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Evaluation Report of the Tightness and Resistance of the Injection System Hilti HIT-HY 200-A Used in Facilities Dealing with Water Hazardous Substances

SUBJECT:	Testing the substances resistance, the penetration depth and the design resistance of the mortar system Hilti HIT-HY 200-A in uncoated liquid-tight concrete against chemical liquids
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1 Intruduction

Hilti distributes the injection system „Hilti HIT-HY 200-A“ for anchorages as well as the production of post-installed rebar connections in concrete. The development and manufacture of this injection system is in the hands of Hilti. The injection system contains of a foil pack containing two components of the injection mortar Hilti HIT-HY 200-A and a steel element. Hilti HIT-HY 200-A injection system is used for anchoring steel supports, steel beams, stairways, railings, etc. as well as anchoring secondary steel constructions, safety barriers, railings and fire conductors. "Hilti HIT-HY 200-A" has various European Technical Assessments (ETA) and approvals from the Deutsches Institut für Bautechnik (DIBt) [U1]-[U6] for the different fields of application.

The installation of the HIT-HY 200-A bonded anchors [U1],[U4]-[U6] required trained anchor installers. Which competences are required is specified in [U7].

Arrangements for the installation of post-installed rebar connections are given in [U2] and [U3]. The basis for this opinion is the European Technical Assessment ETA-11/0493 of 28 July 2017 [U1].

The injection system HIT-HY 200-A is often used in facilities for handling substances hazardous to water in accordance with the German Water Resources Act (so called WHG) [U9] as well as the German regulation for the handling of hazardous substances AwSV [U10]. These factories usually have a secondary barrier to the retention of potentially leaking hazardous for water substances for the protection of soil and waters. These secondary barriers are usually made of a special liquid-proof concretes (FD concrete) with proof of tightness. Often, the tightness is also ensured by means of a coating applied to concrete. The construction products (for example, coatings) used in case of WHG plants or factories used for storage, filling and handling substances hazardous (so called LAU-factories) must have a general building authority approval or rather ETA for use in LAU-factories by the Deutsches Institut für Bautechnik (DlBt). The approval and/ or ETA for LAU systems ensure the tightness and resistance as defined by the German Water Resources Act (WHG) and the Ordinance on facilities for handling substances hazardous to water (AVSV) by means of established test programs.

Since there is currently no obligatory test procedure for verifying anchorage systems in WHG area, Hilti has carried out comprehensive tests in consultation with the expert using HIT HY 200-A in LAU-systems in accordance with the approval principles specified for WHG areas. This is the supplementary WHG qualification of a proven and widespread bonded anchoring system. The published media list of chemicals by DIBt [U12], which allows a simple assessment and grouping of the impact situation on the basis of chemical groups, served as the basis for the tests of proof of tightness and resistance to typical occurring water-polluting fluids.

As an expert according to the German Water Resources Act WHG [U9] and AwSV [U10], I was commissioned by Hilti to determine the necessary test program as well as to monitor the tests carried out and to draw up this evaluation report.

2 Documents

[U1] European Technical Assessment ETA-11/0493 of 28 July 2017: Injection system Hilti HIT-HY 200-A – Bonded anchor for use in concrete. Deutsches Institut für Bautechnik, Berlin.

[U2] European Technical Assessment ETA-11/0492 of 26 June 2014: Injection system Hilti HIT-HY 200-A - for rebar connections. Deutsches Institut für Bautechnik, Berlin

[U3] Z-21.8-1948 of 13 October 2016: Rebar connections with injection mortar Hilti HIT-HY 200-A – application of ETA-11/0492. Deutsches Institut für Bautechnik, Berlin

[U4] European Technical Assessment ETA-12/0006 of 18 August 2016: Injection system Hilti HIT-HY 200-A with HIT-Z / HIT-Z-F/ HIT-Z-R - Bonded anchor for use in concrete.
Deutsches Institut für Bautechnik, Berlin

