Cooling Tower Structural Refurbishment and Performance Enhancement

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Abstract

This project documents the comprehensive refurbishment of a cooling tower at Amgen's biopharmaceutical facility in Juncos, Puerto Rico. The tower exceeded its service life with significant degradation affecting structural integrity, mechanical systems, and heat transfer performance. Executed September 15-October 9, 2025, the refurbishment was completed one day ahead of schedule. Performance testing demonstrated 15% energy reduction and improved cooling capacity. The refurbishment extends service life by 15-20 years at a lower cost than a full replacement.

Introduction

Cooling towers are heat exchangers that remove heat from water used in industrial facilities [1]. At Amgen's biopharmaceutical site in Juncos, Puerto Rico, these towers maintain temperature control for air conditioning and production equipment cooling systems. The facility requires precise environmental conditions in cleanrooms to meet FDA regulations and ensure product quality.

One cooling tower at the central utility plant had exceeded its service life and required comprehensive refurbishment to restore reliable operation. The tower supports critical chilled water systems serving the entire manufacturing facility; its continued operation is essential for daily operations. The cooling tower exhibited significant degradation including brittle fill media, corroded structures, and worn mechanical components. Performance testing showed reduced cooling capacity, resulting in higher energy consumption and frequent unplanned shutdowns that could potentially disrupt manufacturing operations.

The facility chose refurbishment over replacement based on cost analysis. Minor spot repairs rarely address structural integrity concerns, requiring a general overhaul of components rather than minor mechanical fixes [2]. The work targeted performance degradation root causes, while ensuring compliance with safety and environmental standards. Refurbishment could extend service life another 15-20 years at significantly lower cost than replacement [3].

Planning & Preparation

The project team developed a detailed schedule coordinating with facility operations to minimize manufacturing disruption. September 15 through October 10, 2025 was selected as the execution window. Project timeline is presented in Table 1.

Table 1: Project timeline with key phases and milestones

Phase/Milestone	Date
Planning & Preparation	**Aug 1-15**
◆ Scope Confirmation	Aug 15
Procurement & Vendor Selection	**Aug 12 - Sep 14**
◆ Procurement Complete	Sep 5
Shutdown & Execution	**Sep 15 - Oct 10**
Testing & Commissioning	**Oct 11-16**
◆ Final Acceptance	Oct 17

Methodology

Refurbishment began with safely removing degraded components and installing access platforms meeting safety requirements. Detailed structural inspection documented actual conditions, revealing additional damage not visible in initial assessments. Structural repairs followed systematic corrosion remediation through grinding and paint removal. Damaged areas received rust inhibitors before repair material application. Corroded steel members were reinforced with welded additions following structural codes. The tower basin was repaired to eliminate leaks, and all metal surfaces received multi-coat protective coatings for water damage prevention. Main components replaced are presented in Figure 1.

The mechanical upgrade involved installing a new premium-efficiency motor which was laser aligned to the gearbox assembly. The transmission system was completely replaced including gearbox, drive shaft, and fan mounting. Vibration sensors were integrated for condition monitoring. Fill media installation involved positioning modular sections with proper spacing for uniform water and air distribution. Refurbishment activities are presented in Figure 2 and Figure 3.

Results and Discussion

The refurbishment was completed one day ahead of schedule, with costs slightly over budget due to unforeseen structural repairs. Performance testing demonstrated significant energy reduction and enhanced cooling capacity with dramatically reduced vibration levels. Operational reliability improved substantially with zero unplanned shutdowns and reduced maintenance requirements. The comprehensive work extends the tower's service life by an estimated 15-20 years. Main results are presented in Table 2.

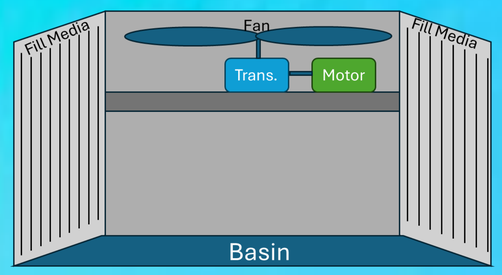

Figure 1: Cooling tower components impacted during the refurbishment

Figure 2: New motor installation with new transmission pending installation

Table 2: Cooling tower operational parameters and improvements

Performance Parameter	Pre-Refurbishment	Post-Refurbishment	Improvement
Energy Consumption	185 kW average	157 kW average	15% reduction
Water Flow Rate	2,350 gpm	2,500 gpm	+6.4%
Approach Temperature	8.5°F	6.0°F	2.5°F improvement
Cooling Capacity	4,250 tons	4,750 tons	11.80%
Motor Efficiency	91.50%	96.20%	+4.7 points
Maintenance Hours/Month	42 hours	18 hours (projected)	57% reduction
Vibration Level	0.45 in/sec	0.08 in/sec	82% reduction

Figure 3: Central utility plant cooling towers with scaffolding installed for refurbishment.

Performance Enhancements

The refurbishment incorporated energy efficiency improvements beyond component replacement. The new premium-efficiency motor was VFD-compatible for future optimization, while modern fill media design required less airflow for equivalent cooling.

The upgraded transmission featured high-efficiency gearbox design with synthetic lubricants and integrated vibration monitoring for predictive maintenance. Comprehensive functional testing verified design flow rates, temperatures, and mechanical operation under varying conditions.

Conclusions

The cooling tower refurbishment project successfully restored reliable operation and improved performance of critical infrastructure supporting pharmaceutical manufacturing. The comprehensive approach addressing structural integrity, mechanical systems, and heat transfer components achieved the primary objectives of extending equipment service life and enhancing operational efficiency.

Key Achievements:
- 15% energy consumption reduction
- Enhanced cooling capacity (11.8% increase)
- Zero unplanned shutdowns in initial operation
- 15-20-year service life extension
- Completed one day ahead of schedule

While final costs exceeded budget by 8%, the additional expenditure addressed previously unidentified structural damage essential for long-term reliability. Performance improvements validated the refurbishment approach, with energy reduction and enhanced cooling capacity directly supporting facility sustainability goals. Implementation of vibration monitoring enabled predictive maintenance for proactive equipment management.

References

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