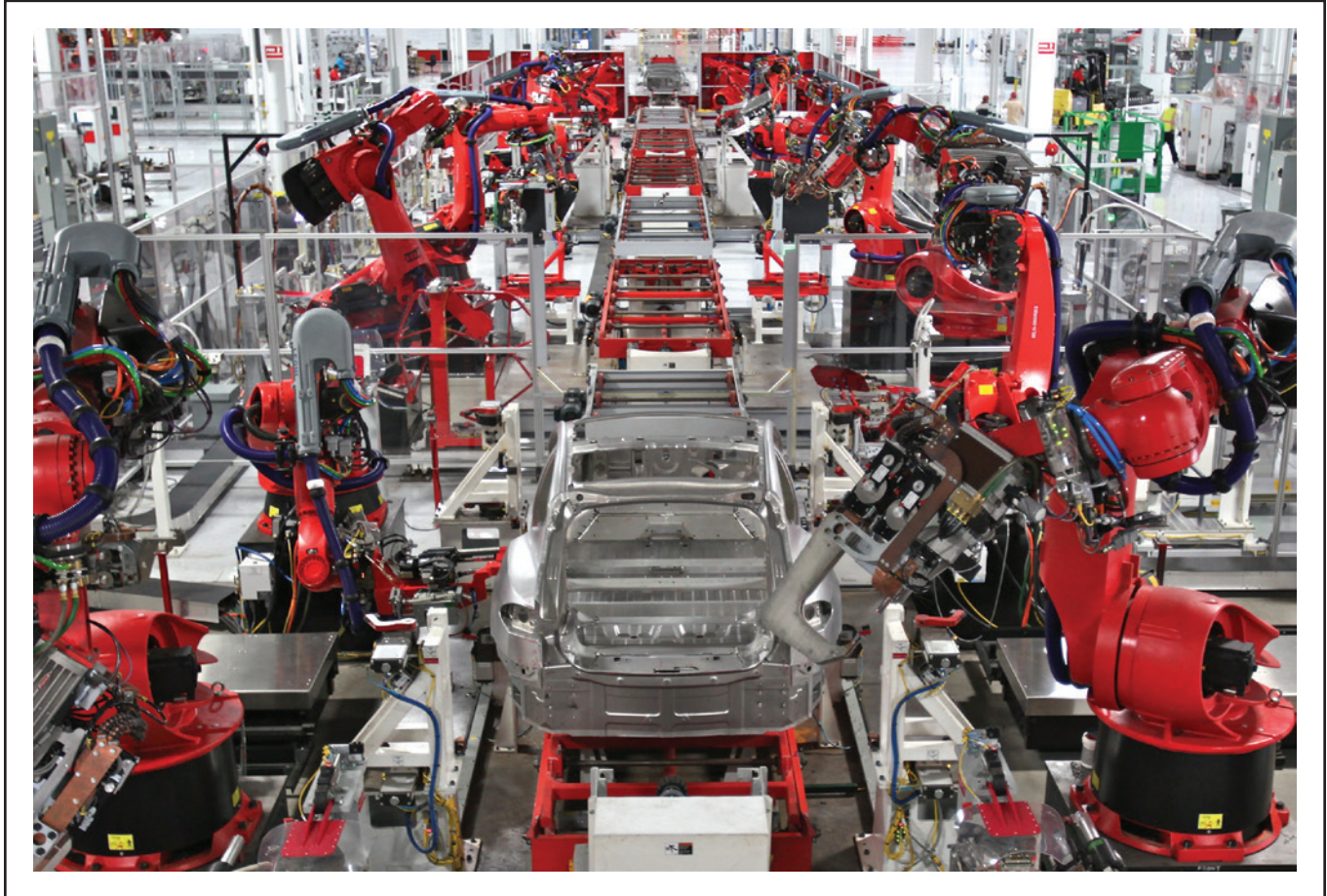




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for Manufacturing and Life Sciences



Final Report MLS-02



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Project Definition Rating Index (PDRIx) for Manufacturing and Life Sciences Projects

Prepared by

Construction Industry Institute
Manufacturing and Life Sciences Sector Committee
Research Team MLS-02, PDRI for Manufacturing and Life Sciences

Final Report MLS-02

October 2018

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The University of Texas at Austin

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Executive Summary

PDRix for Manufacturing and Life Sciences (MLS) Projects is a scope definition tool developed specifically for the MLS sector to help project teams measure the degree of scope definition, identify gaps, and take appropriate actions to reduce risk during front end planning. PDRix for MLS Projects is a derivative of PDRI–Industrial that follows the same recommended practices for conducting PDRI assessments. Research Team MLS-02 (RT-MLS-02) updated the earlier PDRI element list to address the critical scope definition needs of capital projects with the following features:

- Involve manufacturing of products within a facility.
- Include both process- and building-related design elements.
- Follow a rigorous commissioning and qualification process in a highly regulated environment (e.g., FDA, EPA, OSHA).
- Make extensive use of enterprise and control systems for business and process automation.
- Adhere to strict environmental controls.

This report provides an overview of RT-MLS-02's research and development of PDRix for MLS Projects. The research team identified several new elements to address critical scope definition needs of the MLS sector. It also made element updates and additions to address technological, design, and project management innovations that have become industry standards since PDRI–Industrial was first published in 1995.

Overall, PDRix for MLS Projects includes 83 elements, compared to 70 in PDRI–Industrial. The additional elements in this PDRix are primarily located in two new categories under Section II – Basis of Design:

- Category H. Building Programming & Design Parameters
- Category K. Enterprise & Control Systems

The research team conducted weighting workshops to assess the relative importance of each element in terms of its potential risk to successful project delivery. These workshops attracted 30 industry professionals (26 with previous PDRI experience) from 18 different organizations within the MLS sector. This undertaking represented the first time in more than 20 years that the relative weighting of elements derived from PDRI–Industrial has been revisited, and the results showed a substantial shift in element weighting. Specifically, the most highly weighted elements in PDRix for MLS Projects included the project cost estimate (a new element), project objectives and strategy, and specifications for the products to be manufactured or the services to be offered.

The PDRI methodology has helped project teams to improve scope definition and alignment, and it has provided greater transparency by identifying gaps. These benefits help equip all project stakeholders to respond better to risks identified in PDRI reviews, to predict potential issues, and to improve cost and schedule performance. PDRIx for MLS Projects aligns with this proven methodology, as well as CII's recommended practices for implementing PDRI. Previous CII research shows that industrial projects with a PDRI score under 200 (better-defined scope) consistently outperform projects with a PDRI score above 200 in terms of cost, schedule, and change orders (CII 2013).

