e) Fitted with automatic thrust recording equipment monitoring load cells incorporated in each jack together with a pressure metering device.

1.2.1.3 Tunnelling Shields for Pipe jacking

a) Where considered necessary, the Contractor shall provide and maintain a shield suitable for excavating in the ground conditions as envisaged by him and in accordance with his chosen method of excavation.

b) In determining the type of shield and method of excavation to be used, the Contractor shall take account of the need to ensure that the face of the excavation is adequately secured at all times such that ground loss is kept to a minimum and is controlled to prevent excessive ground loss. The shield shall be removed on completion of the tunneling operation.

c) Rotating excavating heads fitted to shields shall be capable of rotating clockwise and counter-clockwise.

d) The shield shall be equipped with steering jacks and such heads, ploughs and copy cutters as may be required for adjusting the alignment of the pipes.

e) Multiple lubricant injection points shall be provided within the shield in order to provide immediate ground support when necessary.

f) In case of manual excavation, the shield should be pushed into the soil. The excavation should be limited to the soil falling inside the sleeve. No excavation should protrude outside the shield face.

1.2.2 NDM Pipes

A. Pipes for NDM works shall be one of the following, unless otherwise approved by the Engineer:

1. Composite GRP pipe with reinforced concrete encasement.
2. Steel casing pipe.
3. Reinforced concrete jacking pipe or composite GRP pipe may also be used as casing pipes.

B. The Contractor shall ensure that all pipes including cut lengths and all fittings before dispatch from the pipe manufacturer's works are indelibly marked as follows.

1. The manufacturer's name, initials, or identification mark.