



7 1/4 Inch Gauge Society Limited

**Driving an Internal Combustion Engine (ICE)
Locomotive**

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Introduction

This manual is intended to introduce Trainees into driving Internal Combustion Engine (ICE) Locomotives as part of the 7¼" Society Proficiency Scheme Gold Award but may also be used as guidance for any club to help train their drivers.

To use this manual to qualify for the Gold Award, you will need to have achieved at least the Silver Award first.

Thanks are due to Ranald Freestone for drafting this guide, and to the many other people, who helped develop these notes further.

Before we even think of driving; there are many things that need to be understood and things to be put in place. Importantly, you need to be sure you have the appropriate insurance paperwork in place. It is important that you check with the owners of the track for any particular requirements or procedures they may have. This will be covered in detail in another module.

For this manual we define an ICE Locomotive as a motorised vehicle using Internal Combustion as the power source. The vehicle may have a riding truck coupled to it for the driver to sit on which may contain some of the equipment mentioned in this manual or may be a self-contained unit like a Tram, Quarry or Mine type locomotive. There are different types of ICE power sources, these are briefly introduced in the next section. It is worth pointing out that this is a 'Driving' Manual so the internal workings of different types of ICE are not explored in detail.

Proficiency Scheme Co-Ordinator.
May 2025

This manual covers:-

- Safety considerations
- Basic Components of an ICE Locomotive
- Preparation; including pre-running checks
- Running
- Disposal

This manual is intended to support and enhance your journey into locomotive operation on a miniature railway, providing some information on design elements, guidance on safe use of the engine and things to consider when your running session ends.

Safety considerations

This module should be read in conjunction with the Health and Safety guidance document that can be found on the 7¼" Gauge Society website.

Miniature railways are a fun hobby and building or owning an ICE locomotive should be fun in its own right. However, in order to ensure it remains enjoyable there are some important considerations to keep yourself and others safe around them.

With this in mind let's consider some sensible precautions around the various elements of operating an ICE locomotive. Safety requirements will form part of the assessment for the Gold Award.

Fuel handling (in particular refuelling)

By their very nature, internal combustion engines require "combustible" fuels. Storage (and indeed purchase of such fuels from garages, etc.) requires the use of appropriate containers and is covered by legislation. As petrol is one of the most volatile, the main points are laid out below:

Storage/purchase by individuals in appropriate containers:

You can store up to 30 litres of petrol at home or at non-workplace premises without informing your local Petroleum Enforcement Authority (PEA). By definition your car/van bringing fuel to or from the track is included as "non-workplace premises." Types of containers include:-

- plastic containers storing up to 10 litres
- metal containers storing up to 20 litres
- demountable fuel tank up to 30 litres

Other fuel storage guidelines include:

- petrol must not be stored in your living accommodation
- petrol must not be dispensed (i.e. it is not pumped either manually or electrically from a storage tank) at your storage place
- if your storage place is not in the open air, you need a direct exit to the open air and appropriate ventilation.
- you should take all reasonable precautions to prevent any sources of ignition or heat that would be able to ignite the petrol or its vapour
- you should not use petrol in the storage place other than in the fuel tank of any internal combustion engine
- It must not be stored in quantities (not exceeding 150 millilitres at any one time), for cleaning or as a solvent for repair purposes

Clubs will have their own fuel storage rules, especially for larger quantities, but this is outside the scope of this document. Please refer to the Club Health & Safety guidelines, assessments and procedures.

Further guidance may be found in [HSE Guidelines](#).

Refuelling and topping-up:

Avoid refuelling or topping-up a running engine, switch off the engine and all electrics prior to refuelling.

Refuelling and topping up of the locomotive should be done at a safe location. If running at a club track, then there may already be a designated locations for the refuelling of ICE locomotives. These locations should have been briefed to you as a club driver or as a visiting driver, if so, follow the instructions given. In addition, locations of fire extinguisher(s) and first aid kits should also be briefed. If no briefing is provided, then it is your responsibility to request guidance as to the relevant information for refuelling, fire extinguishers and first aid.

