Arnold Schwarzenegger
Governor

ATTACHMENT#4
LABORATORY EVALUATION TEST PLAN

PIER FINAL PROJECT REPORT

Prepared For:
California Energy Commission
Public Interest Energy Research Program

Prepared By:
Gas Technology Institute

August 2004
CEC-500-2007-035-AT4

Prepared By:
Gas Technology Institute
Neil Leslie
Des Plaines, Illinois 60018
Commission Contract No. 500-03-013

Prepared For:
Public Interest Energy Research (PIER)
California Energy Commission

Phil Spartz
Contract Manager

Norm Bourassa
Program Area Lead
Building End-Use Energy Efficiency Program

Daryl Mills
Office Manager
Energy Efficiency Research Office

Martha Krebs, Ph.D.
PIER Director

Thom Kelly, Ph.D.
Deputy Director
ENERGY RESEARCH & DEVELOPMENT DIVISION

Melissa Jones
Executive Director

DISCLAIMER

This report was prepared as the result of work sponsored by the California Energy Commission. It does not necessarily represent the views of the Energy Commission, its employees or the State of California. The Energy Commission, the State of California, its employees, contractors and subcontractors make no warrant, express or implied, and assume no legal liability for the information in this report; nor does any party represent that the uses of this information will not infringe upon privately owned rights. This report has not been approved or disapproved by the California Energy Commission nor has the California Energy Commission passed upon the accuracy or adequacy of the information in this report.

Laboratory Evaluation Test Plan

Task 3.1 Report

Prepared by

Neil Leslie

Gas Technology Institute
1700 S. Mount Prospect Road
Des Plaines, IL 60018

(GTI Project No. 15485)

for

California Energy Commission

Contract No. 500-03-013

Commission Project Manager
Phil Spartz
August 2004

Legal Notice

This report was prepared as a result of work sponsored by the California Energy Commission (Commission). It does not necessarily represent the views of the Commission, its employees, or the State of California. The Commission, the State of California, its employees, Contractors, and subcontractors make no warranty, express or implied, and assume no legal liability for the information in this report; nor does any party represent that the use of this information will not infringe upon privately owned rights. This report has not been approved or disapproved by the Commission nor has the Commission passed upon the accuracy or adequacy of the information in this report.

Table of Contents

Background 4
Task 3.1 Goal 4
Test Objectives, Rationale, and Approach 4
Test Matrix 6
Facilities, Equipment, and Instrumentation 9
Test Procedures 11
  Window Installation Methods 11
  Stucco Wall Assemblies 11
  Concrete Slabs 13
  Test Log 15
Data Analysis Procedures 15
Quality Assurance Procedures 15
Predicted Performance 16
Contingency Measures 16

Task 3.1 – Laboratory Evaluation Test Plan

Background

The first technical task (Task 2) of the "Energy Efficient Mold-Resistant Building Assemblies and Construction Practices for California Homes" project was to perform a situation analysis of mold problems and state-of-the-art methods of addressing these problems in the residential new construction market in California. The overall goal of Task 2 was to identify the most challenging mold problems facing California builders and recommend potential solutions for detailed laboratory evaluation and possible use in demonstration homes to be built by the two participating builders. Based on discussions with Commission staff, the project team, and Project Advisory Committee (PAC) members, the highest value areas for this project to address are drainage plane design options (especially around windows) and drying time for built up assemblies. This focus will provide defensible, repeatable results that advance the understanding of overall system performance. Components and subsystems have been tested for mold growth and impact of moisture by building scientists, universities, and manufacturers. The recommended focus will build on that testing to provide a better understanding of the behavior of the entire assembly as well as collect unique data on the performance of wall cavities and materials as a part of a complete assembly. This approach also allows flexible configurations and innovative combinations of materials and systems to be tested. Table 1 summarizes the list of building assemblies and construction practices recommended for laboratory testing in Task 2.4.

Task 3.1 Goal

The overall goal of Task 3 is to perform a systematic evaluation of residential building materials, assemblies, and construction practices identified in Task 2.4. The goal of Task 3.1 is to provide the framework and protocols for all laboratory evaluations. The test plan includes:

- Test objectives, rationale, and approach.
- A test matrix showing the building assemblies, number of test conditions, and replicated runs.
- A description of the facilities, equipment, and instrumentation required to conduct the tests.
- A description of test procedures, including parameters to be controlled and how they will be controlled; parameters to be measured and instrumentation to measure them; calibration procedures to be used; recommended calibration interval; and maintenance of the test log.
- A description of the data analysis procedures.
- A description of quality assurance procedures.
- Predicted performance based on results of the situation analysis.
- Contingency measures to be considered if the test objectives are not met.

