REHAU®
Unlimited Polymer Solutions

RAUTITAN – THE NEW GENERATION

WATER SERVICES – TECHNICAL INFORMATION

Subject to technical modifications
Valid from January 2012
www.rehau.com.au

Construction
Automotive
Industry

This Technical Information RAUTITAN - THE NEW GENERATION is valid from **January 2012**.

Its publication means that the previous Technical Information ANZ 893 0277 (as of November 2009) is no longer valid.

Our current technical document can found at **www.rehau.com.au** for download.

All measurements and weights are of approximation values.
Errors and changes are excepted.

RAUTITAN – THE NEW GENERATION: WATER SERVICES

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WATER SERVICES

INFORMATION AND SAFETY ADVICES

NOTES ON THIS TECHNICAL INFORMATION

Validity
This technical information is valid for **Australia and New Zealand.**

Other applicable REHAU technical information:
- SYSTEM GUIDELINES, PIPING AND CONNECTION

Navigation
At the beginning of this document you can find a detailed content page which lists the individual chapters and their respective page numbers.

Definitions
- **Supply lines or piping** consist of pipes and their joints (e.g. compression sleeves, fittings, threads or similar). This applies to gas piping, drinking water and heating piping and all other pipes in this Technical Information.
- **Piping systems, installation, systems**, etc. consist of the pipes and the necessary components.
- **Connection components** consist of fittings with the corresponding compression sleeves and pipes, as well as seals and threaded connections.

Display
Illustrations for individual subsystems are listed in the corresponding pipe, fitting and compression sleeve colours.

Illustrations which are applicable for system-wide applications, such as drinking water, heating, gas installation or underfloor heating/cooling are illustrated with grey piping and white fittings and compression sleeves.

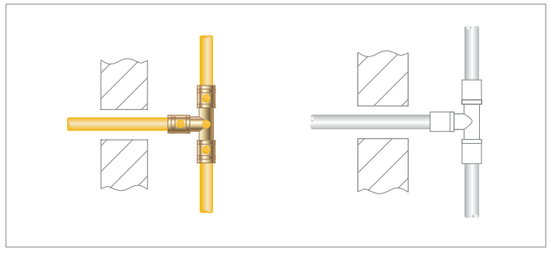


Fig. 1-1 Example: illustration for gas installation sub-system (left) and example: illustration for system-wide application (right)

Explanation of symbols

Safety Information

Legal information

Important information, which needs to be taken into account

Information in the internet

Your benefits/advantages

Latest technical information
For safe usage of REHAU products, please check regularly if a newer version of the technical information is available to you. The date of issue of your technical information can be found on the back cover in the bottom right hand corner. The latest technical information manuals are available from the REHAU sales office, appointed wholesalers as well as from our website: **www.rehau.com.au.**

Safety advice and operating instructions
- For your own safety and other's, read the safety instructions and the operating instructions carefully and completely before beginning installation.
- Store the operating instructions in a safe place and make sure it is available when needed.
- In case you did not understand the safety advice or the individual assembly situations, or if they are not clear to you, please contact your REHAU sales office.
- **Failure to observe the safety information/instructions can result in damage to property and persons.**

Intended use
The REHAU system components and compression sleeve jointing technique is considered as proprietary systems and should be designed, installed, and operated in accordance to REHAU's Technical Information. Any other use that does not fall within the intended use of the system is prohibited.

Observe the applicable national and international regulation on installation, accident prevention and safety when installing piping systems, as well as the instructions in this Technical Information.

Also observe the applicable laws, standards, guidelines and regulations (e.g. DIN, EN, ISO, NCC, BCA, PCA, NZBC, AS/NZS) as well as regulations on environmental protection, provisions of professional associations and regulations of the local public utility companies.

Areas of application not contained in this Technical Information (special applications) require consultation with our Applications Department. For detailed advice, please contact your REHAU sales office.

The design and installation instructions related solely to the specific REHAU product. Occasionally references are made to parts of applicable standards and directives.
Always observe the current version of any guidelines, standards or directives. Further directives, regulations and guidelines related to the design, installation and operationof drinking water, heating and buildings services systems must also be referred to but these do not form part of this Technical Information.

Staff requirements
- Only allow authorised and trained persons to install our systems.
- Only allow work on electrical systems or conductors to be carried out by suitably trained and authorised people.

General safety precautions
- Keep your workplace tidy and free of obstructions.
- Ensure adequate lighting at your workplace.
- Keep children, household pets and unauthorised people away from tools and the installation places. This applies particularly to refurbishment in occupied places.
- Only use those components in the corresponding piping system, which have been generally approved by REHAU. Using components which are not part of the system or tools which do not originate from the respective REHAU installation system can lead to accidents or other hazards.

Work clothing
- Wear eye protection, adequate work clothing, protective shoes, a helmet, and a hairnet if you have long hair.
- Do not wear lose clothing or jewellery which can be caught by moving parts.
- A safety helmet has to be worn during installations work at face level or overhead.

Follow the assembly instructions
- Always read and observe the available operating instructions of the REHAU installation tool.
- Incorrect handling of tools can cause cuts and crushing or sever limbs
- Incorrect handling of tools can damage connection components and bring about leaks.
- The REHAU pipe cutters have sharp blades. Store and handle in such a way that they will not create any risk of injury.
- When cutting the pipes, keep a safety distance between the holding hand and the cutting tool.
- When cutting, do not reach into the cutting zone of the tool or near its moving parts.
- After the pipe expansion process, the expanded end of the pipe returns to its original shape (memory effect). During this time, do not put any other objects into the expanded end of the pipe.
- Keep your hands away from movable parts or the tools pressing area duirng jointing.
- Before the joint is completed, the fitting may fall out of the pipe. Danger of injury!
- Always disconnect the power from a tool prior to carrying out maintenance work, changing over movable parts (i.e. compression jaws) or when moving the tool to a new location on site.

Operating parameter
If the operating parameters are exceeded, the pipes and joints may become overstrained. Not adhering to the operating parameters is thus not allowable.

Keeping within the operating parameters must be ensured by safety/control equipment (e.g. pressure reducers, safety valves, etc.)

2. RAUTITAN - THE NEW GENERATION

WATER SERVICES

OVERVIEW – BENEFITS AT A GLANCE

REHAU compression sleeve jointing technique
- Universal and robust jointing technique, highly suitable for construction site
- Without O-ring, self-sealing piping material
- Simple visual inspection
- Good hydraulic properties, pipe is expanded at the joint

REHAU pipes
- Hot and cold water pipe RAUTITAN platinum
- Hot water pipe RAUTITAN red
- Heating pipe RAUTITAN pink
- Rainwater pipe RAUTITAN green
- Recycled water pipe RAUTITAN lilac
- Universal pipe RAUTITAN stabil for hot and cold water and heating installation
- Gas pipe RAUTITAN gas stabil
- Pipe size from 16 to 63 mm
- Complete installation of manifold, rising and connecting pipes

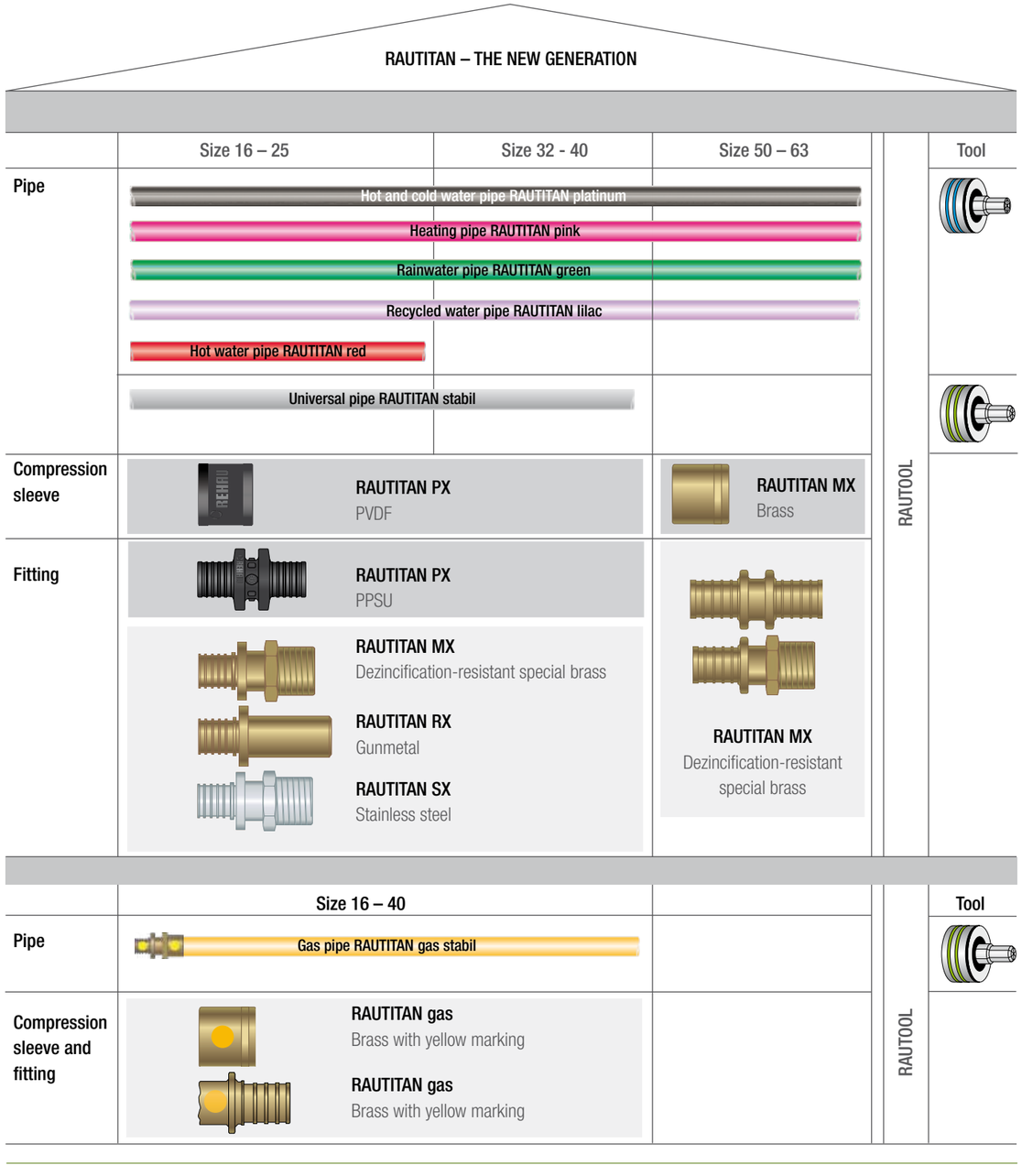
REHAU fittings
- RAUTITAN fittings and RAUTITAN compression sleeves for water services and heating installation
- RAUTITAN gas fittings and RAUTITAN gas compression sleeves for gas installation
- Special fittings for specific installation

Universal tools RAUTOOL from REHAU
- Manual, hydraulic, or electro-hydraulic drives
- Suitable for all pipe dimensions

3. RAUTITAN - THE NEW GENERATION

WATER SERVICES

SYSTEM COMPONENTS OVERVIEW



4. RAUTITAN - THE NEW GENERATION

WATER SERVICES

SYSTEM DESCRIPTION

4.1 RAUTITAN PIPES

Fig. 4-1 RAUTITAN pipes

- Corrosion resistance of RAUTITAN pipes: No pitting
- Acoustic insulation properties of RAU-PE-Xa pipe material
- No tendency to deposits or encrustation
- High impact toughness of RAU-PE-Xa pipe material
- Good resistance to abrasion
- Pre-insulated pipe for hot water services
- Application-oriented delivery packaging of the pipes as coils or straight lengths

Detailed information on planning, installation and execution of the heating/cooling systems using RAUTITAN pipes and RAUTHERM S pipes can be found in the Technical Information: UNDERFLOOR HEATING/COOLING.

Hot and cold water pipe — RAUTITAN platinum
- Suitable for potable water installation
- Platinum PE outer layer
- Dimensions 16 – 63
- Flexible

Hot water pipe — RAUTITAN red
- Suitable for potable water installation
- Red PE outer layer
- Dimensions 16 – 25
- Flexible

Heating pipe — RAUTITAN pink
- Suitable for heating installation and radiator panels
- Oxygen diffusion-tight according to DIN 4276
- Dimensions 16 – 63
- Flexible

Rainwater pipe — RAUTITAN green
- Suitable for rainwater application
- Green PE outer layer
- Dimensions 16 – 63
- Flexible

Recycled water pipe — RAUTITAN lilac
- Suitable for recycled water application
- Lilac PE outer layer
- Dimensions 16 – 63
- Flexible

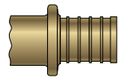
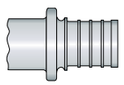
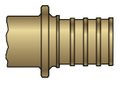
Universal pipe — RAUTITAN stabil
- Suitable for water services, heating installation and radiator panels
- Aluminium layer to prevent oxygen diffusion
- Complies with KTW (plastics for drinking water) recommendations of the German Federal Environment Agency
- Dimensions 16 – 40
- Rigid and resistant to deformation

Gas pipe — RAUTITAN gas stabil
- Suitable for NG and LPG installation
- Aluminium layer to prevent oxygen diffusion
- Dimensions 16 – 40
- Rigid and resistant to deformation

4.2 RAUTITAN FITTINGS AND COMPRESSION SLEEVES FOR WATER SERVICES AND HEATING INSTALLATION

Fig. 4-2 RAUTITAN fittings

Fig. 4-3 RAUTITAN compression sleeves

Compression sleeves and fittings		
Compression sleeve	Size 16 - 40 	Size 50 - 63 
	RAUTITAN PX	**RAUTITAN MX**
Material	PVDF	Brass
Threadless fittings	Size 16 – 40 	Size 50 – 63 
	RAUTITAN PX	**RAUTITAN MX**
Material	PPSU	Brass
Fittings for screwing, soldering, clamping	Size 16 – 40 	Size 16 – 63 
	RAUTITAN SX	**RAUTITAN MX**
Material	Stainless steel	Brass
		RAUTITAN RX
Material		Gunmetal

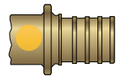
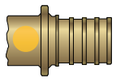
Tab. 4-1 Allocation of RAUTITAN compression sleeves and fittings for water services and heating installation

- RAUTITAN fittings can be used in water services and heating installation
- RAUTITAN gas fittings can be used in gas installation, water services and heating installation
- Special fittings for effective installation
- RAUTITAN MX fittings for water services are made of special dezincification-resistant brass according to AS 2345, DIN EN 12164, DIN EN 12165 and DIN EN 12168 standards, Grade A and are equivalent to the highest requirement category

4.3 RAUTITAN GAS FITTINGS AND COMPRESSION SLEEVES

Fig. 4-5 RAUTITAN gas fitting set

Fig. 4-6 RAUTITAN gas compression sleeve

Compression sleeves and fittings		
Compression sleeve	Size 16 - 40 	Size 16 - 40 
	RAUTITAN PX	**RAUTITAN gas**
Material	PVDF	Brass
Threadless fittings	Size 16 - 40 	Size 16 - 40 
	RAUTITAN PX	**RAUTITAN gas**
Material	PPSU	Brass
Fittings for screwing, soldering, clamping	Size 16 - 40 	
	RAUTITAN gas	
Material	Brass	

Tab. 4-2 Allocation of RAUTITAN gas compression sleeves and fittings

4.4 REHAU COMPRESSION SLEEVE JOINTING TECHNIQUE

Fig. 4-6 Compression sleeve jointing technique

Fig. 4-7 Compression sleeve jointing technique suitable for all RAUTITAN pipes

- Universal and robust jointing, highly suitable for construction site
- Connection without O-ring (self-sealing pipe material)
- Simple visual inspection
- Good hydraulic properties, pipe is expanded at the joint
- Joint can be immediately pressurized
- Pipe does not need to be calibrated or deburred
- Same jointing technique and tools for water services, gas and heating installation
- Permanently sealing compression sleeve jointing technique according to DIN 1988, DVGW worksheet W 534 and DVGW VP 625
- Approved for flush-mounted installation according to DIN 18380 (VOB)

Combination with RAUTITAN PX

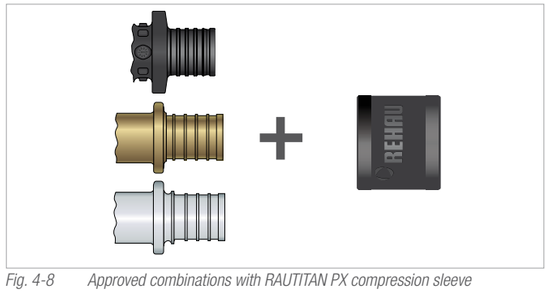


Fig. 4-8 Approved combinations with RAUTITAN PX compression sleeve

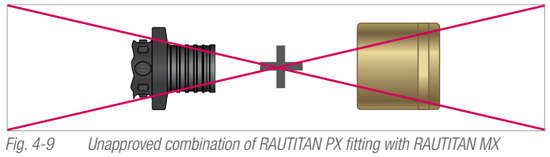


Fig. 4-9 Unapproved combination of RAUTITAN PX fitting with RAUTITAN MX compression sleeve

Orientation of RAUTITAN compression sleeves

With RAUTITAN PX compression sleeves, the orientation is not significant.

