Many industries—aerospace, telecommunications, and computer applications—use redundant design to ensure that the most critical components of their systems are dependable. A redundant design might include backup components in a system, or comprise interchangeable components so that the system can be repaired quickly and without interruption.

Wastewater treatment plants began to explore redundant design in the early 1980s, after two U.S. EPA surveys indicated that a major problem facing treatment plants was a lack of flexibility in their unit processes. Treatment plants must be able to operate continuously during equipment failures and while performing routine maintenance that requires equipment to be taken out of service.

Researchers surveyed 37 treatment plants and 57 state and provincial regulatory agencies on redundant design.

In this project, the researchers surveyed 37 treatment plants to identify the most effective wastewater treatment redundancy design practices. They also surveyed 57 state and provincial regulatory agencies to examine the influence of regulatory requirements on redundant design.

The resulting report documents the best examples of applied conventional and alternative redundancy design practices. Through survey results and case study descriptions, the report reveals:
- redundancy design practices that work,
- required level of redundancy for optimal performance,
- costs and benefits of applying redundancy practices, and
- methods for implementing redundancy.

The report includes profiles of the surveyed treatment plants and their general redundancy design practices. It also includes detailed survey results indicating how plants implement redundant infrastructure, equipment, instrumentation, and automation practices at various treatment stages.

The report provides an overview of the researchers’ interviews with state and Canadian provincial regulators regarding redundancy design guidelines and regulations. Finally, it includes four in-depth case studies of different utilities’ redundancy practices.

Overall, this report is a practical guide for treatment plant operators and designers, who can use it to replicate documented successes from comparable treatment plants and processes.

Results
For the purposes of this project, the project team defined redundancy as any of the following units that are not used during normal operations:
- infrastructure (tanks),
- equipment (pumps, motors),
- instrumentation (flowmeters, analyzers), and
- automation and control (computers, power source, PLCs, etc.).

This list includes backup items, secondary items, and items used for more than one purpose. Redundancy also includes installed units (not spare parts) used for monitoring and control of processes.

For this project, researchers contacted all 50 U.S. states and the District of Columbia and received 49 replies. Of the U.S. state regulators who responded, 41% reported having regulatory requirements for redundancy design practices and 71% of those interviewed use recommended guidelines or standards for implementing redundancy design criteria. Ten Canadian province regulators provided information.

Benefits
- Identifies critical redundancy components in wastewater treatment processes.
- Identifies redundancy requirements associated with regulatory agencies.
- Reveals leading design and construction methods that incorporate redundancy.
- Discusses the cost-benefits of applying redundancy practices.

Related Products
Benchmarking Wastewater Treatment Plant Operations (D73001)
Best Practices for Treatment of Wet Weather Flows (00CTS6)
Effective Practices for Sanitary Sewers and Collection Systems (01CTS20T)

Related Ongoing Research
Upset Early Warning Systems for Biological Treatment Processes (01-CTS-2, 99-WWF-2a)
Disinfecting Wet Weather Flows (00-HHE-6)
Decision Support Systems (00-CTS-7)
Succession Planning (02-CTS-7CO)
Selecting Stormwater Treatment and Control Options (02-SW-1)
Water Quality Trading (02-WSM-1)
Securing Wastewater Infrastructure and Protecting Public Health (03-CTS-1S)

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ed information. Of the Canadian regulators who reported, 57% have recommend-
ed redundancy design guidelines or standards in place, and 100% noted that local
and regional authorities have redundancy design regulations in place.

The project team also compared receiving water discharge parameters at
different utilities with the utilities’ self-reported reasons for implementing redun-
dancy design practices. This comparison revealed that regardless of the type of
discharge receiving stream (or discharge permit), all treatment facilities reported
operational efficiency and maintenance issues as the driving force behind redund-
dancy design practices.

To successfully implement redundant design, the project team found that treat-
ment plants must identify critical compo-
nents in the treatment process. Survey
data revealed those components to be:
- pumping to move flows;
- basins and bypasses for hydraulic
capacity;
- level sensors, dissolved oxygen (DO)
analyzers, and chlorine residual analy-
ers to detect process changes; and
- DC/SCADA systems to monitor, con-
trol, and automate the treatment process.

Learning by Example

The results of the four case studies
highlighted several aspects of redundancy
design practices.

Orange County Utilities (OCU) applies redundancy design to their facilities to
meet regulatory requirements and to
decrease operational costs by reducing
process-unit downtime. This level of
redundancy is cost effective at OCU
because its operating costs have stabi-
lized in the last three years, even though
claimed water production has
increased. OCU redundancy levels have
also decreased costs by reducing onsite
staffing needs.

Western Lake Superior Sanitary District
(WLSSD) reports that the commitment of
staff, management, and owners is one of the
most important factors in successful
implementation of redundancy design.
WLSSD states that facilities managed with a “performance culture” could add redund-
dancy to a continuous improvement plan.

The local power company also gave a
$141,000 grant to WLSSD for the net
reduction of approximately 700 kW elec-
trical demand due to redundancy practices.

The city of Toronto stresses that imple-
menting successful redundancy design
practices depends on a thorough under-
standing of the treatment processes that
require redundant process units, equip-
ment, and automation. The implementa-
tion of proven technology also is a large
part of Toronto’s successful redundancy
design practices. The city has used redund-
dancy to optimize operation and mainte-
nance costs and also is able to manage
electricity use more effectively.

The city of Santa Barbara states that
the basis of their redundancy programs is
economics, which dictate a sufficient level
of automation and reliable power sources.
Santa Barbara’s redundancy practices
have improved the city’s treatment reliabil-
ity and have allowed it to meet National
Pollutant Discharge Elimination System
discharge standards. The city also reports
that redundancy requirements have initiat-
ed major capital improvement projects
that will improve system performance.

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