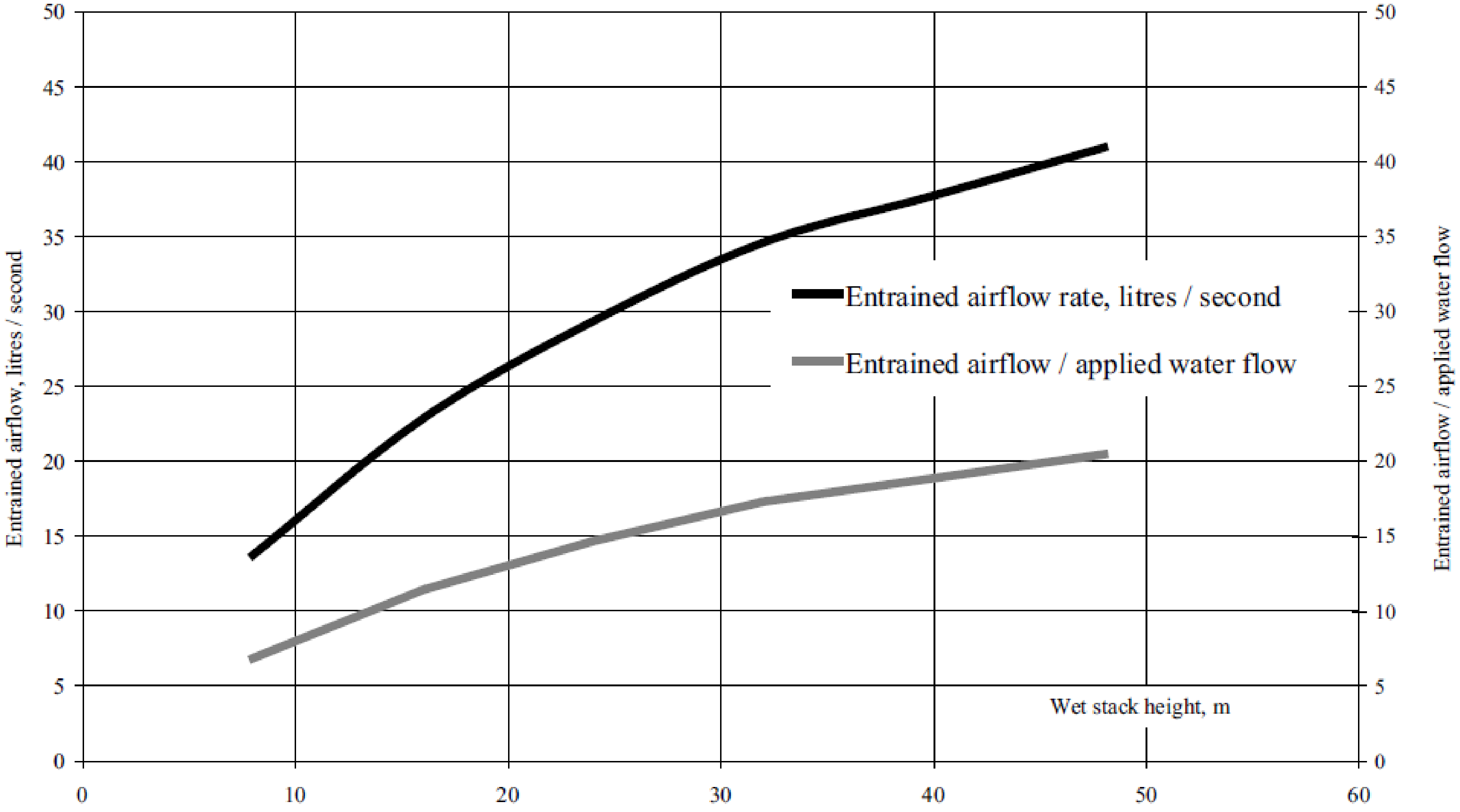


Figure 4.21 Increasing entrained airflow as a direct result of increased wet stack length by introducing a 2 litre/second water inflow further up the stack in a 150 mm diameter single stack system, Figure 4.1(b)

$$L = \frac{\partial u}{\partial t} + (\lambda + u)\frac{\partial u}{\partial x} + \left(\frac{2}{\gamma - 1}\right)\left[\frac{\lambda}{c}\frac{\partial c}{\partial t} + \left(\lambda\frac{u}{c} + c\right)\frac{\partial c}{\partial x}\right] + \frac{4fu|u|}{2D} = 0$$

$$L = \frac{\partial u}{\partial t} + (\lambda + u)\frac{\partial u}{\partial x} + \left(\frac{2}{\gamma - 1}\right)\frac{\lambda}{c}\left[\frac{\partial c}{\partial t} + \left(u + \frac{c^2}{\lambda}\right)\frac{\partial c}{\partial x}\right] + \frac{4fu|u|}{2D} = 0$$

As $u = \theta(x,t)$ and $c = \theta(x,t)$ it follows that

$$\frac{du}{dt} = \frac{\partial u}{\partial t} + \frac{\partial u}{\partial x}\frac{dx}{dt} \quad \text{and} \quad \frac{dc}{dt} = \frac{\partial c}{\partial t} + \frac{\partial c}{\partial x}\frac{dx}{dt}$$

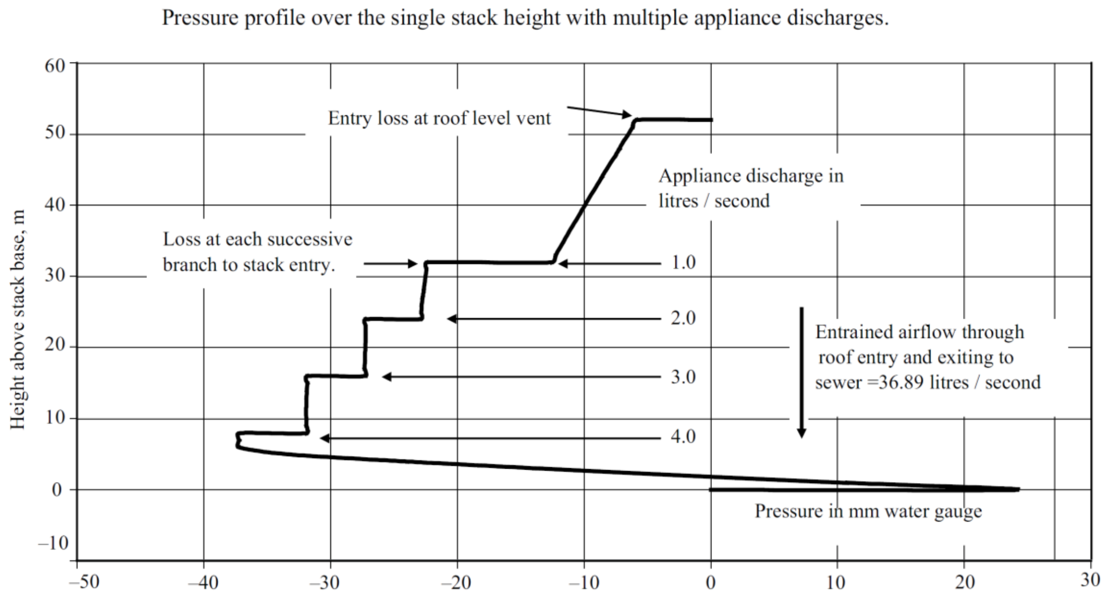
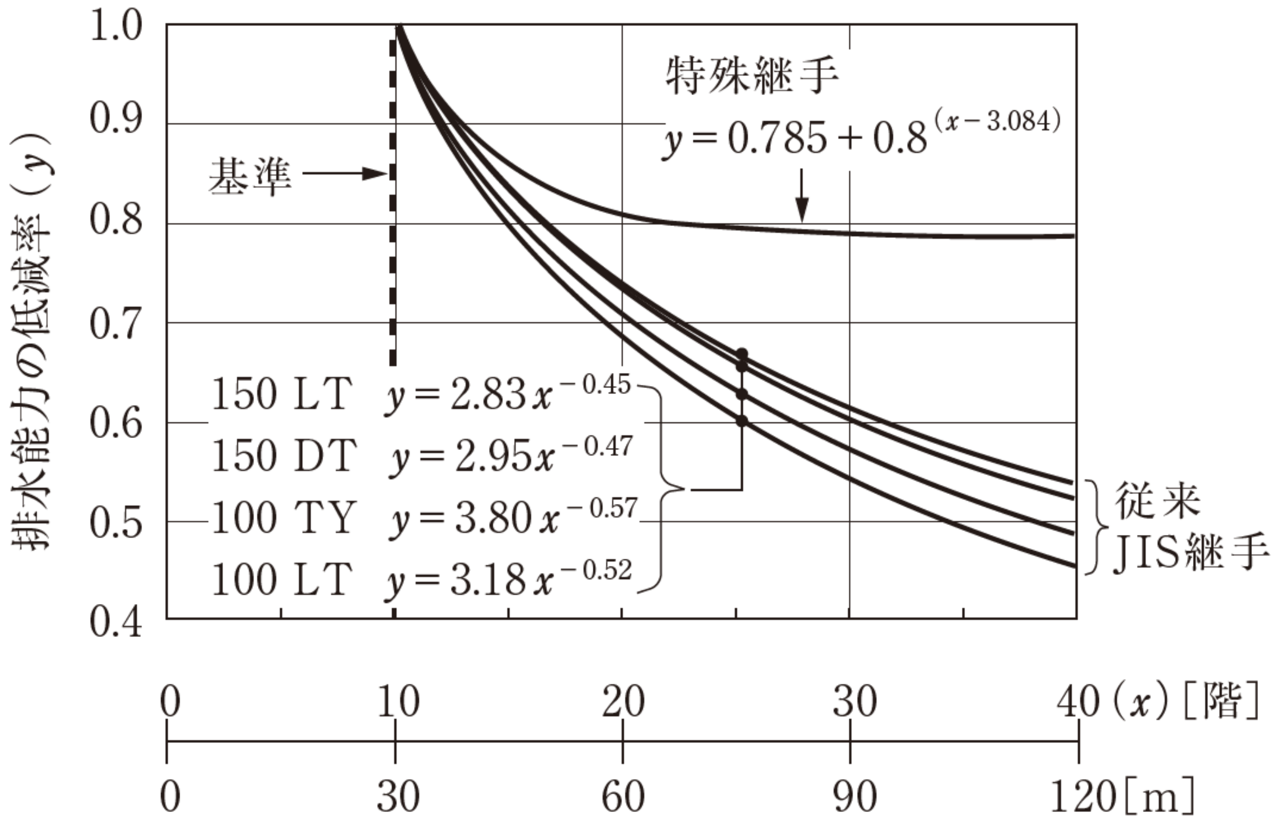


Figure 4.2 Expected air pressure regime within the vertical stack of a single stack system subject to four individual discharging branches