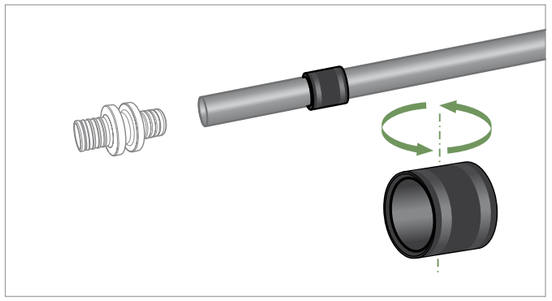


Fig. 4-10 Orientation of RAUTITAN PX compression sleeve: any direction

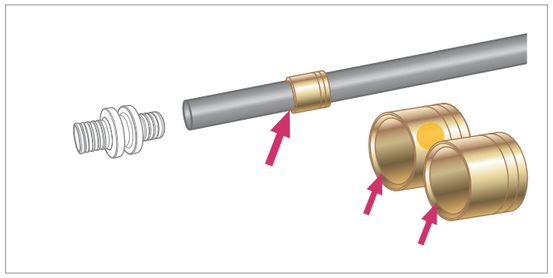


Fig. 4-11 Orientation of RAUTITAN MX compression sleeve and RAUTITAN gas compression sleeve: chamfered side facing the joint

Notes on compression jaws 40

RAUTITAN PX compression sleeve size 40 need to be compressed with the new black compression jaws size 40.

Previous compression jaws (gold-yellow) of other dimensions e.g. 16, 20, 25, 32, 50 and 63 can still be used without restriction.

Please read the notes on using the compression jaws 40 in the Technical Information: SYSTEM GUIDELINES, PIPING AND CONNECTION

Compression jaws for RAUTITAN PX compression sleeves, size 40

	Compression jaws, new Ø 40	Compression sleeves Ø 40		Compression jaws, old Ø 40	Compression sleeve RAUTITAN PX Ø 40
Compression jaws set 40 (Black) 201801-001 201803-001			Compression jaws set 40 (Gold-yellow) 137805-001 138223-001		
Compression jaws set M1 40 (Black) 201798-001 201804-001			Compression jaws set M1 40 (Gold-yellow) 137374-001 138333-001		
Compression jaws set G1 40 (Black) 201802-001			Compression jaws set G1 40 (Gold-yellow) 137964-001		

Tab. 4-3 Compression jaws for compression sleeves size 40

5. RAUTITAN - THE NEW GENERATION

WATER SERVICES

AREA OF APPLICATION

5.1 RAUTITAN CONNECTION COMPONENTS FOR WATER SERVICES

Fig. 5-1 RAUTITAN pipes for water services

Please also read the notes in Technical Information: SYSTEM GUIDELINES, PIPING AND CONNECTION

RAUTITAN connection components for water services

Size	Pipes					Fittings	Compression sleeves
16	RAUTITAN stabil Universal pipe	RAUTITAN platinum Hot & cold water pipe	RAUTITAN red Hot water pipe	RAUTITAN green Rainwater pipe	RAUTITAN lilac Recycled water pipe	RAUTITAN PX	RAUTITAN PX
20							
25						RAUTITAN MX RAUTITAN RX	
32						RAUTITAN SX	
40							
50						RAUTITAN MX	RAUTITAN MX
63							

5.2 STANDARDS AND GUIDELINES

RAUTITAN system for water services must be planned, calculated, installed and operated according to AS/NZS 3500 and other relevant standards.

5.2.1 RAUTITAN PLUMBING SYSTEM

RAUTITAN platinum plumbing system must be installed according to AS/NZS 3500. It can be used for hot and cold water services with normal operating temperature of 70°C and can also temporarily withstand temperature of up to 100°C. It can also be operated at a pressure of up to 2.0 MPa for PN20 system.

The complete RAUTITAN platinum system is designed for installation in new buildings, and for carrying out renovations and repairs. It is suitable for drinking water systems in buildings for residential, industrial and commercial use such as hospitals, schools, kindergartens, sports halls, churches, aged care facilities, supermarkets and services stations, as well as industrial premises, etc.

5.2.2 RAUTITAN HOT WATER SYSTEM

RAUTITAN red hot water system must be installed according to AS/NZS 3500. It is designed to be used for hot water services with normal operating temperature of 70°C and can also temporarily withstand temperature of up to 100°C. It can also be operated at a pressure of up to 2.0 MPa for PN20 system.

The complete RAUTITAN red system is designed for installation in new buildings, and for carrying out renovations and repairs. It is suitable for hot drinking water systems in buildings for residential, industrial and commercial use such as hospitals, schools, kindergartens, sports halls, churches, aged care facilities, supermarkets and services stations, as well as industrial premises, etc.

5.2.3 RAUTITAN RAINWATER SYSTEM

RAUTITAN green rainwater system must be installed according to AS/NZS 3500. It can be used for rainwater services with normal operating temperature of 70°C and can also temporarily withstand temperature of up to 100°C. It can also be operated at a pressure of up to 2.0 MPa for PN20 system.

The use of RAUTITAN green rainwater plumbing system is specified for the connection between residential rainwater tank to a number of appliances such as outdoor tap, toilet cistern, washing machine, etc.

5.2.4 RAUTITAN RECYCLED WATER SYSTEM

RAUTITAN lilac recycled water system must be installed according to AS/NZS 3500. It can be used for recycled water services with normal operating temperature of 70°C and can also temporarily withstand temperature of up to 100°C. It can also be operated at a pressure of up to 2.0 MPa for PN20 system.

RAUTITAN lilac system is used for the distribution of treated recycled water inside buildings and to connect appliances such as outdoor taps, irrigation, washing machine and toilets from the treated recycled/reclaimed water mains.

5.2.5 RAUTITAN STABIL UNIVERSAL SYSTEM

RAUTITAN stabil universal system must be installed for plumbing services according to AS/NZS 3500. It can be used at normal operating temperature of 70°C and can also temporarily withstand temperature of up to 100°C. It can also be operated at a pressure of up to 2.0 MPa for PN20 system.

RAUTITAN stabil system can be used for all plumbing applications (hot and cold water, rainwater and recycled water). It can also be used for heating/cooling applications (underfloor heating/cooling and radiator connection).

5.3 APPROVAL AND CERTIFICATIONS

The complete range of RAUTITAN pipes and fittings comply with international and national standards and fully certified:

National certifications

- REHAU PE-Xa pipes comply with AS/NZS 2492 for crosslinked polyethylene (PE-Xa) pipe for pressure application, and certified under WaterMark LN1413.

- RAUTITAN fittings comply with AS/NZS 2537 for mechanical jointing fittings for use with crosslinked polyethylene (PE-Xa) pipes for pressure applications, and certified under WaterMark LN1412.
- RAUTITAN stabil universal pipe and fittings comply with ATS 5200 Technical Specification for plumbing and drainage products Part 490: Cross-linked polyethylene/aluminium/polyethylene composite pipe systems for pressure applications, respectively AS 4176 multilayer pipes for pressure applications, and is certified under WaterMark LN21210.

International cerfications

- RAUTITAN platinum system complies with ISO 15875 Plastic piping systems for hot and cold water installations – Crosslinked polyethylene (PE-X).
- RAUTITAN stabil universal pipe, REHAU compression sleeve and fittings are registered and approved under DVGW DW-8501AU2346.
- RAUTITAN stabil pipe's self-supporting inliner (pressure-resistant inner pipe) of crosslinked polyethylene conforms to DIN 16892.
- RAUTITAN stabil universal system is certified in many European countries such as: Poland, Austria, The Netherland, Switzerland, Belgium, Russia, etc.

5.4 OPERATING PARAMETERS

For continuous operation, the following parameters must not be exceeded.

Continuous operating temperature	Maximum 70°C
Continuous operating pressure	Maximum 10 bars
Minimum designed service life	50 years

Tab. 5-1 Parameters for continuous operation

For operating parameters higher than specified in Table 5-1, please consult your REHAU Sales Office.

5.5 REQUIREMENTS OF DRINKING WATER

The drinking water must comply with the currently valid limits of the following standards:

- DIN 2000
- German drinking water ordinance[1)]
- Council directive 98/83/EC of 3 November 1998 on the quality of water intended for human consumption
- Australian Drinking Water Guideline 2004

In locations with highly corrosive water composition, e.g. in volcanic areas, installations using bore/well water etc., the suitability of RAUTITAN pipe system must be checked with REHAU. In some cases, the available water quality may void the REHAU warranty unless appropriate water treatment is provided.

With its RAUTITAN MX fittings made of dezincification-resistant brass, REHAU satisfies the highest requirements category according to AS 2345, DIN EN 12164, DIN EN 12165, and DIN EN 12168 and continues to developed these further in order to meet the increasing quality demands.

Nonetheless, there is no fundamentally ideal material for every application. Thus, different influential factors can lead to corrosion in drinking water installation, regardless of the materials used.

In some specific cases, corrosion can happen even with water qualities within the permitted range of the drinking water ordinance.

The chloride concentration and the hydrogen carbonate concentration of the water have considerable influence on how aggressive the corrosion is. High chloride concentration combined with low hydrogen carbonate concentration can negatively influence the corrosion behaviour.

However, the interaction under the following factors, according to DIN EN 12502-1:2005 (D), also influence the corrosion resistance:

- Material properties (chemical composition, surface integrity)
- Water quality (physical and chemical properties, solid matter)
- Planning and execution (geometry, mix installation, connections)
- Leak testing and initial start-up (purging, drainage, disinfection)
- Operating conditions (temperature, temperature changes, flow conditions)

1) The limit values for maximum disinfection agent concentrations detailed in the drinking water ordinance are not to be interpreted as permanent, lasting application concentrations. They represent the temporary maximum values defined under hygienic and toxicological aspects. Top priority of the drinking water ordinance is the principle of minimization, that is, nothing should be mixed into the water. Only if a chemical additive is required due to contamination may the minimum amount required be mixed in.

The application of water after-treatment (e.g. water softening), in principle, changes the corrosive-chemical behaviour of the water. To avoid corrosion damage as a result of incorrect use and operation of a water treatment system, we explicitly recommend that you have your individual situation examined before hand by an expert or the system manufacturer.

The most practical way of evaluating the likelihood of corrosion due to water quality is to test the water which is to be distributed to the area.

It is the responsibility of the system designer that the above-mentioned factors and parameters be taken into account when it comes to corrosion protection and sediment formation in actual application.

Our Technical Application Department for RAUTITAN application area provides support when needed.

If the drinking water quality is outside the limits of the drinking water guidelines, evaluation and approval is definitely required from our Technical Application Department if the RAUTITAN system is intended to be used.

In this case, please contact your REHAU Sales Office.

5.6 DISINFECTION

REHAU pipes intended for drinking water together with the compression sleeve jointing technique without O-ring help to keep the hygiene level of drinking water installation. They correspond to the KTW guidelines of the German Federal Environment Agency and satisfy the requirements of the DVGW worksheet W 270. Thus, they are suitable for fields of application with special hygiene requirements when it comes to drinking water. It has been proven that RAUTITAN pipes for water services and heating installation do not cause any multiplication of micro-organisms and thus do not support microbial contamination or legionella growth.

Due to **errors made during planning, construction and operation, during stagnation or substandard water quality** (e.g. wastewater, floodwater, maintenance works on the piping network) contamination can occur. Furthermore, damage to the piping network, e.g. a supply line with external water inflow, can be the cause of possible contamination.

The disinfection of drinking water installation is only necessary in exceptional cases (in the case of contamination) and all operational and structural engineered system deficiencies are to be rectified first.

Repeated or constant bacterial exposure of domestic water installation is often caused by the installation method (e.g. stubs) or by the operation method (e.g. long stagnation periods), as such that continuous disinfection is not justifiable.

5.6.1 THERMAL DISINFECTION IN CASE OF CONTAMINATION

For drinking water installations in compliance with the latest technical standards (no stubs, etc.), removal of dirt can be done by thorough water rinsing as long as the dirt is water-soluble or remains soluble in water.

If contamination is suspected, an additional thermal disinfection as per DVGW worksheet W 551 is possible as a sensible and urgent measure. According to the latest technological standards, for water with temperature of at least 70°C, it is very likely that germs and bacteria, including legionella which is found freely in water will be killed off. **It is important that the appropriate measures have to be taken to avoid scalding to people.**

All RAUTITAN piping system for water services and heating installation are suitable **for multiple thermal disinfections according to DVGW worksheet W 551 at 70°C**. It must be ensured that the allowable operating pressure is not exceeded during thermal disinfection.

5.6.2 CHEMICAL DISINFECTION IN THE CASE OF CONTAMINATION

Alongside with thermal disinfection, chemical disinfection is being used more and more. Chemical and thermal disinfection measures always strain the materials used in water services installation. According to today's level of awareness, some disinfection measures are not suitable for standard materials in installation technology. This also applies to materials, for which it was previously assumed that they were sufficiently corrosion-resistant, e.g. stainless steel, copper and some synthetic materials.

Before introducing these types of process measures, it needs to be ensured that all parts of the installation system are thermally and chemically suited for the corresponding measure. This is regulated by DVGW

worksheet 551. If necessary, please have the suitability of the disinfectant approved by the disinfectant's manufacturer for all system parts of the installation.

5.6.2.1 CHEMICAL "POSTRINSE DISINFECTION"

For short-term chemical disinfection (postrinse disinfections), only special active ingredients may be used which are specified in corresponding rules and standards.

