PAPER 4

Risk management for real time control in urban drainage systems - what happens if they break down?

by

Nicola Harding of CIRIA

&

Ian Noble of Montgomery Watson

&

Martin Osbourne of Reid Crowther

Risk management for real time control in urban drainage systems - what happens if they break down?

Nicola Harding BSc(Hons) DipWEM
CIRIA, 6 Storey's Gate, London, SW1P 3AU
Ian Noble BEng(Hons) CEng MICE
Montgomery Watson, Terriers House, 201 Amersham Road, High Wycombe, HP13 5AJ.
Martin Osborne BSc(Hons) CEng MICE
Reid Crowther, 10 Hitching Court, Blacklands Way, Abingdon, OX14 1RG

Introduction

Real time control (RTC) maximises the efficiency of urban drainage systems; excess flows are diverted to those parts of the systems that have spare capacity, preventing flooding and premature operation of combined sewer overflows.

The principles of RTC are well researched and understood but there are uncertainties over the practicalities of its implementation, such as the risk of failure and liability if they do fail.

CIRIA has recently completed a scoping study which captured the state-of-the-art on RTC and identified areas for further research. The results of that scoping study are presented in this paper.

What is real time control?

Real time control (or active control) of an urban drainage system involves using monitoring data to control the operation of the system while flows and conditions are changing. The converse is a passive or static system, which s not altered during changes in the flow conditions.

RTC can increase the efficiency of urban drainage systems by reducing flooding and premature operation of combined sewer overflows. It can also improve the operational performance of systems by allowing them to react to faults such as blockages and sewer collapses.

Most urban drainage systems already include some components of RTC, e.g. flow control on pumping stations, although there are very few catchments which have system wide control of flows using flow prediction and optimisation of operation.

Regulatory framework

Pollution

The use of RTC in urban drainage depend on the policy of the Environment Agency regarding the conditions that they set before granting a consent for discharging to controlled waters.

When calculating the frequency of pollution limits being exceeded, Environment Agency policy is to take the risk of the failure of the system into account. Although limits are defined for frequencies of exceedence of once, four times and twelve times a year, there are no clearly defined standards for frequencies of exceedence of less than once per year and the limits that are set under this condition vary from site to site. In general, frequencies of exceedence of less than once per year will not be considered by the Environment Agency for passive systems - but they will for RTC systems.

Sewer flooding

OFWAT requires annual returns of the number of properties which are at risk from flooding more than once in 10 years and more than twice in 10 years. Where properties are protected from flooding by a

RTC system, the risk of failure should be taken into account in calculating the flooding risk. However OFWAT would probably not require proof that a detailed analysis for the risk of failure had been carried out. Some flood prevention measures e.g. flap valves are considered to have such a high risk of failure that they do not effectively remove properties from the risk. RTC systems are not considered to be in this category.

Commercial framework

Capital costs

RTC systems can potentially reduce the need for capital costs albeit with some increase in operational costs. However, it is generally accepted that reductions in operational costs are easier to model; the regulator has noted this and is looking closely at whole life costs with the intention of reducing the trend of favouring capital schemes over operational solutions. As there is this increasing pressure to reduce capital expenditure RTC appears more attractive. However, if an RTC system fails additional costs may be incurred in repairs, compensation payments, and a reassessment of the operational parameters of the system.

Compensation costs

Many water service companies now have their own customer service standards that exceed the statutory requirements of OFWAT e.g. covering external as well as internal flooding of properties. Data for one company show that payments under OFWAT's guaranteed levels of service for 1995/96 were £136 000 while the payments under the company's own guarantee scheme totalled an additional £213 000.

Pollution costs

Dischargers are liable for clean-up costs, the cost of repairing the damage to the environment and for refunding the Environment Agency's costs. They are also likely to incur costs in terms of their own staff helping to deal with the incident. There is the additional risk of a criminal prosecution and the imposition of a punitive fine. OFWAT expects the water services companies to be able to estimate the risks of prosecution and fines and to take this into account in selecting scheme options.

Other costs

Other costs of failures of RTC systems include additional costs of cleaning sediment deposits, cost of treating additional flow diverted to treatment and increased maintenance costs.

Risk assessment

The scoping study reviewed the use of risk assessment and HAZOPs techniques in other industries and assessed whether RTC systems have been assessed. No examples of such techniques being applied to any RTC schemes in Britain or Europe were found. Also the risk of failure of static systems has not been formally calculated, making the comparison of static versus RTC very subjective.

There was a general perception that static systems are fail-safe whereas RTC systems should be fail-safe. But what *is* fail-safe?

