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CATHODIC PROTECTION ON SINTAJOINT® PIPELINES

A review of the need for CP on steel pipelines was carried out a few years ago. It was undertaken by a group comprising Steel Mains (previously Tubemakers & Tyco Water) Pipelines Research, Mark Heathcote of the Sydney Water Board and Brian Martin, an expert in the application of cathodic protection (also Chairman of the Australian Electrolysis Committee). The findings are summarised herein.

The study commenced by putting the factors involved in the decision making process in a coatings selection chart (enclosed). The issue of strategically important mains was considered on the basis of the performance of modern pipeline steels with SINTAKOTE® as the benchmark coating. Due to the high ductility and resistance to brittle fracture of currently used pipeline steels, together with the performance of Sintakote, we formed the view that any corrosion perforations that might occur would be small in size and very localised, and would not lead to the need for a large scale repair. The view was that "leaks" that occurred in this way would not be catastrophic, unless their location led to an unacceptable time to repair or cost to repair. These small perforations would be repaired within a 24 hour period. This would not be expected to result in any disruption to supply, as service reservoirs would usually have sufficient capacity.

High cost/strategically important areas were then identified as:- major road crossings, railway crossings and in close proximity to buildings. In these areas it was considered that additional protection should be applied, typically by encasement or by the use of CP. Having considered strategically important areas, an economic evaluation was carried out to compare the costs/frequency of repairs with the cost/maintenance of CP systems.

The outcome of the study led to the Sydney Water Board's Policy of not applying CP to Sintajoint pipelines. The Policy also allows the use of short lengths of welded pipelines (up to 1km long) provided there are no stray current issues. A copy of their guidelines is enclosed.

An example of the type of economic analysis undertaken is shown in the enclosed Table for a 914 mm OD, 10 km long pipeline. In the analysis a SINTAJOINT® pipeline was compared to the following:-

1. A rubber ring pipe system with field applied tape coating. This system has an epoxy coating on the RRJ ends with a tape coating applied to the joint in the field.
2. A welded pipeline with Sintakote pipe coating and heat shrink sleeve coating at the joints.

3. A welded pipeline with factory applied tape coating on pipes and field applied tape coating at the joints.

The number of holidays expected for each of the coating systems was estimated. The rate of one holiday per kilometre was used for Sintakote, based on the number of holidays found by a DC gradient survey done on a 1200 mm OD, 1.8 km pipeline coated with Sintakote. Clearly the quality of pipe laying will have a major bearing on the final result. Adherence to good laying practice and appropriate enforcement/inspection is likely to result in fewer holidays, whilst poor installation would result in more. On this basis and using Sintakote as the benchmark, we rated the expected performance of other coatings. The analysis was for low density polyethylene Sintakote. Better performance is expected from the currently used Sintakote, which is a medium density polyethylene. It was assumed that the soil environment is aggressive, with the first perforation occurring after only 15 years in service.

An NPV analysis was carried out using a 4% discount rate. The cost summary indicates that it is cheaper not to apply CP when Sintakote is used as the pipe coating for both RRJ and welded steel pipelines. However, it is recognised that for welded pipelines above approximately 5 km in length, accelerated corrosion would be expected due to telluric currents, and this would necessitate the application of cathodic protection.

When major pipelines are planned it is expected that the issue of CP will be considered. The question of whether to apply CP is only available as a viable option when Sintajoint pipes are used. With a Sintajoint pipeline each pipe is electronically isolated from the next pipe. This ensures that "long line" corrosion will not occur. The application of a high quality coating to the entire pipeline, including the joints, means that the number of coating holidays that occurs during installation will be minimised and the extent of deterioration expected over a 100 year life will be insignificant. Concerns about the possibility of a perforation in such a major pipeline need only to be evaluated in a cost/benefit analysis.

The WA Goldfields pipeline is an example of a major strategic single supply pipeline - conveying water from Perth to Kalgoorlie. It has suffered and continues to suffer from perforations. These events are managed so that there is continuity of supply. We are not suggesting that the rate of perforations experienced in the Goldfields pipeline is acceptable. Nonetheless, it indicates that a strategy that allows the possibility of a small number of perforations over a 100 year life is acceptable, and it is a much more cost effective strategy than applying CP.

