

ACQUITY UPLC H-Class, H-Class Bio, and I-Class Series Systems

Solvent Considerations

General information

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Contact Waters with enhancement requests or technical questions regarding the use, transportation, removal, or disposal of any Waters product. You can reach us via the Internet, telephone, fax, or conventional mail.

Table 1–1: Waters contact information

Contacting medium	Information
Internet	The Waters website includes contact information for Waters locations worldwide. Visit www.waters.com .
Telephone and fax	From the USA or Canada, phone 800-252-4752, or fax 508-872-1990. For other locations worldwide, phone and fax numbers appear in the Waters website.
Conventional mail	Waters Corporation Global Support Services 34 Maple Street Milford, MA 01757 USA

Safety considerations

Some reagents and samples used with Waters instruments and devices can pose chemical, biological, or radiological hazards (or any combination thereof). You must know the potentially hazardous effects of all substances you work with. Always follow Good Laboratory Practice (GLP), and consult your organization's standard operating procedures (SOPs) as well as your local requirements for safety.

Safety hazard symbol notice

The  symbol indicates a potential hazard. Consult the documentation for important information about the hazard and the appropriate measures to prevent and control the hazard.

System height



Warning: To avoid spinal and muscular injury, do not attempt to lift a system module without assistance.



Warning: To avoid injury, do not stack modules, including the solvent tray and rails, higher than one meter (39.4 inches) above the bench top.



Warning: To avoid crushing your fingers beneath or between modules, use extreme care when installing a module in the system stack.

Power cord replacement hazard



Warning: To avoid electric shock, use the SVT-type power cord in the United States and HAR-type (or better) in Europe. The main power cord must be replaced with one of adequate rating. For information regarding what cord to use in other countries, contact your local Waters distributor.

High voltage hazard



Warning: To avoid electric shock, do not remove protective panels from the device. The components within are not user-serviceable.

Bottle placement prohibition



Warning: To avoid injury from electrical shock, fire, broken glass, falling objects, or exposure to toxic substances, and to avoid damage to the equipment, follow these guidelines:

- Do not expose the workstation or ancillary equipment to dripping or splashing liquids.
- Do not place objects filled with liquid, such as solvent bottles, on top of the workstation or ancillary equipment.
- Place bottles in the bottle tray, which serves as secondary containment in the event of spills.

FCC radiation emissions notice

Changes or modifications not expressly approved by the party responsible for compliance, could void the users authority to operate the equipment. This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Electrical power safety notice

Do not position the instrument so that it is difficult to disconnect the power cord.

Equipment misuse notice

If equipment is used in a manner not specified by its manufacturer, the protection provided by the equipment may be impaired.

Safety advisories

Consult [Appendix A](#) in this publication for a comprehensive list of warning advisories and notices.

Operating the ACQUITY UPLC H-Class, H-Class Bio, and I-Class Series Systems

When operating the ACQUITY UltraPerformance Liquid Chromatography (UPLC) H-Class, H-Class Bio, and I-Class Series Systems, follow standard quality-control (QC) procedures and the guidelines presented in this section.

Applicable symbols

Table 1–2: Applicable symbols

Symbol	Definition
	Manufacturer
	Date of manufacture
	Confirms that a manufactured product complies with all applicable European Community directives
	Australia EMC compliant
	Confirms that a manufactured product complies with all applicable United States and Canadian safety requirements
	Environmentally friendly use period (China RoHS): indicates the number of years from the date of manufacture until the product, or components within the product, are likely to be discarded or degrade into the environment
	Consult instructions for use
	Alternating current

Table 1–2: Applicable symbols (continued)

Symbol	Definition
	Electrical and electronic equipment with this symbol may contain hazardous substances and should not be disposed of as general waste. For compliance with the Waste Electrical and Electronic Equipment Directive (WEEE) 2012/19/EU, contact Waters Corporation for the correct disposal and recycling instructions.
	For indoor use only
	No pushing
	Indicates the maximum load you can place on that item (for example, 10kg)
	Serial number
	Part number catalog number

Audience and purpose

This document is intended for personnel who operate and maintain ACQUITY UPLC H-Class, H-Class Bio, and I-Class Series Systems. The term "Series" refers to both the latest generation ("PLUS") and previous generations of H-Class, H-Class Bio, and I-Class systems.

This document provides solvent considerations necessary to the operations of ACQUITY UPLC H-Class, H-Class Bio, and I-Class Series Systems.

Intended use of the ACQUITY UPLC H-Class, H-Class Bio, and I-Class Series Systems

Waters designed the ACQUITY UPLC H-Class, H-Class Bio, and I-Class Series Systems to perform liquid chromatography separations in these environments:

- Pharmaceutical development and discovery
- Quality assurance and quality control
- Chemical materials
- Environmental
- Food safety

The ACQUITY UPLC H-Class, H-Class Bio, and I-Class Series Systems are not intended for use in diagnostic applications.

Calibrating

To calibrate liquid chromatography (LC) systems, adopt acceptable calibration methods using at least five standards to generate a standard curve. The concentration range for standards must include the entire range of quality control (QC) samples, typical specimens, and atypical specimens.

When calibrating mass spectrometers, consult the instrument's online Help system for calibration instructions.

Quality control

Routinely run three QC samples that represent subnormal, normal, and above-normal levels of a compound. If sample trays are the same or very similar, vary the location of the QC samples in the trays. Ensure that QC sample results fall within an acceptable range, and evaluate precision from day to day and run to run. Data collected when QC samples are out of range might not be valid. Do not report these data until you are certain that the instrument performs satisfactorily.

EMC considerations

Canada spectrum management emissions notice

This class A digital product apparatus complies with Canadian ICES-001.

Cet appareil numérique de la classe A est conforme à la norme NMB-001.

ISM Classification: ISM Group 1 Class B

This classification has been assigned in accordance with CISPR 11 Industrial Scientific and Medical (ISM) instrument requirements.

Group 1 products apply to intentionally generated and/or used conductively coupled radio-frequency energy that is necessary for the internal functioning of the equipment.

Class B products are suitable for use in both commercial and residential locations and can be directly connected to a low voltage, power-supply network.

