



# Plumbing and Heating Technical Handbook

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We thank all the amazing sponsors that make this competition possible:



## Occupation Overview

Plumbing and Domestic Heating Technicians plan, select, install, service, commission and maintain all aspects of plumbing and heating systems. Plumbing and domestic heating technicians can find themselves working inside or outside a property. Customer service skills and being tidy and respectful are important qualities as they can often find themselves working in customers' homes as well as on building sites.

As a competent Plumbing and Heating Technician, the installation of plumbing and heating systems includes accurate measuring, marking, cutting, bending and jointing metallic and non-metallic pipework. Appliances and equipment can include gas, oil and solid fuel boilers as well as pumps, heat emitters, bathroom furniture or controls as part of a cold water, hot water, and central heating or above ground drainage and rainwater systems. Plumbing and Domestic Heating Technicians are at the forefront of installing new and exciting environmental technologies like heat pumps, solar thermal systems, biomass boilers and water recycling systems. It is important for a plumbing and heating technician to be able to work independently or as a team and use their knowledge and skills to ensure that both the system and appliances are appropriately selected and correctly installed, often without any supervision, and done so in a safe, efficient and economical manner to minimise waste.

[Reference © Institute for Apprenticeships and Technical Education / Plumbing and domestic heating technician]

Whether the Plumbing and Heating technician is working alone or in a team, the individual takes on a high level of personal responsibility and autonomy. From working to provide a safe and reliable plumbing and heating service, in accordance with relevant standards, through to diagnosing malfunctions, and commissioning plumbing and heating systems and components, precision, accuracy and attention

to detail every step in the process matters and mistakes are largely irreversible, costly, and potentially life threatening.

With the international mobility of people, the Plumbing and Heating technician faces rapidly expanding opportunities and challenges. For the talented Plumber there are many commercial and international opportunities; however, they carry with them the need to understand and work with diverse needs, cultures, and trends. The diversity of skills associated with Plumbing and Heating is therefore likely to expand.

[Reference ©WorldSkills International TD15 v8.0 WSC2021 Technical Description]

## Competition Overview

WorldSkills UK is an annual skills competition designed to promote standards and skills across the plumbing industry, developing competence into excellence. The competition sees talented young plumbers test their expertise on a series of challenging practical tests in a bid to be named the WorldSkills UK National champion.

WorldSkills UK can bring invaluable benefits to students, colleges and employers. Competitors can gain recognition for exceptional skills, injecting dynamism and excitement into training. Employers can enhance their business reputation and improve the skills of their workforce.

This guide will provide you with a clear path to follow, from initial registration to the National Finals and beyond.

## Resources

For information and resources, including how to register, competition rules, and the steps to competing, visit:

<https://worldskillsuk.org/champions/national-skills-competitions/tools-and-resources>

For competition specific information relating to Plumbing the WorldSkills UK and SkillPLUMB websites have a lot of information about competitions past and present to help you in getting ready for competition, including a video of a past National competition.

<https://www.worldskillsuk.org/competitions/plumbing/>  
<https://bpec.org.uk/the-bpec-charity/activities/skillplumb/>

## Project specifications

Projects will be designed to test competitor's technical ability to:

- Read drawings
- Interpret Instructions
- Communication Skills
- Work Safely
- Measure
- Prepare work area
- Setting out for installation of pipes and components
- Install Pipes and Components using industry practices
- Test completed work for leaks

## Passive Stage Project overview

The passive stage is open to all registered plumbing students entered for competition. Details will be sent to competitors after registration on the timescale for completion.

This stage consists of a small piece to be completed in your training workshop under the supervision of a plumbing tutor to observe the process. The tutor is not to give technical advice as to how the task is to be completed but can clarify the drawing or information provided by SkillPLUMB.

The task will be completed in 2hrs. The task will be very similar to a plumbing

qualification task at level 2 using copper pipe and endfeed soldered joints. The task will require testing and the test is to be completed within the allocated time.

Upon completion the task will then be marked by your tutor to standards set in this technical handbook and the marking sheet provided. The marks recorded are sent to SkillPLUMB. Analysis of these marks will lead to the selection of up to 72 competitors nationally who will progress to the National Qualifier Stage.