Since 1985 Steel Mains has supplied Sintajoint pipes. More and more operators are using Sintajoint pipelines without applying CP. Some notable examples of long length/large diameter Sintajoint pipelines where CP has not been applied are:-

1. WMC Roxby Downs M1 pipeline. 502 mm OD x 4.5 mm WT x 54 km, installed in 1986 (LDPE Sintakote used). This pipeline operates in a very corrosive environment at a temperature of 33°C.
2. Hunter Water Chichester Pipeline CTGM. 1219 mm OD x 8 mm WT x 1.8 km, installed in 2016 (MDPE Sintakote used).
3. Albert Water (Gold Coast region). 600 mm diameter, 17 km, installed in 1993 (LDPE Sintakote).

4. MacArthur WTW (Sydney). 1200 mm diameter, 18 km, installed in 1995 (LDPE Sintakote).

5. Tarong power station (Queensland). 900 mm diameter, 78 km, installed in 1995 (MDPE Sintakote).

In summary the costs/benefits/ramifications need to be assessed by the users in determining whether or not to apply CP to rubber ring joint Sintajoint pipelines. The analysis indicates that it is cost effective to apply CP when metallic pipeline systems other than Sintajoint are used. However the low number of holidays expected in a Sintajoint pipeline gives the user the opportunity to save money by not applying CP. Provided acceptable laying practices are adhered to, the number of holidays is expected to be small, and therefore the number of perforations over a 100 year life is also expected to be small.

Accelerated corrosion due to "long line" corrosion, including telluric currents will not occur with Sintajoint pipelines. The first perforation would not be expected to occur for at least 15 years even in a corrosive/aggressive soil environment (with a steel wall thickness of ≥ 9 mm). Considerable cost savings can be expected by adopting an approach of repair of perforations as they occur, compared to the high cost of application of CP bonding cables, CP equipment and maintenance/replacement of the CP system during service.

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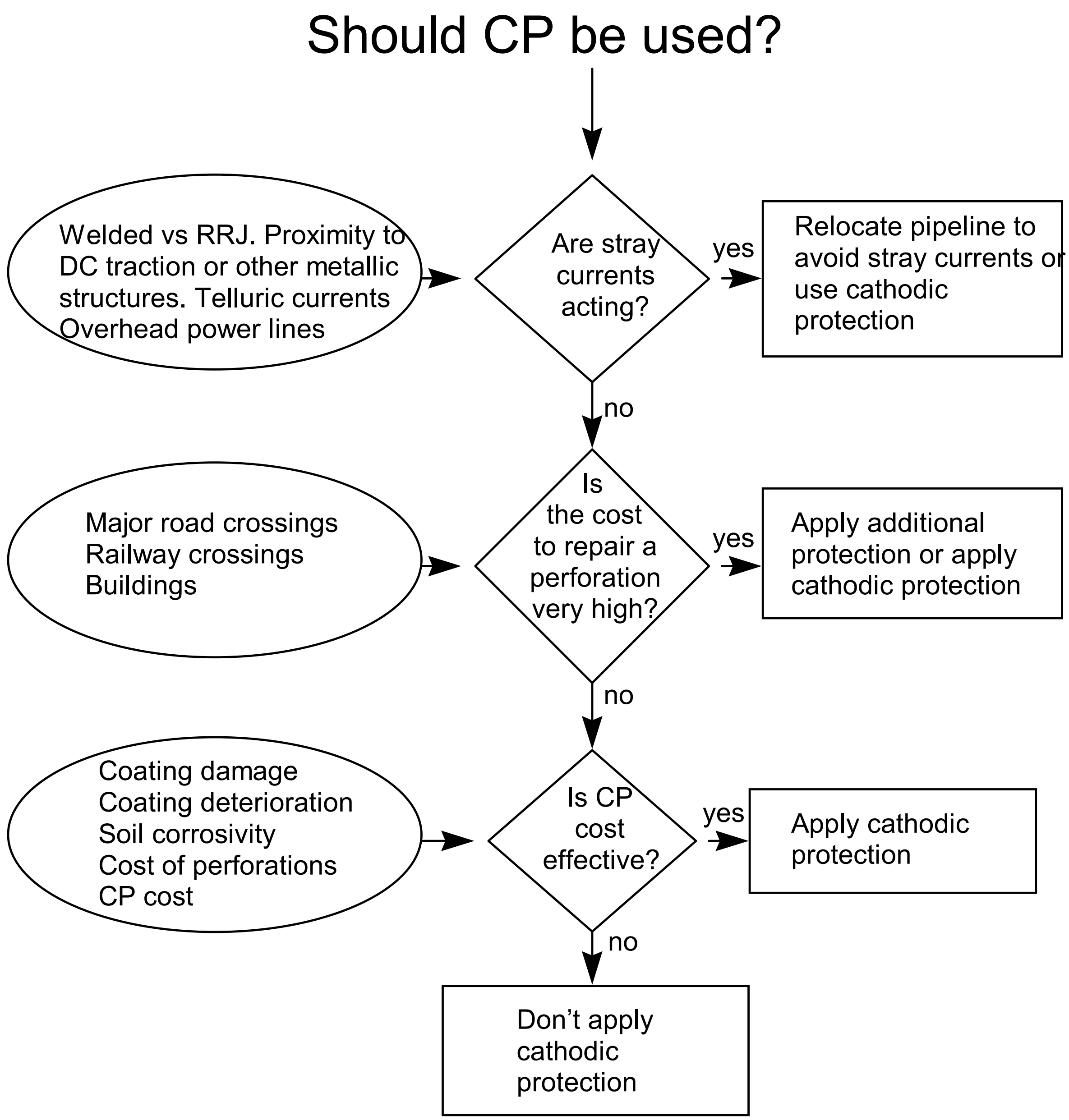
Cathodic protection selection chart



