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# MEP engineering in post-conflict reconstruction: Managing deviations, quality and schedule

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## Abstract

Reconstruction and construction projects in post-conflict environments belong to a class of high-uncertainty projects: limited baseline documentation, hidden defects, damage to engineering systems, resource shortages, complex logistics, and rapidly changing site conditions. At the same time, the social importance of such facilities (residential areas, public buildings, infrastructure) requires accelerated timelines without compromising quality, safety, or long-term operational performance.

This paper systematizes a practice-oriented approach to managing reconstruction and construction projects with a focus on MEP engineering (HVAC/VRV, water supply, firefighting systems, power supply, automation). It examines methods for defining scopes of work under uncertainty, structuring teams and responsibility frameworks, managing deviations and changes, schedule compression mechanisms, and principles of quality control through inspections and testing.

It is demonstrated that a strong engineering decision-making framework and disciplined verification of MEP systems enable accelerated project delivery without transferring critical defects into the operational phase.

**Keywords:** Post-conflict reconstruction; Project management; MEP; HVAC; VRV/VRF; Deviation management; Change management; Quality control; Inspections and testing; Schedule compression; Infrastructure; Safety

## 1. Introduction

Post-conflict reconstruction projects are characterized by a high density of risks and constraints. Unlike "standard" construction, where most uncertainties are resolved at the design stage, in reconstruction key information is often discovered on site: the condition of structures and systems, site accessibility, hidden damage, and the actual routing of engineering utilities.

At the same time, there is significant schedule pressure: residential and social infrastructure must be commissioned quickly, while maintaining regulatory safety, quality, and maintainability.

In such conditions, MEP engineering becomes especially critical. Engineering systems determine the functionality of a building: even a well-built structural shell cannot be commissioned without properly functioning power supply, water supply, ventilation, and fire protection systems. Moreover, MEP errors often manifest not during installation but during operation—and at that stage they become more costly: rework requires shutdowns, access to concealed areas, repeated testing, and often leads to reputational consequences.

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Therefore, in reconstruction projects, the following are critically important: early engineering diagnostics, disciplined change management, and rigorous verification of system readiness through testing.