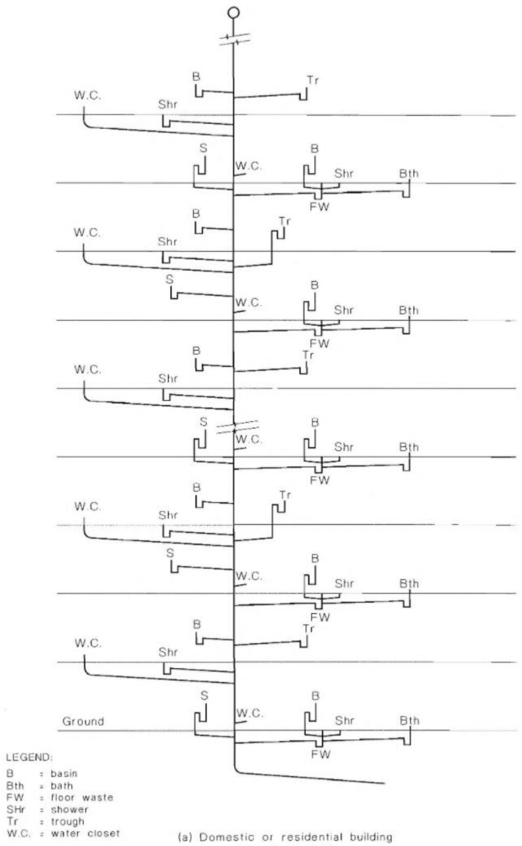
J. A. Swaffield, Transient Airflow in Building Drainage Systems, 2010



注 1階＝3 m，図中LT，DT，TYは継手型状を100，150は管径を示す。

解説図 8—負荷高さによる排水能力の低減率の例[4),5)]

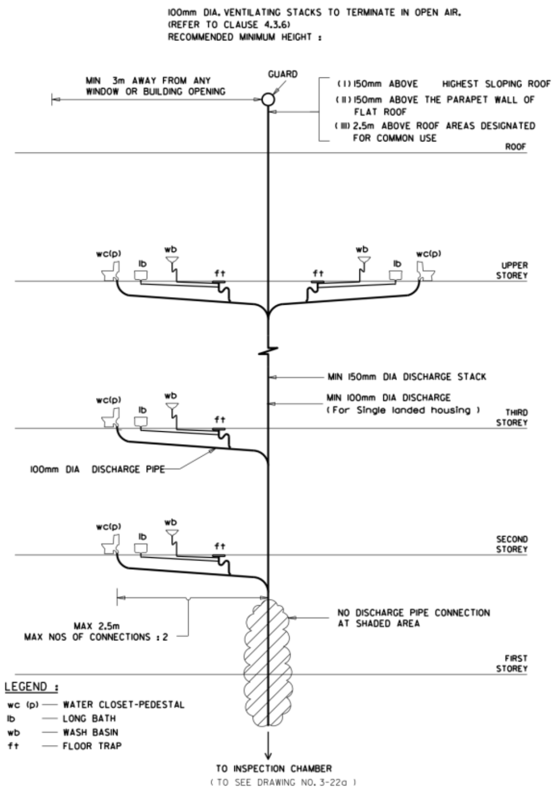
Australia



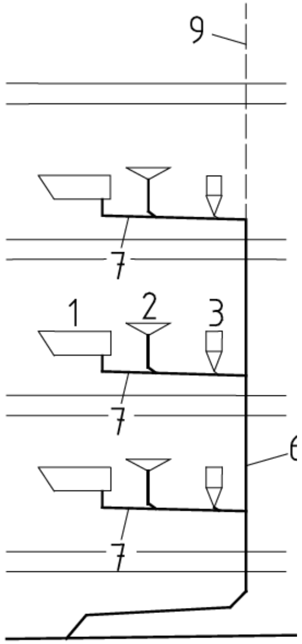
(a) Domestic or residential building
(see Table 8.3)

