Design Intent and Basis of Design: Clarification of Terms, Structure, and Use

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ABSTRACT

The development of design intent, and verification that it has been met, should be considered essential to the building delivery process in virtually all commissioning guidelines. Documenting the basis of design is also considered essential. However, there is confusion as to the actual definition, content, and format of “design intent” and “basis of design,” how they are best obtained, and how verification is actually conducted. Often confused is whether the design intent is the documentation of the owner’s or of the designer’s goals. Conflicting definitions of design intent and basis of design are common. ASHRAE’s Commissioning Guideline Committee (GPC 1-1996R) is in the process of renaming “design intent” to get away from the misconceptions surrounding this term. Without clarity in the content, scope, and use of design intent and basis of design, their application will continue to be limited and ineffective. This paper develops and discusses consistent names, definitions, and documentation format for the information associated with design intent and basis of design that will facilitate their collection, review, storage, modification, distribution, and use.

NEW TERMINOLOGY FOR DESIGN INTENT

ASHRAE Guideline 1-1996, The HVAC Commissioning Process uses the term “design intent” to describe the owner's project objectives or requirements. The term has been consistently misunderstood and misapplied by owners, commissioning practitioners, designers, and policymakers. The term itself implies the “designer's intent” or what the designer intends to design and, thus, many documents titled “Design Intent” are really only the designer's narratives of system descriptions. The confusion surrounding the term has resulted in a dilution, if not elimination, of the practice of developing owner's project objectives before design begins. To eliminate confusion, the current decisions of ASHRAE Guideline Committee GPC-1-1996R, who are revising the commissioning guideline, are proposing to replace the term “design intent” with “owner's project requirements.” The remainder of this document will use the new terminology.

PURPOSE OF OWNER’S PROJECT REQUIREMENTS AND BASIS OF DESIGN

Clear owner’s project requirements (OPR) are the heart of a successful design and construction delivery process. “Creating clear design intent (OPR) is the most critical aspect of the HVAC commissioning process. Design intent (OPR) defines the benchmark by which the success of a project is judged” (ASHRAE). Basis of design is the narrative description of what the designer will or has developed to respond to and meet the owner's project requirements (OPR), including the assumptions and criteria used. OPR and basis of design documentation provide the parties involved with the building at each respective stage an improved understanding of the building systems and assemblies so as to better perform their respective responsibilities regarding the design, construction, or operation of the building.

Specifically, OPR and basis of design:

• Help ensure the participants in project planning are clear on what they want and need and provide a systematic way to communicate that to the designers and contractor.
• Help the designer and contractor understand what they are tasked with achieving.

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1. Owner’s project requirements (which consist of two primary types of data: qualitative requirements and specific performance criteria).

2. Basis of design (which consists of two primary elements: design narratives and design assumptions).

**COMPONENTS OF THE DESIGN RECORD**

To clearly describe and understand what OPR and “basis of design” are and how they fit into the design process, it is useful to clarify a few related terms. ASHRAE Guideline 1-1996, The HVAC Commissioning Process currently uses the terms “owner’s program,” “design intent,” “systems design concepts,” and “basis of design.” Within these major terms are the very substantial components “performance criteria” and “description of systems,” both of which are listed with the definitions of basis of design and design intent. The ASHRAE definitions and use of all these terms in the guideline present two problems: (1) the terms cover issues that logically belong under another term and (2) the definitions of the terms overlap. To remedy this problem, the author has examined the terms and the documentation they represent as to what is their purpose, how they are developed, and how they are used. In this paper the elements included within each term have been explicitly defined and more consistently grouped and categorized. In particular, the elements of performance criteria and description of systems have been elevated in importance and explicitized. In particular, the elements of performance criteria and description of systems have been elevated in importance and explicitly defined and more consistently grouped and categorized.

Owner’s project requirements consist of the owner’s requirements or objectives in specific or general terms and include quantitative metrics or criteria for each objective. The basis of design consists of narrative descriptions of systems and assemblies and the criteria and assumptions behind design decisions. Owner’s program is according to ASHRAE’s 1996 definition and is not, as a whole, included in the design record. The idea of systems design concepts, which in the ASHRAE guideline applies to the program phase, is left unchanged, though not explicitly used in this construct.

In summary, the design record consists of two primary components:

1. Owner’s project requirements (which consist of two primary types of data: qualitative requirements and specific performance criteria).

