Introducing the Process Guide

The Process Guide presents a step-by-step method for managing the design process in ways that ensure the desired outcome: a high-performance school building.

The Guide contains a series of questions, organized by design phase, that the "owners" of a new school (superintendents, business officials, board members, and others guiding the facility development process) can use to ensure that their design team considers *all* the key components of a high-performance school during each phase of the development process.

Using the Process Guide

Over the course of designing and building a new facility, school representatives will meet regularly with their design team to discuss progress. The Process Guide should be used to help guide discussion during these meetings.

The Guide is divided into eight sections corresponding to key phases in the design/development process:

- Site Analysis
- Selecting the A/E Team
- Programming and Goal Setting
- Schematic Design
- Design Development
- Construction Documents
- Bidding and Negotiation
- Construction Administration

The appropriate section of the Process Guide should be consulted at the start of each phase. The list of phase-specific questions should be used to help frame productive discussions with the design team.

The questions in each section of the Process Guide are designed to address the key Building Blocks of any high-performance school:

- Acoustic Comfort
- Commissioning
- Daylighting
- Durability
- Energy Analysis Tools
- Environmentally Preferable Materials and Products
- Environmentally Responsive Site Planning

© Jim Schafer,
www.jimschaferphotography.com

A study by the U.S. General Accounting Office shows the types of impacts substandard buildings can have on environmental conditions, and consequently, on teaching and learning. The table below indicates the percentage of schools nationwide reporting unsatisfactory conditions in six key environmental areas (from GAO Report GAO/HEHS –95-61).

Acoustics	28.1%
Ventilation	27.1%
Security	24.2%
Heating	19.2%
Air Quality	19.2%
Lighting	15.6%

- High-Performance HVAC (Heating/Ventilating/Air Conditioning)
- High-Performance Electric Lighting
- Life Cycle Cost Analysis
- Renewable Energy
- Safety and Security
- Superior Indoor Air Quality
- Thermal Comfort
- Visual Comfort
- Water Efficiency

For a quick overview of each of these Building Blocks, and a guide to more detailed resources on each topic, consult section 3 of this *Resource and Strategy Guide*.

Questions to ask as a potential or actual site is being reviewed:

1. **Acoustic Comfort**
   - ❒ Are there major sources of noise near the site (e.g., highways, shopping areas)?
   - ❒ Can the site be used to minimize the impacts of these noise sources (e.g., through planting, earth berms, etc.)?

2. **Commissioning**
   - ❒ N/A

3. **Daylighting**
   - ❒ Does the site allow the building to be oriented on an east–west axis, maximizing southern exposure?
   - ❒ How will site elements (e.g., existing trees or adjacent buildings) influence the building's access to sunlight?
   - ❒ Can the site accommodate one-story construction to allow skylights or roof monitors in the classrooms?

4. **Durability**
   - ❒ N/A

5. **Energy Analysis Tools**
   - ❒ N/A

6. **Energy-Efficient Building Shell**
   - ❒ N/A

7. **Environmentally Preferable Materials and Products**
   - ❒ N/A

8. **Environmentally Responsive Site Planning**
   - ❒ Can existing natural areas on the site be preserved?
   - ❒ Does the site lend itself to controlling stormwater runoff?
   - ❒ What areas of the site could be used as "outdoor laboratories" for teaching?
   - ❒ Is there good pedestrian, mass transit, and/or bicycle access?

9. **High-Performance HVAC (Heating/Ventilating/Air Conditioning)**
   - ❒ N/A

10. **High-Performance Electric Lighting**
    - ❒ N/A

11. **Life Cycle Cost Analysis**
    - ❒ N/A

12. **Renewable Energy**
    - ❒ Does the site have good solar access for daylighting, active and passive solar heating, solar hot water, and/or photovoltaic systems?
    - ❒ Could the site use wind power to generate electricity?

13. **Safety and Security**
    - ❒ Are there clear lines of sight to and from the school building throughout the site?
    - ❒ Are there areas (depressions in the ground, stands of trees, thick shrubs) where people can be hidden from view?

14. **Superior Indoor Air Quality**
    - ❒ Is the site near any sources of outdoor pollution?

15. **Thermal Comfort**
    - ❒ Are there prevailing breezes that could be used to help naturally ventilate the building?

16. **Visual Comfort**
    - ❒ Does the site provide special views that should be preserved?

17. **Water Efficiency**
    - ❒ Does the site lend itself to the use of high-efficiency irrigation techniques?
    - ❒ Could the site accommodate on-site wastewater treatment?

Questions to ask prospective architecture/engineering teams to ensure that they have the necessary experience and qualifications to deliver a high-performance school:

1. Acoustic Comfort
- ❒ How has the team addressed acoustic performance in previous projects?
- ❒ What specific strategies has the team used to ensure acoustic quality?
- ❒ How has the team applied these strategies in classrooms?

2. Commissioning
- ❒ Have any of the team's previous buildings, especially schools, gone through a commissioning process?
- ❒ How detailed was the commissioning? Who acted as commissioning agent?
- ❒ What were the results?

3. Daylighting
- ❒ What examples can the team provide of previous projects that incorporate daylighting?
- ❒ Are any of these examples schools, especially classrooms?
- ❒ What daylighting strategies did the team use?
- ❒ Are the occupants satisfied with the results?
- ❒ Are the strategies saving energy? How much?
- ❒ What analysis tool does the team use to optimize performance of the daylighting systems it designs?

4. Durability
- ❒ What experience does the team have in specifying durable materials, products, and systems in its projects?
- ❒ Does the team have knowledge of how these materials and products perform over time?
- ❒ Is the team familiar with how schools are operated and maintained?
- ❒ Does the team design in such a way that long-term operating and maintenance costs are minimized? How? Can the team give examples from its own work?