Test Objectives, Rationale, and Approach

The objectives of the laboratory evaluations are to

1. Evaluate performance of drainage plane design alternatives around windows and in stucco wall construction; and
2. Characterize the moisture content over time of wall assemblies and concrete floor slabs and footings when subjected to water intrusion events.

These tests will provide empirical data using existing and newly developed test protocols that will permit replication by other testing organizations and provide a technical basis for demonstration home design recommendations in Task 4 and builder guidelines in Task 5.

Table 1 List of Building Assemblies and Practices for Laboratory Evaluation

Category	Description of Building Assembly
Window Installation Methods (Highest Priority)	This category will examine different window installation methods to evaluate moisture penetration through the drainage plane. Tests will include medium quality installations to reflect variability in skill levels in the field. Baseline will include vinyl windows, 3 coat stucco.
- ASTM E2112 Method A	Sill flashing; window; jamb flashing; head flashing; weather barrier
- ASTM E2112 Method A1	Weather barrier; sill flashing; window; jamb flashing; head flashing
- ASTM E2112 Method B	Sill flashing; jamb flashing; window; head flashing; weather barrier
- ASTM E2112 Method B1	Weather barrier; sill flashing; jamb flashing; window; head flashing
- CAWM Method A	Similar to ASTM E2112 Method A, different details
- CAWM Method B	Similar to ASTM E2112 Method B, different details
- Silverline	Head flashing over weather barrier
- Marvin	Multiple layers of weather barrier and flashing
- Certainteed	Similar to Method B; extra sill flashing; different sealing details
- Pella	Similar to Method A1; extra sill flashing; different flashing details
- Owens Corning	Felt paper flashing; sealant; no gaps
- One-Coat Stucco	Evaluate joint details at selected windows
Stucco Wall Assemblies (High Priority)	This category will examine different wall assemblies used with stucco to determine the impact of various moisture loading scenarios on stucco drainage planes, wall cavities, and interior finishes. Baseline includes 3 coat stucco, double wrap grade D building paper over sheer wall, single wrap grade D building paper, no sheathing away from sheer wall, unfaced batt fiberglass insulation, 5/8" gypsum board
- High/Low Drainage Openings	Baseline with high/low drainage openings.
- No Drainage	Baseline without weep screed
- Stucco Wrap	Baseline with DuPont Tyvek™ "Stucco Wrap"
- One Coat Insulated Sheathing	Baseline with one coat, insulated sheathing, no drainage channel
- Cellulose Insulation	Baseline with cellulose instead of fiberglass insulation
- Fungicide in gypsum board	Baseline with USG Humitek™ fungicidal gypsum board
- Fiberglass faced gyp. board	Baseline with GP DensArmor™ gypsum board
- Mold Resistant Sealer/OSB	Baseline with Foster 42-42® mold resistant sealer
- High Permeance Housewrap	Baseline with Owens Corning Pinkwrap® house wrap
- High Permeance Housewrap	Baseline with DuPont Tyvek™ house wrap
- Low Permeance Housewrap	Baseline with Dow Styrofoam Weathermate™ house wrap
Concrete Floor Slab (High Priority)	This category will examine the impact of various vapor retarder and fill material locations and options on drying time and pooled water for 4" concrete floor slabs and grade beams.
- Sand, VR	4"Sand; 10 mil polyethylene sheet; soil
- Sand, VR, Sand	2"Sand; 10 mil polyethylene sheet; 2" sand; soil
- Sand, VR, CDF	2" sand; 10 mil polyethylene sheet; 2" compactable, drainable fill; soil
- CDF, VR, Sand	2" compactable, drainable fill; 10 mil polyethylene sheet; 2" sand; soil
- VR, CDF	10 mil polyethylene sheet; 4" compactable, drainable fill; soil
- VR, Sand	10 mil polyethylene sheet; 4" sand; soil
- Sand alone	4" sand; soil
- VR under Grade Beam	10 mil polyethylene sheet also under grade beam; 4" CDF; soil

Table 1 List of Building Assemblies for Laboratory Evaluation (Continued)

Category	Description of Building Assembly
Innovative Wall Assemblies (Medium Priority)	This category will examine innovative wall assemblies, with focus on insulated concrete forms and structural insulated panels. Experiments are likely to focus on drying time from initial pour.
- ICF	Owens Corning Lite-Form® insulation panels.
- T-Mass	Dow STYROFOAM™ T-MASS™ system
- SIP	Structural insulated panel with OSB
Challenging Interface (Lower Priority)	This category will examine challenging interfaces, especially at the roof and wall joint, to determine the impact of installation practices on moisture penetration. Based on PAC input, only one assembly will be considered for this project.
- Roof/Wall Assembly	Roof/Wall joint at roof flashing, counterflashing, and side wall

