DOCUMENT RESUME

ED 055 357 EA 003 764

TITLE	Building Systems Planning Manual. Building Systems Information Clearinghouse Special Report Number Three.
INSTITUTION	Building Systems Information Clearinghouse, Stanford, Calif.
PUB DATE	Aug 71
NOTE	51p.
AVAILABLE FROM	BSIC/EFL, 3000 Sand Hill Road, Menlo Park, California 94025 ($1.00 postpaid)
EDRS PRICE	MF-$0.65 HC-$3.29
DESCRIPTORS	Annotated Bibliographies; *Architectural Programing; Bids; *Component Building Systems; Contracts; *Educational Facilities; Manuals; Modular Building Design; Performance Specifications; School Architecture; School Construction; *Structural Building Systems; Systems Analysis; *Systems Development

ABSTRACT

This document attempts to provide a "state of the art" study of the application of building systems to construction with emphasis on educational facilities. Although directed primarily at the architect and the building team, this material can also be useful to those who contemplate using building systems. Building systems are considered part of a more comprehensive systems approach to design and construction emphasizing the importance of the procedures and techniques of application. The first section surveys means of learning about the use of building systems, and the second describes a generalized model of a project that utilizes building systems and includes discussions of programing, design, and multistage bidding. The text is supported by sample bidding sheets, drawings, letters of intent, and a 29-item annotated bibliography. (Author/MLF)

Building Systems Information Clearinghouse
Special Report Number Three

BUILDING SYSTEMS PLANNING manual

Published by
Building Systems Information Clearinghouse
Educational Facilities Laboratories, Inc.
3000 Sand Hill Road
Menlo Park, California 94025

August 1971

BSIC/EFL

Building Systems Information Clearinghouse was established by Educational Facilities Laboratories to undertake research on matters pertaining to the development and use of building systems; accumulate and distribute information about systems projects to architects, educators, and manufacturers; and to serve as a medium to encourage communication among those interested in building systems.

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ALAN C. GREEN, *Secretary and Treasurer*

BSIC STAFF

JOHN R. BOICE, *Director*
JOSHUA A. BURNS, *Assistant Director*

Library of Congress Catalog Number: 73-165264

Copies of this publication, as well as other publications dealing with building systems, are available from BSIC/EFL, 3000 Sand Hill Road, Menlo Park, California 94025.

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INTRODUCTION

This publication has been prepared by BSIC/EFL to bring a general state of the art discussion of building systems use to both active systems users and those who may be contemplating their use for the first time.

In November of 1970 BSIC invited a small group of people, who were active in the field of school architecture and had considerable experience in the use of building systems, to sit down together and discuss their experiences. In this publication BSIC has isolated some points from these discussions and added some additional material to provide a comprehensive view of the use of building systems for schools.

In order to provide the reader with a basic vocabulary of systems language, a glossary of terms used in the text has been included at the beginning of the publication. The text has been divided into four parts: 1) how to learn about building systems, 2) how to use building systems, 3) a list of sources of additional information about each of the major topics discussed in the text, and 4) samples of materials used in the preparation of bid documents for early bidding of subsystems.

The authors are indebted to a great number of persons who have contributed their ideas, experiences, and comments during the preparation of the manuscript. We are especially indebted to A. F. Allen, Christopher Arnold, Michel Bezman, James Bruce, Carl Bryant, Thomas Cloonan, Jean Farley, Albert Hanscom, Ervin Hill, Jonathan King, Norman Kurtz, Robert Malcolm, Carroll McGuffey, Robert Miles, Richard Miller, Peter Piven, Paul Roelke, Norman Rutgers, Ken Wilson, and John Wurz.

In addition to the above, parts of the manuscript were reviewed by Bernard Cromi, Ted Gilles, William Locke, Jon Schleuning, Louie Sudheimer, and Ed Wundram.

GLOSSARY OF TERMS USED IN THIS REPORT

In the following glossary, terms are defined as they are used in this report. These definitions may or may not reflect a term's meaning in every context. Terms marked with an (*) are also defined in this glossary.

Building Component. A group of parts which form a portion of a building subsystem*; e.g., a door, its frame and hardware as part of a partitioning subsystem; the second subdivision of a building system*.

Building Subsystem. A group of building components* that performs as specified; e.g., an HVC subsystem made up of components such as energy converters, air-handling units, ductwork, diffusers, and controls; the first subdivision of a building system*.

Building Subsystem Performance Characteristics. The actual characteristics of a given manufacturer's subsystem as opposed to the needs established by the user.

Building Subsystem Performance Requirements (Criteria). A set of statements of the essential characteristics that a building subsystem* must provide in order to satisfy user needs*.

Building System. A set of coordinated building subsystems*, intended for application as a group, performing many or all of the functions of a building.

Compatibility. The state of functional*, dimensional*, economic, and aesthetic coordination between two or more building subsystems* or components*; see *Interface**.

Development. The effort required to create new products or to substantially modify existing ones in response to a given performance standard.

Dimensional Coordination. The organizing of dimensions to enable building subsystems*, components*, and parts to be used together without modification.

Functional Coordination. The organizing of performance characteristics to enable optimum performance to be obtained from combinations of building subsystems*, components*, and parts.

Hardware. The physical elements of a system*.

Interface. The common boundary between two building subsystems*, components*, or parts including both the physical contact which may or may not form a joint and the overlap of performance characteristics.

Lead (or Lead-In) Time. The length of time preceding an event which must be allowed for all implementing activities if the event is to have reasonable chance of occurring as scheduled.

Modular. Having commensurable dimensions; i.e., dimensions based upon modules* and integer multipliers.

Modular Coordination. Dimensional coordination* using commensurable dimensions, or modules* and integer multipliers.

Module. A basic fixed dimension.

Performance Specification. A set of specifications which describes a building system*, subsystem*, or component* for bidding purposes, not by its physical materials, shapes, dimensions, or other physical properties, but by the desired results; in other words, not by what it is, but by what it does.

Planning Grid. A reference grid, usually rectangular with the spacing of the grid lines determined by the module* of the building system*, which serves as a dimensional framework for organizing the building and/or the site plan.

Planning Module. A standard unit of measurement established as a tool for space planning; in many U.S. building systems, the planning module is 5′-0″ (60″) or 152 centimeters.

Software. The nonphysical elements of a system*; e.g., a program, a design, or procedures.

System. An interdependent group of items forming a unified whole.

Systems Approach. The viewing of a problem as a system*, stressing the interrelation of problem elements and processes and the relation of the problem to its larger context.

Systems Building. The application of the systems approach* to construction, normally resulting in the organization of programming, planning, design, financing, manufacturing, construction, and evaluation of buildings under single, or highly coordinated, management into an efficient total process.

User Needs. Those conditions which the user of a building considers necessary or desirable as environment and support for his activities, without particular reference to how such conditions are to be physically produced.

HOW TO LEARN ABOUT BUILDING SYSTEMS

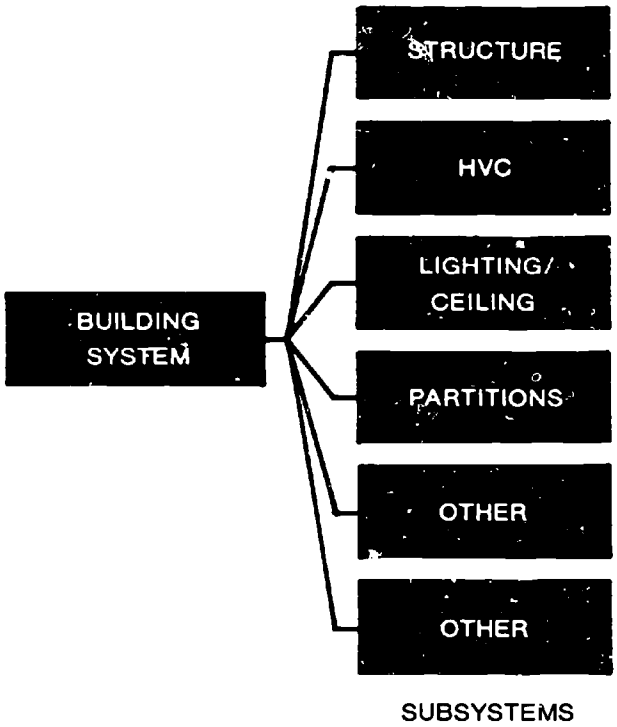
For the individual or firm interested in learning about building systems, whether for use on a specific project or for information alone, the path begins with the collection and study of existing information. As this study progresses, new ideas and concepts, as well as new interpretations of traditional ideas, will be discovered.

One of the principles of the systems approach is that all work is *iterative*; that is, each project is built upon evaluation of the results of former projects. The use of building systems leads to new knowledge and understanding which leads to an improved ability to use systems. Each office will develop and evolve its own techniques and methods for building systems use which may differ from those of other offices.

A formal definition of *building system* is a set of coordinated building components, intended for application as a group, performing many or all of the functions of a building. In simpler terms, a building system is a set of parts which have rules for how they may be used. With these parts a building can be designed and constructed. To this definition, BSIC likes to add that a building system must include structure and at least one other compatible subsystem.

The parts in a building system are organized into categories known as functional subsystems. These categories differ somewhat from the trade-based classification categories of the Construction Specifications Institute (CSI) and the AIA. Four subsystems—structure, heating/ventilating/cooling (HVC), integrated lighting/ceiling, and interior space division—are found in almost all building systems projects to date. Several other subsystems—exterior wall, electric and electronic distribution, carpeting, cabinetry, plumbing—are found with increasing frequency.

Although the subsystems of a building system could be used in a traditional design and construction program by careful attention to the system's constraints and discipline, most effective use comes when building systems are combined with some of the procedures which have been evolved for systems projects. Many of these procedures are discussed in the following chapter, "How To Use Building Systems." When building systems and these procedures are used together, it is indeed possible to build better schools in less time and at the same or lower costs.



SOURCES OF INFORMATION

Information about building systems and their use may be obtained from a number of sources. These sources may be loosely grouped as follows:

- *Educational institutions.* Many schools of architecture and engineering presently offer courses in both building systems and systems analysis. In addition to formal course structures, these institutions often hold seminars, short courses, workshops, and conferences which may be open to both students and nonstudents. Other agencies, such as state boards of education, chapters of professional organizations, and the federal government also hold such sessions.

• *Periodical articles.* Systems building, including the use of building systems, has been the subject of a number of articles in architectural and other journals recently. Because the quality of these articles varies from essential to inane, a selected bibliography is included at the end of this publication.

• *Individuals and firms involved in the use of systems.* Groups actually using building systems form a vital source of information. A major drawback of this source, however, is that the better an individual or firm is in the use of systems, the less time they have available to give information. One of the reasons BSIC was established was to bring together the experience of leaders in the field and to communicate this experience to others.

• *Systems building periodicals.* There are several magazines which are devoted to systems and industrialized building. Some of these are:

BSIC Newsletter, primarily aimed at educational construction, published every tenth week free of charge.
BSIC/EFL
3000 Sand Hill Road
Menlo Park, California 94025

Systems Building News, primarily aimed at housing construction, but with broader interests, published monthly, $18.00 per year.
Systems Building News
1760 Peachtree Road, N.W.
Atlanta, Georgia 30309

Industrialization Forum, covers industrialized and systems building but with a theoretical bias, published four times per year, $5.00.
Industrialization Forum
School of Architecture
Box 1079
Washington University
St. Louis, Missouri 63130

• *BSIC and other information centers.* Although BSIC is currently the only active clearinghouse for information on building systems, both the federal government and The American Institute of Architects are planning to open centers. Various organizations have groups whose role is to study and disseminate information on systems within the parent organization.

• *Manufacturers of building system components.* The manufacturers of systems products have available information on their products and, in some cases, information of general value about building systems and their use.

In the remainder of this report an introduction to the use of building systems will be made in the form of a description of a "model" of a more or less typical building systems project. At the conclusion of the report, a list of suggested readings for further information will be found.

HOW TO USE BUILDING SYSTEMS

Although building system components may be used in a traditional approach to the design and construction of a project, they are used with greatest effect as part of a systems approach. Properly used the systems approach provides a means for tapping the creativity and judgment of a broad assortment of relevant technical and professional disciplines. The systems approach is highly dependent on imagination, judgment, and originality to generate solutions from data which are often incomplete, ambiguous, and unique to a particular situation. The systems approach is pragmatic in that it is action oriented. Systems are developed in response to some specific set of circumstances which require different solutions based upon the unique conditions of a particular project.

The systems approach, then, dictates that the actual procedure used on each project must arise out of the project's specific conditions. There is, however, sufficient similarity among most school construction projects to have given rise to a "model" building systems project. This model must be viewed as a basis for development of project procedures rather than as an absolute model to be copied in detail.

Before proceeding to a discussion of some aspects of this "model" project, it will be useful to clear up a misunderstanding about what is involved in a typical building systems project.

DEVELOPMENT AND OFF-THE-SHELF PROJECTS

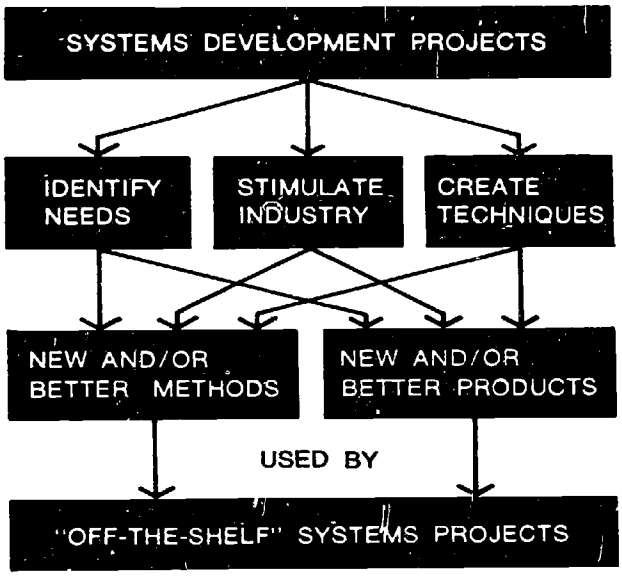
In North America to date there have been two kinds of building systems projects— 1) those which develop new building systems, and 2) those which use building systems which have previously been developed and are available for general use. Because the two are often confused, a distinction must be made between them. Development can be defined as the effort required to create new products or substantially modify existing ones in response to a given performance standard.