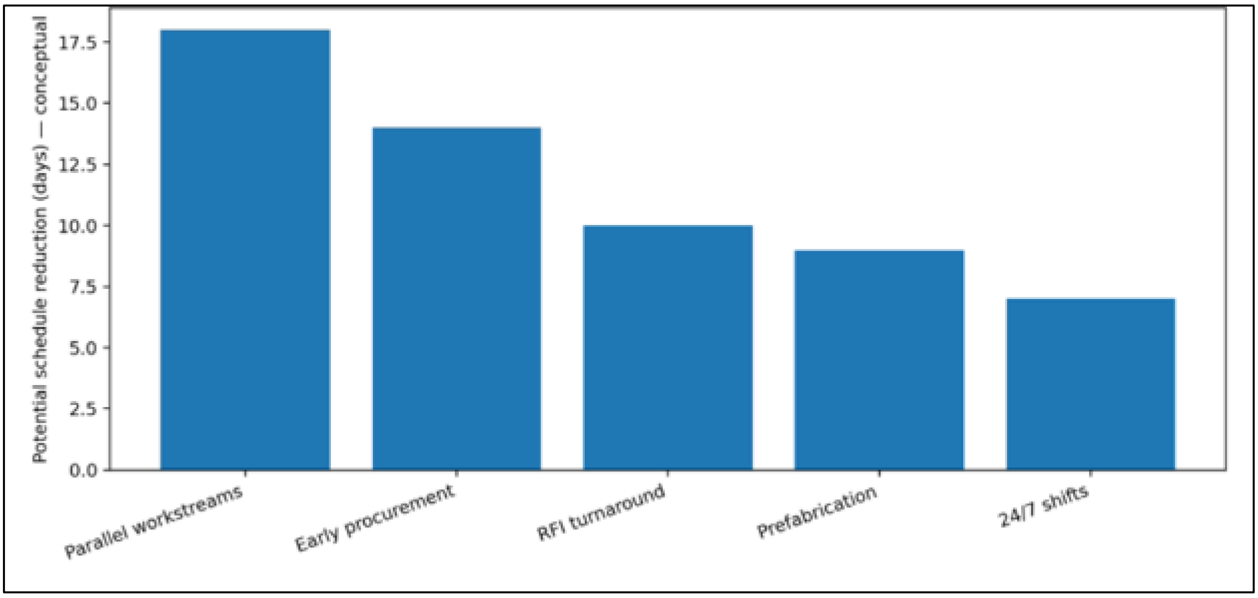


**Figure 1** Schedule compression levers in reconstruction projects (conceptual)

## 2. Main Sections

### 2.1. Defining Scope of Work with Incomplete Initial Data

In post-conflict and reconstruction projects, the classical model of "full design first, then execution" is rarely applicable. A phased refinement of scope is more typical:

- Initial survey (visual + instrumental);
- Identification of critical damage and uncertainty zones;
- Preparation of a high-level bill of quantities with allowances;
- Refinement of scope as concealed areas are opened and access is restored.

An engineering-sound approach is to categorize work by criticality:

- Critical for safety and commissioning (fire protection, electrical, water, basic HVAC operation);
- Critical for operation (automation, balancing, redundancy, air quality);
- Enhancement/comfort-related (optimization, aesthetics, advanced scenarios).

This enables accelerated commissioning without "masking" defects or compromising key safety requirements.

### 2.2. Team Structure and Responsibility Frameworks

In conditions of parallel workstreams (residential districts, public buildings, infrastructure), the risk of losing control is associated with the dilution of responsibility. An effective practice is to assign discipline leads for each MEP domain:

- HVAC/VRV
  Power supply and low-current systems
- Water supply and drainage
- Fire protection and alarm systems
- Automation/bms (where applicable)

At the same time, a unified coordination framework for system interfaces must be established: critical failures often occur at interfaces (e.g., fire scenarios, interaction between ventilation and smoke extraction, power redundancy logic).

Equally important is the incentive system: if only "speed of volume completion" is rewarded, quality inevitably declines. A more effective approach is to use combined metrics: schedule performance + inspection pass rates + closure of remarks without recurring defects.

### 2.3. Deviation Management: the "Fact → Assessment → Decision → Plan Update" Cycle

Deviations in reconstruction are the norm: hidden defects, routing mismatches, supply delays, changes in access and priorities. The risk arises when deviations are "resolved on site" without proper engineering assessment—this leads to systemic errors that are difficult to detect before operation.

A robust deviation management process includes:

- Recording the fact (what was found, where, and its impact);
- Engineering assessment (solution options, impact on safety/compatibility/schedule);
- Management decision (mitigation, resource reallocation, sequence changes);
- Updating the plan and control milestones;
- Documenting changes for future operation.

This cycle ensures traceability: why decisions were changed, what risks were accepted, and what tests are required after the change.

### 2.4. Schedule Compression Mechanisms Without Quality Degradation

Schedule reduction is possible when based on controlled "levers," not simply increased workload. In practice, the following are used:

- Parallelization of workstreams (by zones, floors, buildings; independent crews);
- Early procurement of critical items (long lead-time equipment, automation, cabling);
- Accelerated rfis/approvals (clear decision channels and response slas);
- Prefabrication/modularity (off-site assembly of components with on-site installation);
- Shift work / 24-hour windows (with enhanced quality and safety control).

A key condition: acceleration must be accompanied by strengthened inspections and testing. Otherwise, "time savings" turn into defects that surface later and require significantly higher costs to fix.

### 2.5. MEP Quality Control Through Inspections and Testing

MEP quality control should not be limited to visual checks. Most critical defects manifest:

- Under load;
- In transient conditions;
- During system interaction.
- Therefore, a rational quality control model includes:
- Functional testing (including automation and protection algorithms);
- Fire scenario testing (zone-based scenarios);
- Backup power and switching verification;
- Hydraulic testing and leak checks;
- Ventilation/hydraulic balancing (where applicable);
- Measurement of baseline parameters (voltage, current, pressure, flow rates, temperature).