Carrying out the disinfection measures according to the specifications of DVGW worksheet W 291 can be done without impairing the functionality of REHAU drinking water installation if the active ingredients, concentrations, application duration and maximum temperatures are observed (as listed in Table 5-2)

It should be noted that combining thermal-chemical disinfection at temperatures of higher than 25°C, as well as permanent or regular disinfection cycles (e.g. monthly), are not permitted. In relation to the lifespan of the piping, the total number of disinfection cycles is limited to five "postrinse disinfections". Otherwise, it cannot be guaranteed that the specified lifespan will be reached.

The person carrying this out must guarantee that the water is not used for human consumption (e.g. as drinking water) at any time during the disinfection phase, including the subsequent rinsing phase.

Description	**Commercial size and packing**	**Storage**	**Safety advice [1]**	**Max. application concentration [2]** Application duration and temperature in the piping
Hydrogen peroxide **H_2O_2**	Hydrous solution in various concentrations	Light-protected, cool, avoid contamination at all costs	With >5% solutions, protective equipment necessary	150 mg/l H_2O_2 Max. 12h Tmax ≤ 25 °C
Sodium hypochlorite **NaOCl**	Hydrous solution with maximum 150g/l chlorine	Light-protected, cool, sealed and in a collecting reservoir	Alkaline, corrosive, toxic, protective equipment necessary	50 mg/l chlorine Max. 12h Tmax ≤ 25 °C
Calcium hypochlorite **$Ca(OCl)_2$**	Granules or tablets approx. 70% $Ca(OCl)_2$	Cool, dry and sealed	Alkaline, corrosive, toxic, protective equipment necessary	50 mg/l chlorine Max. 12h Tmax ≤ 25 °C
Chlorine dioxide **ClO_2**	Two components (Sodium chloride, sodium peroxide sulphate)	Light-protected, cool and sealed	Oxidizing effect, do not inhale chlorine dioxide, protective equipment necessary	6 mg/l ClO_2 Max. 12h Tmax ≤ 25 °C

Tab. 5-2 Chemical postrinse disinfections, active ingredients and concentrations according to DVGW W 291

1) The corresponding notes in the safety data sheets of the manufacturer must be adhered to.
2) REHAU approval: this value may not be exceeded at any stage of the entire application duration of the installation.

5.6.2.2 CONTINUOUS CHEMICAL DISINFECTION

We **cannot** recommend using **indefinite chemical disinfection** in domestic installation, especially as a preventive measure for legionella prophylaxis, due to the possible occurrence of material damages to installation components. We cannot provide any guarantees in these cases. In some cases, it may be the case that chemical disinfection may be necessary for a long time, but finite period of time, until structural decontamination has been completed. These disinfection measures may only be carried out if the permitted method is used. The parameters listed in Table 5-3 must be monitored and documented for the full duration of the disinfection measure, immediately after the dosing point. If the active ingredients, concentrations, application durations and maximum temperatures as listed in Table 5-3 are adhered to, execution without impairing the functionality of REHAU drinking water installation is possible.

Description[1]	Max. application concentration[2]	Max. application duration in the piping[3]	Application temperature in the piping
Chlorine Cl_2	Max. 0.3 mg/l Free chlorine	4 months	60°C
Calcium hypochlorite $Ca(OCl)_2$	Max. 0.3 mg/l Free chlorine	4 months	60°C
Chlorine dioxide ClO_2	Max. 0.2 mg/l ClO_2	4 months	60°C

Tab. 5-3 Chemical disinfection with finite period according to drinking water ordinance 2001

1) The corresponding notes in the safety data sheets of the manufacturer must be adhered to.
2) REHAU approval: this value may not be exceeded at any stage of the entire application duration of the installation.
3) Maximum application duration is an accumulation of the entire system lifespan.

In relation to the lifespan of the pipe, the full application duration is limited to four months. Otherwise, it cannot be guaranteed that the specified lifespan will be reached.

We generally exclude other non-listed disinfectant from being used, especially strong oxidants (e.g. ozone).

Erroneously listed chemical and thermal disinfection measures can lead to permanent damage to drinking water installation components.

Before introducing these types of methodological measures, it needs to be ensured that all parts of the installation system are thermally and chemically suitable for the corresponding measure. If necessary, please have this approved by the disinfectant's manufacturer.

With thermal disinfection, it is important that the appropriate measures be taken to avoid scalding to people.

When carrying out chemical "postrinse disinfection" it must be guaranteed that water is not used for human consumption (e.g. as drinking water) at any time during the disinfection phase, including the subsequent rinsing phase.

The safety advice from the disinfectant manufacturer must be observed.

5.7 IMPORTANT ADDITIONAL INFORMATION ON THE CURRENT DRINKING WATER ORDINANCE AND DIN 50930 PART 6

A new drinking water ordinance was issued based on the drinking water directive 98/83/EC. This came into force on 1 January 2003.

In August 2001, DIN 50930 (Corrosion of metals – corrosion of metallic materials under corrosion load by water inside of tubes, tanks and apparatus) was supplemented by Part 6 – Influence of the properties of drinking water.

The notes below provide you with additional information on the new guidelines:
- New drinking water ordinance dated 21 May 2001
- DIN 50930 Part 6, August 2001

Notes on the new drinking water ordinance dated 21 May 2001
Basis: EU drinking water directive 98/83/EC dated 3 Nov 1998 Implementation in German law with the revised drinking water ordinance on 21 May 2001.

Significant revisions for piping and fitting materials:
- The limits for lead emission and nickel to the drinking water were substantially reduced.
- The recommendation for copper was replaced by an explicit limit.
- The requirements no longer apply only up to domestic mains connection as in the past, but also to the entire domestic installation.
- Compliance with the values (drinking water ordinance) for water supply system in public facilities (schools, hospitals, public houses, etc.) will be monitored by the health authorities.

Notes on DIN 50930 Part 6 dated August 2001

Piping materials

REHAU piping made of crosslinked polyethylene
RAUTITAN pipes for water services and heating installation have been tested continuously for years by a neutral institute with regard to the changes in water properties for the purpose of DVGW registration. There is still no restriction for these pipes to be used in drinking water application with regard to the quality of drinking water.

Copper piping
For bright copper pipes, usage at pH values under 7.4 with a simultaneously high content of organically bonded carbon (TOC, particularly in certain regions of northern Germany) is not permitted without individual tests, i.e. the use of copper must be verified by the installer.

Fittings in drinking water systems
With respect to the current drinking water ordinance, the maximum lead content of the raw materials for fittings made of dezincification-resistant brass was restricted to a maximum of 2.2% and a maximum of 3% for gunmetal.

These revisions in the raw materials are applicable since the drinking water ordinance was introduced on 1 January 2003.

Fittings from RAUTITAN system for water services and heating installation
The current fittings for RAUTITAN system for water services and heating installation correspond to the latest requirements.

Nickel-plated fittings
Fittings with nickel-plated surfaces have been defined as generally unsuitable. As the “technical rules” must be fulfilled on behalf of the client within the premises of work contracts, the use of nickel-plated fittings in drinking water installation should be avoided.

Conclusion
With the publishing of DIN 50930 in August 2001, it has become a part of the “generally acknowledged technical rules”. As these must be fulfilled on behalf of the client within the premises of work contracts, failure to observe them may become critical and expensive for the installer.

Apart from the drinking water ordinance and Part 6 of DIN 50930, further stringency must be anticipated due to the ever decreasing water quality (mixing of water and, among others, the risk of corrosion).

Consult your REHAU Sales Office if you have any enquiries.

5.8 WATER HAMMER

The low elastic modulus of PE-Xa pipes and their ability to expand quickly and contract slowly enables the pipes to absorb water hammer effectively. In cold water service installations, the water hammer effect can be reduced by up to 75% compared to metal pipe installations.

5.9 PIPE SIZING

Required flow rates, loading units, etc. are detailed in AS/NZS 3500 and the approved document for NZBC Water Supplies: Clause G12.

- Because of its unique jointing system, RAUTITAN system can achieve satisfactory performance levels at small bore sizes.
- The excellent corrosion and incrustation resistance of PE-X pipe ensures the bore size is maintained even after years of service. This means no extra allowance for pipe size is required.

In most cases, RAUTITAN system can achieve a satisfactory performance with smaller pipe sizes than the given equivalent pipe size table in AS/NZS 3500.
- However, the final performance will strongly depend on the available mains pressure, the location (e.g. on top of a hill) and overall size of the building and how many bathrooms and outlets the pipe system has to supply.

To avoid unnecessary large pipe sizes, REHAU recommends carrying out pipe sizing based on the method described in AS/NZS 3500 and the REHAU pressure loss tables (available in Appendix A and B) rather than sizing the system in copper and applying the equivalent pipe size table.

6. RAUTITAN - THE NEW GENERATION

WATER SERVICES

INSULATION

6.1 THERMAL INSULATION

Thermal insulation requirements for water services are specified in the NCC/BCA and in AS/NZS 3500.

In cold water installations, the likelihood of pipe damage due to freezing can be reduced. It is, however, not possible to prevent static water from freezing completely. For longer periods during which freezing is likely to occur, pump warm water periodically through the pipe system. Alternatively, the complete system could also be drained.

Table 6-1 may be used to aid heat loss calculation.

Insulation	None		9 mm		13 mm		25 mm	
Dimension mm	PE-X W/m	Copper W/m	PE-X W/m	Copper W/m	PE-X W/m	Copper W/m	PE-X W/m	Copper W/m
16 x 2.2	31.3		11.2		9.5		7.1	
12.7 x 0.91		27.2		10.0		8.5		6.5
20 x 2.8	36.8		12.9		10.8		8.0	
19.05 x 1.02		38.3		13.0		10.7		8.0
25 x 3.5	43.3		14.9		12.5		9.0	
25.4 x 1.22		48.9		15.9		13.0		9.4
32 x 4.4	51.8		17.7		14.7		10.4	
31.75 x 1.22		59.2		18.7		15.1		10.7
40 x 5.5	60.2		20.8		17.1		12.0	
38.1 x 1.22		69.2		21.5		17.2		12.0
50 x 6.9	69.8		24.5		20.0		13.7	
50.8 x 1.22		88.6		27.0		21.3		14.6
63 x 8.6	80.9		29.1		23.7		16.1	

Tab. 6-1 Heat losses per meter of PE-X and copper pipes

The heat losses are calculated based on:

- ISO 12241 (Thermal insulation for building equipment and industrial installations – calculation rules)
- Horizontal pipe installation indoors in still air
- Laminar air flow over pipe/insulation
- Internal heat transfer coefficient larger than 1000 W/m²K
- Water temperature of 65°C
- Ambient temperature of 20°C
- Emissivity of:
  - 0.77 for copper (strongly oxidized)
  - 0.93 for polymer piping
  - 0.90 for insulation
- Thermal conductivity of:
  - 380 W/mK for copper pipes
  - 0.35 W/mk for PE-X pipes
  - 0.04 W/mK for insulation

Although PE-Xa pipe is polymeric in nature and its thermal conductivity is more than 100 times lower compared to metallic pipes, it cannot be automatically assumed that no insulation is required.

6.2 REHAU PRE-INSULATED PIPES

To minimize heat loss in hot water system, REHAU pre-insulated pipes are available for RAUTITAN platinum pipe with 13 mm concentric insulation.

Insulation material and quality

The concentric pipe insulation is made of co-extruded PE-foam and moisture barrier PE layer. The insulation is not easily deformed, long lasting and CFC-free. It has a thermal conductivity of 0.04 W/mK and an R-value of 0.3.

Fire hazard properties

These pre-insulated pipe assemblies have been tested according to AS/NZS 1530.3 and obtained:

- Spread of Flame Index of 5
- Smoke Developed Index of 5

With the above result, the pre-insulated pipes can be installed concealed in all types of building specified by BCA.

The pre-insulated pipes are not suitable for exposed installation in fire-isolated areas.

6.3 ACOUSTIC INSULATION

Sound is conducted through the pipe wall as well as through the flowing water itself. The sound is then transmitted into the building fabric through the pipe, brackets and clips. Walls, ceilings, etc. start to vibrate and emit sound themselves.

Compared to metal pipe, PE-Xa pipes transmit significantly less impact sound. To obtain independent test results, REHAU commissioned the Acoustic Division of the Fraunhofer Institute for Structural Physics, Stuttgart to conduct a study of the sound level differences of PE-Xa, copper and galvanized steel pipes.

Three common pipe diameters were compared under identical conditions such as flow pressure and flow rate.

Overall, the report established that PE-Xa pipes generate up to four times less noise (sound level difference LA = 12.7 dBA) than the metal pipes (see Figure 6-1). A complete copy of the report is available on request from REHAU.

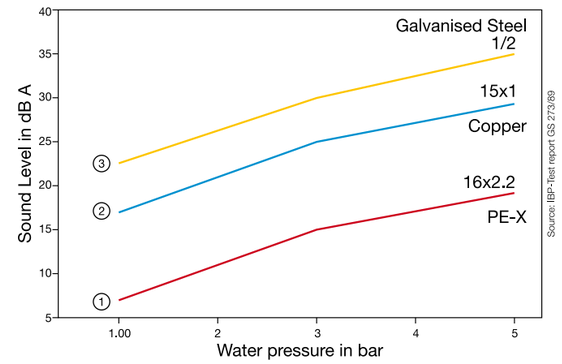


Fig. 6-1 Result of acoustics report from Acoustics Division of the Fraunhofer Institute of Structural Physics

7. RAUTITAN - THE NEW GENERATION

WATER SERVICES

SPECIFIC SYSTEM APPLICATION NOTES

7.1 WATER HEATER CONNECTION

REHAU recommends the installation of both isolation valve and non-return valve connected directly to the inlet of every water heater or with metallic piping between the valves and the water heater. REHAU recommends that the non-return valve be connected closest to the water heater and with the isolation valve at the up-stream of the non-return valve.

RAUTITAN platinum and RAUTITAN red system can be used for re-circulating hot water systems provided the operating temperature and pressure does not exceed the capabilities of the piping system.

7.1.1 STORAGE WATER HEATERS

All storage water heaters should be fitted with operational temperature and pressure relief valves for safety in the event of malfunction of the heater's operation. The rating of the temperature and pressure relief valve must be determined by the storage water heater manufacturer in terms of maximum temperature and pressure as required for the design and operational requirements of the water heater.

If the storage water heater does not have provision on the heater for fitting such a valve, REHAU recommends the installation of a temperature and pressure relief valve on the tee-connection of the heater's hot water outlet and its outlet piped to a drain location. This will allow the release of hot water during the heater's normal operation and in the event of safety operation of the valve. REHAU also recommends that the valve be operated manually every six months.

Should there be any doubt on the suitability of any storage water heater for connection to RAUTITAN plumbing system, please contact your local REHAU Sales Office with technical details of the water heater for further advice.

REHAU recommends that the outlet of storage water heaters be fitted with a minimum of 1 meter of metallic piping prior to the installation of RAUTITAN platinum or RAUTITAN red system.

7.1.2 INSTANTANEOUS WATER HEATER

Before connecting RAUTITAN piping system to either electric or gas fuelled instantaneous water heaters, the installer must observe the appliance manufacturer's instructions regarding the connection of polymer pipes. The appliance operational temperature and pressure may exceed the capabilities of RAUTITAN piping and might cause failure of the piping system. Some manufacturers of instantaneous water heaters state that connection of their appliances to polymer piping systems is not suitable or subject to restrictions.

The installer must confirm with the appliance manufacturer that the maximum operational limits of the appliance will not exceed those of the piping system as determined in Section 5.4 of this Technical Information. REHAU recommends that only appliances with temperature control devices which can, at all times, restrict the outlet water temperature to within RAUTITAN piping system's capabilities, as defined in Section 5.4 of this Technical Information, be installed in conjunction with RAUTITAN piping system.