FIGURE 8.1 (in part) SINGLE STACK SYSTEMS

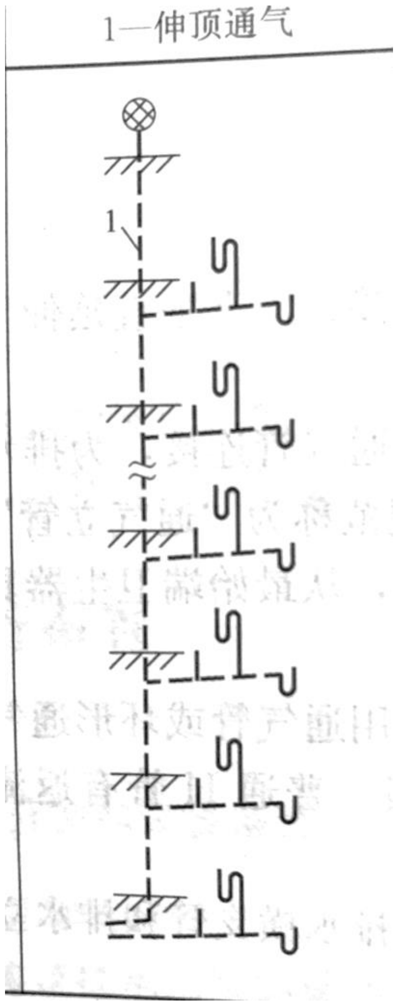
Singapore



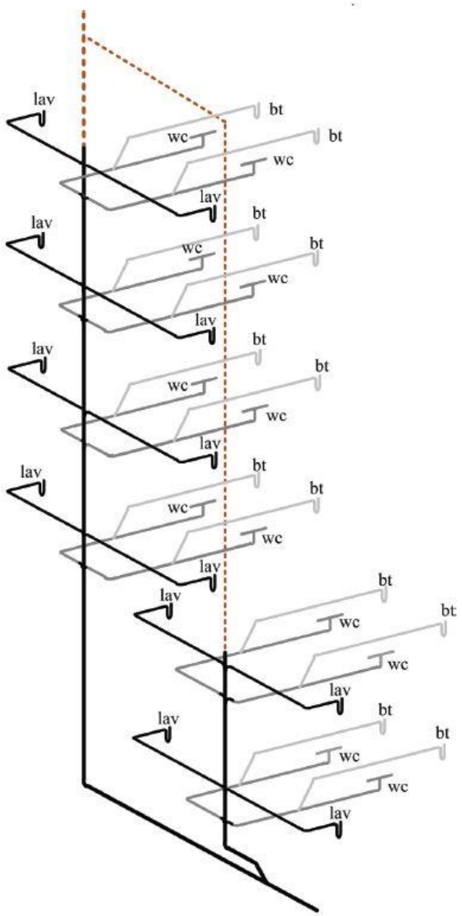
Europe



China



US



Single Stack System for a Six Story Building

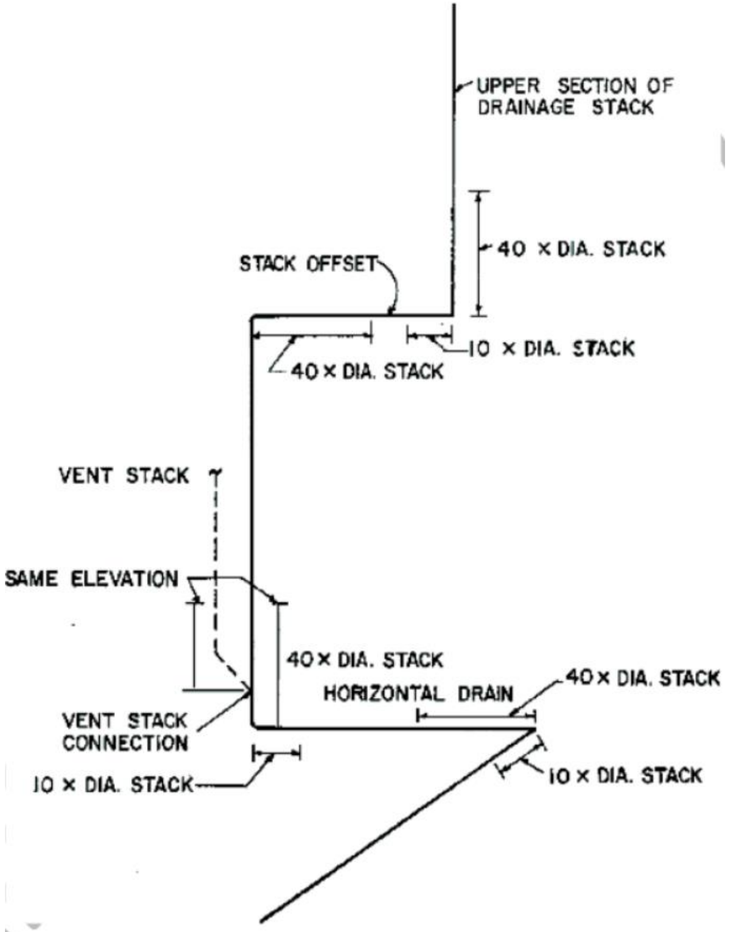


FIGURE 704.6
SUDS PRESSURE ZONES

New York City Plumbing Code

OFFSET FLOOR VENTING IN GERMANY

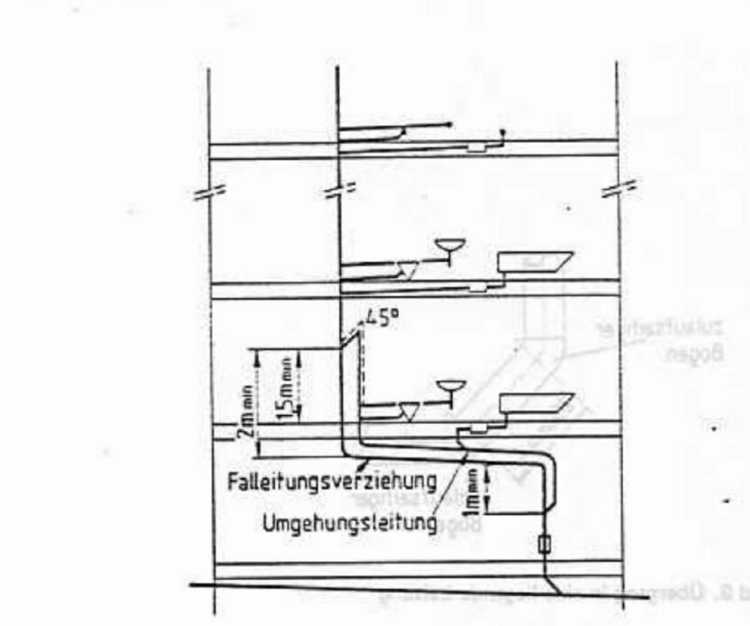


Bild 7. Falleitungsverziehung mit Umgehungsleitung

LOWEST FLOOR VENTING IN CHINA

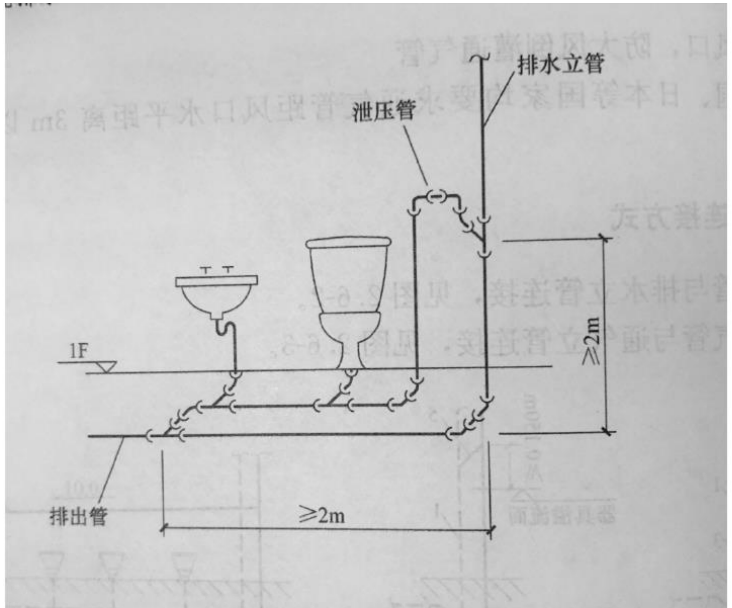
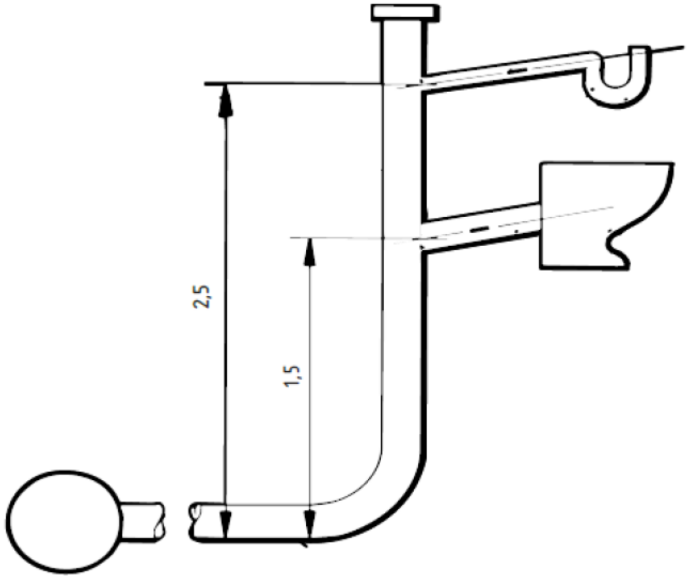


图 2.6-6 底层卫生间排水利用排水立管通气方式

STUB STACK IN UK



Peak Drainage Flow Calculations

EQUATION 1 – Loading calculation in EN 12056 (EUROPE)

$$Q_{ww} = K\sqrt{\Sigma DU}$$

Q_{ww} = waste water flowrate (L/s)

K = Frequency factor

ΣDU = Sum of discharge Units

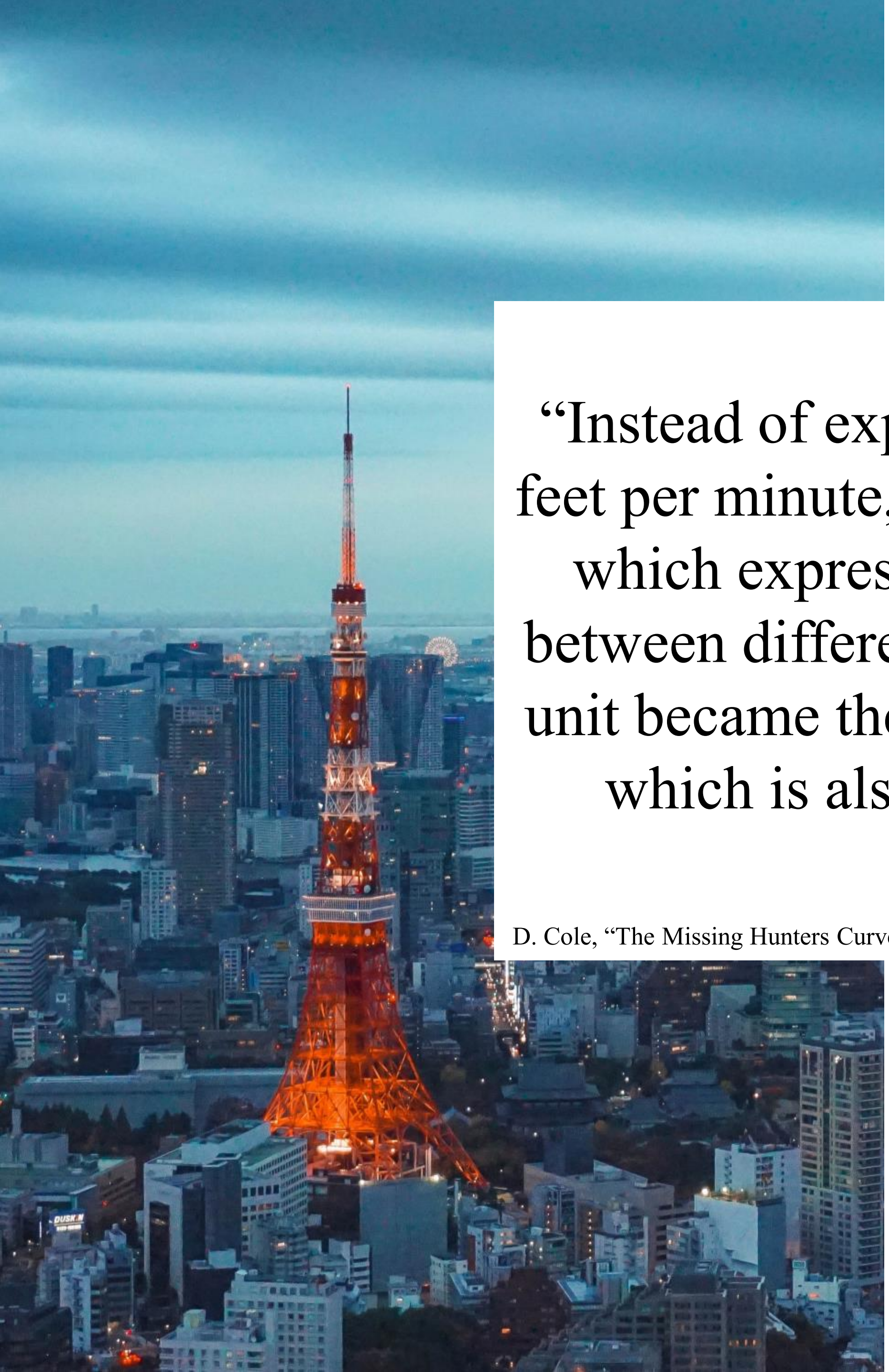
EQUATION 2 – Loading calculation in GB 50015 (CHINA)

$$q_p = 0.12a\sqrt{N_p} + q_{max}$$

q_p = Drainage design flowrate (L/s)

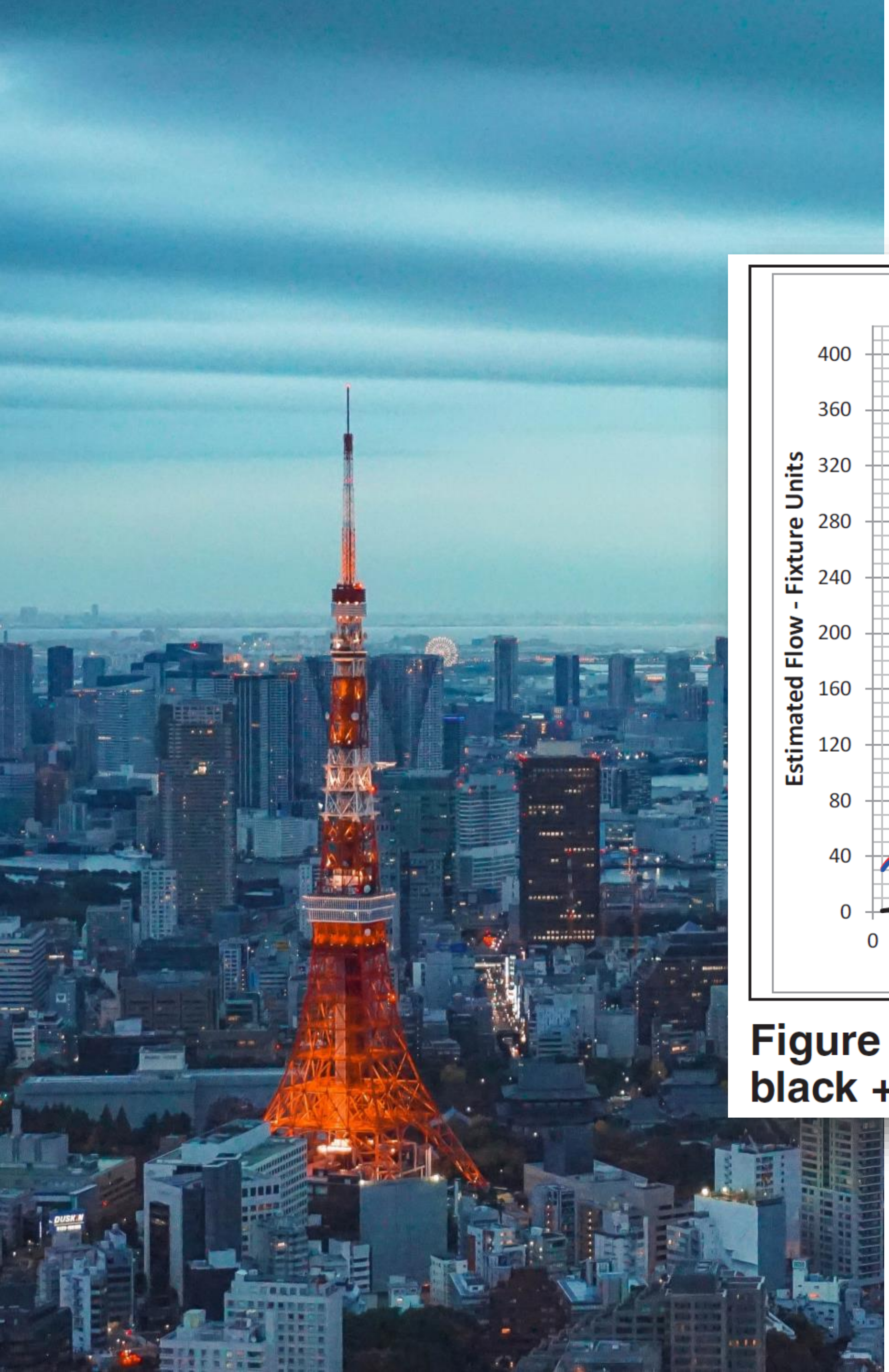
N_p = Sanitary appliance drainage equivalent value

a = Building type coefficient



"Instead of expressing the unit of measurement in cubic feet per minute, Dr. Hunter coined the term "fixture unit," which expressed both a flow rate and a relative value between different kinds of plumbing fixtures. The fixture unit became the unit of measure to express pipe capacity, which is also a flow rate in cubic feet per minute."