EC authorized representative



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Table of contents

General information	iii
Copyright notice	iii
Trademarks	iii
Customer comments	iii
Contacting Waters	iv
Safety considerations	iv
Safety hazard symbol notice.....	iv
System height.....	iv
Power cord replacement hazard.....	v
High voltage hazard.....	v
Bottle placement prohibition	v
FCC radiation emissions notice	v
Electrical power safety notice	v
Equipment misuse notice.....	vi
Safety advisories	vi
Operating the ACQUITY UPLC H-Class, H-Class Bio, and I-Class Series Systems	vi
Applicable symbols	vi
Audience and purpose.....	vii
Intended use of the ACQUITY UPLC H-Class, H-Class Bio, and I-Class Series Systems.....	vii
Calibrating.....	viii
Quality control.....	viii
EMC considerations	viii
Canada spectrum management emissions notice	viii
ISM Classification: ISM Group 1 Class B	viii
EC authorized representative	ix
 1 Solvent considerations	 13
1.1 Overview	13
1.1.1 Preventing contamination	13
1.1.2 Clean solvents	13
1.1.3 Solvent quality	14
1.1.4 Solvent preparation.....	14
1.1.5 Water	14

1.2	Solvent recommendations	15
1.2.1	General solvent guidelines	15
1.2.2	Solvents to avoid	17
1.2.3	ACQUITY UPLC H-Class, H-Class Bio, and I-Class Series Systems recommendations	18
1.2.4	Solvent manager recommendations	19
1.2.5	Sample manager recommendations	19
1.2.6	Detector recommendations.....	19
1.3	Common solvent properties	20
1.4	Solvent miscibility	21
1.4.1	Using miscibility numbers (M-numbers).....	22
1.5	Solvent stabilizers	22
1.6	Solvent viscosity	23
1.7	Wavelength selection	23
1.7.1	UV cutoffs for common solvents	23
1.7.2	Mixed mobile phases	24
1.7.3	Mobile phase absorbance.....	24
A	Safety advisories	27
A.1	Warning symbols	27
A.1.1	Specific warnings.....	28
A.2	Notices	30
A.3	Bottles Prohibited symbol	30
A.4	Required protection	31
A.5	Warnings that apply to all Waters instruments and devices	31
A.6	Warnings that address the replacing of fuses	34
A.7	Electrical and handling symbols	36
A.7.1	Electrical symbols.....	36
A.7.2	Handling symbols	37

1 Solvent considerations

This document provides solvents considerations necessary to the operations of the ACQUITY UltraPerformance Liquid Chromatography (UPLC) H-Class, H-Class Bio, and I-Class Series Systems and certain individual instruments, as listed in the section below.

1.1 Overview



Warning: To avoid chemical hazards, observe Good Laboratory Practice (GLP) at all times, particularly when working with hazardous materials. Consult the Material Safety Data Sheets (MSDS) regarding the solvents you use. Additionally, consult the safety representative for your organization regarding its protocols for handling such materials.

The information in this document applies only to the following instruments:

- ACQUITY UPLC H-Class Series and H-Class Bio Series System modules
- ACQUITY UPLC I-Class Series System modules
- ACQUITY UPLC Photodiode Array (PDA) Detector
- ACQUITY UPLC PDA Detector with TaperSlit
- ACQUITY UPLC PDA eλ Detector
- ACQUITY UPLC Tunable Ultraviolet (TUV) Detector

1.1.1 Preventing contamination

For information on preventing contamination, refer to *Controlling Contamination in LC/MS Systems* (715001307) on the Waters website (www.waters.com).

1.1.2 Clean solvents

Clean solvents ensure reproducible results and permit you to operate with minimal instrument maintenance.

Dirty solvents can cause baseline detector noise and drift, and they can clog solvent reservoir filters, inlet filters, and capillary lines.

1.1.3 Solvent quality

Use MS-grade solvents for the best possible results; the minimum requirement is HPLC-grade. Filter solvents through a 0.2- μ m membrane filter.

Recommendation: Ensure that you choose solvents and membrane filters that are compatible with each other and that you follow the recommendations of their manufacturers or suppliers.

1.1.4 Solvent preparation

Proper solvent preparation, primarily filtration, can prevent many pumping problems.

Recommendation: Use brown-tinted glassware to inhibit microbial growth.

1.1.5 Water

! **Notice:** To avoid microbial growth, a frequent consequence of using 100% water, add a small amount of organic solvent (greater than 10%) to the water. Also, never add fresh aqueous mobile phase to old. Completely replace the mobile phase daily and clean the containers.

Use water only from a high-quality water purification system. If the water system does not deliver filtered water, filter the water through a 0.2- μ m membrane filter.

Recommendation: Use MS-quality (or better) water.

1.1.5.1 Using buffers

- !** **Notices:**
- To avoid damaging instruments by unwittingly introducing incompatible buffers, consult the instrument's accompanying documentation to determine what buffers are compatible.
 - After you finish using a buffer, flush the pump by running a wet-prime with HPLC-grade, distilled or deionized water. Then, run at least five system volumes through the remainder of system.
 - To prevent microbial growth during shutdowns lasting longer than 24 hours, flush the pump and solvent lines with a solution of organic solvent/water in which the organic component is greater than 20%.

Adjust the pH of aqueous buffers. Filter them, to remove insoluble material, and then blend them with appropriate organic modifiers.

Tip: To avoid salt precipitation in LC instruments, nonvolatile buffer concentrations must not exceed 100 mM or their solubility concentration.

See also: For information about preventing contamination, refer to *Controlling Contamination in LC/MS Systems* (715001307) on the Waters web site (www.waters.com).

1.2 Solvent recommendations

This section lists solvents recommended for the ACQUITY UPLC H-Class, H-Class Bio, and I-Class Series Systems. Contact Waters Customer Service or Marketing to determine whether you can use solvents that do not appear in the list without adversely affecting instrument or system performance.

The ACQUITY UPLC I-Class Series System was designed for reversed-phase chromatography and ACQUITY UPLC BEH column chemistries. Waters evaluated the system's reliability using traditional reversed-phase solvents. Nevertheless, you can use some normal-phase solvents, if you make appropriate modifications. See sections [“Other solvents”, page 15](#) and [“H-Class, H-Class Bio, and I-Class Series hexane/THF compatibility kits”, page 16](#).

1.2.1 General solvent guidelines

Always observe the following general solvent guidelines:

- Use high-quality, brown-tinted glassware to inhibit microbial growth.
- Filter solvents through a 0.2- μ m filter, or use pre-filtered solvents. Small particles can permanently block a system's capillary lines. Filtering solvents also improves check-valve performance.

1.2.1.1 Recommended solvents

- Acetonitrile
- Isopropanol
- Methanol
- Water

1.2.1.2 Other solvents

You can use the following solvents. Note, however, that these solvents can shorten instrument life if used without the appropriate compatibility kit. If you routinely use the solvents on this list, Waters recommends you install a hexane/tetrahydrofuran (THF) compatibility kit. (See [“H-Class, H-Class Bio, and I-Class Series hexane/THF compatibility kits”, page 16](#).)

- THF
- Hexane
- Acetone
- Ethyl acetate

For additional information, see section [“ACQUITY UPLC H-Class, H-Class Bio, and I-Class Series Systems recommendations”, page 18](#).

Consider solvent polarity when you change solvents. Flush the system with miscible and compatible solvents, like isopropanol, when switching between polar and nonpolar solvents.

1.2.1.3 H-Class, H-Class Bio, and I-Class Series hexane/THF compatibility kits

The ACQUITY UPLC H-Class, H-Class Bio, and I-Class Series Systems Hexane/THF Compatibility Kits (contact Waters for part numbers) can be installed in relevant ACQUITY UPLC systems. They are designed for users who must run their systems with hexane, THF, acetone, and ethyl acetate at high concentrations and high pressure.