5. Energy Analysis Tools
- ❒ What energy analysis tool(s) does the team use on its projects?
- ❒ How does it use the tool(s) to reduce energy consumption in its designs?
- ❒ Has it applied the tools to school design? What were the results?
- ❒ What tool(s) does the team propose for the project under discussion?

6. Energy-Efficient Building Shell
- ❒ How has the team achieved energy efficient walls, floors, and roofs on previous projects?
- ❒ What key techniques, materials, and products were used, and what was the resulting impact on energy performance?
- ❒ Are the systems still performing as designed?

7. Environmentally Preferable Materials and Products
- ❒ What experience does the team have in specifying environmentally responsible materials and products in its projects?
- ❒ Does the team have knowledge of how these materials and products can be procured and how they are installed?
- ❒ Does the team have knowledge of how these materials and products perform over time?
- ❒ Has the team ever specified environmentally responsible materials and products for schools?

8. Environmentally Responsive Site Planning
- ❒ Has the team created environmentally responsive and responsible site plans before?
- ❒ What were the key features and how are they performing?

9. High-Performance HVAC (heating/ventilating/air conditioning)

- ❒ Does the team specify high-performance HVAC systems as standard practice?
- ❒ What tools does the team use to analyze and optimize the performance of HVAC systems?
- ❒ What high-performance HVAC systems has the team put in place in previous projects (preferably schools)?
- ❒ How much energy was saved as a direct result of specifying these systems?
- ❒ How have these systems performed over time?

10. High-Performance Electric Lighting

- ❒ Does the team have experience designing high-performance electric lighting systems (preferably in schools)?
- ❒ Are these systems providing a high-quality visual environment and saving energy?
- ❒ What is the team's experience in integrating daylighting and electric lighting systems?
- ❒ What tool(s) does the team use to analyze and optimize the combined performance of daylighting and electric lighting systems?

11. Life Cycle Cost Analysis

- ❒ What life cycle cost methodology does the team use on its projects?
- ❒ How does it use the methodology to reduce the total ownership costs of the buildings it designs?
- ❒ Has it applied the methodology to school design? What were the results?
- ❒ What methodology does the team propose for the project under discussion?

12. Renewable Energy

- ❒ What is the team's experience designing and/or installing renewable energy systems?
- ❒ What specific systems have they used or installed (preferably in schools)?
- ❒ How much energy are these systems saving?
- ❒ Are they still performing as intended?

13. Safety and Security

- ❒ Does the team have experience with Crime Prevention Through Environmental Design (CPTED)?
- ❒ How has the team incorporated CPTED principles into previous projects (preferably schools)?
- ❒ How does the team balance the use of security technology and the use of CPTED principles in its buildings? Does it emphasize "security by design" first and technology second?

14. Superior Indoor Air Quality

- ❒ What is the team's approach to delivering superior indoor air quality?
- ❒ In previous projects (preferably schools), how has the team addressed 1) controlling sources of contaminants in a building, 2) providing adequate ventilation, and 3) avoiding moisture accumulation?
- ❒ Have any of their buildings experienced indoor air quality problems requiring remedial action?

15. Thermal Comfort

- ❒ What is the team's approach to maintaining thermal comfort in the buildings they design?

16. Visual Comfort

- ❒ What is the team's approach to ensuring visual comfort in the buildings they design?
- ❒ Do they have examples (preferably classrooms) that can be visited and "test driven"?

17. Water Efficiency

- ❒ What is the team's experience with water-efficient landscaping, water use reduction techniques, and/or innovative wastewater treatment systems?
- ❒ Have they applied any of these techniques to schools?
- ❒ What have the results been?

Questions that will help establish clear, explicit high-performance goals as early as possible in the design process and in the development of the building's program (the document detailing the basic scope of the project, the types and number of rooms required, etc.):

1. Acoustic Comfort
- ❒ Have good classroom acoustics been established as a design goal for the project?

2. Commissioning
- ❒ Has the team committed to, and budgeted for, commissioning as a basic component of the project?
- ❒ Has a commissioning agent been engaged?

3. Daylighting
- ❒ Has optimized daylighting been specifically established as a design goal for the school and, in particular, for the classrooms?

4. Durability
- ❒ Has using durable materials, products, and systems been established as a design goal?
- ❒ Has designing to reduce long-term operating and maintenance costs been established as a design goal?

5. Energy Analysis Tools
- ❒ Is the design team required to use an energy analysis tool to help maximize the building's energy performance?
- ❒ What tool has been selected?
- ❒ At what stages in the design process will the tool be used, and what types of analyses will be performed?
- ❒ Has an energy use goal (i.e., a maximum amount of non-renewable energy the school should consume in a year) been established? What is it (e.g., __ percent better than the building code requires)?

6. Energy-Efficient Building Shell
- ❒ Has providing an energy-efficient building shell been established as a goal for the project?
- ❒ Does the basic programming allow windows on the east and west to be smaller (to reduce unwanted heat gain) and those on the north and south to be larger (to enhance daylighting opportunities)? For example, does the programming group together functions that may need less glazing (auditoriums, kitchens, etc.) on the east and west, and those that will benefit most from daylight (classrooms, corridors, etc.) on the north and south?

7. Environmentally Preferable Materials and Products
- ❒ Has using environmentally preferable materials and products (to the extent feasible) been established as a design goal?
- ❒ Has the meaning of "environmentally preferable" been agreed to by the owner and the design team?

8. Environmentally Responsive Site Planning
- ❒ Has preserving natural areas on the site been established as a design goal?
- ❒ Is minimizing stormwater runoff a design goal for the site?

