SPIROTECH

Maximising Performance for You

HOW TO ACHIEVE HEATING WATER ACCORDING TO VDI 2035 ?

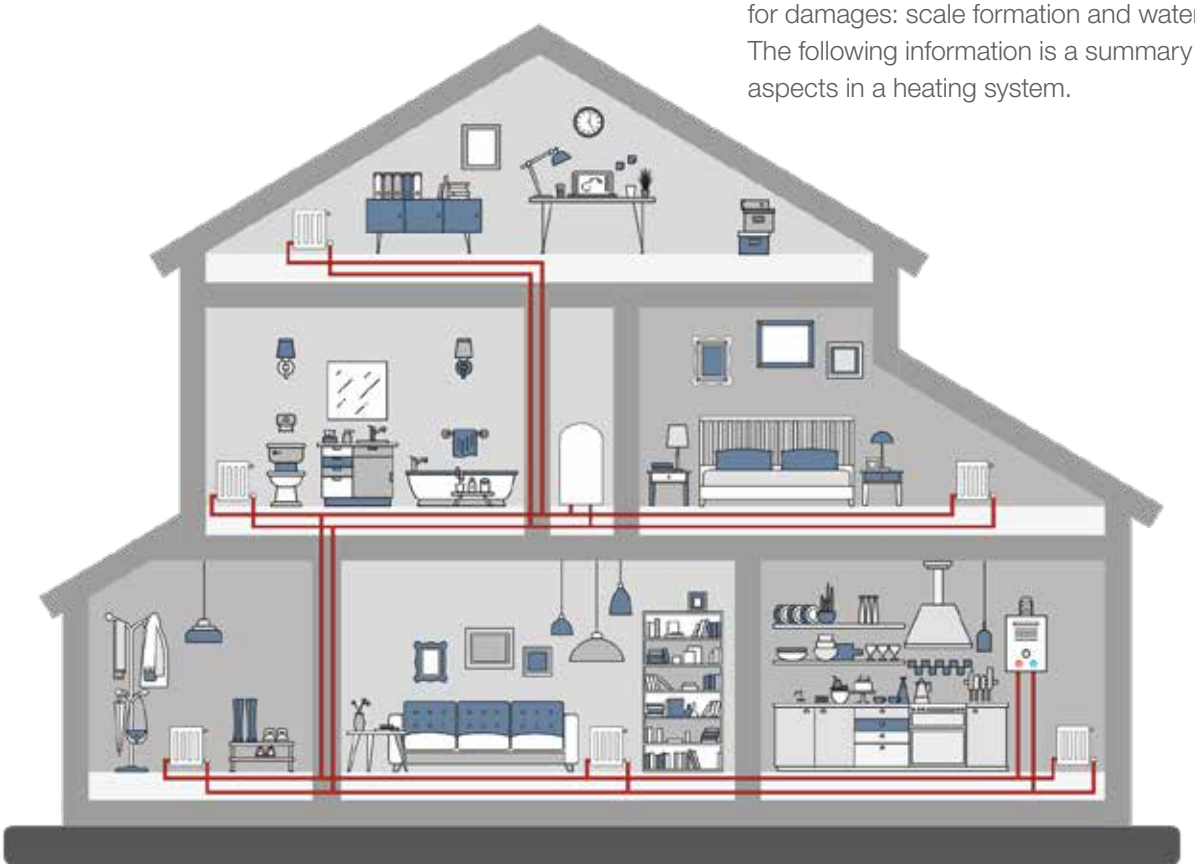
BASICS OF THE VDI 2035

1

Cast iron boilers, voluminous designed pumps and welded piping was yesterday. Today's energy efficient heating systems require a good heating water quality: small and compact heat exchangers are more sensitive to hardness, efficient pumps and valves more sensitive to dirt, Aluminium alloys require a correct pH value, modern installation material call for a different view on corrosion protection (if any possible without chemicals).

The VDI 2035 is a guideline regarding the design, installation, filling and maintenance of heating systems (< 100°C) in buildings. District heating systems are not covered by the VDI 2035 but under the AGFW 510 guidelines. Beware: VDI 2035 is also not applicable for systems where antifreeze agents (e.g. glycol) are used. For more details see table 6.

The recommendations are not only related to the water quality but focus on the prevention of two main sources for damages: scale formation and water-side corrosion. The following information is a summary of all water related aspects in a heating system.



2 HOW TO PREVENT SCALING ?

Scaling reduces the heat transfer resulting in a lower heat performance and increasing energy costs – in extreme cases even damages through overheating stress cracks. Scaling mainly occurs at areas in the heating system with the highest temperatures – the heat exchanger in the boiler. In order to avoid scaling, one major parameter has to be considered: the (total) hardness of the filling and/or make-up water.