Table 7-1 lists the suitable instantaneous water heaters that can be connected to RAUTITAN platinum and RAUTITAN red without any restrictions.

Should there be any doubt on the suitability of any instantaneous water heater for connection to RAUTITAN piping system, please contact your local REHAU Sales Office with technical details of the water heater for further advice.

7.1.3 WATER HEATERS WITH UNCONTROLLED ENERGY SOURCES

RAUTITAN platinum and RAUTITAN red pipes should not be used with uncontrolled energy sources and installation of a tempering valve is required.

7.1.4 SOLAR WATER HEATERS

As per AS/NZS 3500 requirement, polymer pipe systems must never be used on the flow and return piping to any solar panel.

Solar collectors and other uncontrolled heat sources generally have operating conditions which exceed those of RAUTITAN pipe system.

- Never use RAUTITAN pipes in the flow and return piping to any solar collectors/panels.
- Do not install RAUTITAN pipes in the flow and return of any uncontrolled heat source (e.g. wood fire heaters, etc.).
- If a heat storage tank is used, RAUTITAN pipes can be used after the tempering valve. Potential back siphoning of super heated water through the cold port of the tempering valve from cold feed to the uncontrolled heat source (including solar panels) must be prevented through adequate measures, e.g. fitting a suitable high temperature rated non-return valve between the cold feed to the solar panels and the tempering valve.

Manufacturer	Model	Capacity (kW)					Regulation
AEG	DDLE XX*	-	18	21	24	27	Electronic
AEG	DDLT XX*	12	18	21	24	27	Hydraulic
Buderus	BDE XX*	-	18	21	24	-	Electronic
CLAGE	DBX	-	18	21	24	27	Electronic
CLAGE	DCX	-	18	21	24	-	Electronic
CLAGE	DEX	-	18	21	24	27	Electronic
CLAGE	DSX	-	18	21	24	27	Electronic
Junkers	ED XX*-1 HE	-	18	21	24	-	Electronic
Junkers	ED XX*-2 S	-	18	21	24	-	Hydraulic
Siemens	Typ DE XX* 410	-	18	21	24	-	Electronic
Siemens	Typ DE XX* 415	-	18	21	24	27	Electronic
Siemens	Typ DE XX* 515	-	18	21	24	27	Electronic
Siemens	Typ DE XX* 555	-	18	21	24	27	Electronic
Siemens	Typ DH XX* 400	12	18	21	24	-	Hydraulic
Siemens	Typ DH XX* 401	12	-	-	-	-	Hydraulic
Stiebel Eltron	DEL XX* SL	-	18	21	24	27	Electronic
Stiebel Eltron	DHE XX* SL	-	18	21	24	27	Electronic
Vaillant	VED E XX*/5	-	18	21	24	27	Electronic
Vaillant	VED E XX*/6 C	-	18	21	24	27	Electronic
Vaillant	VED E XX*/6 E	-	18	21	24	27	Electronic

Tab. 7-1 Certified electrical water heaters (as of November 2008) for RAUTITAN pipes

XX* = The product model is indicated by its capacity.

7.2 RAINWATER SYSTEM

The development of sustainable house regulations has tightened the requirement of energy and water savings for new dwellings. Each state and territory in Australia and New Zealand are already implementing or in the process of implementing such regulations.

Each state in Australia adopts the Building Code of Australia and some even set higher standard of sustainability through star-rating system. Harvesting rainwater is one of the substantial ways to achieve high star-rating.

7.2.1 PIPE IDENTIFICATION

RAUTITAN green is clearly identified as rainwater plumbing system by its special green outer coating and the marking “RAINWATER” as required by AS/NZS 3500 regulation.

7.2.2 SYSTEM INTEGRATION

For applications where rainwater is also used for drinking water, the local council or water authority may have imposed special restrictions regarding water treatment and compliance with the Australian Guidelines for Drinking Water. Conduct a careful check on the local requirements with your licensed plumber before contacting REHAU with regard to the suitability of RAUTITAN green for this application.

7.2.3 SYSTEM INSTALLATION

Installation must be carried out by a licensed plumber, adhering to the requirements of AS/NZS 3500 and that of the local water provider.

To keep your system fully operational if using water with low pH level, it is recommended to maintain the tank water at a pH level between 6.5 and 9.

- This can be done by e.g. fitting a suitable inline filter system at the tank outlet.
- Do not add kerosene into the rainwater tank for mosquito control as this can have an adverse effect on your tank and the polymer piping.

7.2.4 SYSTEM MAINTENANCE

Guidelines on rainwater tanks from your local authority should be observed.

The installation of filters or screens on tank inlets and outlets is recommended to protect the appliances and the rainwater plumbing system from becoming clogged with sludge from sediments and organic materials.

Rainwater varies in its chemical composition with the geographical location and aggressive water can accelerate wear and tear on metal components of the system.

To keep your system operational, periodic checks on the pH value of the tank water should be carried out. This can be done easily without technical knowledge by obtaining pH indicator sticks (recommended pH range 4.5 to 10), which are readily available.

Should the pH value drop below 6.5, REHAU recommends the application of suitable measures to bring the pH level back to an acceptable range (i.e. between pH 6.5 and 9.0).

7.3 RECYCLED WATER SYSTEM

7.3.1 PIPE IDENTIFICATION

The system is specifically manufactured to meet AS 2492 and AS 2537 standards. RAUTITAN lilac is identified as a recycled plumbing system by its special lilac outer coating and the marking “RECYCLED OR RECLAIMED – WATER – DO NOT DRINK” as required by AS/NZS 3500.

7.3.2 SYSTEM INSTALLATION

Installations must be carried out according with AS/NZS 3500 and the requirements of the local water utility by a licensed plumber.

7.3.3 SYSTEM LIMITATIONS

Recycled/reclaimed water varies in its chemical composition depending on the end use. RAUTITAN lilac system must only be used together with treated greywater (Class A and higher) and dual reticulation system. RAUTITAN lilac system is not suitable for use with Class B – D treated greywater and direct untreated greywater reuse on domestic dwellings.

7.3.4 WATER QUALITY

Aggressive water can accelerate wear and tear on metal components of the system. To keep the system operational and to enjoy its life long benefits, RAUTITAN lilac recycled water system must only be used in combination with highly treated recycled/reclaimed water.

In some cases, the available water quality may void the REHAU warranty unless appropriate water treatment is provided.

7.3.5 RECYCLED / RECLAIMED WATER

There is a difference in water quality of recycled/reclaimed water depending on the intended end use. Table 7-2 summarizes the different treated greywater classes, their intended use and their suitability with RAUTITAN lilac system. Because of great variations between the different treatment levels, not all classes are recommended to be used with systems comprising metal components.

The main application for RAUTITAN lilac plumbing systems are dual reticulation systems. Different states in Australia may have different guidelines for recycled water applications, please adhere to the state-specific guidelines. Table 7-2 summarizes the suitable applications for RAUTITAN lilac system. For applications other than stated in the state-specific guideline and the table below, please contact your nearest REHAU sales office.

Class	Application	Suitability with RAUTITAN lilac
A	• Residential (non-potable) - Garden watering - Toilet flushing - Car washing	Yes
	• Irrigation food crops to be consumed raw	Yes
	• Municipal with uncontrolled public access	Yes
	• Primary contact recreation	Yes
B	• Municipal with controlled public access	No
	• Pasture/fodder for diary animals	No
	• Washdown water	No
	• Secondary contact recreation	No
C	• Municipal with controlled public access	No
	• Irrigation food crops to be sold to customer cooked or processed	No
	• Pasture/fodder for grazing animals (except pigs)	No
D	• Non-food chain aquaculture	No
	• Silviculture	No
	• Irrigation for turf production	No

Tab. 7-2 Treated greywater classes, their intended use and suitability with RAUTITAN lilac system

8. RAUTITAN - THE NEW GENERATION

WATER SERVICES

PRESSURE TESTING AND PURGING OF DRINKING WATER PIPES

8.1 PRESSURE TEST AND FLUSHING

A visual check must be carried out prior to pressure testing to ensure all compression sleeve joints have been secured completely. Flushing of the system should occur prior to and after pressure testing.

8.2 FLUSHING THE PIPE SYSTEM

Installers must comply with AS/NZS 3500 requirements. Coarse foreign particles can be removed simply by flushing the pipe system with water.

8.3 PRESSURE TEST PROCEDURE

Prior to concealment, fill the finished pipework with water, care must be taken to avoid air pockets. The pressure test must be conducted in accordance with AS/NZS 3500, which is pressure tested to 1500 kPa for a minimum of 30 minutes.

Notes

A factor that may influence the test result is the temperature difference between the pipe and test medium. This is due to the high coefficient of thermal expansion of plastic pipes. A temperature change of 10K corresponds approximately to a pressure change of 0.5 to 1 bar (50 to 100 kPa). For this reason, every effort should be made to ensure that the temperature of the test medium remains constant when carrying out pressure tests on system components made of plastic pipes.

In this context, it is important to carry out a visual inspection of all joints while the pressure test is in progress, since experience has shown that minor leakages cannot always be detected simply by monitoring the pressure gauge. Following the pressure test, the drinking water pipes must be flushed thoroughly.

8.4 REHAU RECOMMENDATIONS

8.4.1 GUIDELINES FOR PRESSURE TESTING

The successful execution and documentation of a pressure test is a prerequisite for any warranty claims from REHAU guarantee and the liability agreement with the German Central Association for Plumbing, Heating and Air Conditioning (ZVSHK).

According to DIN 1988, a pressure test must be conducted after completion of piping installation but before the concealing phase. For smaller system components (e.g. distribution and connecting pipes in wet rooms), DIN 1988 only requires a preliminary test with water.

Statements on the system's leak-tightness derived from the pressure test (constant, decreasing, increasing) can only be asserted in a limited capacity.

- The leak-tightness of the system can only checked by performing a visual inspection of unconcealed lines.
- Micro leaks can only be detected by performing a visual inspection (water outlet or leak detection agent) at high pressure.
- Subdividing the piping system into smaller test sections increases the inspection accuracy.

Leak detection agents

Only use leak detection agents (e.g. foaming agents) with current DVGW certification, which were also approved by the respective manufacturers for PPSU and PVDF materials.

Important information on testing with pressurized air and inert gas:

- Small leaks can only be detected by using leak detection agents at high test pressures (load test) or with a supplementary pressure test with water and the applicable visual inspection.
- Temperature fluctuation can impair the test result (pressure loss or increase).
- Pressurized air and inert gas are compressed gases. This means the piping volume has big influence on the shown pressure result. A high piping volume reduces the determination of small leaks using pressure reduction.

8.4.2 WATER PRESSURE TEST

8.4.2.1 PREPARATION OF WATER PRESSURE TEST

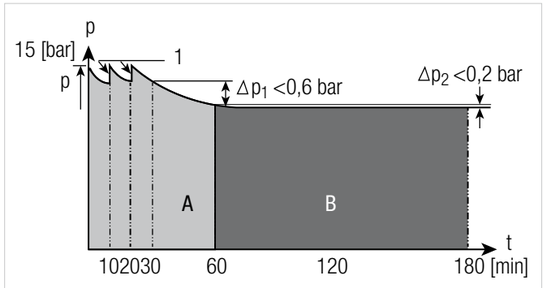


Fig. 8-1 Pressure testing diagram according to DIN 1988

1 - Topping up
A - Pre-test
B - Main test
p - Test pressure
t - Time

1. Piping needs to be accessible and cannot be concealed.
2. Dismount safety devices and meters as necessary safely and replace with pipes of pipe stoppers.
3. Fill the piping at the lowest point of the system with filtered water until all air is purged out.
4. Vent the extraction points until water is purged without air.
5. Connect the pressure testing device to the lowest point of water service installation.
6. Close all extraction points carefully.
7. Ensure that the temperature remains as constant as possible during the pressure test.
8. Prepare the pressure test record and note the system data.

The pressure test can be heavily influenced by temperature fluctuations in the piping system, e.g. a temperature change of 10 K can cause a pressure change of 0.5 bar to 1 bar (50 to 100 kPa).

Due to the pipe material properties (e.g. pipe elongation when there is increased pressurization), the pressure loss (Δp_1 and Δp_2) during the pressure test (pre-testing and main test) can deviate from standard values.

The test pressure and the pressure progression which occur during testing do not permit any sufficient conclusions as to the leak-tightness of the system. For this reason, the entire water service installation, as required in the standards, must be visually checked for leaks.

8.4.2.2 PRE-TESTING WITH WATER

1. Build up pressure of 15 bars (1500 kPa) in the water services installation.
2. After 10 minutes and 20 minutes, read and write down the test pressure and pressurize it back to 15 bars (1500 kPa).
3. Perform visual inspection for leaks on the entire water service installation, especially on the jointings.
4. After an additional test period of 30 minutes, note the test pressure in the pressure test record.

If the test pressure has fallen by more than 0.6 bars (600 kPa) (Δp_1):

1. Repeat a thorough visual inspection of the piping, extraction points and joints.
2. If no leak is found during visual inspection, the main test can be started.
3. After resolving the cause of the drop in pressure, repeat the pre-testing.

8.4.2.3 MAIN WATER PRESSURE TEST

The main test is conducted immediately after a successful pre-testing and takes about two hours:

1. Read the test pressure after the pre-testing and note it in the pressure test form.
2. After two hours, read the test pressure and note it down in the pressure test form.
3. Check the entire water service installation, particularly the joints for leaks by visual inspection.

If no leak is found during the visual inspection, the pressure test is deemed satisfactory.

If, after two hours, the test pressure has dropped by more than 0.2 bars (200 kPa) (Δp_2):

1. Repeat a thorough visual inspection on the piping, extraction points and joints.
2. If no leak is found during the visual inspection, the pressure test is deemed satisfactory.
3. After resolving the cause of the drop in pressure, repeat the pre-testing and main test.

8.4.2.4 COMPLETION OF WATER PRESSURE TEST

After completion of the main test:

1. Confirm the pressure test in the pressure test form with the contractor and client.
2. Disassemble the pressure test unit.
3. After the pressure test, thoroughly rinse out the water service pipe installation for hygiene purpose.
4. Reinstall all removed safety devices and water meters.

8.4.3 PURGING OF WATER SERVICES PIPES

To remove dirt from the storage and construction phase, open all extraction point for several minutes and thereby purge contaminants from water services installation.

Time-consuming purging of the piping with a mixture of air and water required by DIN 1988, Part 2 to protect metallic piping against corrosion is not necessary for RAUTITAN pipes.

We recommend that drinking water system should be fully drained if it is not put into immediate operation for hygienic reason and to avoid frost formation.

Purge the drained system thoroughly before commissioning.

