

A
Project Delivery
Quality Assurance Process
for
Deep Energy Retrofit Projects

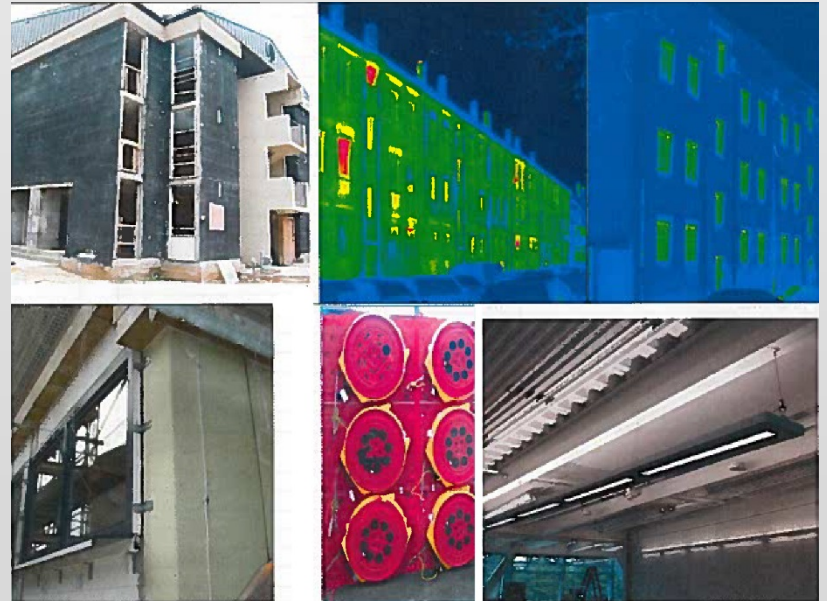
APPENDIX H

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September 2016

International Energy Agency

Deep Energy Retrofit

A Prescriptive Approach to Achieve Significant Energy Use Reduction with Major Renovation Projects
Annex 61, Subtask A



Appendix H – Quality Assurance Process

INTRODUCTION

For Deep Energy Retrofit Projects the question is:

How can we insure that we attain the proper energy savings through implementation of a DER project?

- Many, (myself included) contend that all too often this does not happen
- One method is the inclusion of a project specific Project Delivery Quality Assurance process (PDQA)

The point of this document (Appendix H) is to address actions needed to help insure a successful **DER** with regard to the building exterior enclosure.*

*However, the process for other building systems would be the same, or very similar. It should be noted that testing of other systems is generally much further advanced and accepted than for enclosure systems.

I Further Contend that:

Appropriate levels of Quality and Performance in the exterior building enclosure can be accomplished only by the practice of:

- Proper Design
- Appropriate Manufacture and Fabrication
- Correct Application and Installation

For materials and systems

PDQA
APPENDIX H

Terms:

- **DER** – Deep Energy Retrofit Project
- PDQA – Project Delivery Quality Assurance process
- SOW – Scope of Work
- OPR – Owner's Project Requirements

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This is a simple premise and is particularly true for
Deep Energy Retrofit Projects

As a building owner or enclosure systems designer, the question you need to ask yourself is very straight forward and to the point:

How can we attain the desired energy savings through implementation of a DER project?

One method is the inclusion of a well executed **Project Delivery Quality Assurance** process (PDQA).

An important definition: (for purposes of this document)

Desired : The level of quality and performance established by the Scope of Work (SOW) and Owner's Project Requirements (OPR) as determined by the Owner during Pre-design.



This Document identifies:

- Procedural tools available to OWNERS and DESIGNERS to implement a project specific **PDQA** for the exterior building enclosure.
- All 8 separate phases of a project are addressed.