If no local guidance or briefing is given, then you, the driver, should ensure that the place you choose to refuel is sufficiently far away from possible ignition sources (remember that, particularly with the lighter fuels, that vapour is more of a hazard than the liquid itself so also bear in mind wind direction). Possible ignition sources include steaming bays, idling/operating steam locomotives and even battery charging locations. It may be obvious but don't forget....no smoking!!

It is important to fill the tank carefully, ensuring the correct fuel type is used. Mop up any spillages before re-starting the engine. Remember to place the storage container back into a safe location.

Operational safety:

When operating the locomotive be aware that certain components may become hot to touch, particularly exhaust pipes, electric motors and components and the cylinder block of the engine itself. Residual heat may remain in the ICE itself for some time after being shut down. You need to be aware of this if attempting to work on the locomotive or packing it for transit/storage.

A general safety consideration with any vehicle is entanglement, in other words getting fingers, long hair or loose clothing caught in machinery. Avoid putting anything that may stand a chance of becoming entangled near transmission elements.

The driver should also be aware of the proximity of admiring members of public (especially the small ones!) and caution them if getting too close to hot/dangerous parts of the locomotive as they may be unaware of the dangers involved.

The driver is responsible for the safe operation of their locomotive. If you are a club driver or visiting driver at a club/track then you should receive a safety briefing and/or an accompanied check-ride as per any local procedures, it is on you to follow these instructions and to query any you are uncertain of.

Components of an ICE Locomotive

This section is a very brief introduction to the basic components of an ICE Locomotive. This is a Driving Manual rather than an Engineering or Design Manual so does not cover the detail.

The following is a diagram of the basic components (in most cases variations exist at each level):

ITEM	NAME	PURPOSE
	FUEL (Petrol, Diesel, Gas)	• Chemical Energy to be 'burnt'
 	Internal Combustion Engine + Throttle assembly	• Converts chemical energy to rotational energy by combustion. • Throttle controls amount of fuel entering the system
	Alternator/Generator	• Converts rotational energy of ICE to electricity
 	Drive Motor/s + Speed/Direction Controller	• Converts the electrical energy to mechanical energy • Speed/Direction Controller for reverse and forward selection plus speed
	Transmission	• Chain is shown here, but could be shaft and gearbox
	Driving wheels	• Transfer the energy to forward (or reverse) motion

Fuel – the common types are petrol and diesel; however, propane, butane and kerosene may also be encountered.

Internal Combustion Engine – the heart of the machine, burning the fuel to create (usually) rotational energy. Due to the availability and suitability (and size match to 7¼ dimensions/power requirements), petrol lawn mower type ICE engines are popular. These are also relatively simple to operate and maintain. Other fuel types as mentioned above may also exist as well as, in a few cases, scratch built ICE engines.

Throttle Assembly – Used to control the speed of the ICE engine itself, in many variants of ICE locomotives then this is not necessarily directly linked to speed of the locomotive itself (see comments in the later sections).

Alternator/Generator – Used to generate electricity from the rotational energy of the ICE engine (not present in direct mechanical drive solutions unless ancillary electrical power is required).

Drive Motors – For ICE Locomotives that involve an initial production of electricity, these are electric motors used to drive the wheels and may be a single simple motor, or one per axle or even multiple motors on bogies. These motors are often the same as produced for e-scooters, mobility chairs, etc.

Speed/Direction Controller – Some form of electronic controller between the alternator/generator and drive motors used to adjust the direction and flow of current so as to provide variable speed and direction of travel. There may or may not also be some form of deadman's pedal/switch to prevent accidental operation and/or runaways.

Transmission – Often chain drive but can also include shaft drive and hydraulic drive, to link the drive motors to the wheels themselves. Note that transmissions are covered in a separate module of the Gold Award.

Chassis, Bogies, Bodywork – The rest of the locomotive (Due to varieties available), are not covered in this manual.

Brakes – (not shown in diagram) This module focusses on driving an ICE Locomotive and hence covers considerations related to the locomotive braking systems. Where the locomotive is being used with a separate driving truck, either on a private or club track, it is likely that other braking systems may be available from this vehicle. Examples of braking systems that may be fitted to a driving truck may include, separate mechanical brake or continuous air or vacuum systems. Whatever braking systems are available, always ensure that you know how they work and understand their use.

