**Building Performance Institute, Inc.**
BPI Standard

BPI-2100-S-2013

# Standard for Home Performance-Related Data Transfer

## Notice

BPI standards, bulletins and other technical publications are designed to serve the public interest through eliminating misunderstandings between manufacturers, service providers and purchasers, facilitating interchangeability and improvement of products and services, and assisting the purchaser in selecting and obtaining, with minimum delay, the proper product or service for his or her particular need.

Existence of such standards, bulletins and other technical publications shall not in any respect preclude any entity affiliated with BPI (or not) from manufacturing or selling products or services not conforming to such standards, bulletins or other technical publications, nor shall the existence of such standards, bulletins and other technical publications preclude their voluntary use by those unaffiliated with BPI, whether the standard is to be used either domestically or internationally.

Standards, bulletins and other technical publications are adopted by BPI in accordance with the American National Standards Institute (ANSI) patent policy.  By such action, BPI does not assume any liability to any patent owner, nor does it assume any obligation whatever to parties adopting the standard, bulletin or other technical publication.

This standard does not purport to address all safety problems associated with its use or all applicable regulatory requirements.  It is the responsibility of the user of this standard to establish appropriate safety and health practices and to determine the applicability of regulatory limitations before its use.

Formulated under the cognizance of the BPI Standards Technical Committee.

# Table of Contents

# Introduction (Informative)

BPI-2100 is designed to facilitate communication and the exchange of information and data among all actors in the home performance industry by providing an extensible mark-up language (XML) standard for transferring information related to whole-house energy efficiency upgrades. The standard is informally known as Home Performance XML, or HPXML.

BPI-2100 is a companion standard to BPI-2200 (Standard for Home Performance-Related Data Collection). Each of the data elements defined in BPI-2200 can be transferred via HPXML.

The schemas are hosted online on a site maintained by the National Renewable Energy Laboratory (NREL). A link to the website is provided in Annex A of this standard.

# 1. Scope

This standard provides requirements for an XML standard data transfer protocol that can be used to transfer any home performance-related data between any actor involved in a home performance program, including contractors, program administrators, utilities, U.S. Department of Energy (DOE) and Environmental Protection Agency (EPA), etc. The scope of this standard is limited to existing detached single-family dwellings and townhouses that have independent mechanical systems for each dwelling unit (heating, cooling, water heating, and ventilation); direct access to outdoors for each dwelling unit; and were designed to have continuous party walls with no penetrations to adjacent units, with such party walls extending from ground to roof where the dwelling unit is attached to one or more adjacent single-family dwelling units.

# 2. Objective

BPI-2100 provides extensible mark-up language (xml) schemas that allow all data elements identified in BPI-2200 to be transferred from one software system to another. The standard is intended to reduce the transactional costs associated with collecting and transferring data by making communication between systems easier, and by reducing the need for the development of a data transfer protocol each time two systems need to communicate.

# 3. Required Use of HPXML

To comply with BPI-2100, HPXML shall be used to transfer all data that can be adequately represented by the HPXML vocabulary. Data can be "adequately represented" by HPXML if HPXML data elements, singly or in combination, can provide a representation of the thing or person to be described that a) could reasonably be understood by other home performance professionals, and b) does not result in significant loss of information or create significant risks of miscommunication.

For example, using a non-HPXML data element entitled NumberofPanes to describe the number of layers of glass in a window would not be HPXML-compliant, because the HPXML element NumberofLayers could be used; in the context of a description of window, this would be understood by home performance professionals, and would not result in miscommunication. However, in some contexts, it might not be sufficient to use the Door element to describe an attic or crawlspace hatchway.

# 4. Non-HPXML Data

HPXML allows incorporation of non-HPXML data through use of the extension element, which is a child element of more than one hundred elements in the schema. The extension element allows the addition of data elements from any namespace to be added as child elements, facilitating transfer of data that is not included in the schema.
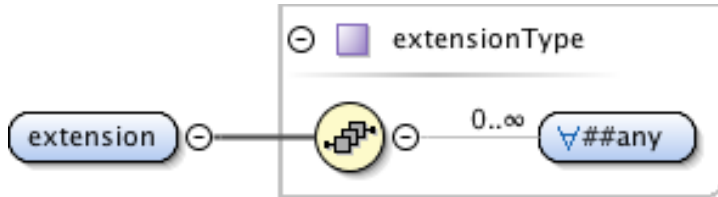


# 5. HPXML in Other Schemas

BPI-2200 does not require that HPXML be the root element of a schema; HPXML namespaces can be incorporated into XML documents with non-HPXML root elements. If a non-HPXML element is the root element of a schema, the schema shall not use non-HPXML data elements to describe persons, characteristics, concepts, or other things that can be adequately represented by HPXML. To the greatest extent possible, use of HPXML in documents with non-HPXML root elements shall be limited to uses in which HPXML elements are contained as a unit within a non-HPXML envelope.

# 6. Validation

Validation is conducted against an entire HPXML scheme (e.g., MaintainBuilding or MaintainProject). Because very few elements in HPXML are required, files should be validated providing that they are well-formed and include the utilized data elements in the proper document context and order.

# Annex A: BPI-2100 Schemas – HPXML (Normative)

The HPXML schemas that form a part of BPI-2100, entitled "HPXML 1.1.1 Release," are located on NREL's website at https://hpxml.nrel.gov/wiki/SchemaDocumentation.

Individual links to each HPXML schema are also provided below:

## A.1 HPXML – Full Schema

https://hpxml.nrel.gov/pubsvn/tags/hpxml-1.1.1/docs/HPXML.html

## A.2 Maintain Building

https://hpxml.nrel.gov/pubsvn/tags/hpxml-1.1.1/docs/MaintainBuilding.html

## A.3 Maintain Project

https://hpxml.nrel.gov/pubsvn/tags/hpxml-1.1.1/docs/MaintainProject.html

## A.4 Maintain Customer

https://hpxml.nrel.gov/pubsvn/tags/hpxml-1.1.1/docs/MaintainCustomer.html

## A.5 Maintain Contractor

https://hpxml.nrel.gov/pubsvn/tags/hpxml-1.1.1/docs/MaintainContractor.html

## A.6 Maintain Utility

https://hpxml.nrel.gov/pubsvn/tags/hpxml-1.1.1/docs/MaintainUtility.html

## A.7 Maintain Consumption

https://hpxml.nrel.gov/pubsvn/tags/hpxml-1.1.1/docs/MaintainConsumption.html

# Annex B: HPXML User's Guide (Informative)

This Informative Annex is designed to provide an overview of some of the most important features of HPXML. It is not an exhaustive review of all of the elements in the standard.