The tests will be performed using three approaches to meet the test objectives. Drainage plane tests will use spray nozzles with dyed water to simulate wind-driven rain on the vertical surface of wall assemblies and windows. Moisture content experiments on wall assemblies will inject a specified quantity of water into the wall cavity with edges sealed to characterize drying time toward the interior and exterior wall surfaces. Solar and rain effects will be simulated with heat lamps and spray nozzles. A final decision on whether to conduct any differential pressure testing will be made during the experiments based on experimental results, but at this time it is not included in the test suite. Moisture content experiments on concrete slabs will evaluate drying time after the initial pour and will subject the cured concrete to intentional water injection from underneath the slab to simulate changes in water content of the soil.

Test Matrix

Table 2 shows the test matrix for each type of test, including building assemblies, test conditions, and replicated runs.

Table 2 Test Matrix

Building Assembly	Water Spray	Replicate
Window Installation Methods (Highest Priority)	**32 Tests**	**32 Tests**
Window as installed, without sheathing except as shown		
- ASTM E 2112-01 Method A	x	x
- ASTM E 2112-01 Method A1 with OSB Sheathing	x	x
- ASTM E 2112-01 Method B with OSB Sheathing	x	x
- ASTM E 2112-01 Method B1	x	x
- ASTM E 2112-01 A with One-Coat Stucco/Exterior Insulated Sheathing	x	x
- ASTM E 2112-01 A with Exterior Insulation and Finish System	x	x

Table 2 Test Matrix (Continued)

Building Assembly	Water Spray	Replicate
- ASTM E 2112-04 (draft) Method A	x	x
- ASTM E 2112-04 (draft) Method A1 with OSB Sheathing	x	x
- ASTM E 2112-04 (draft) Method B	x	x
- ASTM E 2112-04 (draft) Method B1 with OSB Sheathing	x	x
- Tyvek® FlexWrap® After WRB	x	x
- Certainteed	x	x
- Marvin	x	x
- Owens Corning	x	x
- Pella	x	x
- Silverline	x	x
Window with 1/8” holes in bottom corners from front to back of flange		
- ASTM E 2112-01 Method A	x	x
- ASTM E 2112-01 Method A1 with OSB Sheathing	x	x
- ASTM E 2112-01 Method B	x	x
- ASTM E 2112-01 Method B1 with OSB Sheathing	x	x
- ASTM E 2112-01 A with One-Coat Stucco/Exterior Insulated Sheathing	x	x
- ASTM E 2112-01 A with Exterior Insulation and Finish System	x	x
- ASTM E 2112-04 (draft) Method A	x	x
- ASTM E 2112-04 (draft) Method A1 with OSB Sheathing	x	x
- ASTM E 2112-04 (draft) Method B	x	x
- ASTM E 2112-04 (draft) Method B1 with OSB Sheathing	x	x
- Tyvek® FlexWrap® After WRB	x	x
- Certainteed	x	x
- Marvin	x	x
- Owens Corning	x	x
- Pella	x	x
- Silverline	x	x

Table 2 Test Matrix (Continued)

Building Assembly	Solar/Moisture Loading	Moisture Loading	Solar/Soaking
Stucco Wall Assemblies (High Priority)	**13 Tests**	**13 Tests**	**7 Tests**
- Baseline Wall	x	x	x
- High/Low Drainage Openings	x	x	
- No Drainage	x	x	
- Stucco Wrap	x	x	
- One Coat Insulated Sheathing	x	x	x
- Exterior Insulation and Finish System	x	x	x
- Cellulose Insulation	x	x	x
- Fungicide in gypsum board	x	x	x
- Fiberglass faced gypsum board	x	x	x
- Mold Resistant Sealer on OSB	x	x	x
- Higher Permeance Housewrap 1	x	x	
- Higher Permeance Housewrap 2	x	x	
- Lower Permeance Housewrap	x	x	
Concrete Floor Slab (High Priority)		**8 Tests**	
- Sand, Vapor Retarder		x	
- Sand, Vapor Retarder, Sand		x	
- Sand, Vapor Retarder, CDF		x	
- CDF, Vapor Retarder, Sand		x	
- Vapor Retarder, CDF		x	
- Vapor Retarder, Sand		x	
- Sand alone		x	
- Vapor Retarder under Grade Beam		x	
Innovative Wall Assemblies (Medium Priority)		**3 Tests**	
- ICF	x	x	
- T-Mass	x	x	
- SIP	x	x	
Challenging Interface (Lower Priority)	**Water Spray (1 Test)**		**Replicate (1 Test)**
- Roof/Wall Assembly	x		x