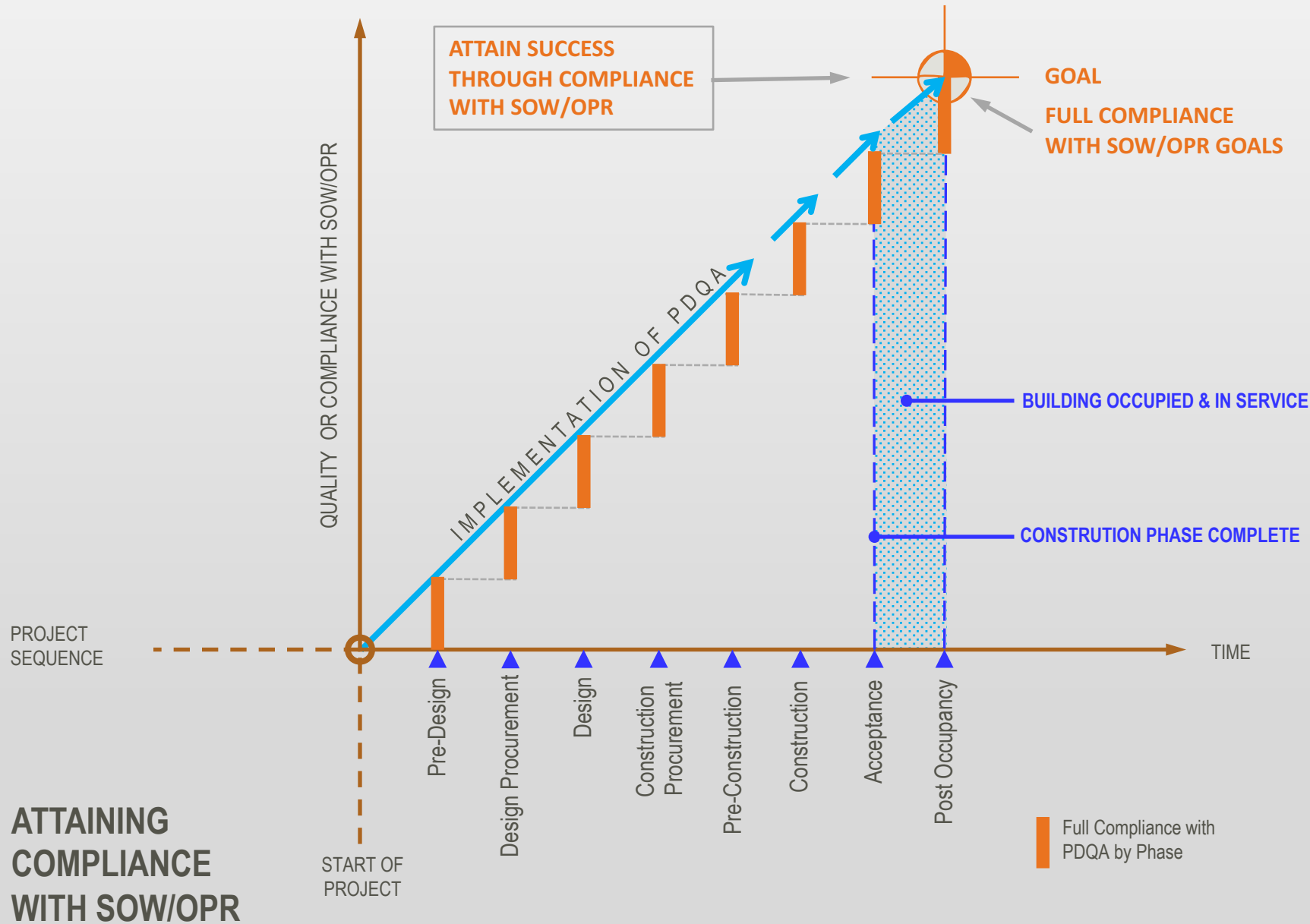
These tools are always available to the project team and it is their choice, guided by sound professional judgment, to determine **when, how, and to what extent** to implement these tools for a specific project.

The project stages identified are generally followed in most building projects in a manner similar to that identified. However...

