Supplementary Material

# Supplementary Appendix - Definitions of specific information items for ten common decision areas for supply chain management across detailed design, procurement, and construction phases of an industrial construction project

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| **Information Needed** | **Definitions** |

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| **D1. Detailing the construction sequence to get materials on site** | |
| Upstream Constraints | Visibility into constraints in fabrication yard release dates, modular yard schedule, fabrication yard, and tier-2 supplier contractual milestones. |
| Site constraints | Visibility into site constraints such as area release dates, logistics limitations, readiness reviews. |
| Construction sequence/path of construction | The general plan for construction sequencing, including work areas that supports plan for Construction work packages (CWPs) /Installation work packages (IWPs). |
| Current supplier lead times for early planning | Current windows between ordering and delivery for components. May include sub-tiers of suppliers (upstream) for clarity. |
| Supplier ability to accelerate | A supplier's ability to add capacity by adding a shift or additional or alternate resources to production. This supplements availability based on production windows. |
| Design dependencies | Identification of dependencies and constraints to design; e.g., vendor data, owner inputs, internal dependencies between systems. |
| Engineering Work Package Completion | Status and progress of engineering deliverables associated with each Engineering work package (EWP). |
| Bill of Material quantities by CWP/IWP | Detailed bill of material quantities including systems and associated assemblies, components, sub-components, consumables as per CWP and IWP. |
| System interface points and boundaries | Clear delineation of boundary points in design (by CWP, EWP). |
| Regional resource availability | Understanding of regional availability (key constraints) of labor and limited resources (e.g., specialized equipment) that may limit resources available to the project |
| Materials handling costs offsite | Costs for materials handling, including storage costs offsite. |
| Materials handling costs onsite | Costs for materials handling, including storage, re-handling, and maintenance costs onsite. |
| Logistics availability windows | Shipping window/logistics constraint; e.g., limited availability of the heavy-lift capability |

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| **D2. Reviewing long lead items and need dates** | |
| Identification of critical components/long lead time items | Critical/long-lead components are identified through a review of Required-at-site (RAS) dates against purchase order (PO) lead times; such components require early ordering to assure timely delivery to the site. Critical/long-lead components set key procurement dates and may require extra monitoring. Critical components may also be identified as specific site installation dates from contractual milestones or critical constraints such as limited availability of installation/expertise providers, weather windows, etc. |
| Installation/expertise provider availability | Dates that specialized expertise (such as installation or technical monitoring) are available. Such availability may limit construction windows. |
| Design deliverable dates by EWP | The agreed completion dates of engineering work packages. |
| Current supplier lead times for early planning | Current windows between ordering and delivery for components. May include sub tiers of suppliers (upstream) for clarity. |
| Design dependencies | Identification of dependencies and constraints to design; e.g., vendor data, owner inputs, internal dependencies between systems. |

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| **Information Needed** | **Definitions** | |
| **D3. Identify Materials/Equipment requiring higher visibility** | | |
| Identification of critical components/long lead time items | | Critical/long-lead components are identified through a review of RAS dates against PO lead times; such components require early ordering to assure timely delivery to the site. Critical/long-lead components set key procurement dates and may require extra monitoring. Critical components may also be identified as specific site installation dates from contractual milestones or critical constraints such as limited availability of installation/expertise providers, weather windows, etc. |
| Installation/expertise provider availability | | Dates that specialized expertise (such as installation or technical monitoring) are available. Such availability may limit construction windows. |
| Materials that require special handling | | Identify materials that require special handlings, such as over-size/overweight, and or that have special storage, unique resources for delivery (e.g., cranes), or related requirements. |
| Shipment quantities and composition - engineered materials, major equipment packages | | Visibility into shipment quantities as well as how suppliers (and sub-suppliers) ship materials (e.g., major equipment, packages of equipment including sub-assemblies and parts. Also, loose components, spares, etc. of equipment that is designed and shipped by the vendor) |
| Design dependencies | | Identification of dependencies and constraints to design; e.g., vendor data, owner inputs, internal dependencies between systems. |
| Supplier delivery performance history for ordering | | History of on-time performance for suppliers used to screen qualified suppliers before placing an order. |
| Supplier quality history for ordering | | History of quality (ability to meet specifications) for suppliers, used to screen qualified suppliers before placing an order. |
| **D4. Establish Supplier quality surveillance program and plan** | | |
| Detailed supplier progress reports | | The report provides status and progress of the delivery including forecasted delivery dates, constraints, associated document status, engineering issues, fabrication, sub-supplier progress, packing/transport, look ahead activities and inspections planned, status of deviations (technical queries, supplier variation requests, non-conformance reports), pictures, schedule, quality performance that affects the schedule. |
| Supplier production schedule | | Supplier production plan and schedule (including incremental milestones) - constraints; cutting, welding, fit-up, inspection etc. |
| Supplier delivery performance history for ordering | | History of on-time performance for suppliers used to screen qualified suppliers before placing an order. |
| **D5. Use of Catalogue vs. Custom** | | |
| Visibility into what is catalog (standard) | | Ability to identify catalog components that should be readily available compared to custom |
| Current supplier lead times for early planning | | Current windows between ordering and delivery for components. May include sub tiers of suppliers (upstream) for clarity. |

