Appendix E
Energy Systems
Performance Verification Plan

I. THE VERIFICATION PLAN

A written Energy Systems Performance Verification Plan (or Verification Plan) is a *required*, critical piece of the SEED process. It should be submitted to the Oregon Department of Energy along with the Energy Analysis Report.

The Verification Plan is a *planning* document, which describes how the verification process (see description below) will work, including:

- Who is responsible for verification?
- What is being verified?
- How is verification performed?
- What verification results are reported?

The owner, energy analyst, or any qualified person appointed by the Agency can write the Verification Plan or implement the verification process.

For larger projects, which are being commissioned, the verification process and the commissioning process will likely overlap. It this case, the Verification Plan (or a detailed Commissioning Plan) should generally be the responsibility of the commissioning agent, preferably an independent party with no affiliation to participating contractors, such as a third party contractor or design engineer.

II. VERIFICATION PROCESS

The verification process confirms that all building energy systems perform interactively as intended and in accordance with the contract documents, the owner's objectives, and the operational needs. The verification process is integrated with the phases of design and construction and continues for 18 months after the building is occupied.

In order for the verification process to work effectively, it is necessary to establish and document the owner's criteria for system function, performance, and maintainability. Such criteria need to be documented during the design phase, checked during construction, verified during start-up procedures, and handed off during initial period of operation. The Energy Programming and Design Intent Checklist and Design Criteria Documents (see Appendix G) should be submitted to the ODOE during the pre-design phase, along with any other statements of design intent including programming documents or design narratives.

III. APPLICABILITY / LEVEL OF RIGOR

A systematic process of quality control and assurance should apply to *every* construction project.

Under prevailing construction practices, however, the level of appropriate rigor and the respective tasks of the project team will vary with project objectives, complexity, and the relative importance of the systems. In general, the performance of heating, ventilating and air-conditioning systems (e.g., boiler, chiller, air handling units, etc.) and controls, lighting controls and life safety systems should be verified.

If the system is simple and some degree of latitude in equipment operation can be afforded, a less rigorous verification scope may be acceptable. A project manager can use the following questions to decide the appropriate verification rigor to apply to specific systems and equipment:

- Is the design or operation of the system under consideration complex?
- Does the equipment interact with other equipment and systems?
- If the equipment malfunctions, will this endanger the occupant's health, safety and comfort?
- Is the total capital cost of construction greater than $5 million?

If the answer to any one of the questions above is yes, then a comprehensive commissioning process is required. More details about commissioning may be found at: http://oregon.gov/ENERGY/CONS/BUS/comm/bldgcx.shtml

IV. COMPONENTS OF THE VERIFICATION PLAN

Since SEED projects vary widely in size and scope, the Oregon Department of Energy does not have a required format for the Verification Plan; the plan should be tailored to the individual project. However, *at a minimum,* the following nine (9) elements *must* be part the Verification Plan.

1. *Owners Design Intent and Programming Requirements*. How is the owners design intent and programming requirements being documented?
2. *Design Verification.* Who is verifying throughout the design process that the required Energy Conservation Measures (ECMs) (both analyzed and baseline) are incorporated? Who is verifying that the design intent is incorporated in the design? How is this being documented?

3. *Training.* What systems require training? How much training is required? Who provides the training? Who receives the training? Who verifies that the training occurred? Where in the construction documents are these requirements specified?

4. *Functional Testing.* What pieces of energy consuming equipment will be functionally tested? Who writes functional testing procedures? Who approves functional testing procedures? Who performs the functional tests? Will seasonal tests be performed? Who witnesses and documents the results of the tests? How will the results be recorded? Where in the construction documents is this procedure specified?

5. *Building Controls*. Who verifies that control points are specified for all equipment? How is the sequence of operations to be verified? Who tests and does the trend logs? Who reviews this data? Where in the construction documents is this information specified?

6. *Operations and Maintenance.* What pieces of equipment require Operations and Maintenance (O&M) documents or manuals to be prepared? Where in the construction documents is this required? Who verifies they are complete?

7. *Construction Documentation.* How are differences between design and actual construction documented? Are "as builts" required? Are marked-up construction documents sufficient? Who provides these documents? Who reviews them?

8. *Submittal/Change Order Review.* Who is reviewing submittals and change order requests to ensure ECMs are incorporated as intended? Who performs visual "spot-checks"?

9. *Post Occupancy Monitoring.* What is the established energy efficiency goal and how is it developed? When will the required 18-month period reporting of energy use begin? How will it be reported? Who is responsible for reporting post-occupancy energy savings to the Oregon Department of Energy? If there are discrepancies (e.g., more energy used than predicted), who will investigate? Is energy analyst or design team still involved, or is it solely the owner's responsibility?

V. DEFINITIONS

The following definitions are relevant to the verification process and are provided to assist in writing the Verification Plan.

- *Commissioning*. Commissioning is the process of ensuring that building systems are designed, installed, functionally tested, and capable of being operated and maintained according to the owner's operational needs. Commissioning also can

restore existing buildings to high productivity through renovation, upgrade and tune-up of existing systems.

- *Design Intent and Programming Requirements*. A document that provides the owner's vision for the planned facility and expectations for how it will be used and operated. It describes the assumptions used for sizing and selection of systems (i.e., operating conditions, design conditions, weather data, interior environmental criteria, and other pertinent design assumptions).

- *Functional Tests*. Tests that evaluate the dynamic function and operation of equipment and systems using manual (direct observation) or monitoring methods. Functional testing is the assessment of the system's (as opposed to the component's) ability to perform within the parameters set up in the design intent document. Systems are tested under various modes, such as during low cooling or heating loads, high loads, component failures, unoccupied, varying outside air temperatures, fire alarm, power failure, etc. Functional test requirements are included in the specifications. Seasonal tests may also be needed to verify proper operation during seasons that were not tested under building turnover. Written test procedures shall be developed by the respective installing trades and presented to the verification provider for approval. (Resources: Commissioning Toolkit - www.energy.state.or.us/bus/comm/bldgcx.htm) The verification provider witnesses, and documents the functional tests, with the actual hands-on execution of the test procedures typically carried out by subcontractors, particularly the controls contractor. Some functional testing is done by monitoring system operation over time through the building automation system (BAS) or data loggers. Controls contractor trend-logging requirements through the BAS should be clearly defined.

- *Functional Testing Records*. To record the results of functional testing, the verification provider may use the report forms from SMACNA's HVAC Systems Testing, Adjusting and Balancing Manual, NEBB's Procedural Standards for Building Systems Commissioning, or from other equivalent sources.

- *O&M Manuals.* Operation and maintenance (O&M) manual requirements are included in the specifications. The manual shall include a chapter on "systems" that contains single line drawings or schematic for major systems, instructions for operation of each piece of equipment for emergencies, seasonal adjustment, startup and shutdown; instructions for energy savings operations, and descriptions of the energy savings strategies in the facility.

- *Visual Spot-Checks*. During construction the verification provider verifies that the physical installations of components and systems substantially complies with the contract documents. Particular attention should be paid to the elements that are later covered by insulation, hidden behind ceilings, and otherwise hardly accessible.

- *18-Month Post-Occupancy Monitoring*. Although the construction is essentially complete, some verification tasks may continue beyond the typical one-year warranty period. During the first 18 months of occupancy, energy use by the building systems should be monitored and compared with the modeling results and forwarded to the Oregon Department of Energy. If significant differences are discovered during this period, the Agency shall investigate to find the cause. Two options exist; (i) an adjustment can be made in either the model or the operation of the building, or (ii) an explanation for the difference can be found that is acceptable to the Agency and the Oregon Department of Energy.