2. Basis of design (which consists of two primary elements: design narratives and design assumptions).

**CONTENT OF OPR**

The term “owner’s project requirements” may refer to the compilation (document) of a number of requirements or just one or more specific requirements. The OPR may be confused with the owner’s programming report. Much of the pre-design programming report data should be part of the OPR. However, to be most useful, the sometimes large amount of information generated in programming a project should be distilled into the OPR—the most salient concepts considered important to the owner, to have in writing and to be explicitly tracked through design and construction. Information extraneous to forwarding key concepts of the actual design—such as citing facts, permitting details, company history, or policy issues, etc.—do not become part of the OPR. OPR is not the designer’s concepts or narrative of what they have submitted in their design—it is the owner’s requirements and goals for what they want in the contract documents. The OPR generally consists of concise objective statements, qualitative in nature. Attached to each qualitative objective or requirement are one or more quantitative performance metrics or criteria (as discussed in the performance criteria section below).

The OPR can also include directives from the owner to the designer, such as what type of design tools the owner expects the designer to use (hourly energy simulation or a less rigorous method; three-dimensional visualization software for exteriors, interiors, and lighting design or less costly methods, etc.). The owner may also include in the OPR requirements to follow a specific company standard or guideline or other applicable regulatory codes and standards. The specific codes and
standards to meet this requirement become the performance criteria for that requirement. Limitations including budgets, building height, use of reflective glass, or other features the owner does or does not want to have in the design are also listed in the OPR.

Generally, qualitative functional objective OPR statements should not be mixed with their performance criteria. The qualitative OPR statements remain relatively fixed from their initial development until budget or other priorities require a change. Often the OPR statements are general and may not need to be changed even if budgets are reduced; rather, the associated performance criterion or design narrative is changed. For example, after a budget cut, an OPR statement may still note that the owner desires “an energy efficient facility,” but the performance criterion is reduced from “exceeding ASHRAE 90.1-1999 by 20%” to “...by 10%” or an OPR statement of “a highly maintainable facility” remains fixed, but the design narrative for the reduced budget version deletes a fixed roof crane.

In summary, OPR statements consist of the needs, goals and special directives of the owner. The following list captures the types of content that make up qualitative OPR statements. Additional OPR categories organized by design area are found in Table 1.

- Functional requirements, needs and goals for building use, operation, maintenance, renovation and expansion, including user requirements (including redundancy requirements and level of operator knowledge relative to system and controls complexity)
  - Occupancy schedules and space plan requirements
  - Sustainability, reliability, durability and aesthetic goals
  - Quality of materials and construction
  - Warranty, project documentation and training requirements
  - Goals relative to the process and outcome of the design and construction (budgets, schedules, change orders, safety, aesthetics, impacts to adjacent or integral occupied spaces and tenants)
  - General commissioning scope and objectives
  - General statements about codes and standards to be followed
  - Limitations likely to impact design decisions
  - Specific features, systems, assemblies, or brands the owner requires (these will be repeated in the design narrative)
  - Instructions to designers on types of design tools and aids expected to be used
  - Initially the qualitative OPR statements can stand alone without attached performance criteria, though to be useful as many of the OPR statements as possible should eventually have performance criteria attached.

### TABLE 1

**Example Design Areas and OPR Categories**

<table>
<thead>
<tr>
<th>Design Area</th>
<th>Owner’s Project Requirements and Directive Categories (Identify one or more OPR under each category)</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPR categories common to all design areas</td>
<td>Functional goals • Budget • Reliability &amp; durability • Maintainability • Flexibility • Quality of materials and construction • Codes, standards, and policies (general statement)</td>
</tr>
<tr>
<td>General project and architecture (most requirements here are general statements covering the entire building, not any specific design area)</td>
<td>See common categories • Aesthetics • Life-cycle cost • Future expansion • Egress, ceiling height • Facility/owner culture • Operational cost • Sustainable design • Commissioning • Schedules • Warranty requirements • Indoor environmental quality • Acoustics (interior and exterior issues) • Connection to outdoors • Project documentation</td>
</tr>
<tr>
<td>HVAC and controls</td>
<td>See common categories • Temperature, humidity, and draft control • Indoor air quality • Natural cooling • Training (match system complexity with staff knowledge) • Controls • Energy efficiency • Peak demand control • Equipment redundancy • Monitoring • Acoustics and vibration • Safety • Commissioning • Sizing, piping, ducting; energy design tools/ methods</td>
</tr>
<tr>
<td>Lighting (interior, exterior)</td>
<td>See common categories • General light quality • Ambient lighting • Task lighting • Daylighting • Fixture efficiency • Fixture style • Energy efficiency • Peak demand control • Controls • Monitoring • Design software • Training</td>
</tr>
</tbody>
</table>
PERFORMANCE CRITERIA

Performance criteria are measures that demonstrate a specific owner requirement or element in the design narrative or basis of design has been met.

