

REFURBISHMENT OF OLD PIPELINES HAVING SEVERELY DETERIORATED COATINGS



Buried pipelines with coal tar/bitumen and other coatings, which were installed more than 15 years ago, are now exhibiting signs of extreme deterioration. The requirements for cathodic protection have now reached a level where the existing installations are no longer able to provide sufficient protection to the pipeline and where corrosion will be taking place due to the deterioration of the coating. A large percentage of the pipeline metal is now exposed to the soil and the cathodic protection systems are under performing. If the life of the pipeline is to be extended for maybe another 20 years, consideration must now be given to rehabilitation of the pipeline coating and/or the cathodic protection systems.

Rehabilitation may be in the form of extensive coating testing to locate areas of severe coating deterioration and then repair by excavation, removal of old coating and applying a new coating. This is a long, difficult and very costly exercise.

As an alternative to this, PML offer a less much costly solution to this problem. The *PML Pipeline Refurbishment Anode (PRA anode)* can be used to ensure full protection along the entire length of the pipeline.

Why should a PRA anode be used? The following examines the design philosophies of remote and close anode systems.

Remote vs. close Groundbed

Flow of current from an external source to a pipeline (as occurs when the pipeline is cathodically protected) will be accompanied by a potential difference between the earth and the pipeline. The potential difference is used in certain criteria for determining the degree of cathodic protection. Developing the desired potential difference can be accomplished in either of two ways:

- By making the pipeline negative with respect to remote earth, or
- By making the earth positive with respect to the pipe in local areas.

The first method uses remote ground beds, from which substantial lengths of pipeline can be protected. The second method uses close ground beds or anodes, which afford protection only in their immediate vicinity.

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Data Sheet PLRF01 Rev 01

Page No 1 of 3

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Since the existing remote groundbed has already failed to provide sufficient cathodic protection current, it is therefore necessary to consider the alternative form of protection using close anodes

The use of close anodes, a series of anodes or a long continuous anode is quite different from the remote type of installation. Their successful use depends on the area of influence surrounding each ground bed anode. For a better understanding of how close anodes are used, the conductive path between a ground bed anode and remote earth is examined in greater detail.

The current per unit of cross-sectional area of earth (current density) flowing away from a groundbed anode is highest close to the anode and decreases with distance. Where the current density is highest, the greatest point-to-point potential gradient can be observed in the earth. The net result of this effect is that most of the potential drop to remote earth of a single anode would normally be encountered within the first few feet. If the anode is designed as a continuous anode running closely parallel with the protected structure, then the conductive path between the anode and the structure is maintained approximately constant. The current flowing onto the pipeline will therefore be approximately equal at all points along the anode thereby making the earth positive with respect to the pipe in local areas and achieving protection. This is the principle used in the *PRA anode*

When designing impressed current *PRA anode* systems, effective soil resistivity along the section of pipeline to be protected should be known or measured. With this information, the resistance of individual anode sections can be calculated using standard procedures. The voltage required to drive the system is selected and anode spacing is calculated using the following principles. Existing potentials to earth must be known along the section to be protected, so the earth potential change needed to attain a minimum potential of -0.85 V (pipe-to-close CSE) can be determined at the midpoint between anodes. The parallel resistance of all anodes is calculated. With allowances for header cable resistance and back voltage between pipeline and anodes, voltage and current requirements of the power source may be calculated.

It should be noted if relatively long distances are covered by *PRA anodes* fed from one power source, voltage attenuation resulting from potential drop in the header cable (current flowing through the cable resistance) will result in reduced voltage to the more remote anodes than that impressed on those close to the power source. This should be verified during the design phase. If the difference is significant, the length of a single *PRA anode* may need to be reduced to attain the similar level of protection from one end of the continuous *PRA anode* to the other.

The *PRA anode* system is a continuous horizontal anode running the length of the pipeline to be protected. This reduces the attenuation to a minimum based on the resistance of the anode conductor and the header cables. It also eliminates the low midpoint between anodes that exist with discrete remote groundbed systems. Because the anodes are close to the protected structure, the loss of current to other metal structures and earthing systems will also be minimised together with any interference on other structures.

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Data Sheet PLRf01 Rev 01

Page No 2 of 3

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PRA anodes are manufactured to provide a low resistance, continuous anode by attaching the continuous anode at frequent intervals to an insulated carrier cable. In this way the main anode/groundbed current is carried by the copper conductor thereby keeping the voltdrop in the anode to a minimum and evenly distributing the current along the length of the anode.

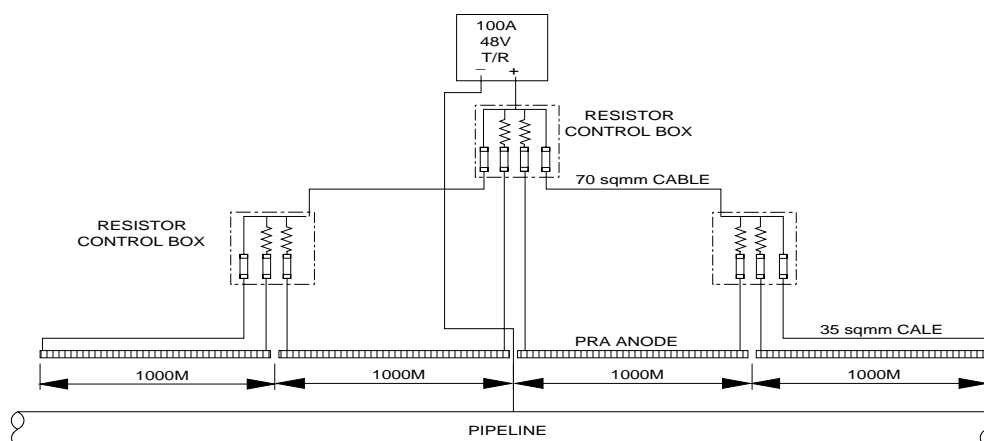
The continuous PRA anode is manufactured in coils or on drums and is available in lengths up to 50m. Several anodes may be easily connected together using standard spice kits to make a longer anode.

Two sizes of PRA anode are available with appropriate current outputs as detailed below. The current outputs are much higher than those available from conductive polymer anodes used in a similar manner. The anode is usually installed in a 50mm square cross-section of calcined petroleum coke breeze to obtain an improved anode/carbon connection and higher current output.

Anode maximum operating current density	Current output/m Type A	Current output/m Type B
In petroleum coke backfill (current density of 100 A/m ²)	0.5 A/m	1.0 A/m

Typically, the header cable is laid in the trench parallel to the pipeline, along the total length of the anode system. A layer of calcined petroleum coke 25mm x 50mm wide is laid in the bottom of the trench. The 50m long sections of PRA anode are laid on the carbonaceous backfill and then covered with a further layer of calcined petroleum coke 25mm x 50mm wide. The ends of the cable are then jointed onto the anode header cable. Lengths of up to 1000m can be protected in this way.

Since a.c. supplies are at a premium, it is possible to feed up to 4000m of anode, i.e. protect 4000m of pipe, from a single transformer rectifier. In order to do this the transformer rectifier is located at the mid point and a larger size cable is fed each way to the mid points for both sides of the rectifier. At this point, a resistor control box feeds the secondary header cables to provide an equal distribution of current from both ends of the anode.



PRA ANODE INSTALLATION FOR 4 KM OF PIPELINE

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Data Sheet PLRf01 Rev 01

Page No 3 of 3

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