Preparation

As driver of an ICE Locomotive, you are responsible for the safe operation of your engine and this includes ensuring that it is fully prepared for use, whether you are setting it up for the first run of the day or taking over from a previous driver during a running session.

Preparing the locomotive for a running session. There may be features of the specific locomotive that you are intending to drive and these may be explained in a manual, or more often will be explained by the owner or builder of the locomotive, in either case ensure that you are familiar with these features.

Alternatively, if you are in a situation where you are driving an ICE Locomotive for the first time and there is no third-party advice or support available then take time to understand the features of the locomotive, as far as possible, before proceeding.

The following steps are advisable to follow when preparing any locomotive and should become intuitive over time.

1. Visual inspection

- a. Initially, at the start of the day/running session;
 - i. Is the bodywork in good condition and is it clean?
 - ii. Is there a built-in control panel, if so, are all controls present and in good condition?
 - iii. Is there a handset, if so, is the cable in good condition and does it connect to the locomotive correctly?
 - iv. Are all controls on the handset present and in good condition?
 - v. Is the 'dead man's handle' cable in place – if a dial system controller or similar
 - vi. If there is no handset, is the 'on/off switch/key' in good order and working correctly?
 - vii. Does the locomotive have a mechanical braking system, if so, is this in good working order, do you understand how to operate the brake?
 - viii. Does the locomotive roll freely in both directions? If not check whether this is 'normal' for this locomotive with the owner or builder*.
 - ix. Are there any unusual noises when moving the locomotive? If so, check whether this is 'normal' for this locomotive with the owner or builder*.
 - x. Check that the fuel level is adequate for the planned run, if not then refill (follow the safety instructions above!).
 - xi. Check that there are no obvious signs of fuel leaks. If so, check whether this is 'normal' for this locomotive with the owner or builder*.
 - xii. Ensure that the engine Kill Switch (where fitted) and Fuel Supply Tap are both in the OFF position at this stage.
 - xiii. Check the engine oil level is correct, top up as necessary (check with the engine manual if not sure).
 - xiv. Is there a primary fuse or circuit breaker installed? If so, ensure that you know where it is located.
 - xv. Do all electrical connections within the locomotive look in good condition?

- xvi. Are there lubrication points on the transmission? If so, do you know where they all are? Do you know what type and quantity of lubricant to use?

2. Preparation for use

- a. Preparing the locomotive at the start of a running session.
 - i. Clean the locomotive, use separate cloths for the bodywork and the running gear.
 - ii. Chain and gear drives should be reasonably clean, not covered in dust, dirt or leaf litter for example.
 - iii. If the locomotive has coupling rods, check these for excessive wear or play.
 - iv. Clean around lubrication points (where fitted) and lubricate for first operation.
 - v. Ensure the mechanical brakes (if fitted) are working correctly.
 - vi. Apply the mechanical brakes (if fitted).
 - vii. Ensure that the handset is properly installed with all controls in the 'off' position.
 - viii. Alternatively, if a control panel is fitted ensure this is turned off, or that all controls are in the 'off' position.
 - ix. Before starting the engine, or with the isolator in the off position, gently feel all accessible wiring connections, do they all feel secure?
 - x. Depending on engine temperature, set the choke to an appropriate setting (check with the engine manual if not sure).
 - xi. Turn on the engine Kill Switch (where fitted) and Fuel Supply Tap.
 - xii. Start the engine (by whatever starting mechanism is provided), allow the revs to settle down and reset the choke as necessary for smooth running.
 - xiii. Re-check all controls on handset/control panel are still in the 'OFF' position.
 - xiv. Turn the isolator on.
 - xv. If any fault conditions occur on initial switch on consult the owner or builder* for advice.
 - xvi. If all indications are correct on initial switch on, then proceed.
 - xvii. Check that horns and ancillary functions, lights etc. are working correctly. (non-working lights, for example, may not prevent use, but a non-functional horn might mean that the locomotive will not be allowed to run at club tracks due to their rules).
 - xviii. Check that any 'dead man's' device (if fitted) is working. Where a handset is used for control, a 'dead man's' device, to turn the controller off automatically when activated, is highly recommended.
 - xix. Ensure that the track where the locomotive is located is clear and it is safe to test the locomotive.
 - xx. Operate the 'dead man's' device to activate the controller.
 - xxi. Select the required direction of travel, forward or reverse, release any mechanical brakes (if fitted) and gently increase power using the rotary speed control, trigger lever, or similar and ensure the locomotive responds correctly. Bring the locomotive to a stop.
 - xxii. Select the opposite direction of travel and ensure that the locomotive responds correctly.
 - xxiii. Once all above checks and tests have been performed proceed to Running.
 - xxiv. Ensure that you are fully aware of all rules and practices related to driving on the railway before proceeding*
- b. Taking over driving of the locomotive during a running session.