Facilities, Equipment, and Instrumentation

The project team will conduct tests at the GTI laboratories in Des Plaines, IL (see Figure 1). The necessary laboratory facilities will be dedicated to these tests throughout the test period. The nature of the tests requires a number of heavy stucco wall and window assemblies to be built, stored, moved, and tested. Wall construction equipment includes all materials, fastening tools (e.g., nail and staple guns), stucco wall application tools (mixer, trowels, hawk, and rake), and miscellaneous wall assembly tools for insulation, housewrap, and gypsum board installation. Instrumentation required for the tests focuses on moisture sensors and relative humidity, with some challenging installation procedures and potentially complex calibration requirements.

Facilities for the water spray tests include

- Unconditioned enclosed chamber, 25’ x 12’ x 7’ high on asphalt paving
- Test stands for 2 window assemblies
- Pumped, recirculated, dyed water spray rigs with sump below test stands
- Access areas for visual inspection of assemblies during tests

Facilities for the wall moisture loading tests include

- Two air conditioned bays within the GIT Res/Com laboratory, 8’ x 15’ x 12’ high each
- Test stands for up to 4 wall assemblies (2 with load cells)
- Moisture loading ports to inject water into wall assemblies
- Moisture, relative humidity, and temperature sensors, scale, and load cells
- Infrared camera for surface temperature measurements
- Sensor control and signal conditioning microprocessors for moisture sensors
- Data acquisition system to record and monitor data

Facilities for concrete slab tests will include:

- Graded, level substrate in the unpaved lot adjacent to GTI’s Res/Com laboratory
- Vertical PVC piping inserts in poured slabs to inject water underneath test slabs
- Relative humidity and temperature sensors for moisture measurements
- Data acquisition system to record and monitor data

