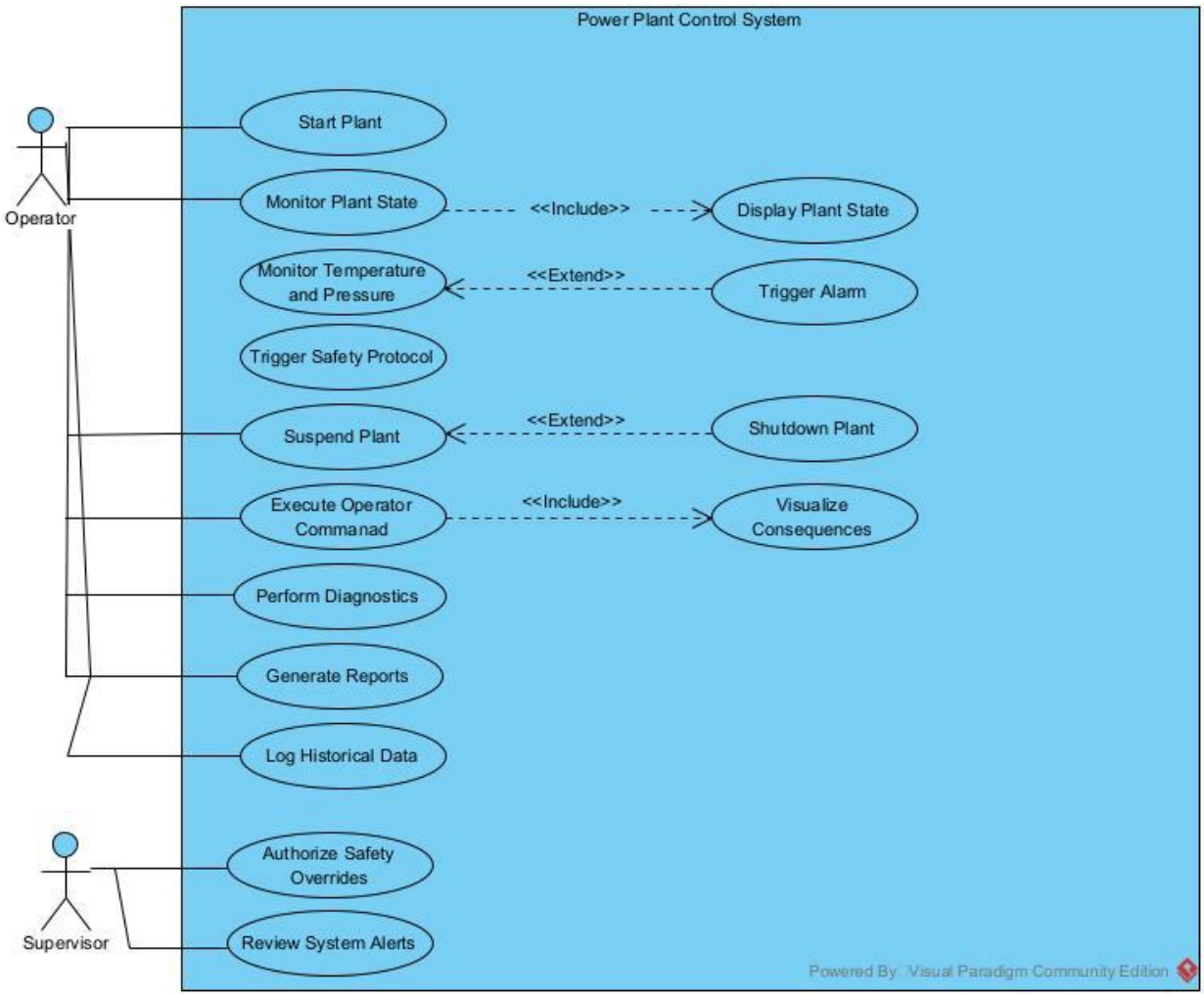

Use Case Scenarios

Use Case 1: Monitor Plant State	
Description: Operator continuously monitors the current operational status of the power plant **Actors:** Operator **Precondition:** The operator is authenticated and sensors are online **Main success scenario:**	
User	**System**
1. The operator logs into the system.	2. The system validates credentials and displays the main dashboard.
4. The operator reviews the displayed parameters.	3. The system continuously updates temperature, pressure, and power levels every 2 seconds.
	5. The system logs all data to historical records.
Alternative: The operator requests historical data, and the system displays past performance records. **Exceptional:** If sensors fail, the system switches to backup sensors and displays a warning message.	