Performance criteria are ideally an integral part of the OPR. Criteria should be project-specific and measurable in a practical way. No distinction is necessary between “performance” and “functional” criteria. One or more performance criteria are normally identified for each qualitative OPR statement. Criteria are most applicable for those OPR statements that allow for a numerical quantitative evaluation. For example, an OPR stating “interior offices shall be well lit” could link to a performance criterion of “offices shall be maintained at 40 FC at the work plane.” However, some OPR may have performance criteria that are not numerical. For example, an OPR may state that the HVAC system have an optimum start function. The related performance criterion might approximately be “Verification of proper operation of the optimum start function through functionally testing the sequence of operations.” Some OPRs may have even softer performance criteria, such as an OPR that “the shell shall provide flexible, economic, basic retail space,” whose performance criterion might be, “owner acceptance of the design.” Other performance criteria may be integral to and inseparable from their OPR. Some OPR may not have performance criteria at all. For example, an OPR stating how many occupants of each type a facility needs to accommodate doesn’t require performance criteria but does need to be verified throughout design.

Some owners may have specific quantitative metrics they desire and want to skip the development of qualitative OPR statements, e.g., the owner wants “40 FC at the work plane in the offices.” However, the astute consultant will suggest that a more generalized statement be developed first, e.g., “offices shall be well lit,” and then move forward with the metrics that will determine if the OPR statement was met—specific foot-candles, glare control, color rendering index value, beam source brightness, daylight factor, etc. It is difficult to come up with a complete list of metrics unless you are tying it to a more general qualitative goal. Codes, standards, and guidelines that are structured similarly to standards can be listed as performance criteria when appropriate. Performance criteria already stated in the owner’s project requirements, in the design narrative, or basis of design may or may not be repeated or extracted for use explicitly as performance criteria. Additionally, specific performance criteria (e.g., 20 cfm/person) may be “buried” in a code or standard (e.g., ASHRAE 62-1999) listed as performance criteria. In such cases it may be appropriate to extract and explicitly list some of the specific metrics within a standard as additional performance criteria for the same qualitative OPR statement when they are to be tracked and verified.

Verification Methods

In developing performance criteria, the method for verifying compliance should be identified and ideally be listed and tracked with the criteria. Methods to verify incorporation and performance of an OPR and its performance criteria will vary with the feature and the stage of the design and construction process. Verification methods include design and submittal review, construction observation, and functional testing.

In the end, it is up to the owner to decide which types of issues they want performance criteria developed for, tracked, and ultimately verified. OPR statements for which no explicit performance criteria are developed may still be verified during subsequent design submissions and during construction, but there will likely be differences between the reviewer and the designer on what is considered an acceptable metric.

DEVELOPMENT AND USE OF OPR AND ASSOCIATED PERFORMANCE CRITERIA

The OPR may be written by the owner or by a third party in consultation with the owner prior to the beginning of design. Workshops, interviews, and surveys with all stakeholders in the facility (financiers, owners, managers, operators, tenants, designers, and constructors) are used to develop the OPR. The approved OPR is provided to the designer who develops an initial concept narrative of how the OPR and associated performance criteria will be met. With each design submission, additional OPR statements and performance criteria may be developed as needed. A party should be selected to manage the OPR.

Performance criteria are ideally developed concurrent with or soon after the qualitative OPR statements—possibly by the commissioning authority. Additional performance criteria are developed later as more concepts and qualitative owner’s project requirements are identified and documented.

Performance criteria may also be associated with a design narrative or basis of design concept where an explicit OPR was not initially developed. For example, the development of the OPR for a project may not include any special requirements for acoustics. However, the design narrative states that the design includes special features to minimize sound entering the executive conference rooms from the HVAC system. In such cases quantitative sound performance criteria could be developed and tied to the narrative. Alternately, to always link performance criteria with an OPR statement, an OPR statement could be developed (minimize HVAC sound in the executive conference rooms) and the performance criteria tied to it, rather than to the narrative statement.