9. High-Performance HVAC (heating/ventilating/air conditioning)
- ❒ Is using high-efficiency heating, ventilating, and air conditioning equipment a design goal for the project?
- ❒ Is "right sizing" this equipment (by accurately predicting demand and sizing the equipment to meet it) a design goal?

10. High-Performance Electric Lighting

- ❒ Is a high-performance electric lighting system (especially in classrooms) a design goal?
- ❒ Is optimizing the interaction between the electric lighting system and any daylighting strategies a design goal?

11. Life Cycle Cost Analysis

- ❒ Has using some form of life cycle cost analysis methodology been established as a requirement for the design team?
- ❒ What methodology will be used?
- ❒ What basic assumptions (e.g., projected life of the facility, projected energy costs, rate of inflation, etc.) have been built into the methodology? Have these assumptions been agreed to by all parties?

12. Renewable Energy

- ❒ Is maximizing the cost-effective use of renewable energy a design goal for the project?
- ❒ What percentage of the projected annual energy use of the facility should be provided by renewable energy systems? Has this percentage been agreed to by all parties?

13. Safety and Security

- ❒ Has security been established as a design goal for the project?
- ❒ As part of programming, are basic room placements and adjacencies being considered in terms of their impacts on safety and security (e.g., is the main entrance visible from the administrative offices, etc.)?

14. Superior Indoor Air Quality

- ❒ Has superior indoor air quality been established as a design goal for the project?

15. Thermal Comfort

- ❒ Has thermal comfort been established as a design goal, especially for the classrooms?

16. Visual Comfort

- ❒ Has visual comfort been established as a design goal, especially for the classrooms?

17. Water Efficiency

- ❒ Has water efficiency been established as a design goal for the project?
- ❒ Have water use goals for the school been established?

Questions to ask during the conceptual design phase, when key decisions on the basic scale and layout of the facility are being made and the project's overall scope and direction are being established (modifying these decisions at later stages may prove to be difficult and costly):

1. Acoustic Comfort
- ❒ Does the basic layout of the classrooms help or hinder good acoustics (i.e., does it dampen or magnify sound reverberation)?
- ❒ Do any of the classrooms face sources of outside noise? If so, what measures are proposed to reduce the impact of this noise?
- ❒ Are any of the classrooms located next to sources of inside noise (music rooms, rooms with amplified sound systems)? If so, what measures are proposed to reduce the impact of this noise?

2. Commissioning
- ❒ Is appropriate design documentation being collected by/delivered to the commissioning agent?

3. Daylighting
- ❒ What basic strategies are being considered for bringing daylight into the school, particularly the classrooms?
- ❒ What strategies are being considered to control unwanted heat gain and glare?
- ❒ What tools are being used to analyze the impact of any daylighting strategies on the electric lighting system and on visual comfort and energy use?
- ❒ What are the preliminary results of these analyses?

4. Durability
- ❒ What types of durable materials, products, and systems are being considered, and where will they be used?
- ❒ How does the basic design of the school facilitate cost-effective operations and maintenance?

5. Energy Analysis Tools
- ❒ Have the energy analysis tool(s) selected for the project been used to project energy consumption at least once (preferably several times) during this phase of design?
- ❒ Do the results meet or exceed the energy goal for the facility?

6. Energy-Efficient Building Shell
- ❒ What basic assemblies and configurations are being considered for the walls, floors, and roofs of the facility?
- ❒ What types of materials (glazing, shading, insulation, air barriers, structural materials) are being considered?
- ❒ How are trade-offs (between amounts of window versus wall, between one type of glazing versus another, etc.) being analyzed, and how will the overall performance of the shell as a whole be optimized?
- ❒ How are the impacts of thermal mass being addressed?
- ❒ Are light colored surfaces (particularly roofing) being considered as a means of reducing heat gain?

7. Environmentally Preferable Materials and Products
- ❒ What types of environmentally preferable materials and products are being considered and where will they be used?
- ❒ Does the basic design facilitate recycling by students and staff?

8. Environmentally Responsive Site Planning

- ❒ Is the building, particularly the classroom wings, oriented in a predominantly east–west direction to facilitate access to daylight?
- ❒ Does the design preserve existing natural areas of the site?
- ❒ Does the design help control stormwater runoff?
- ❒ Does the design minimize areas covered with impervious surfaces (e.g., parking lots, paved walkways, etc.)?

9. High-Performance HVAC (heating/ventilating/air conditioning)

- ❒ What type of HVAC system is being considered for the school?
- ❒ Why is this system optimal from a comfort/energy performance perspective?
- ❒ How are the interactions between the HVAC system and other key building systems (lighting, daylighting, building shell) being analyzed and optimized?
- ❒ Is natural ventilation being considered? If so, are its potential impacts on HVAC performance being factored into the analytic process?

10. High-Performance Electric Lighting

- ❒ What electric lighting system is being proposed for the school and, in particular, for the classrooms?
- ❒ What are its energy and visual performance benefits?
- ❒ How does it interact with the daylighting strategies being used?
- ❒ How are these interactions being analyzed and optimized?

11. Life Cycle Cost Analysis

- ❒ Has the life cycle cost methodology selected for the project been used to compare and optimize alternative design strategies at least once (preferably several times) during this phase of the process?

12. Renewable Energy

- ❒ What renewable energy strategies are being considered for the school?
- ❒ How much energy will they save?
- ❒ What are their life cycle cost benefits?
- ❒ How will they impact the site plan or the building design?
- ❒ How will they impact other building systems (lighting, electrical, HVAC, building shell)?