The recommended nominal value depends on the total heating output and the specific volume of the system:

	SPECIFIC SYSTEM VOLUME		
TOTAL HEATING OUTPUT	≤ 20 l/kW	> 20 to ≤ 40 l/kW	> 40 l/kW
≤ 50 kW (≥ 0,3 l per kW*)	no requirements	≤ 16.8 °dH	< 0.3 °dH
≤ 50 kW (< 0,3 l per kW*)	≤16.8 °dH	≤ 8.4 °dH	
> 50 kW ≤ 200 kW	≤ 11.2 °dH	≤ 5.6 °dH	
> 200 kW ≤ 600 kW	< 8.4 °dH	≤ 0.3 °dH	
> 600 kW	< 0.3 °dH		

** Specific water content heat generator*

Table 1: Guide values for water hardness

Even for small heating systems it can be necessary to treat the water mainly in hard water areas. For larger heating systems or in heating systems in combination with a heat storage tank (higher specific system volume) a complete removal of the hardness is recommended.

It's important to know that this recommendation only addresses the risk of scaling in the heating systems.

How to avoid scaling? To reduce the hardness of water and to avoid scaling, either softening or demineralisation of the filling and make-up water is applicable.

In this case Spirotech recommends (for most applications) demineralisation of the filling and make-up water (please see also next chapter 3).

Demineralisation with SpiroPure is more appropriate than standard demineralised water as it ensures an alkaline pH value from the very beginning.

HOW TO PREVENT WATER-SIDE CORROSION 3

The hardness of the water mainly influences the risk of scaling. Furthermore, corrosion is a very important factor and the main reason for malfunctions and damages in heating systems. The VDI 2035 describes in detail the different corrosion types and corrosion induced damages which is not subject of this information paper.

More important are the main water parameters influencing corrosion in heating water:

- conductivity
- oxygen content
- pH value
- installation materials
- microbiology
- etc.

Although there are a lot of parameters influencing corrosion in a heating system the VDI 2035 only gives a few but important guide values as these few parameters can be easily measured on-site.

3.1 CONDUCTIVITY

CONDUCTIVITY	low-saline operation: > 10 to ≤ 100 µS/cm
	containing salt: > 100 to ≤ 1500 µS/cm

Table 2: Guide value for conductivity

The electrical conductivity by itself is not an indicator for the corrosion risk in heating water. However, a low conductivity can reduce the risk of metal corrosion.

At first glance it seems to be confusing that the VDI 2035 recommends two different operation modes: low-saline and saline! As long as it is assured that there's no oxygen intake into the system during operation a higher conductivity of the water is acceptable. The use of chemicals in a heating system will also increase the conductivity but not necessarily the risk of corrosion.

There are some reasons why a low-saline operation with demineralised water might be the better solution in most cases:

- **Oxygen intake**
  In modern heating systems oxygen diffusion can rarely be completely avoided due to e.g. plastic underfloor heating pipes or the extensive use of easy to install press-fittings with a lot of gaskets.
- **Mixed installations**
  A majority of installations are made of a mixture of different metals like ferrous metals, stainless steel, Copper, Brass, Aluminium etc. A lower conductivity of the heating water reduces the risk of bimetallic corrosion.
- **pH value and Aluminium alloys**
  In case the heating water has been softened (to achieve the recommended values according to table 1) the pH value can easily exceed 9.0 during operation which leads to higher corrosion with aluminium alloys. Therefore, the VDI 2035 does not recommend softening for installations containing Aluminium but demineralisation.

Spirotech recommends demineralisation for filling, refill or treatment of the heating system to avoid scaling and to lower the risk of corrosion. ☞ **SpiroPure**

3.2 APPEARANCE

APPEARANCE	clear, free from sedimentation substances

Table 3: Guide parameter for appearance

Turbid or coloured (yellowish, brown, black) heating water is mostly an indicator for corrosion and/or microbiology in the system.

If the system water is not clear Spirotech can help to determine the cause with a detailed water analysis.

Even the smallest particles like magnetite can be the reason for malfunctions of high efficient pumps and valves. Furthermore dirt particles can cause erosion within the whole installation. In addition sedimented particles in heat exchangers and radiators reduce the heat transfer leading to a higher energy consumption.