## **National Qualifier Project overview**

All competitions have features included in the task that are essential processes, these are listed below. If you want your work to stand out and demonstrate a higher level of skill that will have an impact on visitors, employers etc. the 'optional features' are good skills to have and in today's work environment, customers' expectations are also high. Keeping to 'optional features' will lead to future work through recommendation.

Included features	Optional features
<ul style="list-style-type: none"> <li>• Interpret drawings read drawings carefully to ensure that the work is produced as drawing and in the correct position etc.</li> <li>• Work safely, keeping work area tidy and wearing PPE as per specification</li> <li>• Organise workstation – the ability to organise tools and equipment to provide space for work and enable an efficient system of work.</li> <li>• Fix pipe supports to structure as per specification</li> <li>• Fix Copper pipe to walls and bend tube to various angles as specified.</li> <li>• Prepare pipe for joints &amp; solder fittings using industry processes.</li> <li>• On completion test installation for leaks</li> <li>• Tasks are challenging and require good time management for completion within time allocated.</li> </ul>	<ul style="list-style-type: none"> <li>• Keep walls clean (no dirty fingermarks on walls etc.)</li> <li>• No undue pencil marks (when marking out for clips etc. keep pencilmarks behind clips or components)</li> <li>• Clean pipe work with damp cloth after soldering to remove all traces of flux.</li> </ul>