APPENDIX A

PRESSURE LOSS TABLES FOR RAU-PE-XA

Cold water at 25°C

Peak Flow Rate Qs (l/s) (0.01 to 0.50)	PN 20 16 x 2.2 D_o (mm) = 16.00 D_i (mm) = 11.60		PN 20 20 x 2.8 D_o (mm) = 20. 00 D_i (mm) = 14.40		PN 20 25 x 3.5 D_o (mm) = 25.00 D_i (mm) = 18.00		PN 20 32 x 4.4 D_o (mm) = 32.00 D_i (mm) = 23.20	
	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)
0.01	~~0.0226~~	0.095	~~0.0082~~	0.061	~~0.0029~~	0.039	~~0.0009~~	0.024
0.02	~~0.0720~~	0.189	~~0.0261~~	0.123	~~0.0092~~	0.079	~~0.0028~~	0.047
0.03	~~0.1437~~	0.284	~~0.0518~~	0.184	~~0.0181~~	0.118	~~0.0055~~	0.071
0.04	0.2355	0.378	~~0.0846~~	0.246	~~0.0295~~	0.157	~~0.0090~~	0.095
0.05	0.3464	0.473	0.1241	0.307	~~0.0432~~	0.196	~~0.0131~~	0.118
0.06	0.4755	0.568	0.1701	0.368	0.0591	0.236	~~0.0178~~	0.142
0.07	0.6224	0.662	0.2222	0.430	0.0771	0.275	0.0232	0.166
0.08	0.7864	0.757	0.2802	0.491	0.0970	0.314	0.0292	0.189
0.09	0.9674	0.852	0.3442	0.553	0.1190	0.354	0.0357	0.213
0.10	1.1648	0.946	0.4139	0.614	0.1429	0.393	0.0429	0.237
0.11	1.3786	1.041	0.4892	0.675	0.1687	0.432	0.0505	0.260
0.12	1.6085	1.135	0.5700	0.737	0.1964	0.472	0.0588	0.284
0.13	1.8542	1.230	0.6563	0.798	0.2259	0.511	0.0675	0.308
0.14	2.1156	1.325	0.7480	0.860	0.2572	0.550	0.0768	0.331
0.15	2.3926	1.419	0.8451	0.921	0.2903	0.589	0.0866	0.355
0.16	2.6850	1.514	0.9474	0.982	0.3252	0.629	0.0969	0.378
0.17	2.9927	1.609	1.0549	1.044	0.3618	0.668	0.1077	0.402
0.18	3.3156	1.703	1.1677	1.105	0.4002	0.707	0.1191	0.426
0.19	3.6536	1.798	1.2856	1.167	0.4402	0.747	0.1309	0.449
0.20	4.0066	1.892	1.4086	1.228	0.4820	0.786	0.1432	0.473
0.21	4.3745	1.987	1.5367	1.289	0.5254	0.825	0.1560	0.497
0.22	4.7572	2.082	1.6698	1.351	0.5705	0.865	0.1693	0.520
0.23	5.1548	2.176	1.8079	1.412	0.6173	0.904	0.1831	0.544
0.24	5.5670	2.271	1.9510	1.474	0.6658	0.943	0.1973	0.568
0.25	5.9939	2.366	2.0991	1.535	0.7158	0.982	0.2120	0.591
0.26	6.4354	2.460	2.2521	1.596	0.7675	1.022	0.2272	0.615
0.27	6.8915	2.555	2.4101	1.658	0.8209	1.061	0.2429	0.639
0.28	7.3620	2.649	2.5729	1.719	0.8758	1.100	0.2590	0.662
0.29	7.8470	2.744	2.7406	1.781	0.9324	1.140	0.2755	0.686
0.30	8.3464	2.839	2.9131	1.842	0.9905	1.179	0.2926	0.710
0.31	8.8602	2.933	3.0905	1.903	1.0503	1.218	0.3101	0.733
0.32	9.3883	3.028	3.2727	1.965	1.1116	1.258	0.3280	0.757
0.33	9.9307	3.123	3.4597	2.026	1.1745	1.297	0.3464	0.781
0.34	10.4873	3.217	3.6515	2.088	1.2390	1.336	0.3652	0.804
0.35	11.0582	3.312	3.8481	2.149	1.3050	1.375	0.3845	0.828
0.36	11.6433	3.406	4.0494	2.210	1.3726	1.415	0.4043	0.852
0.37	12.2426	3.501	4.2555	2.272	1.4418	1.454	0.4244	0.875
0.38	12.8560	3.596	4.4663	2.333	1.5125	1.493	0.4451	0.899
0.39	13.4836	3.690	4.6819	2.395	1.5848	1.533	0.4661	0.923
0.40	14.1252	3.785	4.9021	2.456	1.6586	1.572	0.4876	0.946
0.41	14.7810	3.880	5.1271	2.517	1.7339	1.611	0.5096	0.970
0.42	15.4507	3.974	5.3567	2.579	1.8108	1.650	0.5319	0.994
0.43			5.5911	2.640	1.8892	1.690	0.5547	1.017
0.44			5.8301	2.702	1.9691	1.729	0.5780	1.041
0.45			6.0737	2.763	2.0505	1.768	0.6016	1.065
0.46			6.3221	2.825	2.1335	1.808	0.6257	1.088
0.47			6.5750	2.886	2.2180	1.847	0.6502	1.112
0.48			6.8326	2.947	2.3039	1.886	0.6752	1.135
0.49			7.0949	3.009	2.3914	1.926	0.7006	1.159
0.50			7.3617	3.070	2.4804	1.965	0.7264	1.183

Cold water at 25°C

Peak Flow Rate Qs (l/s) (0.05 to 2.50)	PN 20 32 x 4.4 D_o (mm) = 32.00 D_i (mm) = 23.20		PN 20 40 x 5.5 D_o (mm) = 40.00 D_i (mm) = 29.00		PN 20 50 x 6.9 D_o (mm) = 50.00 D_i (mm) = 36.20		PN 20 63 x 8.6 D_o (mm) = 63.00 D_i (mm) = 45.80	
	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)
0.05	~~0.0131~~	0.118	~~0.0046~~	0.076	~~0.0016~~	0.049	~~0.0005~~	0.030
0.10	0.0429	0.237	0.0149	0.151	~~0.0052~~	0.097	~~0.0017~~	0.061
0.15	0.0866	0.355	0.0300	0.227	0.0105	0.146	0.0035	0.091
0.20	0.1432	0.473	0.0495	0.303	0.0173	0.194	0.0057	0.121
0.25	0.2120	0.591	0.0731	0.378	0.0254	0.243	0.0083	0.152
0.30	0.2926	0.710	0.1006	0.454	0.0350	0.291	0.0114	0.182
0.35	0.3845	0.828	0.1320	0.530	0.0458	0.340	0.0150	0.212
0.40	0.4876	0.946	0.1671	0.606	0.0579	0.389	0.0189	0.243
0.45	0.6016	1.065	0.2059	0.681	0.0713	0.437	0.0232	0.273
0.50	0.7264	1.183	0.2483	0.757	0.0858	0.486	0.0279	0.303
0.55	0.8617	1.301	0.2942	0.833	0.1016	0.534	0.0330	0.334
0.60	1.0075	1.419	0.3435	0.908	0.1185	0.583	0.0385	0.364
0.65	1.1637	1.538	0.3963	0.984	0.1366	0.632	0.0443	0.395
0.70	1.3301	1.656	0.4525	1.060	0.1558	0.680	0.0505	0.425
0.75	1.5067	1.774	0.5120	1.135	0.1761	0.729	0.0571	0.455
0.80	1.6933	1.892	0.5749	1.211	0.1976	0.777	0.0640	0.486
0.85	1.8900	2.011	0.6411	1.287	0.2202	0.826	0.0712	0.516
0.90	2.0966	2.129	0.7105	1.363	0.2438	0.874	0.0788	0.546
0.95	2.3132	2.247	0.7832	1.438	0.2686	0.923	0.0868	0.577
1.00	2.5396	2.366	0.8592	1.514	0.2944	0.972	0.0951	0.607
1.05	2.7758	2.484	0.9383	1.590	0.3214	1.020	0.1037	0.637
1.10	3.0218	2.602	1.0207	1.665	0.3493	1.069	0.1126	0.668
1.15	3.2775	2.720	1.1062	1.741	0.3784	1.117	0.1219	0.698
1.20	3.5429	2.839	1.1949	1.817	0.4084	1.166	0.1316	0.728
1.25	3.8179	2.957	1.2867	1.892	0.4396	1.215	0.1415	0.759
1.30	4.1025	3.075	1.3817	1.968	0.4717	1.263	0.1518	0.789
1.35	4.3968	3.194	1.4798	2.044	0.5049	1.312	0.1624	0.819
1.40	4.7006	3.312	1.5810	2.120	0.5392	1.360	0.1733	0.850
1.45	5.0140	3.430	1.6853	2.195	0.5744	1.409	0.1846	0.880
1.50	5.3369	3.548	1.7927	2.271	0.6107	1.457	0.1961	0.910
1.55	5.6692	3.667	1.9031	2.347	0.6480	1.506	0.2080	0.941
1.60	6.0111	3.785	2.0167	2.422	0.6863	1.555	0.2202	0.971
1.65	6.3624	3.903	2.1333	2.498	0.7257	1.603	0.2327	1.002
1.70	6.7231	4.021	2.2529	2.574	0.7660	1.652	0.2456	1.032
1.75			2.3756	2.649	0.8073	1.700	0.2587	1.062
1.80			2.5014	2.725	0.8497	1.749	0.2722	1.093
1.85			2.6301	2.801	0.8930	1.797	0.2859	1.123
1.90			2.7619	2.877	0.9373	1.846	0.3000	1.153
1.95			2.8967	2.952	0.9826	1.895	0.3144	1.184
2.00			3.0345	3.028	1.0289	1.943	0.3291	1.214
2.05			3.1754	3.104	1.0762	1.992	0.3441	1.244
2.10			3.3192	3.179	1.1245	2.040	0.3594	1.275
2.15			3.4660	3.255	1.1738	2.089	0.3750	1.305
2.20			3.6158	3.331	1.2240	2.138	0.3909	1.335
2.25			3.7686	3.406	1.2752	2.186	0.4071	1.366
2.30			3.9244	3.482	1.3274	2.235	0.4236	1.396
2.35			4.0831	3.558	1.3806	2.283	0.4404	1.426
2.40			4.2448	3.634	1.4347	2.332	0.4576	1.457
2.45			4.4095	3.709	1.4898	2.380	0.4750	1.487
2.50			4.5771	3.785	1.5458	2.429	0.4927	1.517

Cold water at 25°C

Peak Flow Rate Qs (l/s) (0.51 to 1)	PN 20 20 x 2.8 D_o (mm) = 20.00 D_i (mm) = 14.40		PN 20 25 x 3.5 D_o (mm) = 25.00 D_i (mm) = 18.00		PN 20 32 x 4.4 D_o (mm) = 32.00 D_i (mm) = 23.20		PN 20 40 x 5.5 D_o (mm) = 40.00 D_i (mm) = 29.00	
	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)
0.51	7.6332	3.132	2.5709	2.004	0.7526	1.206	0.2572	0.772
0.52	7.9093	3.193	2.6628	2.043	0.7792	1.230	0.2662	0.787
0.53	8.1900	3.254	2.7563	2.083	0.8063	1.254	0.2754	0.802
0.54	8.4752	3.316	2.8513	2.122	0.8338	1.277	0.2847	0.818
0.55	8.7651	3.377	2.9477	2.161	0.8617	1.301	0.2942	0.833
0.56	9.0596	3.439	3.0457	2.201	0.8900	1.325	0.3037	0.848
0.57	9.3586	3.500	3.1451	2.240	0.9188	1.348	0.3135	0.863
0.58	9.6622	3.561	3.2460	2.279	0.9479	1.372	0.3234	0.878
0.59	9.9704	3.623	3.3484	2.319	0.9775	1.396	0.3334	0.893
0.60	10.2831	3.684	3.4522	2.358	1.0075	1.419	0.3435	0.908
0.61	10.6004	3.746	3.5575	2.397	1.0379	1.443	0.3538	0.924
0.62	10.9223	3.807	3.6643	2.436	1.0687	1.467	0.3642	0.939
0.63	11.2487	3.868	3.7726	2.476	1.1000	1.490	0.3748	0.954
0.64	11.5796	3.930	3.8823	2.515	1.1316	1.514	0.3855	0.969
0.65	11.9151	3.991	3.9935	2.554	1.1637	1.538	0.3963	0.984
0.66	12.2551	4.053	4.1062	2.594	1.1961	1.561	0.4073	0.999
0.67			4.2203	2.633	1.2290	1.585	0.4184	1.014
0.68			4.3358	2.672	1.2623	1.609	0.4296	1.029
0.69			4.4529	2.712	1.2960	1.632	0.4410	1.045
0.70			4.5714	2.751	1.3301	1.656	0.4525	1.060
0.71			4.6913	2.790	1.3646	1.680	0.4641	1.075
0.72			4.8127	2.829	1.3995	1.703	0.4759	1.090
0.73			4.9355	2.869	1.4348	1.727	0.4878	1.105
0.74			5.0598	2.908	1.4705	1.751	0.4999	1.120
0.75			5.1856	2.947	1.5067	1.774	0.5120	1.135
0.76			5.3127	2.987	1.5432	1.798	0.5243	1.151
0.77			5.4414	3.026	1.5801	1.821	0.5368	1.166
0.78			5.5714	3.065	1.6174	1.845	0.5494	1.181
0.79			5.7029	3.105	1.6552	1.869	0.5621	1.196
0.80			5.8359	3.144	1.6933	1.892	0.5749	1.211
0.81			5.9703	3.183	1.7319	1.916	0.5879	1.226
0.82			6.1061	3.222	1.7708	1.940	0.6010	1.241
0.83			6.2434	3.262	1.8101	1.963	0.6142	1.257
0.84			6.3821	3.301	1.8499	1.987	0.6276	1.272
0.85			6.5222	3.340	1.8900	2.011	0.6411	1.287
0.86			6.6637	3.380	1.9305	2.034	0.6547	1.302
0.87			6.8067	3.419	1.9715	2.058	0.6685	1.317
0.88			6.9511	3.458	2.0128	2.082	0.6824	1.332
0.89			7.0970	3.497	2.0545	2.105	0.6964	1.347
0.90			7.2443	3.537	2.0966	2.129	0.7105	1.363
0.91			7.3930	3.576	2.1392	2.153	0.7248	1.378
0.92			7.5431	3.615	2.1821	2.176	0.7392	1.393
0.93			7.6946	3.655	2.2254	2.200	0.7538	1.408
0.94			7.8476	3.694	2.2691	2.224	0.7684	1.423
0.95			8.0020	3.733	2.3132	2.247	0.7832	1.438
0.96			8.1578	3.773	2.3577	2.271	0.7982	1.453
0.97			8.3151	3.812	2.4026	2.295	0.8132	1.469
0.98			8.4737	3.851	2.4479	2.318	0.8284	1.484
0.99			8.6338	3.890	2.4935	2.342	0.8437	1.499
1.00			8.7953	3.930	2.5396	2.366	0.8592	1.514