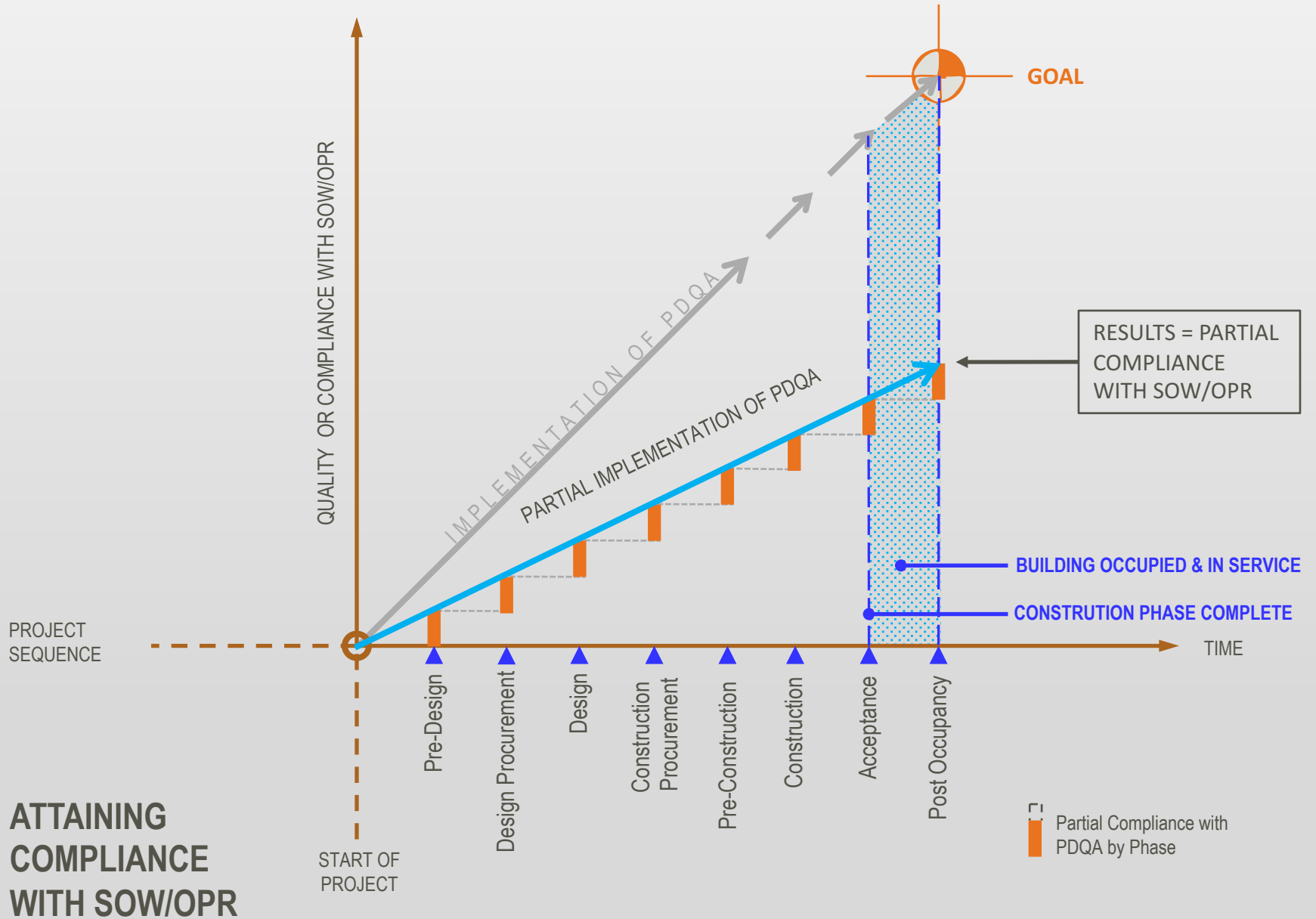
- If the procurement process is different, then the **PDQA** must change to suit process used.
- It is critical that the **PDQA** be matched to the project procurement and delivery system.

Quality

- Quality is defined by the *American Heritage Dictionary of the English Language (Fourth Edition)* as:
"Degree or grade of excellence", and "Essential character; nature".
- *In this document quality is used in both senses, and the measure of this quality is performance.*
- *Remember* - The various performance requirements are defined by the **Owner** through the SOW and OPR.



ATTAINING COMPLIANCE WITH SOW/OPR



ATTAINING COMPLIANCE WITH SOW/OPR

How? We follow a process

PDQA = a **process** to assist in obtaining a project with an exterior enclosure that will provide the proper performance requirements and will meet the owners expectations, or quality desired.

- Some Owners and Designers may need to commission assistance from others to accomplish some of the steps recommended in this document.

The Problem is:

The exterior building enclosure is perhaps not quite as simple as we sometimes think it is, and there are many issues that must be addressed appropriately and completely to obtain the proper results.....

A BUILDING THAT WILL MEET THE SCOPE OF WORK (SOW) AND THE OWNER'S PROJECT REQUIREMENTS (OPR).

If we do **not** meet these expectations and requirements we may expect any number of consequences including:

- The DER will **not** be successful
- The OPR will **not** be met
- The SOW will **not** be met

In other words



The project will be a failure

Causes of failure to perform are many, and may include any of the following:

- **Failure to correctly and thoroughly perform mock-up and testing procedures**
- Incompatibility of adjacent materials
- Material failure due to manufacturing problems
- False, misleading, or inaccurate test procedures or reports
- Environmental exposure changes after construction
- Time and exposure related degradation of certain materials
- Failure to properly accommodate thermally induced movements
- Improper delivery and storage procedures
- Improper acceptance procedures
- Failure to consider fabrication, construction and installation tolerances



The Step We Will Address Here

But wait, there's
more!

(Continued)

- Incorrectly specified performance criteria
- Inaccurate assumptions regarding exposure conditions
- Inaccurate assumptions regarding interior environment
- Improper function or operation of building mechanical systems
- Improper selection of materials or systems
- Improper or incomplete detailing
- Ineffective procurement process
- Incomplete final engineering and submittals
- Lack of suitable installation instructions
- Inadequate installation or fabrication procedures
- Insufficient communication between trades for coordination of interfaces
- And on.....

The **PDQA** has different objectives during each phase of the project, all directed to obtaining a singular goal: **an exterior enclosure which performs as desired (SOW/OPR).**

This document includes recommended quality assurance actions for the eight basic project phases.

1. **Pre-Design**
2. **Design Procurement**
3. **Design**
4. **Construction Procurement**
5. **Pre-Construction**
6. **Construction**
7. **Acceptance**
8. **Post Occupancy**

1. Pre-Design

Development of SOW/OPR that provides clear and concise documentation of the Owner's goals, expectations and measurable performance criteria, cost considerations, benchmarks, success criteria to be obtained by the DER for a building renovation. The SOW or OPR shall be utilized throughout the project delivery to provide an informed baseline for the renovation and focus for design development and for validating building energy and environmental performance. Based in part on these documents, bidders for both design and construction services will be selected upon demonstrating their ability to deliver a DER renovation project which will accomplish the goals of the Owner as defined in the SOW/OPR.