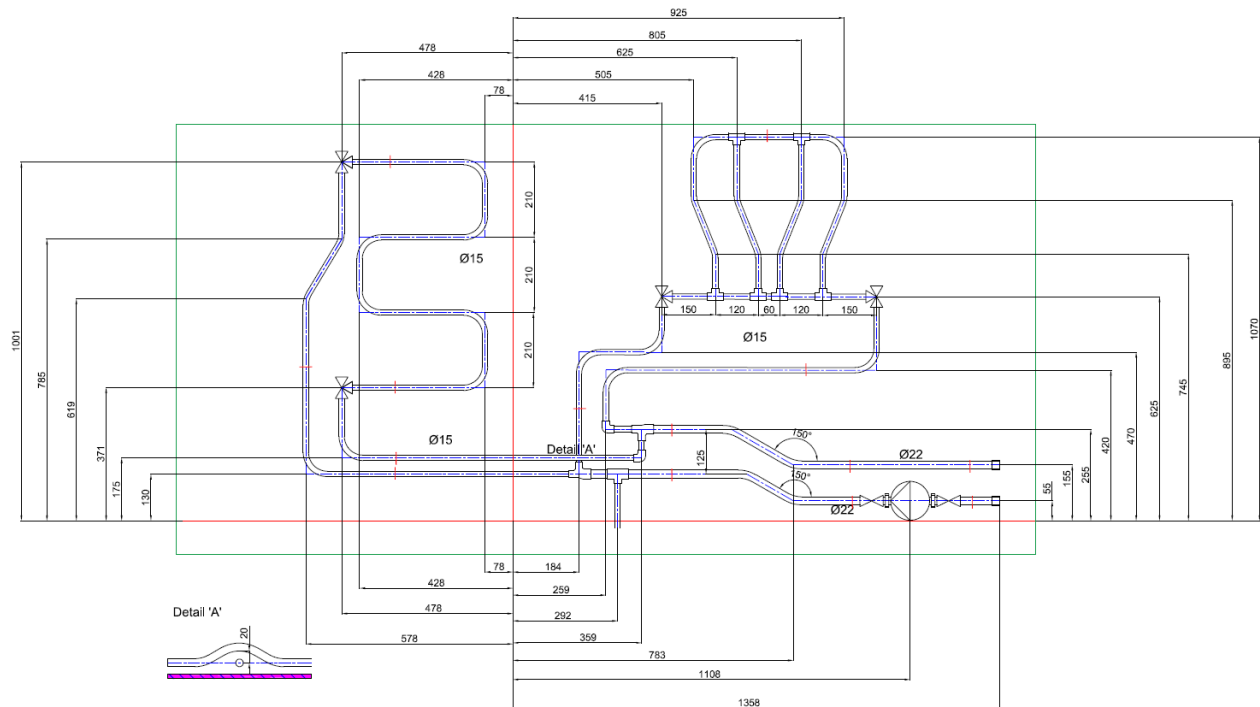
## Project example: National Qualifiers

Details of a past competition is detailed below, with a very simple specification. The task relates to core competencies in bending and jointing pipe and provides stretch to the curriculum with multiple bends and a timescale that requires the competitor to be organized in their planning etc. to complete in the available time.

It is important to remember you are competing against a standard and not the competitor next to you as you will need to be in the Top 8 scoring competitors nationally to get to the next stage, the National Finals

Design specification	
Material	15mm & 22mm Copper Pipe
Time	3.5hrs
Additional data	<ul style="list-style-type: none"> <li>• Pipework exercise to simulate part of a Domestic Heating System.</li> <li>• All soldering to be completed using Lead Free solder</li> <li>• All preparation for bending to be done in competition time (No Templates)</li> <li>• All testing to be completed in competition time (competitor may test prior to asking for official test)</li> </ul>

Example of a previous Qualifier Stage task



## Project example: National Finals

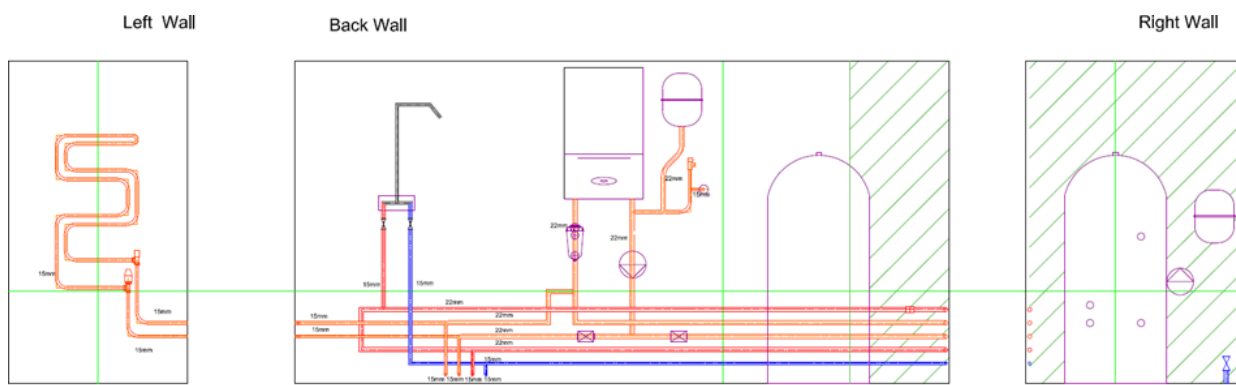
The National Final is a step up from the qualifier and is over three days. Two days of competition and 1 day which is a fun day to demonstrate team working, presenting and explaining to visitors the work you have completed over the competition days. The quantity and quality of work is also a step up from the qualifier as design is included into the task that needs to be communicated by production of drawings prior to installation and then to complete the design as per your drawing.

Design specification	
Material	Heating components (Boiler, Pump, and associated equipment) Hot Water Components (Unvented Hot Water Storage System) 15mm and 22mm Copper Pipe
Time	12Hrs over 2 days
Additional data	<p>Time Management to complete 2 Modules and meet deadlines (competition is over 2 days, so on day 1 approx.50% is completed and ready for assessment and on day 2 the remainder needs to be completed. It is clearly identified on the drawings issued what is to be completed on each day)</p> <p>Interpret Drawings</p> <p>Working Safely</p> <p>Communication Skills – required for communication with judges, for questions, materials and requesting testing of work</p> <p>Measuring Skills - used to position components and pipe as per specification</p> <p>Design part of the pipework installation and produce drawings of the design in 2D or 3D (isometric). To include sufficient detail so a third party could follow the drawing.</p> <p>Prepare work area for installation (organising tools, materials etc. and positioning datum lines)</p> <p>Install components as per drawing,</p>

Bending copper pipe to various angles

Solder copper pipe fittings using lead-free solder

Testing of installation in time at 1bar for 2mins using air.