For healthcare and public buildings, this is especially critical: defects in fire automation, ventilation, or electrical systems are directly linked to accident risks and threats to human safety.

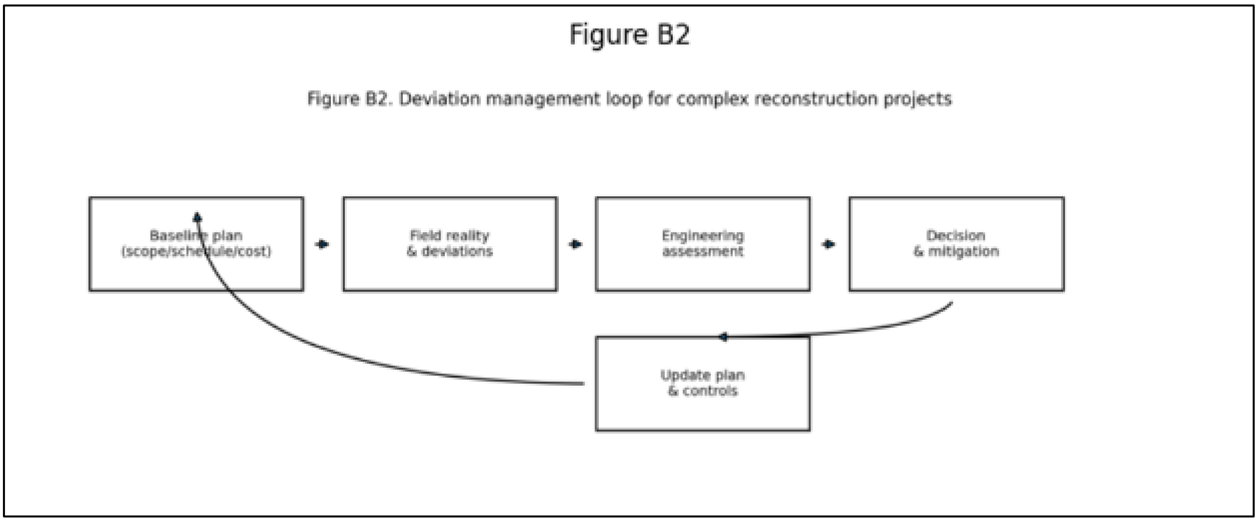


**Figure 2** Deviation management loop for complex reconstruction projects

### 2.6. Commissioning: Readiness Criteria and "Operational Fitness"

A reconstruction project is considered successful not when the "scope is closed," but when the facility can be safely operated. Therefore, readiness criteria should include:

- As-built documentation (reflecting actual execution);
- Test reports and protocols;
- A punch list and a plan for its closure;
- Configured automation setpoints (where applicable);
- Trained operations personnel and maintenance procedures;
- A list of critical spare parts and consumables.

A separate engineering challenge is avoiding the transfer of "technical debt" into operations. If a facility is commissioned with MEP defects, operations turn into constant "firefighting," and the total cost of ownership increases significantly.

### 2.7. Special Requirements for Industrial and Energy Facilities

Reconstruction at industrial sites and energy facilities increases the criticality of decisions: continuity of processes, industrial safety, and restrictions on shutdowns become key factors.

In such cases, the importance of risk management and planning of "work windows" increases, along with strict control over electrical installation and commissioning activities. Even minor errors in system design or configuration can lead to shutdowns and significant losses; therefore, disciplined testing and approvals become an essential part of the project.

## 3. Conclusion

Post-conflict reconstruction and infrastructure recovery projects require that managerial speed be supported by engineering rigor. The most устойчивый (robust/sustainable) outcomes are achieved through a combination of:

- Early diagnostics and prioritization of work by criticality;
- A well-structured, discipline-based team and coordinated system interface management;
- A formalized deviation management cycle;
- Controlled schedule compression mechanisms supported by quality control;
- Mandatory mep inspections and testing prior to commissioning.

Such an approach enables accelerated delivery without compromising safety or transferring critical defects into operation—particularly important for socially significant facilities and infrastructure.

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