1.2.1.4 Additives/modifiers

- $\leq 0.3\%$ vol. acetic acid
- ≤ 50 mM ammonium acetate
- ≤ 10 mM ammonium bicarbonate
- ≤ 50 mM ammonium hydroxide
- $\leq 0.1\%$ wt. ethylenediaminetetraacetic acid (EDTA)
- $\leq 0.2\%$ vol formic acid
- $\leq 0.1\%$ vol heptafluorobutyric acid



Warning: To avoid contact with corrosive material that can be present on instrument components HFIP damages, do not use HFIP in wash solvents.



Notice: To avoid damaging the instrument, do not use HFIP in wash solvents.

- 1% to 4% aqueous solutions of hexafluoroisopropanol (HFIP) for oligonucleotide applications
- ≤ 10 mM phosphate buffer
- $\leq 0.1\%$ vol triethylamine (TEA)
- $\leq 0.1\%$ vol trifluoroacetic acid (TFA)

1.2.1.5 Sample diluents

- Acetonitrile
- Acetonitrile/water mixtures
- Chloroform
- Dimethylformamide (DMF)
- Dimethyl sulfoxide (DMSO)
- Isooctane
- Isopropanol
- Methanol
- Methanol/water mixtures
- Methylene chloride
- Water

1.2.1.6 Cleaning agents

You may use these cleaning agents:

Note: Cleaning agents require short contact time when flushing instruments (less than 30 minutes).

- Formic acid ($\leq 10\%$)
- Phosphoric acid ($\leq 30\%$)
- Sodium hydroxide ($\leq 1M$)

See also: The cleaning procedures in the Waters publication *Controlling Contamination in LC/MS Systems* (715001307) on the Waters web site (www.waters.com).

1.2.2 Solvents to avoid

Avoid these solvents:

- Solvents that contain halogens: chlorine, fluorine, bromine, or iodine.



Warning: Peroxide contaminants in THF can spontaneously and destructively explode when you partially or completely evaporate the THF.

- Compounds that form peroxides, such as ultraviolet (UV)-grade ethers, non-stabilized THF, dioxane, and diisopropylether. (If you must use compounds that form peroxides, be sure to filter them through dry aluminum oxide, to adsorb formed peroxides. Do not allow them to remain on a system for more than 24 hours.)
- Solutions that contain strong concentrations (greater than 0.1% wt) of complexing agents like ethylenediaminetetraacetic acid (EDTA).



Notice: The standard pH operating range for your system is between 2.0 and 12.0. Operating the system below pH 2.0 or above pH 12.0 for more than brief periods can result in increased wear on system components not included in preventative maintenance kits and require more frequent routine preventative maintenance intervals.

- Strong acids. (Use them only in weak concentration, unless using them as cleaning agents. Avoid using acids as mobile phases when their pH is less than 2.0.)
- Strong bases. (Use them only in weak concentration. Avoid using bases as mobile phases when their pH is greater than 12.0.)

1.2.2.1 Material limitations for strong acids and bases

- Stainless steel can be attacked by certain acids below pH 2.3, especially in the presence of halogens and halogen-containing chemicals and strong mineral acids like nitric and sulfuric acids. Stainless steel can also see degradation when used with organic acids in organic solvents.

- Quartz flow cells can have degraded lifetimes in the presence of pH greater than 12.
- Polyetheretherketone (PEEK) can be degraded in strong mineral acids, such as nitric and sulfuric acids especially in the presence of halogens and halogen containing chemicals.
- Silica capillaries and their polyimide coatings will start to degrade at pH 8 and higher.
- Polyimide used in the needle seat is stable in a pH range between 1 and 10 and in most organic solvents. It will degrade in the presence of concentrated mineral acids like sulfuric acid and in the presence of glacial acetic acid. It will be degraded by elevated basic condition, especially in the presence of ammonia or ammonium salts or acetates.

1.2.3 ACQUITY UPLC H-Class, H-Class Bio, and I-Class Series Systems recommendations

Contact Waters for recommended system cleaning and flushing procedures.

See also: The cleaning procedures in the Waters publication *Controlling Contamination in LC/MS Systems* (715001307) on the Waters web site (www.waters.com).



Warning: Peroxide contaminants in THF can spontaneously and destructively explode when you partially or completely evaporate the THF.



Warning: To avoid injury, familiarize yourself with materials and their hazards, observe GLP, and consult your organization's safety representative regarding proper use and handling. Guidelines are provided in the latest edition of the National Research Council's publication, *Prudent Practices in the Laboratory: Handling and Disposal of Chemicals*.

- THF, hexane, ethyl acetate, and acetone can be used as the mobile phase in ACQUITY UPLC H-Class, H-Class Bio, and I-Class Series Systems. As with many nonaqueous solvents, however, they can shorten system and instrument life compared with equipment running typical reversed-phase solvents. If you use THF, hexane, ethyl acetate, or acetone, you must install a hexane/THF compatibility kit. (See section "[H-Class, H-Class Bio, and I-Class Series hexane/THF compatibility kits](#)", page 16.)
- When using non-stabilized THF, ensure that your solvent is freshly prepared. Previously opened bottles contain peroxide contaminants, which cause detector baseline drift.
- Chloroform, methylene chloride, halogenated solvents, and toluene can be used in weak dilutions (less than 10% vol.) as sample diluents.
- Contact your Waters sales representative or local technical support organization to determine whether a specific method is suitable for use with the ACQUITY UPLC H-Class, H-Class Bio, and I-Class Series Systems instruments and components.
- When using THF or hexane, minimize the use of PEEK components by replace PEEK tubing with stainless steel or MP35N tubes.
- Aqueous solvents must not remain in a shut-down system because they serve as a substrate for microbial colonies. Microbes can clog system filters and capillary lines. To prevent their proliferation, add a minimum of 10% of an organic solvent, such as acetonitrile or methanol.

- Methanesulfonic acid is not recommended for use in ACQUITY UPLC H-Class, H-Class Bio, and I-Class Series Systems.

1.2.4 Solvent manager recommendations

- The seal wash system must never run dry, particularly during separations that use a polar mobile phase.
- Isopropyl alcohol or organic solvents are effective seal wash solvents for normal phase separations that employ mobile phases of intermediate polarity (such as THF or hexane). Decrease the seal wash solvent interval when you use nonvolatile buffers and salts.

! **Notice:** For bioBSM PLUS applications that use high salts and buffers, adjust the seal wash solvent interval from 5.0 minutes (default) to 0.5 minutes to prevent salt buildup on the plunger and plunger seals, and a decrease in life of the high-pressure seals.

The 0.5-minutes seal wash flow is not executed until you download a method with the faster flow rate.

See also: Waters Knowledge Base article [WKB96281](#) for instructions on how to adjust the seal wash solvent interval, depending on your system software (Empower or UNIFI).