Preliminary validation testing results from completed and in-progress projects which RT-MLS-02 examined indicate that organizations should achieve improvements in project performance similar to those realized using PDRI–Industrial; however, the PDRIx for MLS Projects' updated element weightings should help project teams more accurately identify which elements pose the greatest risk to successful project delivery. Overall, an analysis of 42 projects, representing more than \$5.06 billion in total installed cost shows that PDRIx for MLS Projects gives project teams in the MLS sector an effective assessment tool to understand risk and help identify gaps in scope definition. (See Appendix D for details on the test projects.)

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Chapter 1

Introduction

Front end planning is a critical process within the project lifecycle that defines the scope of the project. In 1994, CII established Research Team 113 (RT-113), Front End Planning, to help owners and contractors better achieve their business, operational, and project objectives by developing an effective and easy-to-use scope definition tool called the Project Definition Rating Index, or PDRI (CII, 1997). PDRI is a methodology that has been proven to reduce risk in project delivery by promoting rigorous scope definition through a collaborative review process during front end planning. Since the development of the first PDRI tool, CII members have measurably improved the delivery of their capital projects, specifically by improving the predictability of cost and schedule estimates. Through the years, CII has published a series of PDRI tools for industrial, building, infrastructure, small industrial, and small infrastructure projects. Industrial facilities in the MLS sector include the manufacturing of pharmaceuticals, automobiles, high-tech electronics, food, beverages, agriculture products, pulp and paper, and consumer products.

In 2016, CII's Manufacturing and Life Sciences Sector Committee (MLS) formed Research Team MLS-02 (RT-MLS-02), PDRI for Manufacturing and Life Sciences, to develop a new PDRI tool that would combine elements of the PDRI–Industrial (IR113-2) and PDRI–Building (IR155-2) tools to more specifically address MLS sector projects. RT-MLS-02 compiled data and experience from the MLS sector to combine elements from PDRI–Industrial and PDRI–Building, and updated elements to reflect current practices and technological aspects to fully address the scope definition needs of MLS capital projects. The “x” in the title “PDRIx for MLS Projects” indicates that this project followed the CII Sector Leadership Committee's new “advanced development” fast-track process, rather than the traditional CII research process.

The RT-MLS-02 identified three opportunities to increase PDRI's value to the MLS sector:

1. Combine elements from PDRI–Industrial and PDRI–Buildings.
2. Address topics not fully addressed by the existing PDRI templates.
3. Improve the descriptions of deliverables.

RT-MLS-02 developed an initial PDRI element list for MLS projects by identifying key inputs from the PDRI–Industrial and PDRI–Building tools. Next, during several workshops, research team members proposed modifications to the existing scope definition elements and possible new elements. The group used a collaborative

process to review the elements, further refining the element list and descriptions. The team then conducted a series of weighting workshops to provide a wide cross-sectional assessment by participants from the research team, as well as industry professionals from both CII and non-CII member organizations. The research team used the raw weights obtained from these workshops to develop the final version of the PDRIx for MLS Projects scoresheet, normalizing a scoring system that ranged from 70 to 1000 points. The workshop facilitation, data analysis, and the process for weighting elements followed a methodology consistent with the previous PDRI tools. Participants' responses at the workshops were individually evaluated, and a single weight was developed for each level of an element's definition. Several statistical tests were then performed.

RT-MLS-02 used both completed and in-progress projects to validate PDRIx for MLS Projects' usability in a project team setting. This approach also helped establish the tool's viability as a predictor of project success in terms of cost and schedule performance. The research team collected project data for manufacturing-related projects that met three criteria:

1. Included both industrial and building scope.
2. Had a total installed cost of \$1 million or higher.
3. Were in progress or had been completed within the previous three years.

The team collected original PDRI data, where available, to support its analysis of organizational change and implementation considerations for projects that will transition from using existing tools to deploying PDRIx for MLS Projects. The validation questionnaire was consistent with RT-113, and the validation test cases included both "successful" and "unsuccessful" projects. To capture helpful hints for posterity, the testing included feedback from facilitators who were transitioning from previous tools to the new, MLS-focused tool. Ultimately, the results verified the usability of PDRIx for MLS Projects and its viability as an indicator of thorough scope definition prior to project authorization.

This report consists of five main chapters, followed by four appendices of supporting information. Chapter 2 highlights the development methodology. Chapter 3 provides implementation guidance on how PDRIx for MLS Projects can be used to improve project performance. Chapter 4 shares lessons learned during three case studies. The final chapter summarizes the major uses and benefits of PDRIx for MLS Projects, and offers recommendations for implementing it on future projects. Throughout this report, all monetary values are based on U.S. dollars (USD).

Chapter 2

PDRix Development Methodology

Template Development

RT-MLS-02 met multiple times over the course of eight months to prepare the element list and descriptions. The research team designed PDRix for MLS Projects to help project team members use their collective professional judgment to assess the degree of scope definition for an MLS project. The team built this tool based on the work already done to develop PDRI tools for industrial and building projects. PDRix for MLS Projects combines elements of these two tools to more specifically address the requirements of the MLS sector.

The research team also considered other customizations to PDRI suggested by CII members, and discussed all necessary modifications and new elements to ensure that the new PDRI template would meet MLS sector requirements. Figure 1 shows the template development steps, which are the same steps used to develop previous CII PDRI templates (CII, 2006).

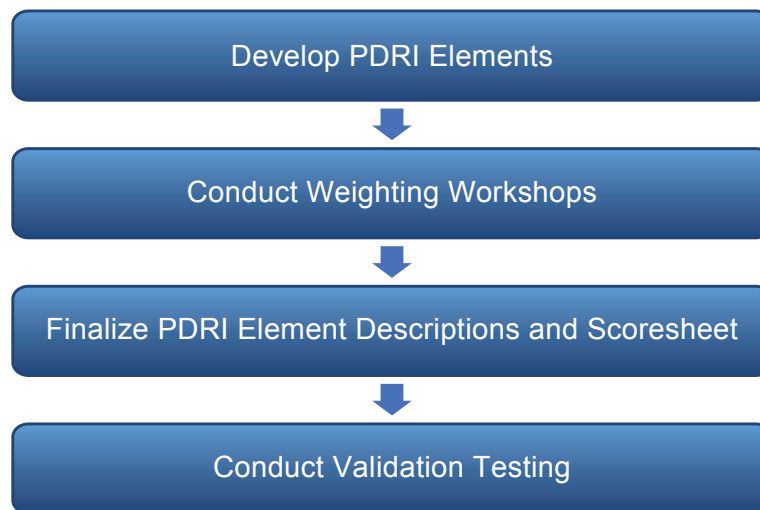


Figure 1. Development Steps

PDRix for MLS Projects consists of 83 elements, grouped into 15 categories and three sections. The PDRix for MLS Projects Excel tool is consistent with the worksheet tools developed for previous PDRI templates, and it presents element descriptions in a manner similar to the earlier tools. The elements included in PDRix for MLS Projects are not uniformly important in terms of potential risk to successful project delivery.