Systems Development Programs.

For educational construction, there have been four major building systems development programs:

1. School Construction Systems Development (SCSD) in California.
2. Study of Educational Facilities (SEF) in Toronto, Ontario.
3. Recherches en Amenagements Scolaires (RAS) in Montreal, Quebec.
4. University Residential Building System (URBS) in California for dormitories.

In these programs, large markets were aggregated to provide a volume of work in order to encourage manufacturers to develop new products. These programs are viewed as "seed projects" by their participants; that is, the development work in hardware and techniques will be used on many more projects than those included in the initial program.



Many of the products available in building systems today and most of the techniques for their use originated as responses to the needs of these large-scale and expensive development programs. The role of this type of program is to generate products with improved performance together with effective methods for their use.

The volume of work required to justify a full-scale systems development program is not fixed, but is known to be in excess of $30 million of construction in a relatively short period of time. The number of full-scale development projects that the school market can sustain is limited. Once the general requirements for various types of buildings have been defined and accepted and hardware solutions marketed, there is little need for the large-size development type project. However, if the market is available and new requirements can be clearly defined and widely accepted, industry will develop new component systems or refine and redesign existing ones to meet this demand.

For persons contemplating school design and construction projects of normal size, a major systems development project is out of the question.

Projects Using Existing or Off-the-Shelf Components.

Although there is a lower limit which will be discussed later in this chapter, projects of almost any size may make use of building systems components and techniques. These projects fall into two categories— 1) volume purchase programs where several projects are grouped together, and 2) single projects. In this report the single project will be emphasized. Excellent work on grouping projects into volume purchasing markets is being done by the Florida Schoolhouse Systems Program and numerous other programs, including those in Detroit and Alaska.

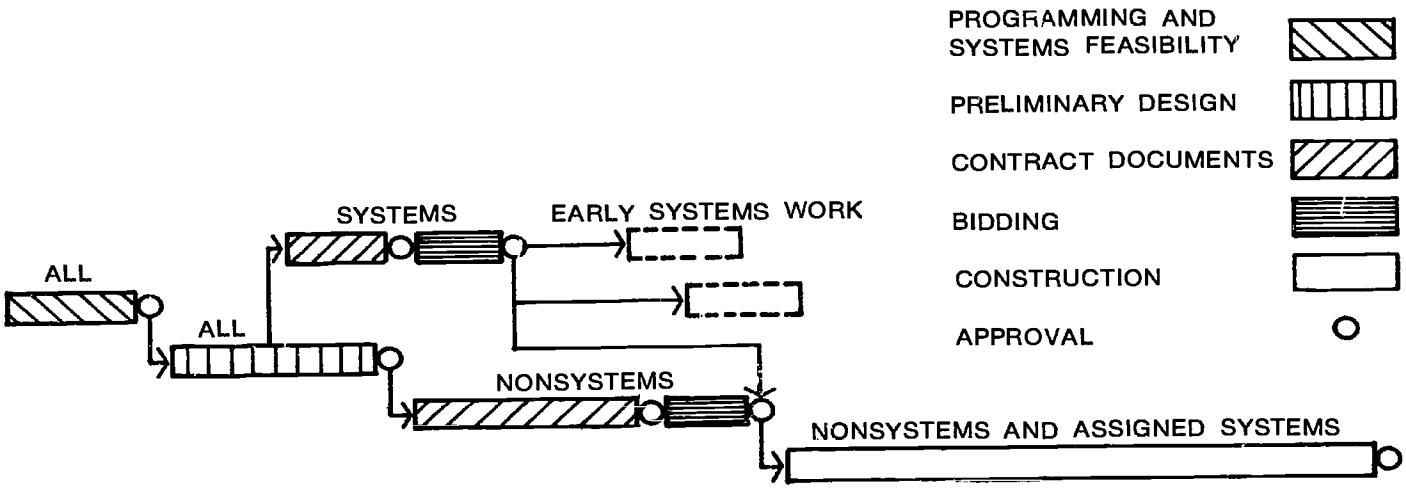
The common characteristic of these projects, whether for a single school or a group of schools, is that they are designed around existing building systems components. Techniques which have been introduced and tested on the large development programs are used to implement the projects. The purpose of this chapter is to show how the individual architectural firm can work with building systems on the average-size construction project.

THE ROLE OF CONSULTANTS

On building systems projects, consultants to the architect, including structural, mechanical, and electrical engineers, are retained as in conventional design and construction projects. The roles of these consultants are changed somewhat, however. Instead of traditional services, consulting engineers must now spell out the performance criteria required to satisfy the needs of the user as specified by the architect and evaluate the manufacturer's response rather than perform actual system design.

Although legal precedent is lacking at the present time, it appears that the architect and his consultants cannot shift their traditional responsibilities to the manufacturer, even when the manufacturer performs design in response to performance specifications

and systems drawings. In building systems projects, as currently formulated, the architect and his consultants must exercise final review and approval of all parts of the design as they do on nonsystems projects.



THE MODEL BUILDING SYSTEMS PROJECT

Although many of the steps overlap, the "model" for a building systems project using off-the-shelf components to design and construct a single project can be outlined as follows:

1. *Preliminary architectural programming.* The architect and the client determine performance levels and sufficient project criteria to test the feasibility of the use of building systems.
2. *Testing the feasibility of building systems use.* The architect and the client study the project to see if the use of building systems is useful or desirable.
3. *Architectural programming.* The architect and client program the facility, either full space programming or sufficient programming to permit development of the preliminary design.
4. *Preliminary design.* The architect then develops the preliminary design and presents it to the client for his approval.
5. *Multi-stage bidding, Stage One.* Key building systems components and the parties who will supply and install them are selected by competitive bidding.
6. *Working drawings.* The architect completes working drawings and other contract documents.
7. *Multi-stage bidding, Stage Two.* The construction contract(s) are let by competitive bidding; these contracts may be let to:
   a. a general contractor,
   b. prime contractors where required by law,
   c. a construction manager and subcontractors, or
   d. a management contractor and subcontractors.

The remainder of this chapter is a discussion of these "model" procedures. The "Suggested Readings" contain additional sources for many of these steps.

PRELIMINARY ARCHITECTURAL PROGRAMMING

The basis of any architectural program is, of course, the requirements of the users of the facility to be constructed. Once this important aspect of the process has progressed to the point where these basic requirements are known, architectural programming can be undertaken.

On systems projects, this involves determining the scope and schedule of the project, and establishing tentative performance levels for the facility. In some projects, preliminary architectural programming has also included definition of additional criteria, such as, structural bay sizes, story heights, and basic building configurations.

The determination of desired performance levels is an important aspect of the programming roles of the architect and the client, and involves a delicate balancing of user needs and resources. At this point, some information as to future directions of the client must be known to determine the levels of flexibility required and possible future performance demands.

BUILDING SYSTEMS FEASIBILITY

Once performance criteria have been established, the appropriateness of building systems as a project solution must be established. To determine whether or not systems are an appropriate solution, the architect and the client must find the answers to several questions. Key among these are:

- Are building systems products the best means to meet the performance requirements?
- Are design constraints inherent in the building systems acceptable for this project?
- Is there sufficient competition in the area among building systems manufacturers to insure good and legal bidding?
- Is this project of sufficient size to stimulate this competition?
- Are there local code and/or bidding requirements which might make building systems use excessively difficult?
- Are there other constraints; e.g., labor or political opposition, which might make building systems use excessively difficult?

Product and manufacturer performance. The best source of information about the performance levels of systems products and the willingness of manufacturers to bid on jobs is, of course, the manufacturers and suppliers themselves. One list of such manufacturers, their products, and generalized performance data for the products is *BSIC Special Report Number One: Manufacturers' Compatibility Study.*

Most building systems projects bid subsystems on an installed basis, with local contractors providing installation service. In most cases, this local contractor is also the bidder, with the national manufacturer providing materials and assistance in preparing the bid.

Project size and building systems. Although the evidence is unclear as to the exact relationship between project size and systems cost, the size of the project modified by other factors may influence

the decision on whether or not to use systems. The willingness of manufacturers to bid on very small projects in the face of difficult locations, unusual or stringent code requirements, unusual bidding conditions, great distances from manufacturing plants, and other factors must be carefully checked.

If a study of these factors indicates that project size is too small to allow all building systems procedures to be used, alternative methods may be tried. For example, several small projects may be combined into one bidding package of sufficient size to attract manufacturer attention. For educational construction, this may be done with projects within the same school district, within the architect's office, or between districts and offices. All of these combinations are currently in use in Florida, and examples may be found in other states.

PRELIMINARY DESIGN

As on nonsystems projects, the preliminary design is the translation of the building program into a design solution. On building systems programs, however, two elements in preliminary design differ from conventional approaches.

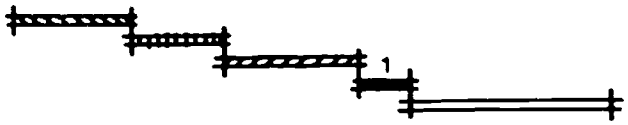
In a system program, the architect works with both the building program and an awareness of the inherent nature, potentials, and constraints of the building systems to develop the preliminary design. In some firms, all sketching, schematics, and diagrams are done on paper on which a 5′ by 5′ grid is imprinted to remind the designers of the planning module of the building system.

In addition to relating all planning to the basic planning module, the architect may wish to use larger planning units, sometimes called "supermodules," or "space modules," which are based upon the performance, rather than the dimensional, characteristics of building systems components. For example, structure of the building may be conceived in terms of bays of approximately 30′ by 60′, an optimum size for many steel structural products. Some HVC systems have optimum service modules based upon the air handling capacity of the unit.

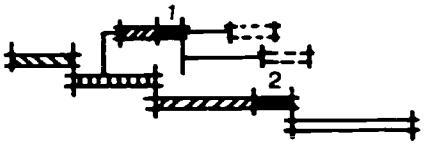
Another performance characteristic of building systems, their flexibility, makes possible a new form of building programming and design which has been experimented with on some school construction projects. Because of the flexibility built into space configuration components— partitions and other space dividers, lighting/ceiling, and HVC—it is no longer necessary to complete detailed space programming before undertaking preliminary design. Instead, a generalized programming based on allocating blocks of space to specialized or functional uses will suffice at the preliminary design stage.

Final decisions on the detailed space programming for the "opening day plan" may be postponed until the last possible moment. This postponement allows the architect to work with the school staff who will work in the space, and permits the programmers to make use of the latest thinking in educational theory and practice. Even beyond this stage, in one systems school in Florida, the architect has remained involved with the staff in the making of changes in the building after occupancy.

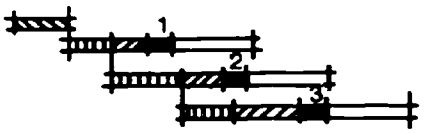
MULTI-STAGE BIDDING, STAGE ONE



TRADITIONAL BIDDING



MULTI-STAGE (TWO STAGE) BIDDING



MULTI-STAGE (FAST-TRACK) BIDDING

In traditional construction projects, bids for construction contracts are taken after the completion of working drawings and other contract documents. Multi-stage bidding, as often used on building systems projects, retains bidding after document completion but adds an earlier bidding of key components of the building system. This bidding of systems components normally takes place following the approval of the preliminary design by the client.

At this time bids for key systems components, not always the entire building system, are taken based upon a set of drawings of each subsystem, and a set of specifications, often of a performance type. In most projects, the subsystems are bid on an installed price basis, with national manufacturers of products usually bidding through a local installer.

The early bidding of components requires that certain decisions be made earlier in the project than is traditionally the case. The intent of this section is to point out some of the advantages of early bidding, some of the options available, how to go about it, and the decisions which must be made to enable its use.

Advantages of Multi-stage Bidding.

Multi-stage bidding, in particular the early bidding of building system components, offers several advantages to the members of the building team. These advantages include:

- *A headstart on the design and construction schedule.* With multi-stage bidding, both the architect and the suppliers have earlier knowledge of some of the products to be used on the project. This permits the subsystem manufacturer to order materials in advance, thereby reducing some of his overhead costs. It may also permit him to begin fabrication and even erection of his subsystem before further contracts are let.
- *Improved cost (price) control.* Although the early bids usually include a percentage contingency to allow for modifications during working drawings, the prices quoted by the subsystem suppliers at the early bid are actual installed costs for the project. Early knowledge of these costs, which may amount to over 50 per cent of total building cost, gives the architect and the client better overall project cost control.
- *Improved schedule control.* As mentioned previously, with multi-stage bidding the architect and client are able to give the manufacturer-installer greater lead-in time than was previously possible. Signing a contract at the early bid may allow the beginning of subsystem installation before the completion of working drawings. Although these steps do not insure better and shorter project schedules, they increase the opportunity for schedule shortening.
- *Simplified design completion for the architect.* The identifications of subsystem products and the submission by selected bidders of shop drawings for their products gives the architect more information with which to complete his design. The architect can develop his working drawings around known products for which the manufacturers prepare many of the details. The

early identification of products to be used in the design reduces the problems of recoordinating the design after final bids due to competitive supply of other than specified items, a practice which is common on many traditional projects.

• *Improved control of quality by client and architect.* The early bidding of systems components places the final selection of these products in the hands of the architect and client. Competition among bidders is on price alone as the performance and quality levels are established by the early bidding documents, notably the performance-type specification.

• *Reduction in "extras" and other additional charges.* Where subsystems are bid on an installed basis, each bidder assumes responsibility for making good his product within the limits set in the scope statements of the specifications, thereby virtually eliminating extra costs in the subsystems. Further, many changes can be accommodated by the system's flexibility with a corresponding decrease in the cost of change orders.

How To Early Bid Building Subsystems.

Assuming that the architect and client wish to use a multi-stage bidding procedure, the steps in taking early bids of building subsystems can be outlined as follows:

1. A study of the feasibility of both early bidding and of various related aspects of the process, including contractual relationships, relation of selected early bidders to later contractors, and other questions of legality.
2. The making of certain key project decisions which affect all contractors whether selected early or at regular times, and which normally appear in the general conditions, special general conditions, or supplementary general conditions sections of specifications, including:
   a. Type of contractual relationship between early bidders and the client, specifically whether contract or letter of intent;
   b. Type of management of construction to be used on the project.
   c. The contractual relationship of early bidder to (b.) above.
3. The selection of subsystems to include in the early bidding.
4. The selection of the method to insure subsystem compatibility.
5. The preparation of bidding documents—drawings and specifications—which include the decisions reached in Nos. 1 through 4.
6. Advertising for bids, issuing of bidding documents, and the holding of prebid conferences.
7. The taking of bids and their evaluation.
8. The awarding of contracts or letters of intent to selected bidders based on the decision reached in No. 2 above.

