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THE FIELD REWORK INDEX: EARLY WARNING FOR FIELD REWORK AND COST GROWTH

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The Field Rework Index: Early Warning for Field Rework and Cost Growth

**Prepared by
The Construction Industry Institute
Causes and Effects of Field Rework Research Team**

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Executive Summary

Field rework is a misleading term. Although it manifests itself in the field during construction, its roots actually begin in the design and project definition phases. If field rework is to be minimized, the majority of effort must be placed in these early project phases rather than in the field.

Previous CII research highlighted the cost of rework, indicating a need for further investigation. CII Publication 10-2, *Measuring the Cost of Quality in Design and Construction*, estimated annual losses due to rework in industrial construction at \$15 billion. CII benchmarking data for field rework show mean values for field rework in excess of three percent of construction phase cost for heavy industrial projects. To address the challenges presented by field rework, CII created a research team to investigate field rework and to develop a tool to aid project management.

This research summary presents important findings about field rework in industrial construction. Information has been developed from an industry survey, a focus group of industry managers with in-depth knowledge of field rework, site visits to six best practices companies, and analysis of a database of over 150 industrial construction projects.

To aid in determining when extra effort is required, the research team has developed an early warning tool — the Field Rework Index (FRI). Requiring less than five minutes to complete, this simple, two-page tool can be used prior to construction to warn of significant field rework challenges during construction. The FRI has great potential to lower field rework and to contribute to improved cost effectiveness. In addition, analysis of the project database revealed an unforeseen relationship between FRI and cost growth. As a result, the FRI also can be used prior to construction to warn of impending cost growth.

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Introduction

Field rework is defined as, “activities in the field that have to be done more than once in the field or activities which remove work previously installed as part of the project.” Field rework is widely recognized as a significant productivity challenge for the construction industry. It increases costs and makes accomplishment of schedule objectives more challenging. Various studies indicate that rework costs range from 5–15 percent of construction costs. CII benchmarking data show mean values for field rework in excess of three percent of construction phase cost for heavy industrial projects. Annual losses due to rework in industrial construction have been estimated at \$15 billion. Even a modest improvement in the ability to effectively identify the causes of, and the means to eliminate, the most prevalent rework will have a major impact on productivity and capital costs.

The CII Causes and Effects of Field Rework Research Team was formed to study field rework in the construction industry. More needed to be known about the severity of the problem, best methods for measuring, common causes, and methods for minimizing field rework.

The research team identified the following four research objectives:

1. Determine the most efficient manner to uniformly and routinely categorize and record factors causing field rework.
2. Determine major causes of rework and their impact on cost and schedule.
3. Identify practices that most effectively minimize field rework.

4. Develop a tool that CII members can use to assist in identifying more frequent/costly causes of rework and take most cost-effective corrective measures.

To accomplish these objectives, the research team took the following steps:

1. Data gathering began with a survey of CII membership to determine the best practices for rework measurement and the availability of data.
2. A focus group was assembled that consisted of owner, designer, and constructor managers with serious interest in and experience with field rework. The focus group helped the research team develop a list of project factors likely to influence the level of field rework experienced on projects.
3. The research team compiled a database of rework measurements, subjective ratings, and project variables identified as potentially related to field rework. Analyses then determined the variables related to field rework. The Field Rework Index (FRI) resulted from analysis of the database.
4. The research team conducted in-depth interviews with six construction industry companies determined to be leaders in measuring and managing field rework. In this report, these companies are designated “best practices” companies.

The initial industry survey of field rework management practices clearly showed a difference in rework measurement and management between industrial projects and the other two industry sectors, buildings and infrastructure. Industrial projects clearly

faced greater challenges, utilized more sophisticated systems, and had higher quality data. Consequently, the remainder of the research effort was restricted to industrial projects, and the results are intended for application to industrial projects.

Data Analysis

The industry survey by the research team set the tone for the research on field rework. CII membership was surveyed. Eighty-five individuals from 48 companies responded.

Industry survey results from the focus group were used to develop a list of about 60 variables likely to be related to or predictive of field rework. Further discussion within the research team reduced the list of variables to 44. These 44 were included in the first version of the data collection form to solicit project data for the research database.

The response to the first project data collection effort resulted in a database of 43 usable projects. Responses to many questions had no statistical significance, and the research team simplified the data collection instrument to obtain more projects for the database. It also became clear that the database would need to focus on industrial projects and exclude all others.

Based on initial statistical analysis, the list of potential predictor variables was reduced from 44 to 19. The more focused form was successful, producing a final database of 153 projects. One-hundred forty-four projects include subjective rework ratings, 109 include measured percent rework, 107 projects include cost growth information, and 137 projects have responses adequate to compute FRIs. The database includes projects ranging in size from \$200 thousand to \$558 million. Mean value is \$58 million and median size is \$17 million.

Factor and regression analysis of the database determined that the most meaningful development of the FRI would include 14 variables. Rather than require individual regression coefficients for