For bioQSM Series applications, the default seal wash interval is 0.5 minutes, so you do not need to decrease it.

- For reversed-phase applications, use aqueous seal wash solutions with a weak organic component (for example, 1:9 methanol/water).
- Do not use nonvolatile buffers as seal wash solvents.
- Ensure that the mobile phase is completely soluble in and compatible with all of the solvents in use on the system.

See also: The appropriate solvent manager operator's guide (www.waters.com) for further details.

1.2.5 Sample manager recommendations

- Do not use concentrations of THF or hexane greater than 10% as purge solvent.
- Typical organic sample diluents such as dimethylsulfoxide (DMSO) and dimethylformamide (DMF) are supported.
- Do not use buffers as needle wash solvents. You can use acids and bases.

1.2.6 Detector recommendations

To transport a flow cell while temperatures are below 5 °C, fill it with alcohol.

1.3 Common solvent properties

The following table lists the properties for some common chromatographic solvents.

Table 1–1: Properties of common solvents

Solvent	Vapor pressure mm Hg (Torr)	Boiling point (°C)	Flash point (°C)
Acetone	184.5 at 20 °C	56.29	-20
Acetonitrile	88.8 at 25 °C	81.6	6
<i>n</i> -butyl acetate	7.8 at 20 °C	126.11	22
<i>n</i> -butyl alcohol	4.4 at 20 °C	117.5	37
<i>n</i> -butyl chloride	80.1 at 20 °C	78.44	-9
Chlorobenzene	8.8 at 20 °C	131.69	28
Chloroform	158.4 at 20 °C	61.15	—
Cyclohexane	77.5 at 20 °C	80.72	-20
Cyclopentane	400 at 20 °C	49.26	-7
<i>o</i> -Dichlorobenzene	1.2 at 20 °C	180.48	66
Dichloromethane	350 at 20 °C	39.75	--
Dimethyl acetamide	1.3 at 25 °C	166.1	70
<i>N,N</i> -Dimethylformamide	2.7 at 20 °C	153.0	58
Dimethyl sulfoxide	0.6 at 25 °C	189.0	88
1,4-Dioxane	29 at 20 °C	101.32	12
Ethyl acetate	73 at 20 °C	77.11	-4
Ethyl alcohol	43.9 at 20 °C	78.32	15
Ethyl ether	442 at 20 °C	34.55	-45
Ethylene dichloride	83.35 at 20 °C	83.48	13
Heptane	35.5 at 20 °C	98.43	-4
Hexane	124 at 20 °C	68.7	-22
Iso-octane	41 at 20 °C	99.24	-12
Isobutyl alcohol	8.8 at 20 °C	107.7	28
Isopropyl alcohol	32.4 at 20 °C	82.26	12
Isopropyl myristate	<1 at 20 °C	192.6	164
Methanol	97 at 20 °C	64.7	11
Methyl <i>t</i> -butyl ether	240 at 20 °C	55.2	-28
Methyl ethyl ketone	74 at 20 °C	79.64	-9
Methyl isobutyl ketone	16 at 20 °C	117.4	18
<i>N</i> -Methylpyrrolidone	0.33 at 25 °C	202.0	86
Pentane	420 at 20 °C	36.07	-49
<i>n</i> -Propyl alcohol	15 at 20 °C	97.2	23
Propylene carbonate	—	241.7	135
Pyridine	18 at 25 °C	115.25	20

Table 1–1: Properties of common solvents (continued)

Solvent	Vapor pressure mm Hg (Torr)	Boiling point (°C)	Flash point (°C)
Tetrahydrofuran	142 at 20 °C	66.0	-14
Toluene	28.5 at 20 °C	110.62	4
1,2,4-Trichlorobenzene	1 at 20 °C	213.5	106
Triethylamine	57 at 25 °C	89.5	-9
Trifluoroacetic acid	97.5 at 20 °C	71.8	-3
Water	17.54 at 20 °C	100.0	—
o-xylene	6 at 20 °C	144.41	17

1.4 Solvent miscibility

Before you change solvents, refer to the table below to determine solvent miscibility. Be aware of these effects:

- Changes involving two miscible solvents can be made directly. Changes involving two solvents that are not totally miscible (for example, from hexane to water) require an intermediate solvent like 2-propanol.
- Temperature affects solvent miscibility. If you are running a high-temperature application, consider the effect of the higher temperature on solvent solubility.
- Buffers dissolved in water can precipitate when mixed with organic solvents.

When you switch from a buffer to an organic solvent, thoroughly flush the system using water (see section “[Water](#)”, page 14) before you add the organic solvent.

Table 1–2: Solvent miscibility

Polarity index	Solvent	Viscosity cP, 20 °C (@1 atm)	Boiling point °C (@1 atm)	Miscibility number (M)	λ Cutoff (nm)
0.0	N-hexane	0.313	68.7	29	—
1.8	Triethylamine	0.38	89.5	26	—
4.2	THF	0.55	66.0	17	220
4.3	1-propanol	2.30	97.2	15	210
4.3	2-propanol	2.35	117.7	15	—
5.2	Ethanol	1.20	78.3	14	210
5.4	Acetone	0.32	56.3	15, 17	330
5.5	Benzyl alcohol	5.80	205.5	13	—
5.7	Methoxyethanol	1.72	124.6	13	—
6.2	Acetonitrile	0.37	81.6	11, 17	190
6.2	Acetic acid	1.26	117.9	14	—
6.4	Dimethylformamide	0.90	153.0	12	—

Table 1–2: Solvent miscibility (continued)

Polarity index	Solvent	Viscosity cP, 20 °C (@1 atm)	Boiling point °C (@1 atm)	Miscibility number (M)	λ Cutoff (nm)
6.5	Dimethylsulfoxide	2.24	189.0	9	—
6.6	Methanol	0.60	64.7	12	210
9.0	Water	1.00	100.0	0	190

1.4.1 Using miscibility numbers (M-numbers)

Use miscibility numbers (M-numbers) to predict the miscibility of a liquid with a standard solvent.

To predict the miscibility of two liquids, subtract the smaller M-number value from the larger M-number value.

- When the difference between the two M-numbers is 15 or less, the two liquids are miscible, in all proportions, at 15 °C.
- A difference of 16 indicates a critical solution temperature from 25 to 75 °C, with 50 °C as the optimal temperature.
- When the difference is 17 or greater, the liquids are immiscible, or their critical solution temperature is above 75 °C.

Some solvents prove immiscible with solvents at both ends of the lipophilicity scale. These solvents receive a dual M-number:

- The first number, always lower than 16, indicates the degree of miscibility with highly lipophilic solvents.
- The second number applies to the opposite end of the scale. A large difference between these two numbers indicates a limited range of miscibility.

For example, some fluorocarbons are immiscible with all the standard solvents and have M-numbers of 0 and 32.

A liquid is classified in the M-number system by testing for miscibility with a sequence of standard solvents. A correction term of 15 units is then either added or subtracted from the cutoff point for miscibility.