In the remainder of this section on multi-stage bidding, some aspects of this process will be discussed in detail. The taking of early bids is neither a difficult nor a complicated process, but it is one involving steps which differ from those used in conventionally designed projects. The experience of firms who have used multi-stage bidding has generally been good, but as with many aspects of systems building, skill and expertise grow over time with experience.

Multi-stage bidding is also one of the tools of fast-track or staggered scheduling. This innovative tool has been used on projects to achieve dramatic savings in time. On such projects as the Merrick school additions on Long Island and the SUNY Surge Facilities at Stony Brook, New York, building systems and overlapping scheduling have been used together to great advantage.

The Selection of Subsystems To Include in Early Bidding.

At the present time it is possible to include over 50 per cent of the building's cost in an early bid building system. Although there is considerable difference of opinion among professionals involved in systems as to how much to bid early, there is general agreement that a subsystem should be included in the early bid package if any or all of the following conditions are true:

- The work on this subsystem is crucial to the project schedule and the commitment of the supplier to the schedule must be insured.
- Some subsystem work, either fabrication, delivery, or installation, must begin before the letting of the full construction contracts for the project.
- An advantage accrues to the project or the manufacturer from the additional lead-in time which early bidding allows.

In most projects employing building systems to date, at least three building subsystems—structure, HVAC, and lighting/ceiling—have been bid early. In the case of structure, at least, this early bidding has allowed some manufacturers to reduce their costs and lower their bid prices.

Because this bidding process places much cost, schedule, and detail information about the building system in the hands of the architect and client at an early point, many firms prefer to bid as much as possible at this time.

On the other hand, other firms feel that the added work of early bidding many subsystems is not justified. They feel there is adequate competition among suppliers of noncrucial subsystems to insure good prices and quality whenever bids are taken on these components. They further point out that on single school projects, the amount of lead-in time required with off-the-shelf products is not great. These firms early bid only those components which are important to the project schedule.

There is no simple answer to the question of which subsystems to include in early bidding. BSIC does not wish to define the course of action for users, but would like to suggest that an initial early

bidding by a firm include at least structural, HVC, and lighting/ceiling subsystems. By bidding these subsystems, the advantages listed above of early bidding are obtained and many problems of recoordination are eliminated. Experience will indicate the direction a firm will want to go in its use of building systems.

Contracts Versus Letters of Intent.

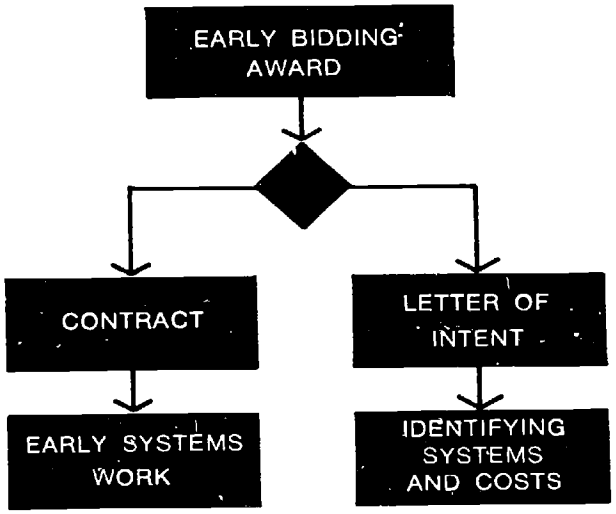
Two types of contractural arrangement can be used to bind selected bidders to the project until the letting of final construction contracts—contracts and letters of intent. Each of these two methods is appropriate to certain project conditions and should be used in those situations. Of the two, the letter of intent is probably the more commonly used.

The letter of intent. A letter of intent is a conditional contract; that is, it binds the signer to the project provided stated conditions are maintained. In building systems projects, the most common condition found in a letter of intent is that the project actually go to construction. If the conditions of the letter of intent are not maintained, the relationship between the signer and the project is dissolved and neither the signer nor the project has further obligation.

Because the letter of intent has the force of a contract as long as the conditions are maintained, the letter is a very useful technique in multi-stage bidding. A bid for a letter of intent is a real bid; the prices stated are real and binding. On the other hand, if the project should not go forward because of failure to obtain financing or other reasons, no financial liability is incurred by the client. This is especially useful where early bids are taken before design completion or bond referendums.

The letter of intent is useful where subsystem suppliers are not required to perform work before the letting of final contracts. Based on a letter of intent, most manufacturers will order materials and arrange production, delivery, and installation schedules but will not perform any actual work.

The contract. A contract with the subsystem suppliers selected by early bidding is simply that, a contractual relationship creating financial responsibility for the client. Cancellation of the contract is more difficult than the dropping of a letter of intent and requires payment for work done. On the other hand, if work must be performed by the subsystem supplier before the letting of final construction contracts, a contract at this stage is essential.



Relation of Early Bid Subsystems to Final Contracts.

Building systems and multi-stage bidding procedures have been used on projects involving all the principal types of management of construction—general contracting, prime construction contracting, construction management, and management contracting. The most common form is with a general contractor to whom the subsystem contracts are assigned. The general then assumes responsibility for the coordination of the work of the assignees as well as his other subcontractors.

Early bid building systems may also be included in projects where prime construction contracting is required. In such projects the subsystems, if of sufficient size and proper nature, may be handled as separate prime contracts or they may be assigned to the relevant prime contract.

Where construction management is practiced, the subsystem contracts are between the owner and the contractor and are managed by the construction management contractor. The situation is similar under management contracting, although the normal form of this process makes the subsystems suppliers subcontractors to the management contractor.

Whichever method is followed, the method and the conditions for assignment must be contained in the general conditions section of the early bidding documents and all subsequent documents used in connection with parties to which such contracts may be assigned.

Insuring Subsystem Compatibility.

The specification documents should contain a statement for each subsystem of the requirements for compatibility with other subsystems, including an assignment of responsibility to one subsystem or the other where conditions may be ambiguous. Where dimensional and functional compatibility is required of two subsystems, such subsystems are sometimes said to have a "mandatory interface."

At the present time, not all building systems products are compatible with each other. Because of this, subsystem selection should be made on the basis of achieving a compatible building system and not simply selecting the lowest bidders in each subsystem category. Selection on this basis places the responsibility for compatibility at the mandatory interfaces upon the manufacturers and any adjustment or modification required to meet specific conditions must be made by them at their expense.

Bidders are often required to state their compatibility with one another by a process known as "mutual naming." The bids sheets provide space for each bidder to name bidders of other subsystems with which he is compatible. With each combination of bidders in all other subsystems with which he has a mandatory interface, he must state a price for his subsystem. Normally only bidders who name each other can be considered compatible. Samples of such bidding sheets are included as an appendix to this report.

These statements of mutual compatibility must be backed up by the submission of sufficient information at the time of bidding to demonstrate this compatibility to the architect. Requirements for these submissions must be contained in the specifications.

For each subsystem, there are appropriate mandatory interfaces. Table I shows suggested mandatory interfaces.

	STRUCTURE	LIGHTING/ CEILING	HVAC	SPRINKLERS	PARTITIONS	ELECTRICAL/ ELECTRONIC	EXTERIOR WALLS	ROOFING	CARPETING
STRUCTURE		●	●	●			●	●	
LIGHTING/ CEILING	●		●	●	●	●	○		
HVAC	●	●		●					
SPRINKLERS	●	●	●						
PARTITIONS		●				●	○		○
ELECTRICAL/ ELECTRONIC		●			●				
EXTERIOR WALLS	●	○			○				
ROOFING	●								
CARPETING					○				

REQUIRED ●

OPTIONAL ○

TABLE I

MANDATORY INTERFACES

The Preparation of Bidding Documents.

Early bidding of systems components is based upon two documents—a set of drawings and a set of specifications. The specifications include bidding sheets, general conditions, and the subsystem descriptions normally of a performance type. In a successful building systems project, the development of preliminary design and the development of the building system package overlap and are inseparable. Because of this fact, coordination problems between drawings and specifications should be at a minimum.

Early bidding drawings. In the preparation of early bidding drawings, the success or failure of the programmers and designers in keeping systems in mind will be readily apparent. One goal of preliminary design in a building systems project should be to develop the preliminary design drawings in such a manner that a minimum of modification and redrawing is required to produce the bidding documents.

As the drawing standards included as an appendix to this report suggest, the drawings should be simple and clear. At least one sheet is prepared for each subsystem bid plus other sheets showing architectural plan, elevations, and site location. Each sheet should contain only such material as is relevant to the subsystem it displays. The graphic indications used on each sheet should be distinct and unambiguous, and the 5′ grid should probably be readable on each sheet. The complete drawing package will, of course, be sent to all bidders.

Early bidding specifications. As the key decisions affecting the project are made, the development of the early bidding specifica-

tions can be undertaken. The specifications used in early bidding of building systems are normally of the performance type; that is, they describe what the components must do rather than state what they must be. Before proceeding to a discussion of the preparation of these documents, it will be useful to examine briefly the major types of performance specifications used in early bidding.

The pure performance type specification was developed for use on building system development projects, such as SCSD in California and SEF in Canada. In these projects, the performance specifications were written to define new products to be developed by industry. As such, these documents contain many elements which are most useful in development projects and which are cumbersome and nonessential when existing products are being procured. In spite of these difficulties, these specifications in modified form have been used successfully on the majority of single school systems projects.

The Schoolhouse Systems Project (SSP) in Florida has adapted these developmental specifications for use on small projects. In addition, several groups, including SSP, the Council of Educational Facilities Planners Subcommittee on Codes and Standards, BSIC, and some manufacturers are working to develop a set of model performance specifications for nondevelopmental school construction projects.

Two simpler forms of performance specifications make use of the fact that smaller projects are purchasing from a known group of products. In one type of specification, a list of acceptable subsystem products is added to a shortened or referenced pure performance type specification document. Bidders may then bid any product on the list, while unlisted products may be acceptable if they meet the conditions of the performance specifications.

The second and slightly less useful type is similar to the material specification in that it establishes an "or equal" type requirement. In this type, a performance specification is written about one of the known subsystem products. Other products which are equal to the selected product may be bid also. Difficulty arises in determining exactly what is equal.

Regardless of the type of specification selected, the early bidding specifications document must contain certain elements. A short outline of a performance specification document for early bidding appears in the margin.

The pages, sections, and paragraphs should be organized and numbered in a coherent manner. Unfortunately, the major organizational schemes for architectural data, such as the CSI 16 division format, do not readily lend themselves to the ordering of performance specifications on a subsystem basis.

PERFORMANCE SPECIFICATIONS OUTLINE

1. "Boilerplate."
   a. Advertisement for bid.
   b. Instructions to bidders.
   c. General conditions (these must be the same in all project documents).
2. Performance specifications for each subsystem.
   a. General requirements for each subsystem.
      (1) General performance requirements for the subsystem.
      (2) Scope of work included in the subsystem.
      (3) Relevant codes and regulations—may be included in general conditions or under performance requirements.
   b. Compatibility requirements with other subsystems.
      (1) Interfacing requirements.
      (2) Coordination requirements.
   c. Subsystem performance requirements.
      (1) Dimensional criteria.
      (2) Design criteria.
      (3) Proof of performance and/or testing required.
   d. Submittal requirements.
      (1) At bid.
      (2) Following nomination.
3. A set of the bidding sheets for each subsystem.

Summary of Multi-stage Bidding.

Multi-stage bidding is a technique used on many building systems projects in which bids are taken on key building systems components upon the completion of preliminary design. The remainder of the project is bid after completion of all contract docu-

ments, with some form of assignment of the selected systems contractors to the full construction contracts.

Bidding the systems components early allows the manufacturer more lead in time, thereby reducing his costs and improving his scheduling. The architect gains better cost and time control, and is able to work with known products.

Systems components are bid on the basis of two sets of documents: 1. bid drawings based upon the preliminary design, and 2. specifications for these subsystems. The specifications are normally of the performance type, although various modified performance types may be used. These specs must be coordinated with all other specifications of the project.

Compatibility of components is insured in part by a process in which each bidder names products or bidders in other subsystem categories with which he is compatible. To be considered "compatible" bidders or products must be mutually named.

If the size of the project justifies the expense to the bidders, a prebid meeting should be held in which problems can be straightened out and misunderstandings cleared up. A second important function of this meeting is that it allows potential bidders to identify one another and to see with whom they should seek to establish compatibility.

WORKING DRAWINGS

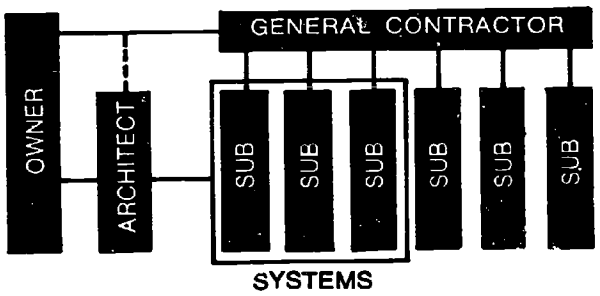
The only difference between a building systems project and a traditional project in the preparation of complete contract documents is that in a systems program, the architect can work from shop drawings of the selected components. The detailing of the interfacing of systems components is performed by the component manufacturers.

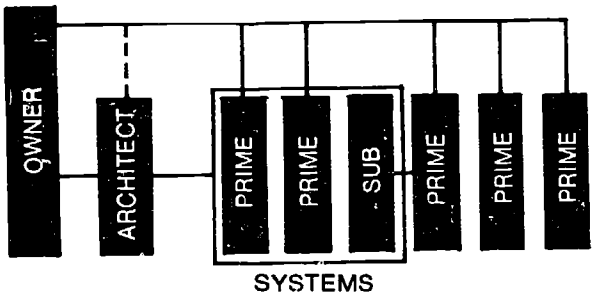
Although building systems can be seen as only a partial cause, some of the offices which use systems have begun to reduce the size of the working drawing package. It may be that the manner of thinking about building systems fosters a more systematic approach to other aspects of the design process.