Failure of sewerage systems

The CIRIA Scoping Study looked at the risk of failure of sewerage systems and compared the risks for passive systems and controlled systems.

Case study 1 - Flooding incidents

The following figures (Table 1) relate to one water service company which has a significant number of pumping stations and also one large sewerage system that uses automated control gates.

Table 1: *Properties affected by internal flooding*

Cause	Number of affected properties	Percentage of total
Overloaded sewers	92	51.5
Blockage	61	34
Collapse	5	3
Flap valve failure	1	0.5
Other equipment failure	0	0
Not specified	20	11
Total	179	100

It is interesting to note that no incidents were directly attributed to pumping station or other equipment failure.

Case Study 2 - Pollution incidents

One water service company provided access to records covering 1 650 overflows. This included 75 with telemetry systems, and a further 70 with control of which 35 are linked to the main RTC system. Mechanical and electrical equipment, predominantly screens, was installed in 501 of the overflows. The frequency of non-storm related spills from the overflows is shown in Table 2.

Table 2: *Overflow spill frequency*

Frequency	Number	Percentage
>10	120	7
2 - 10	1 110	67
<1	430	26

Ninety percent of the overflows suffered less than 1 blockage per year. Of these, 15 sites (0.9%) had between two and ten blockages a year and three sites (0.2%) had more than ten blockages a year.

Maintenance visits varied from one per week (160 sites) to one per year (320 sites) and 500 sites were visited less frequently than once a year. The visits were based on "A guide to Sewerage Operational Practices Appendix C.B.5". This states that maintenance visits can be reduced to one per year if a telemetry system in installed. The average visit takes about two hours and requires a three man crew.

Further detail was given of 112 overflows on the main trunk sewer. These included the 70 controlled overflows. The CSOs and control system have been in operation for twenty years and are now undergoing a major overhaul.

There have been problems with blockages on the CSO penstocks as some of them have to be closed to less than a 225 mm opening to give the required continuation flow. This small opening then blocks causing overflow spill. In the RTC overflow the control rules have been revised to keep the gates fully open until the flow reaches the limit and then to close the penstock down to the pre-set position. This change has helped to reduce blockages from 15 per year ten years ago to three per year. This solution is obviously not applicable to non-controlled penstocks.

The main problem with the initial system was with the master control computer software and the sonic heads used for monitoring water level. Commissioning the system had been difficult. The modern control software and hardware and sensor heads are much more reliable.

There were very few problems with failure of the penstocks. The original system had included pneumatic back-up for use during power failure but these were not being replaced as they had never known to have been needed. The Rotork actuators had been reliable but required skilled maintenance by an electrician, a fitter and a five man crew to fit the shims to set the control rate and points. The new Rotork could be programmed from a key pad and could be set-up by a three man crew of sewer technicians.

The telecommunication links had been very reliable although they had suffered some failure due to lightening strike The existing system was being replaced with a radio system, mainly to reduce costs.

The telemetry and control system is being extended at present and this will reduce operational costs as the frequency of visits will reduce from one visit every two weeks to one visits every three months.

The general feeling from the operator was that the telemetry and RTC systems significantly reduced operational costs and premature overflow spills.

With telemetry and control any problems can be spotted earlier, logged and rectified more quickly. Where systems do not have telemetry and control problems may persist and not be spotted and consequently never logged. This introduces an interesting regulatory dilemma for the water utilities.

Conclusions

- An important consideration in the adoption of RTC systems is the necessarily cautious approach to environmental protection taken by the Environment Agency.
- Most flooding and pollution failures appear to be due to faults on passive systems, primarily blockages and sewer collapses.
- There are significant number of flooding and pollution incidents due to faults at pumping stations and some of these may be due to control system faults.
- Information from one system with real time control of overflows indicated that the use of telemetry and control has given a significant reduction in the number of pollution incidents due to blockages.
- Anecdotal evidence from several sources suggests that most of the problems with RTC systems occur during or shortly after commissioning. Once the teething problems are overcome the systems are usually reliable.
- Anecdotal evidence also indicates that problems occur on many systems when they need major upgrading or refurbishment as there is insufficient documentation to fully understand how they are supposed to work.
- There is a need to develop risk assessment techniques for urban drainage for both static and RTC systems.

Acknowledgements

CIRIA RP543 *Risk management for Real Time Control in urban drainage systems* was jointly funded by Northumbrian Water, North West Water, Southern Water Ltd, South West Water, Thames Water, The Water Service (Northern Ireland) and West of Scotland Water.