Each performance criteria should be referenced back to the OPR statement it is verifying to facilitate tracking and verification at each design submission and during construction. In the written version of the OPR, this may entail keeping them physically together or using a numerical tie. Databases can easily relate these elements.

BASIS OF DESIGN

The basis of design is the documentation of the primary decision-making process and assumptions behind design decisions made to meet the owner’s project requirements. The
DESIGN NARRATIVE AND DESIGN RATIONALE

All elements of the basis of design can be grouped under one of two terms: design narrative or design rationale. These two terms provide a useful separation when developing the basis of design narrative.

Design Narrative

The design narrative is the written description and discussion of the concepts and features the designer intends (during the schematic design phase) to incorporate into the design or what they have incorporated (during the balance of design) to meet the owner's project requirements and associated performance criteria.

The design narrative is a description of the features that all parties of the building delivery and operation process can understand, even though there may be fairly technical and specialized issues addressed. The design narrative is analogous to the “project descriptions” recommended in the Construction Specification Institute’s (CSI) Manual of Practice to be included in each technical specification section. The design narrative is updated and increases in detail with each phase of design. Initially, it may simply describe general building and space use. Later it should include detailed space usage, as well as purpose, special use considerations, a sustainable design features narrative, IEQ issues, a description of each mechanical and major electrical system and the spaces they serve, including zoning rationale and interactions with other systems. It should include details of subsystems, e.g., number and type of all air handlers, different types of lighting controls, etc. It should include a description of all major static assemblies to be commissioned, with their purpose and any special considerations and interactions. The design narratives for dynamic systems should also include sequences of operation with increasing detail as design progresses, providing special attention to interactions between systems. Paragraphs within the design narrative should be numbered for reference and, when possible, numerically referenced back to applicable owner's project requirements.

Design Rationale

The design rationale is the basis, rationale, and assumptions for calculations, decisions, schemes and system, and assemblies selected to meet the owner’s project requirements and to satisfy applicable regulatory requirements, standards, and guidelines.

The design rationale includes design assumptions that vary from one project to another and need to be set in order to make design calculations and other design decisions. These include diversity and safety factors used in sizing, redundancy, pipe and duct sizing assumptions, occupant density, limita-

• System or assembly selection rationale—(including options considered or not considered and why)
• Facility, system, and assembly selection and performance assumptions:
  • Assumptions for calculations
  • Analytical and design procedures and tools used
  • Environmental conditions
  • Limitations and restrictions
  • Reference make and model used for calculations
  • Operational and use assumptions (including system and control sophistication vs. operator knowledge level)
• Discussion of exceptions to, and interpretations of, codes and standards
• Guidelines, owner policies, or handbooks that were used extensively
• Owner directives for using specific system or assemblies

Narrative descriptions should be discretely separate from the design rationale and be called the “design narrative.” Some narrative discussion is desired in the “design rationale” to describe why a particular system or assembly was selected over what could be a likely alternative. This explanation is needed for systems, assemblies, and concepts that are, to the designer or the owner, new, uncommon, unproven, costly, inefficient, very efficient, or which were selected instead of other state-of-the-art concepts meeting the same needs. The commissioning authority may need to elicit this explanatory information from the designer.

Generally, list codes and standards as performance criteria within the OPR, not as part of the rationale within the basis of design. However, if the OPR doesn’t include sufficient references to applicable codes and standards, the designer should include them in the rationale. Guidelines and data sources are appropriate to reference as part of the design rationale. Exceptions to codes, standards, or guidelines should be listed and explained in the design rationale. Indoor temperature setpoint and other similar targets are first identified in the
HVAC performance criteria and may be repeated in the basis of design.

DEVELOPMENT AND USE OF BASIS OF DESIGN

Basis of design is written by the designer and increases in detail as the design progresses. An updated basis of design with increased detail should be submitted with each new design submission and reviewed and approved by the owner and commissioning authority. Ideally, design rationale statements should numerically reference the design narrative statement(s) or sections that use that design rationale statement as their basis.