13. Safety and Security

- ❒ How have Crime Prevention Through Environmental Design (CPTED) principles been applied during this phase of the process?
- ❒ Are opportunities for natural surveillance and access control being "designed in"?
- ❒ What security technologies are being considered? How do they reinforce and extend the impact of the school's security-focused design features?

14. Superior Indoor Air Quality

- ❒ Will the HVAC system being considered provide adequate ventilation, especially to the classrooms?
- ❒ Does the basic layout of the school keep operable windows and air intake vents away from sources of exhaust (e.g., cars and buses)?

15. Thermal Comfort

- ❒ Are windows and skylights being designed to minimize "hot spots" caused by direct sunlight?
- ❒ Are temperature controls being considered for each classroom?

16. Visual Comfort

- ❒ Are the basic daylighting and electric lighting designs being developed so that they provide illumination in as uniform a manner as possible, using task or accent lighting as appropriate to meet specific needs?
- ❒ Are individual lighting designs being developed for individual room types? Do the designs vary, even within room type, depending on the amount of daylight the room will receive?
- ❒ Is the potential for glare being analyzed, and are the lighting/daylighting systems being designed to minimize it?
- ❒ Are the color and texture of wall, floor, and ceiling surfaces being taken into account in terms of their interaction with the lighting and their combined impact on the visual environment?

17. Water Efficiency

- ❒ Is water efficient landscaping part of the preliminary site design?
- ❒ Is irrigating only the athletic fields (not plants near buildings or parking lots) being considered?
- ❒ Are water reduction techniques being considered for school plumbing fixtures and equipment?
- ❒ Is capturing and reusing rainwater being considered?
- ❒ Are innovative wastewater treatment techniques being considered?

Questions to ask as the size and character of the project become more refined and as key building materials and systems (architectural, structural, mechanical, and electrical) become more clearly defined:

1. Acoustic Comfort

- ❒ How do the proposed materials and finishes (especially those used in the classrooms) help reduce sound reverberation?
- ❒ Have the classrooms been analyzed in terms of projected acoustic performance?
- ❒ Will the proposed heating/ventilating/air conditioning (HVAC) system for the classrooms create noise? If so, how will the noise be attenuated?

2. Commissioning

- ❒ Is appropriate design documentation being collected by or delivered to the commissioning agent?

3. Daylighting

- ❒ What daylighting strategies have been selected for the school (particularly the classrooms)?
- ❒ Are the classrooms receiving as much daylight as possible, while avoiding glare and unwanted heat gain?
- ❒ What types of glazing have been selected (for windows, clerestories, skylights, and/or roof monitors) and why are they more energy efficient and cost-effective than competing alternatives?
- ❒ How will the daylighting and electric lighting systems interact?
- ❒ What analyses have been performed to optimize these interactions?
- ❒ Will the combined daylighting/electric lighting strategies reduce energy use and lower the school's operating costs over time?
- ❒ Has the possibility of reducing the number of light fixtures, or the number of lamps, in daylit rooms been investigated?

4. Durability

- ❒ What types of durable materials, products, and systems have been selected, and where will they be used?
- ❒ Why are these materials, products, and systems the most cost-effective choices from a perspective of long-term durability/maintainability?
- ❒ What other design strategies are being used to ensure that long-term operations and maintenance costs will be minimized?
- ❒ What analyses have been done to determine how the materials, products, and systems selected for the school will ensure that long-term operations and maintenance costs will be minimized?

5. Energy Analysis Tools

- ❒ Have the energy analysis tool(s) selected for the project been used to project energy consumption at least once (preferably several times) during this phase of design?
- ❒ Do the results meet or exceed the facility's energy goal?

6. Energy-Efficient Building Shell

- ❒ What basic wall, floor, and roof assemblies have been selected?
- ❒ What types of materials (glazing, shading, insulation, air barriers, structural materials) have been selected and why are they better, from an energy and life cycle cost perspective, than other alternatives?
- ❒ How have trade-offs (between amounts of window versus wall, between one type of glazing versus another, etc.) been analyzed, and how has the performance of the building shell as a whole been optimized?
- ❒ Have the impacts of thermal mass been factored in?
- ❒ Are light-colored surfaces (particularly roofing) being used as a means to reduce heat gain?

7. Environmentally Preferable Materials and Products

- ❒ What types of environmentally preferable materials and products have been selected and where will they be used?
- ❒ Are all the selected materials and products low emitters of indoor air contaminants?

8. Environmentally Responsive Site Planning

- ❒ Does the final design preserve existing natural areas of the site?
- ❒ Does the design help control stormwater runoff?
- ❒ Does the design minimize areas covered with impervious surfaces (e.g., parking lots, paved walkways, etc.)?
- ❒ Do landscaping strategies (particularly tree planting) enhance the building's high-performance features (i.e., by providing shade where it is needed but not blocking sunlight that is used for daylighting)?

9. High-Performance HVAC (heating/ventilating/air conditioning)

- ❒ What type of HVAC system has been selected for the school?
- ❒ Why is this system optimal from a comfort and energy performance perspective?
- ❒ Is it the best system from a life cycle cost perspective?
- ❒ How have the interactions between the HVAC system and other key building systems (lighting, daylighting, building shell) been analyzed and optimized?
- ❒ Has natural ventilation been considered? If so, have its potential impacts on HVAC performance been factored into the analysis process?
- ❒ Has the HVAC equipment been "right sized" to meet predicted demand?
- ❒ What control system(s) have been selected and how will they influence performance?
- ❒ What level of control will individual teachers have over the heating, ventilating, and air conditioning of their classrooms?
- ❒ Is the entire system configured for ease of operation, maintenance, and repair?

