



NAC Executive Insights

Spare Parts in Modular Construction

Key Points

- **Modular construction redefines responsibilities:** Constructors now act like manufacturers, requiring manufacturing-grade controls for parts, commissioning, and warranties.
- **Treat spare parts as contract deliverables:** Include a Structured Bill of Spares, technical specs, lead-time commitments, pricing rules, and return/warranty terms in a Spare Parts Appendix.
- **Make traceability nonnegotiable:** Link every spare to module passports and the AIM so commissioning, warranty claims, and audits are evidence-ready.
- **Prioritize critical spares with tailored controls:** Safety, control, and commissioning-critical items need stricter revision control, certification, and expedited logistics.
- **Hold suppliers to performance and governance KPIs:** Require on-time delivery, part accuracy, batch traceability, and documented evidence with contractual remedies for failures.
- **Plan for lifecycle and sustainability risks:** Implement obsolescence notifications, approved alternates, takeback/refurbishment programs, and annual reviews to protect long-term operability.

Introduction

Modular construction shifts the roles and responsibilities of all members of the construction value chain. The constructor is now not just integrating design more tightly into the design-build process but also taking on responsibilities for what may be better termed a manufacturing process. Overall project cadence and sequence changes, new risks emerge and new metrics are required.

In this modified value chain, the constructor is also often tasked to integrate responsibilities that more traditionally have remained with the asset owner. This Executive Insight looks at one such aspect, namely the requirements and risks associated with spare parts for the various pre-assemblies and modules that are now integral parts of the final, completed project.

Part 1 lays out considerations and contents for a Spare Parts Appendix that should be integrated into a module delivery contract. At a higher level, more general requirements would be included in the contract between Owner and Constructor, with increasingly specific and detailed ones provided by the Constructor to the module or pre-assembly builder.

Part 2 focuses on risks related to Spare Parts. These risks may not be routinely considered by Constructors, especially those new to the use of modular construction.

Part 1 - Spare Parts Appendix

A Spare Parts Appendix defines what parts must be supplied, their specifications, their lifecycle obligations, and the commercial and logistical rules governing their availability. For modular construction, it must be evidence--ready¹, traceable, and aligned to commissioning and warranty gates.

A list of what should be included, as a minimum, in such an appendix follows. This appendix should be an integral part of the module contract.

1. Spare Parts List (Structured Bill of Spares)

1.1 Mandatory Spare Parts

- Parts required for commissioning, start-up, and first year- of operation
- Identified by discipline (mechanical, electrical, plumbing, controls)
- Quantities based on failure modes, OEM (Original Equipment Manufacturer) guidance, and criticality

1.2 Recommended Spare Parts

- Non-critical but high-value or long--lead items
- Items with predictable wear or replacement cycles

1.3 Optional / Owner-Selected- Spares

- Owner-requested extras
- Project-specific- redundancy items

1.4 Spare Parts BOM Structure

Each spare part must include:

- Part name
- Part number (OEM + Supplier)
- Module association (if applicable)
- Quantity per module
- Total quantity required
- Unit of measure
- Revision number
- Cross-reference to commissioning scripts and AIM attributes

2. Technical Specifications for Each Spare Part

2.1 Technical Data

- Material specifications
- Performance ratings, including expected Mean-Time-Between-Failure (MTBF)
- Dimensions and tolerances
- Environmental ratings (IP (Intellectual Property), NEMA (National Electrical Manufacturers Association), corrosion class)

2.2 Compatibility Requirements

- Compatible module types
- Compatible design revisions
- Interface requirements (connectors, fittings, software versions)

¹ In the context of modular construction, “evidence-ready” means that all relevant information, documentation, and data are prepared, organized, and traceable so they can be quickly and reliably used to verify compliance, quality, or performance at key project milestones — such as commissioning and warranty gates

2.3 Quality & Certification

- OEM certificates
- Compliance standards (UL, CE, ASME, etc.)
- Calibration requirements (if applicable)