APPLICATION EXAMPLES

The following are a few scenarios illustrating how information can be managed and consistently categorized in actual projects. The owner identifies one of their project requirements as “to have an energy efficient facility.” They agree on exceeding ASHRAE 90.1-1999 by 10% as their performance criterion for this OPR. This directive was given to the designers prior to the start of schematic design. The designers responded in the design narrative of the basis of design that they would utilize high-performance glazing, daylighting, high-efficiency chillers (0.55 kW/ton), sophisticated HVAC and lighting control sequences, etc. The owner and commissioning authority discuss the designer’s response and decide there are some features in the design narrative they want more explicitly tracked and verified so they add chiller efficiency to the list of performance criteria for the original OPR (“have an energy efficient facility”). The chiller efficiency value is still left in the design narrative. The sophisticated control sequences in the design narrative are not added to the performance criteria but are reviewed in each design submission to ensure they are being adequately incorporated into the design.

If the OPR with performance criteria is not complete, the designer may feel it necessary to add efficiency assumptions and requirements to the design basis. This would not be appropriate. Rather they should list them in the design narrative and recommend that they be added as OPR or performance criteria. The commissioning authority reviews the design basis submissions and provides comments to keep the information properly categorized.

Another example of how to best categorize design information relates to ASHRAE Standard 62-1999, Ventilation for Acceptable Indoor Air Quality. An inappropriate OPR is “ASHRAE Standard 62-1999 shall be followed.” An acceptable OPR is “The HVAC system will provide excellent indoor air quality. No smoking will be allowed.” The performance criteria for this OPR could be, “The facility will conform with ASHRAE 62-1999 using the following special concepts: …” Then remove all ambiguity from the criteria by stating which of the two primary procedures shall be followed and other features of the standard that shall be used (or not) such as multiple space equations, ventilation leading or lagging occupancy, demand-controlled ventilation, etc. Performance criteria could also include statements such as, “Two or fewer customers will feel that indoor air quality is not satisfactory, through a survey of 50 customers during a normal day when the systems have not been and are not in economizer cooling.”

The design narrative describes the features of the design that show that the OPR will be met. This may mean repeating (in more detail) some of what is in the design rationale and possibly some features in the performance criteria. The design rationale for this IAQ example would list such things as: “Space xx is 2000 sf and has 20 occupants (repeated for each space). Dedicated exhaust fans are provided in chemical storage areas. There is no relative humidity monitoring. Building space pressurization will be verified and is integrated with moisture management in the envelope design.”

DEVELOPING AND UPDATING THE DESIGN RECORD

The components of the design record evolve from general descriptors during the schematic design, to more specific descriptors during later design, to in-depth and very specific descriptors during the specifying stage. The design record is completed by fine tuning and adding further detail and accuracy for some components during the as-built documentation stage. Design record documentation should be as firm and complete as possible as early as possible.

At each design submission, the designer updates the basis of design with more detail and accuracy for existing OPRs and performance criteria and develops new design narratives and design rationale for any new OPRs and performance criteria that the owner or commissioning authority may have added since the last submission. The owner and commissioning authority review the basis of design submissions against the drawings and specifications and add new OPRs with performance criteria and additional performance criteria to existing OPRs as necessary and submit these to the designer for review and incorporation into the design. The design record should be provided to the contractor, for their information, as part of the bid package. At the end of construction phase commissioning the design record is given its last update before being turned over to the owner and facility staff. Facility staff should keep the record updated as changes are made in the facility’s systems, assemblies, and operation.

DESIGN RECORD DOCUMENT FORMAT AND CONTENT

Figure 1 illustrates the relationship between the elements of the design record.

Appendix A provides a suggested structure for a document that contains the full design record. Appendix B provides example design record excerpts from a sample project illustrating the structure of Appendix A. Creativity must be used to keep the document “flowing” like a narrative for easy reading and comprehension, yet discretely organized and grouped to facilitate tracking and updating. It is useful to group the OPR by design areas. A few example design areas and owner’s project requirement categories were given in Table 1.
Other design areas for which owner's project requirements may be developed include:

- Space Planning
- Electrical System
- Plumbing
- Acoustics
- Ergonomics
- Fire Alarm and Protection
- Sustainable Design
- Envelope System
- Commissioning
- Security
- Communications
- Audio/Visual
- Data
- Integrated Controls
- Landscaping
- Site-Civil Design
- Exterior Design
- Roofing
- Structural Design
- Conveying Systems
- Occupant Needs and Amenities
- Interiors
- Equipment (loading dock, waste compactors, etc.)

Special Systems or Construction

DISTRIBUTION OF DATA AMONG DESIGN RECORD COMPONENTS

Table 2 gives suggestions of where to put various types of common design record documentation in order to remain consistent among the four components of the design record.