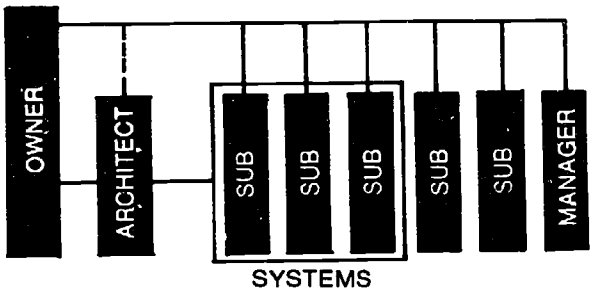
MULTI-STAGE BIDDING, STAGE TWO

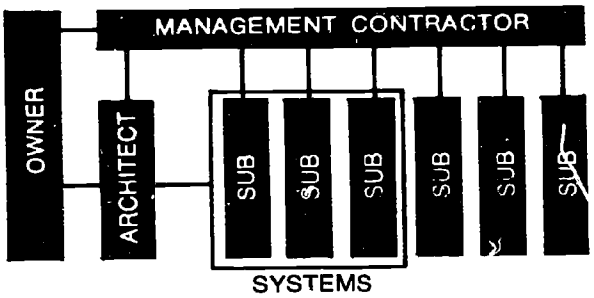
Building systems have been used on projects in which a variety of solutions to the problem of managing construction were employed. These methods can be classified generally in four categories—general contracting, prime contracting, construction management, and management contracting. A brief summary of systems use with each of these methods forms the bulk of the remainder of this chapter.

• *Building systems and general contracting.* The use of a general construction contract is perhaps the most common form of construction management on building systems projects. The only major change from the traditional project structure is that the building systems component contractors are selected by the owner rather than the general contractor. These contracts are then assigned to the general contractor. The general contractor is still responsible for coordination and management of the total construction effort.









• *Building systems and prime contracting.* In some states, public works projects, including schools, must be bid as several prime contracts. In these cases, the client provides such coordination as is necessary on the project. In bidding systems projects under these conditions, two approaches have been used. In one case, the systems contracts are assigned to the relevant prime contractor. In the other, the systems component and installation contracts are treated as additional prime contracts. This latter form is common where the subsystems contracts are relatively large.

• *Building systems and construction management.* A lesser used but potentially useful management approach is the hiring of a construction manager. The construction manager provides the supervision and coordination services normally provided by the general contractor but does no contracting work on the job himself. In this approach, on-site work is performed by subcontractors who submit bids to the client. The construction manager is most often someone with a contracting background.

On projects where a construction manager is used, the building systems contracts are handled simply as additional subcontracts. The Toronto SEF Building System projects are all managed by construction managers.

• *Building systems and management contracting.* Management contracting is a variation on construction management which has been used on the First URBS Project and on building systems projects for the University of Alaska. The references in "Suggested Readings" will provide an understanding of this innovative management technique.

When building systems are used under management contracting procedures, the subsystem contracts are either bid to or assigned to the management contractor for coordination and supervision. These subsystem contracts are usually subcontracts to the management contractor.

SUMMARY

This chapter has presented a necessarily brief description of a general "model" of a building systems project. The reader should remember the caution at the start of the chapter, that this model should serve as a basis for his own development of procedures and not as the "only way to do it."

The steps in the model building systems program are:

1. The architect and the client determine performance levels and sufficient project criteria to test the feasibility of the use of building systems.

2. The architect and the client study the feasibility of a building systems application to the project, weighing the advantages of systems use and determining the appropriateness of building systems to provide the type of facility desired.

3. Assuming that the use of systems is appropriate, the architect and the client program the facility; using the flexibility inherent in building systems, at this stage of project development they may only perform generalized space programming, reserving final detailed programming until the last possible moment before the fa-

cility is placed in use.

4. The architect prepares the preliminary design, a translation of the building program, drawing from his understanding of the characteristics of building systems.

5. Based upon subsystem drawings and performance type specifications, the building systems components and the parties who will supply and install them are chosen by competitive bidding; the selected bidders are given contracts or letters of intent.

6. Using the cost and product information obtained from the building systems suppliers, the architect completes the working drawings and other contract documents.

7. The construction contracts are let by competitive bidding; these contracts may be let to:

   a. General contractor
   b. Prime construction contractors
   c. A construction manager and subcontractors.
   d. A management contractor and subcontractors.

In (a) building system contracts are assigned; in (b) they may be assigned or handled as additional prime contracts; in (c) and (d) they are handled as subcontractors.

8. If the programming method of working from generalized to detailed space programming has been used, the architect and the facility users prepare the final space program and it is implemented in the building.

9. The facility is constructed.

SUGGESTED READINGS

HOW TO LEARN ABOUT BUILDING SYSTEMS

Adams, Velma. "The Trend to School Building Systems," *School Management*, August 1969, pp. 24-30, 49-54; September 1969, pp. 66-73. A good general introduction to the application of building systems to school construction.

BSIC Special Report Number One: Manufacturers' Compatibility Study. Stanford, California: BSIC, April 1970. A listing of products available for use in SCSD-type building systems including a list of manufacturer contacts and matrices showing compatibility of products.
Revision available summer 1971 at $1.00 per copy from:
BSIC/EFL
3000 Sand Hill Road
Menlo Park, California 94025.

Chase, William W. "Systems and the Single School," *Construction Products and Technology*, September 1970, pp. 41-46.

"Florida's Systems Schools." *CEFP Journal*, January-February 1970, pp. 9-16. The results of Florida's first three volume purchasing programs for building systems, with emphasis on cost and time savings achieved.

Gores, Harold B. and Alan C. Green. "Building Ideas that Save Money," *American School and University*, February 1971, pp. 13-32. A discussion of various means of saving money in educational facility provisions, including building systems, fast-tracking, renovation, mixed use, and membrane structures.

Educational Facilities Laboratories. *Systems: An Approach to School Construction*, auth. C. W. Griffin. New York: Educational Facilities Laboratories, 1971. An introduction to the use of building systems in school construction through a history of EFL supported projects—RAS, SCSD,SEF, URBS.
Available at $2.00 per copy from:
Educational Facilities Laboratories
477 Madison Avenue
New York, New York 10022

Metropolitan Toronto School Board Study of Educational Facilities. *Report T-1: Introduction to the First SEF Building System*. Toronto: March 1968. Price $20.00. A comprehensive introduction to the building systems approach to school construction. Because of this document's role in the SEF program, the emphasis is on the development of building systems products.

———. *Report T-7: Sub-System Proposals for the First SEF Building System*. Toronto: 1970. Price $10.00. A catalog of building subsystem products bid on the SEF program and available for use.
Available at price quoted plus 10 per cent postage and handling charges from:
Metropolitan Toronto School Board Study of Educational Facilities
155 College Street
Toronto 2B, Ontario, CANADA.

Miller, Richard P. "A New English Translation: 'Systems Building' for Boardmen and Administrators," *American School Board Journal*, January 1971, pp. 22-29. This article is an attempt to present the building systems approach to single school construction in a language which the layman, or lay-architect, can understand.

"Transferring School Building Systems Experience," a conference held in Washington, D.C., by BRI-BRAB, May 21-22, 1970. *Building Research*, Vol. 7, No. 2, April-May-June 1970; Vol. 7, No. 3-4, July-December 1970. The proceedings of this conference present a comprehensive, although inconsistent, view of the present state of the art.

A. Development Programs and Off-the-Shelf Projects.

Boice, John R. *A History and Evaluation of the School Construction Systems Development Project, 1961-1967*. Menlo Park, California: BSIC/EFL, summer 1971. An in-depth study of the SCSD project written by the Project Coordinator. It contains evaluative information generated about SCSD and the schools since 1967.
Available at $5.00 per copy from BSIC/EFL. Publication scheduled for summer 1971.

BSIC Newsletter. Stanford, California: BSIC, April 1969, Vol. 1, No. 1. An in-depth study of the EFL supported building systems projects—RAS, SCSD, SEF, URBS, and the Pittsburg Great High Schools—through the spring of 1969.
Available at $1.00 per copy from BSIC/EFL.

Haviland, David S. "Some Notes on School Building Systems Projects," compiled as background information for "Transferring School Building Systems Experience," BRI-BRAB conference held in Washington, D.C., May 21-22, 1970. An excellent outline history of the major building systems projects up to the spring of 1970.
Available at $3.00 per copy from:
BRI-BRAB
2101 Constitution Avenue
Washington, D.C. 20418.

Hislop, Patrick and Christopher Walker. *SCSD (School Construction Systems Development): Development of Systems Building Components by Performance Specifications*. The Building Centre Intelligence Report Number 3. London: The Building Centre Trust, 1970. A brief but comprehensive evaluation of the SCSD project.

B. The Model Building Systems Project.

BSIC Research Report Number One: K/M Associates, A Case Study in Systems Building. Stanford, California: BSIC, 1970. A study of the methods and procedures used by a firm which is active in the use of building systems on school construction.
Available at $1.00 per copy from BSIC/EFL.

Chase, William W. "Systems and the Single School," *Construction Products and Technology*, September 1970, pp. 41-46.

C. Testing the Feasibility of Building Systems Use.

Architectural Research Laboratory. *SER 1: Environmental Abstracts*. First volume of *School Environment Research*, 3 Vols. Ann Arbor: University of Michigan, 1965. A cataloging and abstracting of environmental research relevant to the design of schools. The nature of the work probably limits its usefulness for those not involved in research.

BSIC Special Report Number One: Manufacturers' Compatibility Study.

Council of Educational Facility Planners. *Guide for Planning Educational Facilities*. Columbus, Ohio: CEFP, September 1969. A comprehensive guide to the planning and programming of educational facilities.
Available at $7.50 per copy from:
Council of Educational Facility Planners
29 West Woodruff Avenue
Columbus, Ohio 43210.

D. Building Programming and Educational Requirements.

Metropolitan Toronto School Board Study of Educational Facilities. *Report E-1: Educational Specifications and User Requirements for Elementary (K-6) Schools*. Toronto: 1968. Price $10.00.

———. *Report E-2: Educational Specifications and User Requirements for Intermediate Schools*. Toronto: 1969. Price $10.00.

———. *Report E-3: Educational Specifications and User Requirements for Secondary Schools*. Toronto: 1970. Price $15.00. These documents (E-1 through E-3) form model educational specifications for schools in Toronto. Special attention has been paid to two points—the environmental and spatial implications of activities, and the underlying educational philosophy.

Available at prices quoted less 20 per cent educational discount, if applicable, from:

McGraw Hill
330 Progress Avenue
Scarborough, Ontario, CANADA
Attn: Mr. Peter Bradley.

E. Multi-stage Bidding.

Brill, Michael. "Systems Design, Performance Specifications and Building Systems: Summing Up," *Construction Products and Technology*, September 1969, pp. 33-37. An introduction to the meaning and use of performance specifications in systems building.

First California Commission on School Construction Systems. *Contract Documents and Performance Specifications for the SCSD Project, July 1963*. Stanford, California: Stanford School Planning Laboratory, 1963. The performance specifications for the four major subsystems—structure, lighting/ceiling, HVAC, and partitions—of the SCSD program.

Metropolitan Toronto School Board Study of Educational Facilities. *Report T-2: Specifications for the First SEF Building System*. Toronto: June 1968. A comprehensive set of performance specifications covering ten subsystems which account for approximately 80 per cent of building cost.

Available at $30.00 per copy plus 10 per cent for postage and handling from SEF.

Schoolhouse Systems Project. *Performance Specifications SSP Program Three*. Tallahassee, Florida: State Department of Education, 1968. Performance specifications for seven subsystems bid on one of the major nondevelopmental building systems projects.

Available from:

Schoolhouse Systems Project
Department of Education
State of Florida
Tallahassee, Florida 32304.

F. Management Contracting.

Abbott, James F. *Management Contracting at the University of California*. Berkeley, California: University of California, June 1970. This publication consists of contract documents for the management contract for the first URBS building in California plus background information on the management contracting concept.

Available free to public institutions, $2.00 per copy to all others from:

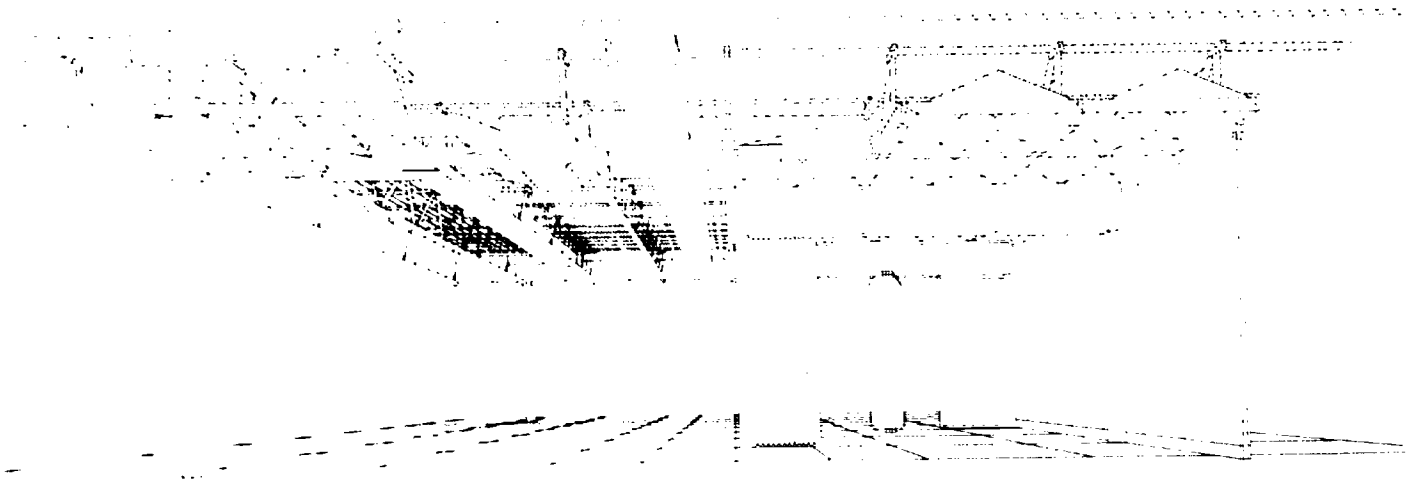
Coordinator
Construction and Maintenance
University of California
641 University Hall
Berkeley, California 94720.

