HIGH LEVEL GEARBOXES – GUIDANCE, HINTS AND TIPS

Guidance notes - general
These notes cover recommended tools (***see italics***), techniques and procedures. As long as you take your time and follow the instructions, you should be fine. Once you've built a few gearboxes, you probably won't need this section as the methods will become second nature to you, but if you have any problems then please feel free to drop us an email, or pick up the phone...

A - Finish-to-Fit
High Level gearboxes build into precision mechanisms which are designed to run with fairly close tolerances. Some holes and components are Finish-to-Fit, which is standard engineering practice to achieve a precise fit of parts. This requires the use of ***basic model making tools*** and will help to ensure that the box performs smoothly and reliably in your loco.

B- Opening out Holes
We have intentionally etched hole sizes for shafts and bushes slightly undersize, so in most cases they will need to be carefully opened out to match the components. Take it slowly as you progressively open out the holes (a ***tapered reamer*** or ***broach*** is ideal for this) until the components, when offered up, are a push-fit in their holes. Remove a small amount of material at a time as you frequently 'gauge' the fit by trying the component in place. De-burr the holes by inserting the tip of a drill bit (of larger diameter than the hole) and gently rotating it between your fingers.

Holes in turned parts, such as axle bushes, may also be finish-to-fit. Occasionally, moulded gears may need to have a small amount of 'flash' removed at the end of bore, which can be done by gently rotating a small round ***needle file***.

C- Axle Bush length
These can be filed flush with the outside of the gearbox if space is tight or, alternatively, you can adjust the length of the bushes to limit gearbox sideplay, thus eliminating the need for packing washers between the box and frames. This is best done before the gears are fitted in order to avoid contamination from filings.

D- Folding the Gearbox and Gearbox Width
Use ***flat-nosed pliers*** to make the bends, gripping the central motor mounting plate with the jaws near the bend lines - this will prevent the plate from accidentally buckling across the motor screw hole centres. Don't use a Hold 'n' Fold or you'll bend the motor mounting lugs over. Note that gearbox width is key dimension which affects the fit of the components. Before re-enforcing the bends with solder, check the width using the remote attachment and, if you have one, a ***digital vernier***, then adjust the width by gentle tweaking.

E- Cutting Gearshafts
Use a ***carborundum disc*** in a ***mini-drill,*** or heavy duty ***cutters*** to cut the shaft(s) to length. Wear effective ***eye protection*** – cutting discs can and do disintegrate if they snag. Remove any burrs with a ***fine needle file***. If space is tight, the length of the shaft should no wider than the overall width of the gearbox, but if you have room to spare you can leave the shaft over-length which will make it easier to fix in place.

F- Fitting Gearshafts and Gears
This can be a tricky job, especially with limited sideplay between parts, but there are ways to ease matters. Try making a slight 'chamfer' on the leading edge of your gearshaft and, if it's still proving difficult, use a ***tapered broach*** (this can be much smaller than the shaft diameter) to locate the parts. Slide the broach through the components as you hold them in-situ then, once all bits are in place, use the gearshaft to push the broach back out. When fixing the shafts in place, a small amount of glue will suffice as there will be no sideways forces acting upon them. In most cases, the gears are free to revolve on the shafts and not fixed.

G- Stage 2, Double Gears (High Ratio Boxes)
In these boxes, the side faces of the stage 1 and 2 double gears are designed make contact, as a way of controlling sideplay. Ensure there is always a tiny amount of sideways clearance in the geartrain to avoid the gears being jammed solid – if none exists, dismantle and inspect the etches for burrs, check the washering arrangements and gearbox width (that it has it been folded squarely and articulated sections are a close fit – see D & H).

H- Articulated Carriages and DriveStretchers
These can be mounted anywhere on an arc, and can be forward or backward-facing, depending on the configuration you require. Some variants may also carry the Idler Gear. They must be a good fit in their locations, with absolutely no sideplay, or this may affect the positioning of the gears (see G & J). Although the gearboxes will run smoothly with the carriage(s) free to swing (for testing only) suitable restraint must be provided in order to prevent the carriage from curling up and fouling the gears when torque is applied. The easiest way to do this is to fix the final drive carriage in one position by running some glue or solder between the layers of the etches.