BPI-2100 (HPXML) includes six schemas, each of which has a title that indicates its purpose:

- MaintainBuilding
- MaintainProject
- MaintainCustomer
- MaintainContractor
- MaintainUtility
- MaintainConsumption

The most important, and most complex, of these schemas are MaintainBuilding and MaintainProject, each of which is described in greater detail below.

## B.1 MaintainBuilding

MaintainBuilding is designed to describe the physical characteristics of a building.
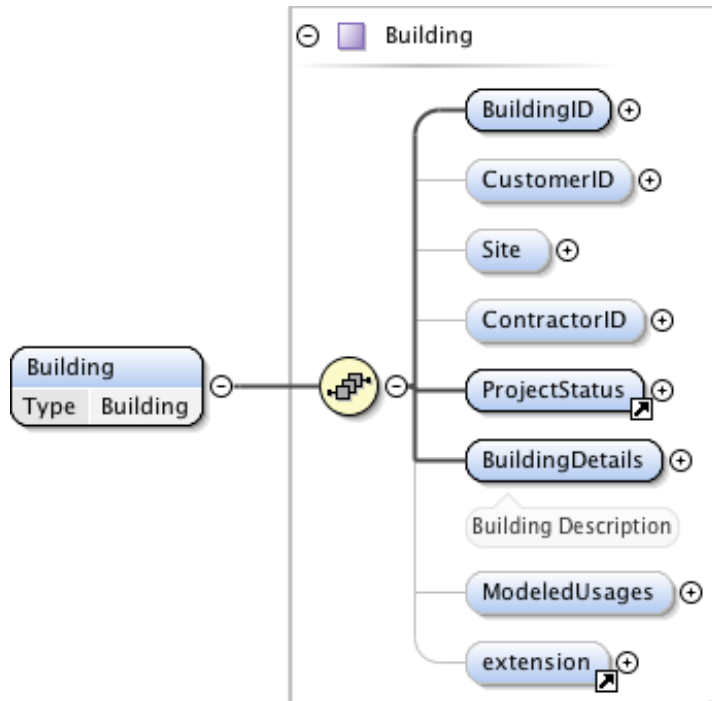


A building can be given a unique **BuildingID** that can be used by a program, contractor or other entity to distinguish it from other buildings.

A customer described in a MaintainCustomer file can be linked to a MaintainBuilding file through a unique **CustomerID**.

The **Site** element provides a way to describe general information about the building site, including its address, school district and e-grid region.

## B.1.1 ProjectStatus

Multiple MaintainBuilding files may be needed to fully describe a whole-house upgrade. For example, a MaintainBuilding file containing data collected at the time of the initial audit could provide baseline information about the project, and a MaintainBuilding file created at the completion of a job could provide information about the building's more energy-efficient state following the upgrade.

**ProjectStatus** provides a way to indicate when the elements in a MaintainBuilding file were captured. The **Date** element of ProjectStatus allows the date on which the data was collected to be recorded.
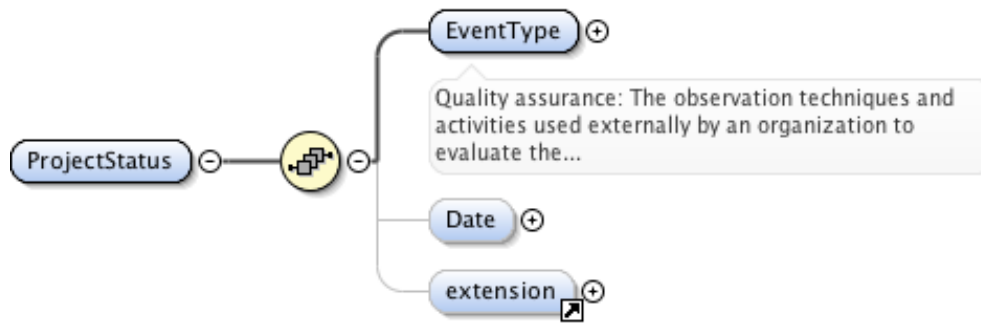


**EventType**, a child element of **ProjectStatus**, describes the stage within the overall whole-house upgrade process to which the data in a MaintainBuilding file pertains: audit, proposed workscope, approved workscope, construction-period testing/daily test out, job completion testing/final inspection, and quality assurance/monitoring. The differences between MaintainBuilding files for the same Building with different Project Status enumerators would reflect improvements made through the upgrade

## B.1.2 ModeledUsage

**ModeledUsage** can be used to provide information about the energy consumption of a building. In addition to describing the type of energy, the unit of measurement and the annual consumption for that particular fuel, elements within ModeledUsage can be used to indicate energy consumption by end use.
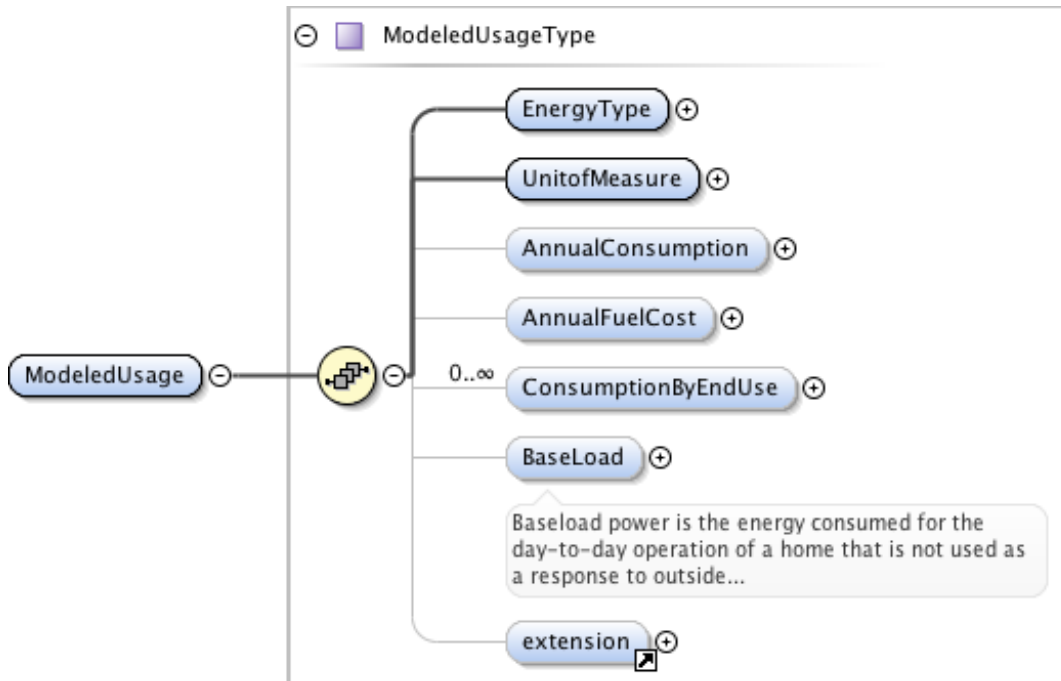
## B.1.3 BuildingDetails

