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COMPARATIVE ANALYSIS OF  
FINNISH AND RUSSIAN  
REGULATING DOCUMENTS ON  
WATER SUPPLY AND DRAINAGE  
OF RESIDENTIAL BUILDINGS


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<b>Abstract</b>  <p>The main subject of this thesis is to compare Finnish and Russian norms on water supply and drainage of residential buildings. It is very important to know the difference between them in order to communicate well on this field and to have possibility of international building design projects.</p> <p>There is great variety of regulations and guidelines related to this topic both in Finland and in Russia. The main documents used here are The national building code of Finland, regulations and guidelines 2007, part D1 and SNIP 2.01.04-85(2000): Inner water supply and drainage. In this thesis the main parameters, the process of design and dimensioning of an example building according to the documents mentioned above are compared.</p> <p>The main results of the comparison are that the main parameters are mostly the same with several minor discrepancies. But this affects on the design and dimensioning so that it should be done from the start to the end according to one or another document. That is why the combination is impossible. The only way is to make two design projects and then to compare and find common decision. This is the only suitable solution for international design projects between Finland and Russia.</p>		
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## 1. INTRODUCTION

During the last two decades the partnership between Finland and Russia in the field of building construction reached a new level. There are a number of residential and industrial buildings already constructed by Finnish companies on the territory of Russia and this tendency seems to continue. The design projects which are done according to the regulating documents of Finland should be adapted to those of Russia to be successfully built there. This thesis is directed to the facilitation of cooperation between two countries.

How can be known, which conditions are the best? Are they different? Do the methods of design and construction vary? What kinds of regulating documents are used and how? It is not easy to answer these questions. The only way is to make serious investigations in this area.

It is possible to compare Finnish and Russian regulating documents in building construction. In this thesis only narrow area of this field is described. This area is water supply and drainage systems of residential buildings in Finland and in Russia. In this thesis are presented the main parameters needed for design. They are: drinking water and drain water temperature, pipe material, diameters of pipes, fall. The dimensioning of example residential building is given according to Finnish and Russian regulating documents.

The comparison is formed the following way. First the main regulating documents of each country are named, described and the main definitions on water supply and drainage systems are given. Second design and dimensioning of example residential building are compared. Comparison is implemented in the following order: first water supply then drainage. Finally the main conclusions of the comparison are presented.

## 2. DESCRIPTION OF REGULATING DOCUMENTS

The main Finnish regulating document is the National Building Code of Finland. The National Building Code contains technical regulations and instructions, which are given by decree. The regulations are binding, and apply to the construction of new buildings. The regulations are applicable to renovation and alteration works only insofar as the type and extent of the measure and a possible change in use of the building require. The instructions are not binding but present acceptable solutions.

There are different parts of Building Code: from A to G. Water supply and drainage systems refers to part D – HEPAC and energy management. In this thesis only one of them will be taken into account. It is D1 “Water supply and drainage installations for buildings Regulations and guidelines 2007”/1/. Being the part of Europe Union, Finland had renovated national Standards and Decrees according to European ones. /2/

The main Russian regulating document is Building Norms and Rules (SNIP). It is a set of normative documents in construction, adopted by the executive bodies and containing the mandatory requirements. Until 1955 there was no centralized system of regulating documents in the field of construction in the USSR. After introducing the system was approved by the State Committee of the council of Ministers of the USSR. /4/

Building Norms and Rules are the main documents in the field of construction. They are separated into four parts: Managing of Business Organization, Design standards, Estimated rates, Cost standards of material and labor recourse. Design standards consist of the following parts: Safety, Design, Engineering networks and systems, Transportation, Hydraulic structures, Town planning, Organization of production and acceptance of work. Each SNIP consists of 4 parts: General provisions, Design standards, Rules of production and acceptance of work and Estimated rules and regulations. In this thesis “SNIP 2.04.01-85 (2000): Water supply and drainage of buildings” /3/ is used. It belongs to the part of design standards, engineering networks and systems. In addition to the Building Norms and Rules there are various rules, regulations, practice instructions, departmental construction norms, and other regulatory documents, which are used here also, but only as indirect source of information. /4/

More than twenty years have passed after the disintegration of the USSR, so the renovation of normative documents is necessary. Each document is corrected and changed according to the demands of modern life and construction. But the main changes are in process now. A great job is already done in this direction and some of the documents are renovated according to the European ones, taking into account standards of Russian Federation.

On this thesis there are the main differences between Finnish and Russian regulating documents and general rules for design and construction of water supply and drainage systems for residential buildings the most safe, reliable and economically efficient way.

### **3. WATER SUPPLY AND DRAINAGE SYSTEMS. GENERAL RULES FOR DESIGN**

Domestic water should be delivered to the taps in such a way that there would be no health hazards. It should be separated from any other substances. Water supply pipes are usually made from copper, stainless steel, plastic and multilayer pipes. It should be reasonable temperature in cold and hot water and minimum time delay between opening the tap and achieving the desired temperature. Water supply pipes should be easy to install and available to repair. Pipelines (if invisible) should be equipped by structure elements which are easy to expose. There must be water meter, and there must be enough space for its installation. /1/, /3/

Drainage systems must be designed and constructed in such a way that there were no health hazards. Smells, noise and flooding also should be avoided. Pipes should be laid in such a way that they are durable, reliable and easily available to repair. Water basin should have overflow. The sewer system should not have extra devices which stop flow. The pumping station should not spread smell. It should be equipped with check valve and ventilation. Each sewer point should have its trap to prevent smells. Each building should have at least one vent pipe. Changes of flow direction in the sewer should be avoided. The drain pipes must be laid underground in such a way that

they will not be damaged by earth pressure, corrosive influence of soil and applied loads. The pipes must be properly protected of sand, sludge, grease, petrol, corrosive substances and heavy metals. The change of flow direction should be avoided. The bends are to install not more than 90 degrees to the flow direction. Easy available openings should be provided. Drainage should be constructed to avoid freezing. /1/, /3/

In Russia is not obliged to have floor drains in washrooms and bathrooms, it depends on the appointment of the place and number of devices. Its also possible not to have vent pipe for each toilet – vent pipes from several toilets can be connected in one output. /3/

#### **4. WATER SUPPLY AND DRAINAGE PIPE MATERIALS**

In Finland it is common to use PEX, copper, stainless steel and cast iron pipes in design of water supply systems. Different kinds of plastic pipes are also used nowadays. They are: PVC, PP, multilayer pipes. Copper and multilayer pipes are often installed as distribution pipelines and the manifold is made of brass. Connection pipes are usually PEX pipes./6/

There are two ways to design a water supply system. The first one is traditional way, when the distribution pipe follows from the water meter to the last faucet. According to this method the diameter of the distribution pipe is getting smaller, until the pipe reaches the last point. In the second method the manifold should be used. In this case the distribution pipe ends up when it comes to the manifold and then the flow is separated on connection pipes to each faucet. The first method is used mostly in renovation. The second one have several advantages over the first one such as small diameters required and simple service: connection pipes are in casing pipe to provide easy changing. PVC pipes are used as connection cold water pipes between the buildings. /1/

In Russia the same materials are used. The first difference is that copper pipes are not often used because of its high price. And one more difference is that in Russia it is not

common to make the special floor for flexible pipes – it is done only in some cases, because it leads to the high prices on the materials and increases the height of the building which is often limited. So this method is allowed but not usual. /3/

For drain pipes in Finland the most common used materials are PP, PVC-U, PE, Cast iron and Stainless steel. Copper pipes are used in some cases for example as rain water drains and for draining the waste water from washing machine and similar. The most common used materials are PP and PVC pipes. PP is for connection and collection pipes inside the building and PVC for connection pipe between the buildings./6/

In Russia the most common used materials are the same except PE, Stainless steel and Copper. PE is not used traditionally. Stainless steel is used only for drain pipes under pressure. Copper pipes are not common, they are used only in small buildings or one family houses. Cast iron is not often used nowadays because of its high weight and difficult installation. The most common used materials are PP and PVC pipes. But, comparing with Finland, in Russia PVC is used not only outside but also inside the building if it is laid under the floor. /3/

## **5. DRINKING WATER AND DRAIN WATER TEMPERATURE**

In Finland the temperature of warm water is to be more than 55°C, the temperature of cold water should be not more than 20°C. The water from the tap should not exceed 65 degrees. /1/

In Russia the temperature of warm water should be not less then 50°C– for the District Heating, not less than 60°C – for the District Heating and Heat Exchanger inside the building. In any case it should be from 50 to 75°C. Cold water should be not less then 10°C in winter time, not more than 20°C in summer time./3, p.3/

Temperature of waste water is an important parameter when choosing pipe material. The PP pipes stand temperature up to 90° for short time and up to 80° for a long time, PVC pipes up to 80° for the short time and up to 40° for a long time. Pipe material which is not deformed of warm waste water is Cast iron./7/



## 6. DIMENSIONING OF WATER SUPPLY AND DRAINAGE INSTALLATIONS

The following tables: Table 1 and Table 2 show the dimensioning order of water supply and drainage installations in residential buildings in Finland and Russia. The tables are mostly the same. So the calculation could be done comparing each step. First follows Table 1 for water supply and next Table 2 for drainage. Two differences in calculation of water supply system are that in Russia the volume check is not performed and the highest flow rates differ.

**Table 1. Dimensioning order in Finland and in Russia /1/, /3/**

Finland	Russia	Comparison
Determination of standard flows of each faucet	Determination of standard flows of each faucet	The same
Calculation sum of standard flows (Q)	Calculation sum of standard flows (Q)	The same
Calculation the dimensioning flow (q) for each section of distribution pipe - warm and cold water separately	Calculation the dimensioning flow (q) for each section of distribution pipe - warm and cold water separately	The same
Dimensioning of distribution pipes (flow rate is < 2,0m/s).	Dimensioning of distribution pipes (flow rate is < 2,0m/s).	The same
Dimensioning of connecting pipes (flow rate < 3 m/s).	Dimensioning of connecting pipes (flow rate < 2 m/s).	Flow rate differs
Volume flow check which is based on calculations of pressure losses. Every faucet must provide water flow that is 70% - 150% from its standard flow.	-	In Russia the volume check is not performed
If the pressure is still too high, then the decompression valve should be installed.	If the pressure is still too high, then the decompression valve should be installed.	The same
If the pressure losses are too high then the larger diameter should be chosen.	If the pressure losses are too high then the larger diameter should be chosen.	The same

**Table 2. Dimensioning of gravity drain /1/, /3/**

Finland	Russia	Comparison
Inspected, that sewer points are installed above the height of backwater and sufficient sewer declivity is reached. Otherwise pump station of sewer water shall be planned in the sewer system.	Inspected, that sewer points are installed above the height of backwater and sufficient sewer declivity is reached. Otherwise pump station of sewer water shall be planned in the sewer system.	The same
The standard flow of each sewer point shall be chosen.	The standard flow of each sewer point shall be chosen.	The same
The sums of standard flows and dimensioning flows shall be calculated in the collector pipes;	The sums of standard flows and dimensioning flows shall be calculated in the collector pipes;	The same
Dimensioning unvented connection pipe;	Dimensioning unvented connection pipe;	The same
Dimensioning of unvented connection sewer pipes;	Dimensioning of unvented connection sewer pipes;	The same
Dimensioning of unvented collection sewer pipes;	Dimensioning of unvented collection sewer pipes;	The same
Dimensioning of vented collection sewer pipes;	Dimensioning of vented collection sewer pipes;	The same
Dimensioning of the vent pipe.	Dimensioning of the vent pipe.	The same

