fatrafol®

FATRAFOL- H

CONSTRUCTION AND TECHNOLOGICAL INSTRUCTIONS

Waterproofing System

FATRAFOL-H

CONSTRUCTION AND TECHNOLOGICAL INSTRUCTIONS

For installation of Fatra waterproofing membranes to protect below ground structures from water, certain liquids and radon

PN 5416/2011 **FATRAFOL-H**

Title:	Construction and technological Instructions for installation of Fatra waterproofing membranes to protect below ground structures from water, certain liquids and radon.
Prepared by:	Insulation Studio
Issued by:	Fatra, a.s., Třída Tomáše Bati 1541, 763 61 Napajedla, Czech Republic
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CONTENTS

INTRODUCTION

The FATRAFOL-H waterproofing system is defined by the use of the below waterproofing membranes, accessories and ancillary materials and by the methods of creating waterproofing barriers as described in this construction and technological manual (‘manual’). This manual provides guidance on the design and installation of waterproofing barriers using waterproofing membranes of plasticised polyvinylchloride (PVC-P), that are made by Fatra, a.s., Napajedla, Czech Republic.

The manual is an integral part of the FATRAFOL-H system and summarises theoretical and practical knowledge and expertise acquired through testing, design, installation and use of waterproofing systems consisting of waterproofing membranes Fatra has been manufacturing since the 1950’s. All requirements contained in this manual are perfectly reasonable and have been verified on countless applications.

No modifications, whether on economic, performance or operational grounds, are allowed without Fatra’s prior review and approval. Fatra disclaims all responsibility for any waterproofing structure that has not been designed and installed in accordance with this manual.

The information contained in this document are based on Czech and European regulations and standards, and for the application of membrane in other regions or areas of the world, the installation of the FATRAFOL membrane must be adapted to local requirements.

This manual supersedes its previous versions.

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1. APPLICATION AND FEATURES OF FATRAFOL-H WATERPROOFING SYSTEM

1.1 Scope of application

The **FATRAFOL-H** waterproofing system is intended for use as fully covered, typically single-ply membrane barriers to protect buildings from adverse effects of water, certain liquids and radon. The system is suitable for all types of buildings and selected types of engineering constructions. for all environments with various types of corrosive stress and with temperatures from -20 °C to +40 °C. The FATRAFOL-H system owes its versatility to the wide variability and mutual compatibility of materials created on a single base, which makes it possible to combine and join waterproofing materials that are best suited for a particular environment.

FATRAFOL-H waterproofing membranes must not be **permanently** exposed to direct sunlight and corrosive stress exceeding their specific resistance limits. For a limited duration (no more than approx. 6 months), membranes can be exposed to direct weathering without a negative impact on their end-use properties.
Once built in, membranes must not be permanently exposed to pressure exceeding 7 MPa unless further precautions are taken.
Appropriate design measures must be taken to reduce any shear stress acting on the membranes.

1.2 Typical end-use properties of FATRAFOL-H waterproofing barriers

- A waterproofing barrier usually consists of a single layer of a 0.6 to 2.0 mm thick membrane.
- The system allows for precise detailing.
- All joints are executed by hot air weld, featuring great strength, water tightness and gas tightness.
- Ability to transfer the mechanical stress of constructions without losing its functions.
- High permissible load caused by the construction and permanent compressive strength.
- Resistance to aggressive groundwater and extracts from building material.
- An effective radon barrier.
- The waterproofing system can be installed all year round except in rain and snow, and the membranes can also be placed on a wet substrate.
- Safe for health and the environment.
- Functional reliability and long service life.

2. Materials of FATRAFOL-H waterproofing system

Classification of materials of the FATRAFOL-H system by function in the waterproofing structure:

- Waterproofing membranes
- Waterproofing accessories
- Ancillary materials

The materials referred to below are manufactured by either Fatra, a.s. or proven producers. When using the FATRAFOL-H system, keep in mind that the specified waterproofing membranes are not interchangeable.

2.1 Waterproofing membranes

Waterproofing membranes are the key material for making waterproofing barriers.

2.1.1 Membrane manufacture and basic classification

The manufacture of membranes uses only raw materials with precisely defined properties. The composition and construction of membrane types are such as to ensure that the technical parameters of the membrane are optimal for the intended use.

According to the purpose of use by EN 13967, the range of membranes can be divided into:

- Membranes to waterproof against ground moisture – type A
- Membranes to waterproof against pressure water – type T

Membrane classification is shown in Table 1.

Table 1: Classification of waterproofing membranes

Reinforcement type	Membrane	Use
Nonreinforced	FATRAFOL 803	All kind of water stress
Nonreinforced	FATRAFOL 803S	All kind of water stress
Glass fleece	FATRAFOL 813	All kind of water stress
Nonreinforced	STAFOL 914	Ground moisture
Nonreinforced	EKOPLAST 806	Chemical waterproofing All kind of water stress

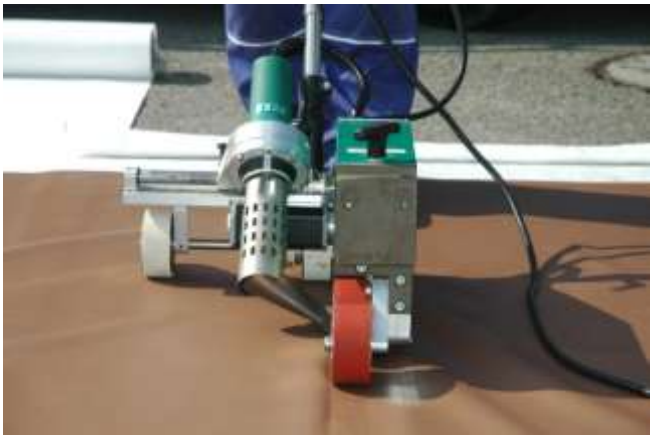
Waterproofing barriers made of all of the above membranes can also function as a **radon barrier**.

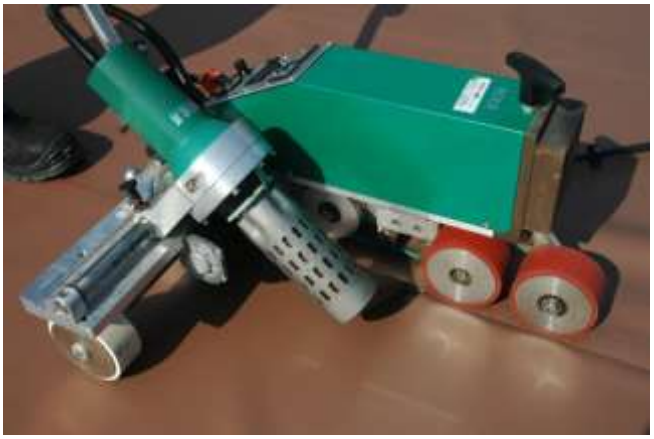
2.1.2 Thermal resistance and welding temperatures

Waterproofing membranes of the FATRAFOL-H system offer long-term resistance to most types of corrosive stress, including thermal stress. Their key performance properties remain largely stable at temperatures from -20 °C to +40 °C (+80 °C for reinforced membranes). The minimum installation temperature for PVC-P-based membranes is -5°C, unless otherwise specified for the product. The maximum outside air temperature recommended for installing all types of non-reinforced membranes is +40 °C. The membranes also withstand, without damage, very sudden and repeated temperature fluctuations. In addition, PVC-P membranes offer short-term resistance to extreme overheating.

Recommended welding temperatures: 430 °C to 580 °C

The welding temperature depends on numerous factors such as membrane thickness and type, welding machine type, welding speed, substrate and ambient air temperature and humidity, wind speed etc. For this reason, an on-site test must be performed to choose the correct welding temperature.





Joints of hot-air welded membranes reach their final strength after approximately 1 hour.

2.1.3 Chemical resistance

All waterproofing membranes of the FATRAFOL-H system feature excellent chemical resistance to both underground and surface water that commonly occurs in nature, irrespective of its pH, the degree and type of aggressiveness and the quantity of minerals dissolved in it. For this reason, it is not necessary, unlike conventional bitumen waterproofing materials, to assess their suitability for waterproofing barriers being built in an environment with standard corrosion stress.

The composition of some membrane types is adapted to their specific use to ensure they are chemically resistant to the environment they are intended for:

- The FATRAFOL 803 and 803S membrane for an environment with products of animal metabolism, inorganic acids, bases and their salts;
- The FATRAFOL 813 membrane for an environment with soil and building materials contaminated with petroleum products;
- The EKOPLAST 806 membranes for an environment containing hydrocarbons such as gasoline, kerosene, diesel, mineral oils etc.

See Table 2 for an overview of chemical resistance of the FATRAFOL 803 and EKOPLAST 806 membranes. The list of chemical substances and products below is not exhaustive and only contains the most common compounds the membranes have long-term, limited or no chemical resistance to.

When choosing the right type of a waterproofing membrane, you should bear in mind that the membrane is usually not in long-term or permanent contact with the chemical substance or product, or that the concentration of the substances in the environment is not hazardous to the membrane material. For the above reasons, the following must be considered when designing a waterproofing barrier for a corrosive environment:

- The likelihood of the waterproofing membrane coming into direct contact with the substance in its concentrated form,
- The time the substance is present in the area of the waterproofing layers,
- The likelihood of a local temperature increases due to, for example, ongoing chemical reactions that may negatively affect the waterproofing membrane (the chemical resistance of the materials deteriorates sharply with rising temperature).

If in any doubt or if dealing with substances not listed in Table 2, feel free to contact Fatra for an assessment and identification of a suitable solution. If you require this assistance, it is essential to provide Fatra with precise specifications of the corrosive environment and its chemical classification and to specify the maximum possible temperature of the medium the waterproofing membrane may come into direct contact with.

Table 2: Overview of chemical resistance of FATRAFOL 803 and EKOPLAST 806 membranes at 23 °C

Corrosive environment / membrane type	803	806
10% hydrochloric acid	+	+
10% hydrogen peroxide	+	+
10% vinegar acid	+	+
100% vinegar acid	–	–
20% chromic acid	+	+
20% hydrofluoric acid	+	+
40% nitric acid	Δ	–
5% nitric acid	+	Δ
6% potassium permanganate	+	+
60% sulphuric acid	+	Δ
Acetaldehyde	–	–
Acetone	–	–
Allyl alcohol	Δ	–
Ammonia	+	+
Ammonium hydroxide	+	+
Aniline	–	–
Asphalt	–	+
Benzene	–	–
Borax	+	+
Bromide	–	–
Butyl acetate	–	–
Butyric acid	Δ to –	–
Chlorates	+	+
Chlorbenzene	–	–
Chlorides	+	+
Chloroform	–	–
Chromates	+	+
Citric acid	+	+
Concentrated hydrochloric acid	Δ	Δ
Cresol	–	–
Cyanides	+	+
Cyclohexanol	–	–
Cyclohexanone	–	–
Dibutyl phthalate	–	–
Dichloroethylenes	–	–
Diesel	Δ	+
Ethyl acetate	–	–
Ethyl alcohol	Δ	–
Ethyl benzene	–	–
Ethylene glycol	Δ	Δ

Corrosive environment / membrane type	803	806
Fluorides	+	+
Formic acid	–	–
Heptane	Δ	+ to Δ
Hexachlorethane	–	–
Hexamethylentetramine	+	+
Hydrogen chloride	+	+
Hydroquinone	+	+
Hypochlorites	+	+
Kerosene	Δ	+
Lactic acid	Δ to –	–
Linseed oil	Δ	+
Liquid manure	+	+
Methyl alcohol	Δ	–
Mineral oils	Δ	+
Motor oils	Δ	+
Nitrates	+	+
Nitrites	+	+
Nitrobenzene	–	–
Perchlorates	+	+
Petrol	–	+
Phenol	–	–
Phosphates	+	+
Potassium hydroxide	+	+
Propanetriol	Δ	Δ
Silage juices and extracts	+	+
Sodium hydroxide	+	+
Stabiliser	+	+
Sulphates	+	+
Tar	–	Δ
Toluene	–	–
Trichloroethylene	–	–
Varnish	Δ	Δ
Xylene	–	–

Degree of chemical resistance: + *Long-term resistance* Δ *Limited resistance* – *Not resistant*

2.1.4 Strength characteristics

In terms of mechanical properties, membranes of the FATRAFOL-H system feature high tensile and compressive strength (usable up to 7 MPa of compressive stress) and high elongation. Deformations of PVC-P membranes are largely reversible (elastic) and these membranes provide very good resistance to point stress (punctures, tears etc.) and do not develop the so-called ‘cold flow’ when exposed to stress.

Membranes of PVC-P feature excellent elongation when exposed to multidimensional stress (**Figure 1** and Figure 2), which allows them to withstand extreme local movements of the constructions they are built into. At the same time, the membranes have a high resistance to damage when installed on an uneven surface (protrusions, pebbles, etc.).

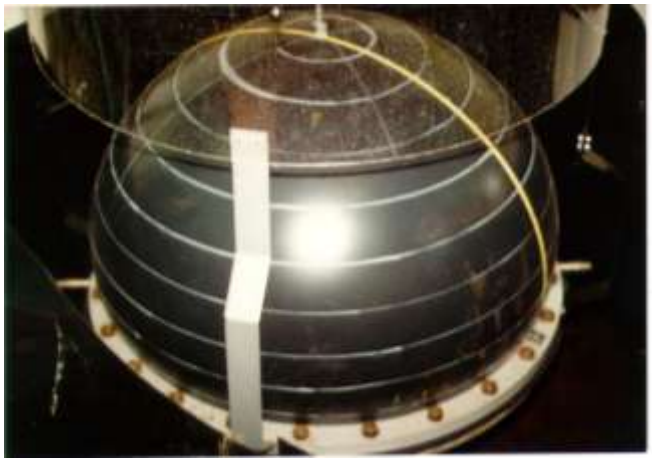


Figure 1: Multidimensional stress testing

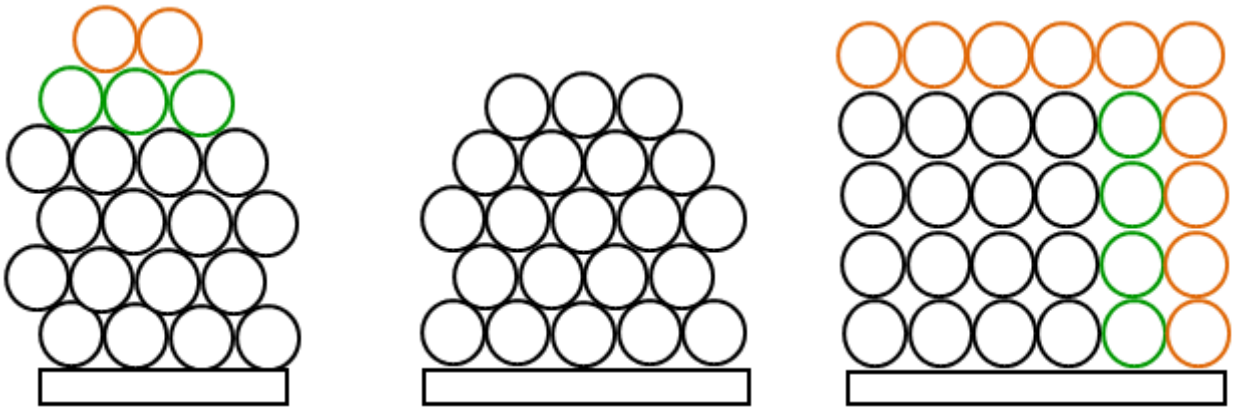
Figure 2: Puncture of the PVC-P membrane at maximum elongation

For added rigidity, dimensional stability and better processing at higher temperatures is membrane FATRAFOL 813, reinforced with glass fibre fleece.

2.1.5 Packing, transport and storage

Membranes are wound and packed on rolls; the rolls are placed on wooden pallets and secured in place with wrap film.
Typically, a pallet contains 19 rolls of 1,300 (1,200) mm wide membranes and 19 or 21 rolls of 2,000 (2,050) mm wide membranes.

See Figure 3 for basic packaging arrangements.



BLOK 16R
BLOK 19R
BLOK 21R6V

BLOK 21R-5V

KVADR 4-16R
KVADR 5-20R
KVADR 6-30R

Figure 3: Handling and transport units – roll placement on pallet

Membranes must be transported in covered vehicles and stored in their original sealed packaging.