SUMMARY

Current understanding and use of design documentation beyond the plans and specifications are inconsistent and inefficient. To remedy this, a clear definition and distinction of content for the owner's project requirements and the design basis have been given and grouped into an overall document, the design record. Within the owner's project requirements are two components: qualitative statements and quantitative performance criteria. Within the basis of design are two components under which all basis of design elements are grouped: the design narrative and the design rationale. The process of providing clear direction from the owner to the designer through the owner's project requirements, and the designer submitting the basis of design clearly describing their design concepts, intentions, and rationale, can result in significantly improved designs. The process also provides a means for building performance verification during construction and full understanding of system and assembly purpose and function during operation and renovation. The commissioning authority may manage and validate this process.

RESOURCES


<table>
<thead>
<tr>
<th>Data Type</th>
<th>Owner’s Project Requirements (OPR)</th>
<th>Performance Criteria (PC)</th>
<th>Design Narrative (DN)</th>
<th>Design Rationale (DR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Codes, standards, policies, and explicit guidelines</td>
<td>Give general reference only, unless known specifically. &quot;The mechanical system will comply with the owner’s design guide and other applicable regulatory codes.&quot;</td>
<td>List specific codes. &quot;Comply with the latest editions of U.S. Courts Design Guide, The Americans With Disabilities Act, Uniform Building Code, NFPA 101....&quot;</td>
<td>Discuss any special considerations.</td>
<td>List the assumptions that will impact the variable requirements in the codes.</td>
</tr>
<tr>
<td>Functional needs or use of the facility by day and time.</td>
<td>List them as OPR. “There will be computer lab space for 300 terminals...”</td>
<td>Likely to be none.</td>
<td>Describe the spaces and features that fulfill the OPR.</td>
<td>List the space assumptions for each terminal as well as other assumptions.</td>
</tr>
<tr>
<td>Occupancy requirements (space plan and loading)</td>
<td>“There will be 400 occupants in this facility...” Break it down by space type.</td>
<td>Likely to be none.</td>
<td>Describe spaces and features. May repeat parts of the OPR.</td>
<td>Give rationale for the space allowed for each occupant, etc.</td>
</tr>
<tr>
<td>Indoor environmental quality requirements (temperature, RH, drafts)</td>
<td>Provide qualitative statements of requirements. “There will be no drafts felt from the HVAC system”</td>
<td>Be specific and measurable.</td>
<td>Describe features that fulfill this OPR and PC.</td>
<td>Give rationale for features fulfilling the OPR. Repeat or reference the space OPR setpoints.</td>
</tr>
<tr>
<td>Ventilation rates</td>
<td>Not usually mentioned.</td>
<td>List applicable code.</td>
<td>Describe outside air controls.</td>
<td>Repeat specific rates from code.</td>
</tr>
<tr>
<td>Levels of illumination</td>
<td>Provide qualitative statements.</td>
<td>Be specific and measurable (footcandles for each area).</td>
<td>Describe features.</td>
<td>Give rationale. Repeat levels in PCs.</td>
</tr>
<tr>
<td>Energy performance goals</td>
<td>Provide qualitative statements.</td>
<td>Normally limit to equipment efficiencies and reference to codes.</td>
<td>Describe features to meet OPR and PC.</td>
<td>List assumptions for sizing equipment. May repeat some DN. Give rationale for feature selection.</td>
</tr>
<tr>
<td>Description of systems</td>
<td>Not part of OPR.</td>
<td>Not part of PC.</td>
<td>Describe in detail.</td>
<td>Some items listed here and in DN.</td>
</tr>
<tr>
<td>Statement of each system’s operation under varying conditions</td>
<td>Certain critical functions unique or important to the owner may be listed as OPR.</td>
<td>List specific criteria that can be verified.</td>
<td>Describe features to meet OPR and PC.</td>
<td>List any assumptions used to develop the design concept and narrative.</td>
</tr>
<tr>
<td>Budget limitations</td>
<td>General statement of how budget compares to similar buildings.</td>
<td>Provide specific budget numbers.</td>
<td>Describe features used to meet this OPR and PC.</td>
<td>May be none.</td>
</tr>
</tbody>
</table>
APPENDIX A: DESIGN RECORD DOCUMENT STRUCTURE

DA=Design Area
OPR=Owners Project Requirements
PC=Performance Criteria
PA=Performance Assessment
DN=Design Narrative
DB=Design Basis
CAT=Category
DR=Design Rationale
APPENDIX B: EXAMPLE DESIGN RECORD
EXCERPT—SMALL GENERIC STRIP MALL

4. HVAC SYSTEM AND CONTROLS (Design Area)
   1. Temperature, Humidity, and Draft Control (OPR Category 1)

Owner's Project Requirement 4.1.1

The HVAC system shall provide a comfortable temperature and relative humidity level, without drafts, for shoppers in all seasons and at all times of the day and provide sufficient flexibility and control to be able to quickly respond to changing occupant numbers.