## **7. CALCULATION OF WATER SUPPLY AND DRAINAGE SYSTEMS ACCORDING TO FINNISH AND RUSSIAN REGULATING DOCUMENTS**

Given values for the example building are listed below. In the following chapters design and dimensioning of water supply and drainage system in the residential building are performed. It is three floor building with ground floor. There are 3 sections, 16 flats in each section, 4 flats in each floor, 4 persons in each flat. In the ground floor there are sauna and laundry. Pipe material for water supply is copper. The material for drainage is cast iron. Pressure loss of service pipe is 15 kPa, pressure loss of main

water meter is 30 kPa including valves. Hot domestic water secondary side of heat exchanger pressure loss is 30 kPa. The pressure loss of secondary side of heat exchanger for hot domestic water is 30 kPa. First the design and dimensioning is done for water supply system then for drainage system. (Appendix 1 – Appendix 6)

## **7.1 WATER SUPPLY SYSTEM**

In this chapter dimensioning of water supply system according to Finnish and Russian regulating documents is performed. At the example such parameters as the building, the number of residents, the number of faucets, pipe material, length of pipes, the diameters of pipes are the same. The main goal is to compare the dimensioning flow, maximum standard flow and pressure losses in pipes. These magnitudes are found at the end of calculation and are given in the table form for Finnish calculation (Appendix 8 and Appendix 9) and Russian calculation (Appendix 12 and Appendix 13)

### **Determination of standard flow**

Standard flow is typical value of flow in a water outlet. From Table 3 and Table 4 follow that Russian standard flows are much less than Finnish ones, and in Russia the concept “common flow” is used. Common flow is the standard flow of warm water and cold water at one time. After each table follows a list of Standard flows needed for dimensioning of pipes from the given example.

In Finland simultaneous demands are to be taken into account in accordance with Table 3. If the fitting has alternative outlets, the maximum flow is to be used in design. A device which supplies water for a consumer unit such as a washing machine through an easily demountable connection is also considered to be an outlet.

Designing the supply pipe, a total standard flow of 0,8 l/s for hot water may be assumed for each flat, single family house or similar even though the aggregate flow according to the table is a higher figure.

A separate pipe for the kitchen or bathroom in a dwelling may be designed without a consideration of a standard flow for a washing machine or dishwasher which is connected there, provided that the design flow of the pipe in question  $\geq 0,2$  l/s. In designing supply pipes common to a number of dwellings, consideration should be given to the flows which occur./1/

**Table 3. Standard flows for design in Finland /1/**

Water outlet	Standard flow $q_N$ , l/s	
	Cold water	Hot water
Bath	0,3	0,3
Bidet	0,1	0,1
Sink	0,2	0,2
Sink unit (bucket unit)	0,2	0,2
Dishwasher, domestic	0,2	0,2
Shower	0,2	0,2
Tap	0,2	0,2
Washing machine, domestic	0,2	0,2
Washing machine, in laundry or similar	0,4	0,4
Garden valve		
In one family house DN15	0,2	
In block of flats DN20	0,4	
Wash basin	0,1	0,1
Urinal with flushing valve	0,4	
Urinal with flushing tap	0,2	
WC	0,1	
WC with flushing valve	1,5	

Standard flows for Finland in my case are:

1. Sink  $q_N=0,2$  l/s
2. Shower  $q_N=0,2$  l/s
4. Wash Basin  $q_N=0,1$  l/s
5. WC  $q_N=0,1$  l/s
6. Washing machine (in laundry)  $q_N=0,2$  l/s

Standard flows and the list of water outlets are given in the Appendix 6.

The Russian table looks different, but it is given here in the similar way as Finnish one for the better understanding. In residential buildings with unknown number of devices maximum standard flow is

$$q_0^{tot} = 0,3 \text{ l/s} \quad q_0^h = q_0^c = 0,2 \text{ l/s}$$

If there are different types of consumers and devices the following formula should be used:

$$q_0 = \frac{\sum_i N_i P_i q_{0i}}{\sum_i N_i P_i} \quad (1)$$

$i$  =  $\Sigma$  the flow for each group of consumers

$q_0$  maximum standard flow in pipe being dimension  $\text{dm}^3/\text{s}$

$q_0^h$  maximum standard flow for warm (hot water)  $\text{dm}^3/\text{s}$

$q_0^c$  maximum standard flow for cold water  $\text{dm}^3/\text{s}$

**Table 4. Standard flows for design in Russia /3,p 53/**

Water outlet	Standard flow $q_N$ , l/s		
	Cold water	Hot water	Common
Bath	0,18	0,18	0,25
Bidet	0,05	0,05	0,08
Sink	0,09	0,09	0,12
Sink unit (bucket unit)	0,09	0,09	0,12
Dishwasher, domestic	0,09	0,09	0,12
Shower	0,09	0,09	0,12
Tap	0,09	0,09	0,12
Washing machine, domestic	Not rated	Not rated	Not rated
Washing machine, in laundry or similar	Not rated	Not rated	Not rated
Garden valve			
• In one family house	0,15		
• In block of flats	0,15		
Wash basin	0,09	0,09	0,12
Urinal with flushing valve	0,2		0,2
Urinal with flushing tap	0,035		0,035
WC	0,1		0,1
WC with flushing valve	1,4		1,4

Standard flows for Russia in my case are:

1. Sink  $q_N=0,09$  l/s
2. Shower  $q_N=0,09$  l/s
4. Wash Basin  $q_N=0,09$  l/s
5. WC  $q_N=0,1$  l/s
6. Washing machine (in laundry)  $q_N=0,2$  l/s

### Flow in distribution pipes

In Finland the dimensioning flow of distribution pipe is defined by sum of standard flows. In designing distribution pipes common to a number of dwellings, consideration shall be given to the flows which occur. The dimensioning flow in the distribution pipe is obtained from the Formula 2:

$$q = q_{N1} + \left( \frac{Q}{q_{N1}} \right)^{0.5} \cdot \left( \frac{q_m}{q_{N1}} \right)^{0.5} \cdot A \quad (2)$$

$q$	dimensioning flow	$\text{dm}^3/\text{s}$
$q_{N1}$	maximum standard flow in pipe being dimension	$\text{dm}^3/\text{s}$
$q_m$	mean flow through valve in question	(0,2) $\text{dm}^3/\text{s}$
$\Theta$	probability that $q_m$ is used during peak consumption periods	(0,015)
$Q$	aggregate standard flows through the connected water outlet	$\text{dm}^3/\text{s}$
$A$	correction factor which takes account of the number of times that the dimensioning flow $q$ is exceeded	(3,1)

Values are given for residential buildings./1/

Factor A depends on the meaning of Uncertainty. In Table 5 there are already calculated magnitudes. To find factor A Uncertainty should be interpolated between the given meanings.

**Table 5. Determination of factor A /1/**

Uncertainty	0,01	0,001	0,0001
Factor A	2,3	3,1	3,7

The meanings of aggregate standard flow in the example are given from 0,1 dm<sup>3</sup>/s to 26 dm<sup>3</sup>/s. In D1 the meanings reach 150 dm<sup>3</sup>/s. The Dimensioning flow is on the cross of Maximum standard flow and Aggregate flow. The aggregate standard flow should be calculated by summarizing all the standard flows. Maximum standard flow is known by the determination of the faucet with the largest standard flow. (Appendix 7)

In Finland the sum of standard flows is calculated according to the number of devices. There are typical devices in each flat and some extra devices in the ground floor. According to the picture, the sum of standard flows for cold water is 43,4 l/s and for warm water is 19,2 l/s. After determination of sum of standard flows, the dimensioning flow is defined according to the Formula 2 or to the Appendix 7.

$$q = 0,2 + 0,015(44,2 - 0,2) + 0,17(44,2 - 0,2)^{0,5} = 1,99 \text{ l/s} \quad \text{for cold water}$$

$$q = 0,2 + 0,015(19,2 - 0,2) + 0,17(19,2 - 0,2)^{0,5} = 1,22 \text{ l/s} \quad \text{for warm water}$$

The full calculation is attached on the table form' (Appendix 8 and Appendix 9)

In Russia there are some differences. At the example Finnish residential building with sauna and laundry in the ground floor is given. In Russia it is not common to design such kind of buildings. It is usually designed flats with bathrooms and washing machines in each flat. Saunas or Russian banias (bathhouses) are designed in separate buildings. Not so long ago it has become popular to design saunas inside the apartments. Anyway, as there are no standard flows taking into account residential buildings with sauna and laundry, the calculation will be more complicated because building, sauna and laundry will be calculated separately. According to the Russian Table 6 when calculating sauna (we consider it as public shower) it should be taken into account the number of changes. If sauna is reserved one time per flat per week, there are six changes per maximum day. If there are four person in each apartment then there will go 24 persons per maximum day. When calculating laundry it is one more assumption. Flows for laundry are taken for one kilogram of dry clothes. So if it will be reserved one time a week for each flat and every of two washing machines can wash

five kilograms of clothes, then per each flat it will be ten kilograms and it can be six changes per maximum day, so 60 kilograms of dry clothes can be washed.

According to the Russian calculation there are several types of consumers. For example residential buildings, hostels, laundries, canteens, saunas etc. As it is not usual for Russia to have sauna and laundry for common use, the calculation includes magnitudes for different types of buildings. /3/

**Table 6. Water consumption rates /3,p 58/**

Type of building	Consumer	Rate of water consumption (l)						Standard flow $q_0$ ( $q_N$ ) l/s (l/h)	
		Average day $q_{u,m}$		Maximum day $q_u$		Maximum hour $q_{hr,u}$		Warm and cold	Warm Or cold
		Warm and cold	Warm	Warm and cold	Warm	Warm and cold	Warm		
Residential building with wash basins and showers	1 inhabitant	195	85	230	100	12,5	7,9	0,2 (100)	0,14 (60)
Sauna with shower	1 person			500	270	500	270	0,2 (500)	0,14 (270)
laundry	1 kg of dry clothes	40	15	40	15	40	15	0,3 (300)	0,2 (200)

Calculation of dimensioning flow can be implemented in two ways. In any case P and N, or their multiplication NP should be known.