Cold water at 25°C

Peak Flow Rate Qs (l/s) (2.60 to 7.50)	PN 20 50 x 6.9 D_o (mm) = 50.00 D_i (mm) = 36.20		PN 20 63 x 8.6 D_o (mm) = 63.00 D_i (mm) = 45.80	
	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)
2.60	1.6609	2.526	0.5290	1.578
2.70	1.7797	2.623	0.5665	1.639
2.80	1.9025	2.721	0.6052	1.700
2.90	2.0290	2.818	0.6451	1.760
3.00	2.1593	2.915	0.6861	1.821
3.10	2.2935	3.012	0.7283	1.882
3.20	2.4314	3.109	0.7717	1.942
3.30	2.5732	3.206	0.8162	2.003
3.40	2.7187	3.303	0.8619	2.064
3.50	2.8679	3.401	0.9088	2.124
3.60	3.0210	3.498	0.9568	2.185
3.70	3.1777	3.595	1.0059	2.246
3.80	3.3383	3.692	1.0562	2.307
3.90	3.5025	3.789	1.1076	2.367
4.00	3.6705	3.886	1.1602	2.428
4.10	3.8423	3.984	1.2139	2.489
4.20	4.0177	4.081	1.2688	2.549
4.30			1.3247	2.610
4.40			1.3818	2.671
4.50			1.4401	2.731
4.60			1.4994	2.792
4.70			1.5599	2.853
4.80			1.6215	2.914
4.90			1.6842	2.974
5.00			1.7481	3.035
5.10			1.8130	3.096
5.20			1.8791	3.156
5.30			1.9463	3.217
5.40			2.0146	3.278
5.50			2.0840	3.338
5.60			2.1545	3.399
5.70			2.2261	3.460
5.80			2.2989	3.521
5.90			2.3727	3.581
6.00			2.4476	3.642
6.10			2.5237	3.703
6.20			2.6008	3.763
6.30			2.6790	3.824
6.40			2.7584	3.885
6.50			2.8388	3.945
6.60			2.9203	4.006
6.70			3.0029	4.067
6.80			3.0867	4.128
6.90			3.1715	4.188
7.00			3.2574	4.249
7.10			3.3444	4.310
7.20			3.4324	4.370
7.30			3.5216	4.431
7.40			3.6119	4.492
7.50			3.7032	4.552

Hot water at 60°C

Peak Flow Rate Qs (l/s) (0.01 to 0.50)	PN 20 16 x 2.2 D_o (mm) = 16.00 D_i (mm) = 11.60		PN 20 20 x 2.8 D_o (mm) = 20.00 D_i (mm) = 14.40		PN 20 25 x 3.5 D_o (mm) = 25.00 D_i (mm) = 18.00		PN 20 32 x 4.4 D_o (mm) = 32.00 D_i (mm) = 23.20	
	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)
0.01	~~0.0181~~	0.095	~~0.0066~~	0.061	~~0.0023~~	0.039	~~0.0007~~	0.024
0.02	0.0590	0.189	~~0.0212~~	0.123	~~0.0074~~	0.079	~~0.0023~~	0.047
0.03	0.1191	0.284	0.0426	0.184	0.0148	0.118	~~0.0045~~	0.071
0.04	0.1968	0.378	0.0702	0.246	0.0243	0.157	0.0073	0.095
0.05	0.2913	0.473	0.1036	0.307	0.0358	0.196	0.0107	0.118
0.06	0.4020	0.568	0.1426	0.368	0.0492	0.236	0.0147	0.142
0.07	0.5286	0.662	0.1871	0.430	0.0644	0.275	0.0192	0.166
0.08	0.6705	0.757	0.2368	0.491	0.0814	0.314	0.0243	0.189
0.09	0.8277	0.852	0.2918	0.553	0.1001	0.354	0.0298	0.213
0.10	0.9999	0.946	0.3519	0.614	0.1205	0.393	0.0358	0.237
0.11	1.1869	1.041	0.4170	0.675	0.1426	0.432	0.0424	0.260
0.12	1.3885	1.135	0.4871	0.737	0.1664	0.472	0.0494	0.284
0.13	1.6047	1.230	0.5622	0.798	0.1918	0.511	0.0568	0.308
0.14	1.8353	1.325	0.6421	0.860	0.2188	0.550	0.0648	0.331
0.15	2.0802	1.419	0.7269	0.921	0.2474	0.589	0.0731	0.355
0.16	2.3394	1.514	0.8165	0.982	0.2776	0.629	0.0820	0.378
0.17	2.6127	1.609	0.9108	1.044	0.3094	0.668	0.0913	0.402
0.18	2.9001	1.703	1.0099	1.105	0.3427	0.707	0.1010	0.426
0.19	3.2016	1.798	1.1136	1.167	0.3775	0.747	0.1112	0.449
0.20	3.5171	1.892	1.2221	1.228	0.4139	0.786	0.1218	0.473
0.21	3.8464	1.987	1.3352	1.289	0.4519	0.825	0.1329	0.497
0.22	4.1897	2.082	1.4530	1.351	0.4913	0.865	0.1444	0.520
0.23	4.5468	2.176	1.5754	1.412	0.5323	0.904	0.1563	0.544
0.24	4.9178	2.271	1.7024	1.474	0.5747	0.943	0.1686	0.568
0.25	5.3025	2.366	1.8340	1.535	0.6186	0.982	0.1814	0.591
0.26	5.7009	2.460	1.9701	1.596	0.6641	1.022	0.1946	0.615
0.27	6.1131	2.555	2.1109	1.658	0.7110	1.061	0.2082	0.639
0.28	6.5390	2.649	2.2561	1.719	0.7594	1.100	0.2222	0.662
0.29	6.9785	2.744	2.4059	1.781	0.8092	1.140	0.2366	0.686
0.30	7.4317	2.839	2.5602	1.842	0.8606	1.179	0.2514	0.710
0.31	7.8985	2.933	2.7191	1.903	0.9134	1.218	0.2667	0.733
0.32	8.3789	3.028	2.8824	1.965	0.9676	1.258	0.2824	0.757
0.33	8.8729	3.123	3.0502	2.026	1.0233	1.297	0.2984	0.781
0.34	9.3805	3.217	3.2225	2.088	1.0804	1.336	0.3149	0.804
0.35	9.9016	3.312	3.3993	2.149	1.1390	1.375	0.3318	0.828
0.36	10.4362	3.406	3.5806	2.210	1.1990	1.415	0.3491	0.852
0.37	10.9844	3.501	3.7663	2.272	1.2605	1.454	0.3668	0.875
0.38	11.5461	3.596	3.9564	2.333	1.3234	1.493	0.3849	0.899
0.39	12.1213	3.690	4.1510	2.395	1.3877	1.533	0.4034	0.923
0.40	12.7100	3.785	4.3501	2.456	1.4535	1.572	0.4223	0.946
0.41	13.3121	3.880	4.5536	2.517	1.5207	1.611	0.4416	0.970
0.42	13.9277	3.974	4.7615	2.579	1.5893	1.650	0.4613	0.994
0.43	14.5568	4.069	4.9738	2.640	1.6593	1.690	0.4813	1.017
0.44			5.1906	2.702	1.7307	1.729	0.5018	1.041
0.45			5.4117	2.763	1.8036	1.768	0.5227	1.065
0.46			5.6373	2.825	1.8778	1.808	0.5440	1.088
0.47			5.8673	2.886	1.9535	1.847	0.5656	1.112
0.48			6.1017	2.947	2.0306	1.886	0.5877	1.135
0.49			6.3404	3.009	2.1091	1.926	0.6101	1.159
0.50			6.5836	3.070	2.1890	1.965	0.6329	1.183

Hot water at 60°C

Peak Flow Rate Qs (l/s) (0.05 to 2.50)	PN 20 32 x 4.4 D_o (mm) = 32.00 D_i (mm) = 23.20		PN 20 40 x 5.5 D_o (mm) = 40.00 D_i (mm) = 29.00		PN 20 50 x 6.9 D_o (mm) = 50.00 D_i (mm) = 36.20		PN 20 63 x 8.6 D_o (mm) = 63.00 D_i (mm) = 45.80	
	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)
0.05	0.0107	0.118	0.0037	0.076	0.0013	0.049	0.0004	0.030
0.10	0.0358	0.237	0.0124	0.151	0.0043	0.097	0.0014	0.061
0.15	0.0731	0.355	0.0252	0.227	0.0088	0.146	0.0029	0.091
0.20	0.1218	0.473	0.0418	0.303	0.0145	0.194	0.0047	0.121
0.25	0.1814	0.591	0.0620	0.378	0.0215	0.243	0.0070	0.152
0.30	0.2514	0.710	0.0858	0.454	0.0296	0.291	0.0096	0.182
0.35	0.3318	0.828	0.1130	0.530	0.0389	0.340	0.0126	0.212
0.40	0.4223	0.946	0.1435	0.606	0.0494	0.389	0.0160	0.243
0.45	0.5227	1.065	0.1773	0.681	0.0609	0.437	0.0197	0.273
0.50	0.6329	1.183	0.2143	0.757	0.0735	0.486	0.0238	0.303
0.55	0.7529	1.301	0.2546	0.833	0.0872	0.534	0.0281	0.334
0.60	0.8825	1.419	0.2979	0.908	0.1019	0.583	0.0329	0.364
0.65	1.0216	1.538	0.3444	0.984	0.1177	0.632	0.0379	0.395
0.70	1.1703	1.656	0.3941	1.060	0.1345	0.680	0.0433	0.425
0.75	1.3284	1.774	0.4467	1.135	0.1523	0.729	0.0490	0.455
0.80	1.4960	1.892	0.5025	1.211	0.1712	0.777	0.0550	0.486
0.85	1.6728	2.011	0.5612	1.287	0.1910	0.826	0.0613	0.516
0.90	1.8590	2.129	0.6230	1.363	0.2118	0.874	0.0679	0.546
0.95	2.0545	2.247	0.6878	1.438	0.2337	0.923	0.0749	0.577
1.00	2.2593	2.366	0.7556	1.514	0.2565	0.972	0.0821	0.607
1.05	2.4733	2.484	0.8263	1.590	0.2803	1.020	0.0897	0.637
1.10	2.6965	2.602	0.9001	1.665	0.3050	1.069	0.0975	0.668
1.15	2.9289	2.720	0.9767	1.741	0.3307	1.117	0.1057	0.698
1.20	3.1704	2.839	1.0564	1.817	0.3574	1.166	0.1141	0.728
1.25	3.4211	2.957	1.1389	1.892	0.3851	1.215	0.1229	0.759
1.30	3.6810	3.075	1.2244	1.968	0.4137	1.263	0.1319	0.789
1.35	3.9499	3.194	1.3128	2.044	0.4433	1.312	0.1412	0.819
1.40	4.2280	3.312	1.4041	2.120	0.4738	1.360	0.1509	0.850
1.45	4.5151	3.430	1.4984	2.195	0.5052	1.409	0.1608	0.880
1.50	4.8113	3.548	1.5955	2.271	0.5376	1.457	0.1710	0.910
1.55	5.1166	3.667	1.6955	2.347	0.5710	1.506	0.1815	0.941
1.60	5.4310	3.785	1.7984	2.422	0.6053	1.555	0.1923	0.971
1.65	5.7543	3.903	1.9042	2.498	0.6405	1.603	0.2034	1.002
1.70	6.0868	4.021	2.0129	2.574	0.6767	1.652	0.2148	1.032
1.75			2.1245	2.649	0.7137	1.700	0.2264	1.062
1.80			2.2389	2.725	0.7518	1.749	0.2384	1.093
1.85			2.3562	2.801	0.7907	1.797	0.2506	1.123
1.90			2.4764	2.877	0.8306	1.846	0.2631	1.153
1.95			2.5994	2.952	0.8714	1.895	0.2759	1.184
2.00			2.7253	3.028	0.9131	1.943	0.2890	1.214
2.05			2.8540	3.104	0.9558	1.992	0.3023	1.244
2.10			2.9856	3.179	0.9993	2.040	0.3160	1.275
2.15			3.1200	3.255	1.0438	2.089	0.3299	1.305
2.20			3.2573	3.331	1.0892	2.138	0.3441	1.335
2.25			3.3974	3.406	1.1356	2.186	0.3585	1.366
2.30			3.5404	3.482	1.1828	2.235	0.3733	1.396
2.35			3.6861	3.558	1.2310	2.283	0.3883	1.426
2.40			3.8348	3.634	1.2800	2.332	0.4037	1.457
2.45			3.9862	3.709	1.3300	2.380	0.4192	1.487
2.50			4.1405	3.785	1.3809	2.429	0.4351	1.517

Hot water at 60°C

Peak Flow Rate Qs (l/s) (0.51 to 1.00)	PN 20 20 x 2.8 D_o (mm) = 20.00 D_i (mm) = 14.40		PN 20 25 x 3.5 D_o (mm) = 25.00 D_i (mm) = 18.00		PN 20 32 x 4.4 D_o (mm) = 32.00 D_i (mm) = 23.20		PN 20 40 x 5.5 D_o (mm) = 40.00 D_i (mm) = 29.00	
	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)
0.51	6.8312	3.132	2.2703	2.004	0.6561	1.206	0.2221	0.772
0.52	7.0831	3.193	2.3530	2.043	0.6797	1.230	0.2300	0.787
0.53	7.3394	3.254	2.4371	2.083	0.7037	1.254	0.2381	0.802
0.54	7.6001	3.316	2.5225	2.122	0.7281	1.277	0.2463	0.818
0.55	7.8652	3.377	2.6094	2.161	0.7529	1.301	0.2546	0.833
0.56	8.1346	3.439	2.6977	2.201	0.7780	1.325	0.2630	0.848
0.57	8.4084	3.500	2.7874	2.240	0.8036	1.348	0.2715	0.863
0.58	8.6866	3.561	2.8784	2.279	0.8295	1.372	0.2802	0.878
0.59	8.9691	3.623	2.9709	2.319	0.8558	1.396	0.2890	0.893
0.60	9.2560	3.684	3.0647	2.358	0.8825	1.419	0.2979	0.908
0.61	9.5473	3.746	3.1600	2.397	0.9095	1.443	0.3070	0.924
0.62	9.8429	3.807	3.2566	2.436	0.9370	1.467	0.3162	0.939
0.63	10.1429	3.868	3.3546	2.476	0.9648	1.490	0.3255	0.954
0.64	10.4472	3.930	3.4539	2.515	0.9930	1.514	0.3349	0.969
0.65	10.7559	3.991	3.5547	2.554	1.0216	1.538	0.3444	0.984
0.66	11.0689	4.053	3.6568	2.594	1.0506	1.561	0.3541	0.999
0.67			3.7604	2.633	1.0800	1.585	0.3639	1.014
0.68			3.8653	2.672	1.1097	1.609	0.3738	1.029
0.69			3.9716	2.712	1.1398	1.632	0.3839	1.045
0.70			4.0792	2.751	1.1703	1.656	0.3941	1.060
0.71			4.1882	2.790	1.2012	1.680	0.4043	1.075
0.72			4.2987	2.829	1.2324	1.703	0.4148	1.090
0.73			4.4104	2.869	1.2641	1.727	0.4253	1.105
0.74			4.5236	2.908	1.2961	1.751	0.4360	1.120
0.75			4.6381	2.947	1.3284	1.774	0.4467	1.135
0.76			4.7540	2.987	1.3612	1.798	0.4576	1.151
0.77			4.8713	3.026	1.3943	1.821	0.4687	1.166
0.78			4.9899	3.065	1.4278	1.845	0.4798	1.181
0.79			5.1099	3.105	1.4617	1.869	0.4911	1.196
0.80			5.2313	3.144	1.4960	1.892	0.5025	1.211
0.81			5.3541	3.183	1.5306	1.916	0.5140	1.226
0.82			5.4782	3.222	1.5656	1.940	0.5256	1.241
0.83			5.6037	3.262	1.6010	1.963	0.5374	1.257
0.84			5.7305	3.301	1.6367	1.987	0.5492	1.272
0.85			5.8587	3.340	1.6728	2.011	0.5612	1.287
0.86			5.9883	3.380	1.7093	2.034	0.5733	1.302
0.87			6.1192	3.419	1.7462	2.058	0.5856	1.317
0.88			6.2515	3.458	1.7834	2.082	0.5979	1.332
0.89			6.3852	3.497	1.8211	2.105	0.6104	1.347
0.90			6.5202	3.537	1.8590	2.129	0.6230	1.363
0.91			6.6566	3.576	1.8974	2.153	0.6357	1.378
0.92			6.7944	3.615	1.9361	2.176	0.6486	1.393
0.93			6.9335	3.655	1.9752	2.200	0.6615	1.408
0.94			7.0740	3.694	2.0147	2.224	0.6746	1.423
0.95			7.2158	3.733	2.0545	2.247	0.6878	1.438
0.96			7.3590	3.773	2.0947	2.271	0.7011	1.453
0.97			7.5035	3.812	2.1353	2.295	0.7146	1.469
0.98			7.6494	3.851	2.1763	2.318	0.7281	1.484
0.99			7.7967	3.890	2.2176	2.342	0.7418	1.499
1.00			7.9453	3.930	2.2593	2.366	0.7556	1.514