—Owner approval of last edit on August 8, 2000.

Performance Criteria

General Verification Method: All related components and systems will be thoroughly tested through all sequences of operation and interactions.

1. The space temperature shall be maintained between 74°F and 78°F in summer and 72°F-76°F in winter during all occupied periods. Verification Method: Spot measurements during near design conditions and owner interview near warranty end.

2. When the space goes from two occupants to full design occupancy over 15 minutes, the average space temperature will not exceed the high value in (a) by more than 3°F and will return to the high setpoint in (1) within 30 minutes after reaching peak occupancy. Verification Method: Review engineer’s calculation for this PC and interview owner about performance near warranty end.

3. During cold weather (10°F above design), passage of three people through the double doors will not result in a noticeable draft to a bare-legged buyer in the nearest shopping area. Verification Method: Review of design and functional test.

4. The relative humidity will be allowed to float between 30% and 60% RH. The design shall seek to ensure that the most recent edition of ASHRAE Standard 55, Thermal Environmental Conditions for Human Occupancy is met. Verification Method: Spot testing during near design conditions and owner interview near warranty end.

—Owner approval on August 20, 2000

2. Indoor Air Quality (OPR Category 2)

Owner's Project Requirement 4.2.1

The HVAC system will provide excellent indoor air quality. No smoking will be allowed.

—Last approved edit on August 8, 2000.

Performance Criteria

General Verification Method: All related components and systems will be thoroughly tested through all sequences of operation and interactions.

1. The facility will be designed to comply with ASHRAE Standard 62-1999, Ventilation for Acceptable Indoor Air Quality. The Method described in 6.1, Ventilation Rate Procedure, shall be used with ventilation neither leading nor lagging occupancy and the multiple space equations not used. Verification Method: Review of design and functional test to verify OA quantity and control in all modes.

2. Two or fewer customers will feel that indoor air quality is not satisfactory, through a survey of 50 customers during a normal day when the systems have not been and are not in economizer cooling. Verification Method: Conduct one survey after 3 months.

—Owner approval on August 20, 2000

[Other HVAC OPRs (for which performance criteria would be developed):]

Acoustics: The HVAC system will be quiet enough to not be noticed by the typical shopper.

Maintenance: The day-to-day operation, control, and maintenance of the HVAC system will be easy enough for nontechnical store staff to execute.

Controls: There will be separate temperature controls in each tenant space.

Energy Efficiency: The system will have above-average reliability and energy efficiency.

[Other HVAC OPR categories for which OPRs and performance criteria would be developed:]

Budget, Flexibility, Codes and Standards, Acoustics and Vibration, Commissioning, Design Tools.

Design Basis 4—HVAC Systems and Controls
Design Narrative 4—HVAC System and Controls

—Submitted with 100% Contract Documents, Oct. 30, 2000

a. Each structural module of 2,000 sf will have a separate constant air volume, package rooftop unit with a natural gas burner for heating (85% efficient burner) and an electric direct expansion air condi-
tioner for cooling (EER of 11), an outside air economizer, and 30% efficient filters. Each unit will be rated for 60,000 Btu/h for cooling and will provide a constant 800 cfm of ventilation air and control building pressure through a barometric relief damper. End occupancy units will be rated for 34,000 Btu/h heating and others at 22,000 Btu/h heating. Supply ducting will be metal uninsulated round after the discharge plenum. Return air shall be open plenum above a dropped ceiling.

b. Each rooftop unit will have a programmable thermostat that will allow for different setpoints and occupancy schedules for each day of the week. Each unit’s fan will run continuously delivering a fixed amount of minimum outside air. The outside air dampers will be shut when the unit is off.

c. Each of two restrooms in each store will have an exhaust fan exhausting 150 cfm when the RTU is on.

d. There will be a cabinet in each space to hold the operating instructions for all controls in the spaces and a copy of the electrical and HVAC layout of the space. There will be a cabinet in the landlord's utility room that will contain a duplicate copy of all operating and maintenance manuals and reduced scale drawings showing the HVAC distribution system and lighting and electrical systems of each space.

e. Each tenant space will have individually metered utilities.

f. Entry doors will be double with a 5 foot vestibule to reduce drafts in and out of the stores.