1.5 Solvent stabilizers

Do not leave solvents containing stabilizers, like THF with butylated hydroxytoluene (BHT), to dry in the system's flow path. A dry flow path, including the detector flow cell, becomes contaminated with residual stabilizer, and a substantial cleaning effort is needed to restore the flow path to its initial condition.

1.6 Solvent viscosity

Generally, viscosity is not a consideration when you operate with a single solvent or under low pressure. However, with gradient chromatography, the viscosity changes that occur as the solvents are mixed in different proportions can effect pressure changes during the run. For example, a 1:1 water/methanol mixture produces twice the pressure of either water or methanol alone.

If you do not know the extent to which pressure changes affect the analysis, monitor the pressure during the run.

1.7 Wavelength selection

The tables in this section provide UV cutoff values for these items:

- Common solvents
- Common mixed mobile phases

1.7.1 UV cutoffs for common solvents

The following table shows the UV cutoff (the wavelength at which the absorbance of the solvent equals 1 AU) for some common chromatographic solvents. Operating at a wavelength near or below the cutoff increases baseline noise because of solvent absorbance.

Table 1–3: UV cutoff wavelengths for common chromatographic solvents

Solvent	UV cutoff (nm)
Acetone	330
Acetonitrile	190
Diethyl amine	275
Ethanol	210
Isopropanol	205
Isopropyl ether	220
Methanol	205
<i>n</i> -Propanol	210
Tetrahydrofuran, non-stabilized (THF)	230

1.7.2 Mixed mobile phases

The following table provides approximate wavelength cutoffs for some other solvents, buffers, detergents, and mobile phases. The solvent concentrations represented are those most commonly used. If you want to use a different concentration, you can determine approximate absorbance using Beer's law, because absorbance is proportional to concentration.

Table 1–4: Wavelength cutoffs for different mobile phases

Mobile phase	UV cutoff (nm)	Mobile phase	UV cutoff (nm)
Acetic acid, 1%	230	Sodium chloride, 1 M	207
Ammonium acetate, 10 mM	205	Sodium citrate, 10 mM	225
Ammonium bicarbonate, 10 mM	190	Sodium dodecyl sulfate, 0.1%	190
Polyoxyethylene (35) lauryl ether (BRIJ 35), 0.1%	190	Sodium formate, 10 mM	200
3-[(3-cholamidopropyl)-dimethylammonio]-1-propanesulfonate) (CHAPS), 0.1%	215	Triethylamine, 1%	235
Diammonium phosphate, 50 mM	205	Trifluoroacetic acid, 0.1%	190
Ethylenediaminetetraacetic acid disodium salt (disodium EDTA), 1 mM	190	TRIS HCl, 20 mM, pH 7.0, pH 8.0	202, 212
4-(2-hydroxyethyl)-1-piperazineethanesulfonic acid (HEPES), 10 mM, pH 7.6	225	Triton X-100, 0.1%	240
Hydrochloric acid, 0.1%	190	Waters PIC Reagent A, 1 vial/liter	200
Morpholinoethanesulfonic acid (MES), 10 mM, pH 6.0	215	Waters PIC Reagent B-6, 1 vial/liter	225
Potassium phosphate: monobasic, 10 mM; dibasic, 10 mM	190 190	Waters PIC Reagent B-6, low UV, 1 vial/liter	190
Sodium acetate, 10 mM	205	Waters PIC Reagent D-4, 1 vial/liter	190

1.7.3 Mobile phase absorbance

This section lists the absorbances at several wavelengths for frequently used mobile phases. Choose the mobile phase carefully to reduce baseline noise.

The best mobile phase for your application is one that is transparent at the chosen detection wavelengths. With such a mobile phase, ensure that any absorbance is due only to the sample. Absorbance by the mobile phase also reduces the linear dynamic range of the detector by the amount of absorbance the autozero function cancels, or “autozeroes”, out. Wavelength, pH, and concentration of the mobile phase affects its absorbance.

Examples of several mobile phases are given in the following table. The absorbances are based on a 10-mm pathlength.

Table 1–5: Mobile phase absorbance measured against air or water

	Absorbance at specified wavelength (nm)									
	200	205	210	215	220	230	240	250	260	280
Solvents										
Acetonitrile	0.05	0.03	0.02	0.01	0.01	<0.01	≈0	≈0	≈0	≈0
Methanol (not degassed)	2.06	1.00	0.53	0.37	0.24	0.11	0.05	0.02	<0.01	≈0
Methanol (degassed)	1.91	0.76	0.35	0.21	0.15	0.06	0.02	<0.01	≈0	≈0
Isopropanol	1.80	0.68	0.34	0.24	0.19	0.08	0.04	0.03	0.02	0.02
Nonstabilized tetrahydrofuran (THF)	2.44	2.57	2.31	1.80	1.54	0.94	0.42	0.21	0.09	0.05
Acids and bases										
Acetic acid, 1%	2.61	2.63	2.61	2.43	2.17	0.87	0.14	0.01	<0.01	≈0
Hydrochloric acid, 0.1%	0.11	0.02	<0.01	≈0	≈0	≈0	≈0	≈0	≈0	≈0
Phosphoric acid, 0.1%	<0.01	≈0	≈0	≈0	≈0	≈0	≈0	≈0	≈0	≈0
Trifluoroacetic acid, 0.1%	1.20	0.78	0.54	0.34	0.22	0.06	<0.02	<0.01	≈0	≈0
Diammonium phosphate, 50 mM	1.85	0.67	0.15	0.02	<0.01	≈0	≈0	≈0	≈0	≈0
Triethylamine, 1%	2.33	2.42	2.50	2.45	2.37	1.96	0.50	0.12	0.04	<0.01
Buffers and salts										
Ammonium acetate, 10 mM	1.88	0.94	0.53	0.29	0.15	0.02	<0.01	≈0	≈0	≈0
Ammonium bicarbonate, 10 mM	0.41	0.10	0.01	<0.01	≈0	≈0	≈0	≈0	≈0	≈0
Ethylenediaminetetraacetic acid disodium salt (disodium EDTA), 1 mM	0.11	0.07	0.06	0.04	0.03	0.03	0.02	0.02	0.02	0.02
4-(2-hydroxyethyl)-1-piperazineethanesulfonic acid (HEPES), 10 mM, pH 7.6	2.45	2.50	2.37	2.08	1.50	0.29	0.03	<0.01	≈0	≈0
Morpholinoethanesulfonic acid (MES), 10 mM, pH 6.0	2.42	2.38	1.89	0.90	0.45	0.06	<0.01	≈0	≈0	≈0
Potassium phosphate, monobasic (KH ₂ PO ₄), 10 mM	0.03	<0.01	≈0	≈0	≈0	≈0	≈0	≈0	≈0	≈0
Potassium phosphate, dibasic, (K ₂ HPO ₄), 10 mM	0.53	0.16	0.05	0.01	<0.01	≈0	≈0	≈0	≈0	≈0
Sodium acetate, 10 mM	1.85	0.96	0.52	0.30	0.15	0.03	<0.01	≈0	≈0	≈0
Sodium chloride, 1 M	2.00	1.67	0.40	0.10	<0.01	≈0	≈0	≈0	≈0	≈0
Sodium citrate, 10 mM	2.48	2.84	2.31	2.02	1.49	0.54	0.12	0.03	0.02	0.01
Sodium formate, 10 mM	1.00	0.73	0.53	0.33	0.20	0.03	<0.01	≈0	≈0	≈0