**BuildingDetails** can be used to describe a building in considerable detail. The child elements within BuildingDetails include a **BuildingSummary** element for providing high-level information about a building, a **ClimateandRiskZones** element for describing several different types of zones, and seven general types of building components: enclosure (the building envelope), systems (including HVAC, combustion and ventilation), appliances, lighting, miscellaneous loads, health and safety, and zones (the zones within a building).
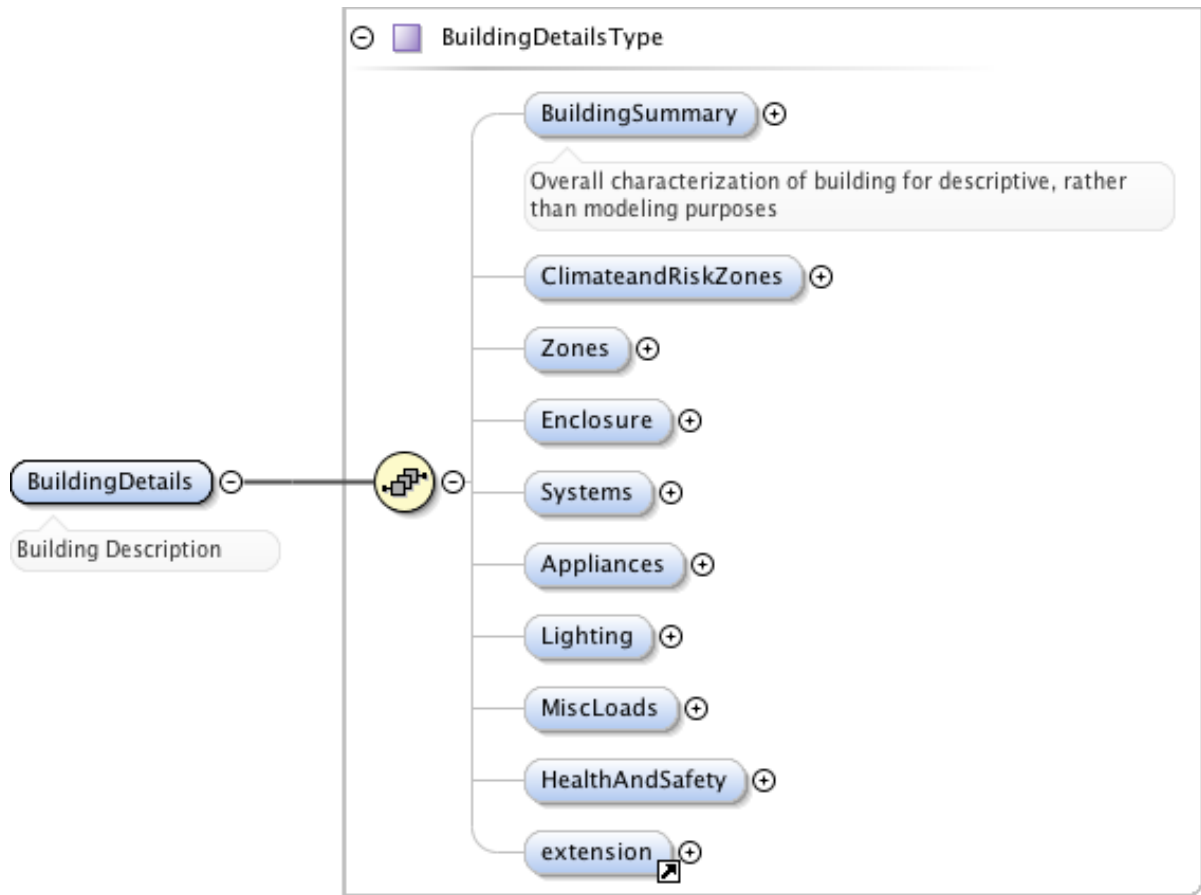
## B.1.3.1 Zones

The **Zones** element provides a way to describe how an HVAC system serves a building. The **ZoneType** element allows indication of whether the zone is conditioned or unconditioned. The child element **Spaces** allows description of some of the basic characteristics of the zone.
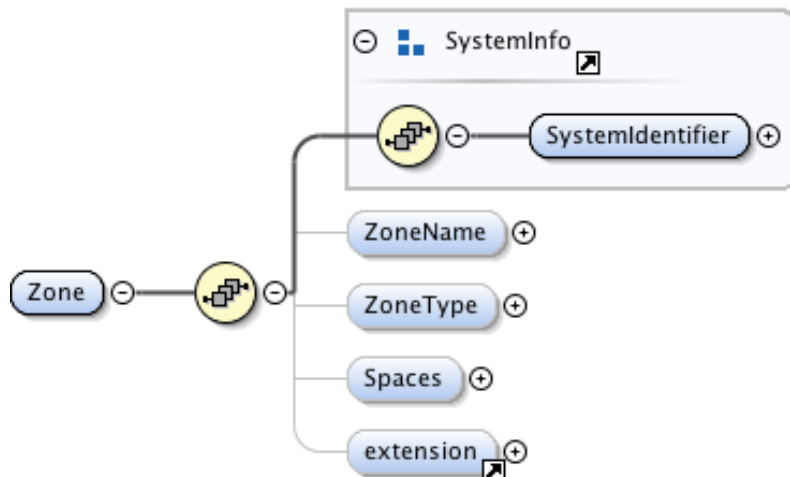
## B.1.3.2 Enclosure

The **Enclosure** element allows description of a building envelope. It allows a level of detail about the envelope to be provided, although minimal information can be transmitted if extensive detail is not required.
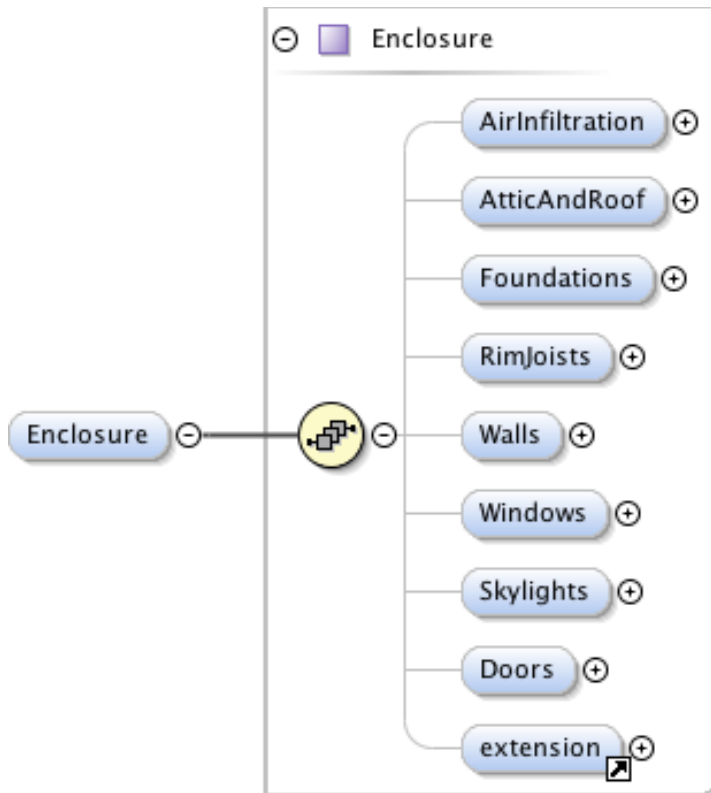