D. Cole, "The Missing Hunters Curves", Plumbing Engineer Magazine 2013



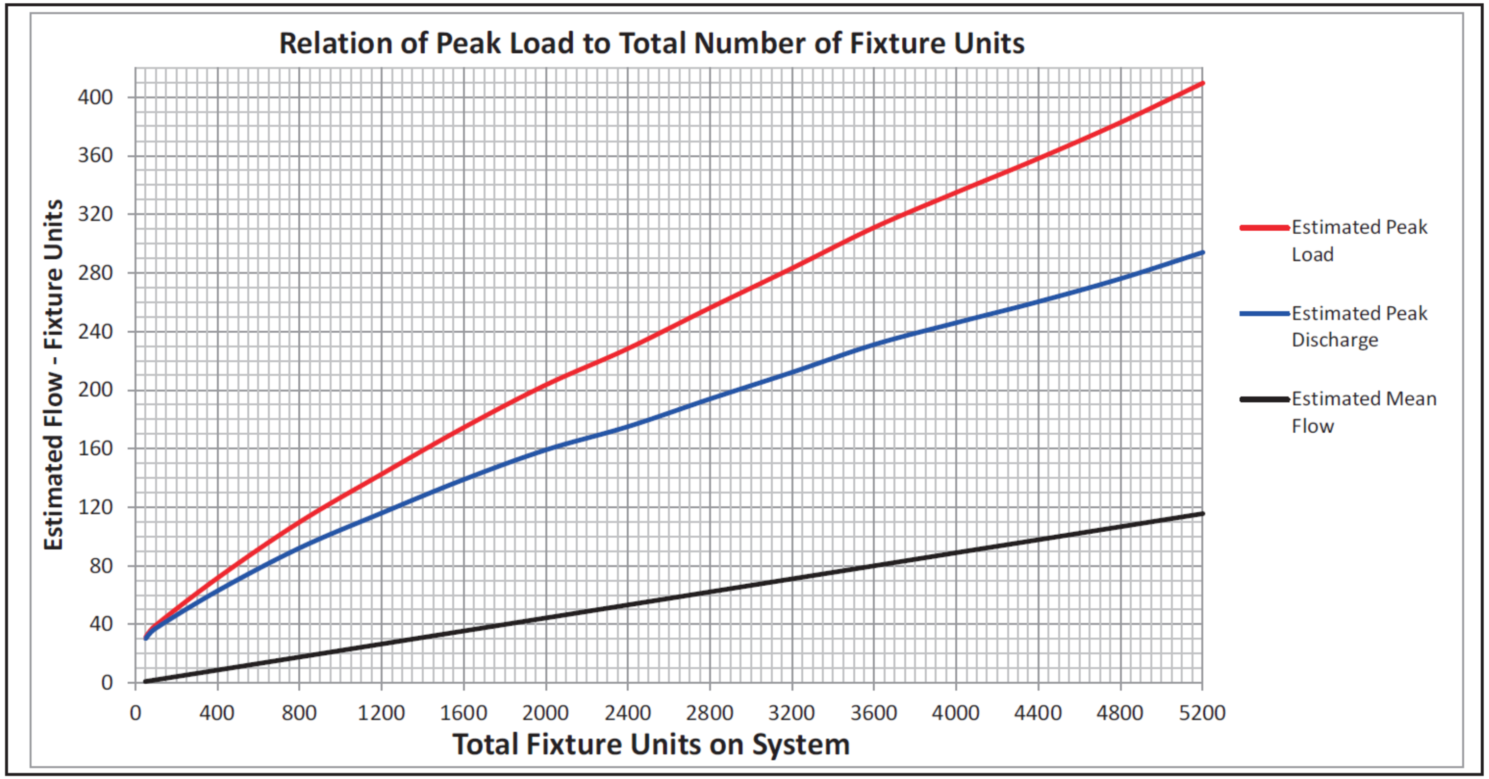


Figure 5: Estimate Curves for Drainage Loads in Report BH13 (red = black + blue)

D. Cole, "The Missing Hunters Curves", Plumbing Engineer Magazine 2013

TABLE 710.1(1) BUILDING DRAINS AND SEWERS

DIAMETER OF PIPE (inches)	MAXIMUM NUMBER OF DRAINAGE FIXTURE UNITS CONNECTED TO ANY PORTION OF THE BUILDING DRAIN OR THE BUILDING SEWER, INCLUDING BRANCHES OF THE BUILDING DRAIN[a]			
	Slope per foot			
	$^{1}/_{16}$ inch	$^{1}/_{8}$ inch	$^{1}/_{4}$ inch	$^{1}/_{2}$ inch
$1^{1}/_{4}$	—	—	1	1
$1^{1}/_{2}$	—	—	3	3
2	—	—	21	26
$2^{1}/_{2}$	—	—	24	31
3	—	36	42	50
4	—	180	216	250
5	—	390	480	575
6	—	700	840	1,000
8	1,400	1,600	1,920	2,300
10	2,500	2,900	3,500	4,200
12	3,900	4,600	5,600	6,700
15	7,000	8,300	10,000	12,000

For SI: 1 inch = 25.4 mm, 1 inch per foot = 83.3 mm/m.

a. The minimum size of any *building drain* serving a water closet shall be 3 inches.

International Plumbing Code

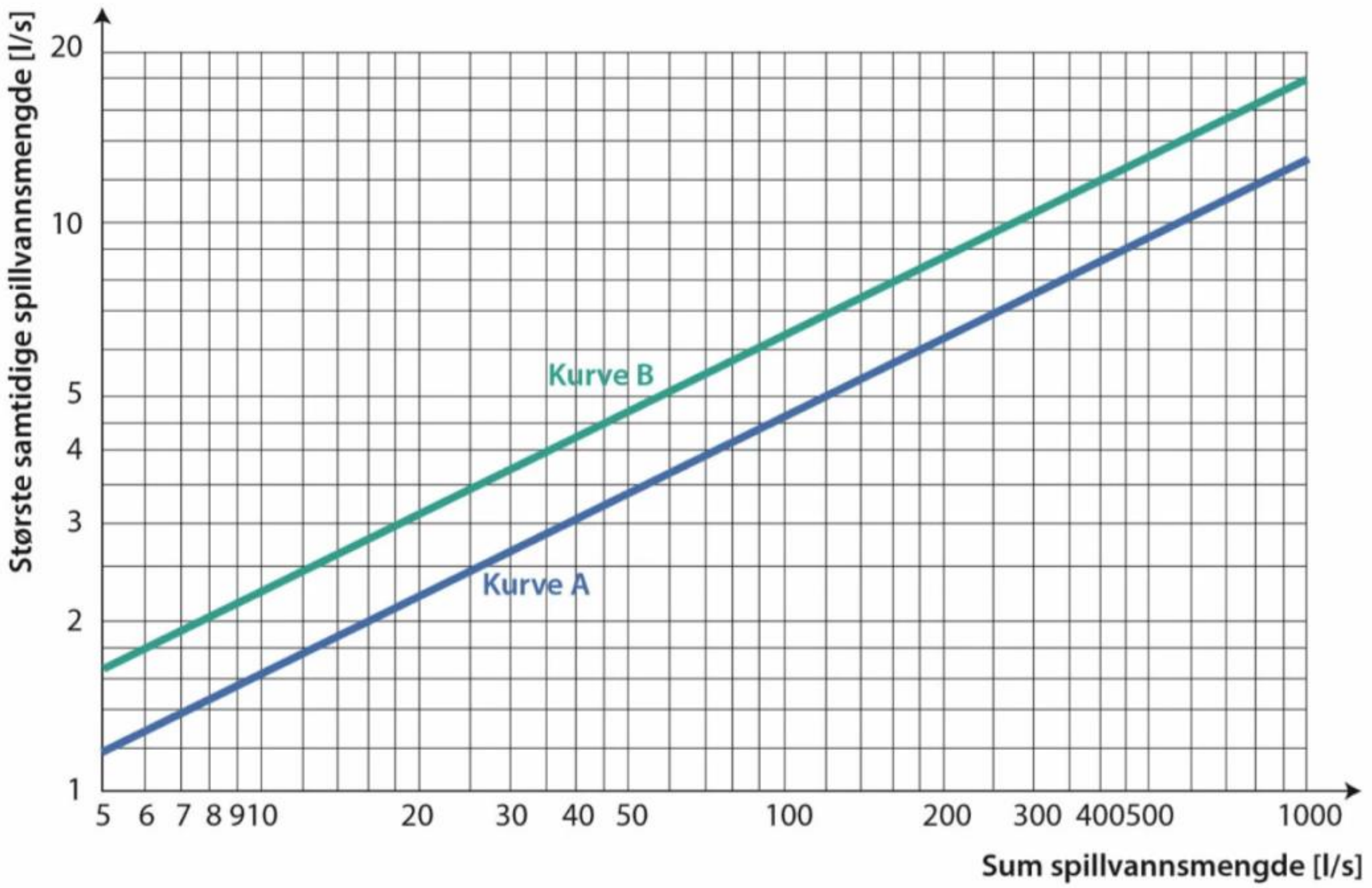
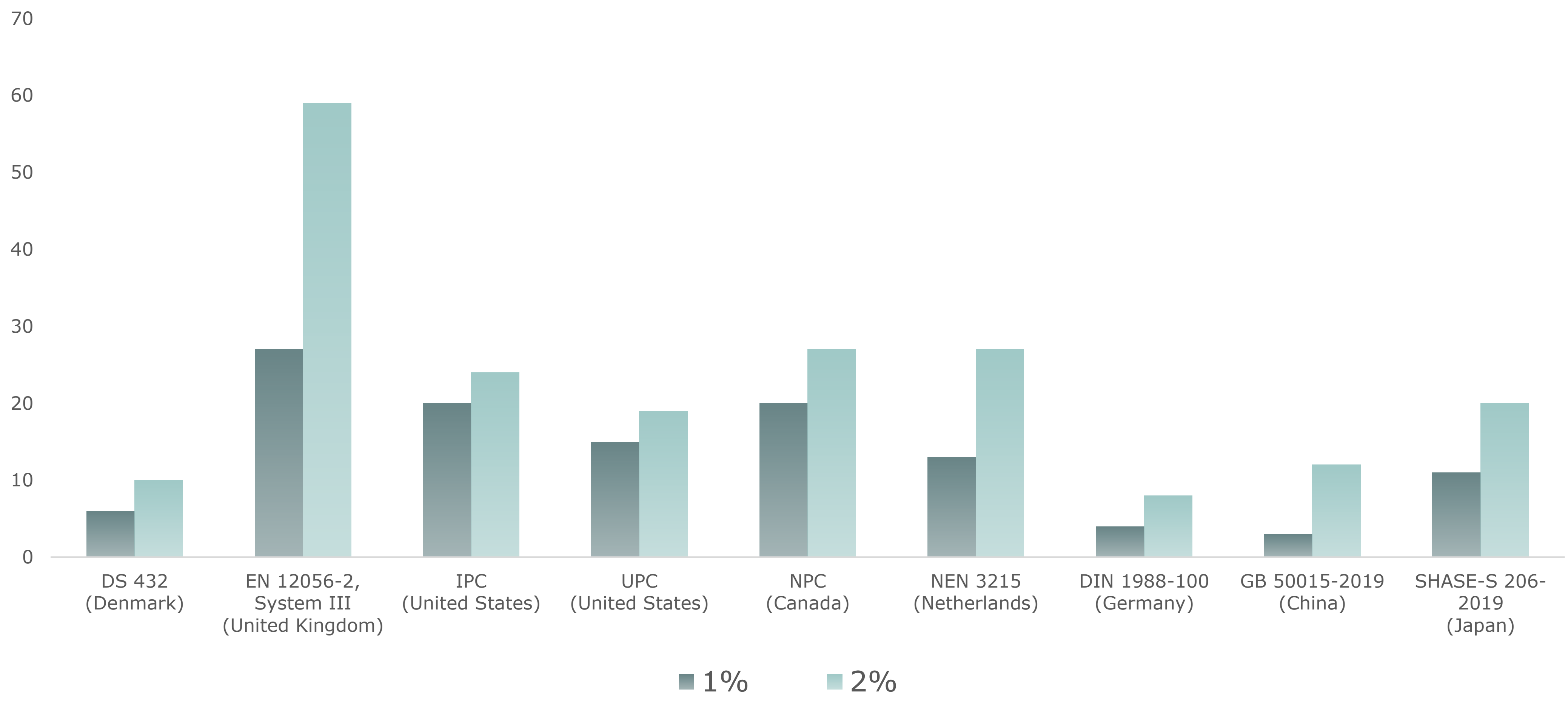


Figure 5.9. Largest simultaneous load of wastewater. See Formula 5.1 for calculating the maximum simultaneous load of wastewater.