[U5] European Technical Assessment ETA-15/0296 of 27 August 2015: Injection system Hilti HIT-HY 200-A with HIT-Z-D und HIT-Z-R-D – Bonded expansion anchor for use in concrete. Deutsches Institut für Bautechnik, Berlin

[U6] General type approval Z-21.3-2045 of 14 October 2016:
Hilti Bonded anchor HIT-Z-D dynamic. Deutsches Institut für Bautechnik DIBt; October 2016

[U7] Instructions for the installation of anchor bolts. Deutsches Institut für Bautechnik, Berlin, October 2010

[U8] Safety Information Hilti HIT HY 200-A of 27 April 2016

[U9] Act on the Regulation of Matters Pertaining to Water (German Water Resources Act – WHG) of 31 July 2009 with amendments of 11 August 2010.

[U10] Regulations on Facilities Handling Water Hazardous Substances (AwSV) of 18 April 2017, Bonn, Federal Law Gazette Volume 2017 Part I No. 22.

[U11] DAfStb-Guideline „Concrete structures for the handling of water hazardous substances“, March 2011, Deutscher Ausschuss für Stahlbeton e. V. – DAfStb; Berlin 2011

[U12] Substances List for sealing elements and sealing constructions used for storage, filling and handling of water hazardous substances, January 2016, Deutsches Institut für Bautechnik (DIBt), Berlin 2016

[U13] Worksheet DWA-A 786, Technical Rule for Substances Hazardous to Water (TRwS) Implementation of Sealed Surfaces, October 2005.

[U14] Assembly protocol for HIT-HY-200-A anchors for use in concrete / WHG (German Water Resources Act) areas, Hilti Deutschland AG of 31 August 2017.

3 General

The injection system is a bonded anchor consisting of injection mortar Hilti HIT-HY 200-A and a steel element. The injection mortar is a two component foil pack comprising:

- Component A: Binder-component being based on urethane methacrylate resin and
- Component B: hardener-component being based on benzoyl peroxide.

Further information can be found in the safety information [U8].

On the scope of WHG facilities, the usage of anchoring systems in concrete, reinforced concrete and prestressed concrete is regulated in DAfStb-Guideline “Betonbau beim Umgang mit wassergefährdenden Stoffen BUmwS” (Concrete structures for the handling of water hazardous substances), March 2011, Deutscher Ausschuss für Stahlbeton e.V. – DAfStb; Berlin 2011. In section 7.3.1 of part 1 of the guideline, anchorages and built-in elements are regulated as follows (translation from [U11]):

(1) For the fortifications of attachments or anchors, bonded anchors, anchor rails or head bolts with general type approval or European Technical Assessment may be used.

The fortifications are to be planned with reference to the respective object. In the case of the use of bonded dowels, the suitability of the binder against the medium to be applied is to be ensured (for example, a manufacturer's declaration of conformity).The installation of the fasteners has to be done in such a way that the depth of the drill hole is smaller than the component thickness reduced by 50 mm.

(2) Installation parts must be designed in such a way that the tightness requirements are also fulfilled in these areas.

The European Technical Assessment ETA [U1] described in paragraph (1), regulates the dimensioning of anchor bolts with HIT-HY 200-A and therefore the load-bearing capacity at European level. An ETA-compliant anchor installation is required as well as for example in Germany the qualification of the dowel fitter (certificate) according to [U7]. This is to ensure both, a consideration of the stability and the high quality requirements within the scope of the production and local execution (trained specialists). In addition to the requirements of ETA, the manufacturer has to certify the suitability of the binding agent for the media concerned by means of a declaration of conformity.

Paragraph (2) requires the tightness requirements for anchorages. It should be pointed out that with the use of dowels, the installation of a compound dowel with compound mortar applied in full anchoring depth, can only ensure tightness within the meaning of the WHG. The joint gap in the case of mechanical anchors (for example, undercut anchors, expansion anchors, bolt anchors, concrete screws) could be filled with water hazardous liquids in the event of an admission and would result in an impermissible continuous admission of the borehole.

