TRANSNET FREIGHT RAIL		
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1. SCOPE

1.1 This document covers the procedure that must be used for the repair welding of BS970, grade 080m40 (En 8 to BS970, 1955), steel crankshafts for all compressor exhausters and diesel locomotive engines.

1.2 Any welding to the crankshafts shall be done according to RW/TE/SPC/0077 - "Welder Transitional and ASME IX Qualification specification" or any similar welding code approved by Transnet Rail Engineering - Engineering department or Transnet Freight Rail - VIT.

1.3 The contractor requires written approval from Transnet to deviate from any of the requirements given in this procedure.

2. MATERIAL

2.1 The first requirement before any work is conducted on the crankshaft is verification of the crankshaft material. A chemical analysis shall be performed on the body of the crankshaft away from the journals. Weld repair shall only be allowed on grade 080m40 (EN8) - if it is not grade 080m40, Transnet must be contacted.

3. DAMAGE MEASUREMENT

3.1 Transnet workshops are responsible for visually examining the crankshafts for bending, cracks (using MPI or Ultrasonic) and conducting a dimensional inspection before the crankshafts are sent for repairs.

3.2 The extent of the damage on each journal must be independently evaluated and recorded.

3.3 The maximum depth the journal may be ground to be 3 mm on diameter. If indications deeper than 3mm exist, remove them by dimpling to a maximum depth of 3 mm. Cracks or damage deeper than 4.5 mm shall render the crankshaft not repairable and must be scrapped.

3.4 If the damage is less than 0.38mm deep, the chrome plating process can be used. It is recommended that the chrome plating process be utilised where only single journal repairs are required.

4. PREPARATION OF WORK AREA

4.1 MPI inspection shall be done to procedure RS/ME/PR/023 to determine if the journal is cracked.

4.2 After crack detection, all defects and cracks from the journal shall be removed by grinding, 3mm on diameter. Grinding shall be done using a wheel that has been

dressed to give a radius between the ground and ungrounded material. Care with the radii on both sides should also be taken.

4.3 If cracks or defects indications deeper than 3mm exist, they shall be removed by dimpling to a total maximum depth of 4.5 mm.

4.4 After removal of all cracks and defects, MPI testing, by using procedure RS/ME/PR/023 shall be done to determine if the cracks and defects have been completely removed.

4.5 No cracks or open indications are allowed on the surfaces to be welded.

4.6 Damage to the thrust face must be ground and welded with this procedure using a wire giving weld strength of 70 Psi.

4.7 For diesel locomotive crankshafts, if crack indications exist on the radius and/or oil hole, the crankshaft must be scrapped.

5. PREPARATION OF OIL HOLES FOR JOURNAL WELDING

5.1 After the journal has been ground undersize for welding, a 30-degree chamfer must be put on the oil hole to approximately 3mm in depth.

5.2 During welding, plugs must be inserted in the oil holes to sustain the welding arc.

6. PROCESS

6.1 The Submerged Arc Micro Welding process with direct current reverse polarity welding is to be used.

6.2 Before welding or welding over previously deposited material, all slag, oil, grease, MPI fluid and any other contaminant, like rust, shall be removed and the weld and adjacent material shall be brushed clean.

7. ELECTRODE AND FLUXES

7.1 The welding must be done with a low carbon steel wire.

7.2 The flux selected must be such that the weld metal obtains a hardness of 45 - 50 HRC. If for some reason the hardness is not obtained, the hardness can be increased with surface treatment like nitriding only. Transnet must however be informed.

8. PREHEATING OF WORK AREA AND INTERPASS TEMPERATURE

8.1 The crankshaft must be preheated in a furnace or in the lathe to between 300°C and 350°C. The crankshaft must be preheated long enough so that when done

on the lathe the temperature when read 100 mm from the welding is constant. The preheat temperature shall be maintained throughout the welding process.

8.2 Temperature measurements must be done with a direct reading pyrometer or a contact thermometer.

9. WELD SEQUENCE

9.1 After preheat, when preheating in a furnace, the crankshaft must be transferred immediately to the welding station to prevent loss of heat. The preheat temperature must be maintained throughout the entire welding process by flame heating of the area to be welded.