Membranes should be stored between -5 °C and +30 °C. Membranes must be protected from dirt and mechanical damage at the construction site. Membranes should be protected from weather until the moment of installation.

2.1.6 Membrane labelling and identification

Identification details are ink-printed on the top surface of FATRAFOL-H membranes, usually 120 mm from their edge. The following details are shown: product name, dimensions (width x thickness) in mm, manufacturing date and identification data.

Each roll carries a label with a CE conformity mark, see Figure 4. A unique production batch identifier and production code are used for material identification in the manufacturing plant.

CE 22	**Fatra, a. s., třída Tomáše Bati 1541, 763 61 Napajedla, Czech Republic**	fatra fatrafol®
	1023-CPR-1225 F / DoP 5104820222	
	EN 13967:2012	
Název výrobku – Trade name	**FATRAFOL 803S**	
Tloušťka / Šířka - Thickness / Width	**1,50 mm**	**2 000 mm**
Délka role / Množství - Length / Quantity	**20 m**	**40 m²**
Barva – Colour	**B4013 - signal yellow**	**ID: 108**

Použití: Izolace staveb proti zemní vlhkosti a tlakové vodě Typ výrobku: T Reakce na oheň: třída E Pevnost v tahu: ≥ 15 N/mm² Tažnost: ≥ 250 % Odolnost proti statickému zatížení: vyhovuje 20 kg Vodotěsnost pro vodu v kapalném skupenství, 400 kPa: vyhovuje Vliv umělého stárnutí na vodotěsnost: vyhovuje Vliv chemikálií na vodotěsnost: vyhovuje Odolnost proti nárazu, metoda A: ≥ 1000 mm, metoda B: ≥ 2000 mm Odolnost proti protrhávání: ≥ 350 N Pevnost spoje: ≥ 840 N/50 mm	Exposed application: Insulation of buildings against ground moisture and underground pressure water Type of product: T Reaction to fire: Class E Tensile strength: ≥ 15 N/mm² Elongation at break: ≥ 250 % Resistance to static loading: pass 20 kg Water-tightness to liquid state, 400 kPa: pass Durability of watertightness against artificial ageing: pass Durability of watertightness against chemicals: pass Resistance to impact, method A: ≥ 1000 mm, method B: ≥ 2000 mm Tear resistance: ≥ 350 N Joint strength: ≥ 840 N/50 mm
	XXXXXXXXX
	Výrobní dávka Batch production
	Výrobní kód Code production

Figure 4: Example of label for FATRAFOL 803S membrane

2.1.7 Safety regulations

Our waterproofing membranes are not classified as hazardous substances within the meaning of the Chemicals Act.

Waste disposal

Waste membranes must be disposed of in accordance with current legislation (Waste Act 185/2001 Coll. as amended).

Clean waste is recyclable. Non-recyclable waste can be landfilled. Waste contaminated by hazardous substances must be burnt in a hazardous waste incinerator.

Table 3 shows categories of waste under Ministry of Environment Decree 381/2001 Coll. (waste catalogue) and its possible use.

Table 3: Categories and reuse of waste waterproofing membranes

Catalog number	Name of the waste according to the catalog number	Detailed description of the waste, note	Intended use or disposal of the waste
07 02 13	Plastic waste	**PVC-P membrane**	- material use [a)] - disposal (incineration of hazardous waste [b)], landfilling [a)])
15 01 01	Paper and cardboard packaging	**Paper tubes**	- material use
15 01 02	Plastic packaging	**Packaging PE foil and PE stretch foil**	- material use

a) Waste
b) Waste contaminated with hazardous substances

Occupational health and safety

All current safety, sanitary and fire regulations must be observed when installing and joining membranes.

2.1.8 Membrane quality and legislative requirements

Our quality management system for the development and manufacture of waterproofing membranes is certified according to EN ISO 9001:2009.

To demonstrate our commitment to the environment and adherence to environmental management standards in the development and manufacture of waterproofing membranes, Fatra is certified according to EN ISO 14001:2005.


Bureau Veritas Certification

Certifikát

udělený organizaci

Fatra, a.s.

Třída Tomáše Bati 1541, 763 61 Napajedla, Česká republika

Tento je certifikát pro výše lokalit, uplatnění je v příloze certifikátu

BUREAU VERITAS CERTIFICATION CZ, a.r.o. tímto osvědčuje, že systém managementu výše uvedené organizace byl posouzen a shledán ve shodě s požadavky následující systémové normy:

Norma

ČSN EN ISO 9001:2016

Oblast certifikace

VÝVOJ, VÝROBA A PRODEJ PLASTOVÝCH FÓLIÍ, HYDROIZOLAČNÍCH FÓLIÍ, PLASTOVÝCH PODLAHOVIN, SVAŘOVANÝCH VÝROBKŮ, VSTŘIKOVANÝCH A TVAROVANÝCH VÝROBKŮ. VÝVOJ, VÝROBA A PRODEJ PVC GRANULÁTŮ A VYTLAČOVANÝCH PLASTOVÝCH PROFILŮ. VÝVOJ, VÝROBA A PRODEJ BIAXIÁLNĚ ORIENTOVANÝCH POLYETYLEN-TEREFTALÁTOVÝCH FÓLIÍ A VÍCEVRSTVÝCH LAMINÁTŮ. VÝVOJ, VÝROBA A PRODEJ PLASTOVÝCH RECYKLÁTŮ.

Datum počátečního schválení: 18-05-2000

Počáteční datum certifikačního / recertifikačního cyklu: 01-06-2024

Konečné datum certifikačního / recertifikačního cyklu: 31-05-2027

Tento certifikát platí – za předpokladu následného uspokojivého udržování funkčnosti systému managementu do: 31-05-2027

Pro ověření platnosti certifikátu volejte: +420 210 089 215

Další vysvětlení týkající se rozsahu tohoto certifikátu a aplikovatelnosti požadavků systému řízení lze získat na základě konzultace s organizací.

Verze: 1 Datum vydání: 01-06-2024

Číslo certifikátu: CZ013337

IAF

S 3100

MANAGING OFFICE: BUREAU VERITAS CERTIFICATION CZ, a.r.o., Olbrachtova 1, 140 62 Praha 4, Czech Republic

REGISTERED OFFICE ADDRESS: BUREAU VERITAS CERTIFICATION CZ, a.r.o., Olbrachtova 1, 140 62 Praha 4, Czech Republic

1/2

Figure 5: ISO 9001 certificate


Bureau Veritas Certification

Certifikát

udělený organizaci

Fatra, a.s.

Třída Tomáše Bati 1541, 763 61 Napajedla, Česká republika

Tento je certifikát pro výše lokalit, uplatnění je v příloze certifikátu

BUREAU VERITAS CERTIFICATION CZ, a.r.o. tímto osvědčuje, že systém managementu výše uvedené organizace byl posouzen a shledán ve shodě s požadavky následující systémové normy:

Norma

ČSN EN ISO 14001:2016

Oblast certifikace

VÝVOJ, VÝROBA A PRODEJ PLASTOVÝCH FÓLIÍ, HYDROIZOLAČNÍCH FÓLIÍ, PLASTOVÝCH PODLAHOVIN, SVAŘOVANÝCH VÝROBKŮ, VSTŘIKOVANÝCH A TVAROVANÝCH VÝROBKŮ. VÝVOJ, VÝROBA A PRODEJ PVC GRANULÁTŮ A VYTLAČOVANÝCH PLASTOVÝCH PROFILŮ. VÝVOJ, VÝROBA A PRODEJ BIAXIÁLNĚ ORIENTOVANÝCH POLYETYLEN-TEREFTALÁTOVÝCH FÓLIÍ A VÍCEVRSTVÝCH LAMINÁTŮ. VÝVOJ, VÝROBA A PRODEJ PLASTOVÝCH RECYKLÁTŮ.

Datum počátečního schválení: 18-05-2000

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Další vysvětlení týkající se rozsahu tohoto certifikátu a aplikovatelnosti požadavků systému řízení lze získat na základě konzultace s organizací.

Verze: 1 Datum vydání: 01-06-2024

Číslo certifikátu: CZ013338

IAF

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MANAGING OFFICE: BUREAU VERITAS CERTIFICATION CZ, a.r.o., Olbrachtova 1, 140 62 Praha 4, Czech Republic

REGISTERED OFFICE ADDRESS: BUREAU VERITAS CERTIFICATION CZ, a.r.o., Olbrachtova 1, 140 62 Praha 4, Czech Republic

1/2

Figure 6: ISO 14001 certificate

In accordance with Regulation (EU) 305/2011 of the European Parliament and of the Council (CPR) all waterproofing membranes of the FATRAFOL-H system are certified, meet the requirements of the harmonised European standard EN 13967 and have been issued with a CE declaration of performance.

2.1.9 Description and technical specifications of waterproofing membranes

2.1.9.1 Waterproofing membranes of plasticised polyvinylchloride

2.1.9.1.1 FATRAFOL 803 waterproofing membrane

- **PRODUCT DESCRIPTION**

  FATRAFOL 803 is a non-reinforced membrane based on plasticised polyvinylchloride (PVC-P), type T according to the EN 13967 standard.

- **USE**
  - A waterproofing barrier, covered on both sides, protecting buildings from aggressive, pressure and seeping water
  - A waterproofing barrier, covered on both sides, for reservoirs, sumps, agricultural buildings, water structures, storage sites for industrial products whose chemical effects correspond to membrane resistance guaranteed by the manufacturer
  - A waterproofing barrier, covered on one side, for structures not exposed to direct UV radiation (reservoirs, sumps, storage sites for products whose chemical effects correspond to membrane resistance guaranteed by the manufacturer)
  - Creation of a radon barrier
- **APPLICATION**

  Membranes may only be installed by qualified and specially trained contractors.

  Membranes must be installed in accordance with this manual.

  Membranes can be hot-air welded. Membranes must be installed and joined at temperatures above -5°C.
- **PRODUCT DATA**
  - **Dimensions and basic data of the packaging FATRAFOL 803**
    - thickness - 1,00 mm; 1,50 mm; 2,00 mm
    - width - 1200 mm; 1300 mm; 1500 mm; 2000 mm
    - lenght on roll - 30 m; 20 m; 15 m
    - quantity per roll - depends on width and the length of the membrane
  - **Appearance and colours**
    - Smooth membrane with a matt surface
    - Top surface - Brown RAL 8025
      - Identification details are printed 120 mm from the membrane edge.

Design	FATRAFOL 803 top surface colour	Colour according to RAL colour chart *)
	Brown	8025

*) *the color shade of the membranes surfaces of different batches may vary slightly. Minor differences in color shade are not a reason for warranty claim*

- **RELATED TECHNICAL DOCUMENTATION**
  - Technical data sheet TL 5-1048-22, FATRAFOL 803 waterproofing membrane, issued by Fatra, a.s.
  - Certificate of conformity of production control No. 1023-CPR-1225 F issued by ITC, a.s. Zlin
  - Measurement report – Radon diffusion coefficient for FATRAFOL 803 membrane

Documentation validity: Installation of the membrane requires the use of current product documentation (Technical Data Sheet, Declaration of Performance). This is available at www.fatrafol.cz.

2.1.9.1.2 Waterproofing membrane FATRAFOL 803S

- **PRODUCT DESCRIPTION**

  FATRAFOL 803S is a color variant of FATRAFOL 803 ground membrane - non-reinforced membrane based on plasticized polyvinyl chloride (PVC-P) with a signal yellow layer, type T according to EN 13967.

- **USE**
  - for closed insulation of buildings against aggressive, pressure and seeping water
  - for closed insulation of tanks, sumps, agricultural structures, water structures, storage of industrial products, where chemical action of mentioned corresponds to the resistance of the membrane guaranteed by the manufacturer
  - exposed insulation of buildings that are not exposed to direct UV radiation (tanks, sumps, storage of products whose chemical action corresponds to the resistance of the membrane guaranteed by the manufacturer
  - to create an anti-radon barrier
- **APLICATION**

  Installation of the membrane on construction sites can only be carried out by specialized companies trained for this purpose.

  The membrane is applied in accordance with the principles established and described in this document

  The membrane can be joined by hot air welding. Laying and joining can be done at temperatures above 5 °C.
- **PRODUCT INFO**
  - **Dimensions and basic data of the packaging FATRAFOL 803S**
    - thickness - 1,50 mm; 2,00 mm
    - width - 2000 mm
    - length on roll - 20 m; 15 m
    - quantity per roll – depends on width and the length of the membrane
  - **Appearance and colours**
    - Smooth membrane with mat surface
    - Top layer - signal yellow
      - Identification details are printed120 mm from the membrane edge
    - Underside - black

Design	Top layer colour FATRAFOL 803S	Colour according to RAL colour chart *)
	yellow	-

*) *the color shade of the membranes surfaces of different batches may vary slightly. Minor differences in color shade are not a reason for warranty claim.*

- **RELATED TECHNICAL DOCUMENTATION**
  - Technical sheet TL 5-1048-2022/2, Waterproofing membrane FATRAFOL 803S, published by Fatra, a. s.
  - Certificate of conformity of production control No. 1023-CPR-1225 F issued by ITC, a.s. Zlin
  - Measurement report - Radon diffusion coefficient in FATRAFOL 803S membrane

Documentation validity: Installation of the membrane requires the use of current product documentation (Technical Data Sheet, Declaration of Performance). This is available at [www.fatrafol.cz.](http://www.fatrafol.cz)

2.1.9.1.3 FATRAFOL 813 waterproofing membrane

- **PRODUCT DESCRIPTION**

  FATRAFOL 813 is a waterproofing membrane based on plasticised polyvinylchloride with integrated glass fibre fleece, type T according to EN 13967. The membrane is made by the process of multiple extrusion. The membrane comes with a high-visibility yellow layer.

  FATRAFOL 813 maintains, even at higher temperatures, dimensional stability, great strength and good chemical resistance to water contaminated by petroleum products. The high-visibility layer makes it easier to check the integrity of the waterproofing system.

- **USE**
  - A waterproofing barrier, covered on both sides, protecting buildings from aggressive, pressure and seeping water
  - In environments where contamination with petroleum products such as mineral oils and diesel may occur
  - For installation on long vertical surfaces where the membrane does not sag
  - For welding at high ambient temperatures
  - Creation of a radon barrier
- **APPLICATION**

  Membranes must be installed in accordance with this manual.

  Membranes can be hot-air welded together. Membranes must be installed and joined at temperatures above -5 °C.
- **PRODUCT DATA**
  - **Dimensions and packaging of FATRAFOL 813 membrane**
    - thickness - 1,50 mm; 2,00 mm
    - width - 2050 mm
    - roll length - 20 m; 15 m
    - quantity per roll – 41,00 m^2; 30,75 m^2
  - **Appearance and colours**
    - Smooth membrane with a matt surface
    - Top surface - Yellow
      Underside - Black

Design	FATRAFOL 813 top surface colour	Colour according to RAL colour chart *)
	Yellow	1012

*) *the color shade of the membranes surfaces of different batches may vary slightly. Minor differences in color shade are not a reason for warranty claim*

- **RELATED TECHNICAL DOCUMENTATION**
  - Technical data sheet TL 5-1053-2022, FATRAFOL 813 waterproofing membrane, issued by Fatra, a.s.
  - Certificate of conformity of production control No. 1023-CPR-1240 F issued by ITC, a.s. Zlin
  - Measurement report – radon diffusion coefficient for FATRAFOL 813/VS membrane (change of name to FATRAFOL 813)

Documentation validity: Installation of the membrane requires the use of current product documentation (Technical Data Sheet, Declaration of Performance, etc.). This is available at www.fatrafol.cz.

2.1.9.1.4 EKOPLAST 806 waterproofing membrane

PRODUCT DESCRIPTION

EKOPLAST 806 is a non-reinforced membrane based on plasticised polyvinylchloride (PVC-P), type T according to the EN 13967standard.

USE

The membrane is used to waterproof facilities for the handling and storage of selected petroleum products. Within the waterproofing system, the membrane prevents the leakage of petroleum products into surface water and groundwater while also stopping the ingress of water and working as an effective radon barrier.