J- Axle Sideplay and Final Gear Clearance

Control of axle sideplay has been engineered into the design of the gearboxes so, if reasonable care is taken, the components should not foul. Sighting through the gears as you push them fully sideways on their shafts should confirm that the final drive is not binding on any of the gears. To achieve this clearance, the gearbox must be folded up square (D) with the axle bushes located fully home on their holes. Depending on the box (and how it's been built) an axle shim washer may be needed to fine-tune the amount of sideplay – again, this is standard engineering practice.

If you need any more sideplay on the driven axle than the design of the box will allow, then you'll need to arrange for the gearbox to move sideways with the axle, or, allow more sideplay on non-driven axles.

For boxes with idler gears, make sure the idler has the correct washering arrangements, so it runs freely in the space provided for it, without excessive sideplay. If necessary, shim the axle so that the idler gear is always in full mesh with the final drive, as above.

K- Fitting the Worms

Always test the motor before fitting it to the box, or before fitting the worm. The worms provided are not interchangeable between ratios. If the worm is tight on the motor shaft, don't use excessive force to push it on or you may bend the shaft. Instead, ease the fit with a ***tapered broach***, doing a bit at a time and working from both ends of the worm to minimise the effect of the taper. If necessary, secure the brass worm with a small drop of ***Loctite 601*** or ***Superglue*** at the outer end of the motor shaft.

L- Motor Mounting Screws and Motor Position

A variety of motor fixing holes is provided, to allow for different motor types and screw spacings. For most motor types, you can use the lateral (outer) holes, which will allow you to fit (and remove) the motor once the power unit is assembled and installed in the chassis. To use the vertical screw holes, with the gears still in place, tighten the motor screws almost fully home in the motor and then offer it up to the curved recesses in the mounting plate – the screw heads will pass thought the large part of the slots – then twist the motor into place, so the screws are on-centre. You will most likely need to experiment with screw tightness to get best fit, so the motor offers resistance as you twist it into place.

M- Checking the Worm and Gear Mesh

Sight through the opening in the gearbox sides, using a ***magnifier*** if you have one, to check the mesh depth - there should be a small amount of daylight between the gear and the worm. A shallow mesh with excessive backlash could result in gear tooth tip failure, whilst a mesh which is too deep will cause wear as the worm and gear 'bottom-out'. If necessary, loosen the motor fixing screws to make minor adjustments.

N- Lubrication

The gearboxes shouldn't really need much maintenance and the plastic gears are virtually self-lubricating, although some ***plastics-compatible light oil*** will do no harm. Metal-on-metal surfaces, like the axle bushes, should be lubricated as you would for chassis parts, using a light machine oil. **DO NOT USE WD40** as this may destroy the plastic gears...

P- Remote Attachments

For most boxes, we suggest you use these parts to check the width of the gearbox, prior to adding bracing wire and/or strengthening the corners with fillets of solder. Once this has been done they can be removed or, for boxes without bracing arrangements (1mm crosswire), left in place for added rigidity.

The attachments also allow you to drive the gearbox using an input shaft but, as they are likely to find only marginal use, bearings and fasteners are not included and so these will need to be sourced separately. Bearings to fit into our remote drive attachments should match the diameter of the input/output shaft, which can vary between makes - for 1.5mm or 2mm shafts, ordinary ***'straw hat' bearings***, available from Alan Gibson, will work reasonably well, but for a proper engineering job, try to get some that are made from sintered bronze. The worm driveshaft should, ideally, be of ***hardened steel*** (like a motor shaft) but silver steel will do.

To fit the remotes, open out their central holes in the Front and Rear Remote etches to accept either 1.5mm or 2mm bushes and solder these into their holes, making sure they sit dead square. If necessary, open out the small location holes in the front attachment so they fit snugly over the locators (X) on the main gearbox etch, and then solder it in place. The rear attachment can be fitted (after the worm and shaft are slotted into place) securing it in place with 14BA, or similar, ***nuts and bolts*** through the using the outer motor mounting lugs. This will allow you to remove the shaft if necessary. You may need to provide some means (washers or tubing) of preventing the shaft moving backwards and forwards.