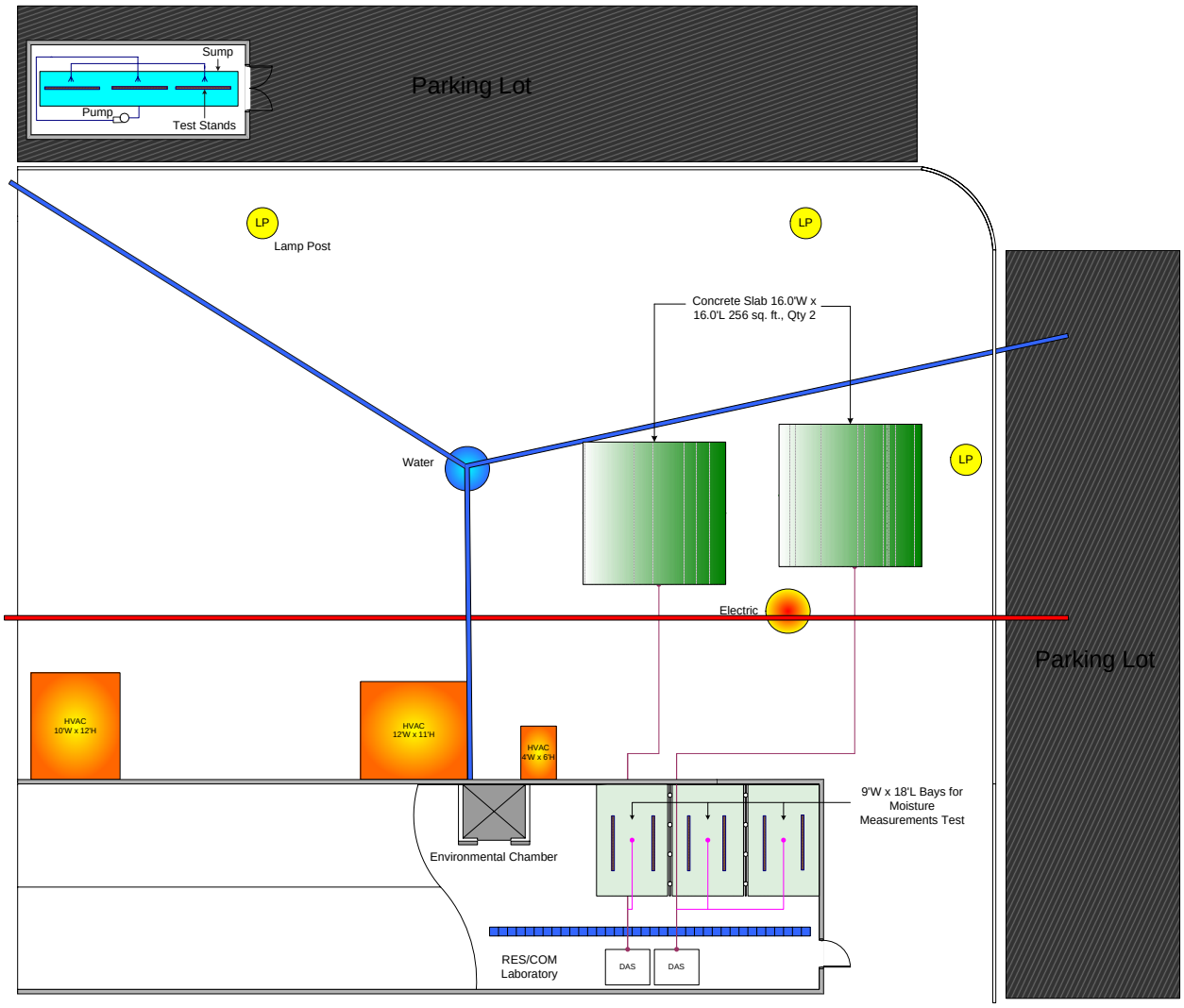

Figure 1 GTI Test Facilities

Test Procedures

Window Installation Methods

Water spray test procedures for window installation methods will evaluate the ability of the drainage plane in each installation method to drain water away from the interior side of the wall assembly. The control parameters will be window installation method and induced window leak. The parameter to be measured is whether water flows into the interior side of the drainage plane when the window/wall assembly is subjected to simulated wind-driven rain using spray nozzles with dyed water.

Each window will be installed according to construction details described in the method under test (e.g., ASTM E 2112-01, Method A) using 36”W x 24”H Pella ThermaStar Series 10 vinyl windows installed in 5’-6”H x 6’-2”W stucco wall sections (see Figure 2). The window size and type were selected to minimize the overall size and height of the test assemblies while still providing a realistic configuration. The window assembly will be sprayed for a specified period of time to simulate desired rainfall patterns. Spray nozzle flow rate, duration, and configuration will be designed to provide acceptable droplet size, total rain load, and wall coverage for test purposes, based on parameters described in ASTM E 331-00 and ASTM E 1105-01, but without application of a pressure differential. Spray nozzles will be Bex 1/4S14WSQ at 40 PSI, 32" from the test sample. Dye will either be Risk Reactor Clear Blue fluorescent water tracer (clear in sunlight, blue in ultraviolet light), or Precision Laboratories Super Signal Blue spray pattern indicator (temporary visible blue stain). A recirculating pump with strainer and bypass to sump will be sized and configured to provide variable flow rate for 2 test stands. An 11½” deep by 3’ wide by 16’ long sump will be placed under the test stands to capture runoff and provide water storage for recirculation. The indoor side of the wall assembly will be protected from inadvertent overspray by a 6 mil polyethylene sheet.

Test results will be determined through visual inspection of the interior side of the window/wall assembly. OSB sheathing will have cutouts away from fasteners to permit maximum possible visual inspection of the drainage plane/OSB interface. Any water stains will be noted and photographed.

Stucco Wall Assemblies

Moisture loading test procedures for stucco wall assemblies will evaluate the ability of each assembly to dry out following a water intrusion event. Each stucco wall assembly will be constructed using the materials shown in Table 2. Each wall will be L-shaped, 4’ high, containing three 16” on center stud bays, with OSB sheathing at the corner bays and no sheathing in the bay away from the corner (see Figure 3). Parameters to be controlled include materials of construction of each wall assembly, moisture loading scenarios, and ambient conditions. Parameters to be measured are moisture content of wood, stucco, and gypsum board, temperature and relative humidity of insulation inside the wall cavity, and weight of the wall assembly.

For moisture loading tests, each wall assembly will be constructed, and 3/8” round openings will be provided in the top framing member of the assembly, spaced 3” apart to permit introduction of water at 4 places within each 16” stud bay. Alternately, water may be introduced by spraying specified quantities of water within each cavity before and after installing the insulation to provide reasonably uniform wetting of hidden surfaces and insulation. The interior wall will then be fastened to studs using drywall screws. To allow disassembly and re-assembly for inspections, corners and edges will be sealed with duct tape. Interior walls will not be painted.