## Marking Scheme

The marking scheme is designed to fairly compare every competitor's work against the specification for the task and the standards defined and assess the quality of work produced by competitors. Marking is split between measurement and judgement aspects; these are explained below.

## Measurement

Measurement is objective in that, it is either the physical measurement of a dimension or angle. It can also be a yes/no scenario, such as was all PPE worn Correctly another, example is, was the work area kept free of hazards and finally are the walls free from burn marks.

Any dimension on the drawing can be a measurement mark. The value of a given dimension is decided by its tolerance, which are split into:

Dimensions ( $\pm 2\text{mm}$ )

Angles ( $\pm 1^\circ$  using a digital angle finder)

Plumb and Level ( $\pm 0.5^\circ$  using a digital level)

Testing with Air (1 bar – 2 minutes)

When the assessor tests, there are to be no leaks detected to pass. The competitor may check their own work and rectify leaks prior to asking for an assessed test. All to be completed in competition time.

All projects will be supplied with a mark summary form. The mark summary form will show only the number of marks assigned to each aspect, not the breakdown of marks (e.g., Dimensions: 40 marks maximum).

All marks for measurement criteria are “all or nothing”, e.g., if a dimension is specified at  $40\text{mm} \pm 2\text{mm}$ , full marks will be awarded from  $38\text{mm}$  to  $42\text{mm}$ . Anything outside of this will be awarded zero marks.

## Judgement

Judgement marks are more subjective. However, to ensure standardisation of assessment clear objective criteria is required of what each mark will be awarded for.

Judgement is used for aspects such as:

- Soldering
- Clean and Tidy work area – yes/no
- No Burn marks on the walls – yes/no
- Additional screw holes – yes/no

Judges will work to a judgement handbook with examples of each criterion. Each judge will reveal a value from zero to three, and an average will be taken. For example, if all judges assess the machine de-burring as a two overall, the competitor will receive 66% of the possible marks.





## Copper Pipe Joint Quality







Soldering of copper pipe is a common process in plumbing systems and a process that takes time to master. If your soldering is to stand out against other people's work the tips below should help. You can then compare your soldering to the standards required in competition detailed below. If these standards are adopted in your daily working life by achieving a high score you will see that the quality of your work will improve, and that customer satisfaction will increase.

The Soldering tips are:










- Ensure you have cleaned the fitting and the pipe for best results, even with self-cleaning flux.
- Do not over-do the flux – it will not improve quality and will lead to runs.

- Ensure that the flame is not too fierce to burn the fitting and the wall. Heat the pipe outside the fitting to get some heat into it, before putting heat on the fitting.
- Ensure 1 touchpoint when applying solder. Lead-Free Solder only
- Do not wipe solder whilst it is still molten with a cloth or brush, as this will lose marks.
- Wipe pipe and fitting with a damp cloth after soldering to remove excess flux.
- Do not polish the joints with abrasive cloths etc.

TABLE HEADING	PICTURE CRITERION	CRITERION
<p>Gold</p> <p><b>WOW!!!</b></p> <p>"excellent/outstanding"</p> <p><b>3 points</b></p>		<p>(*and* Position)</p> <p>Between pipe/fitting and fitting is around solder visible.</p>
		
		<p>(*and* Position)</p> <p>1 flat start point for soldering is allowed (until Ø28mm)</p> <p>2 or more flat start points for soldering are allowed (over Ø28mm)</p>
		<p>(*and* Position)</p> <p>No drops of soldering or too much soldering are allowed.</p> <p>(Attention: It is not allowed to clean away the additional solder or any drops of solder!)</p>
		<p>(*and* Position)</p> <p>The pipe and the fitting are clean of all soldering Flux.</p> <p>(Attention: It is not allowed to clean away the additional solder or any drops of solder!)</p>