10. High-Performance Electric Lighting

- ❒ What electric lighting system(s) have been selected for the school and, in particular, for the classrooms?
- ❒ What are their energy and visual performance benefits?
- ❒ How do they interact with the daylighting strategies being implemented? How have these interactions been analyzed and optimized?
- ❒ What control system(s) have been selected and how will they affect performance?
- ❒ What level of control will teachers have over the lighting in their classrooms?

11. Life Cycle Cost Analysis

- ❒ Has the life cycle cost methodology selected for the project been used to compare and optimize alternate design strategies at least once (preferably several times) during this phase of the process?

12. Renewable Energy

- ❒ What renewable energy strategies have been selected and incorporated into the design?
- ❒ How much energy will they save?
- ❒ What are their life cycle cost benefits?
- ❒ How do they impact other building systems (lighting, electrical, HVAC, building shell)?
- ❒ What analysis has been performed to ensure that all of these systems will interact in a highly effective, integrated manner?

13. Safety and Security

- ❒ How have Crime Prevention Through Environmental Design (CPTED) principles been applied during this phase of the process?
- ❒ Have opportunities for natural surveillance and access control been "designed in"?
- ❒ What security technologies have been selected? How do they reinforce and extend the impact of the school's security-focused design features?

14. Superior Indoor Air Quality

- ❒ Will the HVAC system provide adequate ventilation, especially to the classrooms?
- ❒ Is the system designed to maintain the indoor relative humidity between 30 and 50 percent?
- ❒ Does the design provide local exhausts for restrooms, kitchens, science labs, janitor's closets, copy rooms, and vocational/industrial shop rooms?
- ❒ In large assembly areas, does the design include CO_2 sensors to monitor air quality?
- ❒ Are all the selected interior materials and products low emitters of indoor air contaminants?

15. Thermal Comfort

- ❒ Are HVAC distribution layouts designed to ensure that all areas of a room receive adequate ventilation?

16. Visual Comfort

- ❒ Do the daylighting and electric lighting system designs provide illumination in as uniform a manner as possible, using task or accent lighting as appropriate to meet specific needs?
- ❒ What tools have been used to model the interactions of both of these systems in terms of their influence on visual comfort?
- ❒ Have direct/indirect lighting fixtures been selected for general illumination in classrooms?
- ❒ What shading strategies (internal and external) have been selected?
- ❒ Have individual lighting designs been developed for individual room types? Do the designs vary, even within room type, depending on the amount of daylight the room will receive?
- ❒ Has the potential for glare been analyzed, and have the lighting/daylighting systems been designed to minimize it?
- ❒ Have the color and texture of wall, floor, and ceiling surfaces been taken into account in terms of their interaction with lighting and their combined impact on the visual environment?

17. Water Efficiency

- ❒ Has high-efficiency irrigation technology been selected for athletic fields?
- ❒ Does the design use captured rainwater or recycled water for irrigation?
- ❒ Does the design include high-efficiency equipment (dishwashers, laundry, cooling towers)?
- ❒ Does the design include low-flow showerheads and automatic lavatory faucet shut-off controls?
- ❒ Does the design include innovative wastewater treatment techniques?

Questions to ask once all the design elements are finalized and the documents (drawings and specifications) that will guide construction of the building are completed:

1. Acoustic Comfort
- ❒ Are the walls of classrooms that are located next to noise sources designed for sound attenuation?
- ❒ If rooftop HVAC equipment is being used, is it mounted on isolators to reduce sound transmission?

2. Commissioning
- ❒ Have commissioning requirements been included in the construction documents?
- ❒ Has a written commissioning plan been developed?

3. Daylighting
- ❒ Will the construction details for daylighting components (the windows, lightshelves, roof monitors, skylights, shading devices, etc.) modify the performance of the system as a whole; i.e., will the required amount of daylight still reach the classrooms, will glare and heat gain be sufficiently controlled, etc? What will be the impact, on operating costs and on visual comfort, of any changes in performance?
- ❒ Will the final construction details of other building components (for example, the color and reflectance of roofing materials adjacent to skylights or roof monitors) change the dynamics of the daylighting system and impact performance? What will be the impact, on operating costs and on visual comfort, of any changes in performance?

4. Durability
- ❒ Are the construction documents clear and explicit concerning the required durability of the materials, products, and systems specified?
- ❒ Is language included in the documents requiring that a proposed material, product, or system substitution must be equal to or better than the specified product in terms of its durability and operations/maintenance requirements?

5. Energy Analysis Tools
- ❒ Have the energy analysis tool(s) selected for the project been used to project energy consumption at least once during this phase of design?
- ❒ Do the results meet or exceed the facility's energy goal?

6. Energy-Efficient Building Shell
- ❒ Do the final construction details for the wall, floor, and roof assemblies maintain the original design intent in terms of energy performance? (For example, do the assemblies allow insulation to be installed at the thickness originally specified? Do air barriers cover all the areas they are supposed to? Can areas that need ventilation, such as roof cavities, be adequately vented in the current configuration?)

7. Environmentally Preferable Materials and Products
- ❒ Are the construction documents clear and explicit concerning the required environmental performance of the materials and products specified?
- ❒ Do the documents include language requiring that a proposed material or product substitution be of equal or better quality in comparison to the specified product in terms of its environmental attributes?

8. Environmentally Responsive Site Planning

- ❒ Have hardy, indigenous plants been specified in the landscaping plan?
- ❒ Have exterior lights been designed to focus downward to reduce night sky light pollution?

9. High-Performance HVAC (heating/ventilating/air conditioning)

- ❒ Do the equipment and products specified for the HVAC system continue to meet the design and performance goals previously established?
- ❒ What analyses have been performed to ensure that the system is "right sized" to meet expected demand?