**AirInfiltration** allows description of air infiltration and air sealing through the child elements **AirInfiltrationMeasurement** and **AirSealing**. Energy consumption can be indicated with the **AnnualEnergyUse** element.
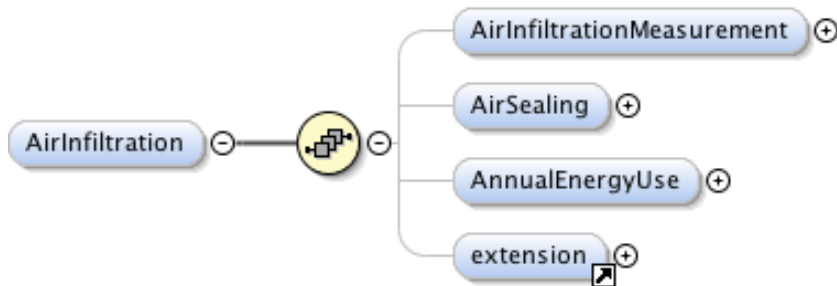
**AirInfiltrationMeasurement** provides a way to describe blower door readings. Each reading can be given a System Identifier for reference purposes if necessary.
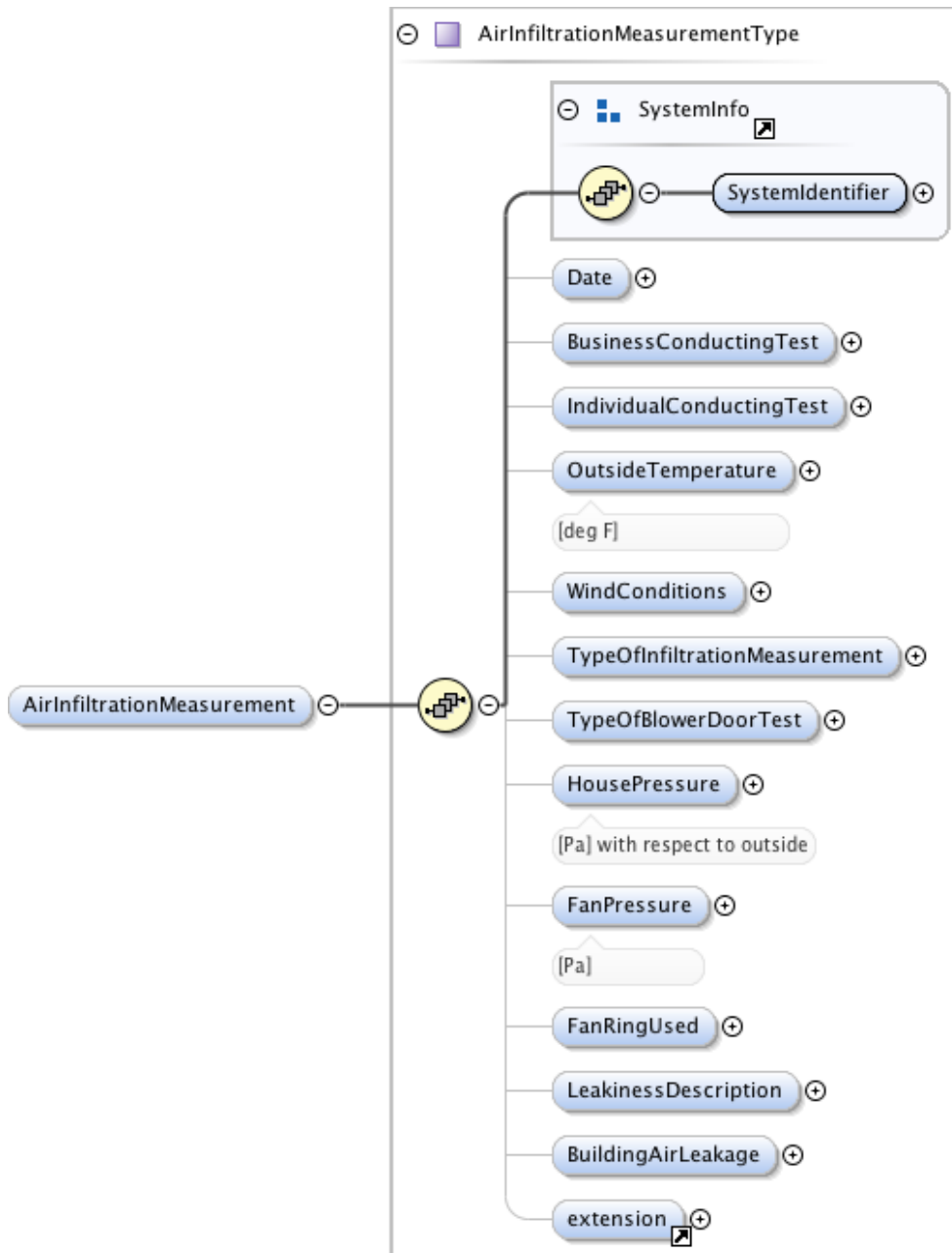


**AirSealing** allows identification of areas air sealed in the home. The **ComponentsAirSealed** element (a child of the AirSealing element) has three child elements, **Attic**, **BasementCrawlspace** and **LivingSpace**, each of which contain enumerators detailing specific areas that may be air sealed. The list of enumerators for the Attic element, for example, are attic

floor, top plates, kneewall transitions, plumbing wet walls, chimney/flue chases, recessed lights, attic access, dropped soffit, attic level transitions, mechanical chases, and other.

**Attic and Roof**, **Foundations**, **Rim Joists**, and **Walls** can each be described in considerable or little detail, depending on the requirements of the specific use case. Foundations can be described by the **FoundationType** element, which allows description of crawlspaces, slabs, garages, etc.