Curve A: Housing, office buildings, retirement homes. Curve B: Hotels, hospitals, cinemas, assembly halls.

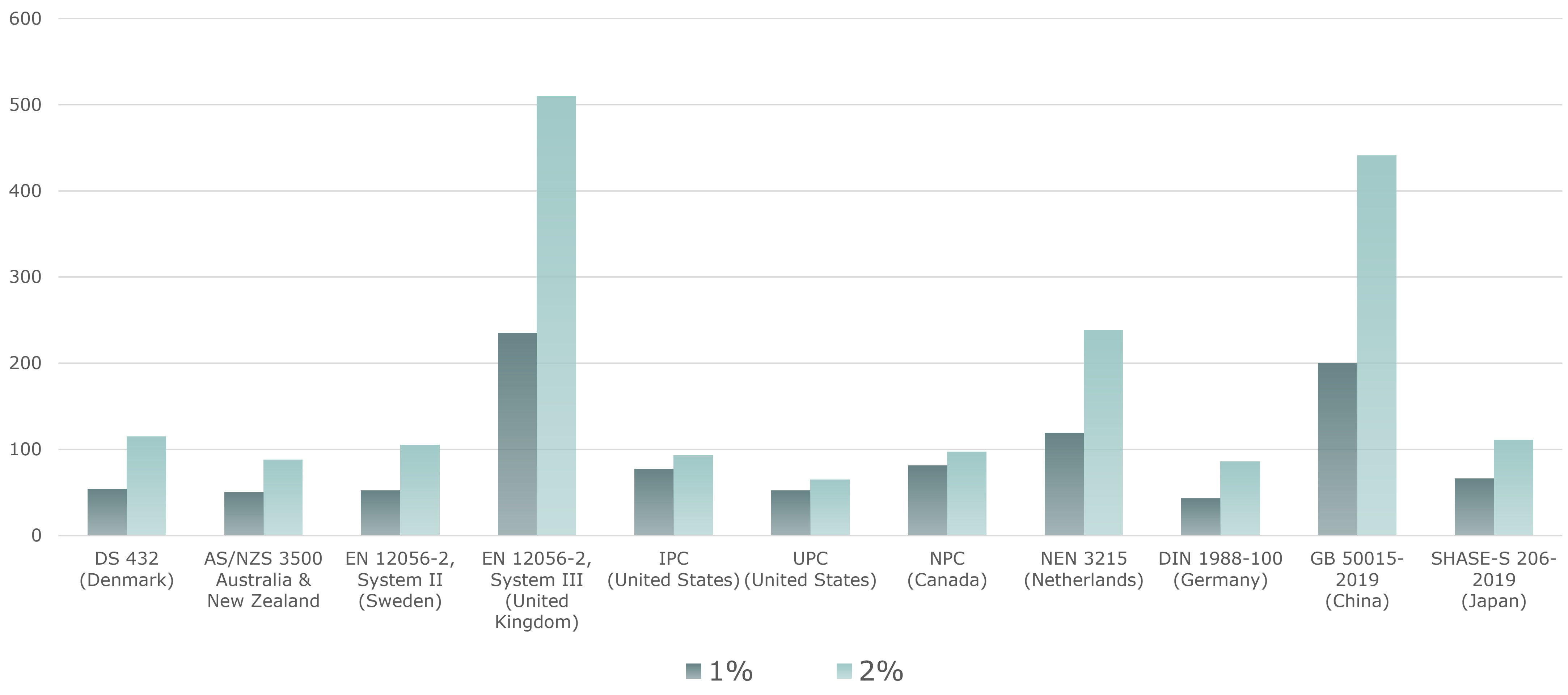
Maximum Dwelling Units on Horizontal Drain (4 inch)

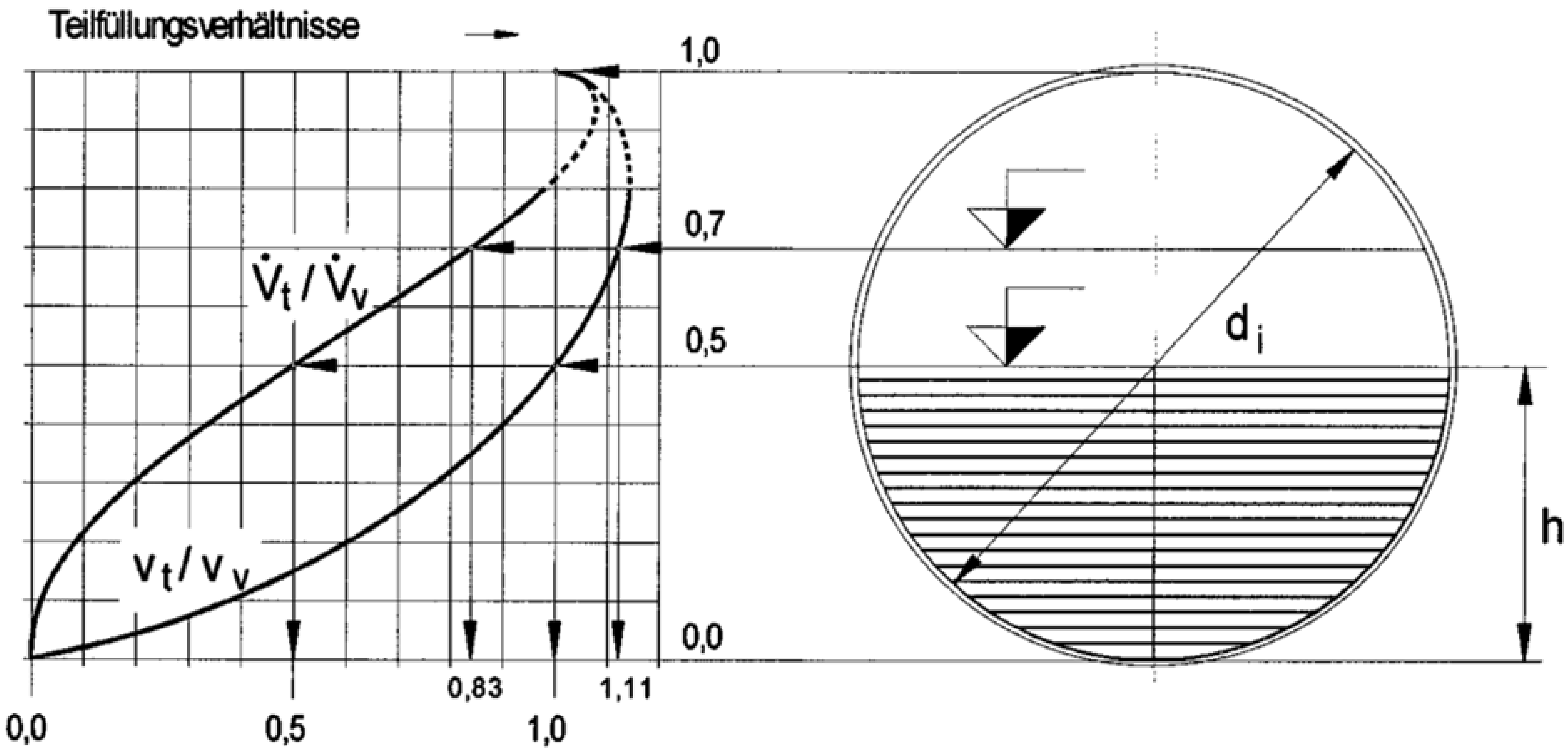
INTERNATIONAL DRAINAGE LOADING COMPARISON



Maximum Dwelling Units Per Horizontal Drain (6 inch)

INTERNATIONAL DRAINAGE LOADING COMPARISON





Teilfüllungsverhältnisse
1,0
0,7
0,5
0,0
V̇t / V̇v
vt / vv
0,0
0,5
0,83
1,0
1,11
di
h

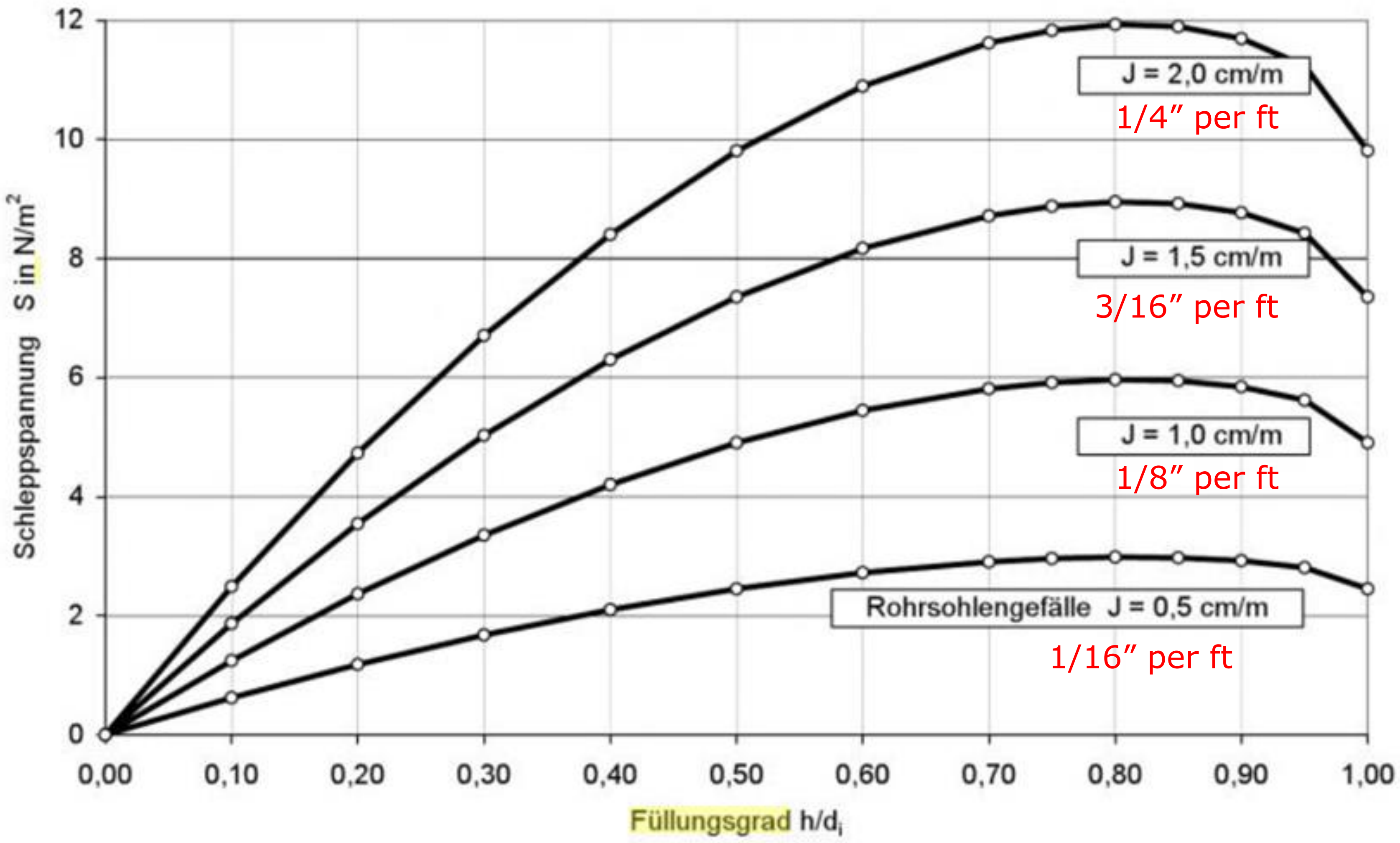


Bild 14-2
Schleppspannung in Abhängigkeit vom Füllungsgrad und vom Rohrsohlengefälle