Use Case 2: Execute Operator Command	
Description: Operator executes control commands to adjust plant parameters **Actors:** Operator, Supervisor (for overrides) **Precondition:** The operator is authenticated and plant is in operational state **Main success scenario:**	
User	**System**
1. The operator selects a parameter to modify.	2. The system displays current values and allowable ranges.
4. The operator confirms the command.	3. The system validates the new value against safety limits and shows predicted consequences.
	5. The system executes the command to the target equipment.
	6. The system monitors the changes and updates the display with actual results.
Alternative: If the command requires safety override, the system requests supervisor authorization before execution. **Exceptional:** If the command violates safety limits, the system rejects it and suggests alternative safe values.	

Power Plant Control System - Project Cost Estimation

Project Overview

System: Power Plant Control System
Total Use Cases: 15
Primary Actors: 2 (Operator, Supervisor)
Key Features: Real-time monitoring, safety-critical command execution, comprehensive logging
UCP as Use Case Points in the Estimation

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1. Interaction Points Analysis

Actor-System Interaction Points

Actor	Connected Use Cases	Interaction Count
Operator	13 use cases	13 interaction points
Supervisor	2 use cases	2 interaction points
Total	15 use cases	**15 interaction points**

Use Case Relationship Points

Relationship Type	Count	Complexity Factor
Include relationships	2	1.5x
Extend relationships	2	2.0x
Total relationship complexity	4	**7.0 points**

2. Use Case Complexity Estimation

Complexity Classification Criteria

- **Simple:** 1-3 scenarios, basic data processing, minimal business logic
- **Average:** 4-6 scenarios, moderate business rules, standard interfaces
- **Complex:** 7+ scenarios, complex business logic, safety-critical features

Use Case Complexity Analysis

Use Case	Scenarios	Business Logic	Safety Critical	Complexity	Points
Primary Use Cases					
1. Monitor Plant State	6 scenarios	High	Yes	Complex	15
2. Execute Operator Command	7 scenarios	High	Yes	Complex	15
Supporting Use Cases					
3. Start Plant	2 scenarios	Medium	Yes	Average	10
4. Display Plant State	2 scenarios	Low	No	Simple	5
5. Monitor Temperature & Pressure	3 scenarios	Medium	Yes	Average	10
6. Generate Alarm	3 scenarios	Medium	Yes	Average	10
7. Trigger Safety Protocol	4 scenarios	High	Yes	Complex	15
8. Suspend Plant	3 scenarios	Medium	Yes	Average	10
9. Shutdown Plant	4 scenarios	High	Yes	Complex	15
10. Perform Diagnostics	3 scenarios	Medium	No	Average	10
11. Visualize Consequences	2 scenarios	Medium	No	Average	10
12. Log Historical Data	2 scenarios	Low	No	Simple	5
13. Generate Reports	2 scenarios	Low	No	Simple	5
14. Authorize Safety Overrides	3 scenarios	High	Yes	Average	10
15. Review System Alerts	2 scenarios	Medium	No	Average	10

Total Use Case Points: 165

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3. Technical Complexity Factors

System Characteristics Assessment

Factor	Weight	Rating (0-5)	Score
Real-time Performance Requirements	2.0	5	10.0
Safety-Critical System	2.0	5	10.0
Complex User Interface	1.5	4	6.0
Data Logging & Reporting	1.0	3	3.0
System Integration	1.5	4	6.0
Security Requirements	1.5	4	6.0
Backup & Redundancy	1.5	4	6.0
Regulatory Compliance	2.0	5	10.0

Technical Complexity Factor: 1.35

- Safety-critical system requirements
- Real-time performance needs
- Regulatory compliance overhead
- Complexity multiplier: 1.35

Adjusted Use Case Points

Adjusted Use Case Points(UCP) = 165 × 1.35 = 223 points

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4. Delphi Approach - Expert Estimation

Expert Panel Composition

- **Expert A:** Senior Software Architect (Industrial Systems)
- **Expert B:** Safety Systems Engineer
- **Expert C:** Power Plant Control Systems Specialist
- **Expert D:** Project Manager (Critical Systems)