CATHODIC PROTECTION ECONOMICS
(10km, 914 mm OD pipeline, first perforation in 15 years, 100 year life)

Joint type	Rubber Ring Joint (RRJ)		Welded Joint	
Pipe coating	Sintakote	Tape	Sintakote	Tape
Joint Coating	Sintakote (Sintajoint)	Epoxy/Tape	Sleeve	Tape
Number of initial holidays in pipe coating	10	50	10	50
Number of initial holidays in joint coating	0, included above	20	20	30
Total number of initial holidays	10	70	30	80
Number of holidays due to deterioration of pipe coating in 100 year life	1	20	1	20
Number of holidays due to deterioration of joint coating in 100 year life	0, included above	5	6	12
Total number of holidays due to deterioration	1	25	7	32
Cost of field joint coating / lining / welding ($k)	0	150	450	450
NPV total cost to repair perforations ($k)	9	78	30	92
NPV cost of CP ($k)	129, includes joint bonding cable	133, includes joint bonding cable	93	93
Is CP cost effective?	No	No	No	Yes
Total NPV cost of minimum cost option ($k)	9, no CP	228, no CP	543, CP (note CP required for pipelines ≥ 5 km)	543, CP

1.5.4 Guidelines Outlining the Need for Cathodic Protection

Cathodic Protection (CP) is one of many techniques which can be employed to minimise the risks of corrosion when using buried metallic pipeline systems. Some of the other risk minimising techniques include such aspects as coatings, controlling trench fill and pipe surround materials, reducing risks from stray current or telluric effects, and eliminating contact with dissimilar metals to name a few. CP is not a guarantee that no corrosion will take place and it comes at a price in terms of initial installation, ongoing monitoring and maintenance, and replacement costs within the life of the pipeline. CP is however an effective and necessary technique under some circumstances.

The following guidelines outlining the need for CP are specific to Sydney Water and are based on Sydney Water's current installation requirements and approved pipeline materials.

Sydney Water primarily uses only two metallic pipeline systems - ductile iron and steel. All buried ductile iron pipelines are polyethylene sleeved, rubber ring jointed and laid in sand surround. Steel pipelines can be coated with fusion bonded polyethylene or tape coating systems and joined using rubber ring or welded joints. All steel pipelines are surrounded in either sand or 7mm nominal size coarse aggregate.

CP with the ductile iron pipeline system is not an effective option and is therefore not recommended.

The steel pipeline system however employs different coatings and construction practices, and under certain circumstances, the application of CP should be investigated. Within Sydney Water's area of operation, using approved products and installation practices as a general rule there is no need to apply CP to rubber ring jointed steel pipelines. Where welded joints are employed CP may be required dependent upon the length of pipeline and its proximity to stray current sources. The following flow chart details when the CP option should be investigated (Table 1.2).