The anchoring is generally planned after the determination of the static requirements and the choice of the anchoring system. In the case of compound anchor systems, an oversized and cleaned borehole is first filled with the injection mortar with a dispenser and then the anchor body is placed directly in the still soft injection mortar with the prescribed setting depth in accordance to the operating manual [U8]. Manual cleaning of the borehole by a manual blow-out pump is not permitted. The borehole must be created either with a hollow drill bit (TE-CD, TE-YD) or, if a standard drill bit without direct extraction is used, with compressed air [U8]. During setting of the anchor, injection mortar exits the borehole at the side of the anchor body, which is removed after curing. After curing of the injection mortar, the installation of the attachment can be started.

4 Testing Principles

4.1 General

Due to the lack of approval for the use of bonded anchors in facilities for the handling of water hazardous liquids, Hilti Entwicklungsgesellschaft mbH has carried out its own tests under the joint development of suitable test principles.

In case of facilities for the handling of water hazardous liquids, in Germany a distinction is made between

- facilities for storage, filling up and handling of water hazardous liquids, (so called **LAU**- facilities) and
- facilities for manufacturing, handling and usage of water hazardous liquids (so called **HBV**-facilities).

The DAfStb Guideline BUmwS [U11] lists the possible and permissible effects on sealing surfaces of concrete constructions, taking into account the requirements according to DWA-A 786 “Ausführung von Dichtflächen" (design of tight surfaces) [U13]. A distinction is made between a one-time application of liquids in facilities for storage, manufacture, handling and usage and an intermittent application of liquids in facilities for filling and handling. In the case of an intermittent application of liquids a single equivalent duration of the application may also be applied as reference according to [U11].

A exact classification of facilities handling water hazardous liquids can do by using DWA-A 786 [U11] as well as the DAfStb Guideline BUmwS [U13] in combination with the requirements of the German regulation for the handling of hazardous substances AwSV [U10]

The present investigations are valid for stress levels according to the guideline BUmwS [U11], which are colored in Table 1.

Table 1 *Stress levels on sealing surfaces during a single or intermittent application*

	Abbreviations	Stress Level	Admission Time	Equivalent Admission	Example
One-time Application LHBV- facilities (storage, manufacture, handling, usage)	**L1**	low	8 h	-	Accident case, e.g. tank farm, production
	L2	medium	72 h		
	L3	high	2200 h		
Intermitted Application A/U- facilities (filling and handling)	**AU1**	low	-	8 h	Filling: □ up to 4 times a year [a)] or □ spray and drip quantities are excluded by technical precaution Transshipment: In packages that do match or are equal to the requirements of dangerous good law.
	AU2	medium	28 days 5 h each	144 h	Filling: □ up to 200 times a year [a)] or □ public petrol station Transshipment: In packages that do not match or are not equal to the requirements of dangerous good law.
	A3	high	40 days 5 h each	200 h	Without limiting the frequency of filling [a)]

[a)] using separate collecting devices for droplets

The tests were carried out with an application time of 72 h (3 days) for one-time application and 200 h (9 days) for intermittent application. This corresponds to the stress level "**L2**" in case of one-time application and up to "**A3/U2**" in the case of intermittent application. In order to get information about the durability and resistance of the bonded anchorage system after application of chemical liquids up to 200 h, the anchor was also tested by pull out test after 30 and 90 days after the application.

4.2 Groups of Chemical Liquids for the Tests

The published substances list of groups of chemical liquids [U12] of the Deutsches Institut für Bautechnik (DIBt) is the basis for the accomplished tests. The substances list consists of total 30 test groups as well as additional individual substances and serves as proof of the tightness and resistance to water-hazarded liquids. In addition to the substances list, the following individual substances was included in the test program:

- Nitric acid 20 %,
- Ammonia 10 %,
- n-methyl-2-pyrrolidone (NMP),
- Sodium hydroxide 25 % and
- Sulfuric acid 96 %.

4.3 Test Criteria

The bonded mortar must be liquid-tight and resistant to water-hazarded substances, as well as to carry the mechanical loads to be expected.