3. Lead Times, Availability, and Supply Chain Requirements

3.1 Lead Time Commitments

- Standard lead time
- Expedited lead time
- Maximum allowable lead time for critical spares

3.2 Stocking Requirements

- Supplier minimum stock levels
- Owner-held inventory (if applicable)
- Consignment stock options

3.3 Obsolescence Management

- Notification period for discontinued parts
- Replacement part equivalency rules
- Evidence requirements for substitution

4. Pricing, Commercial Terms, and Validity

4.1 Pricing Table

- Unit price
- Bulk price (if applicable)
- Price validity period
- Escalation rules

4.2 Warranty on Spare Parts

- Warranty duration
- Warranty start (delivery vs. installation)
- Evidence required for warranty claims

4.3 Return & Restocking Rules

- Return conditions
- Restocking fees
- Packaging and evidence requirements

5. Logistics, Packaging, and Delivery Requirements

5.1 Packaging Standards

- Protective packaging requirements
- Environmental protection (humidity, salt, shock)
- Labeling and barcoding

5.2 Delivery Requirements

- Delivery timelines
- Delivery acceptance criteria
- Evidence required (photos, sensor logs for sensitive items)

5.3 Chain-of-Custody

- Required documentation
- Digital signatures
- Passport integration (if spares are module-specific-)

6. Integration with Module Passports and AIM (Asset Information Model)

6.1 Passport Linkage - For module-specific- spares:

- Spare part ID must be linked to the module passport
- Commissioning scripts must reference spare part usage
- Warranty claims must reference passport evidence

6.2 AIM (Asset Information Model) Integration

- Spare parts must map to AIM asset attributes
- Include maintenance intervals
- Include replacement procedures
- Include OEM manuals

7. Criticality, Risk, and Failure Mode Classification

7.1 Criticality Levels

- Critical (failure stops operation)
- High (failure degrades performance)
- Medium (failure impacts comfort or efficiency)
- Low (non-operational impact)

7.2 Failure Mode Analysis

- Expected failure modes
- Mean Time Between Failures (MTBF)
- Recommended replacement intervals

7.3 Spare Parts Strategy

- Run-to-failure
- Preventive replacement
- Sensor-Based predictive replacement

8. Supplier Obligations and Performance Requirements

8.1 Spare Parts KPIs

- On-time delivery
- Accuracy of supplied parts
- Evidence completeness
- Warranty claim response time

8.2 Support Obligations

- Technical support availability
- Installation support (if required)
- Training for Owner personnel

8.3 Documentation Obligations

- Updated manuals
- Updated drawings
- Updated certificates

9. Sustainability, Take Back-, and End-of-Life Requirements

9.1 Take-Back Program

- Supplier obligations for end-of-life parts
- Refurbishment or recycling options
- Credits for returned parts

9.2 Environmental Documentation

- Environmental Product Declarations
- Hazardous substance declarations
- Disposal instructions

10. Governance, Change Control, and Revision Management

10.1 Revision Control

- Versioning of spare parts lists²
- Change rationale
- Digital signatures

10.2 Change Control

- Process for adding/removing parts
- Cost and schedule impact analysis
- Passport updates

10.3 Auditability

- Evidence trail for all changes
- Annual review and update requirement

Part 2 - Spare Parts Risk Matrix

In the prior section we laid out the range of considerations which must be covered as part of a modular construction contract with a spare parts component. This range of considerations carries with it risks that must be assessed in a manner similar to the other risks a constructor faces.

In this section we will outline the broad risk categories to consider with respect to assessing spare parts risks; lay out a detailed spare parts matrix; look more closely at critical spare parts, those parts that affect safety, commissioning or system operability; identify risk owners; and look at cross-cutting risk mitigation controls.

Risk Categories

- R1 – Technical Specification Risk
- R2 – Quality & Manufacturing Risk
- R3 – Compatibility & Revision Risk
- R4 – Lead Time & Availability Risk
- R5 – Pricing & Commercial Risk
- R6 – Logistics & Handling Risk
- R7 – Evidence, Passport & Traceability Risk

² Versioning of spare parts is the structured practice of tracking, managing and documenting the different iterations or modifications throughout its lifecycle.