"Management Contracting Brings Dividends on California Campus." *Engineering News-Record*, April 29, 1971, p. 17. The results to date of the application of the management contracting procedures described in the publication by James F. Abbott.

"Systems Building at the University of Alaska." *BSIC Newsletter*, Vol. 3, No. 2, June 1, 1971. This article describes briefly the management contracting procedures used on the University of Alaska's 1971 Capital Improvements Program.

Available free of charge from BSIC/EFL.

APPENDIX A
INTRODUCTION TO PLANNING WITH BUILDING SYSTEMS



The Building System

A building system is composed of building subsystems manufactured by a number of competing firms and engineered to be dimensionally and functionally compatible with one another (see Table I, p. 16). Four of these subsystems are major contributors to the building's form and function.

1. The *structural subsystem* gives the building its general form and sets the basic modular pattern.
2. The *mechanical, or HVC, subsystem*, provides thermal control and comfort.
3. The *lighting/ceiling subsystem* provides lighting, acoustical control, possible fire protection for the structure, and support for partitions and other subsystems, and may provide for supply and return of treated air.
4. The *partitions, or interior space division, subsystem* provides interior visual and acoustic control with a potential for change of spatial organization.

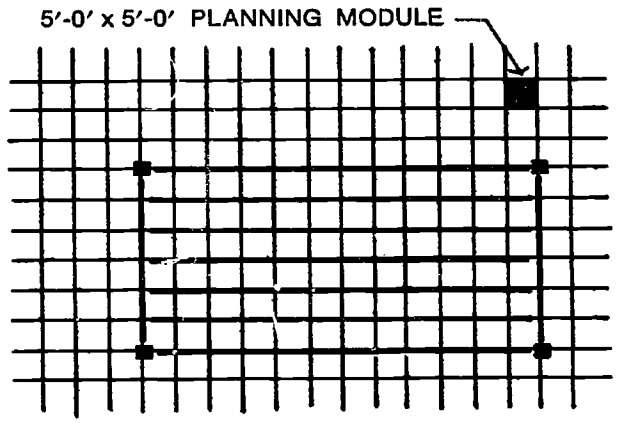
The lighting/ceiling subsystem and the horizontal elements of the structural subsystem create a service sandwich between the top of the deck and the ceiling line. This area is used for the passage of mechanical duct work and electrical and other services. With some types of HVC subsystems the service sandwich forms a return air plenum. In current products the depth of this sandwich varies from 36" to 48".

The building system may contain other subsystems, which are discussed in the section "How To Learn about Building Systems" of this report. Performance characteristics of specific subsystems may be found in *BSIC Special Report Number One: Manufacturers' Compatibility Study*.

Structural Subsystem

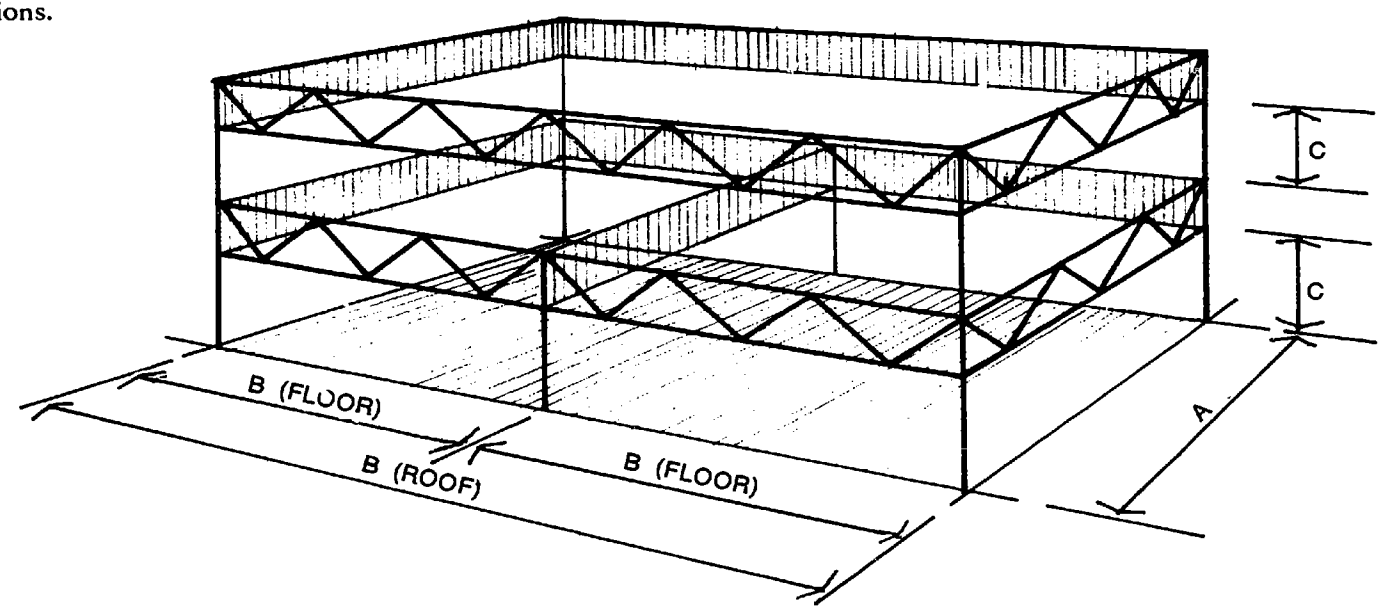
In SCSD-type building systems the horizontal dimensional planning module of the structural subsystem is 5′-0″ by 5′-0″. Although most structural products allow freedom in vertical dimensions, some introduce a vertical dimensional planning module of 1′-0″ or 2′-0″.

The center lines of structural components fall on the plannning grid lines in most available systems. With some exceptions, columns are located at the corners of structural bays *and* at the intersection of these grid lines. In some structural systems, the columns fall *within* the structural bay, either on a grid line or within a grid square.



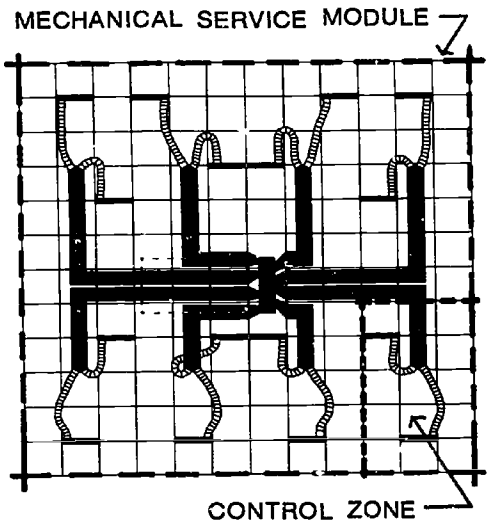
A "supermodule" is a planning module based upon the performance of a building subsystem. In the structural subsystem, the supermodule is the long span structural bay. This supermodule reflects the fact that most of these products were designed to permit large column-free spaces within the building.

The design of structural subsystems considers both the vertical and lateral load conditions normally encountered in schools and related building types. Because the magnitude of lateral loads is the result of the particular building configuration and the requirements of local wind or seismic codes, it is the responsibility of the architect and his consulting engineers to investigate the provision of shear walls and/or other lateral bracing to meet these conditions.



	floor			roof			ceiling heights
	A		B	A		B	C
available range:	5′-35′		5′-40′	5′-40′		5′-80′	as req'd.
supermodules:	25′-35′		25′-35′	25′-35′		55′-70′	9′, 10′
useful combinations:	30′	x	30′	30′	x	60′	
	30′	x	35′	30′	x	70′	

The geometry of building systems requires that design changes involving the structure be made within the disciplines of (1) dimensional coordination imposed by the planning module and (2) structural bay size and shape imposed by the supermodule. Changes in building size and shape must be made with reference to both the 5′x5′ planning module grid and the larger supermodule grid.

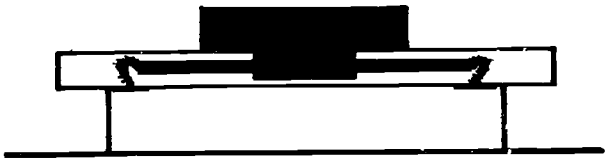


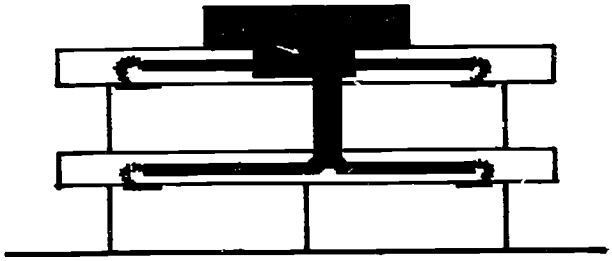
Heating/Ventilating/Cooling (HVC) Subsystem

Although virtually all types of mechanical systems have been integrated into building system designs, the most typical HVC subsystem is the multizone air handling type. These units may be full packages designed for location either on the rooftop or in mechanical spaces or they may be satellite air handling units connected to one or more central plants.

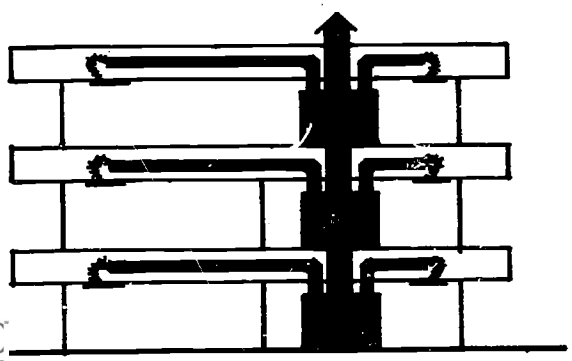
The supermodule for many multizone systems is the "mechanical service module" which varies from 2,000 to 10,000 square feet per unit depending on unit size and other factors. The mechanical service module can be divided into as many as 15 "control zones" each with a thermostat or other control device.

To ensure spatial flexibility, the distribution layout—permanent and flexible ducts located in the service sandwich—must be designed so that air may be supplied to and returned from all possible combinations of control zones by relocating only flexible ducts, boots, and diffusers.





The rooftop multizone unit has proven to be an effective solution for one- and two-story buildings. In two-story applications, a vertical chase brings ducts down to the floor-ceiling service sandwich. Beyond two stories the floor space saved by rooftop units is consumed by these vertical chases.

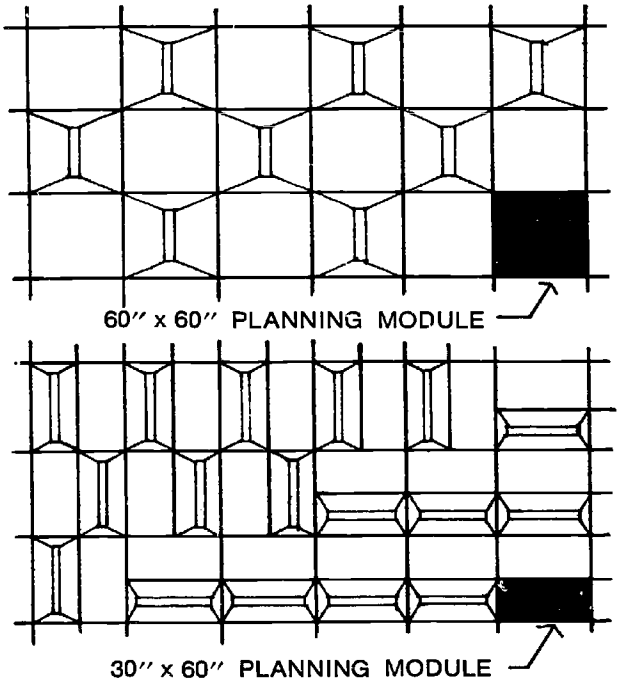


In multistory buildings, the use of multizone air handling units on each floor allows a high degree of flexibility with minimum vertical penetration for ductwork.

Lighting/Ceiling Subsystem

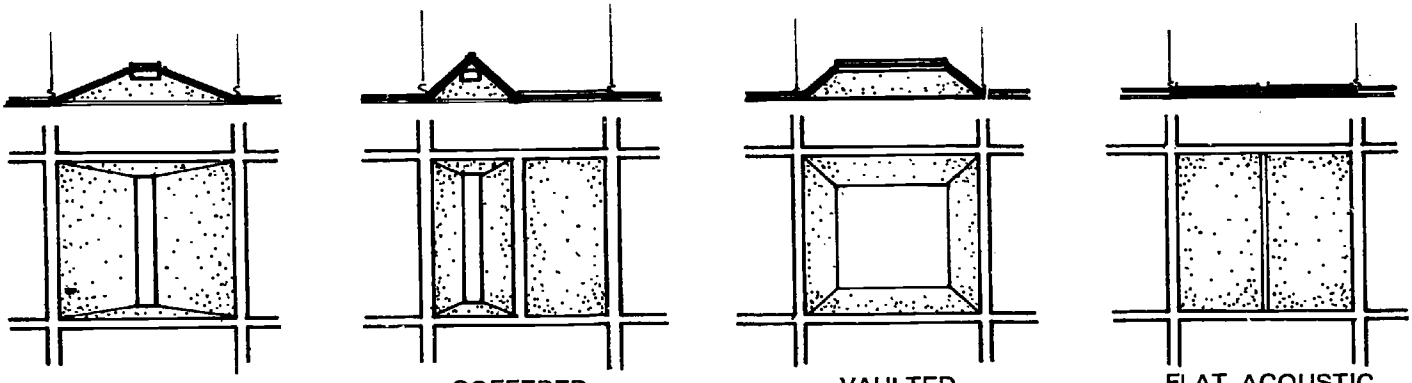
The lighting/ceiling subsystem has a horizonal planning module grid which coincides with that of the structural subsystem. In most products this planning module is either 60″ by 60″ or 30″ by 60″. Some product lines offer both these modules and may permit them to be used interchangeably.

The center line of the ceiling grid runners falls on the planning grid lines. This ceiling grid provides support for other ceiling elements, partitions, and other components, and is often the location of the air supply and return diffusers.