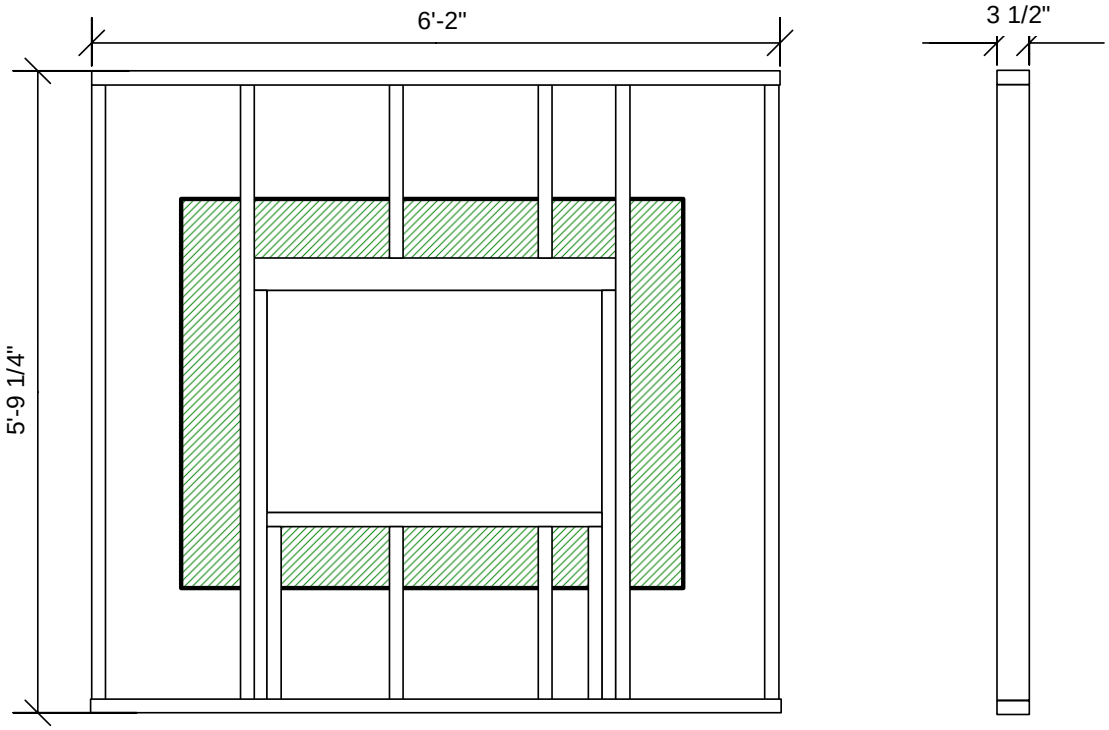

Figure 2 Window Framing in Stucco Wall Assembly

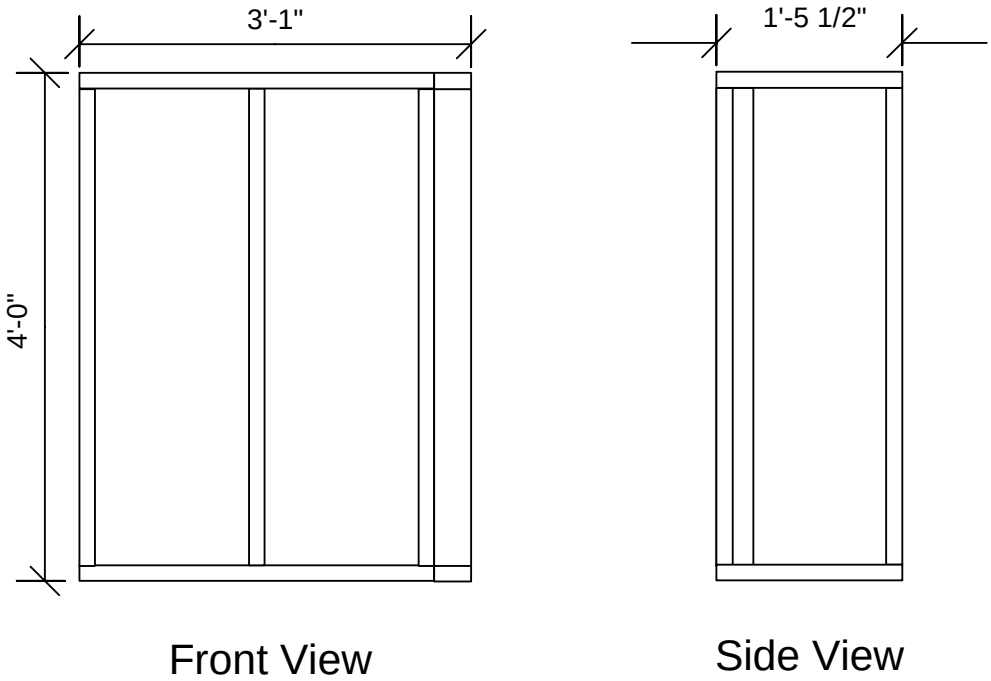

Figure 3 Stucco Wall Assembly Framing

Wall assemblies will be placed on load cells with counterweights to measure the total moisture content of the walls during experiments. They will be placed in an air conditioned laboratory and maintained at room temperature for the duration of the tests. For solar loading tests, heat lamps will be cycled for 8 hours per day on one face of the wall assembly. For solar loading and soaking tests, heat lamps will be cycled for 8 hours per day, followed by one hour of water spray per day. Room temperature and relative humidity will be measured. Specimens will be weighed daily using a scale to determine the change in water content. Moisture levels will be measured using resistance pins inserted in the wood studs and sheathing at 3 elevations in each assembly. Temperature and relative humidity will be measured in the center of the insulation at 3 elevations in each assembly. Moisture measurements will be hourly. Stucco surface temperatures will be measured during soaking and solar loading tests with a Land FTI 6 thermal imager. The moisture sensor data processing and acquisition system will be a custom design from Balanced Solutions, Inc. that includes moisture content pins, temperature and relative humidity sensors, load cells, data logger, multiplexer, interfaces, and associated software. The supplemental signal processing and data collection system will be a National Instruments Labview data acquisition system.

Concrete Slabs