The membrane is suitable, for example, for sealing handling areas and emergency sumps to prevent the leakage of petrol, kerosene, diesel and heating oil, and heating and transformer oils. If the waterproofing system is exposed to ground moisture only, EKOPLAST 806 can be joined to existing bitumen waterproofing membranes.

EKOPLAST 806 is not designed for applications where it will be exposed directly to the weather (in particular UV radiation) and cannot be used as a waterproofing barrier for the storage of petroleum products that is covered on one side only.

APPLICATION

Membranes may only be installed by qualified and specially trained contractors.

Membranes must be installed in accordance with this manual.

Membranes can be hot-air welded together. Membranes must be installed and joined at temperatures above +5 °C.

PRODUCT DATA

Dimensions and packaging of FATRAFOL 806 membrane

- thickness - 1,00 mm; 1,50 mm
- width - 1300 mm; 1500 mm
- roll length - 30 m; 20 m
- quantity per roll – 39 m^2; 30 m^2; 26 m^2

Appearance and colours

- Smooth membrane with a matt surface
- Black colour

Design	top surface colour of EKOPLAST 806	Colour according to RAL colour chart *)
	černá	~ RAL 9011

*) *the color shade of the membranes surfaces of different batches may vary slightly. Minor differences in color shade are not a reason for warranty claim.*

RELATED TECHNICAL DOCUMENTATION

- Technical data sheet TL 5-1002-06, EKOPLAST 806 waterproofing membrane, issued by Fatra, a.s.
- Certificate of conformity of production control No. 1390-CPR-2019-0052/Z issued by CSI, a. s., Prague, workplace Zlín
- Measurement report – radon diffusion coefficient for EKOPLAST 806 membrane

Documentation validity: Installation of the membrane requires the use of current product documentation (Technical Data Sheet, Declaration of Performance, Certificate etc.). This is available at www.fatrafol.cz.

2.1.9.1.5 STAFOL 914 waterproofing membrane

- **PRODUCT DESCRIPTION**

  STAFOL 914 is a non-reinforced membrane based on plasticised polyvinylchloride (PVC-P), type A according to the EN 13967 standard.

- **USE**

  The membrane is designed to waterproof buildings against ground moisture; it cannot be used in locations exposed to pressure water. The membrane is especially suitable:

  - To waterproof floors in industrial, commercial and storage buildings,
  - To waterproof perimeter walls of both new and renovated buildings,
  - For highly aggressive environments (where inorganic acids, bases and their salts occur),
  - As a protective or separation layer in floors etc.

  When welded together and covering the entire area, waterproofing membrane sheets also serve as a radon barrier.

  The membrane is not designed for applications involving long and direct exposure to the weather (in particular UV radiation).

- **APPLICATION**

  Membranes may only be installed by qualified and specially trained contractors.

  Membranes must be installed in accordance with this manual.

  Membranes can be hot-air welded together. Membranes must be installed and joined at temperatures above 0°C.

- **PRODUCT DATA**

  - **Dimensions and packaging of STAFOL 914 membrane**
    - thickness - 0,50 mm; 0,6 mm; 0,7 mm; 0,8 mm; 1,00 mm; 1,20 mm; 1,50 mm
    - width - 1300 mm; 1400 mm; 1500 mm; 2000 mm; 2050 mm
    - roll length - 60 m; 50 m; 40 m; 30 m; 20 m
    - quantity per roll – depends on width and the length of the membrane
  - **Appearance and colours**
    - Homogeneous membrane with a finely textured surface
    - Non-standard black colour

    The color shade of the membranes surfaces of different batches may vary slightly.
    Minor differences in color shade are not a reason for warranty claim.

- **RELATED TECHNICAL DOCUMENTATION**
  - Technical data sheet TL5-1049-2022, STAFOL 914 waterproofing membrane, issued by Fatra, a.s.
  - Certificate of conformity of production control No. 1023-CPR-1223 F issued by ITC, a.s. Zlin
  - Measurement report – radon diffusion coefficient for STAFOL 914 membrane

Documentation validity: Installation of the membrane requires the use of current product documentation (Technical Data Sheet, Declaration of Performance etc.). This is available at www.fatrafol.cz.

2.2 Waterproofing accessories

Waterproofing system accessories help create perfectly sealed details of the waterproofing barrier. Accessories include vacuum-formed components made of homogeneous membranes for detailing (Internal and External Corner), flat membrane cuttings (Patch, Collar) and liquid sealants.

The accessories are made of waterproofing membranes of the FATRAFOL-H system to ensure compatibility.

2.2.1 Pre-shaped piece - Internal corner, type 10

A vacuum-formed component made of FATRAFOL 803, 803S and EKOPLAST 806 waterproofing membranes.

Manufacturer: Fatra, a.s., Napajedla

Documentation: TL 5-1072-2022

Colour: According to the waterproofing membrane used

Dimensions: Height 50 mm, diameter 115 mm

Packaging: 40-piece PE bag, 400-piece cardboard box

Use: Sealing of internal and external corners insulated by waterproofing membranes

2.2.2 Pre-shaped piece External corner, type 11

A vacuum-formed component made of FATRAFOL 803, 803S and EKOPLAST 806 waterproofing membranes.

Manufacturer: Fatra, a.s., Napajedla

Documentation: TL 5-1073-2022

Colour: According to the waterproofing membrane used

Dimensions: Height 35 mm, diameter 160 mm

Packaging: 30-piece PE bag, 240-piece cardboard box

Use: Sealing of internal and external corners insulated by waterproofing membranes

2.2.3 Patch, type 12

A round cutting of FATRAFOL 803 and EKOPLAST 806, waterproofing membranes.

Manufacturer: Fatra, a.s., Napajedla

Documentation: TL 5-1074-2022

Colour: According to the waterproofing membrane used

Dimensions: Diameter 160 mm

Packaging: 50-piece PE bag, 400-piece cardboard box

Use: Covering of damaged spots in a waterproofing barrier, T-joints and of fasteners

2.2.4 Construction chemistry

2.2.4.1 Polyurethane sealant FATRAPUR PU 25

A highly elastic and flexible sealant with great adhesion to membranes and building materials. Has a long-service life even if directly exposed to weather conditions including UV radiation.

Packaging: 310-ml cartridge – hardness 25 Sh A

Use: The sealant provides long-term elastic sealing at the point of contact between a waterproofing membrane and metals, plastics, building materials, connection gaps etc. The surfaces to be sealed must be dry and clean. Not to be diluted. Applied with a sealant gun.

Application temperature: +5°C to +40°C

2.2.4.2 Polymer sealant

One-component adhesive and sealant based on MS polymer. Versatile, moisture-curing, it creates an elastic, waterproof bond with excellent weather and chemical resistance. It is solvent-free, isocyanate-free, and silicone-free and features minimal shrinkage.

Packaging: - Cartridge - 290 ml (white) – 65 Sh A

Use: Adhering and sealing of panels, profiles and other parts, elastic joining of constructions.

Application temperature: +5 °C to +35 °C

2.2.4.3 Kemperol AC Speed+

KEMPEROL AC Speed+ is a very fast-setting waterproofing screed made on the basis of polymethyl methacrylate (PMMA) resin.

Color: traffic gray, anthracite

Use:

- Processing of all details and finishing with waterproofing
- New buildings and reconstructions
- Applies to almost all types of substrate (except polyethylene)

Application: Always use KEMPEROL AC Speed+ waterproofing screed together with KEMPEROL CP catalyst and KEMPEROL 165 Fleece reinforcement insert.

All substrates must be clean, dry, free of dust, oil, grease, loose paint and other contamination. Modification of the substrates (mostly roughening, sanding, etc.) must be carried out according to the manufacturer's recommendations.

Some substrates require the use of suitable penetration.

The created waterproofing layer is waterproof after just 35 minutes.

The curing process affects the amount of KEMPEROL CP catalyst.

Application temperature: - 5 °C to +30 °C

Consumption: 2.5 kg - 3 kg / 1 m² (layer thickness approx. 2 mm)

Packaging: Tin cans of 10 kg, powdered catalyst in plastic bags of 20 g or 100 g

2.2.4.4 Triflex ProDetail

A liquid-applied waterproofing system based on two-component polymethyl acrylate resin and reinforced with Triflex Special Fleece 110 g/m^2. Triflex ProDetail is resistant to hydrolysis, permanent water exposure and root penetration. For certain types of substrate, the system includes a primer.

Colour: RAL 7032 (pebble grey), RAL 7035 (light grey) and RAL 7043 (traffic grey).

Packaging: Triflex ProDetail – 15.0 kg tin
Triflex Catalysator – 0.10 kg plastic bag
Triflex Special Fleece – reinforcement fleece, width: 150 mm to 1,050 mm; length: 50 m
Triflex Cryl Primer 222 and 276 – 10 kg tin
Triflex Reiniger (cleaner) – 1 or 9 litre tin

Use: Finishing of non-standard complex details, including those exposed to pressure water. Usable for virtually all substrates when combined with a FATRAFOL PVC-P membrane. Applied with a brush or special roller.

Approved substrates:

- Asphalt, bitumen, SBS and APP modified asphalt sheets
- Concrete, polymer concrete, levelling compound, lightweight concrete, plaster
- Steel, stainless steel, aluminium, copper, zinc, lead
- Glass, wood
- PVC-P based waterproofing membranes
- Plastic surfaces (membranes, coatings, panels) - PVC-P, PU, PMMA, epoxy and polyester resins

Application temperature: Triflex ProDetail: - 5 °C to +40 °C

Note: To purchase and use Triflex products outside the Czech Republic, please contact Triflex GmbH & Co. KG, Minden, Germany.

2.2.4.5 Triflex ProFibre

A liquid-applied waterproofing system based on two-component polymethyl acrylate resin and reinforced with dispersed fibres. Triflex ProFibre is resistant to hydrolysis and permanent water exposure. For certain types of substrate, the system includes a primer.

Colour: RAL 7032 (pebble grey), RAL 7035 (light grey) and RAL 7043 (traffic grey).

Packaging: Triflex ProFibre – 10.0 kg tin
Triflex Catalysator – 0.10 kg plastic bag
Triflex Cryl Primer 222 and 276 – 10 kg tin
Triflex Reiniger (cleaner) – 1 or 9 litre tin

Use: Finishing of non-standard complex details, including those exposed to pressure water. Usable for virtually all substrates when combined with a FATRAFOL PVC-P membrane. Applied with a brush or special roller.
For approved substrates and their treatment, see Triflex ProDetail.

Application temperature: Triflex ProFibre: 0°C to +40°C

Note: To purchase and use Triflex products outside the Czech Republic, please contact Triflex GmbH & Co. KG, Minden, Germany.

2.3 Ancillary materials

These are materials and products that primarily serve to separate and protect waterproofing membranes from adjacent structures or to fix them.

As there is a wide range of these components, many are not manufactured by Fatra. The products below were tested and verified for their intended purpose and are recommended for use. If identical end-use properties are maintained, alternative materials can be used.

Please contact Fatra if you consider using any material not listed here.

2.3.1 Separation and protective fleece

2.3.1.1 FATRATEX

Needle-punched non-woven textile based on 100% regenerated synthetic fibres, ironed on both sides.

Dimensions: - Width: 2,000 mm
- Surface density: 200 g/m², 300 g/m², 500 g/m²

Use: Base, protective or separation layer for waterproofing membranes

Advantages: Surface thermal treatment = trouble-free fastening, the textile does not get caught in drill bits.

Packaging: Rolls are covered with PE film.

2.3.1.2 FATRATEX H

Needle-punched non-woven textile based on 100 % regenerated synthetic fibres, non-ironed.

Dimensions: - Width: 2,000 mm
- Surface density: 200 g/m², 300 g/m², 500 g/m²

Use: Base, protective or separation layer for waterproofing membranes

Advantages: Better resistance to biological corrosion

Packaging: Rolls are covered with PE film.

2.3.2 Separation PE membranes (FATRAPAR)

A lightweight, PE-based membrane.

Dimensions: - Thickness: 0.15 mm, 0.20 mm
- Width: up to 4,000 mm
- Surface density: approx. 140 to 180 g/m²

Use: Separates the waterproofing barrier from the concrete layer.

Advantages: Prevents the ingress of laitance into the protective textile layer.

Packaging: Rolls are usually covered with PE film.

2.3.3 Plastic-coated sheet metal profiles of FATRANYL PVC

Flat cuttings or preformed profiles made of FATRANYL-L plastic-coated sheet metal (galvanised sheet metal laminated on one side with PVC-P film)

Recommended shapes: See Table 4.

Use: The profiles are used for peripheral or intermediate fastening waterproofing membranes to the substrate. Plastic-coated metal profiles are fixed with fasteners.
The PVC-P layer can be hot-air welded to waterproofing membranes.

Table 4: An overview of the main shapes of plastic-coated sheet metal profiles FATRANYL PVC

Shape and recommended dimensions in mm	Name	Unfolded width [mm]	Use
	Strip with reinforced edge	50	- Ending of waterproofing barrier in stages - Linear fastening at penetrations and inclination changes - Ending on vertical structure
	Internal corner flashing	71	- Fastening on internal edges
	External corner flashing	70	- Fastening on external edges

2.3.4 NOVODUR profiles, type 1214

Profiles made of a mixture of resilient PVC and additives, manufactured using extrusion technology.

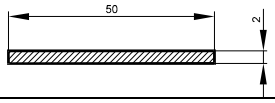
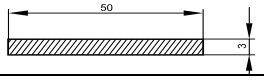
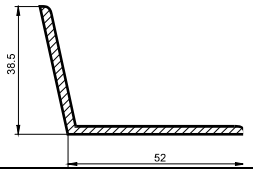
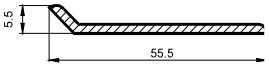
Use: See Table 5.
Profiles should be installed at temperatures above +5°C.

Colour: According to the current colour chart for NOVODUR profiles

Dimensions: See Table 5.
Length: 2,000 mm

Packaging: Wooden or cardboard box.

Table 5: Dimensions and use of Novodur profiles

Profile type (nozzle no.)	Shape and dimensions	Use
1590		Peripheral or intermediate fastening of PVC-P waterproofing membranes to substrate
1681		Peripheral or intermediate fastening of PVC-P waterproofing membranes to substrate
1922		Peripheral fastening of PVC-P waterproofing membrane in internal corners
1923		Ending of PVC-P waterproofing membrane on vertical structure, with sealing

2.3.5 Fasteners

2.3.5.1 Expansion rivet

An expansion aluminium rivet with a wide head and an expansion steel spike. Installed with a hammer.

Dimensions: Diameter: 6 mm; shank length: 30 mm to 60 mm

Use: Fastening of linear sheet metal fixing components and additional spot fastening of membranes (in combination with force-spreading washers), suitable for substrates made of non-lightweight concrete or solid walls.

2.3.5.2 Concrete screw

Screws made of heat-treated carbon steel with corrosion protection.

Dimensions: Shank diameter: 6.3 mm; shank length: 30 mm to 160 mm

Use: Fastening of linear sheet metal fixing components and additional spot fastening of membranes (in combination with force-spreading washers), suitable for substrates made of non-lightweight concrete.

2.3.5.3 Force-spreading washer

A circular or oval metal washer, plastic telescope.

Dimensions: Circular washer minimum diameter: 40 mm, oval washer minimum dimensions: 40 x 80 mm

Use: Designed to spread the compressive force of fasteners where the waterproofing membrane is spot-fastened to the substrate.

2.3.6 Adhering membrane

2.3.6.1 FATRAFIX PVC

Contact adhesive for bonding FATRAFOL membranes based on plasticized PVC to different types of substrate.

Use: For bonding waterproofing FATRAFOL membranes to vertical surface of parapets, vertical walls and to attach ground waterproofing FATRAFOL membranes to wall structures. FATRAFIX PVC can be used on variety surfaces such as concrete, coated sheet metal or wood particle boards.

Application: Surfaces must be clean, dry and free of dirt, dust, oil and paint before application. Optimal **temperature of adhesive** for application of FATRAFIX FM is 18 °C. Minimum is 10°C. Optimal **surface temperature** for proper use is between 15 °C and 30 °C. Temperatures below 15 °C will prolong curing time.