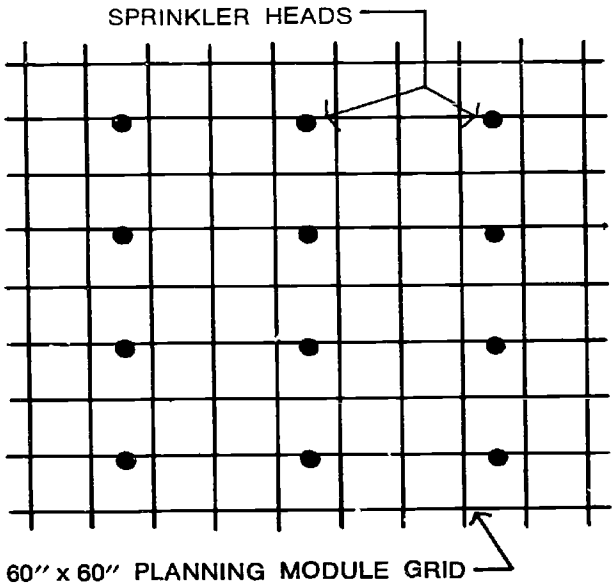
Several types of ceiling infill may be placed on these runners, creating two basic types of ceilings—coffered or vaulted and flat. By combining these ceilings with various types of lighting fixtures—direct, indirect, luminous ceiling, recessed, and surface mounted—a variety of ceiling configurations can be created, some of which are illustrated below.

The fixtures and lenses in most of these products are designed so that, as a rule of thumb, the equivalent of a single two 40W tube lumination level of at least 70 footcandles with relatively low fixfixture in each 60″ by 60″ module will produce a maintained ilture brightness.



COFFERED DIRECT (1) | COFFERED DIRECT (2) | VAULTED LUMINOUS CEILING | FLAT ACOUSTIC PANEL

The ceiling is one of the main elements of acoustic control in the building system. Because in many cases sound isolating partitions do not penetrate the ceiling, the sound attenuation of the ceiling is of great importance. In addition, attention to the sound absorbing qualities of the ceiling is necessary, especially in large open-plan spaces.



Fire resistance for steel floor-ceiling and roof-ceiling assemblies is provided largely by the ceiling. In addition to the fire rating required for structural protection, and with concrete structural systems where this rating may not be necessary, the ceiling may have to be rated separately from the total assembly in order to provide fire protection for an air return plenum, if such is used.

Partitions Subsystem

In most cases elements of the partition subsystem are located on the planning module of the lighting/ceiling subsystem. With some lighting/ceiling and/or partition products, however, partitions may be located off the ceiling grid. Several types of partitions are available for use with the other subsystems of a building system. These partitions have varying degrees of flexibility and types should be carefully selected to provide the flexibility actually required by the design. With the development of furniture and casework products which are dimensionally coordinated with the building system, the division of interior space into functional units should utilize a variety of elements and not partitions alone.

The major types are:

1. *Fixed partitions*, normally a part of the general construction contract, are used where the location of the wall will likely be the same over the building's life, such as fire walls, some wet walls, and vertical shaft walls.
2. *Demountable/movable partitions* are used where long term flexibility is desired and require mechanical attachment to the floor and ceiling.
3. *Portable partitions* can be quickly and easily relocated by relatively untrained persons and are used where short term flexibility is desired.
4. *Operable panel and accordion partitions* are primarily used where spaces are repeatedly divided on a more or less regular basis; the high cost of these partitions and the fact that they are normally underused reduces their usefulness.

PPENDIX B
UGGESTED STANDARDS FOR DRAWINGS USED IN THE ARLY BIDDING OF BUILDING SUBSYSTEMS

OTES TO STANDARDS:

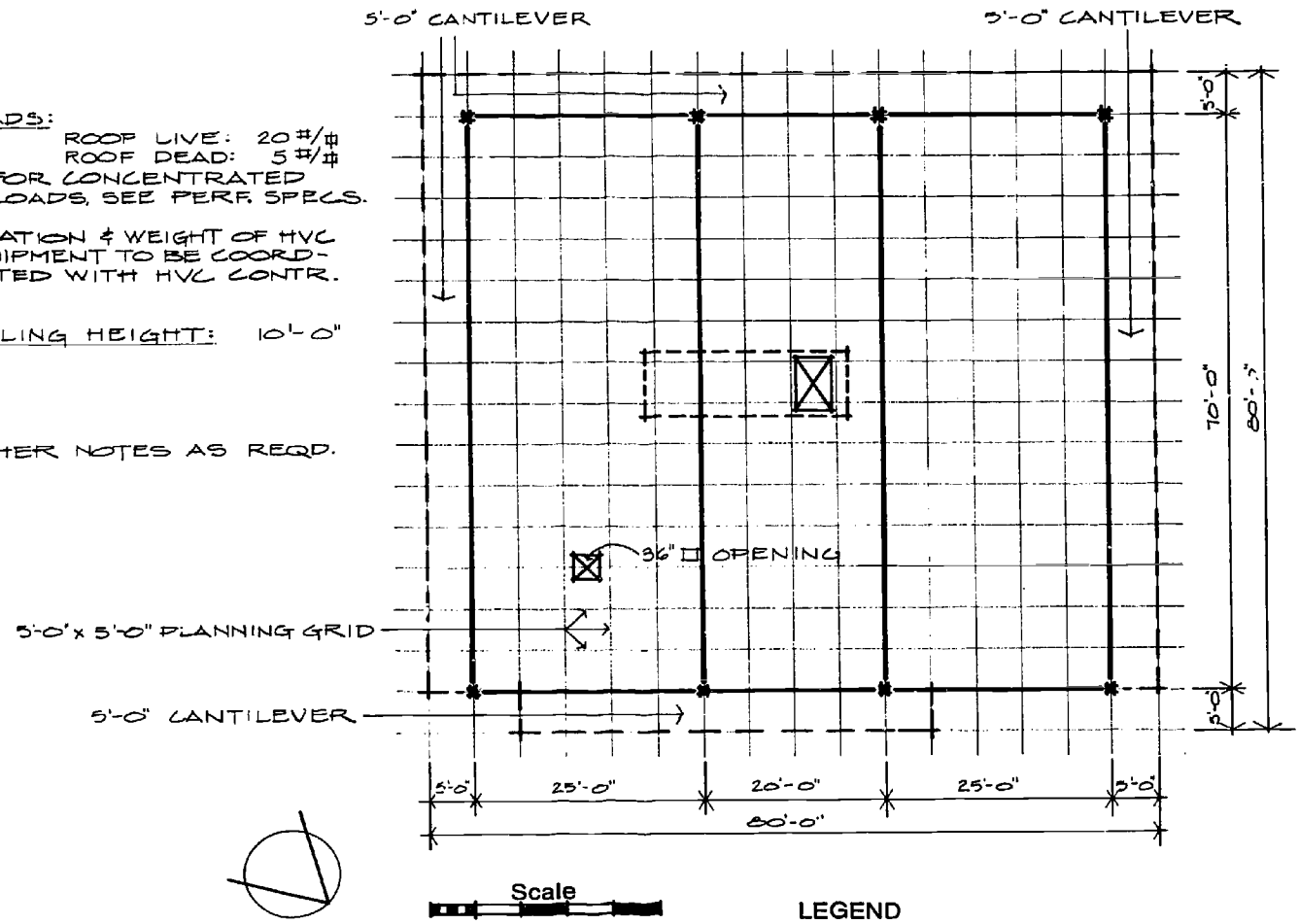
1. These standards are intended to show clarity and completeness of early bidding ("prebidding") drawings. Actual project drawings may include items not shown in these standards or may contain different information.
2. The symbols selected in these standards have been chosen to provide consistency in these drawings only. The set of symbols used on project drawings will have to be selected by the architect. Symbols should be clear, logical, and unambiguous.
3. The early bidding documents consist of, at least, drawings, specifications, and bidding sheets for each subsystem. None of these items should be considered in isolation from the others. Neither drawings, specs, nor bidding sheets present the entire subsystem by themselves.

LOADS:
ROOF LIVE: 20 #/#
ROOF DEAD: 5 #/#
FOR CONCENTRATED LOADS, SEE PERF. SPECS.

LOCATION & WEIGHT OF HVC EQUIPMENT TO BE COORDINATED WITH HVC CONTR.

CEILING HEIGHT: 10'-0"

OTHER NOTES AS REQD.



ROOF STRUCTURAL PLAN

LEGEND

Column

Structural bay outline

Fascia

Roof opening

HVC unit

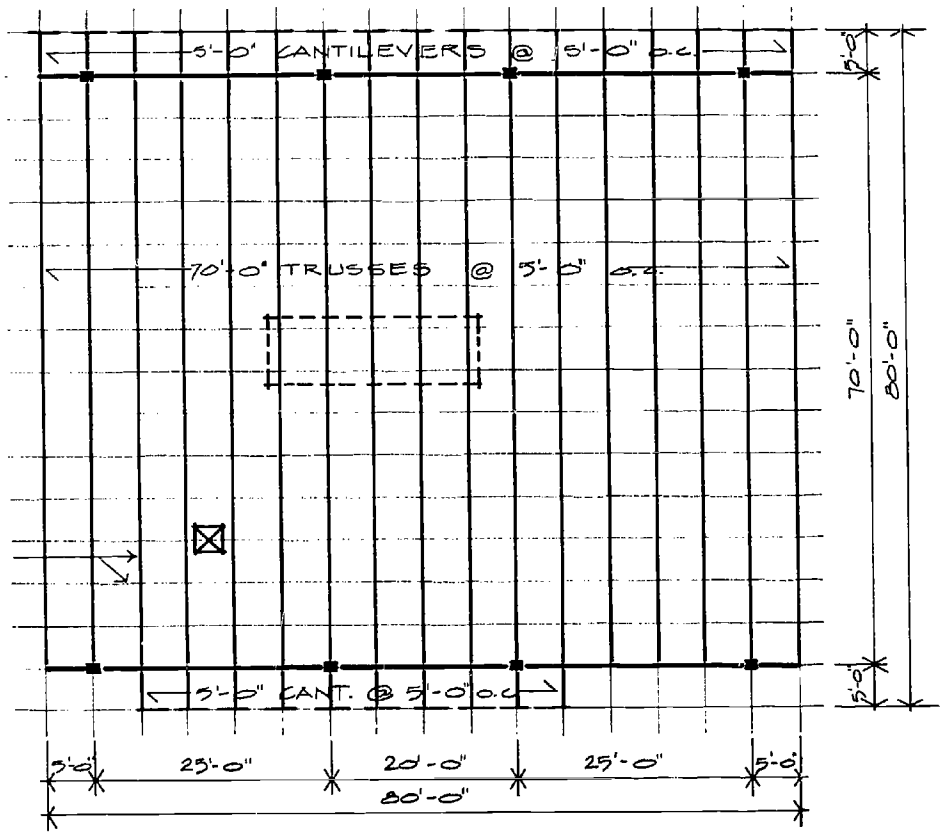
1. Locate columns and outline structural bays. Column location may be indicated by "acceptable column location zones" in lieu of specific location (see page 33).
2. Indicate special structural conditions such as cantilevers, known openings, and special loading conditions.
3. Indicate floor to ceiling heights.
4. Location of rooftop HVC units and required openings may be indicated or may be handled as an interface requirement for bidders.

STRUCTURAL SUBSYSTEM METHOD A
OUTLINING OF STRUCTURAL BAYS

NOTES AS FOR METHOD "A" — SEE PRECEEDING SHEET.

OTHER NOTES AS REQD.

5'-0" x 5'-0" PLANNING GRID



Scale

LEGEND

Column

Primary spanning element

Secondary spanning element

Fascia line

Roof opening

HVC unit

ROOF STRUCTURAL PLAN

1. Locate structural elements on five foot planning grid. Column location may be indicated by "acceptable column location zones" in lieu of specific location (see page 33).
2. Indicate special structural conditions such as cantilevers, known openings, and special loading conditions.
3. Indicate floor to ceiling heights.
4. Location of rooftop HVC units and required openings may be indicated or may be handled as an interface requirement for bidders.

STRUCTURAL SUBSYSTEM METHOD B SIMPLIFIED FRAMING PLAN

LOADS: ROOF LIVE 20 #/#
ROOF DEAD 5 #/#

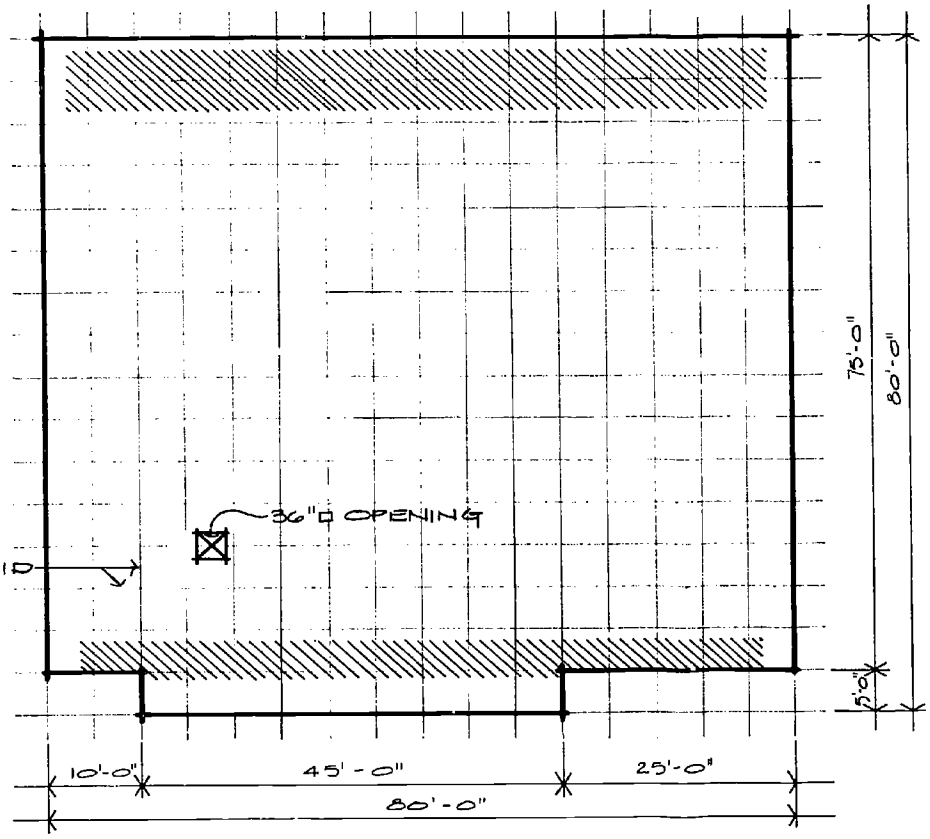
SEE PERF. SPECS FOR CONCENTRATED LOADS.

