

1. Introduction

People have lived on-board their boats along the UK's canal networks since the canals were first built. In Britain this was prior to the Industrial revolution for trade distribution purposes.

Today many people live along the canal by choice as it brings a freedom that conventional living cannot offer. Over the past few years London has seen a rise in residents, The Greater London Authority (GLA) predicts population growth of approximately 1m people every 5 years. With population growing faster than homes can be built, canal living is an essential component of the overall housing mix. Such densification brings with it problems of nuisance, this occurs along the canal as well as along our streets.

With a lack of available infrastructure along the towpath, boaters need to use alternative fuels for heating and electricity; in many areas this has led to noise and smoke nuisance for residents living alongside the canal. Exposure to high levels of smoke and diesel emissions is well documented as being harmful to health.

This best practice guide aims to provide advice about fuels and techniques that can help to improve the surrounding environment as well as protect the health of boaters and surrounding residents.

2. History

In 1812, the Regent's Canal Company was formed to cut a new canal from the Grand Junction Canal's Paddington Arm to Limehouse, where a dock was planned at the junction with the Thames. The architect John Nash played a part in construction, applying his concept of 'barges moving through an urban landscape'.

Completed in 1820, it was built too close to the advent of the railway age to produce the financial success that had been envisaged - at one stage only narrowly escaping early conversion into a railway. But it was subsequently to become instrumental in much commercial development throughout the 19th Century.

Together with the Grand Junction Canal and the associated routes to the Midlands and north, the Regent's Canal formed an essential component in southern England's transport system. Huge quantities of timber, coal, building materials and foodstuffs were carried and long-distance traffic continued to use it into the 1960s. (*Source: Canal and River Trust 02/04/2014*).

3. Legislation

3.1 Environmental Protection Act 1990

Part III of the Environmental Protection Act 1990 (EPA) covers statutory nuisances and clean air. Section 79 of the EPA specifies which matters may constitute a statutory nuisance. Most of the items are relevant to boaters as well as land dwelling residents and businesses; these are listed below.

Section 79 (1)

- (a) any premises in such a state as to be prejudicial to health or a nuisance;
- (b) smoke emitted from premises so as to be prejudicial to health or a nuisance;
- (c) fumes or gases emitted from premises so as to be prejudicial to health or a nuisance;
- (d) any dust, steam, smell or other effluvia arising on industrial, trade or business premises and being prejudicial to health or a nuisance;
- (e) any accumulation or deposit which is prejudicial to health or a nuisance;
- (f) any animal kept in such a place or manner as to be prejudicial to health or a nuisance;
 - (fa) any insects emanating from relevant industrial, trade or business premises and being prejudicial to health or a nuisance;
 - (fb) artificial light emitted from premises so as to be prejudicial to health or a nuisance.
- (g) noise emitted from premises so as to be prejudicial to health or a nuisance;
- (h) any other matter declared by any enactment to be a statutory nuisance.

Under the EPA local authorities are required to have regard for local conditions and circumstances pertaining to the alleged nuisance before making a determination.

A Statutory nuisance is defined as being something that is “unreasonably interfering with the use or enjoyment of someone’s premises”. Once a local authority officer is satisfied that a statutory nuisance exists then they are required to serve an abatement notice. In practice and in the interest of being reasonable, the officer will speak to the person(s) responsible for the nuisance to reach an informal resolution. In most cases this action is effective and in the case of a boater they may switch off their engine, switch to burning only smokeless fuel or move to a less sensitive location if possible.

In the event that an abatement notice is served under section 80 of the EPA, the officer will specify a timeframe for compliance; this can range from immediately to 3 or even 6 months. The chosen timeframe will be dependent on the level of nuisance being caused and the proportionate cost of abatement.

The receiver of such a notice may appeal to a magistrate’s court within 21 days of the date the notice was served. Failure to comply with the notice is an offence and the person committing the offence may be liable to a fine not exceeding scale 5 on the standard scale (currently £5,000 or up to £20,000 for an industrial or trade premises) with a further fine of up to one tenth of the total value on each day the offence continues after conviction.

In the event of a number of people collectively being responsible for a nuisance, whether or not what any one of them is doing would be a nuisance on its own, then a notice may be served on all relevant individuals under section 81 of the EPA.

3.2 The Clean Air Act 1993

The Clean Air Act was first issued in 1956 after the Great Smog episode of December 1952 which reportedly caused the deaths of 4000 Londoners. A dependence on coal to heat homes coupled with still weather conditions created toxic smog. The Clean Air Act declared smoke control zones which prohibited dark smoke and required that only authorised fuels or exempted appliances were used.