10. High-Performance Electric Lighting

- ❒ What lamps, ballasts, and fixtures have been specified?
- ❒ Why are they the best choices in terms of visual comfort, energy use, and long-term performance?
- ❒ Will the system as finally configured and specified be easy to operate, maintain, and repair?
- ❒ What is the impact of the system as finally configured on electricity use?
- ❒ Does the system as finally configured minimize waste heat? Has this been taken into account in sizing the cooling system?
- ❒ What controls have been specified? How will they help save energy and operating costs?
- ❒ What level of control will individual teachers have over the heating, ventilating, and air conditioning of their classrooms?

11. Life Cycle Cost Analysis

- ❒ Has the life cycle cost methodology selected for the project been used to compare and optimize alternative design strategies at least once during this phase of the process?

12. Renewable Energy

- ❒ Do the final construction details for renewable energy systems allow the systems to perform as designed? (For example, are solar systems installed so that they face the right direction, at the correct angle, to receive the right amount of sunlight? Does the final location of another building component, such as a rooftop air conditioner, now prevent sunlight from reaching a solar collector?)
- ❒ How are the renewable energy systems in their final configurations anticipated to perform from a life cycle standpoint?
- ❒ What warranty periods have been specified for the systems?

13. Safety and Security

- ❒ What type of exterior lighting has been specified and how will it improve security?
- ❒ Have durable materials been specified in critical areas such as entrances?
- ❒ What security technologies have been specified? How do they reinforce and enhance the building's security-focused design features?

14. Superior Indoor Air Quality

- ❒ Will the HVAC system as finally configured provide adequate ventilation, especially to the classrooms?
- ❒ Will the system maintain the indoor relative humidity between 30 and 50 percent?
- ❒ Are local exhausts provided for restrooms, kitchens, science labs, janitor's closets, copy rooms, and vocational/industrial shop rooms?
- ❒ Have CO_2 sensors been included in large assembly areas to monitor air quality?
- ❒ Are all the selected interior materials and products low emitters of indoor air contaminants?
- ❒ Have recessed grates or "walk off" mats been installed at entrances to reduce the amount of dirt entering the building?

15. Thermal Comfort

- ❒ In their final configurations, do HVAC distribution layouts ensure that all areas of a room receive adequate ventilation?
- ❒ Have controls been installed to provide teachers with adequate control over the thermal comfort of their classrooms?

16. Visual Comfort

- ❒ In their final configurations, do the daylighting and electric lighting systems provide illumination as uniformly as possible, using task or accent lighting as appropriate to meet specific needs?
- ❒ Have direct/indirect lighting fixtures been specified for general illumination in classrooms?
- ❒ What shading strategies (internal and external) have been specified?
- ❒ Have the final configurations of other building components (such as the color of the walls, floor, or ceiling) been changed in ways that might influence system performance? Have the potential impacts of these changes on visual comfort been accounted for?

17. Water Efficiency

- ❒ Has high-efficiency irrigation technology been specified for athletic fields?
- ❒ Has high-efficiency equipment (dishwashers, laundry, cooling towers) been specified?
- ❒ Have low-flow showerheads and automatic lavatory faucet shut off controls been specified?
- ❒ Does the design include innovative wastewater treatment techniques?
- ❒ In their final configurations, what will be the impact of all these water saving strategies on water use at the school? Will the results meet the school's water use goal?

Questions to ask as contractor bids are received to ensure that any proposed material or product substitutions do not adversely affect the school's performance goals:

1. Acoustic Comfort
- ❒ Have any substitutions been proposed (alternate wall/floor/ceiling materials, different types of HVAC equipment) that could diminish acoustical quality, particularly in the classrooms?
- ❒ If these substitutions are accepted, how will they affect overall acoustic comfort?

2. Commissioning
- ❒ Has the commissioning plan been clearly described to potential bidders?

3. Daylighting
- ❒ Have any substitutions been proposed (alternate glazing materials, different types of shading) that could influence the intended performance of the daylighting system?
- ❒ If these substitutions are accepted, how will they affect system performance, visual comfort, and life cycle cost?

4. Durability
- ❒ Are all proposed substitutions equal to or better than specified materials, products, and/or systems in terms of their durability?
- ❒ Are the material or product substitutions also functionally equivalent to the specified materials or products? (In other words, if they are accepted, they will not adversely affect the performance of the system or assembly in which they are used.)
- ❒ Will material, product, or system substitutions require operating or maintenance changes that will increase long-term operation and maintenance (O&M) costs? If so, can alternate material, product, or system substitutions be made that will bring projected long-term O&M costs back down to design levels?
- ❒ What analyses have been done to ensure substitutions will not degrade durability and/or O&M performance?

5. Energy Analysis Tools
- ❒ Are the energy analysis tool(s) selected for the project being used to evaluate the energy consumption consequences of proposed material, product, or system substitutions?
- ❒ Do the substitutions diminish the school's ability to meet its energy goal?

6. Energy-Efficient Building Shell
- ❒ Have any substitutions been proposed (alternate glazing materials, different types of insulation, alternate roofing products) that could influence the intended performance of the building shell?
- ❒ If these substitutions are accepted, how will they affect the energy performance of the building and its life cycle cost?

7. Environmentally Preferable Materials and Products
- ❒ Are all proposed substitutions equal to or better than the specified products in terms of their environmental attributes?
- ❒ Are the substitutions also functionally equivalent to the specified products? (In other words, if they are accepted, they should not adversely affect the performance of the system or assembly in which they are used.)
- ❒ What analyses have been performed to ensure that substitutions will not degrade environmental quality or system performance?