Element Weighting

The research team conducted two weighting workshops to assess the relative importance of each element, invited experienced project managers and estimators from both CII and non-CII member companies to help determine which elements had the greatest impact on overall project success. Each workshop participant was asked to consider a typical project type and size familiar to his or her organization. The weighting exercise focused on assigning a contingency percentage for each element, based on the project's level of definition going into detailed design. Table 1 shows the levels of definition that were evaluated for each element.

Table 1. Definition Level for Each Element

1 = Complete Definition	• Documented accurately. • All approvals for documents have been obtained (as required) . • Documents have been communicated to affected stakeholders. • No further work required.
5 = Poor Definition	• Little or no thought has been given to the element.

The first workshop was held in Indiana with participation from industry experts from 18 different organizations. The second workshop was conducted virtually with participation from 12 industry experts. In both workshops, participants were asked about their personal experiences and invited to weight each element based on contingency. The team used this feedback to evaluate PDRix for MLS Projects, and to determine how it best could be updated and modified to work as an improved tool for the industry.

Twenty-six of the workshop participants had previous PDRI experience. These industry experts brought an extensive amount of knowledge to the workshops and provided excellent input. The participants had 711 years of collective experience, including 441 years of project management, 178 years of project planning, and 62 years of estimating experience. Results from one participant were excluded from the team's computations of element weights because significant amounts of data were missing from this entry. Figure 2 lists workshops participants' general affiliations.

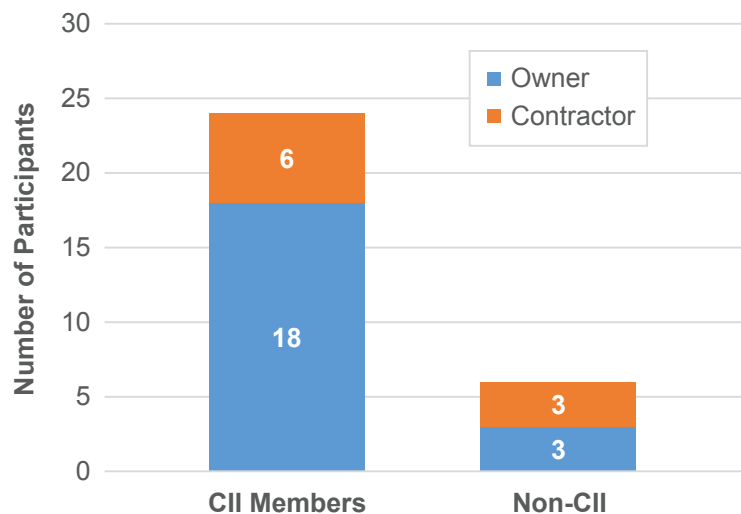


Figure 2. Weighting Workshop Participant Breakdown

Once the researchers had normalized all of the PDRIx for MLS Projects weighting factor evaluation forms, they calculated the corresponding mean element weights for the final version of the PDRIx for MLS Projects and sorted them in order of importance. Figure 3 shows the top 10 weighted elements. (The elements with the most weight have the highest potential to negatively affect project performance.) Out of a potential 1000 points, the 10 highest-weighted elements contain 217 points, or approximately 22 percent of the total maximum score.

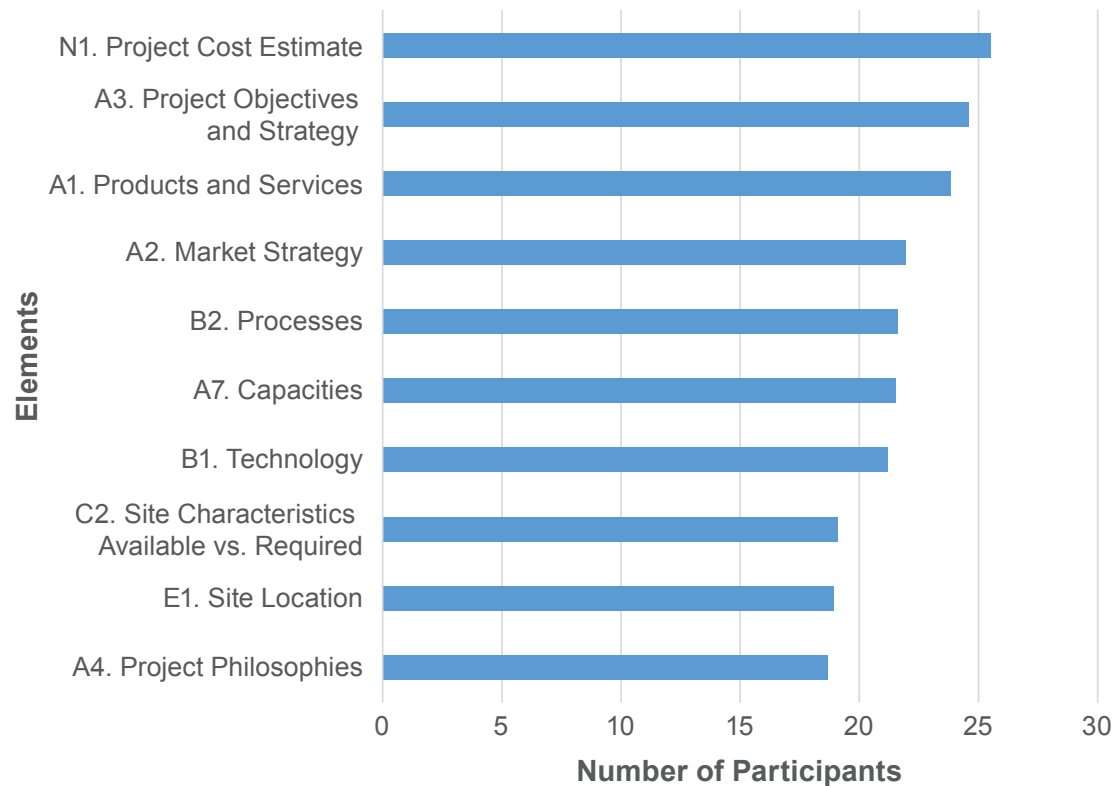


Figure 3. Top 10 Weighted Elements

Identifying the highest-weighted elements is important because market demand or other pressures to reduce project cycle times often lead to the authorization of projects with underdeveloped definition. In these instances, the amount of time available to refine the scope of the project decreases. The ability to quickly and accurately identify which factors represent the greatest risk becomes critical. To minimize risk during the detailed design, construction, and startup phases of a project, the front end planning effort should prioritize the elements and focus on the critical few that, if poorly defined, could have the greatest potential to negatively affect project performance (CII, 1996)

The three sections and 15 categories were weighted in the same manner as the elements. Section II – Basis of Design was identified as the most important section, receiving 451 points. Section III – Execution Approach was identified as the least important section, receiving 223 points. That left Section I – Basis of Project Decision with 326 of the 1000 points (see Figure 4).