Spirotech recommends the removal of particles and magnetite using a magnetic dirt separator. ☞ **SpiroTrap MB3/MBL/Magnet**

3.3 pH VALUE

pH VALUE	without Aluminium alloys: 8.2 to 10.0
	without Aluminium alloys: 8.2 to 9.0

Table 4: Guide values for pH value

The pH value is a very basic water parameter indicating an acid or alkaline reaction of water. The corrosion risk at a certain pH value depends on the metal material being used: for ferrous metals, an alkaline pH value above 8.0 is ideal to lower the risk of corrosion whereas a lower pH below 9.0 is preferred for Aluminium alloys. Thus, the recommended pH range is a compromise.

It's important to know that the recommendations for the pH value are valid for the heating water and not for the filling or make-up water. Even if the pH value is below the guide values (table 4) directly after commissioning of the heating system the pH value can rise during operation within the first weeks (self-alkalinisation).

The pH measurement should be performed 10 weeks after starting the heating operation or latest being at the yearly maintenance.

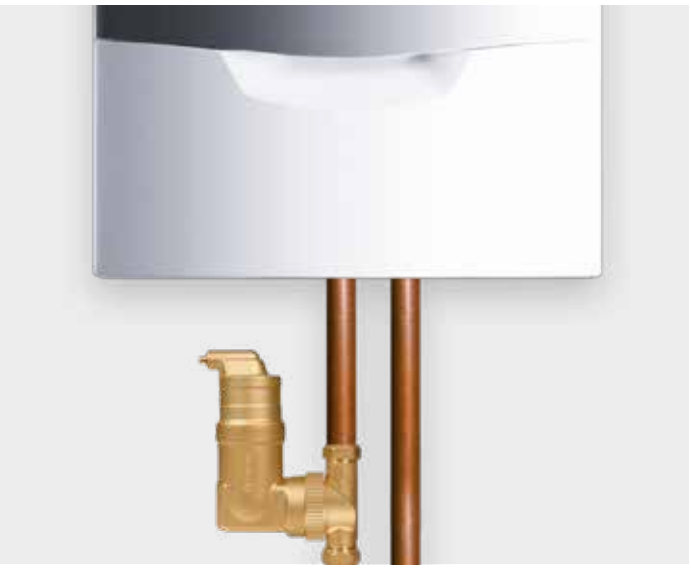
If the pH value is slightly below 8 but the water sample is clear and free of particles then there's no need for any action. A pH value below 7.5 is a signal for increased corrosion risk and the VDI recommends corrective measures in this case.

Spirotech recommends a detailed lab analysis in case of an inadequate pH value. SpiroCare

3.4 OXYGEN

Although oxygen is the major source for corrosion the new VDI 2035 doesn't recommend any guide values for oxygen for some obvious reasons:

- To measure a correct oxygen value, special and very expensive in-line measurement devices are necessary.
- The measured oxygen value is only representative for the place where the measurement takes place and not for the whole system as oxygen can react very quickly with metal surfaces.



Therefore the VDI 2035 focuses on recommendations to reduce or even avoid the continuos oxygen intake into the system:

PROBLEM	SOURCE	ACTION ACCORDING TO VDI 2035	ADDITIONAL RECOMMENDATION SPIROTECH
Local under pressure	Inappropriate pressurisation	Correctly designed and operated pressurisation	See 4.3
Air pockets	Insufficient venting	Proper venting during and after filling process	Continuous air removal of the system water → **SpiroTop and SpiroVent**
Diffusion	Insufficient plastic piping, sealings, membranes, hoses	Use of material with low oxygen permeability	Continuous degassing of the system water → **SpiroVent/Superior**
Dissolved oxygen	Dissolved oxygen in the filling and make-up water	Limit the amount of make-up water	Degassing of the make-up water → **SpiroVent Superior**

Table 5: Prevention of oxygen intake

4 FURTHER REQUIRE-MENTS

4.1 GAS BUBBLES & GAS CUSHIONS

Gases can enter a heating system through different ways:

- Gases are dissolved in the filling and refill water.
- Local under pressure due to insufficient pressurisation.
- Formation through chemical and/or microbiological reactions.

The main problem of gas or air bubbles is that they act like an insulation reducing the heat transfer;
for example in radiators or leading to overheating in the boiler. Besides that, they also can create noises in the whole system or even cavitation and erosion at higher flow velocities.

Spirotech recommends the removal of air and gas using an air separator or a vacuum degasser. SpiroVent & SpiroVent Superior

More details about deaeration and degassing of heating systems are described in the VDI 4708-2.

4.2 MICROBIOLOGY

Due to higher efficiency of heating systems and the usage of green heating technologies, the temperature in heating systems has dropped significantly in the past years.
Especially when using a heat pump, flow temperatures of 40° and below are common.