Multiple Attic and Roofs, Foundations, Rim Joists, and Walls can be created, and each can be given a SystemIdentifier so that they can be distinguished from one another. Each attic, foundation, etc., can also be linked to a specific Space (a characteristic of a Zone) with the **AttachedtoSpace** element.

One of the most significant characteristics of Attic and Roof, Foundations, Rim Joists, and Walls is that they are used to describe insulation. The Wall element, as shown below, contains a child **Insulation** element.
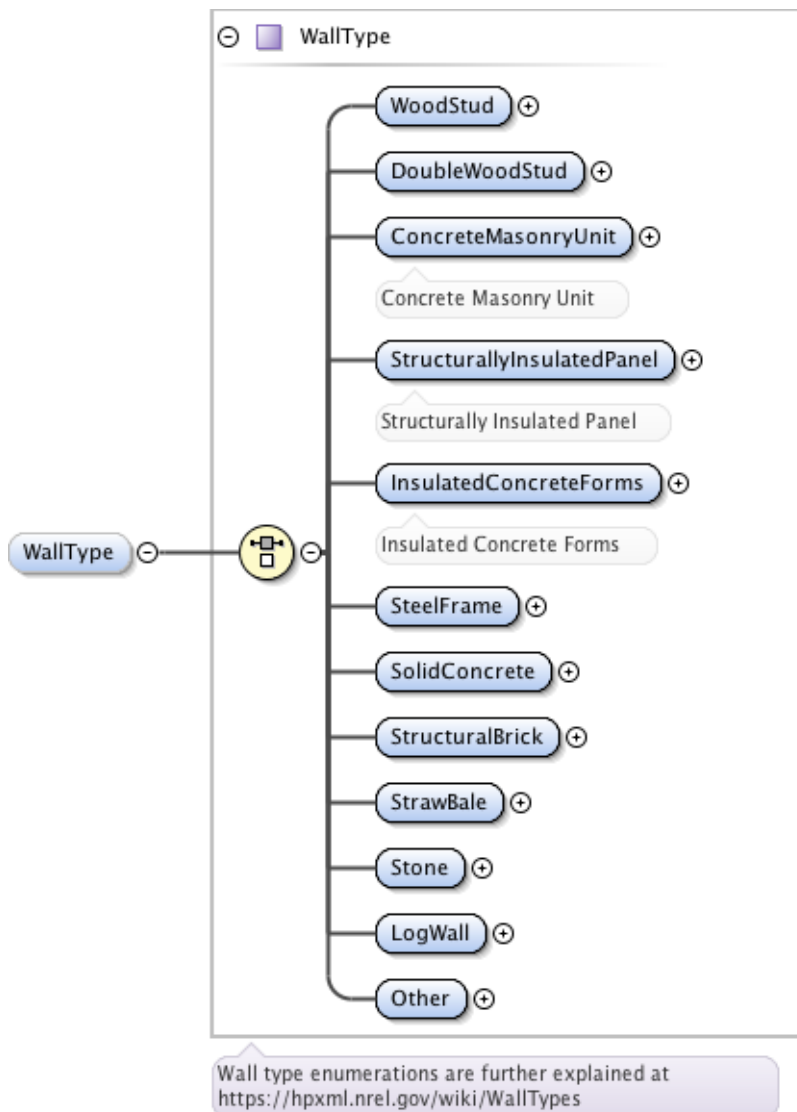
The **Insulation** element contains a **Layer** element that allows description of multiple layers of insulation. Each layer can be described in terms of multiple characteristics, including insulation type, material, thickness and R-value.
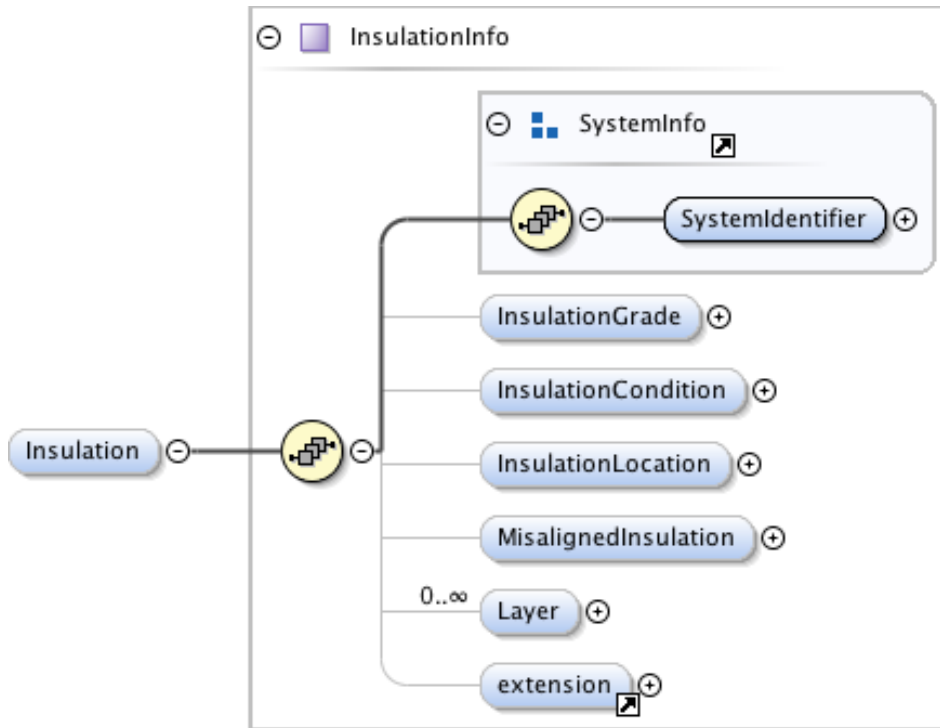


**Windows**, **Skylights** and **Doors** are all child elements of **Enclosure**. Each contains child elements that allow detailed descriptions of these building components. Each of these building components can be identified with a SystemIdentifier. Each can also be grouped into sets with the same or similar characteristics (frame type, number of layers, U-factor, etc.).

As with walls, foundations, etc. windows, skylights and doors can be located in the building through the **AttachedToWall** and **AttachedToRoof** elements if necessary.