Currently only Part 1, Section 1 of the Act “prohibition of dark smoke from chimneys” applies to boats. When applying the law there is an acceptance that there may be a small amount of dark smoke on start-up if the engine when started was cold, however, if after a few minutes the dark smoke continues to be emitted from the chimney then the owner/occupier of the boat will be guilty of an offence and may be liable to a fine of up to £5,000.

The requirements to only burn authorised fuels and/or use exempt appliances applies to all properties within smoke control zones (unless exceptions have been made) this does not apply to boats. Mooring rules may specify restrictions on what types of fuel to use and this would be enforced by the Canal & River Trust.

3.3 The Environment Act 1995

Part 4 of the Environment Act 1995 details the requirement for a national air quality strategy which will contain policies with respect to the assessment or management of the quality of air. The strategy specifies air quality objective limits passed down from EU legislation which must be met by each member state. If it is considered that these objective limits will not be met, then the relevant authority will need to declare and Air Quality Management Area (AQMA). This can be within all or part of a local authority’s designated boundary.

The local authority is required to have in place an Air Quality Action Plan (AQAP) which will detail all the actions it proposes to take to reduce pollutant concentrations within the AQMA in order to meet the objective limits. Progress reports are required to be submitted to Defra each year to demonstrate the effectiveness of the plan.

4. Fuels and associated health effects

4.1 Wood

If using wood for fuel it should be well-seasoned and dry; ideally the wood will have been dried out until the moisture content is less than 25%; a moisture meter can be purchased to test this. Hardwoods will burn for longer than softwoods, if the wood is wet it will burn inefficiently, reducing heat to the room and more wood will be required.

Waste wood should never be used as it is likely to contain chemicals that will burn off when burned. These will be toxic and can cause ill health effects as well as polluting the local environment.

Whilst wood is considered to be low in carbon the other pollutants (nitrogen dioxide and particulate matter) which affect local air quality and public health are very high.

Burning wood releases large amounts of Particulate Matter (PM) into the atmosphere. The adverse health effects of these inhaled particles are very much dependent on their size and toxicity (Bolling et al, 2009). Smaller particles are able to penetrate deeper into the lungs and create more severe health effects. Researchers have found that even natural wood emits significant quantities of known health damaging properties including gases as well as PM (Naeher et al, 2005). The main components comprise of carbon (CO), nitrogen oxides (NO_x) and many other carcinogenic and dangerous chemicals. The particulate matter in wood smoke is so small windows and modern homes can't keep it out.

Studies have shown that exposure to wood smoke has a range of adverse health effects such as decreased lung function (particularly in children), increased respiratory symptoms, aggravated asthma, irregular heartbeats and premature death in people with heart or lung disease.

4.2 Diesel

There are many recent studies which prove diesel exhaust is damaging to health and the environment. Diesel exhaust is a complex mix of gases and fine particles known as 'soot'. It contains more than 40 toxic air contaminants known to be cancer causing including benzene, arsenic, and formaldehyde. It is a component of urban smog and there are many known health implications associated with exposure to diesel exhaust emissions.

The Health and Safety Executive report that short term exposure to diesel emissions can cause irritation to the eyes and respiratory tract. Moving away from the source will reduce these symptoms; however, prolonged exposure could lead to coughing, chestiness and breathlessness.

In 2012 the World Health Organisation classified diesel as being carcinogenic (cancer causing in humans). The International Agency for Research on Cancer (IARC) stated they had based their decision on “sufficient evidence that exposure is associated with an increased risk for lung cancer”.

Almost all canal boats have diesel engines to propel the motor for navigation. Many boats also run their engines to produce electricity for charging batteries. The advantages of diesel are that it's fuel efficient and low in carbon dioxide (CO₂), however it produces 4 x more Nitrogen oxides (NO_x) and 22 x more particulate matter (PM) than petrol.

4.3 Smokeless fuel

Smokeless fuels include gas, electricity and anthracite as well as many brands of solid smokeless fuel. These products have been tested to confirm they are able to be burned in an open fireplace without producing smoke. A current list of smokeless fuels can be found at <http://smokecontrol.defra.gov.uk/>.

This is the most common form of fuel used by boaters. Good quality smokeless fuel will burn for longer than a cheaper product thus reducing the need to use additional kindling and creating more smoke. In the long term this will also be more cost effective.

Emissions from solid smokeless fuels are lower than conventional coal and wood. The legislation used to authorise fuels under the Clean Air Act dates back to 1963 and was devised to reduce sulphur and eliminate dark smoke; therefore smokeless fuels will still produce some emission to the air. Incorrect burning may still cause smoke and result in nuisance being caused.

4.4 Electricity

Using mains electricity to charge items on canal boats produces no emissions at the point of use and is therefore considered to be clean. All residential moorings will have mains electricity, however this is not readily available across the canal network. Not all boats are set up to be able to “plug in” so some modifications may be required.