2. Design Procurement

The purpose of this phase is to procure the services of a designer who the owner determines will be well suited to provide professional leadership and the design and technical services necessary for the project. The designer must demonstrate a clear understanding of the owner's project needs, as established by the owners SOW and OPR during the Predesign phase of the project. In addition, the designer must demonstrate previous design and analytic experience, ability to successfully coordinate different design disciplines, and the ability to deliver the **DEEP ENERGY RETROFIT**, meeting the SOW/OPR criteria.

The procurement method for establishing the project contractual basis may be different from project to project. However all parties should be experienced in the specific project delivery process selected, should demonstrate a clear understanding of the process, and be comfortable with the approach. Proposals for design services may be solicited by many means, but in all cases the more explicit and clear the solicitation, the more likely it is to be a success. In some cases, the owner may elect to obtain assistance in writing the SOW and/or OPR, and in evaluating the proposals prior to award. Owners with little experience in building projects in particular should consider seeking guidance.

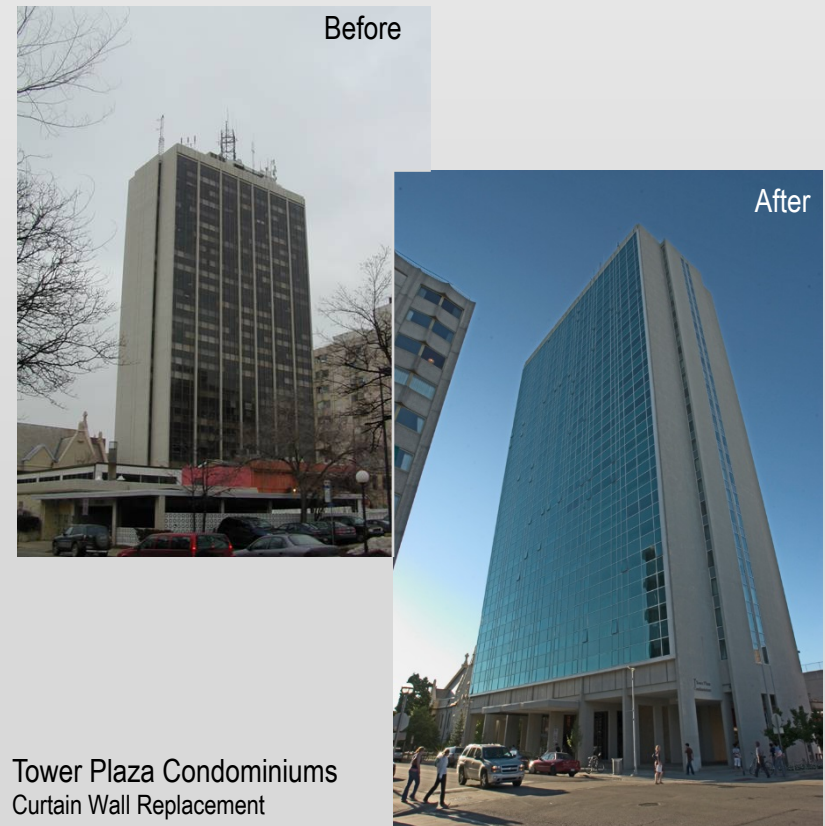
3. Design

The design phase starts with concept development by the designer and continues through the completion of documents for bidding or negotiating. During the design phase the appearance, configuration, basic system selections, terminations, materials, performance criteria and interface conditions with other building systems are established. There is a set of procedures which the designer must follow at this time to make sure the exterior enclosure systems are appropriately considered, designed, specified, and drawn to attain an enclosure that performs properly, and in compliance with the SOW/OPR.



4. Construction Procurement

This should include analysis of construction bidder's qualifications, their understanding of the SOW and OPR, previous construction and validation of experience and ability to coordinate different construction trades, performance to meet established schedule and budget and deliver the deep energy renovations in compliance with the SOW/OPR.



5. Pre-Construction

As with the Procurement Phase, there are provisions the designer can build into the documents, including drawings, technical specifications, and front end documents for the Pre-Construction Phase, that will help to increase the quality of the completed project, the exterior enclosure systems, and other DER provisions.

The Pre-Construction Phase covers the activities between award of the contract and delivery of materials, products, and systems to the building site. This includes final design and engineering, completion of mock-up construction and testing necessary before production, and fabrication and delivery of materials and systems for incorporation into the building.

Our example in this presentation is for a portion of this Phase – Mock-up/Performance Testing.