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| **Information Needed** | **Definitions** |
| **P1. Order long lead time products** | |
| Logistics availability windows | Shipping window/logistics constraint; e.g., limited availability of heavy-lift capability |
| Supplier production windows for ordering/monitoring | Availability of production capacity time (low volume production - the window has start/end dates) for the supplier to produce components. |
| Current utilization for ordering/monitoring | Availability of production capacity as a fraction of utilization for volume production. |
| Supplier capabilities for ordering | Critical limitations of supplier's ability to produce, such as limits to the size of parts they can handle (e.g., ability to galvanize) |
| Work breakdown structure including EWP, PWP, CWP, IWP | The division of the project into different work packages, including engineering, procurement, and construction. |
| Required-onsite (ROS)/Required-at-site (RAS) dates | The date needed onsite (or laydown/receiving yard) derived from the construction needed date plus the time needed to receive materials (including testing or assurance). May include a buffer between construction need date and date need to deliver to site (e.g., regulations may require a buffer). |
| **P2. Supplier selection** | |
| Logistics availability windows | Shipping window/logistics constraint; e.g., limited availability of heavy-lift capability |
| Supplier production windows for ordering/monitoring | Availability of production capacity time (low volume production - the window has start/end dates) for the supplier to produce components. |
| Current utilization for ordering/monitoring | Availability of production capacity as a fraction of utilization for volume production. |
| Construction need date | Installation date for materials onsite based on current information (path of construction, schedule level of detail) |
| ROS/RAS dates | The date needed onsite (or laydown/receiving yard) derived from the construction needed date plus the time needed to receive materials (including testing or assurance). May include a buffer between construction need date and date need to deliver to site (e.g., regulations may require a buffer). |

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| **Information Needed** | | **Definitions** |
| **P3. Expediting decisions considering overall project picture** | | |
| Logistics availability windows | Shipping window/logistics constraint; e.g., limited availability of heavy-lift capability | |
| Construction need date | Installation date for materials onsite based on current information (Path of construction, schedule level of detail) | |
| ROS/RAS dates | The date needed onsite (or laydown/receiving yard) derived from the construction needed date plus the time needed to receive materials (including testing or assurance). May include a buffer between construction need date and date need to deliver to site (e.g., regulations may require a buffer). | |
| Detailed supplier progress reports | The report provides status and progress of the delivery, including forecasted delivery dates, constraints, associated document status, engineering issues, fabrication, sub-supplier progress, packing/transport, look ahead activities and inspections planned, status of deviations (technical queries, supplier variation requests, NCRs), pictures, schedule, quality performance that affects schedule. | |
| Supplier production schedule | Supplier production plan and schedule (including incremental milestones) - constraints; cutting, welding, fit-up, inspection etc. | |
| Materials that require special handling | Identify materials that require special handlings, such as over-size/overweight, and or that have special storage, unique resources for delivery (e.g., cranes), or related requirements. | |
| Engineering progress | Visibility into status of engineering deliverables (% complete) and engineering milestones. | |
| EWP Completion | Status and progress of engineering deliverables associated with each EWP. | |
| Supplier capabilities for ordering | Critical limitations of suppliers' ability to produce, such as limits to the size of parts they can handle (e.g., ability to galvanize). | |
| Supplier quality history for ordering | History of quality (ability to meet specifications) for suppliers, used to screen qualified suppliers before placing an order. | |
| Supplier delivery performance history for ordering | History of on-time performance for suppliers used to screen qualified suppliers before placing an order. | |
| Materials handling costs offsite | Costs for materials handling, including storage costs offsite. | |
| Materials handling costs onsite | Costs for materials handling, including storage, re-handling, and maintenance costs onsite. | |
| Finished goods inventory levels offsite | The stock level of finished goods offsite at various supply chain nodes. | |
| Finished goods inventory levels onsite | The stock level of finished goods on the construction site. | |
| Logistics constraints | Identification of constraints and availability on delivery of certain items (especially oversize/overweight). An example is regulations that limit delivery times or number per day. | |

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| **Information Needed** | **Definitions** |
| **C1. Adjustment in schedule and/or supply chain to accommodate materials flow disruption** | |
| Supply chain's ability to hold inventory/delay deliveries | Ability of a supplier or logistics yard to hold additional inventory or delay deliveries. This can relieve the pressure onsite storage needs. May be contractual. |
| IWP readiness, including design, materials, labor, equipment, etc. | Visibility into IWP readiness to assure they are constraint-free. |
| Visibility into status and location of materials in the supply chain (at the tag level) | Near real-time transactional information (status and location) of physical material as it traverses through different supply chain nodes as appropriately planned for the project (includes desired upstream nodes such as fabrication shops and 2nd tier suppliers; specification of extent of tracking is part of project planning). Must include BOM information for parent-child assemblies. Tags may need to be assigned upon receiving if common parts are shipped in quantity (bag and tag). |
| Warehouse space availability over time | Allocation of warehouse space over time according to plan deliveries and installation of materials onsite that releases space. |
| Client milestones | The client's dates for critical activities (e.g., start dates, turnaround windows, and required completions). |
| Availability level/options of alternate supply source for common parts/consumables | Alternate supply of standard parts that can substitute for parts that are ordered (i.e., can substitute an alternate if the desired is unavailable) |
| EWP Completion | Status and progress of engineering deliverables associated with each EWP. |
| Line breaks/piece marks | Visibility into fabricator information that affects design such as breaks between spools, piece marks for structural steel |
| BOM quantities by CWP/IWP | Detailed bill of material quantities including systems and associated assemblies, components, sub-components, consumables as per CWP and IWP. |
| Site resource availability | Resources assigned/available to the site over time (resource pool) |
| Resource allocation | Allocation of resources to specific activities (over time) by IWP/detailed schedule |