P probability

N number of devices

Probability can be calculated either for one type of consumers using Formula 3 or Formula 4 for different types of consumers.

$$P = \frac{q_{hr,u} U}{q_0 N \cdot 3600} \quad (3)$$



$$P_i = \frac{\sum_{i=1}^n N_i P_i}{\sum_{i=1}^n N_i} \quad (4)$$

$U$  a number of consumers person  
 $q_{hr,u}$  standard flow for one person per hour  $\text{dm}^3/\text{h}$   
 $q_0 (q_N)$  standard flow l/s  
 /3,p 4/

From Formula 3 the multiplication of N and P can be found:

$$NP = \frac{q_{hr,u} U}{q_0} = \dots \cdot 3600 \quad (5)$$

$$\begin{aligned}
 (NP)_{tot} &= \frac{12,5 \cdot 144}{0,2 \cdot 3600} = 2,5 \\
 (NP)_c &= \frac{7,9 \cdot 144}{0,14 \cdot 3600} = 2,257 \\
 ( ) &= \frac{4,6 \cdot 144}{0,14 \cdot 3600} = 1,314
 \end{aligned}$$

PN of the sauna can be calculated the same way, so the results are:

$$(NP)_2^{tot} = 2,222$$

$$(NP)_2^h = 1,257$$

$$(NP)_2^c = 2,083$$

From Formula 4 the multiplication of N and P can be found:

$$(NP)^{tot} = 4,722$$

$$(NP)^h = 3,507$$

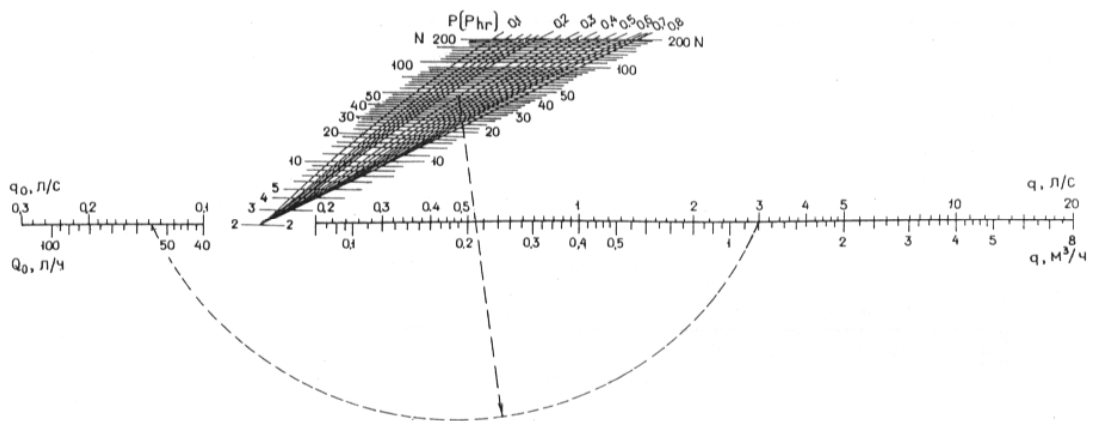
$$(NP)^c = 3,398$$

After probability is calculated, the dimensioning flow can be known in two ways first is with Formula 6 and second is with Nomogram (Figure 2). If the dimensioning flow is known with Formula 6 then coefficient  $\alpha$  is unknown. To determine  $\alpha$  Appendix 10

or Appendix 11 should be used. Coefficient  $\alpha$  is found at the cross between the lines denoting P and N. Appendix 10 is used when  $P > 1; N \leq 200$ , Appendix 11 is used when  $P \leq 0,1$  and any N or when  $P > 0,1$  and  $N > 200$ . Appendix 10 is taken from SNIP, but it is reduced to the number of devices of 80 as an example. Appendix 11 is taken from SNIP, but it is reduced to the meaning of  $NP = 2,3$  as an example. The original table has the biggest meaning of  $NP = 2000$ .

$q$	$q_0$	$\alpha$		(6)
$q = 5 \cdot$		.dimensioning flow		l/s
$\alpha$		coefficient, depends on N and P		
$q_0 (q_N)$		standard flow		l/s

If the dimensioning flow is known with Nomogram (Figure 2) the meaning of Standard flow,  $q_0 (q_N)$  is 0,1; 0,14; 0,2; 0,3. The Nomogram is read the following way: the number of devices ( $N=50$ ) and Probability ( $P=0,2$ ) is known. First the cross between the lines denoting these magnitudes should be found. The Standard flow is also known. So the Dimensioning flow is determined with putting the compasses on the cross and making the round counterclockwise. The start point is Standard flow ( $q_N=0,14$ l/s) the final point is Dimensioning flow ( $q=3,0$  l/s).



**Figure 2. Nomogram for determining Dimensioning flow  $q$  ( $N \leq 200$ ,  $P > 0,1$ ) /3,  
p 65/**

Translation of Russian definitions: л/с - l/s, л/ч - l/h, м<sup>3</sup>/ч - m<sup>3</sup>/h.

After determination of Dimensioning flow  $\alpha$  is determined:

$$\alpha^{\text{tot}} = 5,32$$

$$\alpha^{\text{h}} = 5,23$$

$$\alpha^{\text{c}} = 3,49$$

(Appendix 10, Appendix 11)

Standard flow is calculated with Formula 7:

$$q = \frac{\sum_{i=1}^i N_i P_i q_{0i}}{\sum_{i=1}^i N_i P_i} \quad (7)$$

$$q_0^{\text{tot}} = 0,213 \text{ l/s}$$

$$q_0^{\text{h}} = 0,145 \text{ l/s}$$

$$q_0^{\text{c}} = 0,154 \text{ l/s}$$

Dimensioning flow for sauna is calculated as multiplication of Standard flow from the faucet on the number of showers (Formula 8):

$$q_3 = N q_0 \quad (8)$$

$$q_3^{\text{tot}} = 2 \cdot 0,213 = 0,426 \text{ l/s}$$

$$q_3^{\text{h}} = 2 \cdot 0,145 = 0,29 \text{ l/s}$$

$$q_3^{\text{c}} = 2 \cdot 0,154 = 0,308 \text{ l/s}$$

Dimensioning flow for whole building is calculated with Formula 9:

$$q = q_0 \cdot \alpha + q_3 \quad (9)$$

$$q^{\text{tot}} = 5 \cdot 0,213 \cdot 5,32 + 0,426 = 6,417 \text{ l/s}$$

$$q^{\text{h}} = 5 \cdot 0,145 \cdot 5,23 + 0,29 = 4,071 \text{ l/s}$$

$$q^{\text{c}} = 5 \cdot 0,154 \cdot 3,49 + 0,308 = 2,968 \text{ l/s}$$

The full calculation is attached in the table form (Appendix 12 and Appendix 13)

## Dimensioning of pipes

Dimensioning of pipes should be done according to the laws of Hydraulics, so it is the same for Finland and for Russia. In the example calculation pipe material is copper. In Russia the calculation of pressure losses of copper pipes for water supply and heating is described in the standard of non-profit organization of HVAC engineers “Pipelines from copper pipes for systems of internal water supply and heating. General specifications”/5/ Standard is approved by federal law, but is applied as recommendation.

In Finland pressure losses in pipe are determined with Formula 10:

$$\Delta p = R \cdot l + Z \quad (10)$$

$$\Delta p = \zeta \cdot p_d \cdot \left( \frac{v}{v_0} \right)^5 \quad (11)$$

$$p_d = \rho \cdot v^2 \quad (12)$$

$\sum \Delta p_{\text{local}}$  0,5 . . . sum of local pressure losses kPa

R friction loss per one meter of pipe kPa

l pipe length m

Z the pipe part's single (local) resistance pressure loss kPa

$\sum \zeta$  sum of pipe part's coefficients depended on the nature of local resistance

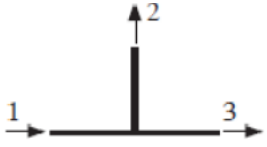
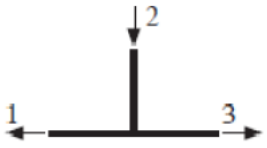
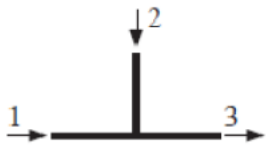
$p_d$  dynamic pressure kPa

$\rho$  density of the fluid kg/m<sup>3</sup>

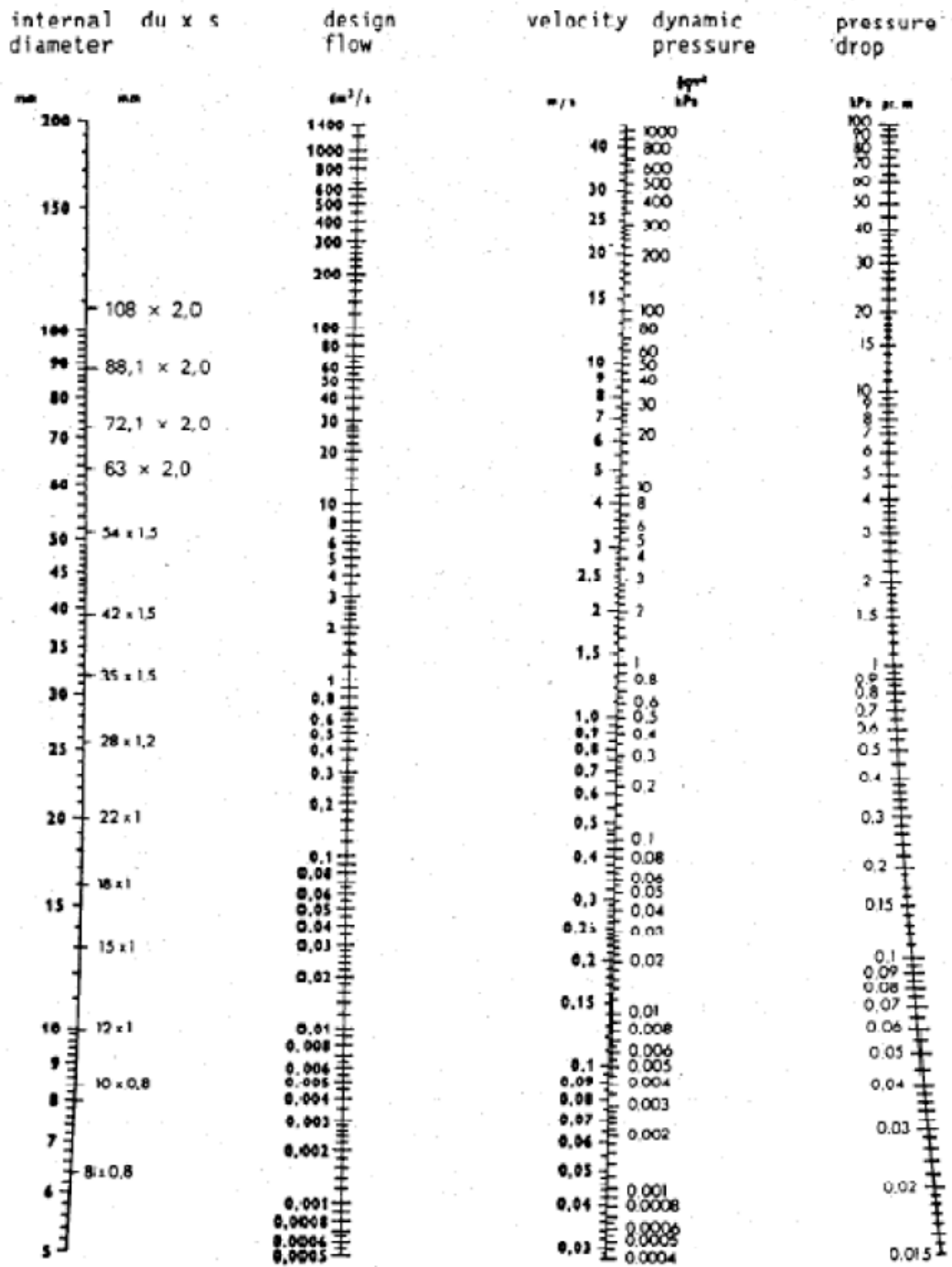
v rate of flow m/s

The sum of pressure resistance is found with Table 7. Where r is radius of curvature and d is inner diameter. The local resistance coefficient relates to the rate of flow after the branch.

