The importance of whole life cost –
in the evaluation of RBC tenders

by

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Most water companies would agree they are fully conversant with the application of whole life cost in tender evaluation. The exception, however, may be in the case of RBC tenders, where wrongful evaluation can lead to the selection of plant with a short life and result in major criticism of RBCs. Proper financial evaluation can avoid such criticism and result in an extremely robust technically sound plant capable of producing a highly nitrified effluent. The release of information following Severn Trent Water/Cranfield initiative has shed a new light on the area of contract selection. Severn Trent Water Ltd showed that it is extremely important to purchase a plant with a long life since any interruption in treatment can increase costs by a minimum of two to three times the whole life cost of a plant capable of lasting twenty years at a discount factor of 5 per cent.

Copa rotor being assembled on site *(courtesy Copa Ltd)*

This is primarily due to the cost of temporary treatment facilities whilst a replacement rotor is being procured. Design, manufacture and maturation can take up to 9 months and is an inconvenience best avoided. The plant is more cost effective if the life is long.

Unfortunately, to produce a plant with a long life is more costly because of the higher metal content and the essential quality control requirements to avoid stress raisers.

Failure mode - RBCs fail primarily as a result of fatigu*e*.

Failure occurs when the number of cycles employed in the design match the designed fatigue stress. Bending a paper clip back and forward until it fails can simulate this. The clip will fail once its fatigue life has been exhausted. The thicker the clip the longer the period to failure. So it is with RBCs.

The speed of rotation, therefore, determines the life of the plant and is a useful parameter to assess tenders.

The slower the speed of rotation the longer the plant will last. Too slow a speed rotation, however, may have process consequences. Consequently, Severn Trent has settled on a speed rotation of not less that one rpm. Doubling the original design speed of rotation will decrease the life by 50 per cent since the design cycle life will be achieved sooner.

Cranfield University

During AMP2, suppliers wishing to tender to Severn Trent, were invited to submit details of their plant for audit by Cranfield University School of Engineering. Not all plants were acceptable consequently the number of tenderers was significantly reduced.

Acceptable rotors were subsequently modified on Cranfields advice to produce a 20 year life at the suppliers design speed rotation.

The design speeds ranged from 0.6 rpm to a maximum of 1.0 in the case of the *Copa* plant. This was specifically designed by

Rotor assembly at Copa factory *(courtesy Copa Ltd)*

Cranfield to achieve a minimum 20 years life at a 5mm biomass thickness and a Speed of Rotation of one rpm and is the only plant currently designed to rotate at that speed.

Severn Trent Water Ltd revised the specified Speed of Rotation in July 2000 to a minimum of one rpm. This has the effect of reducing the life of previously validated plants unless they have been fully validated by Cranfield University at the higher speed rotation. (1.0 rpm). Indications at Cranfield at present is that has not been done. Consequently, plants may be rotating at more than their validated speed of rotation or alternatively at less than the Severn Trent specified process condition.

A plant rotating at a higher than validated speed risks failure before the 20 years is achieved. Where the speed rotation was validated at say 0.5 rpm and 1.0 now applies, doubling the speed, should in theory result in failure after 10 years requiring plant to be replaced once during its 20 year life. Conversely, reducing the speed of rotation of a plant designed at 1.0 rpm will increase the life.

Obviously biomass thickness will have an effect. A thinner than specified thickness will increase the life, Since this is true for all plants its role in discounted cash flow evaluation is irrelevant.

Unfortunately, the speed of rotation is rarely, if ever, taken into consideration in tender evaluation, despite the importance of its significance.

Each option needs to be carefully evaluated using discounted techniques. **Table 1** is based on a discounted cash flow analysis at six per cent. It assumes plant A is validated at 0.5 rpm and plant B at one rpm.It also assumes plant A is £10,000 cheaper than plant B costing £100,000 and the revenue cost is the same. Revenue costs may not, however, be the same in every instance and engineers should check the Operational Maintenance requirements of each tenderer's RBC and include the appropriate revenue costs in his evaluation.

Option	Description	Capital cost	Year 1	Year 10	Total cost
A	10 year life	£90k	£90k	£90k	£180k
Discount. Factor			1.0	0.558	
Net Present Value			£90k	£50.22	£140.22
B	20 year life	£100k	£100k	Nil	£100k
Net Present Value			£100	Nil	£100k

Table 1: Comparison of Net Present Values for a 10 & 20 year life

The discount cash flow analysis suggests that plant B is the more cost effective by some £40,000. Indeed to break even the more expensive plant could be £60,000 dearer.

This further bears out Severn Trent's contention about the importance of long life.

Clearly to accept the lowest tender purely on capital cost without regard to speed of rotation, validation and discounted cash flow techniques is not an appropriate method of evaluation.

Ordinarily, purchasers would accept the lower cost plant and complain about the process when the plant subsequently fails. Adopting the appropriate DCF techniques and understanding the consequences of Cranfields validation should avoid any future criticism of the process.

Regardless of the figure, it is incumbent on the engineer to consider the effect of whole life cost if he is to advise his client properly.
During AMP2 Severn Trent employed Cranfield University to check at three stages to ensure suppliers were delivering to their specified conditions and Cranfield's recommendations. This security provided an assurance that each plant would last 20 years and is an option purchasers should seriously consider. If a supplier should improve his plant he should seek a re-validation by Cranfield University and advise his customers accordingly.

Conclusions

RBCs have been the subject of unfair criticism but that criticism has been resolved by Cranfield University It is, however, still possible to purchase plant not validated by the University.

Engineers, if they are to serve their client properly, must ensure that their recommendations are valid, well thought out and subject to audit. This can achieved by a proper evaluation of tenders taking into consideration the speed of rotation and discounted cash flow techniques and selecting as long a life as possible.

Regrettably, it would seem a proper evaluation might not be undertaken in every case. Consequently it is a matter for the employer to ensure that he is being properly advised before accepting a tender. Otherwise, he may well be faced with the consequences of unexpected premature failure in later years, which is very expensive and can be avoided by the application of proper financial techniques.■

Note: T*he author of this paper, Eric Findlay, was formerly Principal Engineer with Severn Trent Water Ltd responsible for RBCs. He is a visiting Professor at Cranfield University School of Engineering and RBC Manager, Copa Ltd.*