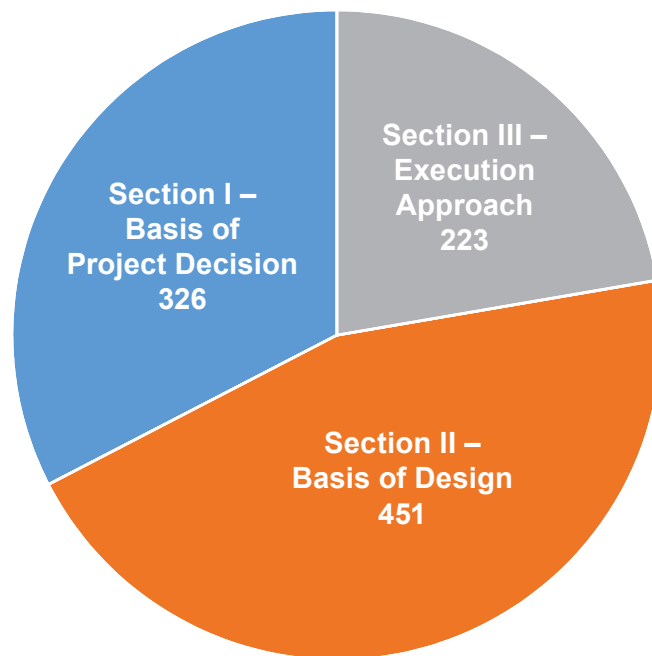


Figure 4. Section Totals

Validation Testing

The aim of the validation testing process was to correlate PDRI scores with project success ratings. The hypothesis was that low PDRI scores, representing well-defined project scope definition, would correspond to higher project success. Since PDRix for MLS Projects is a derivative of PDRI–Industrial, RT-MLS-02 sought to validate whether PDRI–Industrial validation results could be adopted for PDRix for MLS Projects. **Although this tool is being used by MLS members, it has not yet been statistically validated.** Please use the tool and submit project data to CII, so CII can validate the tool when sufficient data have been gathered. Contact CII to learn how to submit project and PDRix for MLS Projects data.

Referring to PDRI–Industrial validation results, Table 2 compares project performance for a sample of 129 industrial projects representing approximately \$6.7 billion. Projects with better scope definition (and thus a lower PDRI score) outperformed projects with poorly defined scope in terms of cost performance at the 95 percent confidence level (CII 2013).

Table 2. Comparison of Projects with PDRI–Industrial Project Scores Above and Below 200 (from IR113-2)

Performance	PDRI Score	
	< 200	> 200
Cost	4% below budget	4% over budget
Schedule	4% behind schedule	10% behind schedule
Change Orders	7% of budget	8% of budget
	N = 75	N = 54

Chapter 3

Implementing PDRIx for MLS Projects

This chapter will help both new and experienced PDRI users successfully implement PDRIx for MLS Projects.

New to PDRI

For users new to PDRI, please consult IR113-2 to review background information and understand how to assess projects using PDRI. The following sections will be particularly helpful for getting started:

- Chapter 3: Instructions for Assessing a Project
- Chapter 4: What Does a PDRI Score Mean?
- Appendix F: Facilitation Instructions

Experienced PDRI Users

For an organization with experience in using PDRI—Industrial, PDRI—Buildings, or a customized PDRI template, the following sections outline key implementation considerations to support the transition to PDRIx for MLS Projects. The suggestions and comments presented in this publication were derived from the following sources:

- Recommendations from team members with extensive PDRI experience
- Qualitative survey responses from MLS weighting workshop participants
- Interviews conducted with selected MLS validation testing participants

No Change to PDRI Methodology

PDRIx for MLS Projects is similar to existing PDRI templates. Organizations are encouraged to continue to apply the following practices for PDRI implementation, as CII recommends:

- Use a PDRI facilitator who is independent of the project team.
- Apply PDRI during front end planning (PDRI 1, 2, 2i, and 3).
- Use the same definition levels when assessing elements.
- Score elements as “not applicable” when they are not applicable to the project.
- Normalize.
- Employ the same recommended score ranges for PDRI 1, 2, 2i, and 3.
- Interpret PDRIx for MLS Projects scores the same as other PDRI scores.

Modernization of Element List and Element Descriptions

Significant technological and project management innovations have been achieved since PDRI–Industrial was first published in 1995. Many element descriptions were revised in PDRIx for MLS Projects, and new elements were added to align with the most recent CII research publications and best practices.

Category N. Project Controls was revised to align with Association for the Advancement of Cost Engineering International (AACEI) standards for project cost estimate classifications, cost control, and schedule control. A detailed list of element changes is provided in Appendix C.

Building Programming & Design Parameters

Many capital projects in the MLS sector are a mix of both industrial and building scopes. The researchers added Category H. Building Programming & Design Parameters to help project teams assess building-related scope items. PDRI–Buildings was a key reference for the following new elements:

- H1. Building Space Requirements
- H2. Site/Plot Plan
- H3. Circulation & Open Space Requirements
- H4. Building Functional Programming
- H5. Architectural Layouts, Sections & Elevations
- H6. Room Requirements Data
- H7. Loss Prevention Considerations
- H8. Civil/Structural Requirements
- H9. Building Mechanical Design
- H10. Building Electrical Design
- H11. Building Life Safety Requirements
- H12. Information Technology and Telecommunications

Enterprise & Control Systems

Automation has become an integral part of many capital projects in the MLS sector. The team added Category K. Enterprise & Control Systems to help project teams conduct a thorough assessment of automated interfaces between enterprise and control systems. This category aligns with ANSI/ISA 95.01-2000, “Enterprise-Control System Integration – Part 1: Models and Terminology.”