NOTES:

(a) Where pipelines cross major roads or railways, special construction practices are required - ***consult Standard Drawings.***

(b) Where welded steel pipelines simultaneously run parallel and close to high voltage powerlines (ie for more than 2 km parallel, and within 500m of powerlines >50kV) induced AC currents may pose a safety risk - ***investigations shall be carried out.***

(c) Where metal pipelines are located with 5m of a transmission tower, or if pipeline access is within 50m of a transmission tower, possible earth potential rise during fault conditions may pose a safety risk - ***investigations shall be carried out.***

(d) Where pipelines are laid in high risk areas, such as old landfill sites, anaerobic swamps or tidal zones, the option of CP should be investigated.

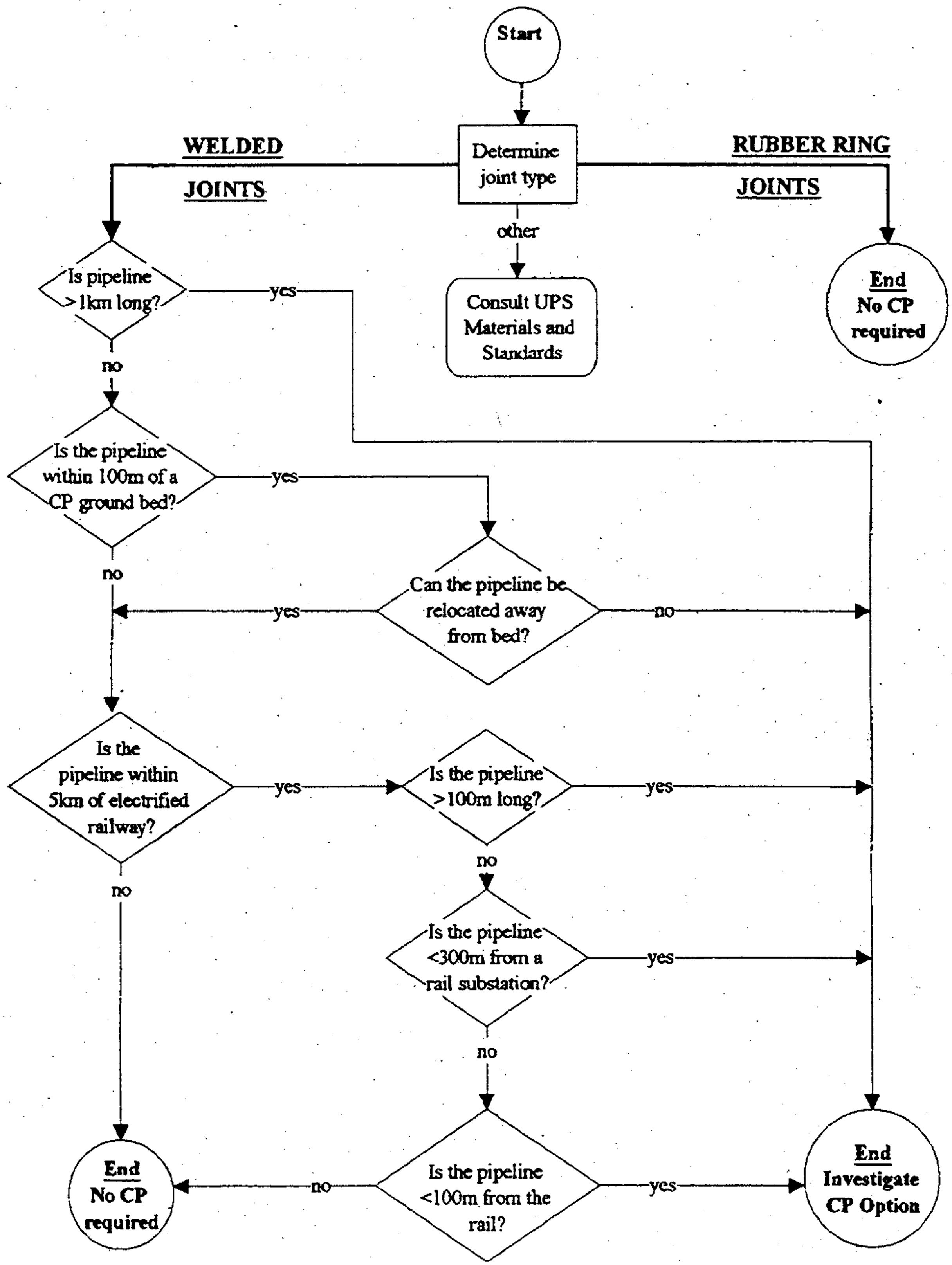


Table 1.2 Steel Pipelines Cathodic Protection Selection Process