Moisture loading test procedures for concrete slabs will evaluate the impact of the vapor retarder location on drying time after the pour, and concrete moisture content when subjected to water loading from below grade subsequent to the pour. Parameters to be varied include location of vapor retarder relative to the slab, fill material, moisture loading, and ambient conditions. Parameters to be measured are temperature and relative humidity of the slab at 5 depths and in the substrate below the slab.

The eight 4” thick concrete slab sections and 12” deep by 12” wide footings (see Figure 4)will be poured using 2,500 PSI mix L-427 from Prairie Concrete. The concrete will have the following mix design:

No-Air	Mix #L-427	ASTM Specification
Cement	330 lbs.	C-150
Fly Ash	100 lbs.	C-618
Sand	1,630 lbs.	C-33
#67 Limestone	1,740 lbs.	C-33
Water	32.5 gals.	Potable
Water Reducer	4 oz/cwt.	C-494
Slump	3±1	

Each slab section will be separated from other test sections using 12” deep plywood forms. Concrete slabs will be sprayed with water periodically to aid curing. Initially the concrete slabs will be exposed to ambient conditions and not under cover. One month after the pour, the slabs will be covered with OSB sheathing on 8” concrete blocks to reduce exposure to sunlight and rain.

Humidity probes in the slabs will be Vaisala HMP44, inserted into drilled holes 5” from each other at depths of ½”, 1”, and 2” below the slab surface. Two sets of measurements will be taken in each 8’ slab section, one near the center of each slab, and one near the edge of the slab. A single probe will be used for each section, with readings taken daily on weekdays. During weekends, the RH sensors will be in the center of each slab section at 2” depth for continuity of measurement. Temperature and relative humidity