<p>Silver</p>  <p>better than "meeting the industry standard"</p>			<p>(*and* Position)</p> <p>Between pipe/fitting and fitting is around solder visible.</p>
<p>2 points</p>			<p>(*and* Position)</p> <p>Until Ø28mm more than 1 flat start point (or around) for soldering are visible.</p>
			<p>(*and* Position)</p> <p>No drops of soldering or too much soldering are allowed. (Attention: It is not allowed to clean away the additional solder or any drops of solder!)</p>
			<p>(*and* Position)</p> <p>The pipe and the fitting are clean of all soldering Flux. (Attention: It is not allowed to clean away the additional solder or any drops of solder!)</p>



<p><b>Bronze</b></p>  <p>"meeting the industry standard"</p> <p>1 point</p>			<p>(*and* Position)</p> <p>Between pipe/fitting and fitting is around solder visible.</p> <p>(*and* Position)</p> <p>Until Ø28mm more than 1 flat start point (or around) for soldering are visible.</p>
<p>Oops, what is that?</p>  <p>"not competent"</p> <p>0 point</p>			<p>(*and* Position)</p> <p>1 drop of soldering is on the Pipe/Fitting.</p> <p>(*and* Position)</p> <p>The pipe and the fitting are clean of all soldering Flux. (Attention: It is not allowed to clean away the additional solder or any drops of solder!)</p>
<p>Oops, what is that?</p>  <p>"not competent"</p> <p>0 point</p>			<p>(*and/or* position)</p> <p>Between pipe/fitting and fitting is not around solder visible.</p> <p>(*and/or* position)</p> <p>Too much solder is visible or more than 2 drops. (Attention: It is not allowed to clean away the additional solder or any drops of solder!)</p> <p>(*and/or* position)</p> <p>The pipe and/or the fitting are not clean of all soldering Flux.</p>

## Sample Mark Allocation

The table below shows the 7 headings used in a previous competition and marks that are awarded in each section.

Each section then will have assessment points, so for example for dimensions which carries 40 marks the judges may well have between 20 and 50 measurements to check.

The scores then for each section are used at each stage to determine the best competitor. The scores are also used to provide constructive feedback to enable you to determine a plan of action with your tutor for training to improve your performance at the next stage of competition or in your everyday working life.

Summary	Max Mark Available
Task layout and pipework soundness Completed in time and test complete with no leaks	8
Dimensions +/-2mm	40
Joint Quality Judgement 0-3	12
Bend Angles +/- 1o	8

Plumb & Level  +/- 0.5o	6
Material Usage & overall presentation No additional materials such as pipe/fittings  No Burn marks on walls  No additional holes on wall surface	16
Health & Safety  Clean and Tidy work area no debris on floor etc.and safe working environment.  PPE to be worn as specified.	10
Cumulative Result	100

## Equipment

During the competition at the National Qualifier and National Finals, a limited number of tools and equipment will be required to complete the task. To maintain standards of fairness for all competitors, it is essential that every competitor has access to the same tools. This will be checked by judges prior to the competition rounds taking place. The tools listed below will be required to perform the tasks at both National Qualifier and National Final Stage, no other tools are permitted. Competitors are to provide their own tools for competition.

TOOL
2 x Adjustable spanners to suit compression connections (15mm & 22mm)
Full set of Screwdrivers flat and cross head
Battery Drill driver with spare battery / charger with bits (No impact drivers)
Bradawl
2 x adjustable Water pump pliers
Junior Hacksaw complete with spare blades
Tape measure (3m)
Steel rule 300mm / 600mm / 1000mm types
Digital Small and Large (600mm) spirit levels
Protractor / Angle finder
Pencils, rubber and pencil sharpener

Plain paper for drawing templates or roll of lining paper(no pre-prepared templates)
Tube cutters (i.e., pipe slice) 15mm and 22mm
Tube reamer
Claw Hammer
Pipe bender mechanical 15mm – 2mm (portable hand scissor bender only)

Blow torch and cylinder
Soldering Mat
Cleaning pad, flux and Lead-Free solder suitable for potable water
PTFE tape
Tool Bag

## Personal Protective Equipment (PPE)

PPE
Goggles / safety glasses (clear) Mandatory to wear
Gloves
Safety boots / shoes
Work-wear trousers or overalls

## Training

### Self-directed training

Every competitor is encouraged to practice at work or in college, to ensure that they have the best chance of competing in the competition. To assist with any training needs that competitors might have, the SkillPLUMB website has information and In-House activities that are free and open to all. There is also information on marksheets in order to assist competitors with preparing for the competition.