LOCATION, WEIGHT, & ROOF OPENINGS FOR HVC UNITS TO BE COORDINATED WITH HVC BIDDERS.

CEILING HEIGHT: 10'-0"

OTHER NOTES AS REQD.

5'-0" x 5'-0" PLANNING GRID



Scale

LEGEND

Area in which columns are acceptable

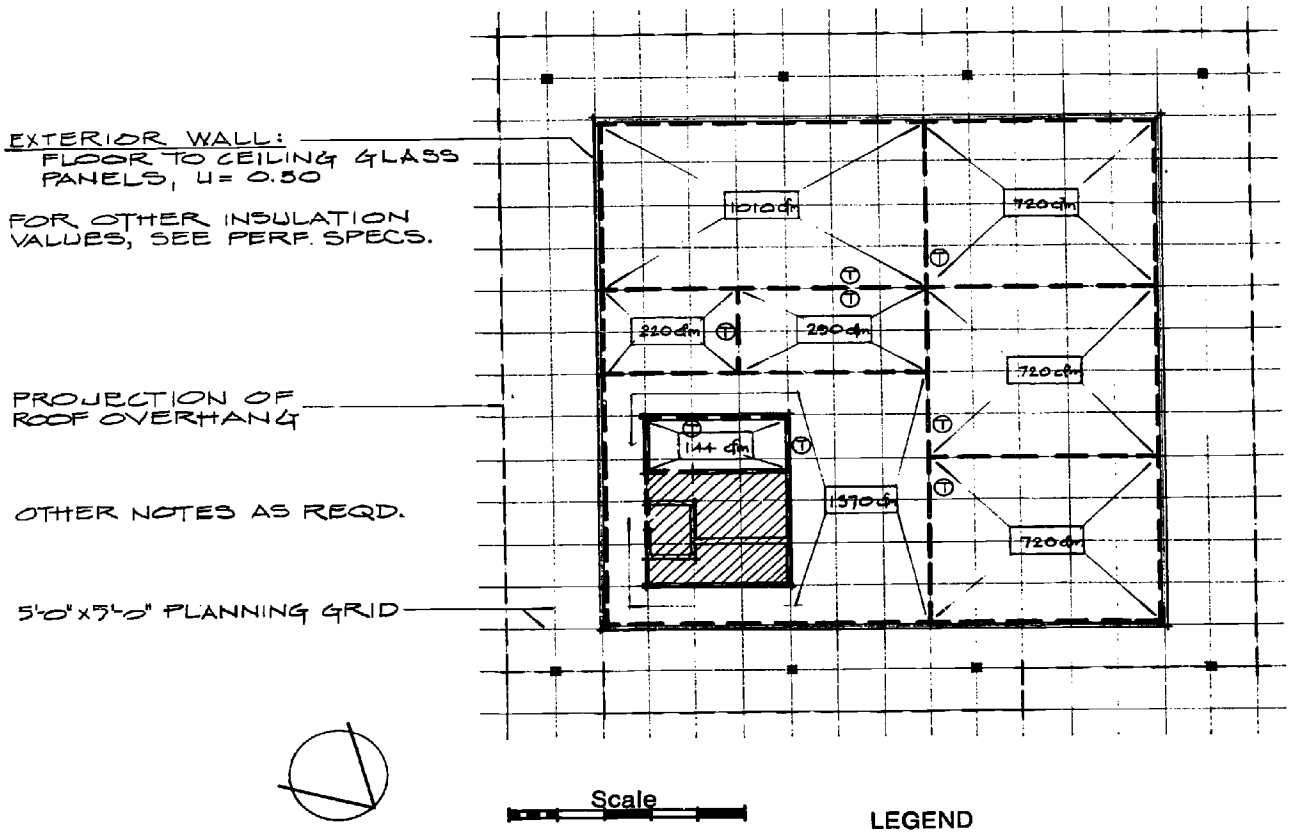
Structural perimeter outline

Roof opening

ROOF STRUCTURAL PLAN

1. Locate columns or "acceptable column location zones." Outline building structural perimeter.
2. Indicate special structural conditions such as cantilevers, known openings, and special loading conditions.
3. Indicate floor to ceiling heights.
4. Location of rooftop HVC units and required openings may be indicated or may be handled as an interface requirement for bidders.

STRUCTURAL SUBSYSTEM METHOD C
OUTLINING OF STRUCTURAL PERIMETER



LEGEND

Control zone boundary

CFM per control zone

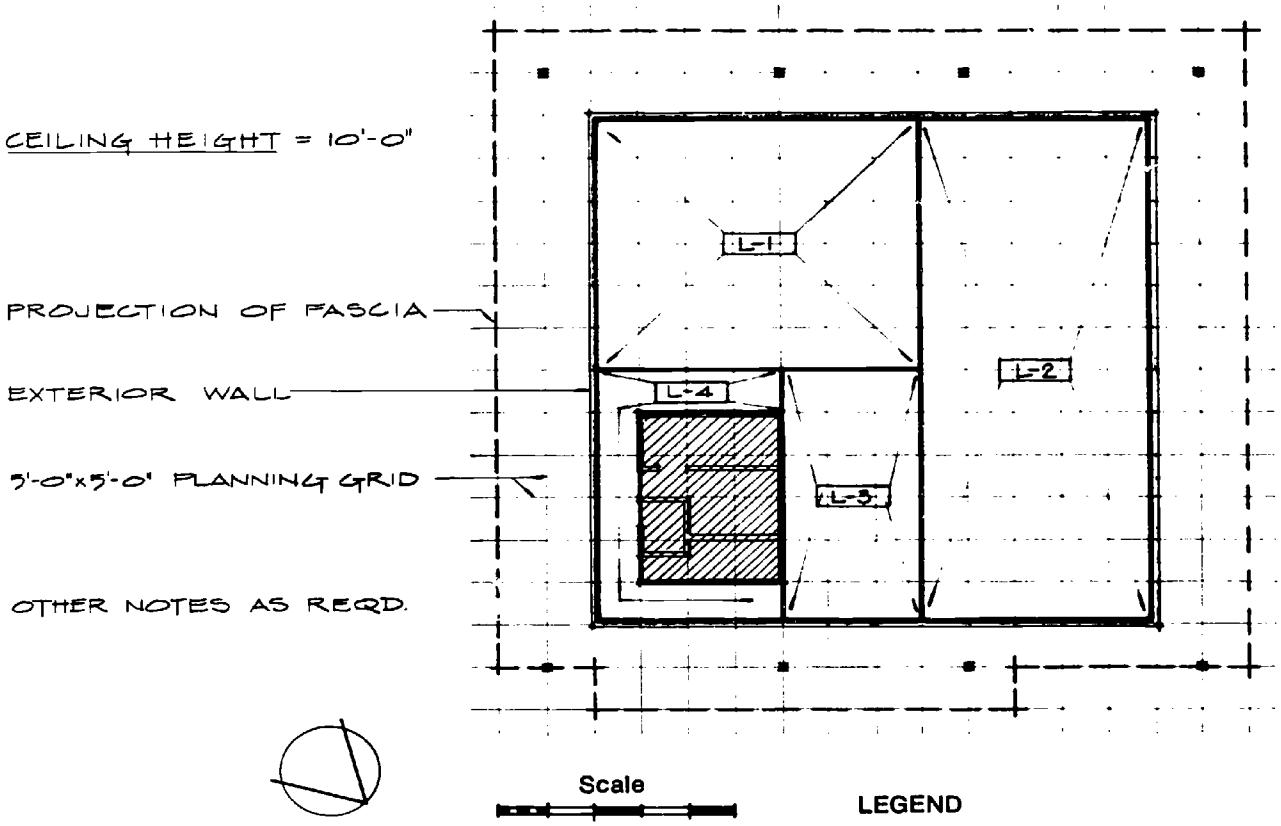
Nonsystems area

Thermostat

FLOOR PLAN—HVC

1. Locate all fixed elements—column, fixed partitions, exterior wall, etc. on planning grid. Indicate nonsystems areas.
2. Indicate areas of known flexible space and their HVC control zones.
3. Indicate control zones in areas of nonflexible space.
4. If desired, indicate locations of controls.
5. Indicate factors affecting HVC—wall and roof U-factors, ceiling heights, etc.
6. Show CFM for each zone.

HEATING / VENTILATING / COOLING SUBSYSTEM



LEGEND

Lighting type boundary

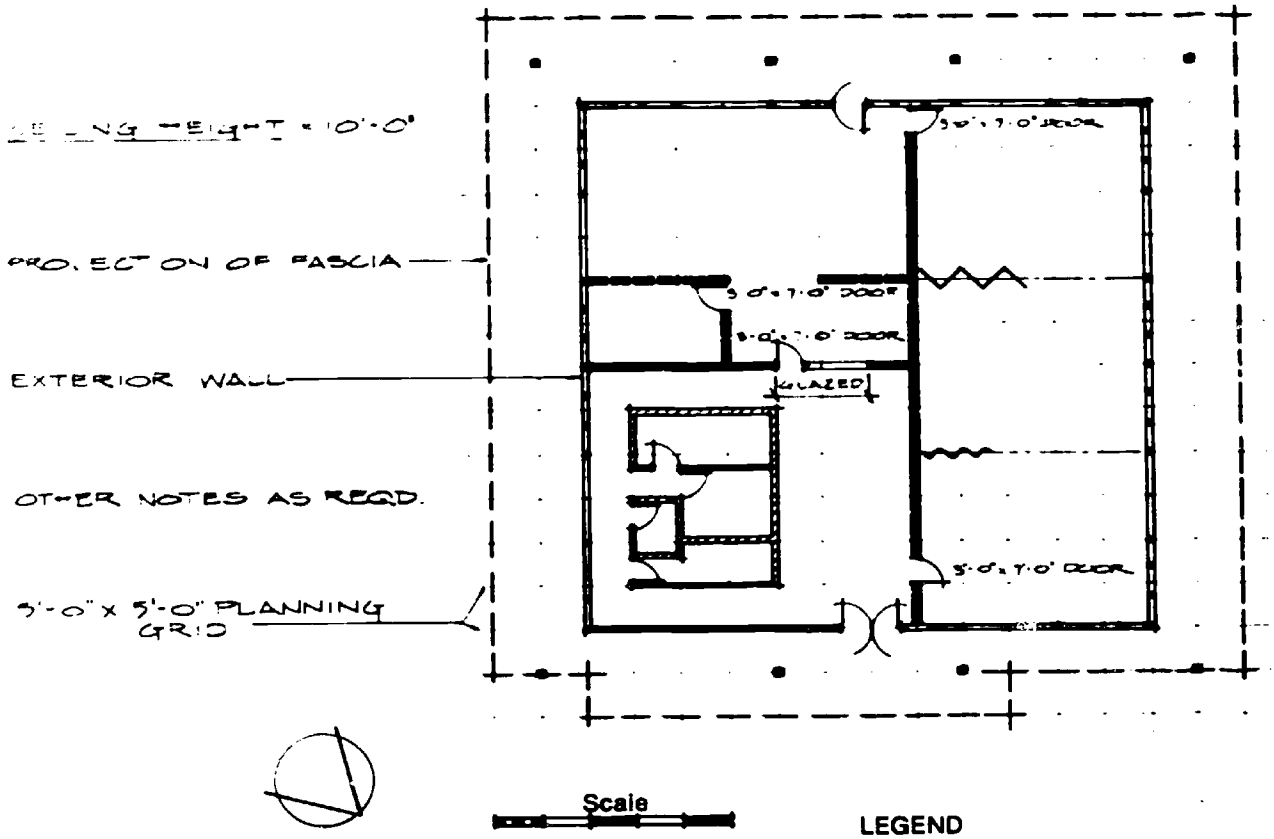
Lighting type indicator

Nonsystems area

REFLECTED CEILING PLAN

1. Locate all fixed elements—column, fixed partitions, exterior wall, etc. on planning grid. Indicate nonsystems areas.
2. Outline lighting type areas.
3. Enter lighting type designation in each area.

LIGHTING / CEILING SUBSYSTEM



Scale

LEGEND

Exterior wall (nonsystems)

Fixed partitions (nonsystems)

Demountable partitions

Glazed demountable

Portable partitions

Special surface

Operable panel partition

Operable accordion partition

FLOOR PLAN—PARTITIONS

1. Locate all fixed elements—column, fixed partitions, exterior wall, etc. on planning grid. Indicate nonsystems elements.
2. Locate all elements of partition subsystem.
3. Indicate floor to ceiling heights.

PARTITIONS SUBSYSTEM

APPENDIX C
SAMPLE BIDDING FORMS FOR THE EARLY BIDDING OF BUILDING SUBSYSTEMS

SAMPLE BID PROPOSAL FORM

PROJECT:_____

STRUCTURAL SUBSYSTEM

The undersigned hereby proposes and agrees to furnish any and all labor, materials, equipment, transportation and services for the supply and installation of this building subsystem as indicated in the Contract Documents and the following addenda:_____.

It is hereby confirmed that this proposal is compatible with product assemblies of at least one bidder from each of the HEATING/VENTILATING/COOLING (HVC) and LIGHTING/CEILING subsystem categories.

The undersigned further agrees that his company name may be listed on the proposal forms of all bidders named below. It is understood that the Owner will consider subsystems to be compatible only when the names of compatible bidders are mutually listed.

It is further understood (a) that bids will be awarded only on a composite basis which includes the four subsystem categories; structure, HVC, lighting/ceiling, and partitions, and that the bid price to be considered by the Owner will be the sum of the four lump figures from four compatible subsystem categories, and (b) that if a manufacturer submits bids to cover two or more of the subsystem categories, he shall submit a separate price for each category on the proposal form for that category.