Adhesive is applied to both sides by spraying an even and uniformed thin layer from 30 cm to 40 cm distance to 80 % to 100% of surface. Spray one surface (membrane) in vertical and the other (wall) in horizontal direction

Let the adhesive slightly dry (sticky to fingers but does not leave stain when touched). It usually takes about 3 minutes at 23 °C. Adhere membrane to surfaces and apply adequate pressure. To distribute pressure evenly and achieve maximum bond strength use a roller. Adhesive will reach a maximum strength in 24 hours.

Coverage: 75 - 100 m^2/canister 17 kg

Packaging: 17.0 kg (22.0 l) single use canister, for professional use only

Cleaner: FATRAFIX AC cleaner

Storage: in original canisters for 9 months at ambient temperature +5 °C to +30 °C

2.3.6.2 FATRAFIX AC cleaner

FATRAFIX AC is a solvent cleaner specially designed to remove uncured FATRAFIX polyurethane adhesives.

Use **FATRAFIX AC cleaner**- For cleaning of spraying equipment - hoses, spray guns and nozzles

FATRAFIX AC cleaner 500 ml – cleaning of work aids and nozzles

Packaging: 5 kg (13.7 l) single use canister, only for industrial application

500 ml aerosol for industrial application and general use.

Storage: In original canisters at ambient temperature +5 °C to +30 °C

3. Main construction principles

3.1 Protection of structures from water

3.1.1 General rules and terms

3.1.1.1 Specifics of waterproofing barriers made of FATRAFOL-H system waterproofing membranes

The design of the composition, overall arrangement and details of a waterproofing system must always be based on the properties of the waterproofing material to be used and on the technological possibilities to process it under the existing conditions. Waterproofing barriers consisting of FATRAFOL-H system plastic membranes are characterised by these specifications:

- A waterproofing barrier creates a protected environment or constructions to avoid the negative effects of water for the required period of time, i.e. for the lifetime of the structure or of the waterproofing measures.
- Depending on structural requirements and construction technology, a FATRAFOL-H waterproofing barrier can be formed on the inside or the outside the protected construction.
- Protective fabric must be placed on both sides of a waterproofing membrane to protect it from mechanical damage caused by related construction works, building movements, building pressure, surface roughness etc.
- Protective fabric need not be used if the adjacent surface is made of material that has similar protective properties provided that it is compatible with the membrane (keep in mind the interaction of materials - e.g. PVC-P and EPS/XPS).
- If possible, the waterproofing barrier is installed entirely loose on a horizontal substrate.
- On sloping and vertical surfaces where the waterproofing barrier may collapse, it is fastened to the substrate at the upper edge or at several levels above each other, depending on the wall height. Linear (using fixing profiles) or spot fastening can be used to fix a waterproofing barrier to the substrate.
- Waterproofing membrane sheets must be firmly joined in a watertight and gastight manner to create a waterproofing barrier.



3.1.1.2 Main sources of information for waterproofing design

The main sources of information for preparing a waterproofing design include, in particular:

- Information and data from the Hydrometeorological Institute,
- Information from water authorities,
- Hydrogeological survey (to establish the structure, nature and properties of foundation soil layers and groundwater),
- Radon survey at the site,
- The identification of the nature of the hydro-physical stress on the waterproofing barrier (based on the design level of groundwater),
- The structural solution and material of foundation, basement and, if applicable, floor structures of the building and its expansion,
- The design and stabilisation of the excavation pit,
- The nature and depth of foundations of neighbouring structures (historical and architectural development of the area),
- An assessment of the risk of mechanical damage to the waterproofing barrier during installation and use, considering the proposed thickness of the membrane,
- Requirements of the client and insurance companies.

3.1.1.3 Hydro-physical stress on waterproofing barrier

Constructions are exposed to the effects of water present in various forms in both nature and the construction. Their severity depends on the location of the construction in the area, its position in the terrain, inside and outside traffic, the construction method etc.

Various forms of water presence in nature and the structure are characterised by certain common elements of hydro-physical exposure. Following categories are:

- Exposure to ground moisture, which results from:
  - The effects of water trapped by sorption and capillary forces in a porous rock environment,
  - The effects of water on the construction that spreads in the adjacent, porous rock environment or in building materials, or that spreads from the construction surface due to the effects of capillary forces, evaporation and condensation in capillary systems in all directions, including against the gravitational direction and through the interface of layers,
  - A drop in the construction surface temperature below the dew point.

  Note: Exposure to moisture depends primarily on the type and location of the moisture source, material porosity and other effects.

- Exposure to water flowing on the surface of constructions, which occurs if:
  - Water flows on the surface of a construction without accumulating at any point of contact with the construction and without creating a continuous horizontal surface, while the water may also exert negligible hydrostatic pressure.

  Note: Depending on the source of the water, hydro-physical stress may be increased by hydrodynamic effects, wind pressure etc. – e.g. by wind-driven rain in the event of rainwater, or water direction flow in the event of service water. These circumstances must be taken into account when designing the waterproofing constructions.

- Exposure to water seepage through an adjacent porous environment, which occurs if:
  - Constructions are affected by water in a liquid state that seeps by gravity through an adjacent porous environment or a part of the construction towards the groundwater level. Water may temporarily and locally accumulate in the vicinity of waterproofing constructions and exert negligible hydrostatic pressure on them.

- Exposure to pressure water, which occurs if:
  - Water in a liquid state affects the construction by definable hydrostatic or hydrodynamic pressure; below the water surface, the pressure spreads in the water in all directions; a hydraulically continuous surface is created in porous structures,
  - Water spreads through cracks in impermeable soils and rocks to different heights where it exerts pressure on protected constructions,
  - If protected constructions are in direct contact with an embankment or natural soil without permanent and safe means of removing water from those layers, preferably an area drainage component.

3.1.2 Base layer

Depending on the site conditions, a waterproofing barrier may be applied on the following substrate:

- A concrete structure (Detail 101H),
- Brickwork with suitable plaster or rough brickwork with treated joints (Detail 207H),
- Compacted gravel with sand (suitable especially for environments with highly aggressive groundwater) (Detail 102H),
- Subgrade with a modified contact layer,
- Other types of substrate.

The substrate must be flat and free of cavities, sharp edges, projections and protrusions and any other projecting sharp objects that may damage the waterproofing barrier. It is not recommended to round internal and external corners of the substrate. Please refer to the CSN 73 0205 and CSN 73 0212-3 standards to determine and verify the planarity of horizontal and vertical substrates.

The concrete bed should be at least 100 mm thick and reinforced with a net or fibres across its area. The concrete bed should be sufficiently robust, and its surface should meet applicable quality requirements.

A waterproofing barrier may also be applied on uncured concrete. If the waterproofing barrier is not mechanically fastened to the substrate, it may also be applied on a set concrete bed (1 to 3 days after concrete placement). While the substrate need not be completely dry, it must be free of puddles, snow, ice and black ice.

In constructions divided by expansion joints, it is also necessary to dilate the waterproofing barrier in the substrate layer (if made of a rigid material). Expansion joints should be without breaks and should not be located in internal and external corners of constructions, especially if there is hydro physical stress by pressure water.

If the waterproofing barrier is penetrated by pipes or other lines, on the perimeter of which the barrier will terminate, these items must be installed in advance in their final position. Materials of penetrating structures should meet at least the same requirements for durability and reliability as the waterproofing construction, especially with regard to the service life of the building and the prescribed renewal cycles.

If penetrating pipes have a flange, the flange should not extend above the surface of the adjacent substrate. Penetrations through the waterproofing barrier should be perpendicular to the plane of the barrier and located at least 250 mm from the edges and internal corners of the substrate and from each other.

If the substrate is below the groundwater level, it is necessary that this level is, during the waterproofing works and until the waterproofing barrier is safely installed, lowered to at least 500 mm below the lowest point of the waterproofing barrier. Exposure of the waterproofing membrane to the effects of pressure water is only possible after the reinforced concrete base plate has been made and fully cured.

When rehabilitating damp masonry, the substrate must meet the same requirements as the substrate of new constructions.

3.1.3 Waterproofing layer

3.1.3.1 Parameter selection according to hydrophysical stress

3.1.3.1.1 Exposure to moisture from adjacent porous environment (ground moisture)

The waterproofing layer must be located and installed in such a way to prevent or reduce the passage of moisture from the adjacent soil and building materials into the protected construction or protected environment. For this type of hydrophysical stress, a single layer of a **0.6 mm thick waterproofing membrane** can be used.

If the substrate is rigid, the required waterproofing efficiency can be achieved by overlapping the waterproofing sheets by a minimum of 100 mm without welding them. Still, it is recommended to weld the sheets together. If the waterproofing barrier is to provide additional protection (radon protection, chemical or biological corrosion etc.), the membrane sheets must be welded together.

3.1.3.1.2 Exposure to water flowing on construction surface

The installation and location of the waterproofing layer must prevent direct contact between the protected constructions or protected environment with flowing water. Sufficient waterproofing efficiency is achieved by using a single continuous layer of a **waterproofing membrane with a minimum thickness of 1.0 mm**.

A waterproofing membrane rated for exposure to freely flowing water may be used on vertical or sloping surfaces of below ground parts of constructions where a free flow of water outside the protected construction or environment can be ensured by using an area drainage component.

3.1.3.1.3 Exposure to water seeping through porous environment and flowing on horizontal surfaces

The waterproofing layer must prevent any hydrostatic or hydrodynamic effects of seeping water on the protected construction or interior, even in the event of its pressure effects in impermeable soil or in the event of temporary stress caused by, for example, the direction of flow of service water or wind in open reservoirs.

In general, the waterproofing barrier can consist of a single layer of **a membrane with a minimum thickness of 1.5 mm** with a random verification of welded joints.

This type of a waterproofing barrier is also possible when the construction is in contact with an embankment, backfill or natural soil through which water may seep all the way to the groundwater level and temporarily exert local hydrostatic pressure, subject to the water being effectively removed, e.g. by an area drainage component, outside the construction or protected environment.

3.1.3.1.4 Exposure to pressure water

The installation and location of the waterproofing layer must prevent any contact of the protected constructions with underground pressure water or fissure water. The following may be used for this purpose:

- A single layer of a waterproofing membrane with a minimum thickness of 1.5 mm, preferably with a high-visibility layer and simple joints that will be checked for tightness,
- A single layer of a waterproofing membrane with a minimum thickness of 1.5 mm, preferably with a high-visibility layer and double track welds that will be checked with pressure air for tightness,
- A single layer of a waterproofing membrane with an electromagnetic monitoring system,
- A single-layer sector system allowing for sector rehabilitation,
- A two-layer sector system with an active check of sector tightness, allowing for sector rehabilitation,
- A combination of the above waterproofing barriers with a waterproof reinforced concrete construction.

This waterproofing category must be applied:

- In the case of permeable foundation soils, i.e. if the waterproofing layer is below the design groundwater level. The upper edge of the waterproofing barrier to be exposed to pressure water must be at least 500 mm above the design groundwater level (safety zone). Above this height, the waterproofing layer is chosen based on the actual hydrophysical stress.
- Always in the case of low-permeable or impermeable foundation soils (K < 1.10-4 m.s-1) if there is no area or pipe drainage to ensure gravity or forced removal of water outside the construction (even if a hydrogeological survey did not detect any groundwater).

3.1.3.2 Passive safety elements

An integral part of waterproofing should be passive safety elements that reduce the stress on the building by water. These elements include the following measures:

- minimization of the number of outlets coming through membrane below the groundwater level
- building design with insulation against pressure water in the simplest shapes without protrusions and niches
- design of waterproofing layer for hydro physical stress a degree higher than required
- design of drainage around the building with cleaning shafts at the junction of directions change
- slope of the terrain around the structure in direction away from it

3.1.3.3 Fastening waterproofing barrier to substrate

On horizontal and gently sloping surfaces, a waterproofing barrier is not usually fastened to the substrate.

On pitched surfaces where a waterproofing barrier may collapse due its weight or works on it, it is usually sufficient to fasten the barrier at the upper edge of the surface.

Waterproofing barriers that are joined in stages on vertical surfaces require temporary fastening (Detail 207H, 208H).

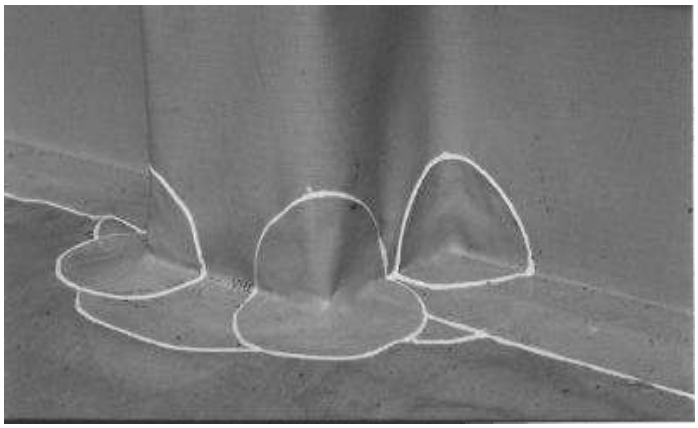
If the wall height exceeds 5 m, the waterproofing barrier must be fastened at several heights (Detail 209H) and the fastening lines must not be more than 5 m apart. For this purpose, linear fixing strips (components) made of plastic-coated sheet metal, Novodur or other non-corrosive material are typically used. For temporary fastening, use can be made of spot fasteners with a washer in the middle of the strip; once installed, the fasteners are patched.

When a waterproofing barrier is being installed on the inside of a construction, the PVC-P membrane should be spot-fastened (Detail 501H and 502H) to the substrate at the point where the horizontal waterproofing barrier becomes vertical.

3.1.3.4 Reinforcement of corners and edges

If the construction is exposed to pressure water causing hydrophysical stress, both horizontal and vertical corners and edges of the waterproofing barrier must be reinforced with a sheet of a membrane that is identical in thickness and at least 300 mm wide. The sheet edges must be welded to the main waterproofing layer with at least a 30 mm wide weld (Detail 502H).

At the intersection of three planes, reinforce the waterproofing barrier by completely welding on a preformed component – Internal corner, type 10, and External corner, type 11 (Detail 503H). If FATRAFOL-H preformed components cannot be used for detailing, use a patch of the required shape and size, made of a non-reinforced membrane. The different color of this Pre-shaped pieces or patches means highlighting the detail and is not a problem.



3.1.3.5 Connecting waterproofing membranes in stages

The waterproofing of small or technologically simple constructions is usually done in a single session. For larger or complex constructions that are built in phases, the waterproofing barrier must also be installed in stages, depending on the expected sequence of construction works.

For each connection made in stages, it is always necessary to leave a sufficiently wide membrane edge to which another piece of the waterproofing barrier will be joined later on. The temporary ending must be carefully protected from construction damage, preferably with a protective cement screed of lean concrete or by increasing the brick backing that will be removed before the next stage begins (Detail 205H). The waterproofing barrier protection must also take into account how long the works will be interrupted for.

In order to connect a vertical waterproofing barrier to a previously installed horizontal one, a so-called ‘counter joint’ is made, either at the base of the vertical wall (Detail 206H) or above the upper edge of the foundation slab. Making the joint in the reverse order (lowering the vertical membrane to the bottom and then bringing out the horizontal overlap of the foil on the vertical wall and welding it) is not possible for buildings with internal corners (e.g. an L-shaped building), and completely excluded for pressure insulation!

A horizontal waterproofing barrier is joined to a vertical one after the horizontal construction is complete (Detail 207H, 208H).

3.1.3.6 Ending waterproofing barrier

The manner in which waterproofing layers are ended above ground must ensure that no water gets behind the waterproofing barrier. The height of the waterproofing barrier above the adjacent ground depends on the design of the details, connection of the construction to the ground, estimated groundwater level, snow thickness etc. Unless the waterproofing barrier is joined watertight to another waterproofing construction of a waterproof material, the barrier should end no lower than:

- 300 mm above the highest point of the adjacent ground in a 1 m wide sheet,
- 200 mm above the highest point of the adjacent ground in a 1.5 m wide sheet,
- 500 mm above the design groundwater level,
- 300 mm above the maximum service level in reservoirs or sumps.

As for open reservoirs, it is important to provide a suitable waterproofing measure (e.g. drain ditch, ground sloping, perimeter drains etc.) to remove surface water outside the reservoir profile. This measure generally applies to all types of waterproofing.