Hilti Entwicklungsgesellschaft mbH carried out numerous tests on specially prepared test specimens in accordance to the DAfStb Guideline BUmwS [U11], Part 2 and Annex A with all substance groups and test substances as described before. The examined tests are listed below in Table 2. Since, in particular, LHBV-facilities often encounter water-hazarded liquids with higher temperatures, additional tests were carried out with admission temperatures of 72 ° C.

Table 2 *Overview of the test with the evidence purpose.*

No.	Test procedure	Evidence
1	penetration depth at room temperature	tightness
2	load bearing behavior at room temperature	resistance
3	penetration depth at an admission temperature of 72 ° C	tightness
4	load bearing behavior - long-term test after 30 an 90 days	resistance

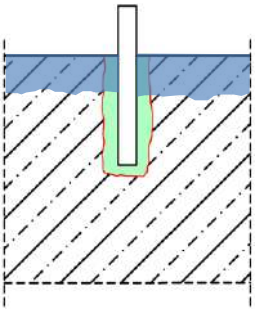
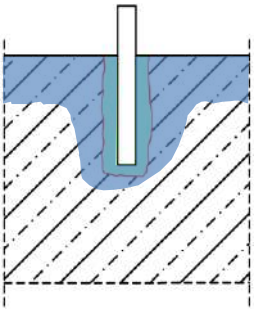
4.4 Evaluation Criteria

4.4.1 Tests for Penetration and Tightness

The evaluation, if a sufficient tightness of the bonded mortar against water-hazarded substances can be detected, is done by analyzing the penetration of the test liquids by means of digital photographs under daylight and by means of infrared cameras under the requirements of the guideline BUmwS [U11].

In concrete-members, the mass transport of liquids in the pore system takes place according to different mechanisms and combinations. According to experience, capillary transport is the most important part. By capillary transport is meant the absorption of water or other liquids into the pore system of the cement stone as a result of capillary forces. This behavior of the penetration of liquids and their penetration depth was used as one of the parameters for verification the tightness. The evaluation of tightness is shown in the following table.

Table 3 *Evaluation criteria for the tightness against the penetration of water-hazarded substances.*

Penetration		
Proof of tightness	passed	not passed
Description	There is a similar penetration behavior in the bonded mortar and in the concrete.	There is no equal penetration behavior in the bonded mortar and concrete, the penetration depth near the bonded anchor increases.

4.4.2 Pull-out Test and Resistance

Proof of the **sufficient resistance** is made by pull-out tests and evaluating the load-bearing capacity of the bonded anchor after application of chemical liquids in comparison with a non-chemically applicated bonded anchor as a reference test.

The non-chemically applicated anchors were examined after air storage as well as after a water storage. A sufficient resistance of the anchor after application of chemical fluids is present when the load does not decrease in comparison to the reference samples applicated by water. A moisten concrete is permissible for the load capacity of the bonded anchor according to ETA. If load variations above 5% (typical scattering range) occur compared to the application by water, the static load has obviously decreased due to the application of the medium.

5 Test Program

5.1 Test Samples

A typical liquid-proof concrete C30/37 (in Germany FD-Concrete) according to the DAfStb guideline BUmwS [U11], part 2 was used for all tests. To test the penetration behavior, concrete test cylinder with a diameter of 120 mm to 150 mm were removed from prepared FD concrete cubes and prepared for the test set-up. The penetration test was carried out in accordance with the DAfStb guideline BUmwS, Annex A, section A2.

In the middle of each test specimens, a **high-strength anchor rod** with strength 12.9 M12 x 110 was set by bonded mortar **HIT-HY 200A** according to ETA. The load-bearing capacity of the anchor rod itself lies above the load-bearing capacity of the anchoring. A pull-out test should therefore generally lead to a compound failure of the anchoring in the concrete.

The preperation of the test specimens as well as the performance of the tests were carried out and documented under the constant supervision of KIWA GmbH, Bautest, Augsburg.