PRESSURE LOSS TABLES FOR RAU-PE-XA

Hot water at 60°C

Peak Flow Rate Qs (l/s) (2.60 to 7.50)	PN 20 50 x 6.9 D_o (mm) = 50.00 D_i (mm) = 36.20		PN 20 63 x 8.6 D_o (mm) = 63.00 D_i (mm) = 45.80	
	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)
2.60	1.4854	2.526	0.4677	1.578
2.70	1.5935	2.623	0.5013	1.639
2.80	1.7053	2.721	0.5361	1.700
2.90	1.8207	2.818	0.5720	1.760
3.00	1.9397	2.915	0.6089	1.821
3.10	2.0623	3.012	0.6470	1.882
3.20	2.1885	3.109	0.6861	1.942
3.30	2.3183	3.206	0.7263	2.003
3.40	2.4517	3.303	0.7676	2.064
3.50	2.5887	3.401	0.8100	2.124
3.60	2.7292	3.498	0.8535	2.185
3.70	2.8734	3.595	0.8980	2.246
3.80	3.0211	3.692	0.9436	2.307
3.90	3.1724	3.789	0.9903	2.367
4.00	3.3272	3.886	1.0381	2.428
4.10	3.4857	3.984	1.0869	2.489
4.20	3.6477	4.081	1.1369	2.549
4.30			1.1878	2.610
4.40			1.2399	2.671
4.50			1.2930	2.731
4.60			1.3472	2.792
4.70			1.4024	2.853
4.80			1.4587	2.914
4.90			1.5161	2.974
5.00			1.5745	3.035
5.10			1.6340	3.096
5.20			1.6945	3.156
5.30			1.7561	3.217
5.40			1.8188	3.278
5.50			1.8825	3.338
5.60			1.9473	3.399
5.70			2.0131	3.460
5.80			2.0800	3.521
5.90			2.1479	3.581
6.00			2.2169	3.642
6.10			2.2870	3.703
6.20			2.3580	3.763
6.30			2.4302	3.824
6.40			2.5034	3.885
6.50			2.5776	3.945
6.60			2.6529	4.006
6.70			2.7293	4.067
6.80			2.8067	4.128
6.90			2.8851	4.188
7.00			2.9646	4.249
7.10			3.0451	4.310
7.20			3.1267	4.370
7.30			3.2093	4.431
7.40			3.2930	4.492
7.50			3.3777	4.552

APPENDIX B

PRESSURE LOSS TABLES FOR RAUTITAN STABIL

Cold water at 25°C

Peak Flow Rate Qs (l/s) (0.01 to 0.50)	PN 20 16.2 x 2.6 D_o (mm) = 16.20 D_i (mm) = 11.00		PN 20 20 x 2.9 D_o (mm) = 20.00 D_i (mm) = 14.20		PN 20 25 x 3.7 D_o (mm) = 25.00 D_i (mm) = 17.60		PN 20 32 x 4.7 D_o (mm) = 32.00 D_i (mm) = 22.60	
	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)
0.01	0.0289	0.105	0.0088	0.063	0.0032	0.041	0.0010	0.025
0.02	0.0925	0.210	0.0279	0.126	0.0102	0.082	0.0032	0.050
0.03	0.1847	0.316	0.0553	0.189	0.0202	0.123	0.0062	0.075
0.04	0.3029	0.421	0.0904	0.253	0.0328	0.164	0.0101	0.100
0.05	0.4459	0.526	0.1327	0.316	0.0481	0.206	0.0148	0.125
0.06	0.6125	0.631	0.1817	0.379	0.0657	0.247	0.0202	0.150
0.07	0.8021	0.737	0.2374	0.442	0.0857	0.288	0.0263	0.174
0.08	1.0140	0.842	0.2995	0.505	0.1080	0.329	0.0330	0.199
0.09	1.2479	0.947	0.3679	0.568	0.1324	0.370	0.0405	0.224
0.10	1.5032	1.052	0.4424	0.631	0.1590	0.411	0.0485	0.249
0.11	1.7797	1.157	0.5230	0.695	0.1878	0.452	0.0572	0.274
0.12	2.0771	1.263	0.6095	0.758	0.2186	0.493	0.0665	0.299
0.13	2.3952	1.368	0.7018	0.821	0.2515	0.534	0.0765	0.324
0.14	2.7337	1.473	0.7999	0.884	0.2864	0.575	0.0870	0.349
0.15	3.0925	1.578	0.9037	0.947	0.3232	0.617	0.0981	0.374
0.16	3.4714	1.684	1.0132	1.010	0.3621	0.658	0.1098	0.399
0.17	3.8702	1.789	1.1283	1.073	0.4029	0.699	0.1221	0.424
0.18	4.2889	1.894	1.2490	1.137	0.4456	0.740	0.1349	0.449
0.19	4.7272	1.999	1.3752	1.200	0.4903	0.781	0.1483	0.474
0.20	5.1851	2.105	1.5068	1.263	0.5368	0.822	0.1623	0.499
0.21	5.6626	2.210	1.6439	1.326	0.5852	0.863	0.1768	0.523
0.22	6.1594	2.315	1.7864	1.389	0.6355	0.904	0.1919	0.548
0.23	6.6755	2.420	1.9343	1.452	0.6877	0.945	0.2075	0.573
0.24	7.2108	2.525	2.0875	1.515	0.7417	0.986	0.2236	0.598
0.25	7.7653	2.631	2.2460	1.579	0.7975	1.028	0.2403	0.623
0.26	8.3389	2.736	2.4099	1.642	0.8552	1.069	0.2576	0.648
0.27	8.9315	2.841	2.5790	1.705	0.9147	1.110	0.2753	0.673
0.28	9.5431	2.946	2.7533	1.768	0.9759	1.151	0.2936	0.698
0.29	10.1736	3.052	2.9329	1.831	1.0390	1.192	0.3124	0.723
0.30	10.8229	3.157	3.1177	1.894	1.1039	1.233	0.3317	0.748
0.31	11.4911	3.262	3.3076	1.957	1.1705	1.274	0.3516	0.773
0.32	12.1780	3.367	3.5028	2.021	1.2389	1.315	0.3719	0.798
0.33	12.8836	3.472	3.7030	2.084	1.3091	1.356	0.3928	0.823
0.34	13.6080	3.578	3.9085	2.147	1.3810	1.398	0.4142	0.848
0.35	14.3509	3.683	4.1190	2.210	1.4547	1.439	0.4361	0.872
0.36	15.1125	3.788	4.3347	2.273	1.5302	1.480	0.4585	0.897
0.37	15.8927	3.893	4.5554	2.336	1.6073	1.521	0.4814	0.922
0.38	16.6914	3.999	4.7812	2.399	1.6862	1.562	0.5048	0.947
0.39			5.0121	2.463	1.7669	1.603	0.5287	0.972
0.40			5.2481	2.526	1.8492	1.644	0.5531	0.997
0.41			5.4891	2.589	1.9333	1.685	0.5780	1.022
0.42			5.7351	2.652	2.0191	1.726	0.6034	1.047
0.43			5.9862	2.715	2.1066	1.767	0.6293	1.072
0.44			6.2423	2.778	2.1958	1.809	0.6557	1.097
0.45			6.5033	2.841	2.2867	1.850	0.6826	1.122
0.46			6.7694	2.905	2.3793	1.891	0.7099	1.147
0.47			7.0405	2.968	2.4736	1.932	0.7378	1.172
0.48			7.3165	3.031	2.5695	1.973	0.7661	1.197
0.49			7.5975	3.094	2.6672	2.014	0.7950	1.221
0.50			7.8835	3.157	2.7666	2.055	0.8243	1.246

Cold water at 25°C

Peak Flow Rate Qs (l/s) (0.05 to 2.50)	PN 20 32 x 4.7 D_o (mm) = 32.00 D_i (mm) = 22.60		PN 20 40 x 6.0 D_o (mm) = 40.00 D_i (mm) = 28.00	
	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)
0.05	0.0148	0.125	0.0054	0.081
0.10	0.0485	0.249	0.0176	0.162
0.15	0.0981	0.374	0.0354	0.244
0.20	0.1623	0.499	0.0585	0.325
0.25	0.2403	0.623	0.0864	0.406
0.30	0.3317	0.748	0.1190	0.487
0.35	0.4361	0.872	0.1561	0.568
0.40	0.5531	0.997	0.1977	0.650
0.45	0.6826	1.122	0.2437	0.731
0.50	0.8243	1.246	0.2938	0.812
0.55	0.9780	1.371	0.3482	0.893
0.60	1.1437	1.496	0.4067	0.974
0.65	1.3211	1.620	0.4693	1.056
0.70	1.5102	1.745	0.5359	1.137
0.75	1.7109	1.870	0.6065	1.218
0.80	1.9232	1.994	0.6811	1.299
0.85	2.1468	2.119	0.7596	1.380
0.90	2.3818	2.244	0.8420	1.462
0.95	2.6281	2.368	0.9282	1.543
1.00	2.8856	2.493	1.0184	1.624
1.05	3.1544	2.617	1.1123	1.705
1.10	3.4342	2.742	1.2101	1.786
1.15	3.7252	2.867	1.3116	1.868
1.20	4.0272	2.991	1.4169	1.949
1.25	4.3403	3.116	1.5260	2.030
1.30	4.6643	3.241	1.6388	2.111
1.35	4.9993	3.365	1.7553	2.192
1.40	5.3452	3.490	1.8755	2.274
1.45	5.7020	3.615	1.9994	2.355
1.50	6.0697	3.739	2.1270	2.436
1.55	6.4482	3.864	2.2583	2.517
1.60	6.8375	3.989	2.3932	2.598
1.65			2.5318	2.680
1.70			2.6741	2.761
1.75			2.8199	2.842
1.80			2.9694	2.923
1.85			3.1225	3.004
1.90			3.2793	3.086
1.95			3.4396	3.167
2.00			3.6035	3.248
2.05			3.7710	3.329
2.10			3.9421	3.410
2.15			4.1168	3.492
2.20			4.2950	3.573
2.25			4.4768	3.654
2.30			4.6622	3.735
2.35			4.8511	3.816
2.40			5.0435	3.898
2.45			5.2395	3.979
2.50			5.4391	4.060

Cold water at 25°C

Peak Flow Rate Qs (l/s) (0.51 to 1)	PN 20 20 x 2.9 D_o (mm) = 20.00 D_i (mm) = 14.20		PN 20 25 x 3.7 D_o (mm) = 25.00 D_i (mm) = 17.60		PN 20 32 x 4.7 D_o (mm) = 32.00 D_i (mm) = 22.60		PN 20 40 x 6.0 D_o (mm) = 40.00 D_i (mm) = 28.00	
	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)
0.51	8.1744	3.220	2.8676	2.096	0.8540	1.271	0.3044	0.828
0.52	8.4703	3.283	2.9703	2.137	0.8843	1.296	0.3151	0.844
0.53	8.7711	3.347	3.0746	2.179	0.9151	1.321	0.3260	0.861
0.54	9.0769	3.410	3.1807	2.220	0.9463	1.346	0.3370	0.877
0.55	9.3876	3.473	3.2884	2.261	0.9780	1.371	0.3482	0.893
0.56	9.7032	3.536	3.3978	2.302	1.0102	1.396	0.3596	0.909
0.57	10.0237	3.599	3.5088	2.343	1.0428	1.421	0.3711	0.926
0.58	10.3491	3.662	3.6215	2.384	1.0760	1.446	0.3828	0.942
0.59	10.6795	3.726	3.7358	2.425	1.1096	1.471	0.3947	0.958
0.60	11.0147	3.789	3.8518	2.466	1.1437	1.496	0.4067	0.974
0.61	11.3548	3.852	3.9694	2.507	1.1782	1.521	0.4189	0.991
0.62	11.6998	3.915	4.0887	2.548	1.2132	1.546	0.4312	1.007
0.63	12.0497	3.978	4.2096	2.590	1.2487	1.570	0.4438	1.023
0.64	12.4045	4.041	4.3322	2.631	1.2847	1.595	0.4564	1.039
0.65			4.4564	2.672	1.3211	1.620	0.4693	1.056
0.66			4.5823	2.713	1.3580	1.645	0.4823	1.072
0.67			4.7098	2.754	1.3954	1.670	0.4954	1.088
0.68			4.8389	2.795	1.4332	1.695	0.5088	1.104
0.69			4.9696	2.836	1.4715	1.720	0.5223	1.121
0.70			5.1020	2.877	1.5102	1.745	0.5359	1.137
0.71			5.2360	2.918	1.5494	1.770	0.5497	1.153
0.72			5.3717	2.959	1.5891	1.795	0.5637	1.169
0.73			5.5089	3.001	1.6293	1.820	0.5778	1.186
0.74			5.6478	3.042	1.6699	1.845	0.5921	1.202
0.75			5.7883	3.083	1.7109	1.870	0.6065	1.218
0.76			5.9305	3.124	1.7525	1.895	0.6211	1.234
0.77			6.0742	3.165	1.7945	1.919	0.6359	1.251
0.78			6.2196	3.206	1.8369	1.944	0.6508	1.267
0.79			6.3665	3.247	1.8798	1.969	0.6658	1.283
0.80			6.5151	3.288	1.9232	1.994	0.6811	1.299
0.81			6.6653	3.329	1.9670	2.019	0.6965	1.315
0.82			6.8171	3.371	2.0113	2.044	0.7120	1.332
0.83			6.9705	3.412	2.0560	2.069	0.7277	1.348
0.84			7.1256	3.453	2.1012	2.094	0.7436	1.364
0.85			7.2822	3.494	2.1468	2.119	0.7596	1.380
0.86			7.4404	3.535	2.1929	2.144	0.7757	1.397
0.87			7.6003	3.576	2.2395	2.169	0.7921	1.413
0.88			7.7617	3.617	2.2865	2.194	0.8086	1.429
0.89			7.9248	3.658	2.3339	2.219	0.8252	1.445
0.90			8.0894	3.699	2.3818	2.244	0.8420	1.462
0.91			8.2557	3.740	2.4302	2.268	0.8589	1.478
0.92			8.4235	3.782	2.4790	2.293	0.8760	1.494
0.93			8.5929	3.823	2.5282	2.318	0.8933	1.510
0.94			8.7640	3.864	2.5780	2.343	0.9107	1.527
0.95			8.9366	3.905	2.6281	2.368	0.9282	1.543
0.96			9.1108	3.946	2.6787	2.393	0.9460	1.559
0.97			9.2866	3.987	2.7298	2.418	0.9638	1.575
0.98			9.4640	4.028	2.7813	2.443	0.9819	1.592
0.99					2.8332	2.468	1.0000	1.608
1.00					2.8856	2.493	1.0184	1.624