- R8 – Warranty & Performance Risk
- R9 – Obsolescence & Lifecycle Risk
- R10 – Sustainability & Take-Back Risk

Spare Parts Risk Matrix

This matrix covers the full lifecycle: design → fabrication → logistics → commissioning → warranty → operations.

Risk Category	Description of Risk	Impact on Modular Delivery	Required Contract Controls
R1 – Technical Specification Risk	Incorrect specs, missing data, unclear tolerances	Wrong parts supplied; commissioning failures	Technical data sheets; OEM certificates; tolerance definitions; AIM attribute mapping
R2 – Quality & Manufacturing Risk	Defective parts, poor QC, inconsistent batches	Early failures; warranty claims; rework	QC certificates; batch traceability; inspection evidence; NC/RCA workflow
R3 – Compatibility & Revision Risk	Parts incompatible with module revision or interface	Installation delays; redesign; commissioning failures	Revision control; cross reference- to module passport; equivalency rules
R4 – Lead Time & Availability Risk	Long lead times, stockouts, supply chain disruption	Commissioning delays; downtime	Lead time commitments; minimum stock levels; consignment options; LDs for late delivery
R5 – Pricing & Commercial Risk	Price volatility, unclear escalation rules	Budget overruns; disputes	Price validity period; escalation formula; bulk pricing; fixed--price windows
R6 – Logistics & Handling Risk	Damage during shipping, improper packaging	Commissioning delays; unusable parts	Packaging standards; sensor logs for sensitive parts; delivery acceptance criteria
R7 – Evidence, Passport & Traceability Risk	Missing certificates, incomplete passport linkage	Warranty disputes; acceptance delays	Passport linkage; evidence completeness; check-sum--verified documents
R8 – Warranty & Performance Risk	Premature failure, unclear warranty terms	High O&M costs; disputes	Warranty duration; exclusions; SLA (Service Level Agreement) for replacements; evidence-based- claims
R9 – Obsolescence & Lifecycle Risk	Parts discontinued or replaced without notice	Long -term maintenance gaps	Obsolescence notification period; approved alternates; lifecycle planning

Risk Category	Description of Risk	Impact on Modular Delivery	Required Contract Controls
R10 – Sustainability & Take-Back Risk	Waste, hazardous materials, lack of recycling	Regulatory non-compliance; cost	Take-back program; EPDs; hazardous substance declarations

Critical Spare Parts Risk Matrix (High Impact- Items)

For parts that affect safety, commissioning, or system operability.

Critical Spare Type	Primary Risks	Required Controls
Electrical components (breakers, controllers, sensors)	R1, R2, R3, R8	OEM certificates; revision control; commissioning test linkage
Mechanical components (pumps, valves, actuators)	R2, R4, R8	MTBF (Mean Time Between Failures) data; preventive maintenance schedule; warranty SLAs
Envelope components (gaskets, seals, fasteners)	R2, R6, R9	Packaging standards; environmental ratings; lifecycle replacement intervals
Control system parts (PLC modules, firmware)	R1, R3, R8, R9	Firmware version control; compatibility matrix; cybersecurity compliance
Safety-critical parts (fire dampers, alarms)	R1, R2, R7, R8	Mandatory certification; commissioning evidence; AIM integration

Risk Ownership Summary

This section assigns clear primary and secondary owners for each risk category, establishing accountability, escalation paths, and decision rights across suppliers, constructors, and owners.

Risk Category	Primary Owner	Secondary Owner
R1 – Technical Specification	Supplier	Designer
R2 – Quality & Manufacturing	Supplier	OEM
R3 – Compatibility & Revision	Supplier	Owner
R4 – Lead Time & Availability	Supplier	Owner (forecasting)
R5 – Pricing & Commercial	Supplier	Owner
R6 – Logistics & Handling	Carrier	Supplier

Risk Category	Primary Owner	Secondary Owner
R7 – Evidence & Passport	Supplier	Owner
R8 – Warranty & Performance	Supplier	OEM
R9 – Obsolescence	Supplier	Owner
R10 – Sustainability	Supplier	Owner

Risk Mitigation Controls (Cross-Cutting)

This section outlines the cross-cutting technical, quality, commercial, logistics, and governance controls that convert identified spare parts risks into enforceable obligations, measurable KPIs, and practical mitigation actions.