4.5 Solar Panels

Solar energy is a renewable source, which means it is an energy from a source that is naturally replenished. Once fitted, they provide a sustainable source of energy without any harmful emission released into the atmosphere.

There are three different types of panelling, rigid, semi-flexible and flexible. The rigid panels can be fixed to the roof and can be angled towards the sun to receive

optimum sunlight. The semi-rigid panels are extensively used on boats because they have a very hard wearing surface making them almost impossible to break. The flexible panels are usually fixed or glued to the top of the boat and can't be moved. This sort of panelling depends on direct sunlight making it the least effective option.

4.6 Wind Turbines

Wind turbines have been developed for use on canal boats. These are also a renewable form of energy and will not cause any pollution to the air in the form of emissions but do have the potential to cause noise nuisance. Much of the noise created by wind turbines is often masked by the wind powering the turbine however the fan blades may emit a high pitch tone.

The primary problem with wind turbines is whether there is enough wind available to power the turbine. Many locations across the canal network are sheltered by buildings and trees which are not favourable conditions for making the best use of the wind turbine.

4.7 Noise

The noise from boat engines can vary quite considerably. Legislation exists to control noise emissions from new boats built after 2005 but as the majority of the boats on the canal are older than this the legislation does not apply.

The health effects of exposure to very loud noise include tinnitus and temporary hearing loss. This temporary loss of hearing is also known as temporary threshold shift (TTS); an individual's hearing can recover from TTS provided they are not further exposed to loud noise. Continued exposure to loud noise can result in permanent threshold shift (PTS) which is a permanent loss of hearing.

We do not usually expect environmental noise to be such that it will lead to permanent hearing loss, however the health effects can be just as severe. The World Health Organisation (WHO) report that acute noise exposure can lead to increased blood pressure and increased heart rate. The "guidelines for community noise" 1999 suggest an increase in ischaemic heart disease when noise levels exceed 65-70dB.

The most common effects of environmental noise are lack of sleep and lack of concentration which will both lead to stress and inability to function at work or school. Environmental noise is also considered to exacerbate a number of mental health symptoms including anxiety, emotional stress, nausea, headaches and an increase in social conflicts.

5. Maintenance

5.1 Engine

A modern narrowboat diesel engine can cost anything from £20,000 upwards. Vintage engines are becoming increasingly popular among traditionalists. However, they are slower, noisier, and more polluting.

The best way to keep your engine fully maintained is to have it serviced regularly by a qualified marine engineer. However, there are several steps that can be taken to keep your engine running at optimum efficiency. The benefits of carrying out regular, simple checks and maintenance have a long-term impact on personal finances and the environment. By keeping components in the engine clean and running efficiently it reduces emissions caused by diesel which are known to be hazardous to health and the environment. Just one litre of leaked oil contaminates over one million litres of water, which can be fatal to fish and aquatic life. Here is a checklist below, it is meant as a guide, as engines differ greatly.

- Check oil levels regularly.
- Make sure your fuel tank is topped up with diesel. This is particularly important in winter to prevent rain and condensation issues.
- Change oil and oil filter at least once a year.
- Check gearbox oil at least once a year.
- Change air filter at least once a year. This will stop dust and small particles entering the combustion chamber, preventing damage to the engine.
- Check fan belt regularly (if your boat has one).
- Ensure all moving engine parts are fully greased.
- Keep spare cooling hoses on board - If the rubber perishes and engine coolant runs away your boat will stop! Furthermore, engine coolant that runs into the canal is polluting and damaging to wildlife and vegetation.
- To prevent 'diesel bug' which can clog up filters and engine components, remove water that has built up in tank when required. Add a combination biocide and de-emulsifier to protect against reoccurrence.
- Check anti-freeze strength- top up as required. This has two functions, it act as anti-corrosive and stops the engine freezing.
- Regularly check couplings on boat. If bolts are loose, any movement could sheer them off causing loss of propulsion.
- Bilges need to be checked to ensure they are not full of water and oil which has the potential to be thrown over your engine precipitating early failure.

There are other things that can be considered when looking at engine maintenance. Find out if your boat has a 'fuel trap separator'. This is a device that can be fitted to your engine on top of your fuel tank. It separates any unwanted water from the tank and removes solid contaminants that might otherwise build up in the fuel chamber. It is worth mentioning that the separator doesn't protect your engine against diesel bug.

5.2 Batteries

Most canal boats are run on 12v DC low voltage systems. Ordinarily they have two battery banks, one for starting the engine, and a 'leisure' bank consisting of 2-4 batteries used to power most electrical items on-board. This includes lighting, pumps, toilet, fridge etc.