### B.1.3.3 Systems

**Systems** can be used to provide detail about a number of types of building systems, including HVAC, ventilation, water heating and photovoltaic systems.
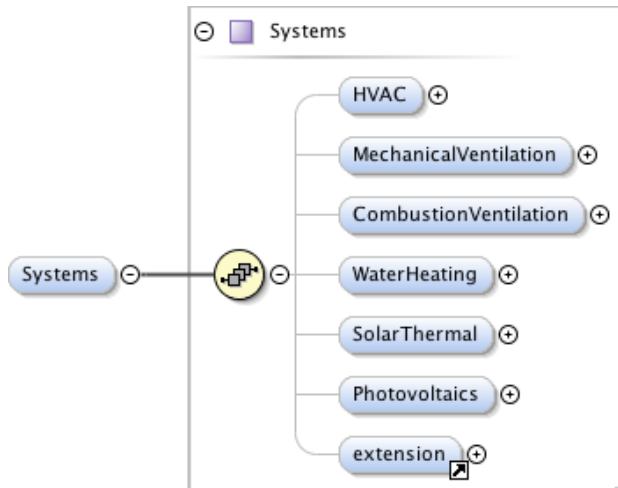
The **HVAC** element is the parent of a set of elements common to all HVAC systems, including controls, distribution systems, maintenance, and annual energy use.
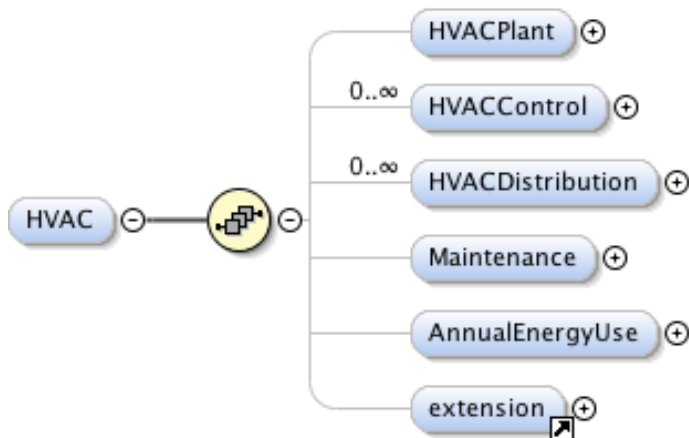


**HVACPlant** is the parent of three elements corresponding to types of HVAC systems: HeatingSystem, CoolingSystem and HeatPump. **HVACSystemInfo** is a child of each of these elements: it provides detailed information common to all HVAC systems. HVACSystemInfo contains a SystemIdentifier element that allows each HVAC system to be individually identified and referenced in the schema.
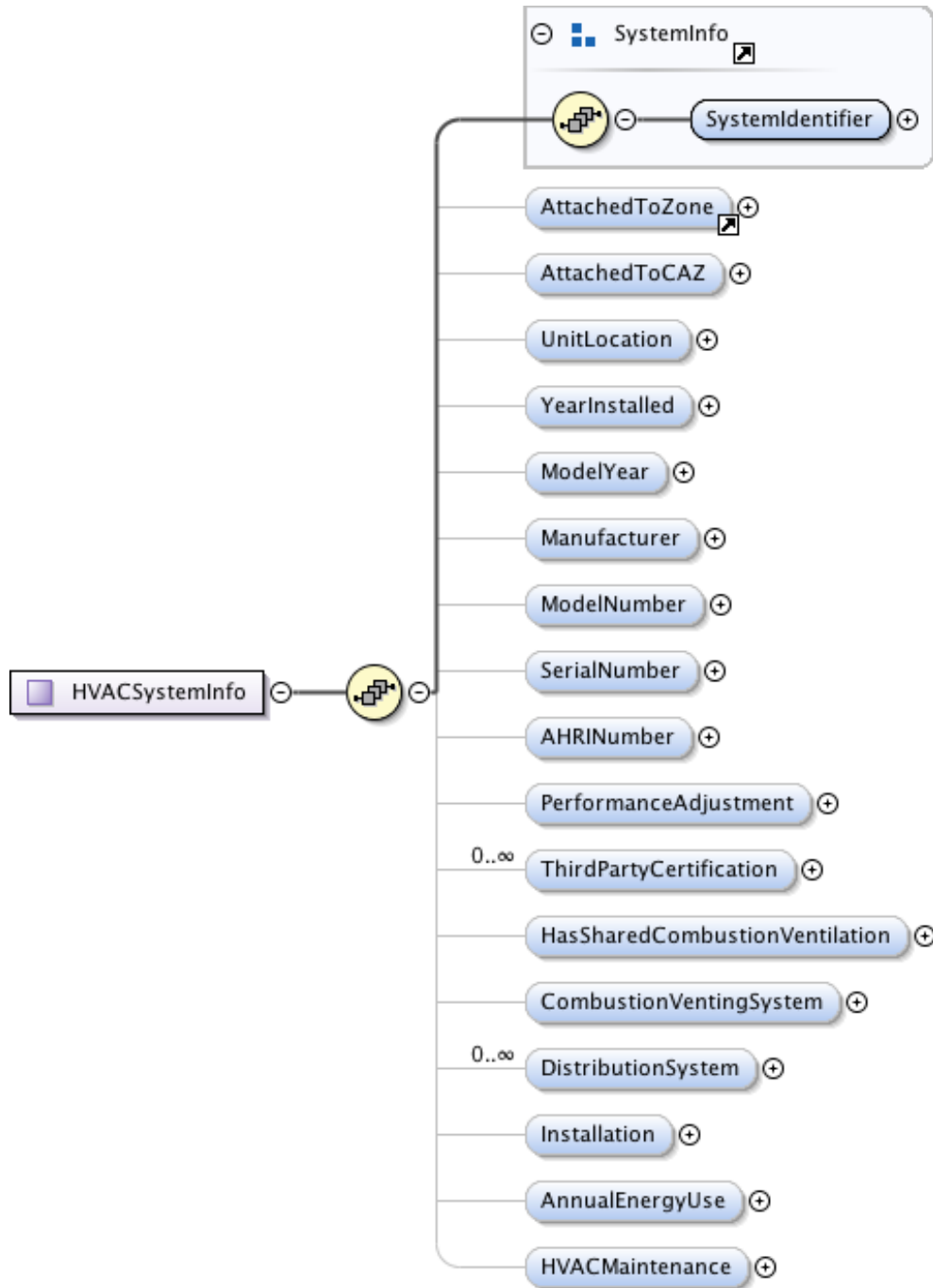
**HeatingSystem**, **CoolingSystem** and **HeatPump** each contain elements specific to that HVAC type: CoolingSystem, for example, has an **AnnualCoolingEfficiency** element with enumerators pertaining to cooling systems (SEER, EER, COP and kWperTon).