**Table 7. Local pressure losses due to local resistance (the coefficient of loss) /1/**

Pipe fitting	r/d or direction of flow	Local resistance coefficient
Bend	$r/d \leq 3$ $r/d > 3$	0,5 0,0
Elbow	-	1,0
Branch 	Direction 1-2 Direction 1-3	2,0 0,0
	Direction 2-1 Direction 2-3	3,0 3,0
	Direction 2-3 Direction 1-3	1,0 0,0

One more unknown parameter of Formula 10 is pressure drop. It is known with Figure 3. The nomogram (Figure 3) is based on the Colebrook formula, with the roughness coefficient  $k=0,15\text{mm}$ . Water temperature =  $+10^\circ\text{C}$ . The error in the pressure drop read of the nomogram is not greater than  $-10\%$  at  $0^\circ\text{C}$  and not greater than  $-25\%$  at  $+55^\circ\text{C}$ .



**Figure 3. Pressure drop in copper pipe, allowance being made for sedimentation in the pipe /1/**

Values for Figure 3:

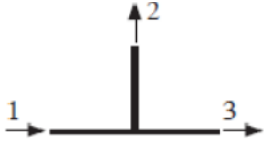
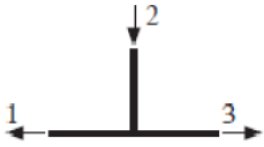
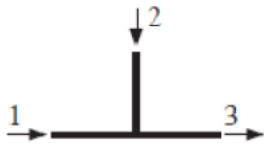
$d_u$	internal diameter	mm
$s$	thickness of the wall of the pipe	mm
$q$	design flow (dimensioning flow)	dm <sup>3</sup> /s
$v$	rate of flow (velocity)	m/s

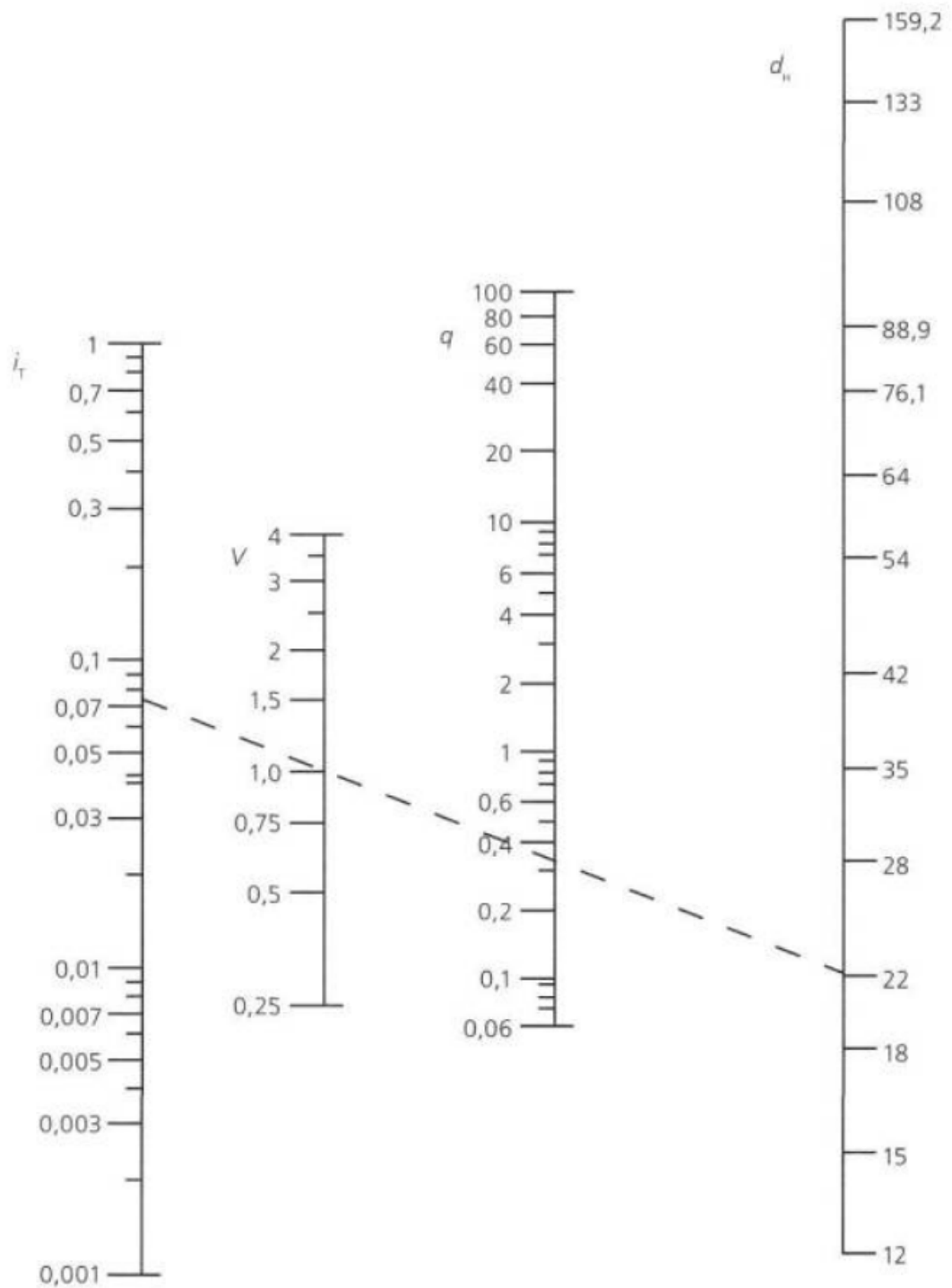
$p_d$	dynamic pressure	kPa
R	Pressure drop	kPa/m

The calculation is attached in the table form (Appendix 8 and Appendix 9)

In Russia the dimensioning has the same order as in Finland, but the local resistance coefficients are different. The nomograms look different but they also have close results.

**Table 8. Local pressure losses due to local resistance (the coefficient of loss) /5/**

Pipe fitting	r/d or direction of flow	Local resistance coefficient
Bend 90 45		0,5
Elbow	-	0,0
Branch 	Direction 1-2 Direction 1-3	1,5 0,5
	Direction 2-1 Direction 2-3	3,0 3,0
	Direction 2-3 Direction 1-3	1,5 0,5



**Figure 4. Pressure drop in copper pipe, allowance being made for sedimentation in the pipe /5/**

Translation of Russian definitions:  $10 \cdot i_t = R$ ,  $d_{\text{н}} = d_u$

Values for Figure 4:

$d_u$	internal diameter	mm
$q$	design flow (dimensioning flow)	$\text{dm}^3/\text{s}$



v	rate of flow (velocity)	m/s
R	Pressure drop	kPa/m

The calculation is attached in the table form (Appendix 12 and Appendix 13)

## 7.2 DRAINAGE SYSTEM

In this chapter dimensioning of drainage system according to Finnish and Russian regulating documents is performed. At the example such parameters as the number of residents, the number of faucets, pipe material and length of pipes are the same. The main goal is to compare the standard flow, the sum of standard flows, fall, diameters of drain pipes and diameters of vent pipes.

### Standard flow

In Finland standard flow for sewer points is found from Table 9. There can be found some remarks which need special description.

- a) In a restaurant with a grease separator.
- b) This flow is not taken into account in design when it is drained to the trap by another waste appliance.
- c) The maximum sum of standard flows in the waste appliances, which may be drained through the floor drain. When water outlets or waste appliances are drained through a floor drain, only the actual standard flows of waste appliances which are drained into the floor drain are taken into account in design. In the sanitary cabin of the dwelling, hotels or similar, only the maximum standard flow which is drained into the floor drain is taken into account in design.

**Table 9. Standard flows for sewer points in dimensioning use /1/**

Sewer point	Standard flow dm <sup>3</sup> /s
Wash basin	0,3
Bidet	0,3
Bath	0,9
Shower	0,6
Shower basin	0,9
WC	1,8
Sink unit (for kitchen)	0,6
- Domestic use	0,6
- Commercial use with 2 sinks	0,9 (a)
- Commercial use with 3 sinks	0,6 (a)
Dishwasher, domestic	1,2 (b)
Dishwasher, restaurant	0,6 (a), In floor drain 100
Washing machines, domestic	0,3 (b)
Washing machines, laundry room	1,2 In floor drain DN 100
Urinal, with flushing valve	0,6
Urinal, with flushing tap	0,3
Floor drain DN 50	≤0,9
Floor drain DN 75 (DN 70)	≤1,5
Floor drain DN 110 (DN 100)	≤1,8

Types of water outlets used in calculation are given below:

1. Bidet  $q_N=0,3$  l/s
2. Shower  $q_N=0,6$  l/s
4. Wash Basin  $q_N=0,1$  l/s
5. WC  $q_N=1,8$  l/s
6. Floor drain  $q_N=0,6$  l/s

Standard flows and the list of water outlets are given in the Appendix 6.

The sum of standard flows is  $Q=34,8$  l/s

The Russian Table 10 looks different, but is given here in the similar way as Finnish one for the better understanding.

**Table 10. Standard flows for sewer points in dimensioning use /3,p 15/**

Sewer point	Standard flow dm <sup>3</sup> /s
Wash basin	0,15
Bidet	0,15
Bath	0,8
Shower	0,2
Shower basin	0,6
WC	1,4
Sink unit (for kitchen)	
- Domestic use	0,6
- Commercial use with 2 sinks	0,6
- Commercial use with 3 sinks	Not rated
Dishwasher, domestic	Not rated
Dishwasher, restaurant	Not rated
Washing machines, domestic	Not rated
Washing machines, laundry room	Not rated
Urinal, with flushing valve	0,2
Urinal, with flushing tap	0,1
Floor drain DN 50	0,7
Floor drain DN 75 (DN 70)	Not rated
Floor drain DN 110 (DN 100)	2,1

Types of water outlets used in calculation are given below:

1. Bidet  $q_N=0,15$  l/s
2. Shower  $q_N=0,2$  l/s
4. Wash Basin  $q_N=0,15$  l/s
5. WC  $q_N=1,4$  l/s
6. Floor drain  $q_N=0,7$  l/s

Standard flows and the list of water outlets are given in the Appendix 6.

The sum of standard flows is  $Q=30,95$  l/s

It can be mentioned from the tables that Finnish standard flows are much bigger than Russian. There are no rates on the dishwashers, washing machines in Russia and DN of floor drain DN 75 (DN 70) is not used. But the sums of standard flows are close.