5.2 Testing the Penetration Depth

In order to **proof the tightness** of the compound system, the intrusion behavior against water-hazarded substances was examined by a temporal application of the chemical liquids.

The conducted tests taking into account the specified parameters are shown in Table 4.

Table 4 *Test program for investigating the penetration depth*

Test liquid	Application temperature	Application time	Number of test samples
DIBt-list of chemicals and selected individual substances [U11]	20 °C (room temperature)	3 days	3 each substance
		9 days	3 each substance
	72 °C	3 days	3 each substance

In addition to the test parameters according to Table 4, tests were also carried out on individual chemical liquids using the following parameters.

Table 5 *Additionally performed tests of individual substances for the investigation of the penetration behavior*

Test liquid	Application temperature	Application time	Number of test samples
N-methyl-2-pyrrolidone (NMP)	60 °C	1 day (8 h)	3 each substance
Sodium hydroxide 25%	40 °C	3 days	3 each substance
Sulfuric acid 96%	40 °C	3 days	3 each substance

5.3 Testing the Load-bearing Behavior after Admission

In order to **proof the resistance** of the bonded anchor, the load bearing capacity of the bonded anchor was tested by a pull-out test after admission with close support. For this purpose, the air and water tests were carried out.

The load-bearing capacity of the anchoring up to the compound failure was first determined immediately after three days of admission. in order to obtain a statement about a time-delayed change in the compound carrier holdings by the penetrated liquid, further samples were stored dry for 30 and 90 days after admission, and a pull-out test with load-bearing determination on compound failure was carries out afterwards.

Table 6 *Test program for testing load bearing behavior*

Test liquid	Application temperature	Application time	Pull-out test after	Number of test samples
DIBt-list of chemicals and selected individual substances [U11]	20 °C (room temperature)	3 days	3 days	5 each substance
		9 days	9 days	5 each substance
		9 days	30 days	5 each substance
		9 days	90 days	5 each substance

Analogous to the investigation of the penetration behavior, additional tests with the individual substances were carried out according to the following table.

Table 7 *Test program for testing load bearing beahvior*

test liquid	admission temperature	admission time	pull-out test after	Number of test samples
n-methyl-2-pyrrolidone (NMP)	60 °C	1 day (8h)	1 day (8h)	5
Sodium hydroxide 25%	40 °C	3 days	3 days	5
Sulfuric acid 96%				5

6 Evaluation of Test Results

The tests were carried out according to the requirements of the DAfStb guideline BUmwS [U11] as well as the test basis ETAG and ETA and evaluated for tightness. The penetration depths of the substances were determined and documented both optically and by means of thermography recording on the broken up test specimen after admission to the individual chemical liquids.

The evaluation of the test results of the tightness is shown in Appendix 1 by the performance of the permissible stress levels L/A/U (storage, filling, handling).

The test evaluation of the load capacities shows a decrease in the compound carrying capacity of a maximum of approx. 10% for individual substances groups after admission. The drop in the composite load capacity of the anchor rod M12 can be explained by the penetration of the liquid front into the concrete and the resulting chemical-physical interactions of individual liquids with the concrete or the injection mortar. In the case of the anchor rod M12 used, the determined reduction of 10% of the load capacity can be compensated for by an increase in the embedment depth by 10 mm.

7 Recommendations for Design and Execution

According to the current state of the art, a reduction in the load capacity of the anchoring after admitting with water-hazarded substances is not further considered. On the basis of the test results of the compound load capacity, an overall increase of the embedding depth by the value $\Delta h_{ef,WHG}$, regardless of the applied chemical is recommended when using HIT-HY 200-A for anchoring in FD concrete. Thus, the reduction in the compound load capacity determined by some substances is full compensated. A differentiation of the increase in the embedment depth for the different substances groups is dispensed with on the safe side.