**ConsumptionInfo** is a child of **AnnualEnergyUse**, which is a child element of a number of building components. ConsumptionInfo can be used to describe the energy consumption of the component to which it is a child. AnnualEnergyUse measurements from two different

MaintainBuilding files corresponding to an initial audit and a completion report following completion of an upgrade would be expected to show different numbers.
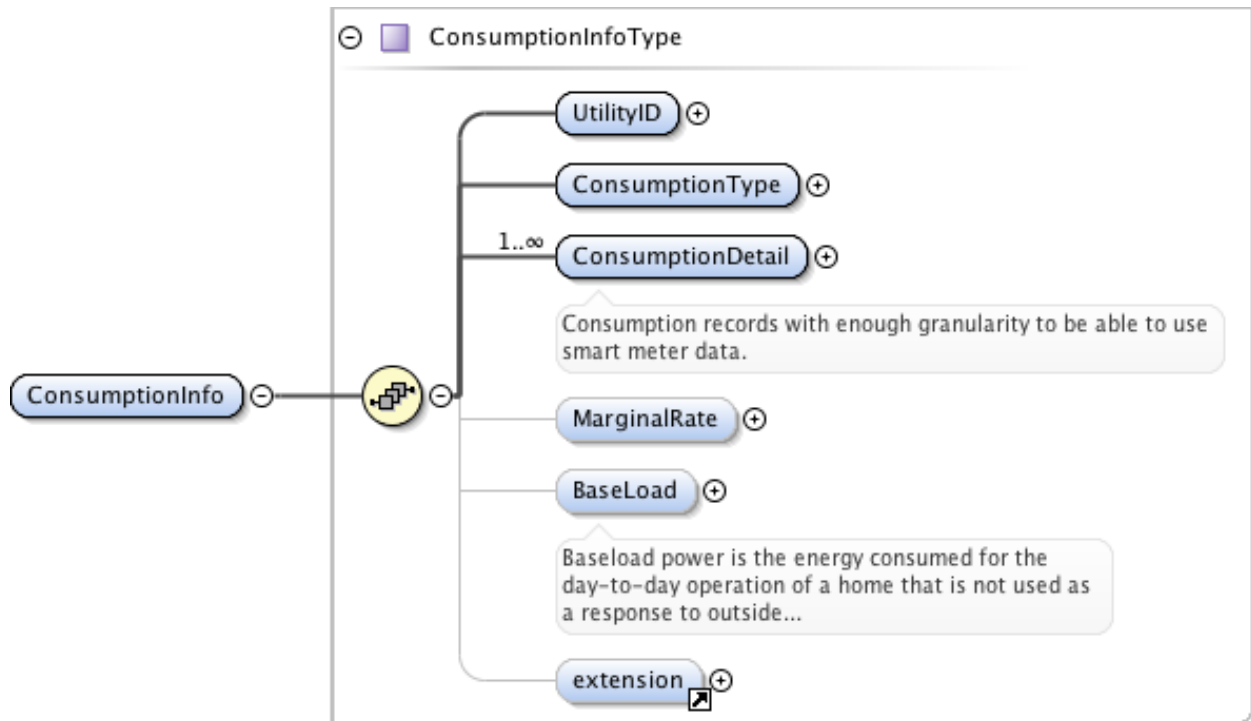


## B.2 MaintainProject

The MaintainBuilding schema is designed to provide a description of a building at a particular point in time. The differences between two MaintainBuilding files created at two different Project Status instances would reflect changes resulting from upgrade work. Determining the measures implemented through a whole-house upgrade through a comparison between MaintainBuilding files, however, could be cumbersome and impractical.

The **MaintainProject** element is designed to describe the measures implemented in a whole-house upgrade more directly. The schema contains the same **BuildingID** and **ProjectID** elements as the MaintainBuilding schema, allowing identification of files pertaining to the same building or project.
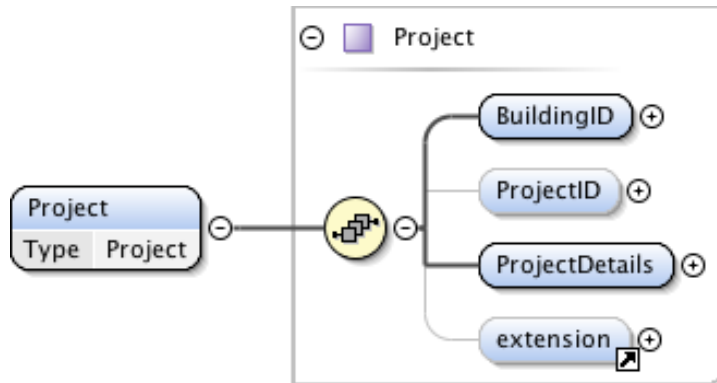
## B.2.1 ProjectDetails

The **ProjectDetails** element allows description of a number of characteristics of an upgrade project, including:

- The name of the program through which the upgrade is conducted;
- The program sponsor;
- The name(s) of the contractor(s) implementing the work;
- Project start and completion dates;
- Costs associated with the project;
- Incentives associated with the project; and
- Energy and water savings associated with the project as a whole

ProjectDetailsType

ProjectDetails

- 1..∞ ProjectSystemIdentifiers
- ProgramName
- ContractorSystemIdentifiers

  These are the system identifiers for a specific contractor at a business

- ProgramSponsor
- CertifyingOrganization
- CertifyingOrganizationURL
- YearCertified
- 0..∞ ProgramCertificate
- EnergyStarHomeVersion
- ProjectType
- Title
- ProjectStatus
- Notes
- StartDate

  Start date of project

- CompleteDateEstimated

  Estimated completion date of project

- CompleteDateActual

  Actual completion date of project

- Hours

  Amount of time spent by contractor on this stage of the project

- FeeCost

  Cost of any fees associated with the audit or other project activities

- ProjectCost

  Cost of all work proposed or performed

- Incentives
- 0..2 EnergySavingsInfo
- 0..2 WaterSavingsInfo
- Measures
- extension