3.1.3.7 Penetrations through waterproofing barrier

A watertight, and if necessary gastight, joint must always be made between the waterproofing barrier and the perimeter of all penetrating objects. In waterproofing barriers that will or may be exposed to hydrostatic or hydrodynamic pressure of water, the joint is made by clamping the barrier between a fixed and loose steel flange. The flanges are typically made of stainless or carbon steel with at least an 80 µm thick hot dip galvanised finish. The minimum thickness of both a fixed and loose flange used in waterproofing barriers against pressure water is 10 mm while the usual thickness is 120 mm. If the loose flange is made up of several components, the gap between them must not exceed 2 mm (Detail 404H).

A waterproofing barrier is ended similarly along the perimeter of steel slabs, frames etc., where it is clamped between the steel structure and the flange plate (Detail 302H).

At the clamping point, the waterproofing barrier is reinforced with a cuff made of the same membrane (e.g. Collar, type 13) and sealed with a layer of PU or MS polymer sealant.

In complex or hard-to-access details where a clamp joint is impossible, waterproofing mortar can be used for sealing (Detail 403H).

The distance of penetrations from each other and from vertical or horizontal edges must be sufficient for proper installation of the waterproofing barrier (at least 250 mm). The designer must take this into account when designing the waterproofing system.

Waterproofing barriers against ground moisture may be ended on the surface of a penetrating object by using a preformed component or creating a non-reinforced membrane cuff that will be fixed at the upper edge with non-corroding tape and sealed (Detail 405H). Alternatively, the penetration can be finished with a collar and sealed with PU sealant (Detail 401H).

3.1.3.8 Expansion joints

In building practice, there are two basic types of expansion joints: building and contraction joints. Other types include relief, corner and connecting joints for expansion in flat constructions where they prevent the undesired transmission of thermal and mechanical stress. As for the waterproofing of constructions, it is the building expansion joints that require adopting structural and technical measures in the waterproofing layer.

No modification to the waterproofing membranes is usually necessary at the point where the waterproofing barrier passes over a building expansion joint filled with a flexible insert. The elongation of the membrane and its loose installation between layers of protective fabric eliminate the risk of damage to the membrane by expected construction movements. At the point of the expansion joint, the waterproofing membrane is only reinforced with an additional sheet of a membrane with the same thickness and a minimum width of 400 mm (Detail 601H).

If the expansion joints are not filled with an expansion insert and move by no more than 10 mm, the waterproofing barrier must be backed, at the point of the joint, with rigid support (e.g. PE board) fastened on one side (Detail 602H).

If movement of the expansion joint is expected to exceed 10 mm, causing shear stress to the waterproofing barrier, a flexible deformation zone must be made of EPS boards both under and above the barrier (Detail 603H). If the movement of the expansion joint exceeds 10 mm, an expansion joint strip can also be used (Detail 604H).

3.1.4 Protective layer of waterproofing barrier

The protection of a waterproofing barrier is crucial to ensuring its performance and reliability. Experience has shown that the subsequent construction of adjacent structures and compacted backfill are the biggest risk in this regard. Protection must also be provided against the effects of process chemicals and of the building materials used.

A suitable separation layer (e.g. fabric with a minimum surface density of 200 g/m^2, an additional layer of suitable adhesive in the footing area) must be used to prevent direct contact between a PVC-P membrane and polystyrene-based materials (EPS, XPS).

After tightness verification and acceptance, all membrane-based waterproofing barriers must be protected, throughout their service life, by protective layers from mechanical damage. Soft and hard protective layers or their combinations serve this purpose.

3.1.4.1 Protection of horizontal waterproofing barrier

Protective layers typically recommended for a horizontal waterproofing barrier and their combinations:

- Non-woven textile, min. 300 g.m^{-2}
- Non-woven textile, min. 300 g.m^{-2} + PE membrane
- Profiled (drainage) membrane
- Glass fibre fleece 120 g.m^{-2} + EPS or XPS thermal insulation
- Non-woven textile, min. 200 g.m^{-2} + EPS or XPS thermal insulation
- Profiled (drainage) membrane + concrete screed with a minimum thickness of 50 mm (at least 80 mm for areas with vehicle traffic)
- Non-woven textile, min. 300 g.m^{-2} + PE membrane + cement screed with a minimum thickness of 30 mm (Detail 101H, 102H)
- Non-woven textile, min. 300 g.m^{-2} + PE membrane + concrete screed with a minimum thickness of 50 mm (Detail 101H, 102H)
- Non-woven textile, min. 300 g.m^{-2} + backfilling material

3.1.4.2 Protection of vertical waterproofing barrier

Protective layers typically recommended for a vertical waterproofing barrier installed from the outside (pit side) and their combinations:

- Non-woven textile, min. 800 g.m^{-2} (Detail 209H)
- Profiled (drainage) membrane (Detail 103H)
- Rigid boards of thermoplastics or expanded plastics
- Non-woven textile, min. 300 g.m^{-2} + XPS or EPS Perimeter thermal insulation
- Non-woven textile, min. 300 g.m^{-2} + XPS or EPS Perimeter thermal insulation + profiled (drainage) membrane
- adhered XPS + profiled drainage membrane + backfill (Detail 702H)
- Non-woven textile, min. 300 g.m^{-2} + PE membrane
- Non-woven textile, min. 300 g.m^{-2} + retention wall or reinforced concrete partition wall (Detail 103H)

Protective layers typically recommended for a vertical waterproofing barrier installed internally and their combinations:

- Non-woven textile, min. 300 g.m^{-2}
- Non-woven textile, min. 300 g.m^{-2} + PE membrane (Detail 501H)
- Profiled (drainage) membrane
- Rigid boards of thermoplastics or expanded plastics

No rigid protection of a vertical waterproofing barrier is required if quarry gravel with sand, without any sharp content, is used as backfill and applied in a way that cannot damage the barrier.

The protection of a vertical waterproofing barrier in reservoirs and sumps that is made of a reinforced concrete partition wall and forms a separate inner structural layer of the construction must be secured against deflections and collapse by adopting suitable structural measures or using steel clamps to join the partition wall to the vertical substrate of the waterproofing membrane.

If waterproofing works are suspended for a longer period of time (e.g. at the point of expansion joints, connections etc.), the waterproofing barrier must be protected from operational effects by using a temporary layer or construction that is easy and safe to remove before resumption of works (Detail 205H).

3.2 Protection of structures from select liquids

The installation of barriers to liquids is based on principles similar to those applying to waterproofing barriers. The differences lie in the need to use waterproofing materials, ancillary materials and accessories that are chemically resistant to that particular environment.

If the membrane is used as face insulation, it is necessary to prevent it from being stressed by UV radiation

Barriers to liquids:

- Protect the construction from extracts from the subgrade or a corrosive environment,
- Protect the construction from spills from equipment or storage tanks (solutions of acids, bases and their salts, hydrocarbons, solvents etc.).

3.3 Rehabilitation of damp masonry

The rehabilitation of damp masonry includes a set of waterproofing, drying and structural-technical measures. These measures are usually taken in constructions where the original protection from water failed or was never provided.

Rehabilitation should permanently reduce the stress exerted by water on the construction and ensure compliance with the requirements standards place on the construction, depending on its type or environment.

Rehabilitation measures are usually based on a site survey. Such a survey typically includes:

- Assessing the technical condition of the construction or its parts,
- Establishing the salinity and humidity of the masonry,
- Identifying the hydrogeological conditions at the site and within the surroundings,
- Assessing the existing or design conditions for the internal protected environment (thermal protection, ventilation, heating, etc.),
- Methods of identifying and assessing individual types of survey activities (CSN P 73 0610).

Based on the survey evaluation, direct or indirect methods of rehabilitation are selected. These are specified in detail in the **project to rehabilitate damp masonry**.

Key direct methods of rehabilitation used with the FATRAFOL-H system include:

- Mechanical methods – a gap is cut or openings are made in wall structures, followed by the insertion of a waterproofing membrane or board, wedging and the subsequent filling of the gap with high-quality cement mortar (Detail 804H),
- Air insulation methods – a method of natural or forced ventilation that involves creating ventilated gaps along both vertical and horizontal constructions, e.g. by using profiled membranes of rigid plastics (Detail 805H).

The main indirect methods of rehabilitation of damp masonry include drainage systems, technical modifications to terrain, natural percolation, etc.

Checking the effectiveness of the works is a vital part of the entire process of rehabilitating damp masonry. Such verifications include taking and evaluating local samples. These activities are usually described in the plan of performance checks, maintenance and renewal cycles. Such a plan should be prepared for all waterproofing structures and measures, and usually comes from the designer of the rehabilitation measures.

The drying of constructions is a long-term process that may take several years and is influenced by a host of technical factors (masonry thickness and type, original dampness, how the rooms are ventilated and heated, etc.).

3.4 Protection of constructions from ingress of radon from ground

3.4.1 Origin of radon in ground

Radon (chemical symbol Rn) is an inert natural radioactive gas having no colour, taste or smell. It is one of the products of the radioactive decay chain occurring in the air, soil and water. A natural radioactive background is a permanent part of our living conditions. Radon is present in varying concentrations in virtually all foundation soils of building plots. Radon is continuously released from the ground, entering the external environment and the interior of buildings through their adjacent (contact) horizontal or vertical basement structures. In terms of radiation protection, the isotope of radon 222Rn is of particular importance. Radon is the heaviest known gaseous element with a half-life of 3.8 days, producing isotopes of heavy metals (lead, bismuth and polonium) that attach themselves to aerosol particles and are inhaled into the lungs along with them. This results in direct irradiation of the alveoli tissue by alpha and beta radiation, posing the risk of lung cancer.

Radon enters constructions in two ways:

- By means of diffusion through the capillary structure of building materials,
- By means of convection through gaps and cracks in building structures.

The harmfulness of the long-term effects of radiation on the human body has been known for many years and is defined as an ‘effective dose’. The higher the radiation dose, the higher the risk of damage to health. The Czech Republic has one of the highest average radon concentrations in homes globally. Growing demands for the energy efficiency of buildings result in more stringent requirements for the tightness of buildings.

Increasingly tight buildings thus lead to higher radon concentrations in the interior. This makes ventilation increasingly more important.

3.4.2 Statutory requirements

The following legislation is currently in force in the Czech Republic:

- Act., 263/2016 Sb as amended (Nuclear Act),
- Decree422/2016 Sb. on radiation protection, as amended
- Czech standard CSN 73 0601 “Protection of buildings against radon from the soil”.

3.4.3 Guiding principles for design and evaluation of radon barriers

Radon barriers must be designed in accordance with the State Office for Nuclear Safety Decree 422/2016 Sb. on radiation protection, which set outs the reference value of radon volume activity in the indoor air of a residential or residence room of 300 $Bq.m^{-3}$

Radon barriers are designed in accordance with CSN 73 0601. Based on the site radon index and information about the construction (method of foundation, position in terrain, gravel sub-base, heating method, ventilation intensity etc.), concrete anti-radon measures are proposed.

Residential buildings must be protected by a radon barrier.

If the building has a low radon index, Sufficient protection for buildings with low radon index can be also created with single-layer coating waterproofing according to ČSN P 73 0606 with waterproof joints and penetration points.

If the building has a medium and high radon index, it must be protected with a radon barrier that must meet the following requirements:

- The radon diffusion coefficient must be determined for the barrier and joints,
- The elongation of the barrier must be such that it accommodates maximum deformations for each type of foundation and design of the below ground structure,
- The barrier’s service life must correspond with the design life of the building in accordance with the EN 1990 standard,
- The barrier must meet all other requirements applicable to waterproofing barriers.

If the radon volume activity in the soil exceeds the limit values, which are:

- 200 kBq/m^3 for low permeability soil,
- 140 kBq/m^3 for medium permeability soil,
- 60 kBq/m^3 for high permeability soil.

anti-radon insulation alone is no longer enough and the protection of the building must be solved by a combined measure. **These additional anti-radon measures must also be taken if a floor heating system is to be installed in the building or if a high permeability drainage layer is created under the building**. The following anti-radon measures are proposed:

- A ventilation system in the soil, (usually an exhaust pipe made of perforated hoses laid in a gravel layer and led out through a building above the roof. In passive ventilation of the subsoil, the so-called chimney effect is used, in active ventilation of the subsoil, a fan is installed in the ventilation pipe
- A ventilation layer in the contact structure,
- An insulating floor.

Experience and test and measurement results show that one of the most effective radon barriers for constructions is an integral waterproofing barrier with gastight joints and penetrations.

3.4.4 Designing anti-radon measures

3.4.4.1 Selection of building rooms for assessment

The rooms to be assessed must be selected on the basis of cooperation between the person preparing the calculation and the designer or client. In terms of the occurrence and effects of radon, it is necessary to select a room (rooms) the usage and location of which make it the most hazardous place in the building. This is the room where the contact surface of the construction with the active soil (natural soil, bedrock, embankment, backfill etc.) is the largest. Usually, this is a residential room where the total time for all persons that may stay in it exceeds 1,000 hours per annum.

Another important aspect to be considered when selecting the room to be assessed is the prescribed (or real) intensity of its ventilation, i.e. a multiple of the air exchange in the room per hour.

3.4.4.2 Design value of radon diffusion coefficient 'D' in selected membrane

The coefficient of radon diffusion in a membrane is a material constant that shows the degree of penetration of radon through the material. In general, materials such as PVC-P membranes, have very low permeability to radon.

All waterproofing membranes of the FATRAFOL-H system that are used for waterproofing below ground structures were assessed for radon permeability by accredited Testing Laboratory no. 1048, specialist laboratory 124, at Czech Technical University in Prague, and their diffusion properties, as determined using the K124/02/95 methodology, are documented in the relevant test reports – seeTable 6. The coefficients of radon diffusion are measured values.

For calculations in the 'Radon 2006' software, it is recommended to use the radon diffusion coefficients from the software database or the design value column. The design value is the sum of the average value and a probable error, this being the higher of the values determined for the material and for the joint.

Table 6: Radon diffusion coefficient for waterproofing membranes of FATRAFOL-H system

Waterproofing membrane type	Material	Radon diffusion coefficient D in membrane [$m^2.s^{-1}$]	Test protocol
FATRAFOL 803	PVC-P	$1{,}2.10^{-11}$	no. 124005/2019
FATRAFOL 803S	PVC-P	$1{,}3.10^{-11}$	no. 124003/2024
FATRAFOL 813 *)	PVC-P	$1{,}1.10^{-11}$	no. 124034/2010
EKOPLAST 806	PVC-P	$5{,}2.10^{-12}$	no. 124208/95
STAFOL 914	PVC-P	$1{,}4.10^{-11}$	no. 124003/2019

**) In 2022, the name of the FATRAFOL 813/VS membrane was changed to FATRAFOL 813 while maintaining the product's design and composition (Certificate of Factory Production Control No. 1023-CPR-1240F dated June 13, 2022).*

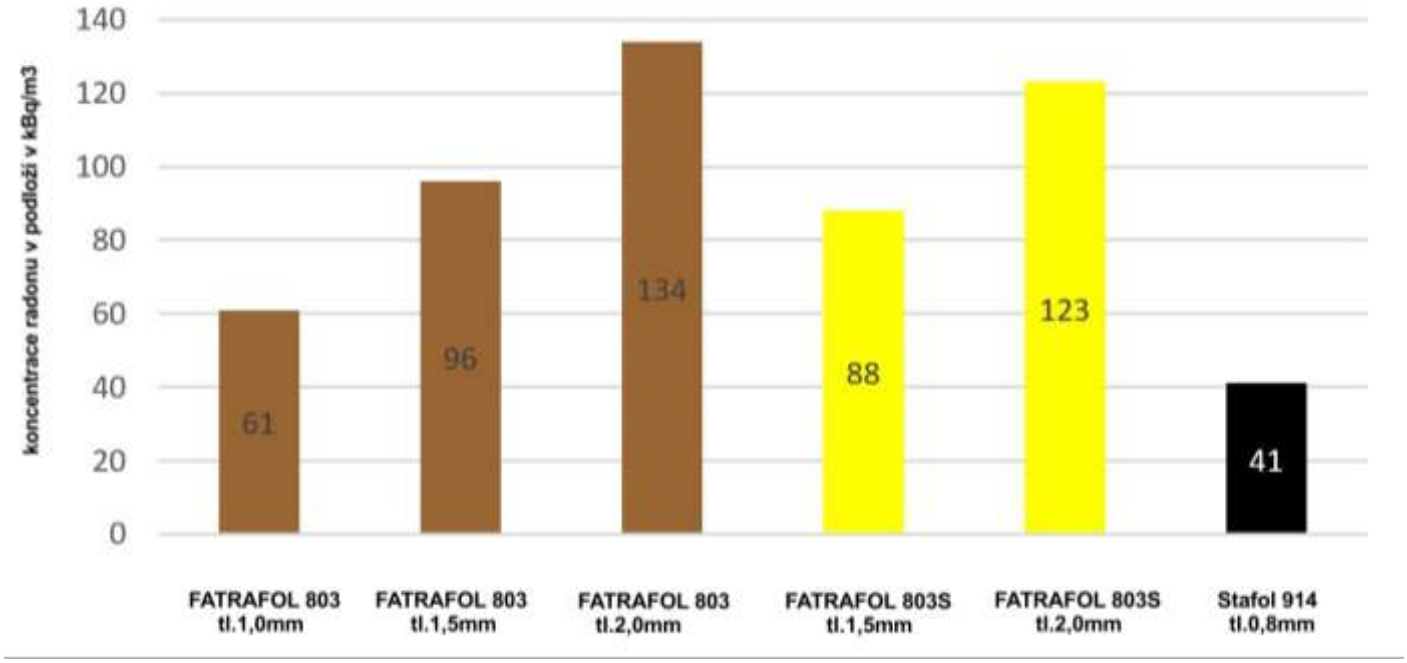
3.4.4.3 Calculation of parameters of radon barrier

The following data is necessary to design anti-radon measures using the 'Radon 2019' software:

- Radon concentration in the soil – the third quartile of C_s [kBq.m^{-3}]
- Soil gas permeability
- Air exchange in the room n [hour^{-1}]
- Building type (new, existing)
- Volume of the assessed room V_k [m^3]
- Horizontal contact surface A_p [m^2]
- Vertical contact surface A_s [m^2]
- Method of soil ventilation
- Value of radon diffusion coefficient D in membrane [m^2.s^{-1}]

The aim of the calculation is to determine the minimum membrane thickness required to achieve the required anti-radon protection according to ČSN 73 0601 "Protection of buildings against radon from the subsoil".