Table 1–5: Mobile phase absorbance measured against air or water (continued)

	Absorbance at specified wavelength (nm)									
	200	205	210	215	220	230	240	250	260	280
Sodium phosphate, 100 mM, pH 6.8	1.99	0.75	0.19	0.06	0.02	0.01	0.01	0.01	0.01	<0.01
Tris HCl, 20 mM, pH 7.0	1.40	0.77	0.28	0.10	0.04	<0.01	≈0	≈0	≈0	≈0
Tris HCl, 20 mM, pH 8.0	1.80	1.90	1.11	0.43	0.13	<0.01	≈0	≈0	≈0	≈0
Waters Paired-ion Chromatography (PIC) reagents										
PIC A, 1 vial/L	0.67	0.29	0.13	0.05	0.03	0.02	0.02	0.02	0.02	<0.01
PIC B6, 1 vial/L	2.46	2.50	2.42	2.25	1.83	0.63	0.07	<0.01	≈0	≈0
PIC B6, low UV, 1 vial/L	0.01	<0.01	≈0	≈0	≈0	≈0	≈0	≈0	≈0	≈0
PIC D4, 1 vial/L	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.01

A Safety advisories

Waters products display safety symbols that identify hazards associated with the product's operation and maintenance. The symbols also appear in product manuals with statements that describe the hazards and advise how to avoid them. This appendix presents all safety symbols and statements that apply to Waters' product offerings. The symbols and statements can apply to a specific product, or apply to other products within the same system.

A.1 Warning symbols

Warning symbols alert you to the risk of death, injury, or seriously adverse physiological reactions associated with the misuse of an instrument or device. Heed all warnings when you install, repair, or operate any Waters instrument or device. Waters accepts no liability in cases of injury or property damage resulting from the failure of individuals to comply with any safety precaution when installing, repairing, or operating any of its instruments or devices.

The following symbols warn of risks that can arise when you operate or maintain a Waters instrument or device or component of an instrument or device. When one of these symbols appears in a manual's narrative sections or procedures, an accompanying statement identifies the applicable risk and explains how to avoid it.



Warning: (General risk of danger. When this symbol appears on an instrument, consult the instrument's user documentation for important safety-related information before you use the instrument.)



Warning: (Risk of burn injury from contacting hot surfaces.)



Warning: (Risk of electric shock.)



Warning: (Risk of fire.)



Warning: (Risk of sharp-point puncture injury.)



Warning: (Risk of hand crush injury.)



Warning: (Risk of injury caused by moving machinery.)



Warning: (Risk of exposure to ultraviolet radiation.)



Warning: (Risk of contacting corrosive substances.)



Warning: (Risk of exposure to a toxic substance.)



Warning: (Risk of personal exposure to laser radiation.)



Warning: (Risk of exposure to biological agents that can pose a serious health threat.)



Warning: (Risk of tipping.)



Warning: (Risk of explosion.)



Warning: (Risk of high-pressure gas release.)

A.1.1 Specific warnings

The following warnings (both symbols and text) can appear in the user manuals of particular instruments and devices and on labels affixed to them or their component parts.

A.1.1.1 Burst warning

This warning applies to Waters instruments and devices fitted with nonmetallic tubing.



Warning: To avoid injury from bursting, nonmetallic tubing, heed these precautions when working in the vicinity of such tubing when it is pressurized:

- Wear eye protection.
- Extinguish all nearby flames.
- Do not use tubing that is, or has been, stressed or kinked.
- Do not expose nonmetallic tubing to compounds with which it is chemically incompatible: tetrahydrofuran, nitric acid, and sulfuric acid, for example.
- Be aware that some compounds, like methylene chloride and dimethyl sulfoxide, can cause nonmetallic tubing to swell, significantly reducing the pressure at which the tubing can rupture.

A.1.1.2 Mass spectrometer shock hazard

The following warning applies to all Waters mass spectrometers.



Warning: To avoid electric shock, do not remove the mass spectrometer's protective panels. The components that they cover are not user-serviceable.

The following warning applies to certain mass spectrometers when they are in Operate mode.



Warning: To avoid harmless, static-like electric shock, ensure the mass spectrometer is in Standby mode before you touch any of its external surfaces that are marked with this high voltage warning symbol.

A.1.1.3 Mass spectrometer flammable solvents warning

This warning applies to mass spectrometers performing an analysis that requires the use of flammable solvents.



Warning: To prevent ignition of flammable solvent vapors in the enclosed space of a mass spectrometer's ion source, ensure that nitrogen flows continuously through the source. The nitrogen supply pressure must not fall below 690 kPa (6.9 bar, 100 psi) during an analysis requiring the use of flammable solvents. Also a gas-fail device must be installed, to interrupt the flow of LC solvent should the nitrogen supply fail.

A.1.1.4 Biohazard warning

The following warning applies to Waters instruments and devices that can process material containing biohazards, which are substances that contain biological agents capable of producing harmful effects in humans.



Warning: To avoid infection with potentially infectious, human-sourced products, inactivated microorganisms, and other biological materials, assume that all biological fluids that you handle are infectious.

Specific precautions appear in the latest edition of the US National Institutes of Health (NIH) publication, *Biosafety in Microbiological and Biomedical Laboratories* (BMBL). Observe Good Laboratory Practice (GLP) at all times, particularly when working with hazardous materials, and consult the biohazard safety representative for your organization regarding the proper use and handling of infectious substances.

A.1.1.5 Biohazard and chemical hazard warning

These warnings apply to Waters instruments and devices that can process biohazards, corrosive materials, or toxic materials.



Warning: To avoid personal contamination with biohazards, toxic materials, or corrosive materials, you must understand the hazards associated with their handling.

Guidelines prescribing the proper use and handling of such materials appear in the latest edition of the National Research Council's publication, *Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards*.

Observe Good Laboratory Practice (GLP) at all times, particularly when working with hazardous materials, and consult the safety representative for your organization regarding its protocols for handling such materials.

A.2 Notices

Notice advisories appear where an instrument, device, or component can be subject to use or misuse that can damage it or compromise a non-clinical sample's integrity. The exclamation point symbol and its associated statement alert you to such risk.



Notice: To avoid damaging the instrument's case, do not clean it with abrasives or solvents.

A.3 Bottles Prohibited symbol

The Bottles Prohibited symbol alerts you to the risk of equipment damage caused by solvent spills.