These low temperatures can promote microbiological growth in the system resulting in the formation of biofilms.
Biofilms can…

- ... negatively influence the heat transfer resulting in a higher energy consumption.
- ... lead to local corrosion, the so-called microbiologically induced corrosion (MIC).

Prevention of microbiological growth is mainly limited to the reduction of “food” (e.g. from plastic piping or some sorts of corrosion inhibitors) for the microorganisms.
If microbiological growth is already present, disinfection (biocide) in combination with a mechanical cleaning (air-water flushing) to remove biofilms is recommended.

Spirotech recommends a detailed lab analysis to detect a possible contamination in the heating system. SpiroCare

4.3 PRESSURISATION

The VDI 2035 clearly states that pressurisation can have a significant influence on the corrosion risk in the heating system. The correctly designed and operated pressurisation ensures an over pressure in the entire system and this avoids uncontrolled oxygen intake. Furthermore, the pressurisation avoids regular water loss over the safety valve and therefore unnecessary refill of fresh water with dissolved oxygen.

Spirotech recommends fixed gas expansion vessels with high quality membranes in combination with a vacuum degasser (for smaller heating systems) or pump-controlled pressurisation systems storing the excess system water in pressureless expansion vessels. ☞ **SpiroPress**

More details about pressurisation are described in the VDI 4708-1.

4.4 WATER CONDITIONING WITH CHEMICALS

According to the VDI 2035, the use of chemicals should be limited to the cases where all other measures were not successful. Although, the VDI 2035 does not prohibit the use of chemicals!

It is quite obvious why the VDI 2035 recommends a cautious handling of chemicals: the VDI 2035 is intended to offer a comprehensive but still practical and easy to follow guideline for the control of heating systems. However, the use of chemicals requires increased expertise, knowledge and adequate tools for the monitoring:

- Over or underdosage of chemicals does more harm than good.
- Interactions with the used materials in the installation have to be considered.
- Interdependencies of different chemicals have to be taken into account.
- Frequent monitoring and follow-up have to be ensured.

Please note: the use of chemicals does not automatically mean that the system is no more according to the VDI 2035!

Spirotech recommends in most cases a detailed lab analysis and advice before using chemicals in a heating system.
☞ **SpiroCare and SpiroPlus**

The following chemical conditioning technologies are described:

TREATMENT	REMARK
Hardness stabilizers	• Increase of conductivity. • Risk of sludge forming.
Corrosion inhibitors	• Only to be used in systems with inevitable continuous oxygen intake. • Increase of conductivity (but “good” conductivity). • Local corrosion due to insufficient protection layer. • Risk of sludge and biofilm forming.
Oxygen scavengers	• Only to be used in systems with inevitable continuous oxygen intake. • Increase of conductivity. • Not suitable for all metals. • Risk of biofilm forming.
Electrochemical oxygen binding	• Only to be used in systems with inevitable continuous oxygen intake. • Only really effective at the point of oxygen entry. • Risk of sludge forming.
Alkalinisation	• Increase of conductivity. • Risk of sludge and biofilm forming.
Antifreeze agents	Systems where antifreeze agents are used are not part of the VDI 2035. In that case, the specifications of the manufacturer of the antifreeze agent (e.g. glycol) should be followed. A good quality antifreeze agent contains sufficient treatment products such as corrosion inhibitors so that no further treatment is required.

Table 6: Overview of chemical water conditioning

SOURCE:

- VDI 2035 Part 1
  Prevention of damage in water heating installations – Scale formation and waterside corrosion
  Verein Deutscher Ingenieure e.V., Düsseldorf 2021

SPIROTECH PRODUCT INFO

SPIROTECH PRODUCT	PRODUCT INFO	PRODUCT URL
SpiroCare	As the leading expert in system water quality, Spirotech and ProLab offer an easy to use water sampling and analysis service.	https://www.spirotech.co.uk/products/spirocare/
SpiroPlus	SpiroPlus flushing agents and water additives are designed to bring and keep system fluid and the water system itself in top condition.	https://www.spirotech.co.uk/products/spiroplus/
SpiroPress	SpiroPress enables automatic pressure monitoring and control.	https://www.spirotech.co.uk/products/spiropress/
SpiroPure	All SpiroPure fill and refill systems use a special mixed bed resin that not only removes the residual hardness and dissolved salts from the heating water, but also stabilizes the water pH levels.	https://www.spirotech.co.uk/products/spiropure/
SpiroTop	SpiroTop automatic air vents quickly and effectively remove free air and allow for fast, reliable deaeration when a cooling or heating system is filled.	https://www.spirotech.co.uk/products/spirotop/
SpiroTrap MB3/MBL/ Magnet	Ensuring quick and efficient dirt separation and removal is essential for cost control and energy conservation.	https://www.spirotech.co.uk/products/spirotrap/
SpiroVent	SpiroVent microbubble deaerators remove the microbubbles and circulating air left behind by automatic air vents, or after bleeding valves.	https://www.spirotech.co.uk/products/spirovent/
SpiroVent Superiors	A fully automatic vacuum degasser for heating, cooling and process systems.	https://www.spirotech.co.uk/products/spirovent-superior/