Water Closet Drainage

COUNTRY	Max FLUSH VOLUME	MINIMUM DIAMETER	GRADIENT
United States	1.6 gal 4.8 L	3″ (DN 80)	IPC: 1% UPC: 2%
United Kingdom	1.6/1.1 gal (1.23 gal) 6/4 L (4.7 L)	4″ (DN 100)	2.5%
Netherlands	Min 1.6 gal 6 L	4″ (DN 100)	0.5%
Scandinavia	1.1/0.5 gal (0.7 gal) 4/2 L (2.7 L)	Denmark: 3″ (DN 80) Sweden: 4″ (DN 100)	2%
Germany	1.2 gal (4.5 L)	3″ (DN 80)	2%

Design cross-sectional filling height

Horizontal drain filling height

STANDARD	ORIGIN	MAXIMUM FILLING HEIGHT
DS 432	Denmark	50%
DIN 1986-100	Germany	50%
GB 50015:2019	China (PRC)	60%
NEN 3215	Netherlands	70%
BS EN 12056-2	UK	75%
IPC/UPC	US	50%

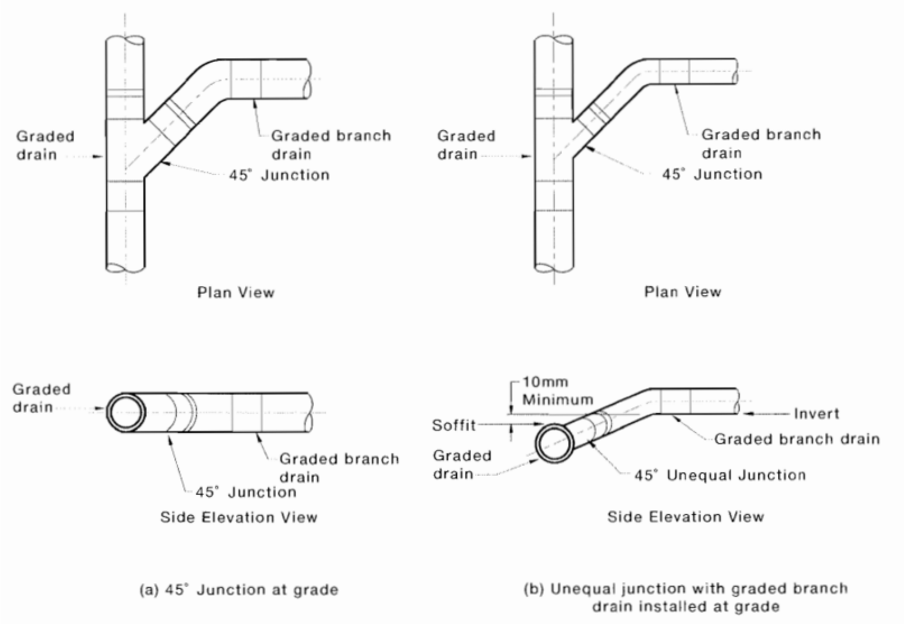
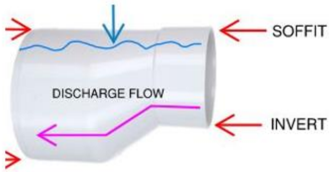
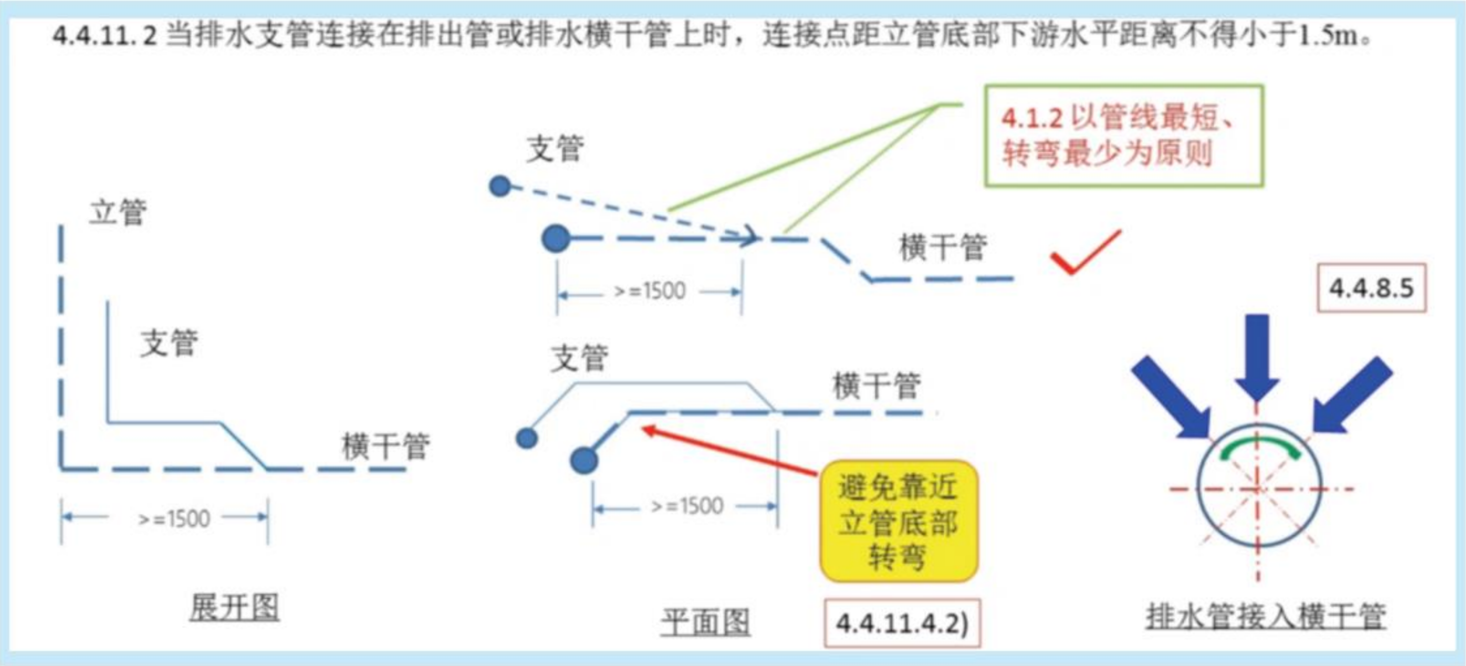


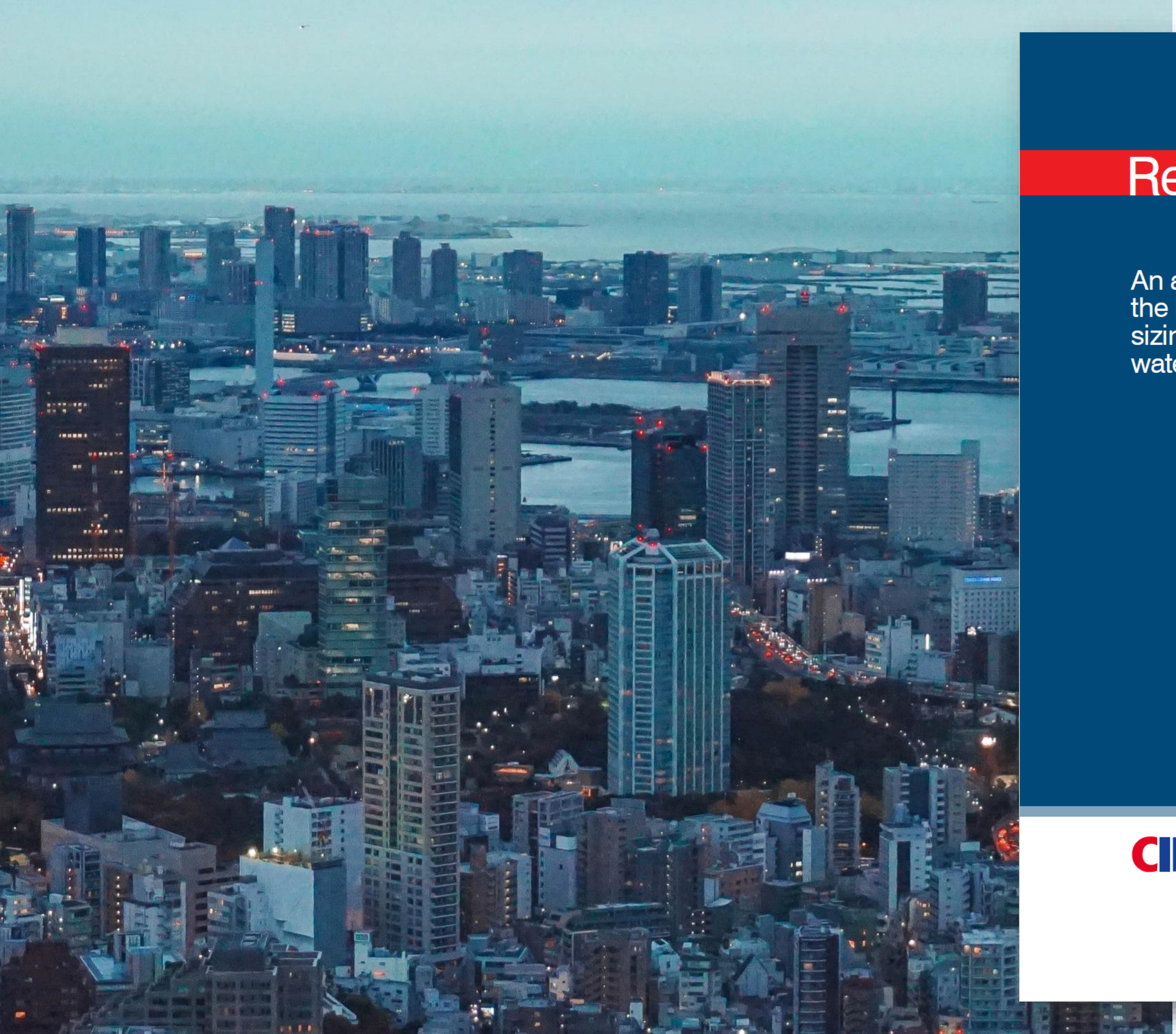
Figure 1 Horizontal junctions in AS/NZS 3500.1