Round 1: Initial Estimates (Person-Hours per UCP)

Expert	Hours/UCP	Justification
Expert A	28	High safety requirements, real-time constraints
Expert B	32	Extensive safety validation and testing needed
Expert C	25	Standard industrial control system development
Expert D	30	Project management overhead for safety-critical system

Round 1 Average: 28.75 hours/UCP

Round 2: Consensus Building

After discussion of differences:

Expert	Revised Hours/UCP	Key Adjustments
Expert A	29	Added integration complexity
Expert B	30	Reduced testing estimate slightly
Expert C	27	Increased for safety documentation
Expert D	29	Refined management overhead

Round 2 Average: 28.75 hours/UCP
Consensus Achieved: 29 hours/UCP

Delphi Approach - Expert Consensus

- 4 industry experts provided estimates
- 2 rounds achieved consensus at 29 hours per Use Case Point
- Factors considered: Safety requirements, real-time constraints, regulatory compliance

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5. Development Effort Breakdown

Core Development Effort
Total Effort = 223 UCP × 29 hours/UCP = 6,467 hours

Project Phase Distribution

Phase	Percentage	Hours	Duration (weeks)*
Requirements & Analysis	15%	970	6 weeks
System Design	20%	1,293	8 weeks
Implementation	35%	2,263	14 weeks
Safety Testing & Validation	20%	1,293	8 weeks
Integration & Deployment	10%	647	4 weeks

Based on 4-person team working 40 hours/week
Total Project Duration: 40 weeks (10 months)

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6. Cost Estimation

Team Composition & Rates

Role	Count	Rate/Hour	Total Hours	Cost
Senior Software Engineer	2	$120	3,200	$384,000
Safety Systems Engineer	1	$130	1,600	$208,000
UI/UX Developer	1	$100	800	$80,000
Test Engineer	1	$90	867	$78,000

Total Labor Cost: $750,000

Additional Project Costs

Category	Cost	Justification
Hardware & Infrastructure	$100,000	Development servers, testing equipment
Software Licenses	$50,000	Development tools, databases
Safety Certification	$75,000	Third-party validation and certification
Project Management	$80,000	PM overhead (10% of labor)
Risk Contingency	$105,500	10% of total costs

Total Additional Costs: $410,500

7. Final Cost Summary
Total Project Investment

Category	Amount
Development Labor	$750,000
Additional Costs	$410,500
Subtotal	$1,160,500
Risk Contingency (10%)	$116,050
TOTAL PROJECT COST	**$1,276,550**

Cost per Use Case

Average cost per use case: $85,103

Key Cost Drivers

1. **Safety-Critical Requirements** (40% of total cost) - Extensive validation and testing
2. **Real-Time Performance Requirements** (25% of total cost) - Specialized development skills
3. **Regulatory Compliance & Certification** (20% of total cost) - Certification and documentation
4. **System Integration Complexity** (15% of total cost) - Complex hardware interfaces

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8. Risk Assessment & Mitigation

High-Risk Areas

Risk	Impact	Mitigation Strategy	Cost Impact
Safety Certification Delays	High	Early certification involvement	+$50,000
Real-time Performance Issues	High	Prototype early, performance testing	+$75,000
Integration Complexities	Medium	Incremental integration approach	+$30,000

10% contingency included in base estimate
Confidence Level

Estimation Confidence: 85%
Recommended Budget Range: $1.2M - $1.5M

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9. Project Recommendations

Critical Success Factors

1. **Early Safety Engineer Involvement** - Essential for requirements validation
2. **Incremental Development** - Reduce integration risks
3. **Continuous Performance Testing** - Ensure real-time requirements
4. **Regulatory Engagement** - Early certification planning

Alternative Approaches

Approach	Cost Impact	Timeline Impact	Risk Level
Phased Delivery	-10%	+3 months	Low
Commercial Components	-15%	-2 months	Medium
Extended Testing	+20%	+4 months	Very Low

Recommended Approach: Phased Delivery with Extended Testing
Revised Cost Estimate: $1.4M over 12 months

Conclusion

The Power Plant Control System project requires an investment of **$1.28M** over **10 months** with a 4-person specialized team. The estimate reflects the safety-critical nature of the system and incorporates industry standards for industrial control system development. The Delphi consensus approach provides confidence in the technical estimates, with the primary cost drivers being safety requirements and real-time performance constraints.