Life in the old dog yet?

Will plant that is specified to run for 20 years do so quite comfortably? Brian Tinham talks to Allianz Engineering's Glyn Amphlett about the real world of plant ageing

Above: corroded and scaled plant safety valve

"From the moment plant is put into service, it starts to deteriorate – and that applies to all types, whether electrical, process, local exhaust ventilation, pressure equipment... So a challenge for plant users, engineer surveyors and operations engineers alike is to learn to recognise the signs of ageing plant and to predict when a failure is likely to occur, so they can do something."

So says Glyn Amphlett, principal engineer at Allianz Engineering. "It's all about understanding the ageing processes, and then working out how to manage them to ensure that plants remain safe and reliable," he explains. And that matters particularly because, he says, too many managers are ignorant of the damage mechanisms and degradation problems that still cause plant failures today.

So let's look at the facts. Back in 1998, SAFed (the Safety Assessment Federation) started a plant defects survey. Over a four-year period, all serious failures were recorded and the data passed to HSE for root cause analysis. One and a half million items were examined, involving in excess of 7,000 serious defects, and the results showed: operator error caused 1%; design and construction issues were responsible for 4%; poor installation accounted for 7%; lack of maintenance, 16%; failure of protective devices, 32%; but most were down to development of in-service defects – 40%.

That same data also proved that it's not just very old plant that fails. It will come as a surprise to some, but around 10% of failures were on plants less than five years old, rising to 15% for those between five and 10 years, 30% for plants in the 10–20 year bracket and then 40% for those greater than 20 years old. As Amphlett puts it: "Clearly, although more ageing occurs as plants get older, it also happens even on relatively new plants, and rates vary considerably according to use, operation, maintenance and other factors."

Key degradation mechanisms

Main mechanisms that plant engineers need to look for are corrosion and erosion, but there are others. Allianz Engineering's Glyn Amphlett mentions two classics –longitudinal welds on cylindrical shells operating under cyclic temperature conditions and fatigue failures. Like so many others, all are well-understood ageing mechanisms, each having specific inspection techniques with which plant engineers should acquaint themselves.

What about protective devices? Amphlett warns plant engineers to look for signs of inappropriate or even no maintenance. "Those are always the biggest issues with, for example, safety pressure relief valves. The giveaway signs are valves failing to lift because they're so corroded. The other problem here is that these things are generally hidden from view, so you have to test them to identify whether they're working properly or not."

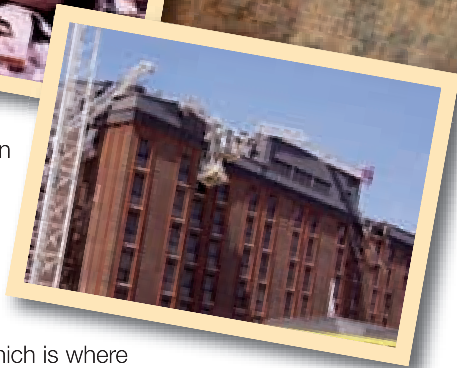
Behind that, though, is a requirement for responsible engineers to fully understand the ageing mechanisms for different plant. Only then can they stipulate the correct examinations and inspection techniques – and make the right decisions to ensure plant integrity and good long-term operation.

Lost skills

Which is worrying – particularly because, with an ageing workforce and ongoing engineering skills shortages, existing plant knowledge is being lost. That means there's an increasing risk of plant integrity problems going unnoticed, leading to early plant failures through premature ageing.

That's why, a few years ago, HSE set up a working group to look into the issues – and why all practising plant engineers and plant owners and managers should read its report (RR 509, published in 2006, available as a 130-page free download from the HSE website). There's a wealth of information, but Amphlett – who was involved in the working group with John Wintle of TWI (The Welding Institute), Neil Henry from ABB Engineering Services and NDT specialist Shaun Smalley – makes three key observations.

First, he suggests that all parties consider ageing to be present, not only where there is evidence or reasonable likelihood of degradation, but also if there is insufficient knowledge or information. Second, he urges plant engineers to look for both lagging and leading indicators of ageing – respectively, those that show damage has already occurred or is about to. "Plant engineers need to review their maintenance regimes, operational parameters, inspection reports etc, to make the



Top left, clockwise: remains of exploded boiler, badly corroded vessel and two tower crane failures

most of this. With multiple sources of information, you can get much better insights into these indicators of plant integrity."

Third, he draws our attention to the relevance of risk factors. "For example, it might be that a plant item was built to an old standard, or using materials or manufacturing methods that don't match today's quality tolerances – like older vessel welding techniques. Such factors will suggest likely deterioration rates and give a better picture of the plant's predicted lifetime."

Just as important, he also warns plant engineers to temper all that with an awareness of four broad stages for any plant's lifetime.

The initial stage, he explains, is when items are new. Then, likely problems include design and manufacturing faults, but also installation and commissioning problems, as plant is run up towards operation. "That's when you're likely to see seal and joint leakages, and unexpected transients as a result of bedding in. Engineers need to be aware that there is a possibility of initial high damage rates – but they should also use their observations to provide a benchmark against which all future examinations should be compared."

Leading indicators

Stage two is about maturity, when plant moves into predictable, reliable, stable operation. "You'll typically find flat performance lines, but during that time routine examinations should be aimed at identifying leading indicators of ageing, so you can start to plot degradation time lines. You might also be able to look at extending some periods between examinations until damage becomes evident or your prediction suggests deterioration is likely to start."

Stage three is plant ageing and here equipment starts to move from predictable deterioration rates to more discernible upwards curves. "With damage increasing significantly, this is when plant engineers need to look for rejection criteria, such as wear, erosion and corrosion. As they identify plant reaching the end of safe use, they also need to think about replacing equipment or reducing operating parameters to extend its life."

Finally, plant enters its terminal stage, which Amphlett describes as totally unpredictable. Then you're into replacing vessels and extended repairs just to keep it running. "The main point here is to look carefully for leading and lagging indicators, which is where experience and skill come in – in terms of what to look for and the choice of inspection techniques."

Why is this so important? Because practices that used to be standard 20 years ago, just aren't any more. "People don't wander around their plants looking for tell-tale signs of deterioration, such as strange noises or vibrations they hadn't seen or heard before – even though that was seen as one of the most important activities," comments Amphlett. And he worries that there's an over-reliance on statutory periodic thorough examinations – when best practice dictates that maintenance, inspection and operational control should all routinely feed plant integrity management.

"The bottom line is that, if you treat plant properly, it will live longer and stage two can be extended," advises Amphlett. But to achieve that, everybody has to play their part. And that includes owners, operators, production and maintenance.

"The biggest change I would like to see is serious improvement in users' understanding of their plants. On larger sites, responsibility is routinely split between production and maintenance, and there are often conflicts. Maintenance is seen as the discipline that stops production, and production rules because of the need to maximise return on the plant. That puts pressure on maintenance and inspectors, in terms of gaining access to ensure operational integrity. Proper plant understanding is essential if we're to resolve that conflict and get plant working safer, longer and more effectively." PE

Pointers

- Analysis of defects shows: operator error caused 1%; design and construction, 4%; poor installation, 7%; lack of maintenance, 16%; failure of protective devices, 32%; but 40% were in-service defects
- Plant engineers must consider ageing to be present, not just where evidence exists
- All parties need to look for lagging and leading indicators
- Watch for risk factors, such as plant built to old standards or out-of-date material tolerances
- We need a return to the old days of engineers patrolling plant, looking for the unusual