The majority of boats tend to use traditional lead acid batteries as this is the cheapest option. However, it is possible to purchase other types of battery including gel, absorbed glass mat (AGM) and golf cart, generally at a higher cost. Lead acid batteries account for about 98% used on canal boats.

Lead acid batteries (wet) come in two different types, sealed and unsealed. Unsealed batteries are a better option as they can be topped up with distilled water to renew the cells. They can also be readily brought back to life with the aid of mains power or a generator. Given that you follow the instructions below the batteries should last about 4 years.

There are ways of prolonging the life of a lead acid battery, making it more environmentally friendly and cost effective. Sometimes referred to as "deep cycle" batteries, they are designed to run at about 50- 80% capacity. *They are not designed to be fully discharged and recharged as this shortens their life expectancy.* The charge should never fall below 11. 8V. If this advice is not followed you will find yourself having to purchase batteries more frequently. Furthermore, you will need to run your engine more often in order to recharge the batteries. This results in higher fuel consumption, more wear and tear on the engine (particularly the alternator), and increased pollution. Where possible, plan ahead. Think about your battery use. If your budget allows install solar panels which will keep your batteries topped up even when you're away.

Something worth considering, if your budget allows, would be to install a battery monitor. They are used to count the amp hours in and out of your battery. The device can be used to measure input and output of your batteries and is able to regulate the batteries so each battery uses the same amount of power. The advantage of this is that all batteries last the same amount of time, meaning there is no need to dispose of half used batteries when the battery bank is replaced.

Another thing to consider obtain optimum efficiency from your batteries is the wiring on your boat. Charge is lost as it is forced through the circuit, the better the cable you use the less charge lost.

Check batteries are charging correctly on a regular basis. Many boaters tend to run their batteries down quickly by not following the above advice. All batteries have to be replaced at the same time and this can be expensive so it is worth trying to follow these tips!

Some boaters use standby generators as a back- up for topping up flat batteries. These can be noisy and polluting, disturbing local residents and neighbouring boaters. If you have to use a generator for this purpose it is worth looking into

soundproofing it to minimise noise and associated nuisance. If you do decide to soundproof your generator some important factors to consider are:

- Consider airflow and exhaust requirements of the generator. You do not want to cause a fire!
- Ensure the platform that the generator sits on is level. If it is not level it can cause vibrations that add to noise. Some generators have 'legs' that can be used to self-level. It is a good idea to place the generator on a piece of foam to eliminate possible vibrations.
- Insulate the generator with sound absorbing foam. This can be bought fairly cheaply on-line. This is best incorporated in to an enclosure designed to reduce noise output.

5.3 Stove

In order to make your stove more efficient and environmentally friendly there are certain simple steps you can take. Make sure your stove is cool before carrying out any maintenance.

- A good chimney is essential for getting the most out of your stove. Sweep flue before the winter months to remove any soot and tar that might have built up. This allows good draw and prevents chimney fires. You can buy special brushes for this job. I spoke to a boater who uses old boat chains and said it is a very effective method cleaning!
- Examine the register plate and flue pipe seals. Re-joint if necessary.
- Check the door is properly sealed. Replace seal if necessary. These last two steps are essential for getting a good draw on the fire. This will help reduce fuel consumption by keeping your stove airtight. It will also protect against emissions escaping into your boat. These fumes can be unpleasant, but also fatal. Carbon monoxide can kill! Be sure to fit a carbon monoxide alarm if using a multi-fuel or wood burning stove.
- Give the firebox a good clean checking baffle, firebricks, and grate are all in good condition.
- Regularly sweep the and clean the grate.

This might sounds like common sense but a dirty stove will produce more smoke releasing pollutants into the atmosphere.

There are a few basic steps to ensure you get a good fire burning, minimising smoke production and getting the most out of your fuel. You are aiming for a strong glow, NOT flames.

- Make sure the ashes that have built up in the grate are removed before lighting a new fire.
- Open the air vent. Coal burns better with an air supply from below.

- Start to build your fire; first use newspaper. Roll into balls and place in the middle of the grate.
- Add your kindling; scatter around the newspaper. Make sure the kindling is dry before use.
- Light the fire: you are trying to create a hot core in the centre of your stove. Close the door.
- Once the fire is strong enough you can add fuel to your stove (preferably smokeless coal). Don't overload your firebox. About 6-8 pieces of coal should be sufficient to start with.

5.4 Lighting

It is worth considering changing the lighting on your boat to LED lighting. This is a low impact, cheap way of lighting your vessel for a relatively low initial outlay. The lighting uses hardly any power, meaning you are drawing less power from your batteries, thus extending their life. Furthermore, your fuel consumption will be reduced by not needing as much time to charge your batteries, saving on diesel. Wear and tear on other engine components will be reduced as a result of not having the engine on for as long. An LED light uses approximately 1/10th of the power a filament light does.