Category K. Enterprise & Control Systems replaces the following PDRI–Industrial elements:

- K1. Control Philosophy
- K2. Logic Diagrams

The new elements in Category K include the following:

- K1. Measurement & Final Control Devices
- K2. Monitoring & Control Systems
- K3. Manufacturing Operations Systems
- K4. Business Planning & Logistics System

Project Execution Plan

The research team significantly changed the following elements in Category P. Project Execution Plan, to more specifically reflect the needs of the MLS sector:

- P2. Owner Approval Requirements
- P3. Engineering & Construction Plan
- P5. Commissioning/Qualification/Validation Plan
- P6. Startup & Turnover Requirements

Number of Elements

In all, PDRIx for MLS Projects includes 83 elements (compared to 70 in PDRI–Industrial). The increased number of elements is primarily attributable to two new categories in Section II – Basis of Design:

- Category H. Building Programming & Design Parameters
- Category K. Enterprise & Control Systems

Any element that is not applicable to a project should be scored as “not applicable.”

Qualitative feedback from validation testing participants indicated that PDRIx for MLS Projects marginally increased the time required to conduct a PDRI session. The case study “Facilitating PDRIx for MLS Projects Assessments of Active Projects” (Case Study 2 in Chapter 4) provides additional insight from an experienced PDRI facilitator.

Section Totals

In PDRIx for MLS Projects, Section III – Execution Approach, carries a significantly higher weight (233) compared to in PDRI–Industrial (78), but this is in line with other PDRI templates published since 2011 (see Figure 5). Since 2011, PDRI weighting workshops have indicated the increased importance of a well-defined execution approach to achieving successful project outcomes – especially compared to 1995, when RT-113 conducted the PDRI–Industrial weighting workshops.

Appendix B gives a full description for each element in PDRIx for MLS Projects.

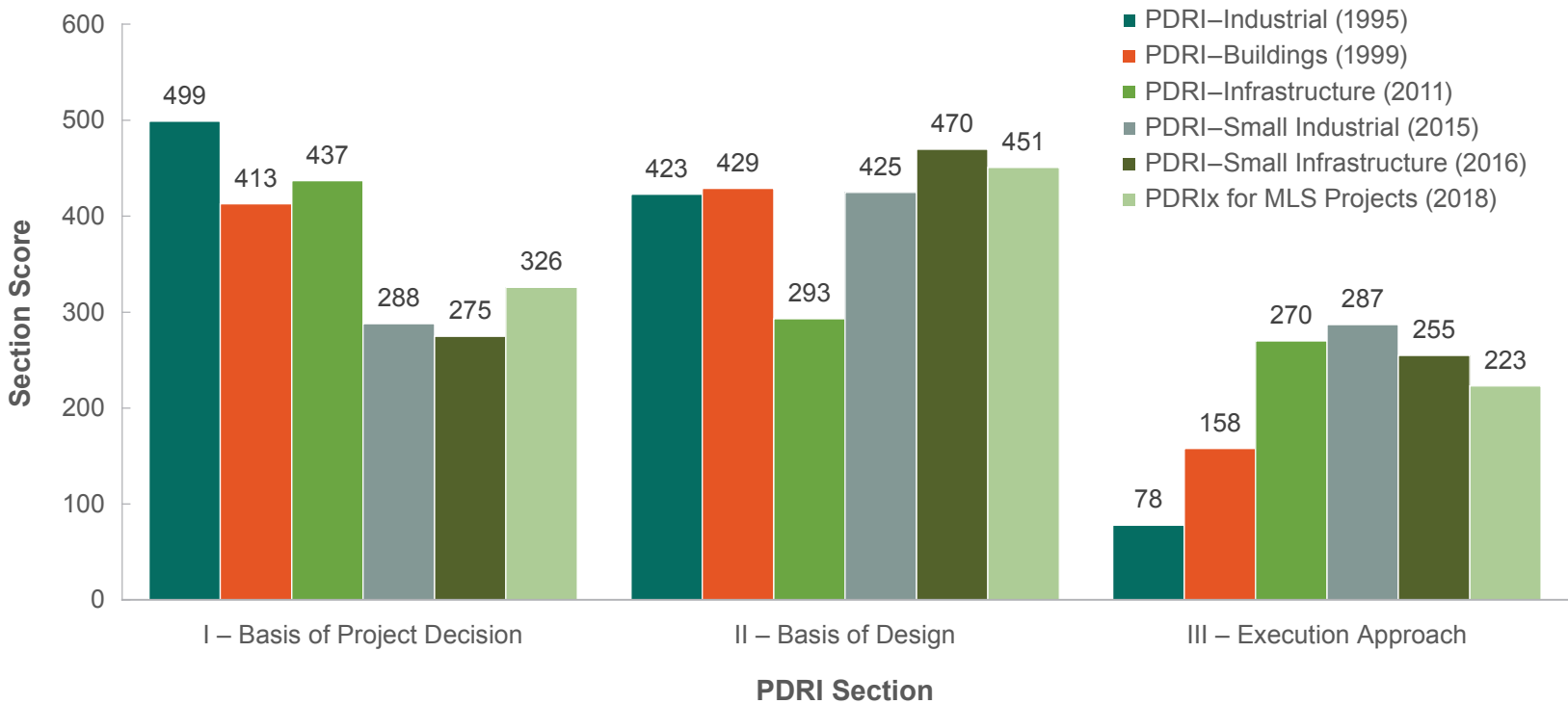


Figure 5. Section Score Comparison by PDRI Template

Chapter 4

Case Studies

The research team selected three participants to interview for validation testing and to gain insight into implementation considerations related to PDRix for MLS Projects. Each participant shared first-hand experiences and feedback from using PDRix for MLS Projects.

Case Study 1: Retrospective PDRI Assessment of a Strategic Project

Background

A U.S. pharmaceutical company participated in validation testing of PDRix for MLS Projects. The owner required a minimum of two PDRI assessments for all projects over \$5 million, with a PDRI-3 required prior to full funding. Over the previous two years, the owner conducted 39 PDRI assessments using PDRI–Industrial, PDRI Small Industrial, or PDRI–Buildings, depending on the nature of the project.

An experienced PDRI facilitator tested PDRix for MLS Projects on a \$30 million strategic capital project. The project scope was to revamp a 35-year-old high-purity water system, servicing the entire pharmaceutical manufacturing campus that the plant supplied with uninterrupted operations. The project included implementing new technologies for high-purity water generation, upgrading the existing building, and demolishing the equipment that was to be replaced.

The project team conducted three PDRI sessions during front end planning, using PDRI–Industrial. Senior leadership approved the project to proceed to detailed design with a PDRI-3 score of 133.

The PDRix for MLS Projects testing was conducted when the project was approximately 20% complete construction, with the process automation scope still in detailed design. The project was on budget but approximately 12 months behind schedule, a delay was primarily attributed to increased complexity and customization related to *process automation*. The owner's senior leadership had expressed concern about the lack of correlation between the PDRI-3 score at time of authorization and the schedule delay they were experiencing.