6. Construction

When implementing quality assurance procedures during the construction phase it may be necessary to explain the intent and process of the PDQA to all parties. Many site representatives, manufacturers, tradesmen may not be familiar with the process and may not understand the goals and objectives. However, if you can successfully explain the program and gain their active support and participation, the results can be impressive.

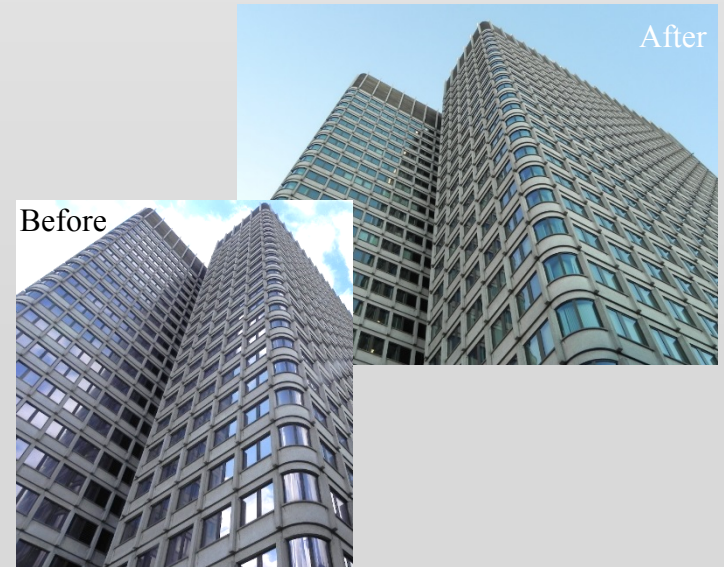
During the construction phase of the project, the previous efforts of the owner, designers, consultants, fabricators, material suppliers, and contractors are brought together for the true test. Will it work, will it fit, will it look right, will it perform properly, and can the work be completed on time? If the project team has performed their jobs correctly, and if they have communicated properly, and paid attention to the details the answer will be yes.

In-progress testing and inspection of the constructed work, as it occurs, is one of the primary tools of the owner to assure compliance with the project requirements and the SOW/OPR for deep retrofit work.

7. Acceptance

Acceptance, or commissioning, can be considered an ongoing process applicable to any or all of the phases indicated for a DER, including post DER occupancy and use of the facility. It can be applied in different forms for different projects.

Acceptance should include a specific and pre-determined approach which is included within the SOW/OPR, and the construction contract documents. Testing and inspection of the completed work is often the last opportunity to assure compliance with contract documents and performance levels of the various systems before the building is accepted on behalf of the owner.



8. Post Occupancy Evaluation

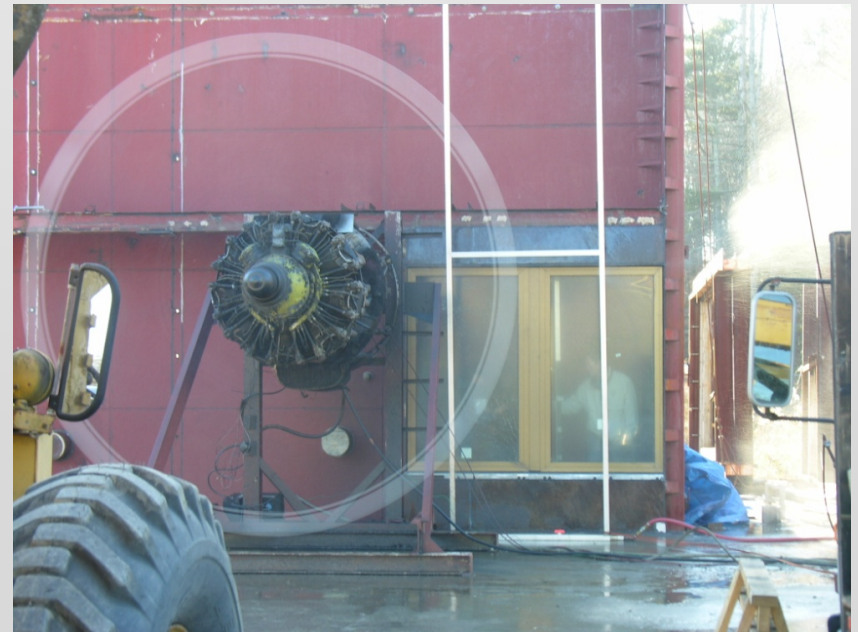
UNDER DEVELOPMENT

Pre-Construction Phase – Phase 5

The Pre-Construction Phase covers the activities between award of the contract and delivery of materials, products, and systems to the building site.