8. Environmentally Responsive Site Planning

- ❒ Have any substitutions been proposed (different plants, alternate materials for parking lots or walkways, alternate exterior light fixtures) that could reduce the environmental quality of the site plan?
- ❒ Will any of these substitutions diminish the building's performance? (For example, fewer trees may mean less shade and more heat gain in daylit classrooms.)
- ❒ Have these impacts been analyzed? How will they affect the overall life cycle cost of the facility?

9. High-Performance HVAC (heating/ventilating/air conditioning)

- ❒ Have any substitutions been proposed (alternate equipment, different types of controls, alternate delivery hardware, e.g., diffusers) that could modify system performance?
- ❒ After the substitutions, will the system still be "right sized" to meet the demand (not over- or under-sized)?
- ❒ If these substitutions are accepted, how will they affect the energy performance of the building and its life cycle cost?

10. High-Performance Electric Lighting

- ❒ Have any substitutions been proposed (alternate lamps, ballasts or controls) that could impact the intended performance of the electric lighting system?
- ❒ Will these substitutions provide the same level of visual comfort consistent with design intent?
- ❒ Will they introduce any additional waste heat to the space?
- ❒ Will they work correctly with the specified control system(s)?
- ❒ If these substitutions are accepted, how will they influence visual comfort, energy performance, and life cycle cost?

11. Life Cycle Cost Analysis

- ❒ Is the life cycle cost methodology selected for the project being used to analyze proposed material or product substitutions in terms of their impacts on overall performance and cost effectiveness?

12. Renewable Energy

- ❒ Have any substitutions been proposed, either to specific systems or to the materials from which the systems are constructed, that could diminish intended performance?
- ❒ If these substitutions are accepted, how will they affect the energy performance and life cycle cost of the whole facility?

13. Safety and Security

- ❒ Have any material substitutions been proposed that could reduce the durability, and increase the vulnerability, of critical areas in the building (such as entrances)?
- ❒ Have any security technology substitutions been proposed?
- ❒ How well will the alternative technologies fit in with and complement the school's design-focused security measures?
- ❒ How will the substitute technologies interface with other controls systems in the school (e.g., those for the lighting and HVAC systems)?
- ❒ If substitutions are accepted, will they be as easy to operate, maintain, and repair as the originally specified products and systems?

14. Superior Indoor Air Quality

- ❒ Have any substitutions been proposed (alternate materials, a different ventilation system) that could impact indoor air quality?
- ❒ Are all substitute materials low emitters of indoor contaminants?
- ❒ Do substitute materials require different cleaning processes that may contaminate indoor air?
- ❒ Are substitutions being proposed for materials or assemblies designed to act as barriers to sources of indoor contaminants? Will the substitute materials/assemblies also act as effective barriers?

15. Thermal Comfort

- ❒ Have any substitutions been proposed (alternate glazing materials, different types of insulation, different types of ventilation hardware) that could affect thermal comfort, especially in the classrooms?
- ❒ If these substitutions are accepted, how will they influence the thermal comfort of students and teachers, the energy performance of the building, and its life cycle cost?

16. Visual Comfort

- ❒ Have any substitutions been proposed (alternate glazing materials, different types of lamps or light fixtures, alternate colors for walls, floors or ceilings) that could affect visual comfort, especially in the classrooms?
- ❒ If these substitutions are accepted, how will they influence the visual comfort of students and teachers, the energy performance of the building, and its life cycle cost?

17. Water Efficiency

- ❒ Have any substitutions been proposed (alternate plumbing fixtures, different types of landscape vegetation, an alternate irrigation system) that could reduce the school's water efficiency?
- ❒ If these substitutions are accepted, how will they affect water use and overall life cycle costs at the facility?

Questions to ask during the course of construction to ensure that the building is being built as designed, that it will meet its performance goals, and that any proposed material or product substitutions do not adversely affect these goals:

1. Acoustic Comfort
- ❒ Is the building being constructed as designed so as to achieve acoustic comfort?
- ❒ Have any substitutions been proposed (alternate wall/floor/ceiling materials, different types of HVAC equipment) that could influence acoustical quality, particularly in the classrooms?
- ❒ If these substitutions are accepted, how will they affect overall acoustic comfort?

2. Commissioning
- ❒ Has the commissioning plan been implemented?
- ❒ Has the functional performance of key systems been tested and verified?
- ❒ Are the results documented in a commissioning report?
- ❒ Have appropriate school staff been trained concerning proper operation of system equipment and controls?

3. Daylighting
- ❒ Is the building, especially the classrooms, being constructed as designed to provide as much natural light as possible?
- ❒ Have any substitutions been proposed (alternate glazing materials, different types of shading) that could diminish the intended performance of the daylighting system?
- ❒ If these substitutions are accepted, how will they affect system performance, visual comfort, and life cycle cost?

4. Durability
- ❒ Are all proposed substitutions equal to or better than specified materials, products, and/or systems in terms of their durability?
- ❒ Are the material or product substitutions also functionally equivalent to the specified materials or products? (In other words, if they are accepted, they will not adversely affect the performance of the system or assembly in which they are used.)
- ❒ Will material, product, or system substitutions require operating or maintenance changes that will increase long-term O&M costs? If so, can alternate material, product, or system substitutions be made that will bring projected long-term O&M costs back down to design levels?
- ❒ What analyses have been done to ensure substitutions will not degrade durability and/or O&M performance?

5. Energy Analysis Tools
- ❒ Are the energy analysis tool(s) selected for the project being used to evaluate the energy consumption consequences of proposed material, product, or system substitutions?
- ❒ Do the substitutions impede the school's ability to meet its energy goal?

