

Reliability Centered Design Implementation Guide

Sacramento Area Sewer District



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1.0 Objective

The Reliability Centered Design (RCD) methodology, which takes its roots from Reliability Centered Maintenance (RCM) principles, was motivated by the need to address overall system functional performance and reliability, starting early in the design process. By identifying and using more reliable components, simpler replacements, and easier inspections, RCD results in more reliable and maintainable designs, thus minimizing maintenance requirements, and optimizing system life-cycle costs.

The primary objectives of the RCD methodology are:

1. The integration of operations and maintenance requirements into the design process, including incorporation of preventive and predictive maintenance strategies;
2. The implementation of a systematic approach to maximize process availability by increasing asset reliability, operability and maintainability; and
3. The establishment of criticality-based decision making on asset redundancy and spares inventory.

This document establishes the basic framework for implementing RCD in designs of the projects comprising the EchoWater Project. The design consultants will be expected to use this document as a guide in developing a design process that is based in RCD principles. Project-specific RCD details will be developed by each design consultant based on the scope and relevance of the design elements within each

2.0 Approach

A system is made up of series of integrated assets designed to perform a common function. While all assets within a process are necessary, they do not all, necessarily, carry the same functional criticality. Critical assets require a concomitant level of reliability and redundancy designed into them to sustain their operational performance under most conceivable scenarios, while other, less critical, assets may not receive the same level of redundancy. Similarly, the maintenance strategies and spares inventories may be markedly different for assets with differing levels of criticality and failure scenarios. The RCD approach focuses on maintaining functional reliability through examination of critical assets, or features, which can disable an entire function.

For example, an aeration system has many assets that make up the process, including aeration blowers to provide the biological mass with oxygen, dissolved oxygen probes for controlling the oxygen levels and a process control system for the entire function to perform as intended. If a single blower fails, there is usually ample redundancy for continued satisfactory operation

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and the restoration of the blower capacity. If a single dissolved oxygen probe fails, there is ample time to troubleshoot and correct the problem before significant process impacts are evident. However, the failure of an otherwise small feature in the process control system could conceivably disable the entire aeration system. In this example, a reliable design would have sufficient redundant blower capacity to respond immediately, and a thoughtfully designed and maintained process control system to sustain system operations under all conceivable failure scenarios. The dissolved oxygen probe would be designed with overlapping sample areas and adequate spares in inventory to sustain the operation.

Key features of the Program-wide RCD implementation approach are depicted by the template shown below. As noted, each phase of the Program includes specific activities for application of RCD- driven design. The approach also leads to development of maintenance strategies and standard operating practices (SOPs) based on Reliability Centered Maintenance (RCM) principles, and collection of relevant information for input into the Computerized Maintenance Management System (CMMS).

RCD IMPLEMENTATION TEMPLATE

RCD Objective: **Design, build and commission wastewater treatment process systems for reliable operation to meet a specified level of system availability**

PROGRAM PHASE			
Planning and Basis of Design	Design		Construction and Commissioning
	Preliminary Design	Detailed Design	
Identify process systems and primary system functions requiring RCD Develop guidelines and procedures for RCD analyses.	Define system functions and functional failures, specify reliability, availability, maintainability and safety (RAMS) criteria. Develop project-specific approach tied to design milestones (info sources: RAMS data, risk acceptance criteria, and P&IDs). Identify critical assets and single-point failures. Identify asset redundancy and strategic spare unit requirements.	Conduct RCD Workshop for FMEA analyses for system functions and functional failures. Perform high-level RCM Analysis (for commissioning and baseline testing requirements). Develop documents for implementing RCM results in CMMS (Maximo) and SOPs, etc.	Validate/confirm RCM requirements for relevance to installed assets. Train staff on RCM-based maintenance recommendations. Perform baseline predictive maintenance testing (e.g., vibration, IR, ultrasound, motor circuit analysis, corrosion, etc.). Finalize/document O&M policies. Baseline (perform) all preventive maintenance tasks in CMMS. Develop preventive maintenance job plans based on findings of RCM analysis Coordinate all related documents with assets in CMMS

3.0 Expected Outcomes

When the P&IDs are substantially completed for each project, the RCD attributes will be established for all functions deemed critical to a process through the application of a Failure Modes and Effects Analysis (FMEA). An FMEA looks at all conceivable failure scenarios for each function and identifies potential effects (or consequences) related to each failure. This process reveals functional vulnerabilities through the identification of critical system components. This leads to more logical, asset-criticality based, engineering decisions for the attributes represented by the following figure and described in the paragraphs below.



3.1 Asset Reliability

While there are many factors that can contribute to or detract from asset reliability, asset selection determines to a large extent how long an asset will remain in service and the maintenance requirements to sustain the operational availability. Assets considered critical through RCD will be evaluated to determine the likelihood of operational availability and the maintenance requirements to sustain a reliable operation.

3.2 Process Availability

When assets are out of service for any reason, the process capacity is potentially impacted and the operation can be at risk. Each critical asset will be evaluated to assure capacity can be achieved to meet operational requirements. This attribute can be achieved through system redundancy, spares inventory, or consideration of seasonal flow trends for a system-wide maintenance approach.

3.3 Asset Maintainability

The system design will emphasize the ability of an asset to be repaired, restored and maintained to a specified condition using prescribed procedures and resources. In addition, design attributes will include easy accessibility for major and minor repairs. The design will document the list of attributes and their purpose.

3.4 Preventive Maintenance Requirements

The design and asset selection will consider the cost of maintenance by evaluating the preventive maintenance requirements. Low value maintenance should be recommended for exclusion if it does not provide a meaningful benefit. All preventive maintenance requirements including activities and frequencies will be developed by the design consultants and submitted in a format consistent with the District's existing CMMS.

3.5 Predictive Maintenance Activities

Based on the RCD analysis, predictive maintenance requirements will be recommended. The frequencies and methodology should be based upon all failure modes evaluated. All predictive maintenance requirements, including specific activities and frequencies, should be submitted in a format consistent with the District's existing CMMS program.

3.6 Spare Parts Requirements and Availability

Specific recommendations, including store stocking levels, for all spare parts for assets considered operationally critical will be made. In some cases, complete spare units may be appropriate when the function of the asset cannot allow long outages. All spare parts stocking levels will be based upon usage and parts availability.