### Dimensioning of vent pipe

In Finland in a cold place vent pipe must be minimum DN 100 (DN 110), a common pipe leading to the roof can connect maximum 3 vent pipes.

**Table 11. Dimensioning of vent pipe /1/**

Sum of standard flows, dm <sup>3</sup> /s	Minimum pipe size. DN
≤5	70 (75)
>5	100 (110)

For the example calculation the sum of standard flows for each vent pipe is 8,7 dm<sup>3</sup>/s, which is more then 5 dm<sup>3</sup>/s. So the size of vent pipe is DN110.

In Russia the dimensioning of vent pipe is done according to Table 12.

**Table 12. Dimensioning of vent pipe /3,p 41/**

Sewer pipe size DN	Angle of connection to standing pipe, Degrees	Maximum flow, dm <sup>3</sup> /s Minimum vent pipe size, DN			
		50	85	100	150
50	90	0,8	2,8	4,3	11,4
	60	1,2	4,3	6,4	17,0
	45	1,4	4,9	7,4	19,6
85	90	—	2,1	—	—
	60	—	3,2	—	—
	45	—	3,6	—	—
100	90	—	—	3,2	8,5
	60	—	—	4,9	12,8
	45	—	—	5,5	14,5
150	90	—	—	—	7,2
	60	—	—	—	11,0
	45	—	—	—	12,6

According to Russian Table 12 each vent pipe has to have DN 150, because the sum of standard flows is  $7,35 \text{ dm}^3/\text{s}$  per each vent pipe.

It can be seen from tables that there is wider classification of vent pipes in Russia according to the diameter of sewer pipe and connection angle. And there are also two more pipe diameters, comparing with Finland.

### **Vertical drain**

In Finland dimensioning of vertical drain is done according to Figure 5 which shows the sizes and the gradients are for cast iron pipes. The chart refers to the internal diameter of the sewer pipe.

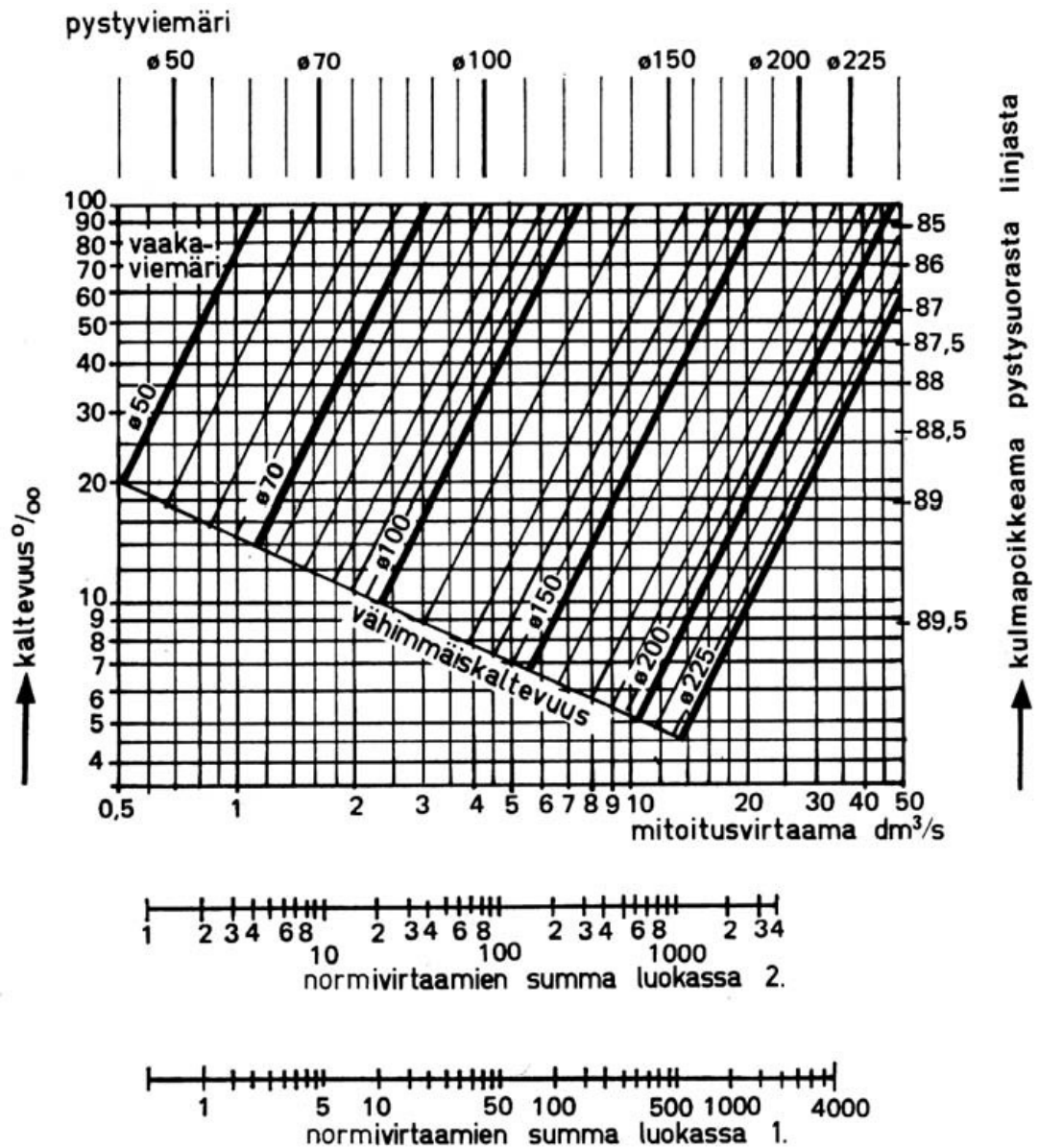
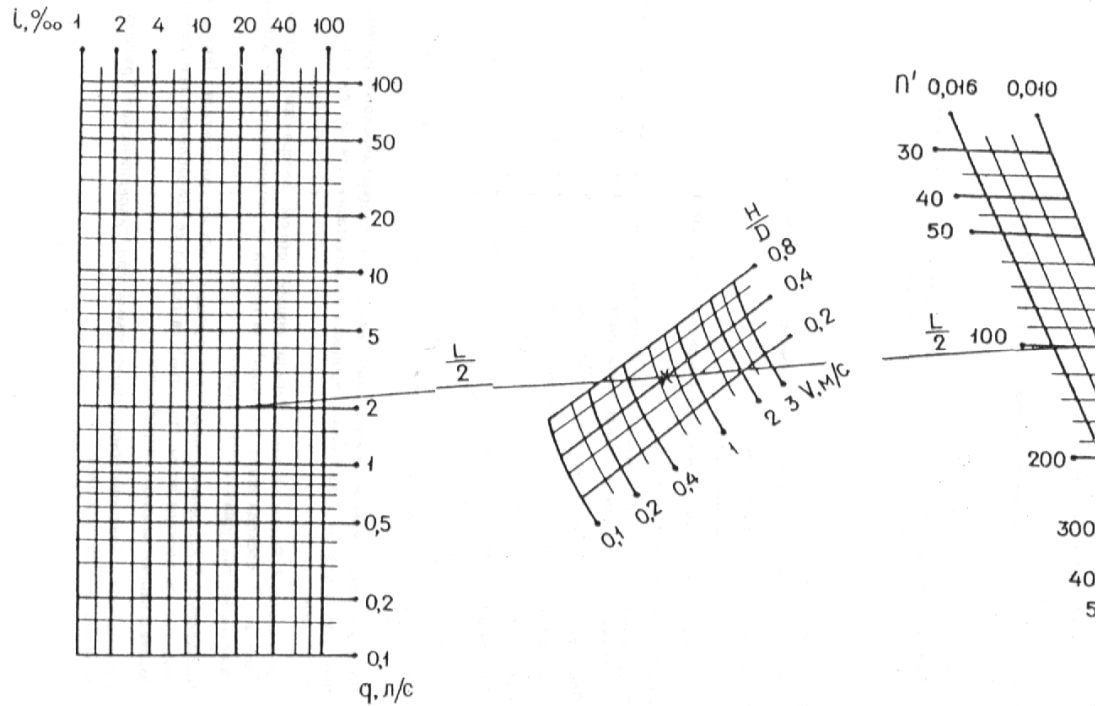


Figure 5. Vented gravity pipes /1/

Translation of Finnish definitions: Kaltevuus – declivity, Kulmapoikkeama pystysuorasta - angular deflection from the vertical line, Vähimmäiskaltevuus - the minimum declivity, Normivirtaamien summa luokassa 2 - sum of standard flows in class 2, Normivirtaamien summa luokassa 1 - sum of standard flows in class 1.

In Russia dimensioning of vertical drain is done the following way. The nomogram given in Figure 6 is for cast iron pipes.



**Figure 6. Nomogram for the hydraulic calculation of drain pipes /3, p 71/**

There are two different nomograms in Finland and in Russia, but the purpose remains the same. In Finland separation on two class and declivity is taken into account. In Russia filling is taken into account.

### **Fall**

In Finland the minimum fall of the connection sewer pipe is at least 10 ‰. The minimum fall shall be always determined by dimensioning flow even diameter of pipe is chosen next larger DN size. The flashing water of WC should be at least 4 liters. The flashing water, which amount is less than 6 liters shall be used only in the dwellings (apartment), where the following limitations shall be taken into account:

The minimum fall of connection pipe of WC shall be set 20 ‰. The minimum fall of the horizontal collection pipe, which is connected into the connection pipe of WC, should be set 20 ‰. The minimum fall of one-family house's plot drain (service pipe) should be set 20 ‰. Minimum filling factors for horizontal drains – 0,5, for vertical drains – 0,2. /1/

In Russia the fall is determined according to Formula 13. When the building has not got great amount of devices the fall is taken according to the minimum fall. The flashing water of WC should be at least 1,8 liters. All the magnitudes are taken from Table 13.

$$V\sqrt{\frac{H}{d}} \geq K \quad (13)$$

**Table 13. The meaning of magnitudes needed for determination of fall /3/**

Magnitude	Name	Meaning	Comments
v	velocity	$\geq 0,7$	-
H/d	filling factor	$\geq 0,3$	-
K	coefficient	0,5	for plastic and glass pipes
		0,6	for other pipes

The minimum fall for the horizontal drains with diameter from 40 to 50 mm should be set 30‰, for the diameter from 85 to 100 mm should be set 20‰. The maximum fall is 150‰. Only for the connection pipes which length is less then 1,5m. /3, p 40/

## 8. CONCLUSION

In accordance with all mentioned above several conclusions can be done: Generally Finnish and Russian calculations and rules on water supply drainage are the same. But there are several differences. First the values of flows for water supply and hence for drainage are different. Second some methods of calculation vary. Third the pipe diameters are not always exactly the same. Next there are some devices in Finland which are not used in Russia.

On my opinion calculation with Finnish regulating documents is much easier then with Russian ones. The reason is that in Russia there is no clear method of calculation. Designer have to find decision himself using documents which he prefers, but the decision should not contradict to the regulating documents. Russian calculation has several drawbacks comparing with Finnish one. First it is longer and more difficult. Sec-



and there are a lot of assumptions which lead to different results. Finally I think that Russian documents need renovation and systematization.