Validation Testing Feedback

Category K. Enterprise & Control System

The facilitator identified the new enterprise and control systems category as a valuable addition for the MLS sector, because the instrumentation and electrical category in the PDRI–Industrial template (published in 1995) did not align well with current automation requirements. The facilitator shared that PDRIx for MLS Projects would likely have positively affected the schedule of this project if it had been used at the completion of basic design. Specifically, there would have been several changes:

- “The automation lead would have benefited significantly from the team understanding the risks that were ahead. Automation ultimately ended up on the critical path of design and led to delays in the detailed design phase.”
- The team probably would have captured more action items related to automation.
- The PDRI total score would not have changed much, but the increased visibility of the action items and low-definition elements would have been beneficial.

Element F11. Process & Mechanical Test Plan

The facilitator identified this new element as a major gap (definition level = 4) in this project. It was one of the biggest issues for the team, because roles and responsibilities for factory acceptance test planning had not been defined at the completion of basic design. The facilitator shared that this element would have helped the team identify this gap earlier, and likely would have led senior leadership to force the team to clarify roles and responsibilities before proceeding to detailed design.

Element F11 complements the owner’s internal efforts to verify design and process earlier in the project lifecycle (rather than downstream, during commissioning and qualification). One challenge shared by the facilitator was “to make sure expectations are clear.” The objective is for project teams to focus on developing the process and mechanical test plan (not the protocols) during front end planning. PDRIx for MLS Projects would direct more discussions around this topic during front end planning.

Category N. Project Controls

The expanded Project Controls category was well received. The facilitator shared that, when using PDRI–Industrial, it had often been difficult to expand the discussion beyond “we have procedures in place to support this.” With a less-mature project team, the expanded element descriptions in PDRIx for MLS Projects should help focus discussion on which deliverables need to be completed, and push back if a project manager is trying to move into detailed design without a sufficient level of schedule development. This category should help make senior leadership more aware of which project controls deliverables are actually required.

Summary

Overall, the facilitator was pleased to see that a more comprehensive PDRI template better reflected projects that include both process and building scope. PDRIx for MLS Projects also brings disciplines to the table that were previously on the sidelines.

“Our HVAC specialists, AF&ID, S&Q, and Automation leads like the PDRI process. PDRIx for MLS Projects should make them feel more engaged.”

The total score of the PDRIx for MLS Projects (157) was in line with the facilitator’s expectations. The score was slightly higher than the PDRI-3 (133) conducted using PDRI–Industrial. This was primarily attributed to additional points from the new Building Programming & Design Parameters category, and the expanded Project Execution Plan category. The facilitator shared the challenge that, “it will likely remain a struggle to get the right people in the room without having 30 people attend a PDRI session.”

Case Study 2: Facilitating PDRIx for MLS Projects Assessments of Active Projects

Background

A large multinational brewing company participated in the validation testing of PDRIx for MLS Projects. Over the previous 15 years, the owner had conducted an estimated 15,000 PDRI assessments. The owner required a PDRI assessment for all capital projects over \$1 million prior to their full funding gate review. PDRI–Industrial had been the primary template utilized, along with PDRI–Buildings for any project primarily involving the construction of a new facility.

An experienced PDRI facilitator tested PDRIx for MLS Projects with three active projects ranging in planned cost from \$3 to \$18 million. Two of the PDRI sessions were facilitated with the entire project team, in place of a planned session where PDRI–Industrial normally would have been used. The third session was held during the construction phase, and it was conducted as a retrospective session with the project manager and project lead.

Validation Testing Feedback

The owner tested PDRIx for MLS Projects on three projects through facilitated, in-person PDRI sessions. The facilitator reported a very positive experience. To frame the testing feedback, the facilitator focused on one project where a PDRI-3 session had been conducted prior to requesting full project funding. The project had a planned cost of \$13 million and involved increasing the packaging capacity for an existing beverage product.

Category K. Enterprise & Control System Category

One of the biggest wins for the owner was the robust discussion on enterprise and control systems. The elements in this category opened up conversations, especially on the brewing side. There was good discussion regarding the valves to be put in and how the robots would be affected on the packaging side. The discussion also focused on ensuring the conveyers were being integrated appropriately, and that anything being added would not hinder the existing control system. The PDRIx for MLS Projects session precipitated valuable discussions that otherwise might have been missed.

Category H. Building Programming & Design Parameters Category

Previously, projects that were primarily process-focused with some building scope utilized PDRI–Industrial. Discussions on building-related scope were *ad hoc* and depended largely on the facilitator’s experience to drill down on building programming considerations. The owner had accepted this as a limitation of PDRI–Industrial. The facilitator shared that this new category flowed well for the project team. It sparked healthy discussion on circulation and open space requirements, which were important considerations in the expansion of the existing packaging operation.

Change Management Considerations

The facilitator shared that using PDRIx for MLS Projects was an easy transition for all three project teams.

“Anyone with experience using PDRI–Industrial is going to have a comfortable transition to this new template.”

One project had previously conducted a PDRI-2. The testing session involved some discussion of the differences between PDRI–Industrial and PDRIx for MLS Projects. The facilitator shared a recommendation for future users of the MLS template: facilitators experienced with PDRI–Industrial or PDRI–Buildings should spend time before the first session reviewing the changes in PDRIx for MLS Projects. This step could help the facilitator effectively address any questions from project team members about the differences between the templates and keep the PDRI session on track.

Summary

Overall, the PDRI total scores for all three projects were in line with the owner’s expectations. The owner voiced plans to proceed with implementing PDRIx for MLS Projects based on the positive results from this testing. The facilitator anticipated minimal barriers to adoption, because PDRIx for MLS Projects had adopted the same structure, methodology, and recommended score ranges as the legacy PDRI templates the company had used for 15 years.

Case Study 3: Mature PDRI Implementation Utilizing a Customized PDRI Template

Background

A European pharmaceutical company participated in validation testing of PDRIx for MLS Projects. The owner required an independent facilitator to conduct a PDRI-2 assessment at the end of concept design and a PDRI-3 assessment at the completion of basic design for all major projects over \$20 million. For projects between \$10 and \$20 million, the owner also required teams to internally execute a PDRI-3 assessment. Over the previous five years, the owner had conducted 57 PDRI assessments for major projects with a combined capital investment of \$3 billion. The company utilized a customized PDRI template that incorporated design elements of both PDRI–Industrial and PDRI–Buildings.

The PDRI process owner (and an experienced PDRI facilitator) tested PDRIx for MLS Projects with three active projects ranging in planned cost from \$40 to \$210 million. All three projects had previously conducted a PDRI session using the owner's customized PDRI template. Two of the projects were in the detailed design phase, and the third project was in the construction phase.