COMPATIBLE BIDDERS

HVC	LIGHTING/CEILING	TOTAL LUMP SUM BASIC BID PRICE
		($)
		($)
		($)
		($)

BIDDER'S NAME _____

PRODUCT DESIGNATION _____

BIDDER'S ADDRESS _____

_____

SIGNATURE _____

SIGNING OFFICER _____

OFFICE HELD _____ DATE_____

SAMPLE PROPOSAL PRICE BREAKDOWN, STRUCTURAL SUBSYSTEM

PROJECT:_____

COMPATIBLE BIDDERS WITH WHOM THESE PRICES APPLY:

HVC	LIGHTING/CEILING	TOTAL LUMP SUM BASIC BID PRICE

SQUARE FOOTAGES: Roof:_____sq ft

Floor:_____sq ft

UNIT PRICES FOR HOLES:

Bidder shall include in his total lump sum bid price the cost of providing holes through structure in the sizes and quantities shown below. He shall provide a single unit price for these holes which may be used to make additive or deductive adjustments when the exact number of holes is known.

Size	Through Roof		Through Floor	
	Quantity	Unit Price per Hole	Quantity	Unit Price per Hole
up to 6" sq.				
over 6" to 12" sq.				
over 12" to 24" sq.				
over 24" to 48" sq.				

BASIC BID PRICE: Roof: $_____

Floor: $_____

Total: $_____

UNIT PRICES FOR ± 5% ADDITION OR SUBTRACTION:

$$\frac{\text{Roof Price Total } \$\_\_\_\_\_}{\text{Roof sq ft } \_\_\_\_\_ \text{sf}} = \$\_\_\_\_\_/\text{sq ft}$$

$$\frac{\text{Floor Price Total } \$\_\_\_\_\_}{\text{Floor sq ft } \_\_\_\_\_ \text{sf}} = \$\_\_\_\_\_/\text{sq ft}$$

SUBSYSTEM BIDDER:_____DATE:_____

SAMPLE BID PROPOSAL FORM

PROJECT: _____

HEATING/VENTILATING/COOLING (HVC) SUBSYSTEM

The undersigned hereby proposes and agrees to furnish any and all labor, materials, equipment, transportation and services for the supply and installation of this building subsystem indicated in the Contract Documents and the following addenda: _____.

It is hereby confirmed that this proposal is compatible with product assemblies of at least one bidder from each of the STRUCTURAL and LIGHTING/CEILING subsystem categories.

The undersigned further agrees that his company name may be listed on the proposal forms of all bidders named below. It is understood that the Owner will consider subsystems to be compatible only when the names of compatible bidders are mutually listed.

It is further understood (a) that bids will be awarded only on a composite basis which includes the four subsystem categories: structural, HVC, lighting/ceiling, and partitions, and that the bid price to be considered by the Owner will be the sum of the four lump figures from four compatible subsystem categories, and (b) that if a manufacturer submits bids to cover two or more of the four subsystem categories, he shall submit a separate price for each category on the proposal form for that category.

COMPATIBLE BIDDERS

STRUCTURE	LIGHTING/CEILING	TOTAL LUMP SUM BASIC BID PRICE
		($)
		($)
		($)
		($)

BIDDER'S NAME _____

PRODUCT DESIGNATION _____

BIDDER'S ADDRESS _____

_____

SIGNATURE _____

SIGNING OFFICER _____

OFFICE HELD _____ DATE _____ CORPORATE SEAL

SAMPLE PROPOSAL PRICE BREAKDOWN, HEATING/VENTILATING/COOLING SUBSYSTEM

PROJECT:_____

COMPATIBLE BIDDERS WITH WHOM THESE PRICES APPLY:

STRUCTURE	LIGHTING/CEILING	TOTAL LUMP SUM BASIC PRICE BID

SQUARE FOOTAGE: HVC Service Area:_____sq ft

FLEXIBLE DUCT UNIT PRICES:

Bidder shall include in his total lump sum bid price the cost of providing all fixed and/or flexible ductwork. He shall also provide a single unit price for each of the following items which may be used to make additive or deductive adjustments when exact numbers of these items are known.

Item	Installed Unit Price
12' flex duct and boot* including connections at both ends	($)
6' flex duct and boot* including connections at both ends	($)

UNIT PRICE FOR ± 5% ADDITION OR SUBTRACTION:

$$\frac{\text{HVC Basic Bid Price } \$\_\_\_\_\_}{\text{HVC Square Footage } \_\_\_\_\_\text{sf}} = \$\_\_\_\_\_/\text{sq ft}$$

SUBSYSTEM BIDDER:_____DATE:_____

* Note to sample sheet only: The air diffuser boots are often supplied by the lighting/ceiling contractors as a part of their subsystem.

SAMPLE BID PROPOSAL FORM

PROJECT:_____

LIGHTING/CEILING SUBSYSTEM

The undersigned hereby proposes and agrees to furnish any and all labor, materials, equipment, transportation and services for the supply and installation of this building subsystem indicated in the Contract Documents and the following addenda:_____.

It is hereby confirmed that this proposal is compatible with product assemblies of at least one bidder from each of the STRUCTURE, HEATING/VENTILATING/COOLING (HVC), and PARTITIONS subsystem categories.

The undersigned further agrees that his company name may be listed on the proposal forms of all bidders named below. It is understood that the Owner will consider subsystems to be compatible only when the names of compatible bidders are mutually listed.

It is further understood (a) that bids will be awarded only on a composite basis which includes the four subsystem categories: structure, HVC, lighting/ceiling, and partitions, and that the bid price to be considered by the Owner will be the sum of the four lump figures from four compatible subsystem categories, and (b) that if a manufacturer submits bids to cover two or more of the subsystem categories, he shall submit a separate price for each category on the proposal form for that category.

COMPATIBLE BIDDERS

STRUCTURE	HVC	PARTITIONS	TOTAL LUMP SUM BASIC BID PRICE
			($)
			($)
			($)
			($)

BIDDER'S NAME _____

PRODUCT DESIGNATION _____

BIDDER'S ADDRESS _____

_____

SIGNATURE _____

SIGNING OFFICER _____

OFFICE HELD _____ DATE_____ CORPORATE SEAL

SAMPLE PROPOSAL PRICE BREAKDOWN, LIGHTING/CEILING SUBSYSTEM

PROJECT: _____

COMPATIBLE BIDDERS WITH WHOM THESE PRICES APPLY:

STRUCTURE	HVC	PARTITIONS	TOTAL LUMP SUM BASIC BID PRICE
			$

SQUARE FOOTAGE: Lighting Classifications L-1, L-2, L-3, and L-4 _____sq ft

AIR DIFFUSER UNIT PRICES:

Bidder shall include in his total lump sum bid price the cost of providing all supply and return air linear diffusers to be installed in the ceiling. He shall also provide a single unit price of each of these diffusers which may be used to make additive or deductive adjustments when the exact number of these items is known.

Item	Installed Unit Price
Supply Air Diffuser	($)
Return Air Diffuser	($)

UNIT PRICES FOR ± % ADDITION OR SUBTRACTION:

Lighting Classification	Module	Installed Unit Price * Lighted Module	Unlighted Module
L-1			
L-2			
L-3			
L-4			

SUBSYSTEM BIDDER _____ DATE: _____

* Note to sample sheet only: Unit prices for materials only may be requested in addition to, or in lieu of, installed unit prices when installation by this contractor is optional or not required.

SAMPLE BID PROPOSAL FORM

PROJECT:_____

PARTITIONS SUBSYSTEM

The undersigned hereby proposes and agrees to furnish any and all labor, materials, equipment, transportation and services for the supply and installation of this building subsystem indicated in the Contract Documents and the following addenda:_____.

It is hereby confirmed that this proposal is compatible with product assemblies of at least one bidder from the LIGHTING/CEILING subsystem category.

The undersigned further agrees that his company name may be listed on the proposal forms of all bidders named below. It is understood that the Owner will consider subsystems to be compatible only when the names of compatible bidders are mutually listed.

It is further understood (a) that bids will be awarded only on a composite basis which includes the four subsystem categories: structure, heating/ventilating/cooling, lighting/ceiling, and partitions, and that the bid price to be considered by the Owner will be the sum of the four lump figures from four compatible subsystem categories, and (b) that if a bidder submits bids to cover two or more of the subsystem categories, he shall submit a separate price for each category on the proposal form for that category.

COMPATIBLE BIDDERS

LIGHTING/CEILING	TOTAL LUMP SUM BASIC BID PRICE
	($)
	($)
	($)
	($)

BIDDER'S NAME _____

PRODUCT DESIGNATION _____

BIDDER'S ADDRESS _____

_____

SIGNATURE _____

SIGNING OFFICER _____

OFFICE HELD _____ DATE_____ CORPORATE SEAL

SAMPLE PROPOSAL PRICE BREAKDOWN, PARTITIONS SUBSYSTEM

PROJECT:_____

COMPATIBLE BIDDER WITH WHOM THESE PRICES APPLY:

LIGHTING/CEILING	TOTAL LUMP SUM BASIC BID PRICE
	$

LINEAR FOOTAGE:

Type	Height	Linear Feet	Bid Price Total
Demountable			$
Portable			$
Operable Panel			$
Operable Accordion			$

SPECIAL SURFACE UNIT PRICES:

Bidder shall include in his total sum unit bid price the cost of providing all special surfaces. He shall also provide a single unit price for each of these surfaces which may be used to make additive and deductive adjustments when the exact quantity of these items is known.

	Installed Unit Prices		
Partition Type	Chalk Surface	Tack Surface	Projection Surface
Demountable	$ /ln ft	$ /ln ft	$ /ln ft
Portable	$ /ln ft	$ /ln ft	$ /ln ft

UNIT PRICES FOR ± 5% ADDITION OR SUBTRACTION:

___' Demountable Price Total $_____ = $_____/ln ft
___' Demountable ln ft _____lf

___' Portable Price Total $_____ = $_____/ln ft
___' Portable ln ft _____lf

Operable Panel Price Total $_____ = $_____/ln ft
Operable Panel ln ft _____lf

Operable Accordion Price Total $_____ = $_____/ln ft
Operable Accordion ln ft _____lf

SUBSYSTEM BIDDER:_____DATE:_____

APPENDIX D
SAMPLE LETTERS OF INTENT

The following letters are based on documents used in actual projects and are intended as examples only.

LETTER FROM SCHOOL BOARD TO NOMINATED SUBSYSTEM CONTRACTOR

May 6, 1971

Rosmith Steel Company, Inc.
P. O. Box 1291
New York, New York 10022

Re: Subsystem No. 1, Structure

Gentlemen:

It is the intent of the Hypothetical Board of Education to assign your proposal for furnishing and installing Subsystem No. 1, Structure, in the amount of $140,967.00 on the new Hypothetical High School to the successful General Contractor. This will be done contingent upon the receipt of proper bids and the sale of the school revenue bonds.

This, of course, will be done in the name of the Hypothetical City Council, as they will be the legal owners of the building. It is anticipated that the working drawings will be out for bids within three (3) weeks from date of this letter and we will allow four (4) weeks for bidding and analyzing the complete general works. In addition, approximately four (4) to six (6) weeks will be required to advertise and sell the bonds. This makes a total of eleven (11) to thirteen (13) weeks from this date to the anticipated date of contract with a General Contractor.

You are to proceed immediately with the subsystem drawings and other information required by the plans and specifications. Please forward this information direct to the School Board's architect, Olson and Johnson, Inc., and if you have any questions concerning this project, get in touch with them.

Sincerely,

William R. Jones, Superintendent
Hypothetical City Schools

J:rp
: Olson and Johnson, Inc.

LETTER FROM SCHOOL BOARD TO NOMINATED SUBSYSTEM CONTRACTOR

August 1, 1969

Mr. Robert Smith, Jr., President
Rosmith Steel Company, Inc.
P. O. Box 1291
New York, New York 10022

Hypothetical High School
Project No. 1598

Your Prebid Proposal,
Dated June 30, 1969

Dear Mr. Smith:

Following review and evaluation by our consultant team of Bids received pertaining to certain component subsystems relating to the Subject Project, the Hypothetical Board of Education, at a special meeting on July 28, 1969 has taken the following action.

As outlined in the Prebid Construction Documents, dated May 29, 1969, prepared by Olson and Johnson, Inc., Architects, the Board of Education, on or before October 1, 1969, intends to enter into contract with you based upon the terms stated in Part III-Component Contract of the Construction Documents. The contract, in the amount of $47,533.00, will include the furnishing and installation of Components Subsystem No. 1 titled Structure in accordance with the provisions noted in the Prebid Construction Documents, the Prebid Proposal Form and Addenda issued during the bidding period.

It should be noted that the Board of Education, consistent with the intent of the Construction Documents, may wish to include your Prebid Proposal in the total building program Construction Documents in lieu of following the assignment procedure referred to in Part III of the Prebid Construction Documents. Should this be done, your firm would ultimately become a subcontractor to the successful General Contractor as would also be true in the case of assignment.

Further, it should be understood that this correspondence is a letter of intent only. Subsequent execution of a Components Contract (or inclusion of your Prebid Proposal in the executed general building program contracts) is subject to receipt of total construction bids within the Board of Education's Construction Budget.

Please acknowledge your receipt of this letter and your acceptance of the terms stated therein by returning a signed copy of this letter to the Hypothetical Board of Education.

Very truly yours,

Hypothetical Board of Education
Hypothetical, Ohio

By_____
President

By_____
Clerk

Dated_____

Accepted_____

By_____
Rosmith Steel Co., Inc.

LETTER FROM GENERAL CONTRACTOR TO NOMINATED SUBSYSTEM CONTRACTOR

March 15, 1971

World Lighting Company, Inc.
161 West Second Avenue
Chicago, Illinois 60894

Attention: Mr. Charles Green, President

Re: New School, Cleveland, Ohio

Gentlemen:

This letter will express our intent to enter into a subcontract with you to furnish and erect subsystem No. 3, lighting/ceiling, for the above referenced project. The award will be in accordance with your proposal dated March 5, 1971, for said work for the sum of $65,996.

The heating, ventilating, and air conditioning contractor for the Cleveland project has not been determined as yet but an award will be made within the next few days. As soon as this award has been made, you will be notified as to the name of the company and the individual to contact in order to coordinate the two systems.

Please review the Critical Path Schedule for this project and make certain that you can comply with the schedule dates on shop drawings and calculations as well as the completion date.

We look forward to working with you on this project as well as the one in Phoenix.

Very truly yours,

John M. Cook, Jr.
Executive Vice President
National Contractors, Inc.

JMCJ:to