Table 8 *Increase of embedment depth of bonded anchors for HIT HY-200-A in case of chemical apply*

Anchor diameter (metric)	Increase of anchoring depth $\Delta h_{ef,WHG}$ [mm]	Application time
M8 – M16	+15 mm	Operating mode and stress level as given in appendix 1
M20 – M24	+25 mm	
M27 – M30	+35 mm	

Insofar as the anchor depth cannot be increased by the type of anchorage (for example, with internal thread sleeves HIS-RN), the loss of the compound load capacity after chemical admission can compensated by a reduction of 10% of the load-bearing capacity. The dimensioning of the anchors under shear load as well as bending stress remains unaffected by this and is carried out without modification in accordance with the Technical Report for dimensioning methods of compound dowels of the DIBt "TR 029 Dimensioning of compound dowels", edition 2016. In case of acid admission, a loss of the load bearing capacity up to the depth of damage according to BUmwS, part 2, section 4.3.2 may have to be considered.

According to BUmwS [U11], part 1, section 7.3.2, the installation of bonded anchors must be carried out in such a way that the depth of the borehole is smaller than the structural thickness reduced by 50 mm. Due to the requirements of ETA [U1] and [U11], the minimum structural thickness in the area of the anchoring is as follows:

Minimum component thickness $h_{min} \geq \max\{h_{ef} + \Delta h_{ef,WHG} + 50\,mm;\ h_{ef} + \Delta h_{ef,WHG} + \Delta h\}$

with h_{ef} = anchoring depth

$\Delta h_{ef,WHG}$ = increase anchoring depth at WHG (Table 8)

Δh = $\geq \max\{2 \cdot d_0;\ 30\,mm\}$

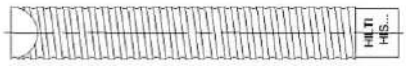
d_0 = borehole diameter

The manufacturer recommends a value d_0 for M24 by 28 mm and for M30 by 35 mm.

On the basis of the results, the following steel elements according to [U1] can be used for the WHG application:

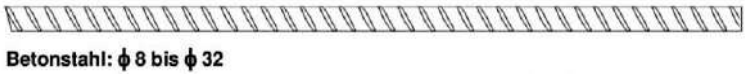
- Threaded rods: Hilti HIT-V-5.8, -8.8, HIT-C-5.8, -8.8, HIT-AM M8 - M30 made of galvanized or hot-dip galvanized steel; HIT-V-R, HIT-V-HCR, HIT-CR, HIT-AM M8 - M30 made of stainless steel 1.4301, 1.4401, 1.4404, 1.4529

- Inner thread sleeve HIS-N M8-M20 made of galvanized steel; Inner thread sleeve HIS-RN M8-M20 made of stainless steel 1.4401, 1.4404



- Tir Rods HZA, HZA-R

- Reinforcement steel B500 B according to DIN 488 (degreased, without coating)



The steel elements shall be selected in the appropriate corrosion resistance class for use (HCR 1.4529; A4 1.4401, 1.4404; made of galvanized or hot-dip galvanized steel).

In order to be able to ensure adequate installation quality even in the field of WHG facilities, an application-related WHG training installers with a written certificate of attendance by the anchor manufacturer is recommended. In this training, in particular, WHG-specific requirements are explained that are not included in the general training course required by the DIBt according to [U7]. In addition, the assembly shall be documented on the relevant assembly protocols [U14], which are attached to the WHG documentation of the building.

Darmstadt, February 22, 2018

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Annex: List of chemicals HIT HY-200-A compound mortar dowels in FD concrete is liquid impermeable.

Annex 1: *List of chemicals HIT HY-200-A compound mortar dowels in FD concrete is liquid impermeable*