Validation Testing Feedback

Alignment with Industry Needs

The owner had not participated in the PDRIx for MLS Projects development process, but was pleased to see that RT-MLS-02 had independently arrived at almost the same element changes that the owner company had incorporated into its customized PDRI template. The process owner identified the following valuable additions, based on this company's testing effort:

- Category K. Enterprise & Control System – a new category
- Category N. Project Controls – an expanded category
- Element A4. Project Philosophies – a consolidation of project philosophies into one element

Category N. Project Controls

The process owner strongly supported the expanded project control category. The owner's first-hand experience with PDRI was that cost and schedule estimates had not been adequately addressed in legacy PDRI templates.

Approximately two years into the implementation of PDRI, the owner faced a challenge where projects with a good PDRI score (less than 200) occasionally had significant cost and/or schedule overruns. The owner was confident that the PDRI process was

improving the level of scope definition; however, it was not providing an adequate assessment of the quality of cost and schedule estimates. Projects with a well-defined scope but poorly defined cost and/or schedule estimates often resulted in cost and schedule overruns.

To address this predictability issue, the owner added a cost and schedule estimate review step to the PDRI process. The day before a project team's PDRI session, a full cost and schedule estimate review was conducted with the project team. The owner's PDRI executive summary report included both the results from the cost and schedule review and the PDRI session, and a facilitator could identify a poorly defined cost or schedule estimate as a show stopper – regardless of the PDRI score.

The updated project controls category in PDRIx for MLS Projects was much better aligned with this owner's expectations.

Summary

Overall, the owner viewed PDRIx for MLS Projects as a positive step forward for the MLS sector. The total scores for all three projects were in line with expectations, based on the level of scope definition at the completion of basic design.

"Our project teams value comparing their projects with historical PDRI benchmarks."

A strong commitment to benchmarking the impact of this new PDRI template on project performance internationally would be one of the most compelling reasons for this owner to migrate from a customized PDRI template to PDRIx for MLS Projects.

Chapter 5

Conclusions and Recommendations

The MLS sector has gained substantial value from using PDRI–Industrial and PDRI–Buildings to assess scope definition during front end planning. PDRIx for MLS Projects will further increase the value that the PDRI process provides, with a single tool that incorporates the following components:

- PDRI–Industrial elements
- PDRI–Building elements
- Modernized element descriptions
- Specific requirements of the MLS sector

As has been true with previous PDRI tools, PDRIx for MLS Projects can be used to help improve scope definition during front end planning in a number of ways. Depending on the level of maturity of front end planning in an organization, PDRIx for MLS Projects can be used as any of the following assets:

- **Checklist** for project teams to determine the necessary steps to fully define project scope
- **Training resource** to help organizations and new project practitioners understand scope definition requirements
- **Alignment tool** to help projects stakeholders gain a common understanding of project objectives
- **Assessment tool** to help project teams identify gaps and appropriate action items
- **Progress measurement tool** to quantify progress during front end planning
- **Risk identification method** to provide input into risk assessment for a project
- **Benchmarking tool** to compare scope definition completeness on current projects against similar historical projects, both internally and externally.

This research effort shows that PDRIx for MLS Projects can be implemented in a manner consistent with PDRI–Industrial, and will deliver comparable results to help achieve predictable project performance.

Combining PDRI with the use of other proven front end planning resources will greatly increase the likelihood of achieving predictable project performance. Consider also utilizing CII's other resources:

- **Front End Planning Toolkit** (IR213-2) – this HTML-based process map offers embedded tools that are applicable at each step in the front end planning process (CII 2014a).
- **Alignment Thermometer** (IR113-3) – this 10-question survey can be used to gauge team alignment during front end planning (CII 2009).
- **Renovation & Revamp Risk Checklist** (IR242-2) – this nine-page section lists potential risk issues unique to renovation and revamp projects that could significantly affect scope development in industrial and building projects (CII 2014).

RT-MLS-02 recommends additional research to further enhance the value of PDRIx for MLS Projects, including the following steps:

- Develop a strategy to improve how consistently project teams score the definition level of each element. The research findings from RT-331, Assessing the Maturity and Accuracy of Front End Engineering Design to Support Phase-gate Approvals, should be considered.
- Establish and maintain benchmarks on the cost and schedule performance impact of using PDRIx for MLS Projects. This potentially could be accomplished in cooperation with the MLS Sector Committee's Performance Assessment Subcommittee.

Appendix A

Element List and Score Sheet

A Microsoft Excel score sheet should accompany this report.
It can also be found under the RT-MLS-02 listing in the CII Knowledge Base.

SECTION I – BASIS OF PROJECT DECISION							
CATEGORY Element	Definition Level						Score
	0	1	2	3	4	5	
A. BUSINESS OBJECTIVES (Maximum Score = 177)							
A1. Products & Services	0	1	6	11	17	24	
A2. Market Strategy	0	1	5	10	15	22	
A3. Project Objectives & Strategy	0	1	6	11	17	25	
A4. Project Philosophies	0	1	5	9	13	19	
A5. Facility Portfolio Coordination	0	1	3	6	9	12	
A6. Affordability/Feasibility	0	1	4	8	12	17	
A7. Capacities	0	1	5	10	15	21	
A8. Future Expansion Considerations	0	1	3	6	9	12	
A9. Expected Facility Life Cycle	0	1	3	5	8	11	
A10. Social Issues	0	1	4	7	10	14	
CATEGORY A TOTAL							
B. BASIC DATA RESEARCH & DEVELOPMENT (Maximum Score = 43)							
B1. Technology	0	1	5	10	15	21	
B2. Processes	0	1	5	13	15	22	
CATEGORY B TOTAL							
C. PROJECT SCOPE (Maximum Score = 76)							
C1. Project Design Criteria	0	1	4	8	13	16	
C2. Site Characteristics Available vs. Required	0	1	1	5	9	19	
C3. Dismantling & Demolition Requirements	0	0	0	2	4	10	
C4. Lead/Discipline Scope of Work	0	1	1	4	7	16	
C5. Project Funding	0	1	3	6	9	13	
CATEGORY C TOTAL							
D. VALUE ENGINEERING (Maximum Score = 31)							
D1. Process Simplification	0	1	2	4	7	9	
D2. Design & Material Alternatives Considered/ Rejected	0	0	2	4	6	9	
D3. Design for Constructability Analysis	0	1	3	6	9	13	
CATEGORY D TOTAL							
Section I Maximum Score = 327				SECTION I TOTAL			