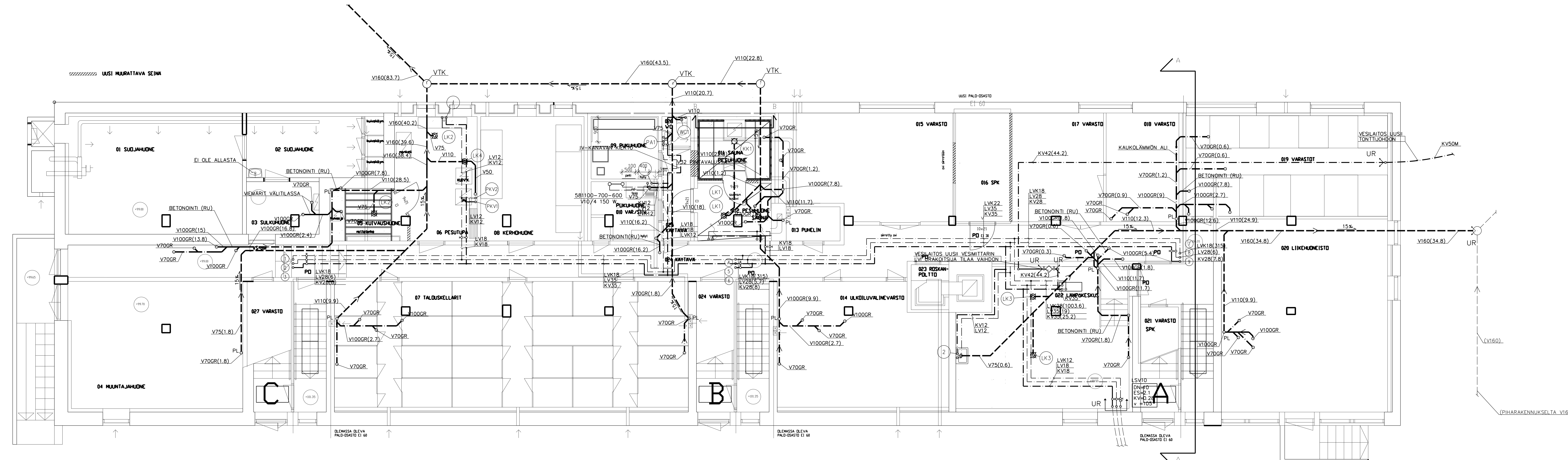
To finish off I would like to mention that the partnership between Finland and Russia in the field of building construction particularly when designing and dimensioning water supply and drainage systems is possible and desirable. But it requires the following steps. First make design project according to the regulating documents of one country. Second make the same project according to those of another country. Third compare results and find suitable solution for Finland and for Russia. Today it is the only way, but if the relationship is going to continue and develop the better decision will be found.

## **BIBLIOGRAPHY**

1. National building code. Regulations and guidelines 2007. Part D1. Water Supply and drainage installations for buildings. Ministry of the Environment.
2. The national Building Code of Finland. Ministry of the Environment. WWW document. <http://www.ymparisto.fi/default.asp?contentid=68171&lan=en>. Updated 5.4.2010. Referred 21.9.2011
3. SNIP 2.04.01-85(2000). Water Supply and Drainage systems for buildings. ГУП ЦПП № 1997 ФГУП ЦПП № 2006
4. А. Ф. Иванов. Строительные нормы и правила, ч. 1, гл. 1. Система нормативных документов. М. 1975.
5. СТО НП АВОК 6.3.1-2007. Pipelines from copper pipes for systems of internal water supply and heating. General specifications. ООО ИИП "АВОК-ПРЕСС" № 2007
6. Mäkinen, Riika. Drinking water quality and network materials in Finland. Summary report. Finnish Institute of Drinking Water. 2008
7. СП 40-102-2000. Design and Installation of Water supply and Drainage systems made from polymer materials. ГУП ЦПП № 2001

**APPENDIX**

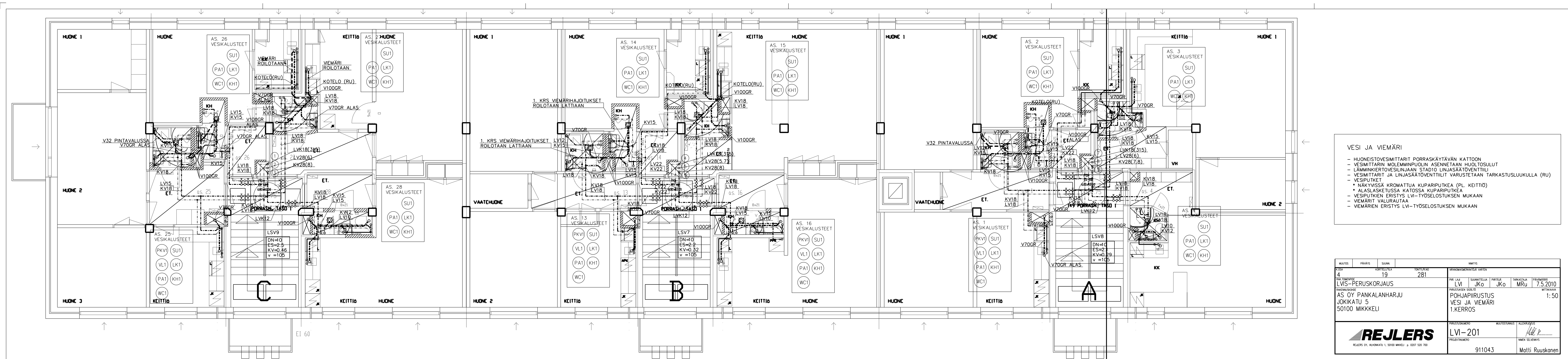
1. **Appendix 1** Pohjapiirustus vesi ja viemäri kellarikerros (Ground floor)
2. **Appendix 2** Pohjapiirustus vesi ja viemäri 1 kerros (1 floor)
3. **Appendix 3** Pohjapiirustus vesi ja viemäri 2 kerros (2 floor)
4. **Appendix 4** Pohjapiirustus vesi ja viemäri 3 kerros ( 3 floor)
5. **Appendix 5** Pohjapiirustus vesi ja viemäri ullakkokerros (Roof)
6. **Appendix 6** Kalusteluettelo (Specification)
7. **Appendix 7** Dimensioning flow for distribution pipe in residential buildings in Finland
8. **Appendix 8** Cold water system pressure loss calculation table for Finland
9. **Appendix 9** Warm water system pressure loss calculation table for Finland
10. **Appendix 10** Probabilities P. Coefficients  $\alpha$ , when  $P > 0,1$ ;  $N \leq 200$
11. **Appendix 11** Probabilities P. Coefficients  $\alpha$ , when  $P \leq 0,1$  and any N;  $P > 0,1$  and  $N > 200$
12. **Appendix 12** Cold water system pressure loss calculation table for Russia
13. **Appendix 13** Warm water system pressure loss calculation table for Russia



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  - \* ALASLASKETUSSA KATOSSA KUPARIPUTKEA
- VESIPUTKIEN ERISTYS LVI-TYÖSELÖSTYKSEN MUKAAN
- VIEMÄRIT POHJALAATAN YLÄPUOLELLA VALURAUTAA, MAASSA MUUVI
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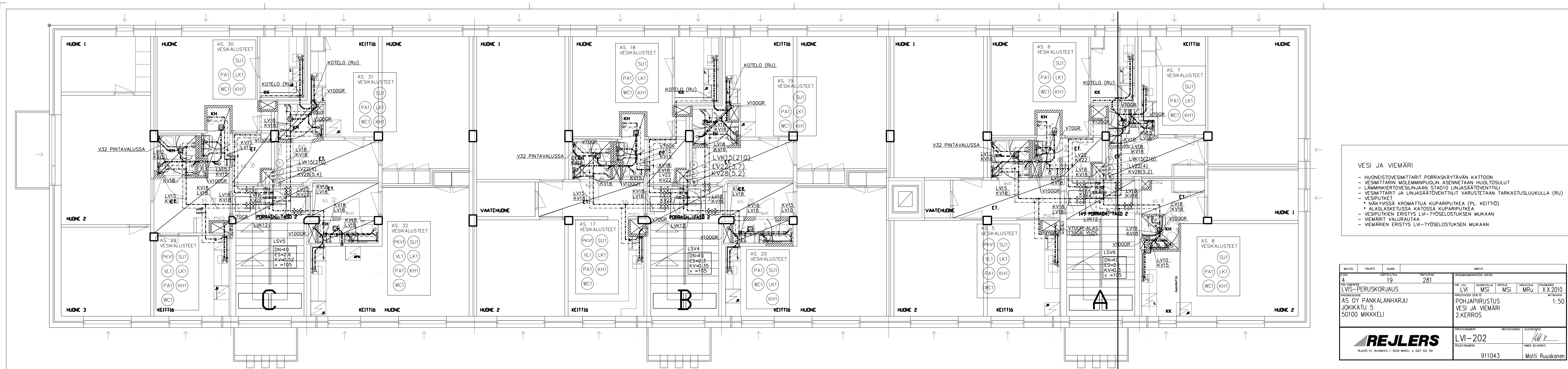
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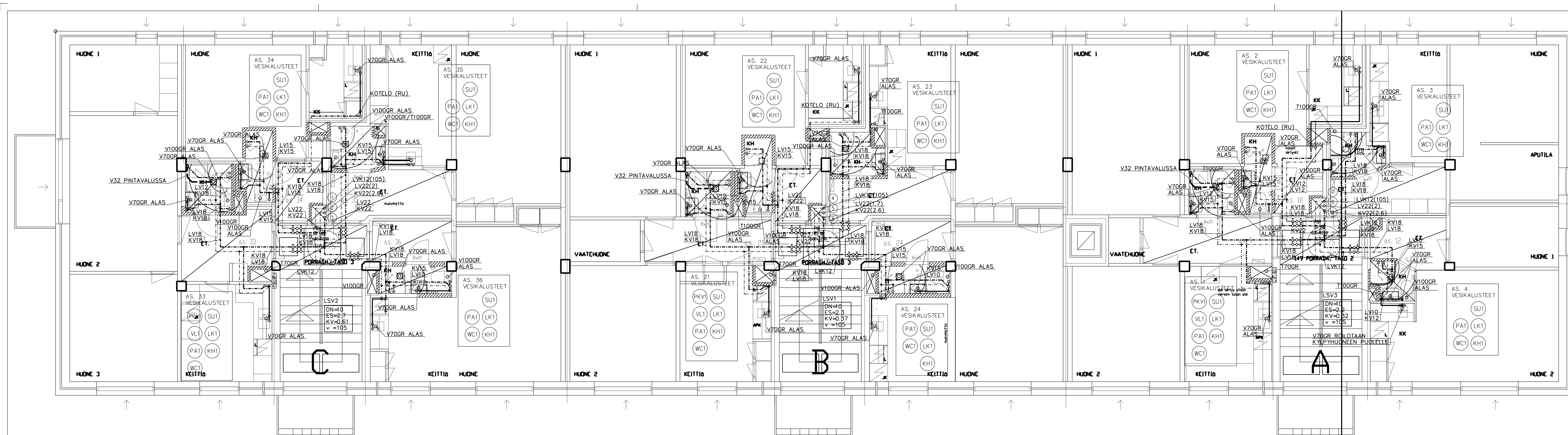
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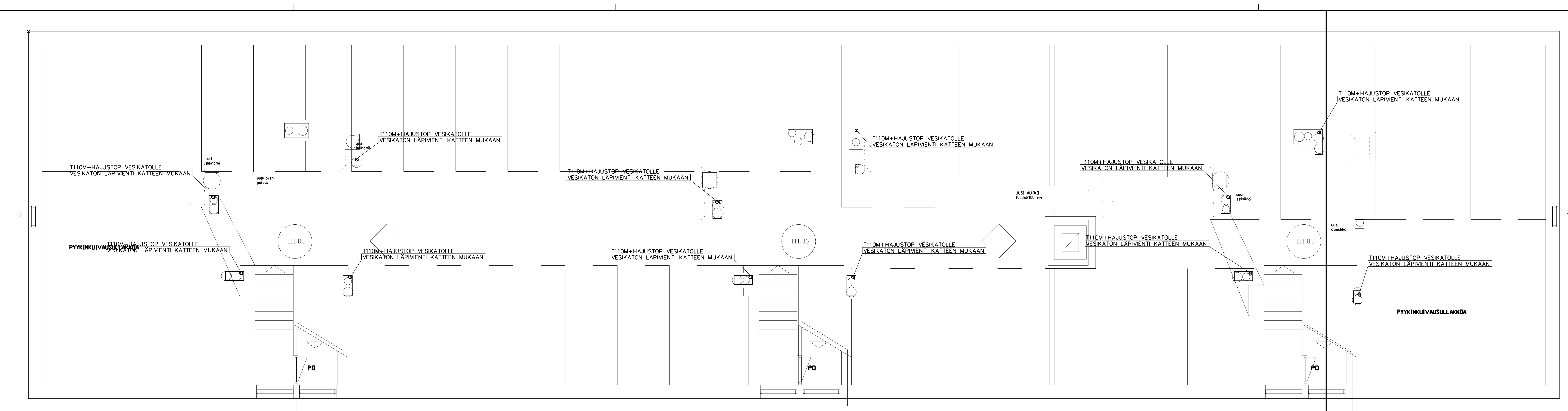
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2		Aputilahana	Oras Safira 1074 Pintakulmaliitinpari Oras 204021Z/2 Pullovesilukko 50 mm Rst-allas Franke Osma		12	12		0.2/0	160	
KH1		Keittiöhana	Oras Vega 1820 Pullovesilukko 50mm Kuulasulkuventtiilipari		12	12	75	0.2/0.6	160	
KH2		Keittiöhana	Oras Vega 1825 Pullovesilukko 50mm Kuulasulkuventtiilipari		12	12	75	0.2/0.6	160	
KK1		Kuivakaivo	Vieser-kuivakaivo 32 Rst-kansi				32	0/0		
LK1		Lattiakaivo	Vieser-vaakakaivo 75 2x32mm Rst- kansi 200x200				75	0/0.6		
LK2		Lattiakaivo	Vieser-vaakakaivo 75 2x32mm Rst-kansi 200x200				75	0/0.6		
LK3		Lattiakaivo	Vieser-vaakakaivo 75 2x32mm Rst- kansi 200x200 Nood-vesilukko				75	0/0.6		
LK4		Lattiakaivo	Brage 110				110	0/0.6		
PA1		Pesuallashana	Oras Vega 1812 Bidetta-käsisuihkulla IDO Seven D pesuallas 11113-01 Kuulasulkuventtiilipari Pullovesilukko		10	10	75	0.1/0.3	130	
PKV1		Pesukoneventtiili	Oras 180		12			0.2/0	75	
PKV2		Pesukoneventtiili	Oras 180			12		0.2/0	75	
SU1		Suihkuhana	Oras Vega 1878 Pintakulmaliitinpari Oras 204021Z/2		12	12		0.2/0	160	
WC1		WC-istuin	IDO Seven D WC, 34210-01		10		110	0.1/1.8	195	
VL1		Viemärintiliitin	Oras 173				32	0/0		