There are 3 different sub-phases

- Final Design and Engineering
- Mock-up/Performance Testing
- Fabrication and Delivery

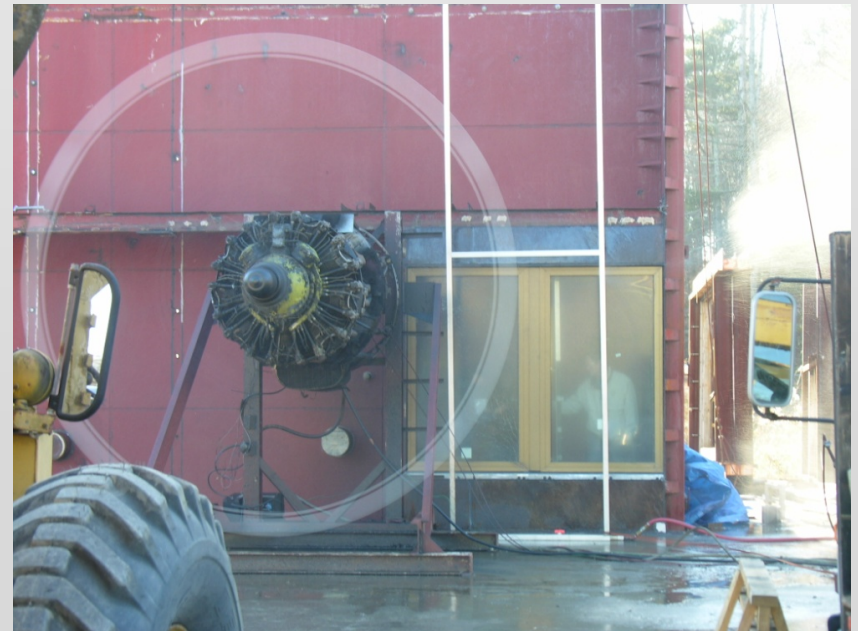


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PRECONSTRUCTION – PHASE 5

As with the Procurement Phase, there are provisions the designer can build into the documents, including drawings, technical specifications, and front end documents for the Pre-Construction Phase, that will help to increase the quality of the completed project and the exterior envelope.

The Pre-Construction Phase covers the activities between award of the contract and delivery of materials, products, and systems to the building site. This includes final design and engineering, completion of mock-up construction and testing necessary before production, and fabrication and delivery of materials and systems for incorporation into the building.

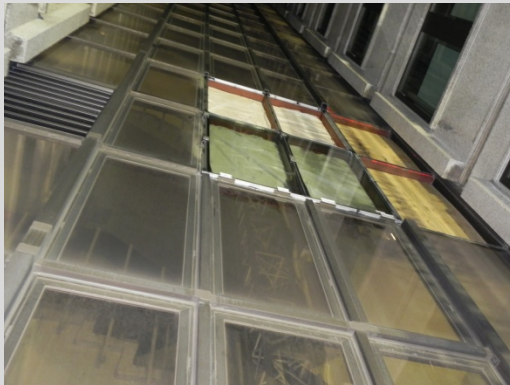
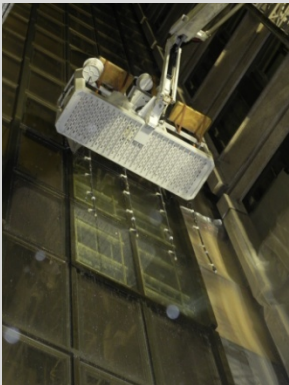
The critical point regarding quality assurance during this phase is to maintain control of the process through diligent and clear **communication** and **attention** to detail.

Addressing the Mock-Up/Performance Sub-Phase of Phase 5

Some exterior enclosure systems will require mock-up or performance testing to confirm that the wall design and installation will conform to the desired appearance and provide performance to meet project criteria.

This process is especially important to those systems with appearance, design, or performance criteria which are unusual, or which have not been previously constructed.

If this is not accomplished in this phase of the project, then the building can become the test facility **Is this acceptable?**



MOCK-UPS: WHAT ARE THEY?

“Mock-ups are full sized erected assemblies used to ensure understanding and coordination of required construction for testing and observation and for establishing standards by which workmanship will be judged”. – CSI Definition