AN ECCENTRIC TAPER FITTING IS:

A REDUCER THAT <u>MAINTAINS LEVEL SOFFITS</u> IN THE ADJOINING PIPES





Research Report

An assessment of the validity of the loading units method for sizing domestic hot and cold water services

CIPHE
CIBSE
HERIOT WATT UNIVERSITY
The Society of Public Health Engineers

Joint Research Project
i/D/001

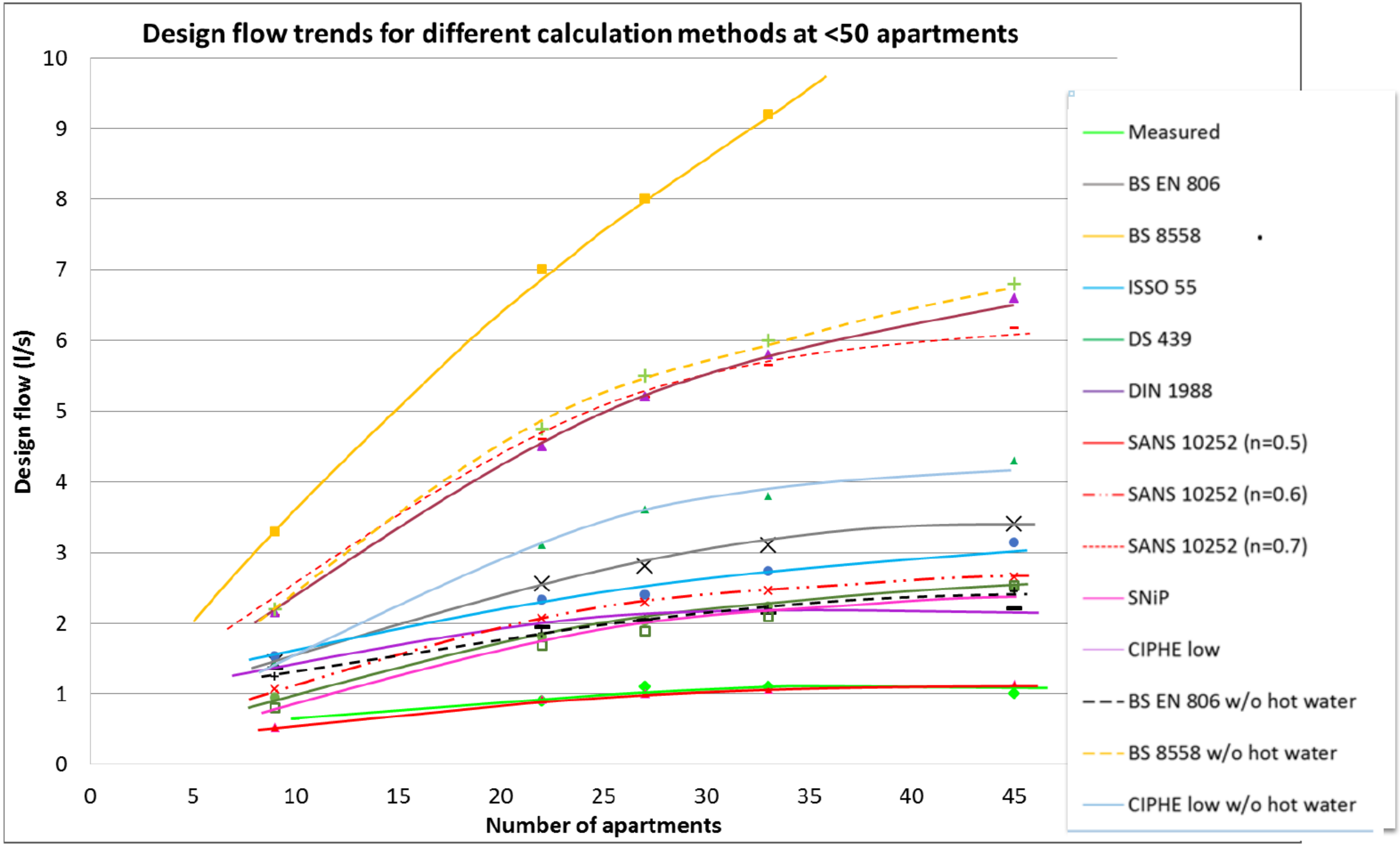
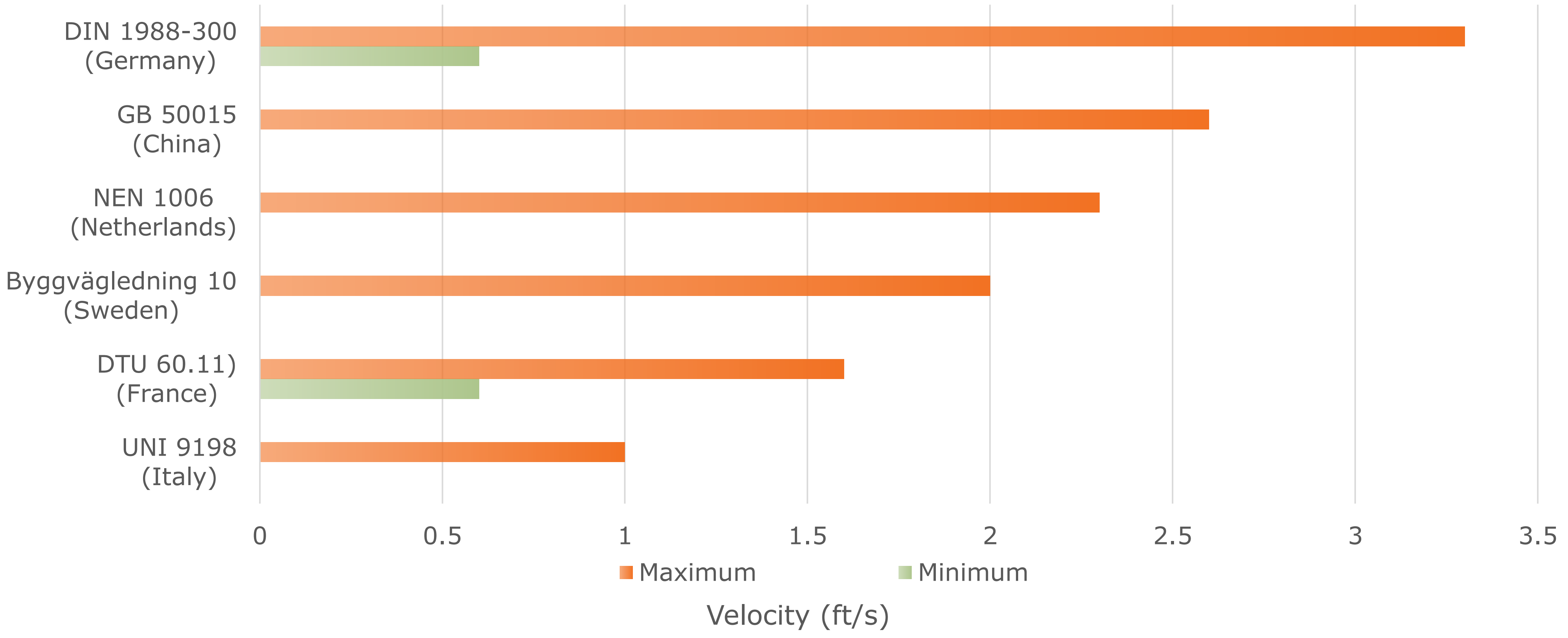
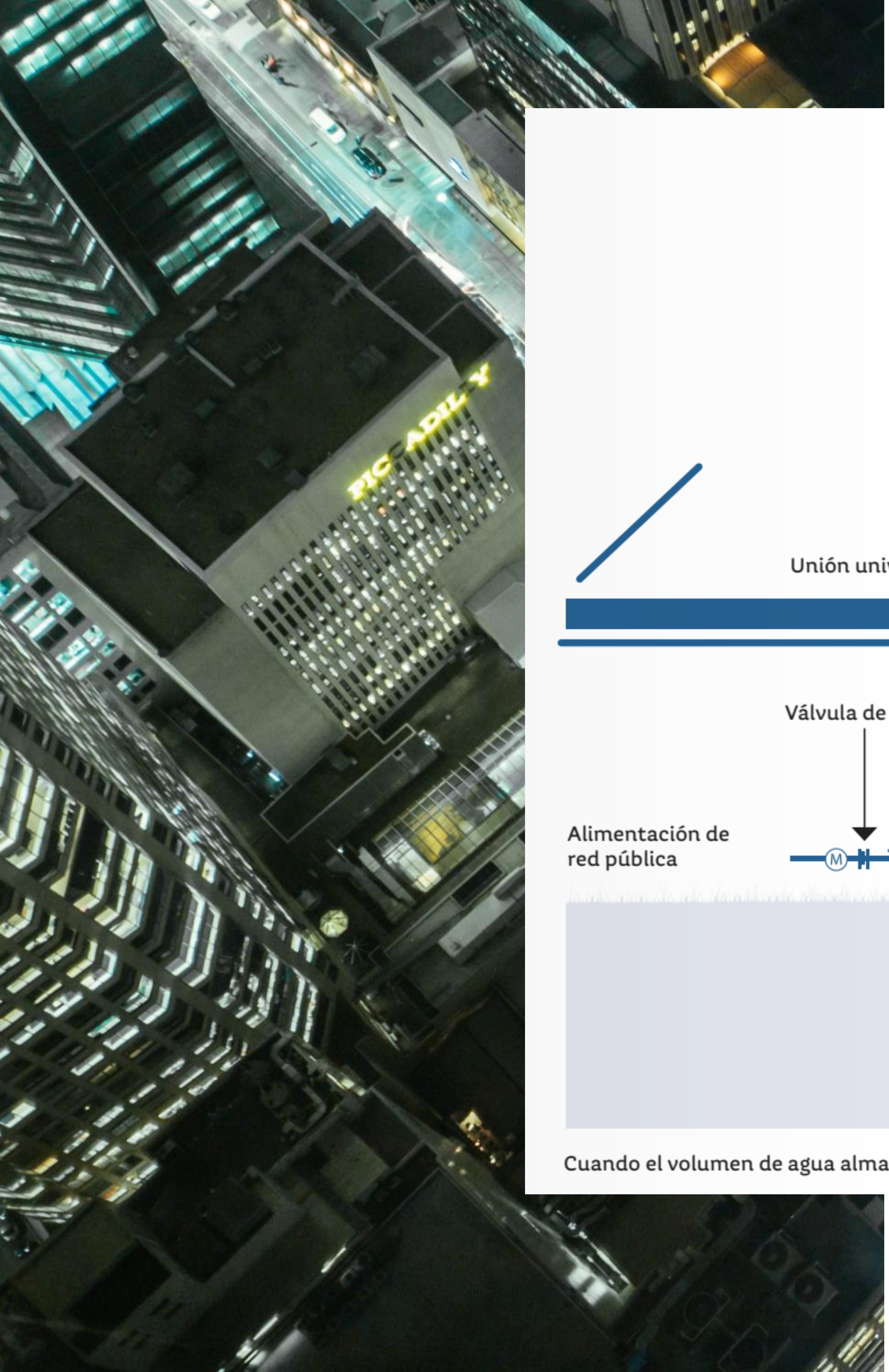
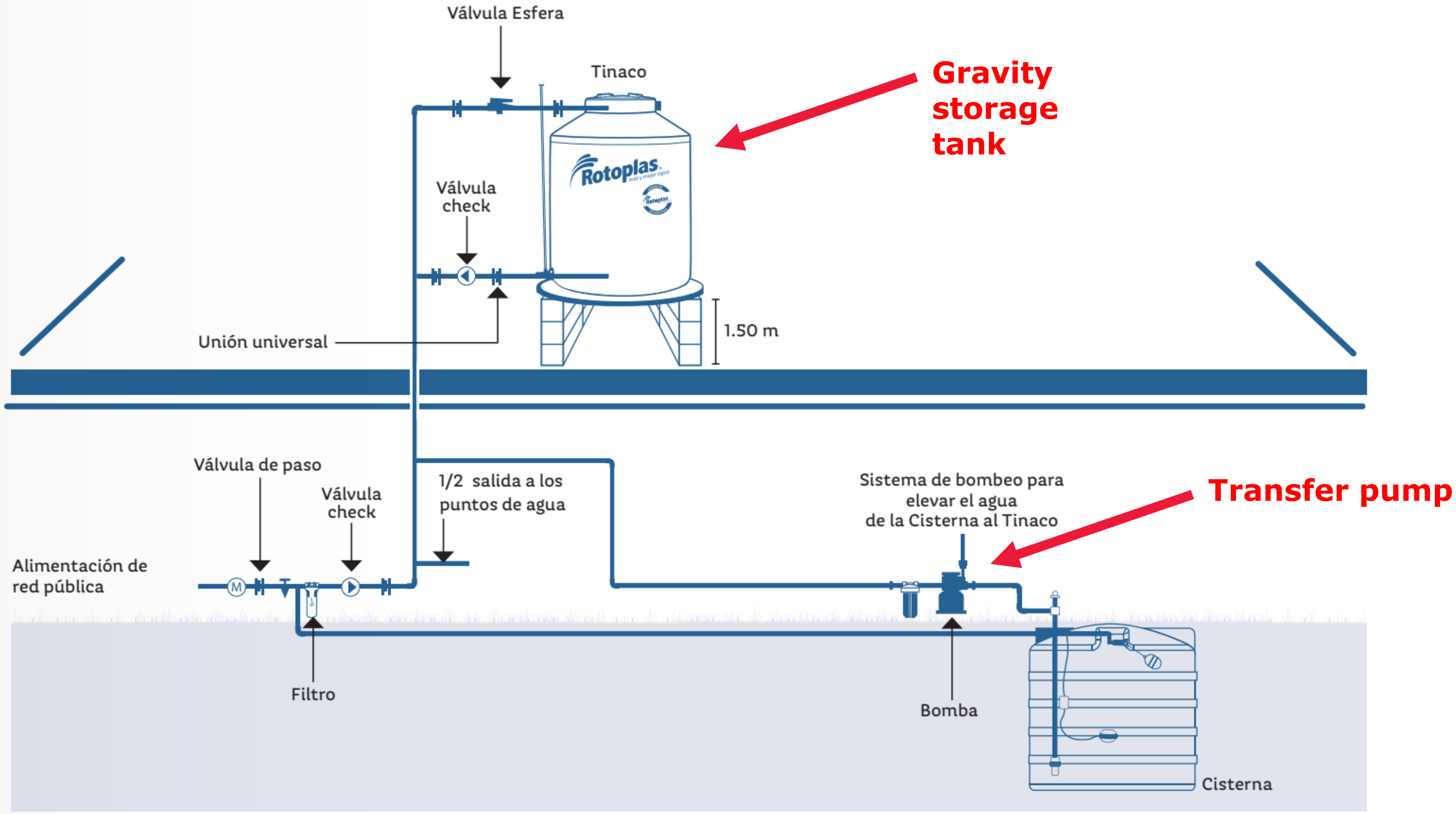