- i. If you are taking over driving of a locomotive that is already in service, then there are still some checks to be made.
- ii. Ensure that the locomotive is in a safe condition before taking over driving
 1. Are the brakes applied (if fitted)?
 2. Are the controls in a safe condition?
 3. Is the dead man's control active?
- iii. Ask the outgoing driver if there are any issues or concerns related to the locomotive?
- iv. Ensure that all conditions are as expected, including;
 1. Fuel level – is a top-up required (follow safety checks!).
 2. General condition.
 3. Is lubrication required?
- v. Ensure that you are fully aware of all rules and practices related to driving on the railway before proceeding.

Notes.

*In circumstances where there is no-one available to advise on such conditions then proceed with caution and investigate more deeply. Ideally seek advice from other experienced owners or your local miniature railway club.

Running

Ensure that you have authority to run your locomotive on whichever track you intend to use. This might sound obvious, but it can have different meanings dependent on where you will be driving the locomotive. For example, if you are driving on a private track in a garden then you may be the only person running on the track, but if you are intending to drive on a club track then it is essential that the 'Person in Charge' has authorised you to run on the track and that you can enter and run at the specific time.

Regardless of where you are driving your locomotive, in your own garden, on a private line or at a club track, as the driver you are responsible for the safe operation of your locomotive, you should remain alert and aware at all times.

Things to be aware of include, but are not limited to:

- Speed. Is your speed safe, in line with any restrictions and suitable for the conditions?
- Line ahead. Is the line ahead clear of obstructions and other trains?
- Are you aware of the signalling system at the track you are using?
- If other trains are running on the line, do you know where they are?
- Are there people, perhaps children and maybe dogs wandering around?
- Are you pulling a train?
- Are you carrying passengers on the train?
- Are you carrying members of the public, perhaps fare paying, on the train?
- Are you old enough and qualified to drive the train you are planning to haul?
- Are you operating with a Guard and are aware of the standard communications between the pair of you?

Specific details of practices for driving at different railways will vary and are outside the scope of this module. This module assumes that all necessary pre-use checks ahead of starting the train have been performed and the train is ready for you to haul, as driver of your ICE Locomotive.

1. Starting the train.

- a. Consider the weight of your train, are you running light loco, lightly loaded train, or fully loaded passenger service?
 - i. Release any mechanical brake (if fitted).
 - ii. Sound your horn (if permitted/required).
 - iii. In the case of a cable dead man's device, ensure it is in place to enable the activation of power to the loco. In the case of a lever operated dead man's device, this is incorporated in the speed lever and therefore, depressing the lever will provide the electrical circuit supplying the motors to engage, and releasing it completely will break that circuit, thereby starving the motors of power.
 - iv. Gently apply power using the controller, the amount of power required will vary dependent on weight of the train. If starting with a heavy load and/or on a gradient, it may be necessary to advance the engine throttle to provide more electrical power to the system.