9.2 All dimpled areas and damage to a depth of 4.5 mm must be repair welded before welding the journal to size.

9.3 The welding station must be a lathe that will rotate the crankshaft at a uniform speed. The weld head must be fed at a constant rate along the axis of the crankshaft.

9.4 Build up a layer of weld deposit on the journal. The welding may start at one fillet before the radii and proceed across the journal, or it may start at each fillet and proceed to the centre of the journal.

9.5 Remove fused flux and visually inspect the weld.

9.6 Build up a second layer of weld deposit on the journal, if necessary. Between weld layers maintain the preheat temperature.

10. STRESS RELIEVING

10.1 After welding return the shaft to the furnace for a post weld heat treatment at 350°C for at least 4 hours.

10.2 The post weld heating must be followed by slow cooling.

10.3 Any straightening must be done after the stress relieving.

11. MACHINING

11.1 The journal shall be ground to final dimensions and finish according to drawings.

11.2 After welding, the fillets and oil holes shall be blended.

12. ACCEPTANCE CRITERIA FOR DEFECTS

12.1 Defect repair of porosity, blow holes or weld undercut shall be done by means of dimpling (localized grinding and polishing) on all tapers, main journals and big end journals.

12.2 The size of the dimple after repair shall not exceed a diameter of 10mm and a depth of 2mm. The bottom radius of a dimple must be a minimum of 5mm.

12.3 A maximum of one defect per taper, one per main journal and one per big end journal, shall be allowed.

12.4 Dimples shall be finished by polishing to the required journal finish.

12.5 MPI inspection shall be done on all dimpled areas and no defect indications shall remain.

12.6 No defects or dimpling shall be allowed on the fillet radii of journals.

12.7 No defects or dimpling shall be allowed on the seal land journals.

12.8 The transition of the seal landings to the start of tapers can have a welding fusion line in the instance where these two seal landings are repair welded but not the tapers.

12.9 The number of repaired defects (dimples) per journal and taper shall be stated on the quality assurance certificate to be supplied to Transnet.

13. QUALITY REQUIREMENTS

13.1 Final dimensions of the journals and taper area shall be measured and recorded according to the drawings.

13.2 The taper and out-of-round shall be according to the 'Dimensional, form and running accuracy of bearing seating and abutments' (ISO tolerance grades), as shown in the bearing manual:

i. Bearing journal out-of-round must be measured at 3 places along the journal length (at the journal centre and 5mm from both journal ends) – 3 measurements at each position, 60 degrees apart.

ii. Taper of the bearing journal must be derived from the out-of-round measurements and be within the IT tolerance (e.g. for 80mm diameter journal: taper < 8µ.

13.3 Surface roughness must be according to the drawing.

13.4 Micrometer for measuring journal diameter with 3 decimal places shall be used.

13.5 The hardness of the journal after weld repair shall be measured and recorded on the data pack. The hardness shall be in the range as per the original hardened journal hardness.

14. FINAL INSPECTION

14.1 After all grinding operations have been finished; the entire crankshaft shall be inspected in accordance with specification RS/ME/PR/023. If cracks are found, the crankshaft must be treated as a cracked crankshaft and the welding procedure must be repeated as if it is a new repair.

14.2 After final inspection, the crankshaft shall be thoroughly cleaned of the MPI fluid and dirt. The oil passages shall be flushed out with pressurized cleaning solution to remove any shot or grit that might be lodged there.

15. CORROSION PROTECTION, PACKAGING AND TRANSPORT

15.1 Finish machined crankshafts shall be protected against corrosion with a heavy viscosity anti corrosion substance that must be approved by Transnet.

15.2 The crankshafts shall be packed in a heavy wooden box with built-in supports for the main journals. An arrangement should be made to hold down the crankshaft in the box to prevent movement during transportation.

15.3 During transport in inclement weather, all crankshafts shall be covered.

16. DOCUMENTATION

16.1 Each crankshaft must be stamped for identification purposes and the relevant documentation must be traceable to this number. Each finished crankshaft must be accompanied with a copy of this documentation for record purposes. The documentation must contain the material analysis certificate as well.