Prohibited: To avoid equipment damage caused by spilled solvent, do not place reservoir bottles directly atop an instrument or device or on its front ledge. Instead, place the bottles in the bottle tray, which serves as secondary containment in the event of spills.

A.4 Required protection

The Use Eye Protection and Wear Protective Gloves symbols alert you to the requirement for personal protective equipment. Select appropriate protective equipment according to your organization's standard operating procedures.



Requirement: Use eye protection when refilling or replacing solvent bottles.



Requirement: Wear clean, chemical-resistant, powder-free gloves when handling samples.

A.5 Warnings that apply to all Waters instruments and devices

When operating this device, follow standard quality-control procedures and the equipment guidelines in this section.



Attention: Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.



Important: Toute modification sur cette unité n'ayant pas été expressément approuvée par l'autorité responsable de la conformité à la réglementation peut annuler le droit de l'utilisateur à exploiter l'équipement.



Achtung: Jedwede Änderungen oder Modifikationen an dem Gerät ohne die ausdrückliche Genehmigung der für die ordnungsgemäße Funktionstüchtigkeit verantwortlichen Personen kann zum Entzug der Bedienungsbezugnis des Systems führen.



Avvertenza: qualsiasi modifica o alterazione apportata a questa unità e non espressamente autorizzata dai responsabili per la conformità fa decadere il diritto all'utilizzo dell'apparecchiatura da parte dell'utente.



Atencion: cualquier cambio o modificación efectuado en esta unidad que no haya sido expresamente aprobado por la parte responsable del cumplimiento puede anular la autorización del usuario para utilizar el equipo.



注意: 未經有關法規認證部門允許對本設備進行的改變或修改,可能會使使用者喪失操作該設備的權利。



注意: 未经有关法规认证部门明确允许对本设备进行的改变或改装,可能会使使用者丧失操作该设备的合法性。



주의: 규정 준수를 책임지는 당사자의 명백한 승인 없이 이 장치를 개조 또는 변경할 경우, 이 장치를 운용할 수 있는 사용자 권한의 효력을 상실할 수 있습니다.



注意：規制機関から明確な承認を受けずに本装置の変更や改造を行うと、本装置のユーザーとしての承認が無効になる可能性があります。



Warning: Use caution when working with any polymer tubing under pressure:

- Always wear eye protection when near pressurized polymer tubing.
- Extinguish all nearby flames.
- Do not use tubing that has been severely stressed or kinked.
- Do not use nonmetallic tubing with tetrahydrofuran (THF) or concentrated nitric or sulfuric acids.
- Be aware that methylene chloride and dimethyl sulfoxide cause nonmetallic tubing to swell, which greatly reduces the rupture pressure of the tubing.



Attention: Manipulez les tubes en polymère sous pression avec précaution:

- Portez systématiquement des lunettes de protection lorsque vous vous trouvez à proximité de tubes en polymère pressurisés.
- Éteignez toute flamme se trouvant à proximité de l'instrument.
- Évitez d'utiliser des tubes sévèrement déformés ou endommagés.
- Évitez d'utiliser des tubes non métalliques avec du tétrahydrofurane (THF) ou de l'acide sulfurique ou nitrique concentré.
- Sachez que le chlorure de méthylène et le diméthylesulfoxyde entraînent le gonflement des tuyaux non métalliques, ce qui réduit considérablement leur pression de rupture.



Vorsicht: Bei der Arbeit mit Polymerschläuchen unter Druck ist besondere Vorsicht angebracht:

- In der Nähe von unter Druck stehenden Polymerschläuchen stets Schutzbrille tragen.
- Alle offenen Flammen in der Nähe löschen.
- Keine Schläuche verwenden, die stark geknickt oder überbeansprucht sind.
- Nichtmetallische Schläuche nicht für Tetrahydrofuran (THF) oder konzentrierte Salpeter- oder Schwefelsäure verwenden.

Durch Methylenchlorid und Dimethylsulfoxid können nichtmetallische Schläuche quellen; dadurch wird der Berstdruck des Schlauches erheblich reduziert.



Attenzione: fare attenzione quando si utilizzano tubi in materiale polimerico sotto pressione:

- Indossare sempre occhiali da lavoro protettivi nei pressi di tubi di polimero pressurizzati.
- Spegner tutte le fiamme vive nell'ambiente circostante.
- Non utilizzare tubi eccessivamente logorati o piegati.
- Non utilizzare tubi non metallici con tetraidrofurano (THF) o acido solforico o nitrico concentrati.
- Tenere presente che il cloruro di metilene e il dimetilsolfossido provocano rigonfiamenti nei tubi non metallici, riducendo notevolmente la pressione di rottura dei tubi stessi.



Advertencia: se recomienda precaución cuando se trabaje con tubos de polímero sometidos a presión:

- El usuario deberá protegerse siempre los ojos cuando trabaje cerca de tubos de polímero sometidos a presión.
- Si hubiera alguna llama las proximidades.
- No se debe trabajar con tubos que se hayan doblado o sometido a altas presiones.
- Es necesario utilizar tubos de metal cuando se trabaje con tetrahidrofurano (THF) o ácidos nítrico o sulfúrico concentrados.

Hay que tener en cuenta que el cloruro de metileno y el sulfóxido de dimetilo dilatan los tubos no metálicos, lo que reduce la presión de ruptura de los tubos.



警告： 當在有壓力的情況下使用聚合物管線時，小心注意以下幾點。

- 當接近有壓力的聚合物管線時一定要戴防護眼鏡。
- 熄滅附近所有的火焰。
- 不要使用已經被壓癢或嚴重彎曲管線。
- 不要在非金屬管線中使用四氫呋喃或濃硝酸或濃硫酸。

要了解使用二氯甲烷及二甲基亞楓會導致非金屬管線膨脹，大大降低管線的耐壓能力。



警告： 当有压力的情况下使用管线时，小心注意以下几点：

- 当接近有压力的聚合物管线时一定要戴防护眼镜。
- 熄灭附近所有的火焰。
- 不要使用已经被压瘪或严重弯曲的管线。
- 不要在非金属管线中使用四氢呋喃或浓硝酸或浓硫酸。

要了解使用二氯甲烷及二甲基亚枫会导致非金属管线膨胀，大大降低管线的耐压能力。



경고: 가압 폴리머 튜브로 작업할 경우에는 주의하십시오.

- 가압 폴리머 튜브 근처에서는 항상 보호 안경을 착용하십시오.
- 근처의 화기를 모두 끄십시오.
- 심하게 변형되거나 꼬인 튜브는 사용하지 마십시오.
- 비금속(Nonmetallic) 튜브를 테트라히드로푸란(Tetrahydrofuran: THF) 또는 농축 질산 또는 황산과 함께 사용하지 마십시오.

염화 메틸렌 (Methylene chloride) 및 디메틸설폭시드 (Dimethyl sulfoxide) 는 비금속 튜브를 부풀려 튜브의 파열 압력을 크게 감소시킬 수 있으므로 유의하십시오 .