[Full detailed sequences of operation should also be provided.]

**Design Rationale 4—HVAC System and Controls**
—Submitted with 100% Contract Documents, Oct. 30, 2000

**Equipment Sizing Assumptions**

a. Interior temperature setpoints:
   - Setpoints (per PC 4.1.1-1): 74°F-78°F in summer and 72°F-76°F in winter with a setback to 55°F heating and 85°F cooling when unoccupied.
   - The moisture loads, outdoor climatic conditions, and ventilation rates are anticipated to not require active management of the RH to meet a 30% to 60% RH criteria.

b. Outdoor ambient design temperatures: 0°F winter, 90°F db, 78°F wb summer

c. Occupancy (per PC 1.1.3-1): 25 people per 1000 square foot of gross floor area (50 people per module)

d. Envelope—General Averages (also see attached COMcheck Compliance Report):
   - 30,000 sf roof area; 8,600 sf gross wall area
   - 10 ft, 0 in. floor to ceiling height; 13ft, 0 in. floor to roof height
   - 1,800 sf glazing area; 6 ft overhang; 6 ft, 0 in. window height; 3ft, 0 in. sill height
   - Windows: fixed alu. framed with a thermal break and 1 in. lowe insulated glass; a U-factor of 0.42
   - Roof: steel trusses, metal decking, fiber insulation board, builtup roofing; total R-value of 23.
   - 1 in. of R-5 foam insulation under the entire first floor slab and 2 ft vertical around the perimeter.
   - Each tenant space will have a vestibule type entrance.
   - Outside ventilation air of 20 cfm per person.
   - Local intermittent bathroom exhaust of 100 cfm from each bathroom.

e. Diversity factor = 1 (no diversity)

[Other assumptions that should be listed: sizing safety factor, internal loads, uncontrolled air infiltration, interior window shade assumptions, etc.]

[Attach sizing calculations and energy code compliance data.]

**Selection Rationale**

The constant volume systems were selected over VAV. Each tenant has a separate unit and the tenant spaces are expected to be open floor plan, thus allowing little control or energy advantage with VAV.

**DISCUSSION**

Ross M. Sherrill, P.E., Owner, Sherrill Engineering, San Francisco, Calif.: This symposium provided many “aspects” of the ASHRAE initiated “Design Intent” terminology, which is almost completely foreign to the owners, architects, and engineers in Northern California. We have been a Commissioning provider since 1990 and I have never seen an official published project Design Intent.

The last paper, by John H. Scofield, dealt with a project that developed an extravagant and detailed “green building” design intent that nobody, including the A&E and the commissioning authority paid any attention to. My understanding is that ASHRAE Guideline 1-1996 indicates that the commissioning authority is to verify that the HVAC systems have been furnished and installed in accordance with the contract documents and function in accordance with the Design Intent. I make a detailed HVAC system “design review” in order to perform this service.

Not one of the five (5) papers mentioned verification of the HVAC systems functioning per design intent or any design review in regard to design intent by the commissioning authority.

What good is developing a “design intent” document if it is “ignored” by the A&E and the commissioning authority?

Karl Stum: Your point is well taken. The owner’s project...
requirements (design intent) should be used to validate the design against and in appropriate situations, the construction. My paper (Design Intent and Basis of Design: Clarification of Terms, Structure and Use) states that two of the purposes of the owner's project requirements are to: “1) Provide criteria from which each design submission can be validated, 2) Provide clear acceptance criteria allowing performance to be verified during construction.” The paper also states, “At each design submission, the designer updates the basis of design with more detail and accuracy for existing owner's performance requirements (OPRs) and performance criteria and develops new design narratives and design rationale for any new OPRs and performance criteria that the owner or commissioning authority may have added since the last submission. The owner and commissioning authority review the basis of design submissions against the drawings and specifications and add new OPRs with performance criteria and additional performance criteria to existing OPRs as necessary and submit these to the designer for review and incorporation into the design.” Reviewing the design against the OPR is not explicitly stated in this last article, but should have been. I agree that the paper could have more explicitly described that very important use of the OPR/design intent.