The link to these resources are

<https://bpec.org.uk/the-bpec-charity/activities/skillplumb/>

On the website there is a guide titled “Training to Succeed” which outlines the competition journey, including tips and training materials. Competitors can use these guides to build into their own confidence and get ahead of the competition.

## National Finals training

As part of the invitation to compete at the National Final, SkillPLUMB provide examples of past competitions at National Level to help develop competitors. This is an excellent opportunity for all competitors to boost their confidence using skills and equipment in a safe environment, while replicating the competition project and expectations.

In the past our sponsors have provided manufacturer's instructions etc. to help train competitors in the installation of components.

BPEC provides finalists with a lot of information closer to the competition to help the development of competitors.

## Judges top tips

- Keep yourself fit
- Have a 'can do' attitude – all competition tasks are possible
- Reflect on your own performance, what's good and what needs improving – write it down
- Always read it thoroughly, make sure you understand what is required.
- Ask questions to clarify what is required.
- Concentrate on your performance not that of others – don't look at others whilst competing
- Prepare yourself for a change in plan – especially when you make an error. Park the problem, re-plan and move on. Think: "I can still do it".
- Prepare yourself for a noisy and distracting environment. Could you do plumbing in front of the crowd at Wembley on cup final day? At the National Final there will be many people watching you during the week – you need to be in the zone where they are not there.
- Don't drink energy drinks – they give a short energy burst then your performance and concentration will drop dramatically
- Eat bananas rather than energy bars – they give a slow, lasting energy release rather than a quick boost.
- Set times for various stages of the task that are achievable as this will make you feel good as you check your progress.
- There are no daft questions! If something doesn't make sense –ask.
- Don't bring impact drivers, they are not permitted.
- Have spare batteries for any tools



- Hand wipes are an easy way of keeping hand clean
- If using digital levels make sure they are calibrated as per manufacturer's instructions prior to starting
- Do not bring blackboard/whiteboard instruments as may not be accurate. Consider a digital angle finder.
- Do not be afraid to go back to tasks you did in your first few days and weeks of training but do them much better, first time.
- Listen to the advice of where to place datums and ensure they are accurate as judges will measure from these.
- Think about tooling – what do I need? Keep them close - don't waste time walking around looking for things.
- Take care using a tape measure as the end that's loose may well exceed the tolerance you're working to.
- Flatten your solder, it will make you more in control of your soldering 15mm of solder for 15mm pipe, 22mm solder for 22mm pipe is about right for the finished product.

## National Finals

### What to expect

In previous years, the National finals were a huge large-scale event, usually taking place at the NEC, Birmingham. There were many skills in diverse sectors, so you had to be prepared to do a lot of walking in potentially crowded areas and your family, friends, and other visitors would try to get the best views of intense competitions going on.

Employers were able to enter the competition floor with the permission of the competition manager; and take sponsorship photos or gain a better understanding of the competition itself. Competitors were also expected to wear the appropriate H&S equipment (e.g., safety boots, glasses) while competing.

The competition stand will be prepared with all the equipment necessary to compete. Each competitor will have a dedicated workspace and will have a session to familiarise themselves with the surroundings and check materials for the task. Competitors are expected to wear the appropriate H&S equipment (e.g., safety boots, glasses).

Below is a picture to demonstrate what a workstation at the finals could look like, sourced from a WorldSkills Final that took place in a prior year.



An example timetable for the National Finals:

On the arrival day competitors arrive with tools and are allocated a workstation. They also have a briefing to get to know each other and the judging team, with time for questions etc...

The main competition is over two days with Module 1 completed day 1 and the following day complete Module 2.