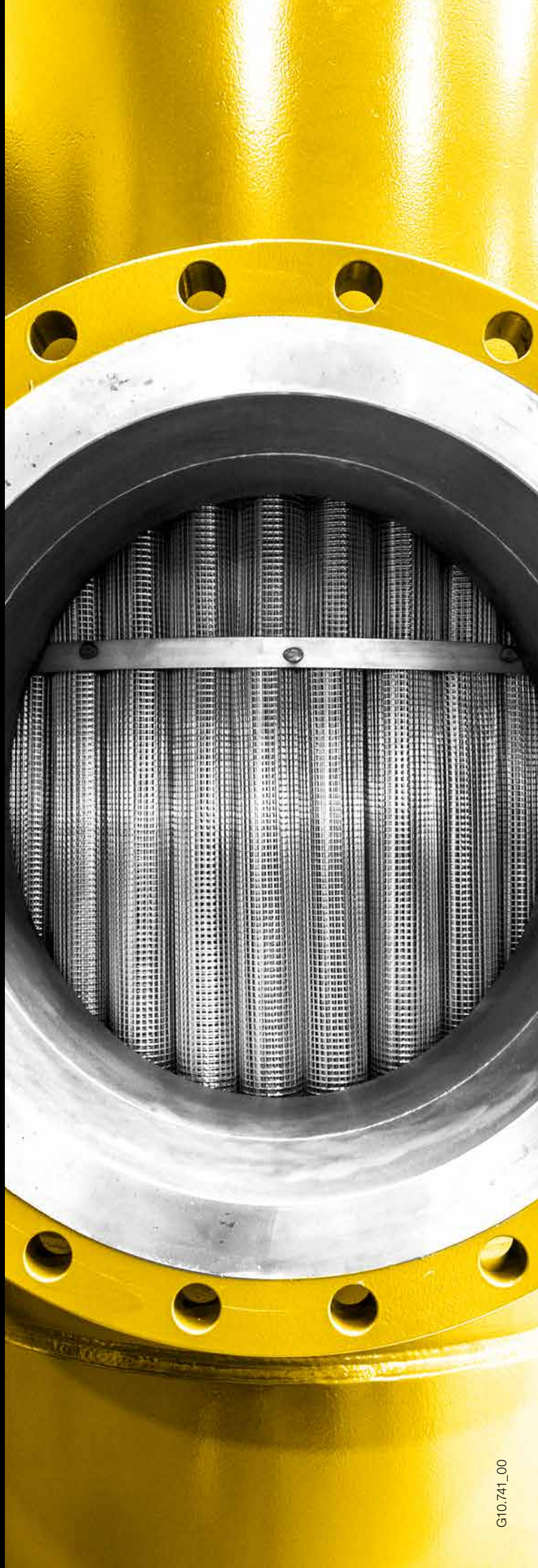
Table 7: Spirotech product info

MAXIMISING PERFORMANCE FOR YOU

Spirotech is a leading expert in improving the efficiency of heating and cooling systems. Our family business has over 60 years of experience in developing solutions for removing and preventing the accumulation of air and sludge deposits in energy systems. Our products save energy, increase comfort, avoid wear and tear and maximise operating periods. Reliable and customer-oriented products that help you get top performance and protect investment in capital assets. We develop high-value solutions with our partners, suppliers and investors that improve the operation of residential and commercial properties, as well as industrial processes. Our comprehensive network of selected importers in over 70 countries means there is always a Spirotech expert near to you.

If you would like to know more about our heating system solutions please visit our website spirotech.co.uk.
Heating and cooling systems are highly complex, particularly when they are run in conjunction with other systems and installations. So locating and analysing faults when they occur is never easy, especially with the clock ticking in the event of a system failure. Spirotech is here to support you with practical advice and solutions, helping you to pinpoint causes and rectify them. Please feel free to contact us.

IF YOU WOULD LIKE TO KNOW MORE ABOUT OUR SOLUTIONS, PLEASE VISIT OUR WEBSITE SPIROTECH.CO.UK.



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