Substances group No.	Permissible chemical liquids for facilities on operating modes storage (L), filling (A) and handling (U) of stress level low (1), medium (2) and high (3)	Operating mode and level
Test results for HIT-HY 200-A at room temperature for anchorage in liquid-tight (FD) concrete		
1	Gasoline according to DIN EN 228 with a maximum (bio) ethanol content of 5% by volume according to DIN EN 15376	L2/ A3/ U2
1a	Gasoline according to DIN EN 228 with the addition of biofuel components according to Directive 2009/28 / EC up to a total content of max. 20% by volume (including group 1)	
2	Aviation fuels	
3	Heating oil EL to DIN 51603-1 Unused combustion engine oil Unused vehicle and transmission oil Mixtures of saturated and aromatic hydrocarbons with aromatics content of max. 20% by volume and a flash point > 60 °C	
3b	Diesel fuels according to DIN EN 590 with the addition of biodiesel fuel according to DIN EN 14214 up to a total content of 20 % by volume	L2/ A1/ U1
4	Hydrocarbons as well as benzene-containing mixtures with max. 5% by volume of benzene, except fuels (including groups 2, 3, 4b and 4c, except groups 1, 1a, 3b und 4a)	L2/ A3/ U2
4a	Benzene and benzene-containing mixtures	
4b	Crude oils	
4c	Used combustion engine oil and Unused vehicle and transmission oil with a flash point > 60 °C	
5	Monovalent and polyvalent alcohols with max. 48% by volume of methanol and ethanol (in total), glycol, polyglycols, their monoethers and their aqueous mixtures thereof (including group 5b)	
5a	Alcohols and glycol ethers as well as their aqueous mixtures (including groups 5, 5b and 5c)	
5b	Monovalent and polyvalent alcohols ≥ C2 with max. 48 % by volume ethanol and there aqueous mixtures	
5c	Ethanol including ethanol according to DIN EN 15376 (irrespective of the manufacturing process) and there aqueous mixtures	
6	Halogenated hydrocarbons ≥ C2 (including group 6b)	
6a	Halogenated hydrocarbons (including groups 6 and 6b)	
6b	Aromatic halogenated hydrocarbons	
7	Organic esters and ketones, except biodiesel (including group 7a)	

Substances group No.	Permissible chemical liquids for facilities on operating modes storage (L), filling (A) and handling (U) of stress level low (1), medium (2) and high (3)	Operating mode and level
7a	Aromatic esters and ketones, except biodiesel	
7b	Biodiesel fuel according to DIN EN 14214	L2/ AU1
8	Aqueous solutions of aliphatic aldehydes up to 40 %	L2/ A3/ U2
8a	Aliphatic aldehydes and there aqueous solutions (including group 8)	
9	Aqueous solutions of organic acids (carboxylic acids) up to 10% and their salts (in aqueous solution)	
9a	Organic acids (carboxylic acid, except formic acid) and their salts (in aqueous solution)	
10	Inorganic acids (mineral acids) up to 20 % and acid hydrolyzing, inorganic salts in aqueous solution(pH < 6), except hydrofluoric acid and oxidizing effective acids and their salts	
11	Inorganic alkalis and alkaline hydrolysing, inorganic salts in aqueoues solution(pH > 8), except ammonia solution and oxidizing effective solutions of salts (e.g. hypo-chlorite)	
12	Aqueous solutions of inorganic non-oxidizing salts (pH-value between 6 and 8)	
13	Amine and their salts (in aqueous solution)	
14	Aqueous solutions of organic surfactants	
15	Cyclic and acyclic ether (including group 15a)	
15a	Acyclic ether	
Individual substances	• Ammonia 10%	L2/ AU1
	• Nitric acid 20 %	L2/ A3/ U2
Test results for HIT-HY 200-A at 72°C for anchorage in liquid-tight (FD) concrete		
7b	Biodiesel according to DIN EN 14214	LAU1
10	Inorganic acids (mineral acids) up to 20 % and acid hydrolyzing,inorganic salts in aqueous solution(pH < 6), except hydrofluoric acid and oxidizing effective acids an their salts	L2/ AU1
11	inorganic alkalis and alkaline hydrolysing, inorganic salts in aqueoues solution(pH > 8), except ammonia solution and oxidizing effective solutions of salts (e.g. hypo-chlorite)	
Individual substances	• n-methyl-2-pyrrolidone (NMP) at 60 °C	LAU1
	• Sodium hydroxide 25 %, at 40 °C	L2/ AU1
	• Sulfuric acid 96 %, at 40 °C	