Figure A.3 Design flow rates for different calculation methods for flow <10 l/s; number of apartments < 50 (*Note*: curves without the addition of hot water loading units are indicative only and do not suggest an alternative design approach)

Comparison of Recommended Velocity Ranges in Design Standards for Return Piping

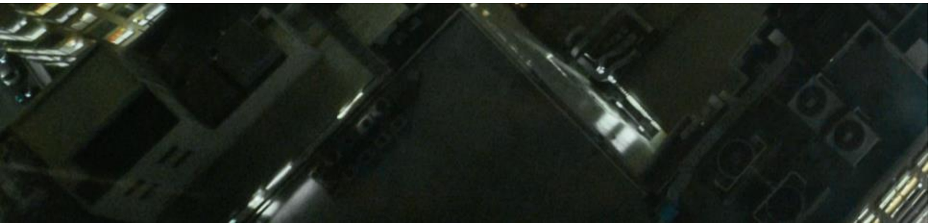






Cuando el volumen de agua almacenada no es suficiente o la presión es muy baja, se hace necesaria la instalación de una Cisterna.

https://rosenwachtank.com/



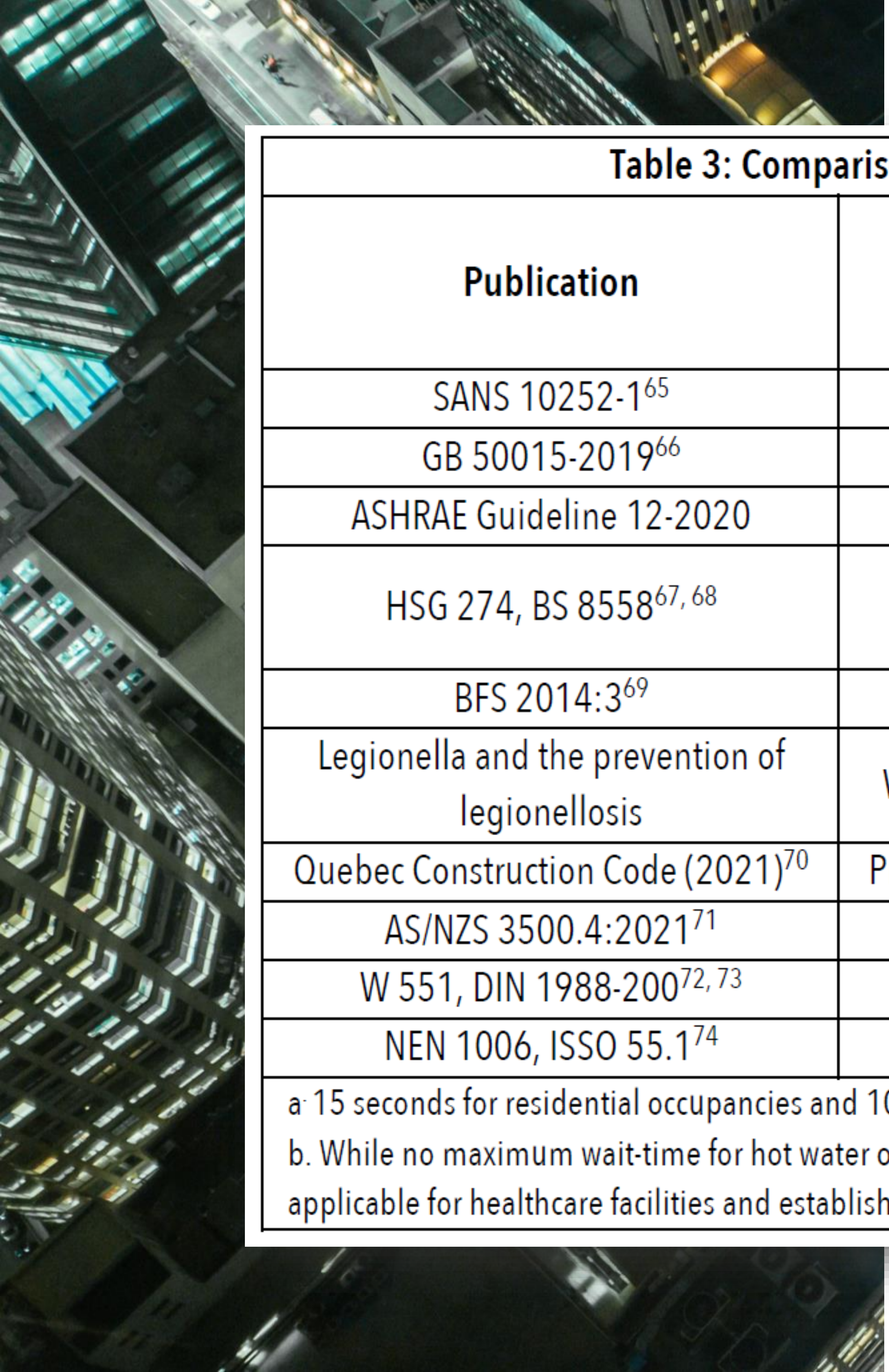


Table 3: Comparison of Standard Temperatures for Domestic Hot Water Circulation Systems

Publication	Region	Minimum Allowable Circulation Temperatures		
		In Piping	Fixture Outlets	Hot Water Storage Tank
SANS 10252-1[65]	South Africa	45°C (113°F)	N/A	55°C (131°F)
GB 50015-2019[66]	China (PRC)	45°C (113°F)	113°F (45°C) within 15 seconds[a]	60°C (140°F)
ASHRAE Guideline 12-2020	United States	49°C (120°F)	49°C (120°F)[b]	60°C (140°F)
HSG 274, BS 8558[67, 68]	United Kingdom	50°C (122°F)	50°C (122°F) within 60 seconds or 0.5 L (0.13 gal)	60°C (140°F)
BFS 2014:3[69]	Sweden	50°C (122°F)	NA	60°C (140°F)
Legionella and the prevention of legionellosis	World Health Organization	50°C (122°F)	50°C (122°F) within 60 seconds	60°C (140°F)
Quebec Construction Code (2021)[70]	Province of Quebec (Canada)	55°C (131°F)	N/A	60°C (140°F)
AS/NZS 3500.4:2021[71]	Australia & New Zealand	55°C (131°F)	N/A	60°C (140°F)
W 551, DIN 1988-200[72, 73]	Germany	55°C (131°F)	55°C (131°F) within 30 seconds	60°C (140°F)
NEN 1006, ISSO 55.1[74]	Netherlands	60°C (140°F)	60°C (140°F) within 15 seconds	60°C (140°F)

a. 15 seconds for residential occupancies and 10 seconds for healthcare and hotel occupancies

b. While no maximum wait-time for hot water or maximum volume of water between circulated main and fixture is listed in ASHRAE 12, FGI Guidelines are applicable for healthcare facilities and establish a limit of 0.7 L (24 ounces), equivalent to 4.9 m (16 ft) for DN 15 (½-inch) piping.


Incorporating the principals of fluid mechanics and regional objectives are key in advancing plumbing standards for the 21st century


Questions?
THANK YOU

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