Definition Levels

0 = Not Applicable 2 = Minor Deficiencies 4 = Major Deficiencies
1 = Complete Definition 3 = Some Deficiencies 5 = Incomplete or Poor Definition

SECTION II – BASIS OF DESIGN							
CATEGORY Element	Definition Level						Score
	0	1	2	3	4	5	
E. SITE INFORMATION (Maximum Score = 73)							
E1. Site Location	0	1	4	9	13	19	
E2. Surveys & Soil Tests	0	1	2	4	6	8	
E3. Environment Assessments	0	1	3	5	8	11	
E4. Permit Requirements	0	1	4	8	12	16	
E5. Utility Sources with Supply Conditions	0	1	3	5	8	11	
E6. Fire Protection & Safety Considerations	0	1	2	4	6	8	
CATEGORY E TOTAL							
F. PROCESS/MECHANICAL (Maximum Score = 120)							
F1. Process Flow/Utility Flow Diagrams	0	1	4	7	11	16	
F2. Heat & Material Balances or Process Modeling	0	0	2	5	7	10	
F3. Piping and Instrumentation Diagrams (P&IDs)	0	0	3	6	9	13	
F4. Air Flow & Instrumentation Diagrams (AF&IDs)	0	0	2	4	6	8	
F5. Process Safety Management (PSM)	0	0	3	5	8	11	
F6. Process & Mechanical Specifications	0	0	3	5	8	11	
F7. Piping System Requirements	0	0	2	4	7	9	
F8. Mechanical Equipment List	0	1	3	6	9	13	
F9. Line List/Tie-in List/Piping Specialty Items List	0	1	2	5	7	10	
F10. Instrument Index	0	1	2	4	6	9	
F11. Process & Mechanical Test Plan	0	1	3	5	7	10	
CATEGORY F TOTAL							
G. EQUIPMENT SCOPE (Maximum Score = 35)							
G1. Equipment Status	0	1	3	6	9	13	
G2. Equipment Location Drawings	0	1	3	5	7	10	
G3. Equipment Utility Drawings	0	1	3	6	8	12	
CATEGORY G TOTAL							

SECTION II – BASIS OF DESIGN <i>(continued)</i>							
H. BUILDING PROGRAMMING & DESIGN PARAMETERS (Maximum Score = 123)							
H1. Building Space Requirements	0	1	3	6	9	13	
H2. Site/Plot Plan	0	1	3	5	8	11	
H3. Circulation & Open Space Requirements	0	1	2	4	7	9	
H4. Building Functional Programming	0	1	2	4	6	8	
H5. Architectural Layouts, Sections & Elevations	0	1	3	6	8	12	
H6. Room Requirements Data	0	1	3	5	7	9	
H7. Loss Prevention Considerations	0	1	2	3	5	7	
H8. Civil/Structural Requirements	0	1	3	5	8	11	
H9. Building Mechanical Design	0	1	3	5	8	12	
H10. Building Electrical Design	0	1	3	5	8	12	
H11. Building Life Safety Requirements	0	1	2	4	6	9	
H12. Information Technology and Telecommunications	0	1	3	5	7	10	
CATEGORY H TOTAL							
I. INFRASTRUCTURE (Maximum Score = 27)							
I1. Water Treatment Requirements	0	1	2	4	6	9	
I2. Loading/Unloading/Storage Facilities Requirements	0	1	3	5	7	10	
I3. Transportation Requirements	0	1	2	4	6	8	
CATEGORY I TOTAL							
J. INSTRUMENT & ELECTRICAL (Maximum Score = 37)							
J1. Electrical Area Classifications	0	1	2	4	6	8	
J2. Substation Requirements/Power Sources Identified	0	1	3	5	7	10	
J3. Electric Single Line Diagrams	0	1	2	4	6	9	
J4. Instrument & Electrical Specifications	0	1	2	5	7	10	
CATEGORY J TOTAL							
K. ENTERPRISE & CONTROL SYSTEMS (Maximum Score = 37)							
K1. Measurement & Final Control Devices	0	0	2	4	6	9	
K2. Monitoring & Control Systems	0	1	3	5	8	11	
K3. Manufacturing Operations Systems	0	1	2	4	7	9	
K4. Business Planning & Logistics System	0	1	2	4	5	8	
CATEGORY K TOTAL							
Section II Maximum Score = 452				SECTION II TOTAL			

Definition Levels

0 = Not Applicable 2 = Minor Deficiencies 4 = Major Deficiencies
 1 = Complete Definition 3 = Some Deficiencies 5 = Incomplete or Poor Definition

SECTION III – EXECUTION APPROACH							
CATEGORY Element	Definition Level						Score
	0	1	2	3	4	5	
L. PROCUREMENT STRATEGY (Maximum Score = 27)							
L1. Identify Long Lead/Critical Equipment & Materials	0	1	3	5	8	11	
L2. Procurement Procedures & Plans	0	1	3	5	7	10	
L3. Procurement Responsibility Matrix	0	1	2	3	4	6	
CATEGORY L TOTAL							
M. DELIVERABLES (Maximum Score = 23)							
M1. CADD/Model Requirements	0	1	2	3	5	7	
M2. Deliverables Defined	0	1	2	4	6	9	
M3. Distribution Matrix	0	1	2	3	5	7	
CATEGORY M TOTAL							
N. PROJECT CONTROLS (Maximum Score = 91)							
N1. Project Cost Estimate	0	1	6	12	18	26	
N2. Project Change Control	0	1	3	6	10	13	
N3. Project Cost Control	0	1	3	5	8	11	
N4. Project Schedule Control	0	1	4	8	13	18	
N5. Progress Measurement	0	1	3	5	7	10	
N6. Risk Management	0	1	3	6	10	13	
CATEGORY N TOTAL							
P. PROJECT EXECUTION PLAN (Maximum Score = 80)							
P1. Project Organization	0	1	3	5	7	10	
P2. Owner Approval Requirements	0	1	2	4	6	9	
P3. Engineering & Construction Plan	0	1	3	5	8	11	
P4. Shut Down/Turn-Around Requirements	0	1	3	5	8	11	
P5. Commissioning/Qualification/Validation Plan	0	1	3	6	9	13	
P6. Startup & Turnover Requirements	0	0	3	5	7	10	
P7. Training Requirements	0	0	2	3	5	7	
P8. Environmental & Safety Procedures	0	0	2	4	6	9	
CATEGORY P TOTAL							
Section III Maximum Score = 221				SECTION III TOTAL			

PDRI TOTAL SCORE

Maximum Score = 1000

Definition Levels

0 = Not Applicable

2 = Minor Deficiencies

4 = Major Deficiencies

1 = Complete Definition

3 = Some Deficiencies

5 = Incomplete or Poor Definition