Hot water at 60°C

Peak Flow Rate Qs (l/s) (0.01 to 0.50)	PN 20 16.2 x 2.6 D_o (mm) = 16.20 D_i (mm) = 11.00		PN 20 20 x 2.9 D_o (mm) = 20.00 D_i (mm) = 14.20		PN 20 25 x 3.7 D_o (mm) = 25.00 D_i (mm) = 17.60		PN 20 32 x 4.7 D_o (mm) = 32.00 D_i (mm) = 22.60	
	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)
0.01	0.0232	0.105	0.0070	0.063	0.0026	0.041	0.0008	0.025
0.02	0.0759	0.210	0.0227	0.126	0.0082	0.082	0.0025	0.050
0.03	0.1534	0.316	0.0455	0.189	0.0165	0.123	0.0051	0.075
0.04	0.2537	0.421	0.0750	0.253	0.0271	0.164	0.0083	0.100
0.05	0.3758	0.526	0.1107	0.316	0.0398	0.206	0.0122	0.125
0.06	0.5190	0.631	0.1525	0.379	0.0547	0.247	0.0167	0.150
0.07	0.6828	0.737	0.2000	0.442	0.0717	0.288	0.0218	0.174
0.08	0.8667	0.842	0.2533	0.505	0.0906	0.329	0.0275	0.199
0.09	1.0704	0.947	0.3121	0.568	0.1114	0.370	0.0338	0.224
0.10	1.2937	1.052	0.3764	0.631	0.1342	0.411	0.0406	0.249
0.11	1.5362	1.157	0.4461	0.695	0.1589	0.452	0.0480	0.274
0.12	1.7980	1.263	0.5212	0.758	0.1853	0.493	0.0559	0.299
0.13	2.0787	1.368	0.6015	0.821	0.2137	0.534	0.0644	0.324
0.14	2.3783	1.473	0.6871	0.884	0.2438	0.575	0.0734	0.349
0.15	2.6966	1.578	0.7779	0.947	0.2757	0.617	0.0829	0.374
0.16	3.0336	1.684	0.8738	1.010	0.3094	0.658	0.0930	0.399
0.17	3.3891	1.789	0.9748	1.073	0.3448	0.699	0.1035	0.424
0.18	3.7630	1.894	1.0809	1.137	0.3820	0.740	0.1146	0.449
0.19	4.1554	1.999	1.1921	1.200	0.4209	0.781	0.1261	0.474
0.20	4.5661	2.105	1.3083	1.263	0.4615	0.822	0.1382	0.499
0.21	4.9950	2.210	1.4295	1.326	0.5038	0.863	0.1507	0.523
0.22	5.4422	2.315	1.5556	1.389	0.5478	0.904	0.1638	0.548
0.23	5.9075	2.420	1.6867	1.452	0.5935	0.945	0.1773	0.573
0.24	6.3910	2.525	1.8228	1.515	0.6409	0.986	0.1913	0.598
0.25	6.8925	2.631	1.9638	1.579	0.6899	1.028	0.2058	0.623
0.26	7.4121	2.736	2.1097	1.642	0.7407	1.069	0.2208	0.648
0.27	7.9497	2.841	2.2605	1.705	0.7930	1.110	0.2362	0.673
0.28	8.5053	2.946	2.4162	1.768	0.8471	1.151	0.2521	0.698
0.29	9.0788	3.052	2.5767	1.831	0.9028	1.192	0.2685	0.723
0.30	9.6703	3.157	2.7421	1.894	0.9601	1.233	0.2854	0.748
0.31	10.2797	3.262	2.9124	1.957	1.0190	1.274	0.3027	0.773
0.32	10.9069	3.367	3.0875	2.021	1.0796	1.315	0.3205	0.798
0.33	11.5520	3.472	3.2674	2.084	1.1418	1.356	0.3388	0.823
0.34	12.2150	3.578	3.4521	2.147	1.2056	1.398	0.3575	0.848
0.35	12.8957	3.683	3.6416	2.210	1.2711	1.439	0.3767	0.872
0.36	13.5943	3.788	3.8359	2.273	1.3381	1.480	0.3964	0.897
0.37	14.3107	3.893	4.0350	2.336	1.4068	1.521	0.4165	0.922
0.38	15.0448	3.999	4.2389	2.399	1.4771	1.562	0.4370	0.947
0.39			4.4476	2.463	1.5490	1.603	0.4581	0.972
0.40			4.6610	2.526	1.6224	1.644	0.4795	0.997
0.41			4.8793	2.589	1.6975	1.685	0.5015	1.022
0.42			5.1022	2.652	1.7742	1.726	0.5239	1.047
0.43			5.3299	2.715	1.8524	1.767	0.5467	1.072
0.44			5.5624	2.778	1.9323	1.809	0.5700	1.097
0.45			5.7996	2.841	2.0137	1.850	0.5937	1.122
0.46			6.0415	2.905	2.0967	1.891	0.6179	1.147
0.47			6.2882	2.968	2.1813	1.932	0.6425	1.172
0.48			6.5396	3.031	2.2675	1.973	0.6676	1.197
0.49			6.7957	3.094	2.3552	2.014	0.6931	1.221
0.50			7.0565	3.157	2.4446	2.055	0.7191	1.246

Hot water at 60°C

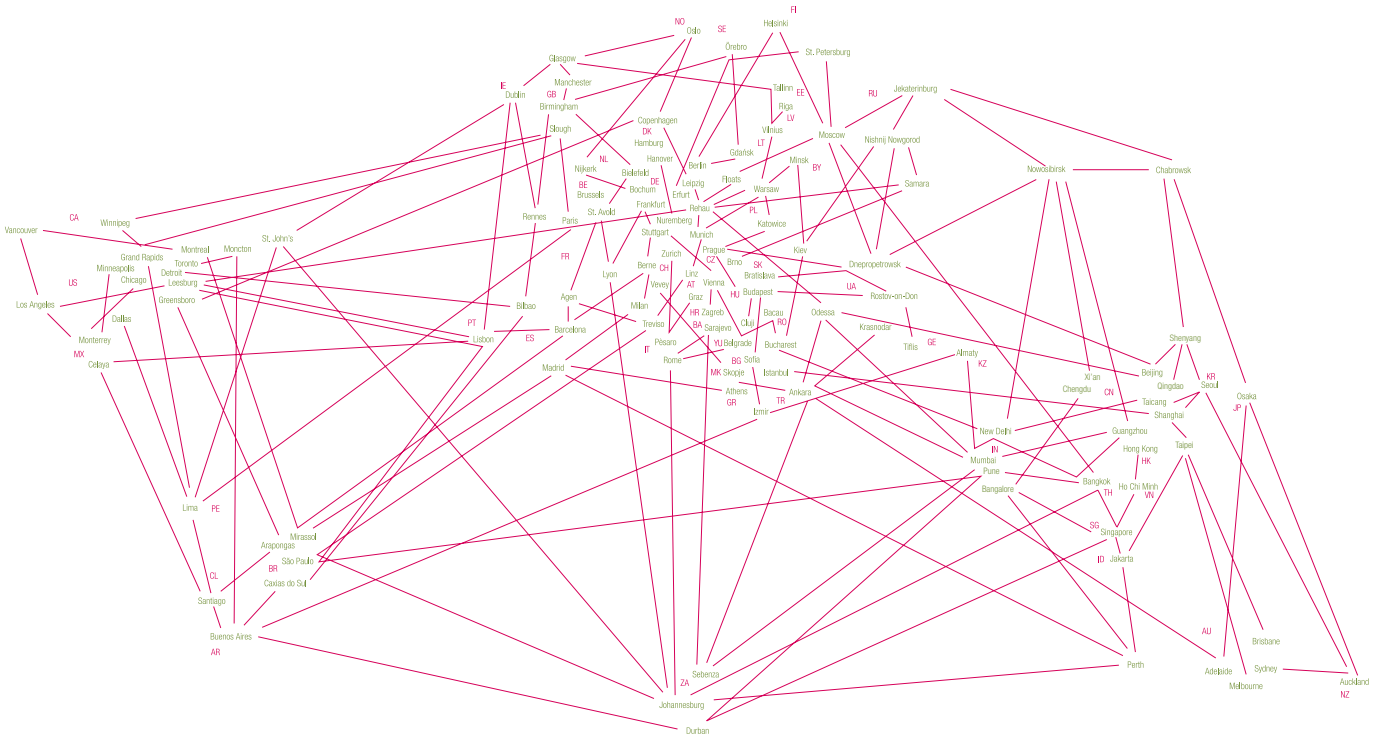
Peak Flow Rate Qs (l/s) (0.05 to 2.50)	PN 20 32 x 4.7 D_o (mm) = 32.00 D_i (mm) = 22.60		PN 20 40 x 6.0 D_o (mm) = 40.00 D_i (mm) = 28.00	
	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)
0.05	0.0122	0.125	0.0044	0.081
0.10	0.0406	0.249	0.0146	0.162
0.15	0.0829	0.374	0.0298	0.244
0.20	0.1382	0.499	0.0494	0.325
0.25	0.2058	0.623	0.0734	0.406
0.30	0.2854	0.748	0.1016	0.487
0.35	0.3767	0.872	0.1338	0.568
0.40	0.4795	0.997	0.1700	0.650
0.45	0.5937	1.122	0.2101	0.731
0.50	0.7191	1.246	0.2540	0.812
0.55	0.8555	1.371	0.3018	0.893
0.60	1.0030	1.496	0.3533	0.974
0.65	1.1614	1.620	0.4085	1.056
0.70	1.3306	1.745	0.4674	1.137
0.75	1.5106	1.870	0.5300	1.218
0.80	1.7014	1.994	0.5962	1.299
0.85	1.9028	2.119	0.6660	1.380
0.90	2.1149	2.244	0.7395	1.462
0.95	2.3376	2.368	0.8165	1.543
1.00	2.5710	2.493	0.8971	1.624
1.05	2.8148	2.617	0.9812	1.705
1.10	3.0692	2.742	1.0689	1.786
1.15	3.3341	2.867	1.1602	1.868
1.20	3.6095	2.991	1.2549	1.949
1.25	3.8953	3.116	1.3531	2.030
1.30	4.1916	3.241	1.4549	2.111
1.35	4.4983	3.365	1.5601	2.192
1.40	4.8154	3.490	1.6688	2.274
1.45	5.1429	3.615	1.7810	2.355
1.50	5.4808	3.739	1.8967	2.436
1.55	5.8291	3.864	2.0158	2.517
1.60	6.1877	3.989	2.1384	2.598
1.65			2.2644	2.680
1.70			2.3939	2.761
1.75			2.5268	2.842
1.80			2.6632	2.923
1.85			2.8030	3.004
1.90			2.9462	3.086
1.95			3.0928	3.167
2.00			3.2429	3.248
2.05			3.3963	3.329
2.10			3.5532	3.410
2.15			3.7135	3.492
2.20			3.8772	3.573
2.25			4.0443	3.654
2.30			4.2148	3.735
2.35			4.3887	3.816
2.40			4.5660	3.898
2.45			4.7467	3.979
2.50			4.9308	4.060

PRESSURE LOSS TABLES FOR RAUTITAN STABIL

Hot water at 60°C

Peak Flow Rate Qs (l/s) (0.51 to 1.00)	PN 20 20 x 2.9 D_o (mm) = 20.00 D_i (mm) = 14.20		PN 20 25 x 3.7 D_o (mm) = 25.00 D_i (mm) = 17.60		PN 20 32 x 4.7 D_o (mm) = 32.00 D_i (mm) = 22.60		PN 20 40 x 6.0 D_o (mm) = 40.00 D_i (mm) = 28.00	
	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)
0.51	7.3221	3.220	2.5355	2.096	0.7455	1.271	0.2633	0.828
0.52	7.5923	3.283	2.6279	2.137	0.7723	1.296	0.2727	0.844
0.53	7.8673	3.347	2.7220	2.179	0.7996	1.321	0.2822	0.861
0.54	8.1470	3.410	2.8176	2.220	0.8274	1.346	0.2919	0.877
0.55	8.4314	3.473	2.9147	2.261	0.8555	1.371	0.3018	0.893
0.56	8.7204	3.536	3.0135	2.302	0.8841	1.396	0.3118	0.909
0.57	9.0142	3.599	3.1137	2.343	0.9132	1.421	0.3219	0.926
0.58	9.3127	3.662	3.2156	2.384	0.9427	1.446	0.3322	0.942
0.59	9.6158	3.726	3.3190	2.425	0.9726	1.471	0.3427	0.958
0.60	9.9236	3.789	3.4240	2.466	1.0030	1.496	0.3533	0.974
0.61	10.2362	3.852	3.5305	2.507	1.0338	1.521	0.3640	0.991
0.62	10.5534	3.915	3.6386	2.548	1.0650	1.546	0.3749	1.007
0.63	10.8752	3.978	3.7482	2.590	1.0967	1.570	0.3859	1.023
0.64	11.2018	4.041	3.8594	2.631	1.1288	1.595	0.3971	1.039
0.65			3.9721	2.672	1.1614	1.620	0.4085	1.056
0.66			4.0864	2.713	1.1943	1.645	0.4200	1.072
0.67			4.2022	2.754	1.2278	1.670	0.4316	1.088
0.68			4.3196	2.795	1.2616	1.695	0.4434	1.104
0.69			4.4385	2.836	1.2959	1.720	0.4553	1.121
0.70			4.5589	2.877	1.3306	1.745	0.4674	1.137
0.71			4.6810	2.918	1.3657	1.770	0.4796	1.153
0.72			4.8045	2.959	1.4013	1.795	0.4920	1.169
0.73			4.9296	3.001	1.4373	1.820	0.5045	1.186
0.74			5.0562	3.042	1.4738	1.845	0.5172	1.202
0.75			5.1844	3.083	1.5106	1.870	0.5300	1.218
0.76			5.3141	3.124	1.5479	1.895	0.5429	1.234
0.77			5.4454	3.165	1.5856	1.919	0.5560	1.251
0.78			5.5782	3.206	1.6238	1.944	0.5693	1.267
0.79			5.7125	3.247	1.6624	1.969	0.5827	1.283
0.80			5.8484	3.288	1.7014	1.994	0.5962	1.299
0.81			5.9857	3.329	1.7408	2.019	0.6099	1.315
0.82			6.1247	3.371	1.7807	2.044	0.6237	1.332
0.83			6.2651	3.412	1.8210	2.069	0.6377	1.348
0.84			6.4071	3.453	1.8617	2.094	0.6518	1.364
0.85			6.5507	3.494	1.9028	2.119	0.6660	1.380
0.86			6.6957	3.535	1.9444	2.144	0.6804	1.397
0.87			6.8423	3.576	1.9864	2.169	0.6950	1.413
0.88			6.9905	3.617	2.0288	2.194	0.7097	1.429
0.89			7.1401	3.658	2.0717	2.219	0.7245	1.445
0.90			7.2913	3.699	2.1149	2.244	0.7395	1.462
0.91			7.4440	3.740	2.1586	2.268	0.7546	1.478
0.92			7.5983	3.782	2.2027	2.293	0.7699	1.494
0.93			7.7540	3.823	2.2473	2.318	0.7853	1.510
0.94			7.9113	3.864	2.2923	2.343	0.8008	1.527
0.95			8.0702	3.905	2.3376	2.368	0.8165	1.543
0.96			8.2305	3.946	2.3835	2.393	0.8323	1.559
0.97			8.3924	3.987	2.4297	2.418	0.8483	1.575
0.98			8.5558	4.028	2.4764	2.443	0.8644	1.592
0.99					2.5234	2.468	0.8807	1.608
1.00					2.5710	2.493	0.8971	1.624

NOTES



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