	Arrival Day	Competition Day 1	Competition Day 2
7-7.30		Breakfast	Breakfast
7.30 8.30		Walk to competition	Walk to competition
9-10		Competition Day 1	Competition Day 2
10-11	Judges briefing		
11-12			
12-1			
1-2	Competitor Arrival to Venue to include, tool check, induction, technical briefing & familiarisation Datum setup		
2-3			
3-4			
4-5			
5-6		Return to Hotel	Return to Hotel (Judges Marking)
6-7			
7-8	EveningMeal	Evening Meal	Evening Meal
8-9			

## Competition sponsor resource

### information**Tools / clothing**



Good information for the specialist tooling for the plumbing industry <https://monument-tools.com/downloads/>



Information on professional clothing for the construction industry, providing a professional appearance and safety.

[https://www.dickieslife.com/uk\\_en/](https://www.dickieslife.com/uk_en/)

## Learning Materials



BPEC have free learning resources for plumbing including, books, videos and games that can be downloaded <https://bpec.org.uk/shop/free-learning-resources/>

- Plumbing text book
- Essential Plumbing Skills Manual
- ACS Re-Assessment Poster
- Legionella Risk Assessment Paperwork
- Get Gas Safe
- Water Regulations Video
- Cut Your Carbon Game
- Asbestos Awareness
- Electrical Safety Awareness
- The Dangers of Carbon Monoxide (CO)

## Equipment



Information in relation to pumps used in both domestic and commercial environments. With good information on correct installation detail and fault finding. <https://www.grundfos.com/uk/support/install-and-operate>



Worcester Bosch provide the boiler jigs and unvented hot water cylinders and all the ancillary equipment for the National Finals. The website is a good resource for technical information on the installation of a wide range of plumbing equipment. <https://www.worcester-bosch.co.uk/professional>



Provides information on installation detail and a range of products to solve plumbing problems  
<https://mcalpineplumbing.com/help-support#installation-downloads>



Information on the various grades of copper and different types of tube for different installations. Detail of manufacturing and characteristics of copper and why we choose copper.

<https://www.wednesburytube.com/index.html>



In the Tech zone this site provides detail of installation of a range of domestic and commercial components for heating and hot water systems.

<https://www.altecnic.co.uk/>

## Trade / Employer Organisations

There are a number of Trade and Employer associations for Plumbing with a wealth of information on the industry and the benefits of membership etc..



The Association of Plumbing and Heating Contractors

(APHC) <https://www.aphc.co.uk/>



The Scottish and Northern Ireland Plumbing Employers' Federation (SNIPEF)

<https://snipef.org/about-us/about-snipef/>



The Joint Industry Board of Plumbing Mechanical Engineering Services in England and Wales.

<https://www.jib-pmes.org/about-jib-pmes/>



The Chartered Institute of Plumbing and Heating Engineering (CIPHE)

The link below provides access to a wide range of plumbing websites that provide products and installation and support details.

<https://www.ciphe.org.uk/professional-members/industrial-associates/>

## Beyond the National Finals

### Career path and progression

You can develop your skills by taking further training in areas like heating, ventilation and air-conditioning, and renewable energy technologies like solar powered heating.

You can also join the Gas Safe Register or get certified with the Oil Firing Technical Association (OFTEC). These would show you're qualified to work on gas or oil-fired appliances.

You could go on to study for a higher national diploma or degree and become an engineer. This could lead to career options in building services engineering, estimating and contract management.

Reference: <https://nationalcareers.service.gov.uk/job-profiles/plumber>



## Further Competitions

Looking beyond the National finals, there are a host of opportunities for competitors. Age-eligible competitors who show the highest skills, passion, and drive to compete will be invited to train for the EuroSkills and WorldSkills international competitions.

Those who are not eligible for international competitions may join the Champions programme, which allows continued involvement, including the opportunity to work with WorldSkills UK and visit schools, colleges, and events to inspire the next generations.

Alternatively, if training is of interest to you, you could consider supporting WorldSkills UK with organising and training, and even helping to run the National Finals.

**Get inspired and you could become part of Team UK!**