If the assessed room does not have a vertical contact surface with the soil, the following bar chart (Figure 7) shows examples of use of selected membranes as a radon barrier for highly permeable subsoil (e.g. gravel layer under the base plate). In addition to anti-radon protection, the membrane naturally also resists various hydro physical stresses in the surrounding environment.



Note: 1. The calculation is made for a simulation living room of dimensions 4 x 5 m, height 2.6 m with a combined measure in the form of passive ventilation of the subsoil (use of the chimney effect without the use of a fan), which is necessary in the case of highly permeable subsoil or underfloor heating.
2. The design concentration of radon in the building is considered at a maximum level of 200 Bq/m^3

Figure 7: Maximum allowable radon concentrations in the soil (3rd quartile) for selected types and thicknesses of membranes

3.4.4.4 Installing radon barrier

The requirements for installing radon barriers are essentially identical to the requirements for installing waterproofing barriers as described in this manual.

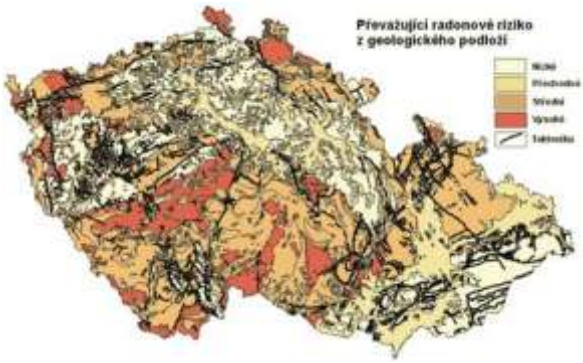
At the same time as anti-radon protection of the building, all waterproofing membrane also perform the function of waterproofing against the given hydro physical stress.

4. Technical preparations for waterproofing works

4.1 Basis for preparation

Construction documentation must be based on the following:

- Findings of the hydrogeological and radon survey,
- Information contained in the land use plan,
- Type of hydrophysical stress,
- Specifications of the corrosive environment,
- Information on activities in the protected environment,
- Design service life and renewal cycles,
- Required reliability of the waterproofing barrier,
- Required accessibility of the waterproofing layer,
- Requirements of public authorities (utility operators, landmarks preservation office, building authority etc.),
- Requirements of the insurance company.



Construction documentation is the fundamental material for installing waterproofing barriers. If construction documentation has not been prepared, the installation contractor is responsible for the design.

4.2 Preparatory work

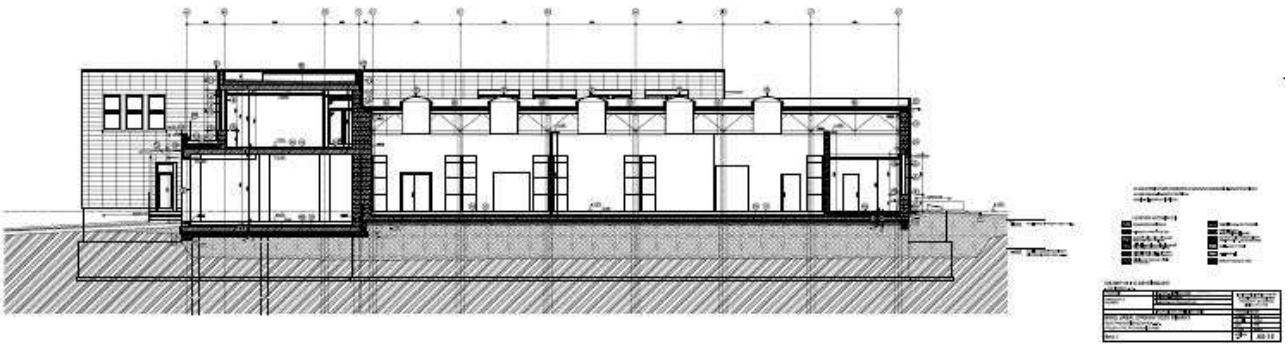
Before waterproofing works begin, it is necessary to determine material consumption for:

- The horizontal surface,
- The vertical surface,
- The reinforcement in internal corners and edges (pressure water),
- Fastening (membrane fixation),
- The ending of the waterproofing barrier on vertical structures (also installed in stages),
- The finishing of expansion joints,
- Detailing, (spatial and penetrating membrane)
- Substrate, protective and separation layers.

It is also necessary to determine how any subsequent layers will be installed and the requirements for implementation in stages, technological breaks, the method of protecting the waterproofing barrier etc.

The following written documents result from the preparatory work:

- Specifications of materials,
- Sample compositions of the waterproofing barrier,
- Drawings of details,
- Technological procedure,
- Quotation (cost calculation).



5. TECHNOLOGICAL PROCEDURES

5.1 External conditions for waterproofing works

5.1.1 Site readiness

Site takeover, this usually means the takeover of a defined jobsite under **Government Regulation 591/2006 Coll.**, on detailed minimum requirements for occupational safety at construction sites, including completed load-bearing structures, all terminating, peripheral and penetrating structures and other built-in components, is performed by a representative of the installation contractor (construction manager, foreman) in the presence of the main contractor's construction manager, the client's technical supervisor and other authorised persons.

As part of site takeover, a visual inspection must be made of the completeness of the substrate structures and walls and of all penetrations through the waterproofing membrane. It is especially important to make sure that the actual situation corresponds to the current construction documentation.

Works should not commence until the owner's technical supervisor accepts the substrate structures. The information below on the site takeover must be noted in the construction log:

- Date and time of site takeover,
- Exact site description using layout axes (map or sketch),
- Site condition in terms of OH&S, fire prevention and EMS,
- Defects and outstanding works, if any, and
- Signatures of those handing over and taking over the site.

Images should be taken of the site at the time of its takeover.

Key items to be provided and determined as part of a site takeover process:

- A material storage location and protection of materials from mechanical damage, weather and theft,
- Safe access to the site and place of installation,
- A safe and cost-effective method of horizontal and vertical transport,
- Space for materials on the load-bearing or substrate structure, subject to permissible load,
- 230/400 V connections in accordance with current regulations, including electricity meters,
- A waste management system (sorting, environmentally friendly disposal, certificates),
- Necessary measures in accordance with the site rules and safety, legal and sanitary regulations and standards,
- The method of coordinating concurrent and related construction works and other activities,
- Performing tightness tests and demonstrating work quality – handover of parts of the work.

5.1.2 Working conditions

Most waterproofing barriers of PVC-P membranes can be installed at a minimum ambient temperature of -5°C and -10°C respectively. Application at low temperatures results in dimensional changes in membranes (contracting), which may cause the membranes to ripple after heating. This does not affect the performance and service life of the waterproofing barrier. The maximum outside air temperature recommended for the application of membranes is +40°C. If the ambient temperature drops below +15°C, membranes can only be joined using hot air. In cold weather, waterproofing membranes should be warmed in a heated room before installation. Works must be interrupted in the case of rain or snow.

Unless appropriate protective measures have been taken, smoking, use of open flames, electric arc and torch welding, use of an angle grinder and similar activities are forbidden at all times during waterproofing works in order to avoid the risk of damage (burning) the membrane.

Before the protective layer of the waterproofing barrier is finished, unauthorised persons must be prevented from stepping on the unprotected waterproofing membrane and from performing any related construction works.

5.2 Working methods

5.2.1 Substrate modifications

The substrate (planarity, load-bearing capacity etc.) must meet the requirements set out in section 3.1.2.

Before waterproofing works begin, the substrate surface must be swept carefully and cleaned of all foreign bodies (nails, shards of glass, stones, mortar residues etc.). A low-quality surface must be repaired by using fine-grained mortar or by grinding.

Steel substrates must be cleaned of post-welding metal residues, and sharp projecting edges must be ground down.

5.2.2 Laying and joining base fabric

Base fabric layers forming part of the waterproofing barrier are laid loosely on the substrate, with overlaps at least 50 mm in width. The direction of fabric sheets and their overlaps does not play a role. The substrate must be thoroughly covered with the fabric and the risk of fabric displacement must be avoided.

Instructions for installing a base fabric:

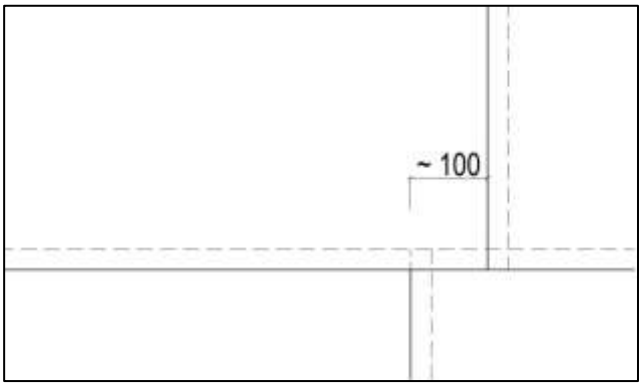
- Sheet overlaps are only spot-welded together, using hot air (Detail 201H).
- Instead of fastening, the fabric is only temporarily loaded or glued as necessary.
- On vertical and inclined surfaces, the fabric is first temporarily fastened to the upper edge of the surface, either with nails or by bending it over the edge and placing some load on it. The fabric is then fixed permanently with fasteners for the waterproofing membrane.

5.2.3 Laying and joining waterproofing membranes

Unwind the waterproofing membrane from rolls on the substrate, keeping at least 50 mm wide overlaps (both side and end overlaps). Cut the membrane length as necessary. End overlaps of neighbouring sheets should be moved by at least 100 mm (brick pattern).

The direction of membrane sheets and their overlaps does not play a role with respect to the building and the direction of water effects. On vertical surfaces, the membrane sheets are usually laid vertically.

If necessary, they can be stabilized by point fastening and subsequently hot-air welded.



5.2.3.1 Fastening waterproofing barriers

Depending on the membrane type, waterproofing barriers are fastened with linear fixing components or spot fasteners.

5.2.3.1.1 Linear fixing components

Linear fixing components for a vertical waterproofing barrier made of PVC-P membranes include:

- Profiles of FATRANYL PVC plastic-coated sheet metal,
- Expansion joint strips.

Instructions for installing linear fixing components:

- They are usually installed after the substrate is covered with the fabric, which they also fix in place.
- If the wall height does not exceed 5 m, fixing components are usually installed on its upper edge only. On higher walls, several levels of fixing components are installed above each other (Detail 209H).
- 2 m long fixing components must have at least a 2 mm wide head joint or be overlapped.
- They are spot-fastened to the substrate using suitable fasteners at 250 mm to 500 mm intervals. The fastener head must fit tightly to the fixing component, and the fixing component must fit tightly to the substrate.
- It is recommended to use fasteners with a rounded head.
- The upper edge of the perimeter wall strip is sealed to the substrate using a PU or MS polymer sealant (Detail 701H).

5.2.3.1.2 Spot fastening

Membranes are spot-fastened, as necessary, in the side overlaps of sheets or in the field by using a fastener with at least a 40 mm wide washer. The following instructions must be followed:

- On a horizontal surface, fasteners are fixed around the perimeter of the waterproofed area at approximately 1 m intervals,
- On a vertical surface, fasteners are fixed in side or end overlaps of the membrane. The fasteners must be positioned in the overlaps in such a way that at least a 30 mm wide weld can be made.
- Outside the membrane overlaps, fasteners are fixed in accordance with the structural solution (Detail 703H), and a patch is welded on them in a watertight manner.

5.2.3.2 Joining waterproofing membranes

Mutual joints of waterproofing membrane sheets can be made using hot air, wedge welder. Joints between a waterproofing membrane and preformed components and fixing profiles are made using hot air.

According to the type of welding device, we will create:

- A single-track hot-air weld made with a hand welding or automatic machine
- A double-track hot-air weld made with an automatic welding
- A single or double -track joint made with a wedge welder

The welding parameters (temperature, speed, pressure) are set depending on the conditions at the point of application (membrane type and thickness, air temperature and humidity, wind velocity and direction, membrane exposure to

sunshine etc.). The parameters must be verified on a 1 m long test weld. The welder must keep monitoring the settings and weld quality. If there is any significant change in the conditions, the parameters must be verified by peel test and adjusted if needed.

5.2.3.2.1 Joining membranes with hot air

Hot-air welding of PVC-P membranes involves heating the surfaces being joined into a plastic state by a jet of air flowing out of the nozzle of a hot-air welding machine, and then compressing the joint. Membrane overlaps are usually joined using a 40 mm wide welding nozzle.

For thermal resistance and welding temperatures see section 2.1.2.

Figure 8, Figure 9 and Figure 10 show joint types and their typical dimensions in mm.

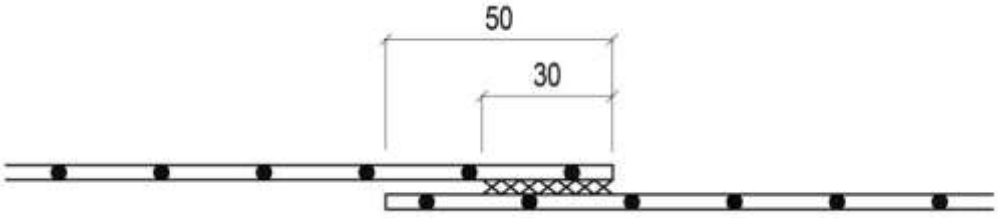


Figure 8: A single-track hot-air weld made with a manual welding machine

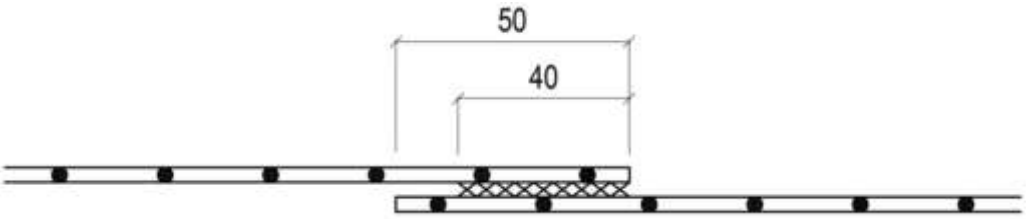


Figure 9: A single-track hot-air weld made with an automatic welding machine

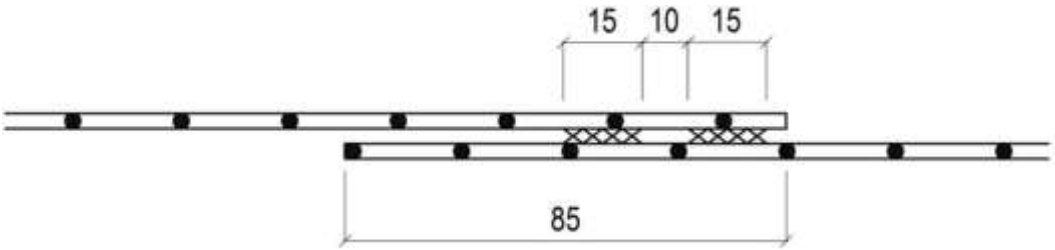


Figure 10: A double-track hot-air weld made with an automatic welding machine

5.2.3.2.2 Joining membranes with wedge welder

Wedge welding of PVC-P membranes involves melting two opposite membranes with a wedge welder heated to the welding temperature and then compressing them together with pressing rollers. The surface in the joint area must be clean, dry and free of damage (scratches, dents etc.). The recommended overlap is 50 mm and 85 mm for single-track welds and double-track welds respectively.