REJLERS OY, VILHONKATU 1.

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NIM. PÄIVÄYS

TUNN. LUKUM. MUUTOS



**Appendix 7 Dimensioning flow for distribution pipe in residential buildings in Finland /1/**

Aggregate standard flow Q (dm <sup>3</sup> /s)	Dimensioning flow q q <sub>NI</sub> (dm <sup>3</sup> /s)			Aggregate standard flow Q (dm <sup>3</sup> /s)	Dimensioning flow q q <sub>NI</sub> (dm <sup>3</sup> /s)		
	0,1	0,2	0,3		0,1	0,2	0,3
0,1	0,1	-	-	5,5	0,58	0,67	0,77
0,2	0,16	0,2	-	6,0	0,60	0,70	0,79
0,3	0,18	0,26	0,3	6,5	0,63	0,72	0,82
0,4	0,20	0,28	0,36	7,0	0,65	0,74	0,84
0,5	0,21	0,30	0,38	7,5	0,67	0,77	0,86
0,6	0,23	0,31	0,40	8,0	0,70	0,79	0,89
0,7	0,24	0,33	0,41	8,5	0,72	0,81	0,91
0,8	0,25	0,34	0,43	9,0	0,74	0,84	0,93
0,9	0,26	0,35	0,44	9,5	0,76	0,86	0,95
1,0	0,27	0,36	0,45	10,0	0,78	0,88	0,97
1,1	0,28	0,37	0,46	10,5	0,80	0,90	1,00
1,2	0,29	0,38	0,47	11,0	0,82	0,92	1,02
1,3	0,30	0,39	0,48	11,5	0,84	0,94	1,04
1,4	0,31	0,40	0,49	12,5	0,88	0,98	1,08
1,5	0,32	0,41	0,50	13,0	0,90	1,00	1,10
1,6	0,33	0,42	0,51	13,5	0,92	1,02	1,11
1,7	0,34	0,43	0,52	14,0	0,94	1,04	1,13
1,8	0,35	0,44	0,53	14,5	0,96	1,06	1,15
1,9	0,35	0,45	0,54	15,0	0,98	1,08	1,17
2,0	0,36	0,45	0,55	15,5	1,00	1,09	1,19
2,2	0,38	0,47	0,56	16,0	1,02	1,11	1,21
2,4	0,39	0,48	0,58	16,5	1,03	1,13	1,23
2,6	0,41	0,50	0,59	17,0	1,05	1,15	1,24
2,8	0,42	0,51	0,61	17,5	1,07	1,17	1,26
3,0	0,43	0,53	0,62	18,0	1,09	1,18	1,28
3,2	0,45	0,54	0,63	18,5	1,10	1,20	1,30
3,4	0,46	0,55	0,65	19,0	1,12	1,22	1,31
3,6	0,47	0,56	0,66	19,5	1,14	1,24	1,33
3,8	0,48	0,58	0,67	20,0	1,16	1,25	1,35
4,0	0,49	0,59	0,68	21,0	1,19	1,29	1,38
4,2	0,51	0,60	0,69	22,0	1,22	1,32	1,42
4,4	0,52	0,61	0,71	23,0	1,26	1,35	1,45
4,6	0,53	0,62	0,72	24,0	1,29	1,39	1,48
4,8	0,54	0,63	0,73	25,0	1,32	1,42	1,51
5,0	0,55	0,64	0,74	26,0	1,35	1,45	1,55

## Appendix 8

Water system pressure loss calculation table for Finland															
Pipe section	CW WW	Flow			Pipe			R kPa/m	Rxl kPa	v m/s	pd kPa	$\Sigma\zeta$	Z kPa	RL+Z kPa	$\Sigma\Delta p$
		Q l/s	qN l/s	q l/s	Material	Size DN du x s	Lenght l m								
SP	CW	44,2	0,2	1,99	Copper	42x1,5							15	15	15
WM	CW	44,2	0,2	1,99	Copper	42x1,5							30	30	45,00
1	CW	25,2	0,2	1,42	Copper	35x1,5	2,7	1,60	4,32	1,7	1,45	0,5	0,72	5,04	50,04
2	CW	25	0,2	1,42	Copper	35x1,5	1	1,60	1,60	1,7	1,45	3,5	5,06	6,66	56,70
3	CW	7,8	0,2	0,78	Copper	28x1,5	9,35	1,70	15,90	1,5	1,13	0	0,00	15,90	72,60
4	CW	5,2	0,2	0,65	Copper	28x1,5	3	1,05	3,15	1,2	0,72	0	0,00	3,15	75,75
5	CW	2,6	0,2	0,5	Copper	22x1,5	3	2,40	7,20	1,5	1,13	0,5	0,56	7,76	83,51
6	CW	2	0,2	0,45	Copper	22x1,5	0,5	1,90	0,95	1,4	0,98	0	0,00	0,95	84,46
7	CW	1,4	0,2	0,4	Copper	22x1,5	0,5	1,50	0,75	1,2	0,72	0	0,00	0,75	85,21
8	CW	0,6	0,2	0,31	Copper	22x1,5	1	0,90	0,90	0,85	0,36	0	0,00	0,90	86,11
WM	CW	0,6	0,2	0,31	Copper	18x2,5	1,8	2,80	5,04	1,5	1,13	0	0,00	5,04	91,15
10	CW	0,4	0,2	0,28	Copper	15x2,5	1	6,00	6,00	2	2,00	0	0,00	6,00	97,15

## Appendix 9

Water system pressure loss calculation table for Russia															
Pipe section	CW WW	Flow			Pipe			R kPa/m	Rxl kPa	v m/s	pd kPa	$\Sigma\zeta$	Z kPa	RL+Z kPa	$\Sigma\Delta p$
		Q l/s	qN l/s	q l/s	Material	Size DN du x s	Lenght l m								
SP	CW	6,417	0,145	1,4	Copper	42x1,5							15	15	15
WM	CW	6,417	0,145	1,4	Copper	42x1,5							30	30	45,00
1	CW	2,968	0,145	1,4	Copper	35x1,5	2,7	1,00	2,70	1,7	1,45	1,5	2,17	4,87	49,87
2	CW	2,968	0,145	1,4	Copper	35x1,5	1	1,00	1,00	1,7	1,45	2	2,89	3,89	53,76
3	CW	2,968	0,145	0,74	Copper	28x1,5	9,35	1,00	9,35	1,45	1,05	0,5	0,53	9,88	63,63
4	CW	2,968	0,145	0,59	Copper	28x1,5	3	0,60	1,80	0,1	0,01	0,5	0,00	1,80	65,44
5	CW	2,968	0,145	0,43	Copper	22x1,5	3	1,30	3,90	1,35	0,91	0,5	0,46	4,36	69,79
6	CW	2,968	0,145	0,38	Copper	22x1,5	0,5	0,80	0,40	1	0,50	0,5	0,25	0,65	70,44
7	CW	2,968	0,145	0,32	Copper	22x1,5	0,5	0,70	0,35	0,95	0,45	0,5	0,23	0,58	71,02
8	CW	2,968	0,145	0,24	Copper	22x1,5	1	0,45	0,45	0,75	0,28	0,5	0,14	0,59	71,61
WM	CW	2,968	0,145	0,24	Copper	18x2,5	1,8	1,00	1,80	1	0,50	0,5	0,25	2,05	73,66
10	CW	2,968	0,145	0,24	Copper	15x2,5	1	3,00	3,00	1,75	1,53	0,5	0,77	3,77	77,42