6. Energy-Efficient Building Shell
- ❒ Is the building shell being constructed as designed to achieve a high level of energy efficiency?
- ❒ Have any substitutions been proposed (alternate glazing materials, different types of insulation, alternate roofing products) that could diminish the intended performance of the building shell?
- ❒ If these substitutions are accepted, how will they affect the building's energy performance and its life cycle cost?

7. Environmentally Preferable Materials and Products

- ❒ Are efforts being made to minimize construction waste?
- ❒ Is some percentage of demolition and/or land clearing waste being salvaged or recycled?
- ❒ Is the building being constructed using the environmentally preferable products specified?
- ❒ Are all proposed substitutions equal to or better than the specified products in terms of their environmental attributes?
- ❒ Are the substitutions also functionally equivalent to the specified products? (In other words, if they are accepted, they should not adversely affect the performance of the system or assembly in which they are used.)
- ❒ What analyses have been performed to ensure that substitutions will not degrade environmental quality or system performance?

8. Environmentally Responsive Site Planning

- ❒ Is the site being constructed and landscaped in the environmentally responsive way it was designed?
- ❒ Have any substitutions been proposed (different plants, alternate materials for parking lots or walkways, alternate exterior light fixtures) that could diminish the environmental quality of the site plan?
- ❒ Will any of these substitutions impact the performance of the building? (For example, fewer trees may mean less shade and more heat gain in daylit classrooms.)
- ❒ Have these impacts been analyzed? How will they affect the overall life cycle cost of the facility?

9. High-Performance HVAC (heating/ventilating/air conditioning)

- ❒ Is the HVAC system being installed as designed to achieve high performance?
- ❒ Have any substitutions been proposed (alternate equipment, different types of controls, alternate delivery hardware [e.g. diffusers]) that could modify system performance?
- ❒ After the substitutions, will the system still be "right sized" to meet the demand (not over- or under-sized)?
- ❒ If these substitutions are accepted, how will they affect the building's energy performance and its life cycle cost?

10. High-Performance Electric Lighting

- ❒ Is the electric lighting system being installed as designed to achieve high performance?
- ❒ Have any substitutions been proposed (alternate lamps, ballasts or controls) that could diminish the intended performance of the electric lighting system?
- ❒ Will these substitutions provide the same level of visual comfort as the design calls for?
- ❒ Will they add any additional waste heat to the space?
- ❒ Will they work correctly with the specified control system(s)?
- ❒ If these substitutions are accepted, how will they affect visual comfort, energy performance, and life cycle cost?

11. Life Cycle Cost Analysis

- ❒ Is the life cycle cost methodology identified for the project being used to analyze proposed material or product substitutions in terms of their impacts on overall performance and cost effectiveness?

12. Renewable Energy

- ❒ Are the renewable energy systems being installed as designed to achieve high performance?
- ❒ Have any substitutions been proposed, to specific systems or to the materials from which the systems are constructed, that could diminish intended performance?
- ❒ If these substitutions are accepted, how will they impact the energy performance and life cycle cost of the whole facility?

13. Safety and Security

- ❒ Is the building being constructed as designed to improve security?
- ❒ Are security technologies being installed as designed?
- ❒ Have any material substitutions been proposed that could reduce the durability, and increase the vulnerability, of critical areas in the building (such as entrances)?
- ❒ Have any security technology substitutions been proposed?
- ❒ How well will the alternative technologies fit in with and complement the school's design-focused security measures?
- ❒ How will the substitute technologies interface with other control systems in the school (e.g., those for the lighting and HVAC systems)?
- ❒ If substitutions are accepted, will they be as easy to operate, maintain, and repair as the originally specified products and systems?

14. Superior Indoor Air Quality

- ❒ Is the impact of the construction process on indoor air quality (for workers and, in the case of renovations, for students and teachers) being managed?
- ❒ Is the building being constructed as designed to ensure healthful indoor air quality?
- ❒ Have any substitutions been proposed (alternate materials, a different ventilation system) that could adversely affect indoor air quality?
- ❒ Are all substitute materials low emitters of indoor contaminants?
- ❒ Do substitute materials require different cleaning processes that may contaminate indoor air?
- ❒ Are substitutions being proposed for materials or assemblies that are designed to serve as barriers to sources of indoor contaminants? Will the substitute materials/assemblies also act as effective barriers?
- ❒ Is there a plan to "flush out" the facility for at least 72 hours after construction and before occupancy?

15. Thermal Comfort

- ❒ Is the building being constructed as designed, for optimal thermal comfort, especially in the classrooms?
- ❒ Have any substitutions been proposed (alternate glazing materials, different types of insulation, different types of ventilation hardware) that could affect thermal comfort, especially in the classrooms?
- ❒ If these substitutions are accepted, how will they affect the thermal comfort of students and teachers, the energy performance of the building, and its life cycle cost?

16. Visual Comfort

- ❒ Is the building being constructed as designed to enhance visual comfort, especially in the classrooms?
- ❒ Have any substitutions been proposed (alternate glazing materials, different types of lamps or light fixtures, alternate colors for walls, floors, or ceilings) that could affect visual comfort, especially in the classrooms?
- ❒ If these substitutions are accepted, how will they influence the visual comfort of students and teachers, the energy performance of the building, and its life cycle cost?

17. Water Efficiency

- ❒ Are the building and grounds being constructed as designed, to conserve water?
- ❒ Have any substitutions been proposed (alternate plumbing fixtures, different types of landscape vegetation, an alternate irrigation system) that could reduce the water efficiency of the school?
- ❒ If these substitutions are accepted, how will they affect water use and overall life cycle costs at the facility?