The wedge welder generally uses a lower welding temperature than hot-air welding.

For welding in cold weather, it is recommended to preheat the joint locations with hot air or to use another suitable method to protect the point being welded from heat loss. Also, weld quality should be checked more often.

Figure 11 and Figure 12 show joint types and their typical dimensions in mm.

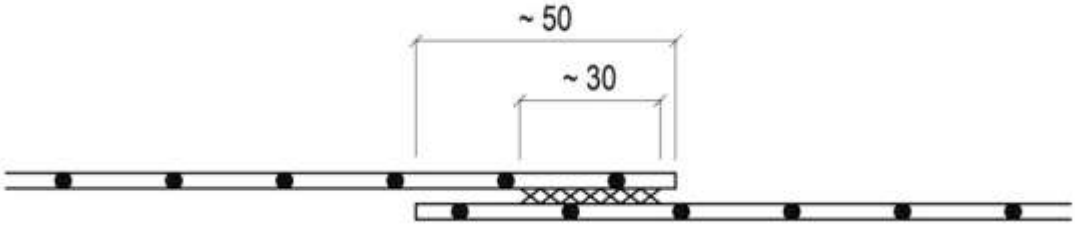


Figure 11: A single-track joint made with a wedge welder

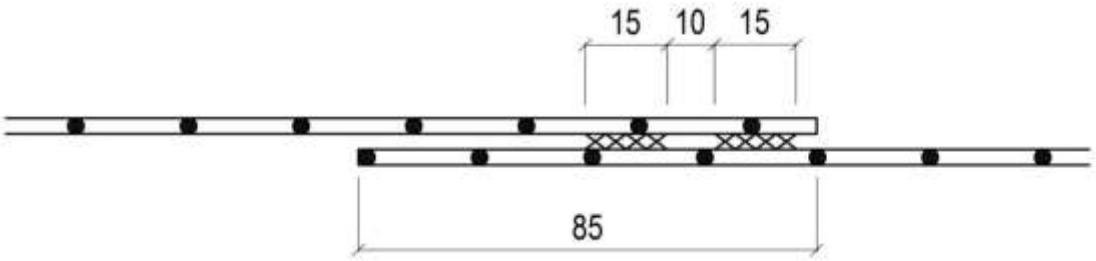


Figure 12: A double-track joint with a wedge welder

5.2.4 Laying and joining protective fabric

Protective fabric layers forming part of the waterproofing barrier are laid loosely on the substrate, with overlaps at least 50 mm in width. The direction of fabric sheets and their overlaps does not play a role. The surface must be thoroughly covered with the fabric, and the risk of fabric displacement must be avoided.

Instructions for installing protective fabric:

- Sheet overlaps must be continuously hot-air welded to protect the waterproofing barrier from the ingress of dirt, foreign matter, backfill material or a concrete mixture between the fabric and the waterproofing membrane (Detail 201H).
- On vertical and inclined surfaces, hang the fabric on the protruding edge of the base layer (Detail 207H).
- On higher walls, the fabric may be spot-glued to the waterproofing membrane with PU sealant.

5.2.5 Laying and joining separation PE membrane

PE membranes (recommended thickness: 0.10 – 0.30 mm) are used as a separation layer to prevent the ingress of a concrete mixture into the protective fabric. The separation membrane is laid immediately before concrete placement, keeping loose overlaps of approx. 150 mm.

5.2.6 Finishing penetrations through waterproofing barrier

5.2.6.1 Finishing penetrations with simple collar and sealant

5.2.6.1.1 Finishing with collar slid on penetration

After unwinding the membrane, cut an opening (with a sufficient allowance) at the point of penetration to slide on and correctly position the membrane. Apply a layer of sealant on the penetration perimeter in an amount that will make a tight joint once the collar is pressed on. The collar must be big enough to allow at least a 30 mm wide weld (minimum recommended overlap of membranes: 50 mm). Cut an opening in the collar, approx. 2/3 up to 1/2 of the size of the penetrating object. For large penetrations, the collar should, in its final position, extend approx. 20 to 30 mm on the penetration wall. Heat the collar with hot air on the perimeter of the cut opening and slide it on the penetration while hot. Seal the penetration by pushing it to the sealant and weld its perimeter to the lower membrane (Detail 401H).

Use:

- For barriers to ground moisture and radon
- For all common penetrations (steel reinforcement, sewers, lightning rods, cables, other steel elements etc.)
- Suitable for all types of membranes

5.2.6.1.2 Finishing without collar slid on penetration (by cutting membrane and collar)

Make a cut in the unwound membrane, going from the sheet edge to the point of penetration. Cut a penetration-sized opening in the membrane and position the membrane correctly. Patch the cut membrane with a membrane strip. The collar must be big enough to allow at least a 30 mm wide weld (minimum recommended overlap of membranes: 50 mm). Cut an opening in the collar, approx. 2/3 of the size of the penetrating object, cut the collar from the inner circle to the outside edge, and round the edges. For large penetrations, the collar should, in its final position, extend approx. 20 to 30 mm on the penetration wall. Wind the collar around the penetration and weld it to the lower membrane. The collar joint should be located outside the patch of the lower membrane. Seal the upper edge of the collar with sealant.

Use:

- For barriers to ground moisture and radon
- For all common penetrations (steel reinforcement, sewers, lightning rods, cables, other steel elements etc.)
- Suitable for all types of membranes

5.2.6.2 Finishing penetrations with collar and cuff

Depending on if the collar can be slid on, the method of its installation is identical to the procedure in section 5.2.7.1 except that sealant is not used.

A cuff made of a sufficiently wide membrane is applied on the vertical part of the penetration. Wind the cuff around the penetration and weld it to the collar. Heat the cuff for extra elongation and tighter fit on the penetration. If the cuff and the penetration are mutually weldable, you can weld them together. In all other applications, seal the cuff with sealant and fix it with non-corroding tape (Detail 402H).

Use:

- For barriers to ground moisture, flowing water and radon
- For all common penetrations (steel reinforcement, sewers, lightning rods, cables, other steel elements etc.)
- Suitable for all types of membranes

5.2.6.3 Finishing penetrations with preformed components

When unwinding the membrane, cut as precise an opening as possible to slide on and correctly position the membrane. Depending on if the penetration can be slid on, cut and patch the membrane or leave it intact. To finish the detail, choose an open or closed preformed component. A closed preformed component is slid on the penetration and welded to the lower membrane; an open preformed component is put on the penetration, welded together in the vertical part and welded to the lower membrane.

Seal the upper edge of the preformed component with sealant and fix it with non-corroding tape (Detail 405H).

Use:

- For barriers to ground moisture, flowing water and radon
- For all common penetrations (steel reinforcement, sewers, lightning rods, cables, closed steel elements etc.)
- Suitable for PVC-P membranes

5.2.6.4 Finishing penetrations with fixed and loose flanges

Slide the waterproofing membrane over the fixed flange. Cut as precise openings as possible at the point of bolts and on the casing perimeter. Remove the membrane and apply two parallel tracks of the sealant on the flange.

Perforate the reinforcing membrane in the same way the lower membrane is perforated. Replace the waterproofing membrane on the fixed flange with the sealant and position it correctly. Now place the reinforcing membrane and weld its edges to the lower membrane. Apply two parallel tracks of the sealant on the loose flange, put the flange on the bolts and tighten it evenly (Detail 404H).

Make sure the membrane joint is not located between the flanges.

Use system components (segment, expansion, cuff seal) to seal the gap between the penetration and the casing.

Use:

- For barriers to flowing, retained and pressure water and radon
- For all common penetrations (pipes, lightning rods, cables etc.)
- Suitable for all types of membranes

5.2.6.5 Finishing penetrations with waterproofing mortar

In the FATRAFOL-H system, open-shaped penetrations and hard-to-access details can be finished using Triflex waterproofing mortar. Depending on the detail, use waterproofing mortar reinforced with fleece or fibres (Detail 403H).

Consult Fatra for possible applications.

Use:

- For barriers to ground moisture, flowing, retained and pressure water and radon
- For open profiles and complex or hard-to-access details
- Suitable for PVC-P membranes

5.2.7 Finishing of waterproofing barrier above ground

5.2.7.1 Finishing of footings without thermal insulation

The finishing of footings can be done either directly on a waterproofing membrane or on a membrane with protective non-woven textile.

There are two ways to apply a plaster system directly on a membrane without protective non-woven textile:

- Without fastening the membrane to the substrate: Apply a layer of a suitable facade adhesive on the membrane and press reinforcing glass fibre fabric (leno) into the layer using a stainless steel trowel. Use the trowel to apply a second layer of the adhesive, which forms a contact layer for the application of other finishing material (thin-coat plaster, topping coat). This solution is recommended for footings not higher than approx. 300 mm (Detail 706H).

- By spot-fastening the membrane mechanically and welding a patch on or by fixing the membrane with adhesive. Either spot-fasten the membrane to the substrate and patch the fasteners or bond the membrane to the substrate, fully or in spots.


If necessary, the reinforcing fabric can be fastened to the membrane using a circular membrane patch. The application of facade adhesive and reinforcing fabric is identical to the process described above. This solution is recommended for footings over 300 mm in height (Detail 705H).


Application of a plaster system reinforced with wire mesh on protective textile:

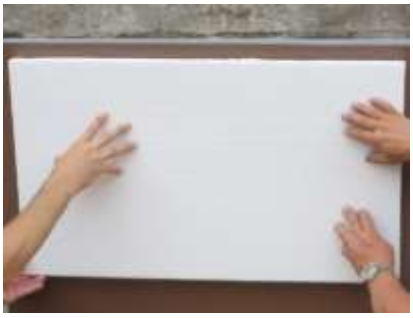
- Mechanically fasten the wire mesh (Rabitz or ceramic) above the end of the waterproofing membrane. A cement coat is applied on the protective textile through the wire mesh. This is followed by the topping coat and the final surface layer (tiles, stucco…) (Detail 704H).


5.2.7.2 Finishing of footings with thermal insulation

The finishing of footings with a thermal insulation system (ETICS) is usually done as follows:

- Use a two-component contact adhesive to spot or fully bond the membrane directly on the substrate. Weld the upper edge of the membrane to the wall strip. Bond thermal insulation boards directly on the membrane (without textile) using PU adhesive foam or adhesive sealant. The remaining steps are identical to the finishing of thermal insulation systems (Detail 702H).





- Weld the upper edge of the membrane to the wall strip, along with the bottom textile. Spot-fasten the membrane field to the substrate using suitable fasteners. Then weld FATRAFOL 807 patches on, with the textile layer up. Bond the thermal insulation panels directly on the patches using PU adhesive foam or facade adhesive. The remaining steps are identical to the finishing of thermal insulation systems (Detail 703H).



5.2.8 Finishing of window wells on basement walls

Extra attention must be paid to the ending of a waterproofing barrier on the perimeter of a window well on basement walls. Window wells are installed on a completed waterproofing barrier, usually after the thermal insulation system is completed. On the edges of the window opening, the membrane is usually ended with profiles of plastic-coated sheet metal, to which the membrane is welded. Install fasteners for the window well prior to the application, if any, of the thermal insulation system. Determine the position of fasteners by holding the body of the window well close to the vertical structure. Through the waterproofing barrier, drill fastener holes with the diameter defined by the manufacturer. After installing the fasteners, seal the perforated waterproofing barrier (Detail 802H) or finish it with preformed components (Detail 803H) – see section 5.2.6.3. After completing the thermal insulation system, install the window well and seal the contact surfaces as recommended by the window well manufacturer.


5.2.9 Repairing damaged waterproofing barriers

If the integrity of the waterproofing barrier is locally damaged (mechanically, by high temperature or chemical effects), cover the damaged spot with a suitably sized patch made of the same membrane and weld the patch on along its perimeter, using hot air (Patch, type 12) Square and rectangular patches should be rounded.

Before applying a patch, remove all dirt from the membrane. Water or water with a detergent is usually sufficient for this. Heavily soiled surfaces can be cleaned with industrial alcohol, benzine, isopropyl alcohol, membrane cleaner etc. Where it is impossible to clean the membrane, the patch should be welded on from the bottom.

5.3 Waterproofing barriers with inspection and rehabilitation system

If the construction has to meet strict requirements for waterproofing safety, especially where there are plans to use its underground space located below the groundwater level (underground car parks, depositories, utility equipment, hospitals etc.) and in all locations where the ingress of water may cause major damage, we recommend installing a waterproofing barrier with an active inspection and rehabilitation system. These are double-layered waterproofing barriers divided into independent sectors, the structure of which makes it possible to inspect the barrier's water tightness throughout the building's service life and to rehabilitate it in a targeted manner.

Key features of the system:

- Both waterproofing barriers (layers) are formed using the same, mutually weldable membrane,
- Each of the waterproofing layers can alone serve as a waterproofing barrier,
- The drainage layer between the waterproofing layers allows for vacuum leak checks and possible rehabilitation,
- The size and location of individual sectors must be specified in a separate project, due to the complexity of the construction and other aspects,
- Each inspection sector must be connected to the external environment through a minimum of three valves joined watertight to the front waterproofing layer,
- Injection tubes are terminated in an accessible place in the interior and clearly marked.

Active inspection and rehabilitation systems are dealt with in a separate construction and technological manual.

6. OCCUPATIONAL HEALTH & SAFETY, FIRE PREVENTION

6.1 Occupational health and safety at construction site

BEWARE!
RISK OF FALLING
INTO A DEPTH!

The essential legal regulations that lay down the requirements for occupational health and safety include **Act 309/2006 Coll.** (further conditions for occupational health and safety), **Act 262/2006 Coll.** (Labour Code as amended), **Government Regulation 101/2005 Coll.** on detailed requirements for workplaces and work environments, **Government Regulation 591/2006 Coll.** on essential requirements for occupational health and safety at construction sites, and **Government Regulation 362/2005 Coll.** on detailed requirements for occupational health and safety for works involving the risk of fall from a height or into a depth.

The contractor's general obligations regarding project preparation and implementation are laid down in Act 309/2006 Coll.

Detailed requirements for construction site safety and safe operation and use of machines, equipment, devices and tools are laid down in Government Regulation 378/2001 Coll. Specific construction site requirements are given in Government Regulation 591/2006 Coll., including requirements related to work organisation and construction works (e.g. material storage and handling, groundwork, concreting, installation works etc.).

Government Regulation 362/2005 Coll. specifies the requirements for the organisation of work and work procedures that the contractor must provide at sites where staff are exposed to the risk of falling from a height or into a depth.

Act 262/2006 Coll., Labour Code, applies to the provision of personal protective equipment (PPE). Detailed requirements for PPE are given in Government Regulation 495/2001 Coll.

6.2 Fire prevention

Act 133/1985 Coll. on fire prevention is the essential guidance for creating conditions that effectively protect human life, health and property from fire, and for providing first aid during natural disasters and emergencies.