- v. Depending on the transmission system, there may also be a clutch provided, as in driving a car, engage the clutch (in balance with the throttle and speed controller) to gain motion – this may take some practice to achieve smoothly!
- vi. Once the train has started to move, use the controller to accelerate the train safely to the desired speed.
- vii. Once on the move adjust the controller and/or engine throttle to maintain a safe and suitable speed for the train.
- viii. Listen to the 'note' of the locomotive - all locomotives sound different, but each will have a distinctive sound when it is running well.
 - 1. This sound will vary according to speed and load, but you should become familiar with it and you will then easily identify if something changes.
 - 2. Along with speed and load this sound will also change if wheelslip occurs. Wheelslip occurs when the locomotive wheels slide on the rail, rather than rotating at the exact same speed as the rail on which they are travelling. When wheelslip occurs, there is a loss of traction and the train will slow down. The wheels will continue to slip until the cause is dealt with. Causes of wheelslip include:
 - a. Railhead conditions, if the rail is wet or perhaps covered in leaves or grease then adhesion is reduced and the amount of power that can be applied is also reduced.
 - b. Weight of the train, if a heavy train is being hauled up a gradient or around tight curves then wheelslip can occur.
 - c. Abrupt changes in power, turning the power controller up too quickly can cause the wheels to wheelslip even on perfectly dry track.
 - d. Sudden increase in load, wheelslip may occur if a vehicle in your train has derailed or is suffering dragging brakes.
 - 3. How will I know if wheelslip is occurring?
 - a. Until you become familiar with your particular locomotive it can be difficult to tell, but there are some clues;
 - i. The train slows down even if the controller is turned up further.
 - ii. The train comes to a halt with the controller still turned up.
 - iii. In each case you should hear a whirring from the motor(s), transmission system, and wheels on the railhead. You will probably 'feel' that the locomotive is still trying to move or move faster than it actually is.
 - b. Once you become familiar with your locomotive you will almost certainly recognise that the sound has changed, and you will 'sense' that the speed of the locomotive does not correspond to the controller setting.
 - 4. How do I avoid wheelslip?
 - a. Whatever the cause of wheelslip, the only way to avoid it, or correct it once it occurs, is to reduce the power to the wheels. Back off the power controller and allow the wheels to rotate at the same speed as the rails are passing. Then, very gradually, turn the controller up again, but back off slightly as soon as you sense wheelslip is restarting.
 - b. In some cases, you may not be able to overcome wheelslip. If your train is heavy and the conditions have changed you may be forced to stop and ask for assistance.

- c. Do not be tempted to continue applying power in the hope that the wheels will suddenly regain grip and get you moving. They almost certainly will not and severe damage can be caused to transmission elements or the wheels themselves.
- d. Good locomotive drivers understand how to manage wheelslip or when to seek assistance if this is not possible.

2. Managing the locomotive along the railway

- a. Maintain awareness of your surroundings, as explained previously, and ensure that you are driving your locomotive at a safe speed and are confident that you could stop the train safely within the distance you can see ahead.
- b. Learn the line, the way that an ICE Locomotive responds to the controller can provide feedback to the driver about the track, where there are gradients, up or down, or where tight curves are creating drag.
- c. Be aware of the location of other trains on the track, even if you can't see them, be aware of whistle or horn sounds, these can help you identify where other trains are.
- d. Learn to understand how much fuel is consumed and how much running time you have remaining. Some, but not all, will have some form of rudimentary fuel gauge. Running out of fuel can mean a long push back, inconvenience to passengers and creates a possible line hazard. Plan ahead for earlier top-ups when getting low.
- e. Most, if not all, ICE engines at this size/scale will be air-cooled, on hot days with lengthy stops it may make the engine run hot, be sympathetic to the conditions and give the engine a break even if you don't need one!