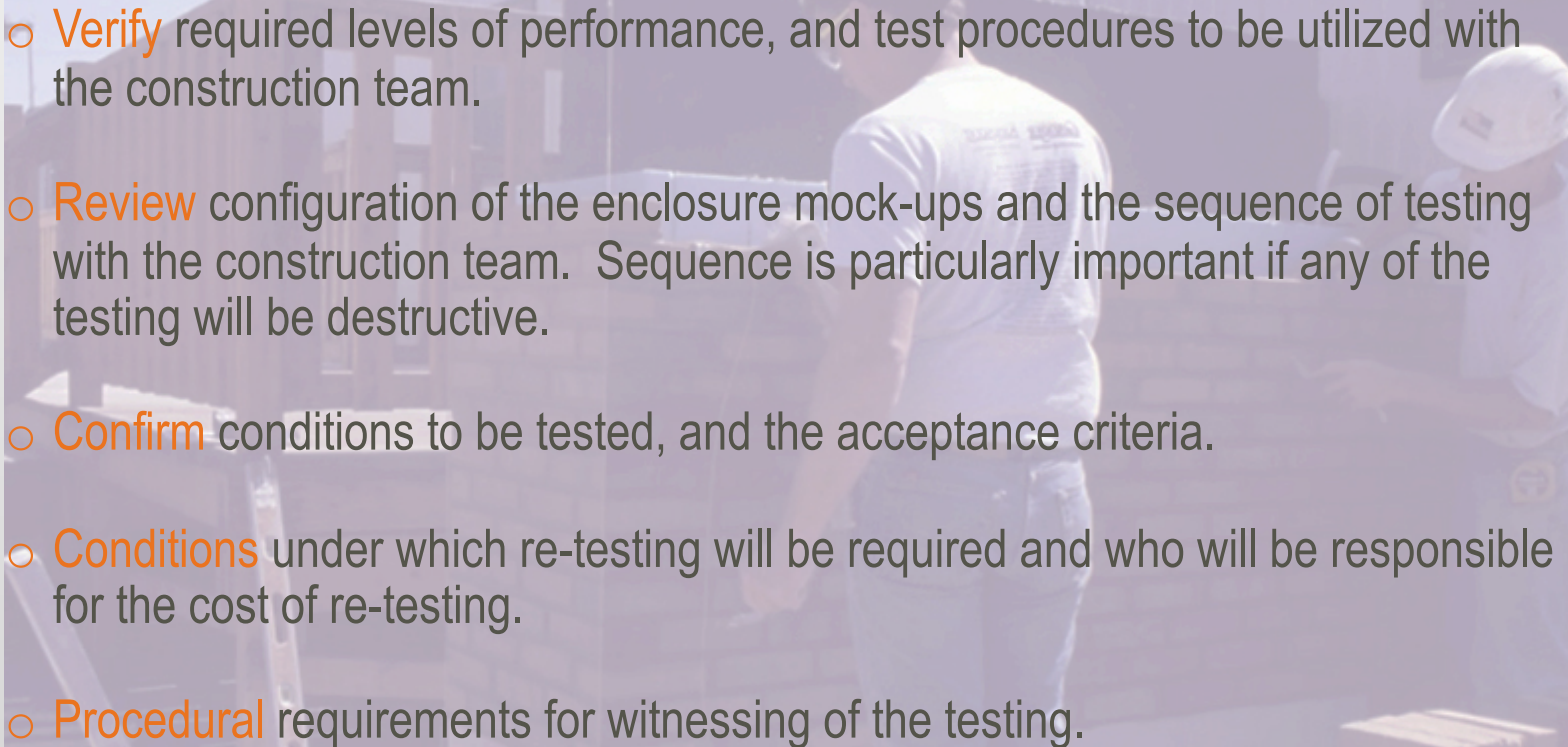
Historic Roof Replacement Mock-Up



Phase 5 – Pre-Construction / Mock-up and Performance Testing Sub-phase

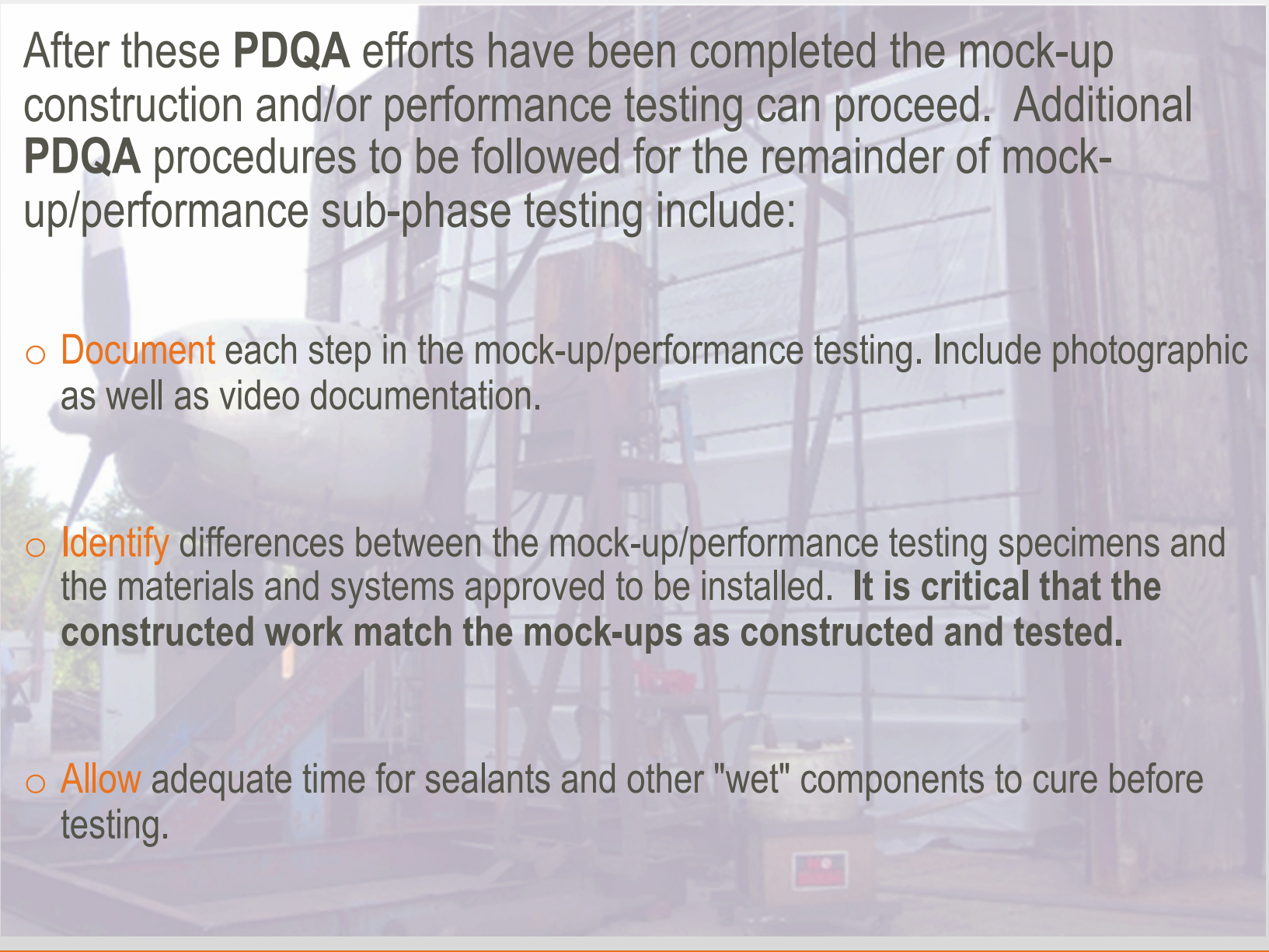
The major **PDQA** points during this phase of the project:

- **Review** submittal procedures relative to the mock-up/testing. This process should have been completed in the previous stage and should be confirmed at this point.
- **Verify** that mock-ups will be erected/constructed by the individuals who will erect/construct the enclosure systems on the building.
- **Verify** location of testing or mock-ups on-site (or on the building) have been fully coordinated.
- **Verify** the length of time which the mock-ups are required to be retained has been clearly communicated to the construction team. Premature destruction or removal of mockups can lead to problems.

- 
- A photograph of two construction workers wearing hard hats and safety vests, standing on a construction site. They are looking at a large, rectangular concrete structure that appears to be a mock-up of an enclosure. The background shows other construction materials and structures under a clear sky.
- **Verify** required levels of performance, and test procedures to be utilized with the construction team.
 - **Review** configuration of the enclosure mock-ups and the sequence of testing with the construction team. Sequence is particularly important if any of the testing will be destructive.
 - **Confirm** conditions to be tested, and the acceptance criteria.
 - **Conditions** under which re-testing will be required and who will be responsible for the cost of re-testing.
 - **Procedural** requirements for witnessing of the testing.

- **Confirm** schedules for production of test panel or mock-up material, erection of the mock-up, and access will be provided for on-site testing.
- **Confirm** the schedule for testing, whether on the building separate from building on-site or at a separate location such as a testing facility has been properly addressed by the construction team.
- **Confirm** the conditions, if any, for which mock-ups will be acceptable for inclusion in the finished enclosure systems.





After these **PDQA** efforts have been completed the mock-up construction and/or performance testing can proceed. Additional **PDQA** procedures to be followed for the remainder of mock-up/performance sub-phase testing include:

- **Document** each step in the mock-up/performance testing. Include photographic as well as video documentation.
- **Identify** differences between the mock-up/performance testing specimens and the materials and systems approved to be installed. **It is critical that the constructed work match the mock-ups as constructed and tested.**
- **Allow** adequate time for sealants and other "wet" components to cure before testing.

- **Monitor** testing procedures and results to confirm compliance with project criteria. Resolve discrepancies or questions immediately.
- **Require** modification to system be documented in the event of changes required due to test failure. This must be documented in detail.
- **Verify** shop and erection drawings and installation instructions are revised to indicate required changes after completion of testing.
- **Review** and confirm that the construction team understands that a final written report of test results from the testing agency or consultant is required. Obtain a firm date for receipt of this information.

Mock-Ups Drawings – Details

Conclusions

- Without a well thought out and executed PDQA process you are not likely to attain the proper OPR and SOW for the building.
- The well designed and well executed **project specific** PDQA will greatly increase the opportunity for success of your **DER** project

- All you have to lose if the DER project goes astray is your reputation, a client, perhaps a LOT of money (depending upon how good your attorney is) and an **irreplaceable** opportunity to reduce the energy consumption of a building and meet the Owner's goals for the next 40-50 years!

Or Longer

Thank You