The act is implemented through Decree 246/2001 Coll. on fire prevention, which defines basic terms related to fire safety.

Other regulations that lay down specific requirements for building fire safety include Ministry of Interior Decree 202/1999 Coll. on technical requirements for fire doors, Act 102/2001 Coll. and Act 59/1998 Coll. on general requirements for building product safety.

6.3 Installation-related safety risks

When installing FATRAFOL-H waterproofing barriers, follow the current version of the above safety, sanitary and fire regulations regarding work at construction sites.

Electrical equipment (welding machines, drills etc.) must be connected and operated in accordance with current regulations, in particular Government Regulation 378/2001 Coll. Connection cables for handheld electrical equipment and construction equipment must be maintained in accordance with the manufacturer's instructions and inspected at regular intervals.

When welding membranes in closed spaces, active ventilation must be ensured.

Installers and all persons accessing the waterproofing barrier must be advised in advance that the membrane surface is very slippery when wet or icy and that walking on the membrane requires extra caution under such conditions (also after morning dew).

A written system of OHS risk prevention is required for most new construction projects. Such documentation is usually part of site takeover documents. Compliance with safety precautions is reviewed by site supervisors and by occupational safety inspectors at larger construction sites.

7. INSPECTION AND ACCEPTANCE OF INSTALLED FATRAFOL-H SYSTEM

7.1 General guidelines

These general guidelines apply to inspections:

- Inspections are organised by the client, usually represented by a technical supervisor. The construction manager or foreman conducts ongoing inspections.
- The designer performs design compliance supervision; inspections can also be conducted by personnel from the Occupational Safety Inspectorate and state construction supervision authorities.
- For each material, compliance with the construction documentation, technical and safety data sheets, delivery notes, match between identification labels and the delivery note, packaging condition and storage method are checked.
- The qualifications of installers are also verified concerning their work and if they have suitable technical equipment.
- Each covered construction must be checked before covering and its acceptance must be documented (e.g. in the construction log).

An inspection of waterproofing barrier layers includes, in particular:

- An inspection of the substrate
  - Accessibility and pollution
  - Completeness including technology completeness
  - Adherence to technological limits (concrete maturity)
  - Planarity and load-bearing capacity
- An inspection of separation, drainage and soft protection layers (fabric, drainage membrane, nylon mat, PE membrane…)
  - Coverage integrity
  - Overlaps (overlap width, welds)
  - Fastening
- An inspection of the waterproofing layer
  - Straightness and rippling of sheets
  - Verification of welding conditions (test weld)
  - Joints (overlap width, welds)
  - Joint tightness test – see section 7.2
  - Details (external corners, internal corners, penetrations)
  - Mechanical and other damage
  - Provision of supervision until a hard-protective layer is installed
- An inspection of the hard-protective layer (concrete screed, cement screed, retention wall, rigid plastic boards…)
  - Coverage integrity
  - Thickness
  - Settlement in case of rigid plastic boards
  - Compatibility with the membrane
  - Adherence to technological limits

As part of its production process management system, Fatra, the manufacturer of waterproofing membranes, formulated and maintains the ‘Inspection Manual for FATRAFOL Waterproofing Systems’, which specifies general rules, responsibility for and methods of inspections of waterproofing barriers and of data processing.

The work handover and acceptance process is governed by current legislation, owner’s requirements, contract terms and conditions, and requirements of other stakeholders. It is highly important to schedule inspections of drainage systems and ensure they are in full working order. A handover report must be prepared for the work handover and acceptance, indicating all relevant matters such as obvious defects, outstanding works, deadlines for corrective action, conditions for later works on the finished surface of the waterproofing barrier etc.

7.2 Onsite testing of waterproofing barrier quality

Since the waterproofing barriers of constructions are mostly inaccessible, it is necessary to inspect their quality using at least one of the methods indicated above.

7.2.1 Visual inspection of waterproofing barrier

A visual inspection of a waterproofing barrier is an essential inspection before the barrier is covered with protective layers. This involves a professional examination of the entire surface, with a focus on critical points such as membrane junctions, details, penetrations, waterproofing membrane ends on walls etc. The entire length of joints is checked and the inspection assesses:

- Shape and integrity of the weld,
- Homogeneity of the joint (use of roller),
- Straightness and parallelism of the edge with other visible edges of the membrane,
- Non-homogeneity (notches, scratches, bubbles etc.) in both the joint and the field.

Note: *Notches and surface scratches must not be deeper than 10% of the membrane thickness and may occur to a limited extent only. Any major damage must be repaired using a patch of the membrane.*

7.2.2 Joint tests

7.2.2.1 Inspections with testing needle

A testing needle can be used to check all types of welds (continuous and detail welds including T-joints) no earlier than 1 hour after welding. A testing needle used for this test is usually included in the welder's basic kit and delivered by the welding equipment manufacturer (Leister, Herz etc.). Drive the needle in the direction of the weld axis and apply gentle side pressure on the joint to easily detect any non-welded or separated points in the weld. The test is positive if the testing needle tip does not get between the welded membranes.

If the joints must be treated with joint sealer, the test must take place before its application.

7.2.2.2 Vacuum testing of single-track welds

A vacuum test based on EN 1593 'Non-destructive testing – Leak testing – Bubble emission techniques' checks selected critical points of the waterproofing layer (T-joints, 3D details etc.) using shaped bells of organic glass and a vacuum pump. The test is limited by the dimensions of the testing bell. Detection liquid is applied on the tested surface and the testing bell is attached. If no bubbles appear on the tested surface within approx. 30 seconds, the tested spot is tight.

7.2.2.3 Vacuum testing of double-track welds

This test allows the entire joint length to be examined in a single operation. The overpressure test cannot be performed earlier than 1 hour after the weld is made. The testing instrument is usually installed in such a way that one end of the weld is used for the inlet of compressed air with a manometer sealing the test channel. The other end is sealed by welding or another suitable method. The test pressure should be adjusted to the type, thickness and temperature of the membrane and to the width of the test channel. After the channel is pressurised to the recommended 200 to 250 kPa, calibration takes place for approx. 5 minutes to give the joint its final shape and balance the air temperature. The test pressure is monitored for the next 10 minutes for any decrease. During that time, the testing pressure must not drop by more than 20% of its original value. The other end of the joint is opened to confirm the test has been passed. If the pressure drops to zero, this indicates that the entire length of the channel is passable.

These tests should be performed in accordance with the DVS 2225 and ÖNORM S 2076 standards.

7.2.2.4 Testing reservoirs and sumps for water tightness

For test methods and guidelines, refer to the CSN 75 0905 standard. By prior arrangement, this standard can also be used as a guideline for testing constructions other than water supply and sewage constructions, e.g. basements of below ground structures (reinforced concrete constructions, emergency and containment sumps etc.).

A water tightness test focuses on testing water leakage through hydrostatic pressure and on groundwater infiltration into the reservoir.

The tests should be done in accordance with these guidelines:

- Water tightness tests are not substitute for the testing of individual constructions parts, e.g. flanges, seals etc.
- In concrete constructions of water management structures, initial water tightness is assessed and tested.
- Reservoirs for liquids that pose a risk to the quality or safety of surface water and ground water must be tested by personnel qualified to the EN ISO 9712 standard.
- Tests of waterproofed reservoirs must be conducted after all of the waterproofing components have been completed.
- If the real level of groundwater is above the bottom of the tested structure, that level must be lowered below the bottom level line for the entire duration of the test.
- The test must not be performed if the air temperature is below 0°C.
- The waterproofed structure to be tested must be allowed at least 30 minutes for conditioning.
- The recommended test duration is 48 hours per construction. Check the construction for leaks every 24 hours.
- The test duration may be shortened to 24 hours, e.g. if a repaired reservoir is retested.
- In open reservoirs, it is necessary to consider evaporation and precipitation that may affect the measurements of the tested level.
- A test report is prepared for each test; a sample report is contained in Annex A to the CSN 75 0905 standard.
- An assessment of water tightness by infiltration is conducted only exceptionally, e.g. when the groundwater level cannot be lowered; seepage is determined using an empirical formula (CSN 75 0509).

7.3 Evaluation of test results

The results of all tests should be documented for future review. These reports usually form part of handover documents. Should doubts arise as to the results of tests performed on site, additional tests may be conducted in a laboratory.

8. INSTALLERS' QUALIFICATIONS AND EQUIPMENT

8.1 Qualifications

In order to be qualified to apply the FATRAFOL-H system, installers must have a perfect knowledge of both essential and ancillary materials including technological procedures of processing them in building practice. Also, a high-quality waterproofing barrier cannot be built without the knowledge of relevant legislation, technical standards and other information. Installers' recommended equipment

Electrical equipment

- Handheld hot-air welding machine (recommended type: Leister Triac, Herz – Rion etc.) with a 40 mm and 20 mm wide flat nozzle
- Hot-air mobile automatic welding machine (recommended type: Leister Varimat or Herz - Laron Herz – Rion
- membranes
- Impact drill
- Electric screwdriver + bit set
- Water extractor
- Extension cord

Work tools and aids

- Broom and shovel
- Folding ruler
- Steel ruler
- Grease chalk
- Marking cord
- Knife with hook
- Scissors
- Testing needle
- Handheld pressing rolls
- Hammer
- Steel cutter
- Plate shears
- Extrusion gun for putty in cartridges
- waste bags

Protective equipment

- Work clothing
- Soft-soled shoes, meeting OH&S requirements
- Protective leather gloves
- Knee guards
- Sun glasses with UV filter
- Cap with shield
- Dust mask

9. NORMATIVE REFERENCES

Standard no.	Czech title	English title
ČSN 73 0205	Geometrická přesnost ve výstavbě. Navrhování geometrické přesnosti	Geometric accuracy in building. Design geometrical accuracy
ČSN 73 0212-3	Geometrická přesnost ve výstavbě. Kontrola přesnosti. Část 3: Pozemní stavební objekty	Geometrical accuracy in building industry. Accuracy checking. Part 3: Building structures
ČSN 73 0601	Ochrana staveb proti radonu z podloží	Protection of buildings against radon from the soil
ČSN P 73 0606	Hydroizolace staveb – Povlakové hydroizolace – Základní ustanovení	Waterproofing of buildings – Continuous sheet water proofing – Basic provisions
ČSN P 73 0610	Hydroizolace staveb – Sanace vlhkého zdiva – Základní ustanovení	Waterproofing of buildings – The rehabilitation of damp masonry and additional protection of buildings against ground moisture and against atmospheric water – Basic provision
ČSN 75 0905	Zkoušky vodotěsnosti vodárenských a kanalizačních nádrží	Water suply and sewerage tanks. Testing of water-tightness
EN 358	Osobní ochranné prostředky pro pracovní polohování a prevenci pádů z výšky – Pásy pro pracovní polohování a zadržení a pracovní polohovací spojovací prostředky	Personal protective equipment for work positioning and prevention of falls from a height – Belts for work positioning and restraint and work positioning lanyards
EN 361	Osobní ochranné prostředky proti pádům z výšky – Zachycovací postroje	Personal protective equipment against falls from a height – Full body harnesses
EN 1593	Nedestruktivní zkoušení – Zkoušení těsnosti – Bublinková metoda	Non-destructive testing – Leak testing – Bubble emission techniques
EN 1990	Eurokód: Zásady navrhování konstrukcí	Eurocode: Basis of structural design
EN ISO 9712	Nedestruktivní zkoušení - Kvalifikace a certifikace pracovníků NDT	Non-destructive testing - Qualification and certification of NDT personnel
EN 13967	Hydroizolační pásy a fólie – Plastové a pryžové pásy a fólie do izolace proti vlhkosti a plastové a pryžové pásy a fólie do izolace proti tlakové vodě – Definice a charakteristiky	Flexible sheets for waterproofing – Plastic and rubber damp proof sheets including plastic and ruber basement tanking sheet – Definitions and characteristics
EN ISO 9001	Systémy managementu kvality - Požadavky	Quality management systems - Requirements
EN ISO 1043-1	Plasty – Značky a zkratky – Část 1: Základní polymery a jejich zvláštní charakteristiky	Plastics – Symbols and abbreviated terms – Part 1: Basic polymers and their special characteristics
EN ISO 14001	Systémy environmentálního managementu - Požadavky s návodem pro použití	Environmental management systems - Requirements with guidance for use
ÖNORM S 2076-1		Landfills — Sealing systems with flexible plastics liners. Part 1: Installation
DIN DVS 2225-2		Joining of lining membranes - Made of polymer materials in geotechnical and hydraulic engineering - Site testing

Notes:

Notes:

10.Guidelines for finishing typical details

10.1 Overview of details

10.1.1 Typical compositions

Detail 101H	Horizontal waterproofing barrier on concrete base
Detail 102H	Horizontal waterproofing barrier on compacted substrate
Detail 103H	Vertical waterproofing barrier constructed from excavation
Detail 104H	Vertical waterproofing barrier constructed from pit
Detail 105H	Waterproofing barrier for tank or sump, not covered on one side

10.1.2 Membrane joints and connections made in stages

Detail 201H	Single-track weld in membrane overlap
Detail 202H	Double-track weld in membrane
Detail 203H	Extrusion weld in membrane
Detail 205H	Counter joint at lower edge of foundation slab – PHASE 1
Detail 206H	Counter joint at lower edge of foundation slab – PHASE 2
Detail 207H	Vertical waterproofing barrier joined to horizontal waterproofing barrier in stages – PHASE 1
Detail 208H	Vertical waterproofing barrier joined to horizontal waterproofing barrier in stages – PHASE 2
Detail 209H	Membrane fastening on vertical wall

10.1.3 Transition joints

Detail 301H	Membrane joined to reinforced concrete construction
Detail 302H	Membrane joined to concrete construction using fixed and loose flange
Detail 303H	Membrane joined to steel construction using fixed and loose flange
Detail 304H	Membrane joined to bitumen waterproofing barrier using fixed and loose flange
Detail 305H	Membrane joined to bitumen waterproofing barrier using liquid screed
Detail 306H	Membrane joined to bitumen waterproofing barrier using EKOPLAST 806 membrane, exposure to ground moisture

10.1.4 Finishing of penetrations

Detail 401H	Waterproofing of penetrating pipe, exposure to ground moisture
Detail 402H	Waterproofing of penetrating pipe, exposure to flowing water
Detail 403H	Waterproofing of penetrating pipe using liquid creed, exposure to pressure water
Detail 404H	Waterproofing of penetrating pipe using fixed and loose flange, exposure to pressure water
Detail 405H	Waterproofing of penetrating steel reinforcement, exposure to ground moisture and flowing water

10.1.5 Transition from horizontal to vertical waterproofing barrier

Detail 501H	Transition from horizontal to vertical waterproofing barrier, exposure to ground moisture
Detail 502H	Transition from horizontal to vertical waterproofing barrier, exposure to pressure water
Detail 503H	Additional sealing of internal and external corners using preformed components
Detail 504H	Membrane installation in corner, exposure to flowing water – PHASE 1
Detail 505H	Membrane installation in corner, exposure to flowing water – PHASE 2

10.1.6 Waterproofing barrier along expansion joint

Detail 601H	Expansion joint with expected movement by no more than approx. 10 mm – option 1
Detail 602H	Expansion joint with expected movement by no more than approx. 10 mm – option 2
Detail 603H	Expansion joint with expected movement by more than 10 mm
Detail 604H	Expansion joint with expansion joint strip

10.1.7 Finishing of waterproofing barrier above ground

Detail 701H	Finishing of footing with thermal insulation – thermal insulation fastened outside membrane
Detail 702H	Finishing of footing with thermal insulation – thermal insulation bonded to membrane
Detail 703H	Finishing of footing with thermal insulation – thermal insulation bonded to discs made of FATRAFOL 807 membrane
Detail 704H	Finishing of footing without thermal insulation – use of ceramic mesh under plaster

Detail 705H	Finishing of footing without thermal insulation – use of reinforcing fabric on discs
Detail 706H	Finishing of footing without thermal insulation – use of reinforcing fabric

10.1.8 Technical solutions

Detail 801H	Removal of water from structure using perimeter drainage
Detail 802H	Waterproofing of window well – option 1
Detail 803H	Waterproofing of window well – option 2
Detail 805H	Additional drainage around non-waterproofed structure

10.2 Drawings of details

The following drawings show how standard details are finished.

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