**Appendix 10 Probabilities P. Coefficients  $\alpha$ , when  $P>0,1$ ;  $N\leq 200$  /3,p 58/**

N	P ( $P_{hr}$ )									
	0,1	0,125	0,16	0,2	0,25	0,316	0,4	0,5	0,63	0,8
1	2	3	4	5	6	7	8	9	10	11
2	0,39	0,39	0,40	0,40	0,40	0,40	0,40	0,40	0,40	0,40
4	0,58	0,62	0,65	0,69	0,72	0,76	0,78	0,80	0,80	0,80
6	0,72	0,78	0,83	0,90	0,97	1,04	1,11	1,16	1,20	1,20
8	0,84	0,91	0,99	1,08	1,18	1,29	1,39	1,50	1,58	1,59
10	0,95	1,04	1,14	1,25	1,38	1,52	1,66	1,81	1,94	1,97
12	1,05	1,15	1,28	1,41	1,57	1,74	1,92	2,11	2,29	2,36
14	1,14	1,27	1,41	1,57	1,75	1,95	2,17	2,40	2,63	2,75
16	1,25	1,37	1,53	1,71	1,92	2,15	2,41	2,69	2,96	3,14
18	1,32	1,47	1,65	1,85	2,09	2,35	2,55	2,97	3,24	3,53
20	1,41	1,57	1,77	1,99	2,25	2,55	2,88	3,24	3,60	3,92
22	1,49	1,67	1,88	2,13	2,41	2,74	3,11	3,51	3,94	4,33
24	1,57	1,77	2,00	2,26	2,57	2,93	3,33	3,78	4,27	4,70
26	1,64	1,86	2,11	2,39	2,73	3,11	3,55	4,04	4,60	5,11
28	1,72	1,95	2,21	2,52	2,88	3,30	3,77	4,3	4,94	5,51
30	1,80	2,04	2,32	2,65	3,03	3,48	3,99	4,56	5,27	5,89
32	1,87	2,13	2,43	2,77	3,18	3,66	4,20	4,82	5,60	6,24
34	1,94	2,21	2,53	2,90	3,33	3,84	4,42	5,08	5,92	6,65
36	2,02	2,30	2,63	3,02	3,48	4,02	4,63	5,33	6,23	7,02
38	2,09	2,38	2,73	3,14	3,62	4,20	4,84	5,58	6,60	7,43
40	2,16	2,47	2,83	3,26	3,77	4,38	5,05	5,83	6,91	7,84
45	2,33	2,67	3,08	3,53	4,12	4,78	5,55	6,45	7,72	8,80
50	2,50	2,88	3,32	3,80	4,47	5,18	6,05	7,07	8,52	9,90
55	2,66	3,07	3,56	4,07	4,82	5,58	6,55	7,69	9,40	10,80
60	2,83	3,27	3,79	4,34	5,16	5,98	7,05	8,31	10,20	11,80
65	2,99	3,46	4,02	4,61	5,50	6,38	7,55	8,93	11,00	12,70
70	3,14	3,65	4,25	4,88	5,83	6,78	8,05	9,55	11,70	13,70
75	3,30	3,84	4,48	5,15	6,16	7,18	8,55	10,17	12,50	14,70
80	3,45	4,02	4,70	5,42	6,49	7,58	9,06	10,79	13,40	15,70

**Appendix 11 Probabilities P. Coefficients  $\alpha$ , when  $P \leq 0,1$  and any N;  $P > 0,1$  and  $N > 200$  /3,p**

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$\frac{NP}{NP_{hr}}$	$\alpha_{hr}$	$\frac{NP}{NP_{hr}}$	$\alpha_{hr}$	$\frac{NP}{NP_{hr}}$	$\alpha_{hr}$	$\frac{NP}{NP_{hr}}$	$\alpha_{hr}$	$\frac{NP}{NP_{hr}}$	$\alpha_{hr}$
0,015	0,200	0,046	0,266	0,115	0,361	0,35	0,573	0,84	0,883
0,015	0,202	0,047	0,268	0,120	0,367	0,36	0,580	0,86	0,894
0,016	0,205	0,048	0,270	0,125	0,373	0,37	0,588	0,88	0,905
0,017	0,207	0,049	0,271	0,130	0,378	0,38	0,595	0,90	0,916
0,018	0,210	0,050	0,273	0,135	0,384	0,39	0,602	0,92	0,927
0,019	0,212	0,052	0,276	0,140	0,389	0,40	0,610	0,94	0,937
0,020	0,215	0,054	0,280	0,145	0,394	0,41	0,617	0,96	0,948
0,021	0,217	0,056	0,283	0,150	0,399	0,42	0,624	0,98	0,959
0,022	0,219	0,058	0,286	0,155	0,405	0,43	0,631	1,00	0,969
0,023	0,222	0,060	0,289	0,160	0,410	0,44	0,638	1,05	0,995
0,024	0,224	0,062	0,292	0,165	0,415	0,45	0,645	1,10	1,021
0,025	0,226	0,064	0,295	0,170	0,420	0,46	0,652	1,15	1,046
0,026	0,228	0,065	0,298	0,175	0,425	0,47	0,658	1,20	1,071
0,027	0,230	0,068	0,301	0,180	0,430	0,48	0,665	1,25	1,096
0,028	0,233	0,070	0,304	0,185	0,435	0,49	0,672	1,30	1,120
0,029	0,235	0,072	0,307	0,190	0,439	0,50	0,678	1,35	1,144
0,030	0,237	0,074	0,309	0,195	0,444	0,52	0,692	1,40	1,168
0,031	0,239	0,076	0,312	0,20	0,449	0,54	0,704	1,45	1,191
0,032	0,241	0,078	0,315	0,21	0,458	0,56	0,717	1,50	1,215
0,033	0,243	0,080	0,318	0,22	0,467	0,58	0,730	1,55	1,238
0,034	0,245	0,082	0,320	0,23	0,476	0,60	0,742	1,60	1,261
0,035	0,247	0,084	0,323	0,24	0,485	0,62	0,755	1,65	1,283
0,036	0,249	0,086	0,326	0,25	0,493	0,64	0,767	1,70	1,306
0,037	0,250	0,088	0,328	0,26	0,502	0,66	0,779	1,75	1,328
0,038	0,252	0,090	0,331	0,27	0,510	0,68	0,791	1,80	1,350
0,039	0,254	0,092	0,333	0,28	0,518	0,70	0,803	1,85	1,372
0,040	0,256	0,094	0,336	0,29	0,526	0,72	0,815	1,90	1,394
0,041	0,258	0,096	0,338	0,30	0,534	0,74	0,826	1,95	1,416
0,042	0,259	0,098	0,341	0,31	0,542	0,76	0,838	2,00	1,437
0,043	0,261	0,100	0,343	0,32	0,550	0,78	0,849	2,1	1,479
0,044	0,263	0,105	0,349	0,33	0,558	0,80	0,860	2,2	1,521

## Appendix 12

Water system pressure loss calculation table for Finland															
Pipe section	CW WW	Flow			Pipe			R kPa/m	Rxl kPa	v m/s	pd kPa	$\Sigma\zeta$	Z kPa	RL+Z kPa	$\Sigma\Delta p$
		Q l/s	qN l/s	q l/s	Material	Size DN du x s	Lenght l m								
HE	WW				Copper								18	18	18
1	WW	19	0,2	1,22	Copper	35x1,5	2,7	1,10	2,97	1,5	1,13	0,5	0,56	3,53	21,53
2	WW	18,8	0,2	1,22	Copper	35x1,5	1	1,10	1,1	1,5	1,13	3,5	3,94	5,04	26,57
2	WW	6	0,2	0,7	Copper	28x1,5	9,35	1,20	11,22	1,3	0,85	0	0,00	11,22	37,79
4	WW	4	0,2	0,59	Copper	22x1,5	3	3,40	10,2	1,9	1,81	0	0,00	10,20	47,99
5	WW	2	0,2	0,45	Copper	22x1,5	3	2,00	6,0	1,5	1,13	0,5	0,56	6,56	54,55
6	WW	1,5	0,2	0,41	Copper	22x1,5	0,5	1,50	0,8	1,2	0,72	0	0,00	0,75	55,30
7	WW	1	0,2	0,36	Copper	22x1,5	0,5	1,10	0,6	1,05	0,55	0	0,00	0,55	55,85
8	WW	0,5	0,2	0,3	Copper	22x1,5	1	0,85	0,9	0,9	0,41	0	0,00	0,85	56,70
WM	WW	0,5	0,2	0,3	Copper	22x1,5	1,8	0,85	1,5	0,9	0,41	0	0,00	1,53	58,23
10	WW	0,3	0,2	0,2	Copper	18x2,5	1	1,30	1,3	0,95	0,45	0	0,00	1,30	59,53

**Appendix 13**

Water system pressure loss calculation table for Russia															
Pipe section	CW WW	Flow			Pipe			R kPa/m	Rx1 kPa	v m/s	pd kPa	$\Sigma\zeta$	Z kPa	RL+Z kPa	$\Sigma\Delta p$
		Q l/s	qN l/s	q l/s	Material	Size DN du x s	Lenght l m								
HE	WW				Copper								18	18	18
1	WW	4,01	0,145	1,1	Copper	35x1,5	2,7	0,70	1,89	1,35	0,91	1,5	1,37	3,26	21,26
2	WW	4,01	0,145	1,1	Copper	35x1,5	1	0,70	0,70	1,35	0,91	2	1,82	2,52	23,78
2	WW	4,01	0,145	0,59	Copper	28x1,5	9,35	0,65	6,08	1,15	0,66	0,5	0,33	6,41	30,19
4	WW	4,01	0,145	0,48	Copper	22x1,5	3	1,50	4,50	1,4	0,98	0,5	0,49	4,99	35,18
5	WW	4,01	0,145	0,36	Copper	22x1,5	3	0,75	2,25	1	0,50	0,5	0,25	2,50	37,68
6	WW	4,01	0,145	0,31	Copper	22x1,5	0,5	0,60	0,30	0,9	0,41	0,5	0,20	0,50	38,18
7	WW	4,01	0,145	0,27	Copper	22x1,5	0,5	0,55	0,28	0,8	0,32	0,5	0,16	0,44	38,62
8	WW	4,01	0,145	0,21	Copper	22x1,5	1	0,35	0,35	0,65	0,21	0,5	0,11	0,46	39,07
WM	WW	4,01	0,145	0,21	Copper	22x1,5	1,8	0,35	0,63	0,65	0,21	0,5	0,11	0,74	39,81
10	WW	4,01	0,145	0,21	Copper	18x2,5	1	0,75	0,75	0,9	0,41	0,5	0,20	0,95	40,76