Technical Controls

- Revision - Controlled- Bill of Materials
- Compatibility matrix
- OEM certificates
- AIM attribute mapping

Quality Controls

- Batch traceability
- QC inspection evidence
- NC/RCA workflow

Commercial Controls

- Price validity
- Escalation formula
- Bulk pricing

Logistics Controls

- Packaging standards
- Sensor logs for sensitive parts
- Delivery acceptance checklist

Governance Controls

- Passport linkage
- Evidence completeness rules
- Digital signatures
- Audit trail

Conclusion and Recommendations

Spare parts are not an afterthought in modular construction but a core element of delivery, commissioning, warranty, and long-term operations. Well specified, traceable, and contractually enforced spare parts arrangements reduce commissioning risk, shorten downtime, protect warranties, and preserve asset value. The following conclusions and recommended actions translate the appendix and risk analysis into practical next steps for owners, constructors, and suppliers.

Key Takeaways

- **Spare parts must be treated as deliverables.** They require the same rigor as modules: clear specifications, traceability, and linkage to commissioning and AIM records.
- **Risk is multi-dimensional.** Technical, supply chain, commercial, and evidence risks interact and must be managed through combined technical, commercial, and governance controls.
- **Critical spares need special handling.** Safety, commissioning, and control system parts demand tighter revision control, mandatory certification, and prioritized logistics.
- **Lifecycle planning prevents future gaps.** Obsolescence rules, notification windows, and approved alternates are essential to avoid long term maintenance shortfalls.

Recommended Contract and Governance Actions

- **Embed a Spare Parts Appendix** into module contracts that includes a Structured Bill of Spares, technical specs, lead time commitments, pricing rules, and evidence requirements.
- **Mandate passport and AIM linkage** so every spare part is digitally traceable to the module, commissioning scripts, and warranty records.
- **Assign clear risk owners** for each risk category and require suppliers to meet KPIs for delivery, quality, and evidence completeness.
- **Include enforceable remedies** such as minimum stock levels, consignment options, and liquidated damages for critical spares, where justified by project impact.

Implementation Roadmap

- **Immediate (0–3 months)**
 - Finalize and attach the Spare Parts Appendix to upcoming module contracts.
 - Identify and classify critical spares for current projects.
- **Short term (3–9 months)**
 - Integrate spare part IDs into module passports and AIM.
 - Establish supplier KPIs and reporting cadence.
- **Medium term (9–18 months)**
 - Implement obsolescence monitoring and approved alternate procedures.
 - Pilot consignment or owner-held inventory for high criticality items.
- **Ongoing**
 - Annual review of the Spare Parts Appendix and risk matrix; update based on lessons learned and supplier performance.

Performance Metrics and Audit Controls

- **Core KPIs:** on-time delivery, part accuracy, evidence completeness, warranty response time.
- **Audit controls:** periodic verification of passport linkage, random batch traceability checks, and annual obsolescence reviews.
- **Escalation path:** defined SLA breach responses and governance forum for cross-party disputes.

Final Recommendation

Adopt the Spare Parts Appendix as a standard contractual module across projects and operationalize the risk matrix through governance, AIM integration, and supplier performance management. Doing so converts spare parts from a latent liability into a managed asset that supports reliable commissioning, reduces lifecycle cost, and protects operational continuity.

For Further Reading – Other Executive Insights

- Craft Training for Modular Construction
- Digital Passports Training for Modular Construction
- Golden Thread
- Modular Construction Contract Consideration
- Modular Construction Transportation Risk
- Economic & Schedule Trade-Offs in Modular vs. Stick-Built Execution
- Modularization vs. Stick-Built Readiness Strategy

About the Author

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