3. Bringing your train to a stop

- a. Whether you are arriving back at a station, stopping at a signal, or stopping for any other reason, always try to stop your locomotive as smoothly as possible.
- b. Use whatever brakes are available and understand how effective they are at different speeds and in different scenarios, including in an emergency.
- c. If running your locomotive on a club track, or large garden layout, there may be either air or vacuum train brakes available. These are the best systems to use when driving if available.
- d. Manual handbrake. Often these are provided on driving vehicles attached to ICE locomotives, although some locomotives may also have them fitted. These can slow and stop light locomotives but are less effective with heavier trains. As a driver you should familiarise yourself with these brakes, where fitted, and understand how many wheels are braked, often only a single axle is braked. Manual handbrakes are most effective at low speeds or for holding a locomotive or train when stationary.
- e. If running with a Guard, be cognisant of the signals they may use to indicate that the need you to bring the train to a standstill, including in an emergency. A Guard may have the capability to operate the train brakes themselves, be aware of the sudden slowing of the train and assist in coming to a halt where possible.
- f. Lastly, if running without a Guard, if held at a signal for an unusually long time or stopped in mid-section for whatever reason, don't forget to take precautions to protect the rear of your train.

Disposal

Disposal is the railway term for what to do with the locomotive once running has been completed.

Each locomotive will vary on what is specifically required, so the following actions may, or may not be applicable. As always, seek advice from the builder or owner regarding your specific locomotive.

1. Taking the locomotive out of service.

- a. Ideally, before running out of fuel, plan to bring your locomotive out of service in a managed way.
- b. Ideally, take your locomotive to a siding or remote section of track to perform the disposal. If you will be handling fuel in any way, this needs to be the safe place designated for ICE refuelling.
- c. Switch off the engine Kill Switch and Fuel Tap, where fitted.
- d. Switch off all the electrical components. Remove any that are removable and stored/transported separately.
- e. The locomotive should be cleaned before putting away, particularly if it has become particularly dusty or dirty, or if it is wet.
- f. If the locomotive has been run in the rain, wipe off all surfaces, remove any panels and ensure that as much moisture as possible is removed from these and the locomotive internals.
- g. Perform a visual check of the transmission, look for any change in chain tensions, or debris in gear teeth, etc.
- h. If the locomotive is to be left in a “ready-to-run” state for possible later use, ensure that it is properly secured to prevent accidental runaway or movement/operation by unauthorized persons.

Questions for the candidate to consider ahead of assessment on this module.

Question 1

What is the greatest element of risk from an ICE Locomotive?

Why is this element the greatest risk?

Can you describe some risks from this element?

How would you mitigate such risks?

Expected answers

The greatest element of risk within an ICE Locomotive is the fuel itself.

This is the greatest risk because of the combustible nature of the fuel sources which are usually more volatile in ICE type cases.

Some of the risks from the fuel sources include:

- *Risk of explosion, fire or burns from fuel/vapour reaching an ignition source such as a locomotive in steam, batteries being charged, individuals smoking, etc.*
- *Improper storage of the fuels when not in use.*
- *Spillages during refuelling.*

Question 2

You appear to have unexpectedly run out of fuel and come to a stand on a remote section of track during public running, what should be your first action? And why?

- a. Re-fuel from the spare container you are carrying
- b. Leave the locomotive securely parked and seek assistance
- c. Take measures to protect the rear of your train
- d. Quickly start pushing the train to get to a safe refuelling spot

Expected answer:

C – we need the situation to be safe with the rear of the train protected, only then can we seek to remedy the problem.

Question 3

In what circumstances would you expect to need to advance the throttle setting of the engine (as opposed to the speed controller of the locomotive)?

Expected answer:

When the locomotive is not able to make sufficient progress even with speed controller at maximum. This may occur when starting off with heavy loads, rounding tight bends or climbing steep gradients.

Question 4

How can I ensure maximum reliability and running capacity from an ICE Locomotive?

Expected answers:

Keep the engine running at an optimum RPM and not over-revving.

Smooth acceleration and braking. Watch and plan ahead.

Regular checks on oil levels.

Maintaining the locomotive is also important, specifically, ensure that all electrical connections are sound and kept tightened.

Check engine maintenance is performed in accordance with owner's manual (where available) – e.g. oil sump levels, air filter cleanliness, spark plug settings, etc.

Check all wiring, particularly where it is subject to flexing or potential chafing where it passes through holes or between panels.

Check that all transmission elements are maintained, e.g.: chain tensions, gear teeth clean, any lubricating points kept lubricated.

Driving practices, use the controller gently, avoid wheelslip as far as possible.

Notes.

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