警告： 圧力のかかったポリマーチューブを扱うときは、注意してください。

- 加圧されたポリマーチューブの付近では、必ず保護メガネを着用してください。
- 近くにある火を消してください。
- 著しく変形した、または折れ曲がったチューブは使用しないでください。
- 非金属チューブには、テトラヒドロフラン(THF)や高濃度の硝酸または硫酸などを流さないでください。

塩化メチレンやジメチルスルホキシドは、非金属チューブの膨張を引き起こす場合があります、その場合、チューブは極めて低い圧力で破裂します。



Warning: The user shall be made aware that if the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.



Attention: L'utilisateur doit être informé que si le matériel est utilisé d'une façon non spécifiée par le fabricant, la protection assurée par le matériel risque d'être défectueuses.

 **Vorsicht:** Der Benutzer wird darauf aufmerksam gemacht, dass bei unsachgemäßer Verwendung des Gerätes die eingebauten Sicherheitseinrichtungen unter Umständen nicht ordnungsgemäß funktionieren.

 **Attenzione:** si rende noto all'utente che l'eventuale utilizzo dell'apparecchiatura secondo modalità non previste dal produttore può compromettere la protezione offerta dall'apparecchiatura.

 **Advertencia:** el usuario deberá saber que si el equipo se utiliza de forma distinta a la especificada por el fabricante, las medidas de protección del equipo podrían ser insuficientes.

 **警告：** 使用者必須非常清楚如果設備不是按照製造廠商指定的方式使用，那麼該設備所提供的保護將被削弱。

 **警告：** 使用者必須非常清楚如果設備不是按照製造廠商指定的方式使用，那麼該設備所提供的保護將被削弱。

 **경고：** 제조업체가 명시하지 않은 방식으로 장비를 사용할 경우 장비가 제공하는 보호 수단이 제대로 작동하지 않을 수 있다는 점을 사용자에게 반드시 인식시켜야 합니다.

 **警告：** ユーザーは、製造元により指定されていない方法で機器を使用すると、機器が提供している保証が無効になる可能性があることに注意して下さい。

A.6 Warnings that address the replacing of fuses

The following warnings pertain to instruments and devices equipped with user-replaceable fuses. Information describing fuse types and ratings sometimes, but not always, appears on the instrument or device.

Finding fuse types and ratings when that information appears on the instrument or device:

 **Warning:** To protect against fire, replace fuses with those of the type and rating printed on panels adjacent to instrument fuse covers.

 **Attention:** pour éviter tout risque d'incendie, remplacez toujours les fusibles par d'autres du type et de la puissance indiqués sur le panneau à proximité du couvercle de la boîte à fusible de l'instrument.

 **Vorsicht:** Zum Schutz gegen Feuer die Sicherungen nur mit Sicherungen ersetzen, deren Typ und Nennwert auf den Tafeln neben den Sicherungsabdeckungen des Geräts gedruckt sind.

 **Attenzione:** per garantire protezione contro gli incendi, sostituire i fusibili con altri dello stesso tipo aventi le caratteristiche indicate sui pannelli adiacenti alla copertura fusibili dello strumento.

 **Advertencia:** Para evitar incendios, sustituir los fusibles por aquellos del tipo y características impresos en los paneles adyacentes a las cubiertas de los fusibles del instrumento.



警告：為了避免火災，更換保險絲時，請使用與儀器保險絲蓋旁面板上所印刷之相同類型與規格的保險絲。



警告：为了避免火灾，应更换与仪器保险丝盖旁边面板上印刷的类型和规格相同的保险丝。



경고：화재의 위험을 막으려면 기기 퓨즈 커버에 가까운 패널에 인쇄된 것과 동일한 타입 및 정격의 제품으로 퓨즈를 교체하십시오.



警告：火災予防のために、ヒューズ交換では機器ヒューズカバー脇のパネルに記載されているタイプおよび定格のヒューズをご使用ください。

Finding fuse types and ratings when that information does not appear on the instrument or device:



Warning: To protect against fire, replace fuses with those of the type and rating indicated in the "Replacing fuses" section of the Maintenance Procedures chapter.



Attention: pour éviter tout risque d'incendie, remplacez toujours les fusibles par d'autres du type et de la puissance indiqués dans la rubrique "Remplacement des fusibles" du chapitre traitant des procédures de maintenance.



Vorsicht: Zum Schutz gegen Feuer die Sicherungen nur mit Sicherungen ersetzen, deren Typ und Nennwert im Abschnitt "Sicherungen ersetzen" des Kapitels "Wartungsverfahren" angegeben sind.



Attenzione: per garantire protezione contro gli incendi, sostituire i fusibili con altri dello stesso tipo aventi le caratteristiche indicate nel paragrafo "Sostituzione dei fusibili" del capitolo "Procedure di manutenzione".



Advertencia: Para evitar incendios, sustituir los fusibles por aquellos del tipo y características indicados en la sección "Sustituir fusibles".



警告：為了避免火災，更換保險絲時，應使用「維護步驟」章節中「更換保險絲」所指定之相同類型與規格的保險絲。



警告：为了避免火灾，应更换“维护步骤”一章的“更换保险丝”一节中介绍的相同类型和规格的保险丝。



경고：화재의 위험을 막으려면 유지관리 절차 단원의“퓨즈 교체”절에 설명된 것과 동일한 타입 및 정격의 제품으로 퓨즈를 교체하십시오.

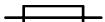


警告：火災予防のために、ヒューズ交換ではメンテナンス項目の「ヒューズの交換」に記載されているタイプおよび定格のヒューズをご使用ください。

A.7 Electrical and handling symbols

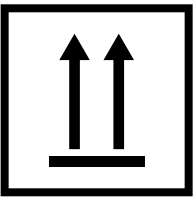
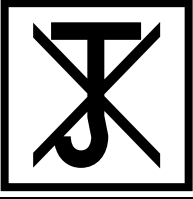
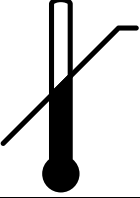
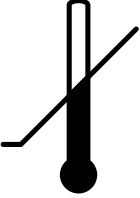
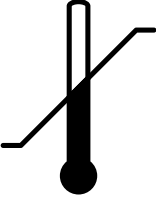
A.7.1 Electrical symbols

The following electrical symbols and their associated statements can appear in instrument manuals and on an instrument's front or rear panels.

Symbol	Description
	Electrical power on
	Electrical power off
	Standby
	Direct current
	Alternating current
	Alternating current (3 phase)
	Safety ground
	Frame, or chassis, terminal
	Fuse
	Functional ground
	Input
	Output

A.7.2 Handling symbols

The following handling symbols and their associated statements can appear on labels affixed to the packaging in which instruments, devices, and component parts are shipped.

Symbol	Description
	Keep upright!
	Keep dry!
	Fragile!
	Use no hooks!
	Upper limit of temperature
	Lower limit of temperature
	Temperature limitation