### B.2.2.1 Measures

The **Measures** element provides the way to describe all measures implemented through an upgrade.
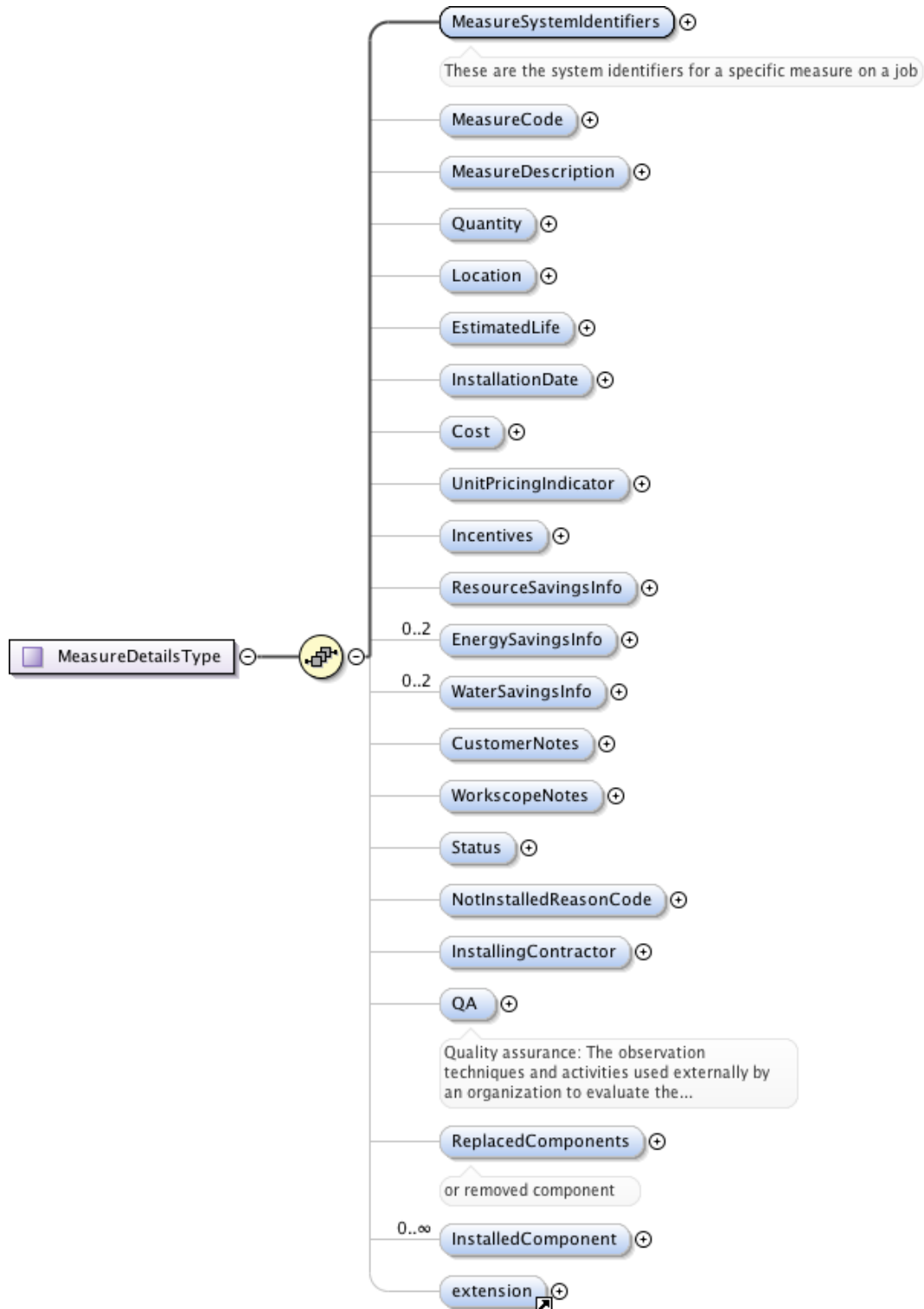
The element allows for description of a number of characteristics of each measure, including:

- Quantity
- Location
- Estimated Life
- Unit pricing
- Incentives (for the individual measure, rather than the project as whole)
- Resource and energy savings (for the individual measure, rather than the project as a whole)
- The name of the contractor responsible for the work

The **MeasureCode** allows identification of measures through a specific code. It is envisioned that codes would be program-specific as of this version of BPI-2100.

The **NotInstalledReasonCode** element allows an explanation of why a specific measure was not installed.

**InstalledComponent** and **ReplacedComponent** elements are crucial to the Measure element. These elements point to measures in the **MaintainBuilding** schema. This is done via the sending and receiving system identifiers as agreed upon by both the sending and receiving systems.

# Annex C: Building Performance Institute, Inc. — Types of Standards (Informative)

The Building Performance Institute, Inc. (BPI) develops technical standards, certifications, accreditations, and related technical documents (e.g., Guidelines, Bulletins, Standard Work Specifications) to support the safe and effective improvement of energy performance in existing residential buildings (including multifamily). These elements reside within a family of related types where they build on each other.

The structure of BPI Standards is made up of six distinct types: Materials Standards, Material Test Methods, Installation Standards, Application Standards, Standard Practices and Standard Specifications. The following overview provides a description of each of these types, and how they relate to each other in order to create a comprehensive and unified structure.

**Materials Standards** are perhaps the easiest member of the family to understand. They define the performance requirements of particular materials. Material standards include methods of testing to confirm acceptability, as well as establishing the performance characteristics of materials under specific conditions.  A material standard would be applicable to the manufacturers of the materials and would include all requirements that a manufacturer shall meet.  A material standard includes requirements for material labeling and requirements for the documentation that a manufacturer would need to provide.

**Material Test Method Standards** are used to outline the process to conduct a standardized test to determine the performance of a material.  Test methods are normally for laboratories and do not include performance requirements. (That is, test methods do not dictate how well a material shall perform, but simply how to test for its level of performance.) An example of a test method is the BPI standard on the air retarder properties of loose fill insulation.  In a test method standard, the outcome would be a test report.

**Installation Standards** provide requirements for the installation of a specific material or product and are limited to that particular material or product. The installation standards are applicable no matter where the material would be installed and no matter what function the material is intended to provide. For example, loose fill fibrous insulation ALWAYS needs proper setup of the equipment to ensure that the fibers are adequately separated as they are being delivered. This is achieved by machine settings, length and configuration of hose, nozzle size and other factors that are covered in the installation standard. Installation standards cover everything that is needed for proper installation of the material, which may include health and safety requirements for the installer, other workers and occupants.

**Application Standards** are requirements for a specific function and would reference material standards and installation standards.  For BPI application standards, the function will be identified along with all the materials that could provide that function for a specific location in a building.  As an example, if you developed a Building Insulation Application standard, the standard would be broken down by location.  In the location of attic floors, it would then lay out all of the requirements to provide the function of thermal insulation at that location.  The Building

Insulation Application standard would require that the attic floor be prepared before the installation of the thermal insulation. Preparation would include confirming that:

- the attic floor is air sealed,

- the proper amount of attic ventilation is provided in the correct locations,

- the electrical wiring is appropriate,

- the appropriate shielding is in place for heat emitting devices so that they do not come in contact with the insulation.

After all the items required for attic preparation have been met, then the installation of the insulation would commence using material that meets the material standard and it would be installed in accordance for the installation standard for that material.

**Standard Practice Standards** provide requirements for conducting a procedure normally done outside of a laboratory. An example of a standard practice is ASTM E 779, which specifies how a blower door test is conducted, but does not specify how tight a building should be. In a standard practice, the outcome would be a report.

**Standard Specification Standards** outline performance requirements and references other standards as to how you would confirm that the specification requirements have been met. As an example, an air tightness specification for a home or building would specify a maximum air leakage rate, and reference ASTM E 779 for how to measure it.