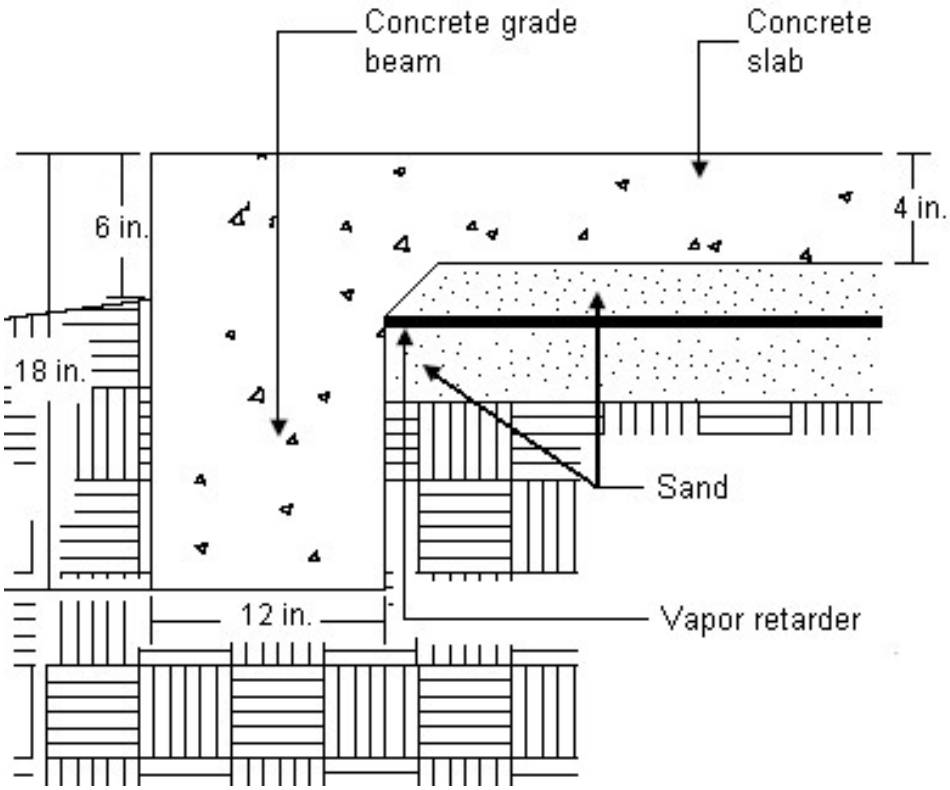

Figure 4 Concrete Slab and Footing

measurements below grade will use E+E Electronik EE03 coated probes. Two sensors will be located in each 8' slab section below the slab RH sensors. Additional moisture content probes using wood-embedded moisture content pins will be located in each 8' slab section near the center of the slab.

Two weeks after the initial pour, water will be injected into the sand or compactible drainable fill under the slabs to simulate a high water table. To the extent practicable, the fill will be "saturated" with water by the end of the injection. A 2" PVC pipe insert at the center of the slab will be used to convey the water 1" under the slab. The amount of water injection will be approximately 10 gallons per 8' slab section.

Humidity sensors will have calibration certificates from the factory. Calibrations will be checked initially using previously calibrated GTI relative humidity sensors collocated with the test sensors. Based on manufacturer input, the sensors should not require recalibration during the test period. Signal processing and data collection for these sensors will use a National Instruments Labview data acquisition system.

Test Log

In accordance with GTI policy, test logs will be maintained in a numbered laboratory notebook assigned to this project. All pertinent lab data and test information will be included in this notebook and transcribed as appropriate into the test report.

Data Analysis Procedures

Data will be collected in the data acquisition system and transferred to Microsoft Excel spreadsheets for analysis and interpretation. Tabular and graphical results will be generated and interpreted by the project team. Qualitative data (e.g., pass-fail or other observations during the tests) will be recorded and summarized in the test report along with an interpretation of the data as appropriate.

Quality Assurance Procedures

Quality assurance for this project involves determining quality objectives, deciding whether or not the objectives have been met, and implementing corrective actions as necessary. In the laboratory, it involves the entire testing process from test setup and purchasing to analytical testing and data analysis and reporting. Quality assurance for this project involves several ongoing procedures, including:

- Adherence to specified assembly instructions, details and materials of construction
- Verification of data collected for reasonableness and validity
- Adherence to ASTM standards
- Compliance with specified protocols for tests
- Cross-checking calibrations
- Automated data acquisition to reduce human error
- Checklists for manual data acquisition
- Feedback on procedures and attendant problems from other researchers
- Material list for wall assemblies
- Material list for data acquisition system
- Record maintenance

Visual inspections and photographic records are a key component of the QA plan for this project. These inspections and photographic evidence of assemblies under construction will enable verification that the assemblies were properly fabricated. Checklists will be used as appropriate to ensure that standard

protocols are followed uniformly. The laboratory notebook will be used to record information and note corrective actions.

Predicted Performance

Based on the situation analysis, it is expected that the laboratory evaluations will demonstrate the significant value of improved flashing and other details for window installation methods. They should also provide solid information on the moisture levels of a variety of wall assemblies. Mold resistance of wall materials with fungicides or reduced cellulose content should show superior mold resistance. Good information is expected about the drainage advantages of housewraps with airspaces compared to single ply conventional building paper. Finally, concrete slab tests should show the superior moisture control characteristics of vapor retarders adjacent to slabs and under concrete footings.

Contingency Measures

The laboratory evaluations will be using untried protocols and imperfect data acquisition methods in an attempt to answer questions about the moisture tolerance of a variety of building assemblies. The tests will use a number of assemblies that are time-consuming to construct. To reduce the overall risk, the team will conduct rudimentary versions of each experiment initially and quickly evaluate the essence of the result. If the result is not aligned with project objectives, the experiments can be halted or re-directed prior to more extensive construction or testing. If a class of experiments (e.g., spray testing of stucco wall assemblies) is deemed to be unproductive, the initial results will help re-direct resources to other areas.

The key method planned to determine the need to re-direct the project will be real time interactions with the PAC members, participating manufacturers, and Commission staff. Small to large changes in direction can be accommodated within the project scope and budget by identifying and addressing problematic testing. This interaction will occur throughout the test period, but most importantly near the beginning of each test set. The only difficult area to re-direct will be the concrete slab pour and related data acquisition and experiments, since the pour will occur only once. Other areas will be more flexible and can be changed if feedback is obtained early enough.