



ARE® 5.0 Handbook

Introduction

This handbook has been developed to help you prepare for the ARE. While the *ARE 5.0 Guidelines* provide information on how to take the exam and exam policies, this handbook provides information on what content will be assessed on the exam.

In this handbook, you will find:

- Descriptions of ARE 5.0 and information on how the exam is structured to assesses candidates
- A breakdown of the sections and objectives of each ARE 5.0 division
- Sample items for each section
- Suggested resources and references you may refer to while preparing for the exam
- Information on resources available to you during the exam

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INTRODUCTION

What is the ARE?

The Architect Registration Examination® (ARE®) is developed by the National Council of Architectural Registration Boards (NCARB). The ARE is used by U.S. jurisdictions as the registration examination for candidates seeking architectural registration. It is also accepted by select Canadian provincial and territorial architectural associations for registration.

The ARE assesses a candidate's knowledge and skills to provide various services required in the practice of architecture. No single examination can test for competency in all aspects of architectural practice; the ARE is not intended for that purpose. The ARE concentrates on the professional services that affect the public's health, safety, and welfare.

In addition to testing for competence in specific subject areas, NCARB is aware of the responsibilities an architect may have for coordinating the activities of others involved in the design/construction process. The ARE assesses a candidate's qualifications in exercising the skills and judgment of a generalist working with numerous specialists. In short, the objective is to reflect the practice of architecture as an integrated whole.

DEFINITION OF COMPETENCE AS RELATED TO THE ARE

To protect the health, safety, and welfare of the public, a newly licensed architect practicing independently must demonstrate the competence to be responsible for a project from its inception through completion. This includes, but is not limited to, the ability to:

- Apply architectural business practices
- Evaluate legal, ethical, and contractual standards
- Establish and coordinate project team activities
- Establish programmatic and regulatory requirements
- Provide design alternatives Evaluate and incorporate appropriate materials and building systems
- Provide and coordinate project documentation for a building and site
- Provide construction phase services
- Assess the project during all phases

INTRODUCTION

Understanding ARE 5.0

NCARB used the results of the NCARB 2012 *Practice Analysis of Architecture* when developing ARE 5.0 to determine the critical knowledge and skills an architect must perform competently. These knowledge and skills were organized into **six practice-based divisions**:

PcM Practice Management

PjM Project Management

PA Programming & Analysis

PPD Project Planning & Design

PDD Project Development & Documentation

CE Construction & Evaluation

Each division is broken down into multiple sections, and each section has objectives on which candidates will be assessed. All of the questions, or items, on an ARE division are authored to assess candidates based on the objectives in that division.

While preparing for the ARE, it is important to understand the cognitive level at which items are targeted for each objective. The cognitive level guides the authoring of items for the exam so that each item represents the appropriate level of assessment at the point of licensure. Some objectives only require the understanding of a concept, while other objectives require analysis and evaluation.

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Understanding ARE 5.0

ARE 5.0 uses one of two levels to designate the appropriate cognitive complexity of each objective: Understand/Apply (U/A) and Analyze/Evaluate (A/E).



Understand/Apply: deduction of meaning from information, demonstration of comprehension of concepts or processes, application of processes or procedures in familiar or unfamiliar situations.

- Requires conceptual understanding to answer
- Focuses on standard, straight-forward application of knowledge
- May require the employment of a mathematical formula



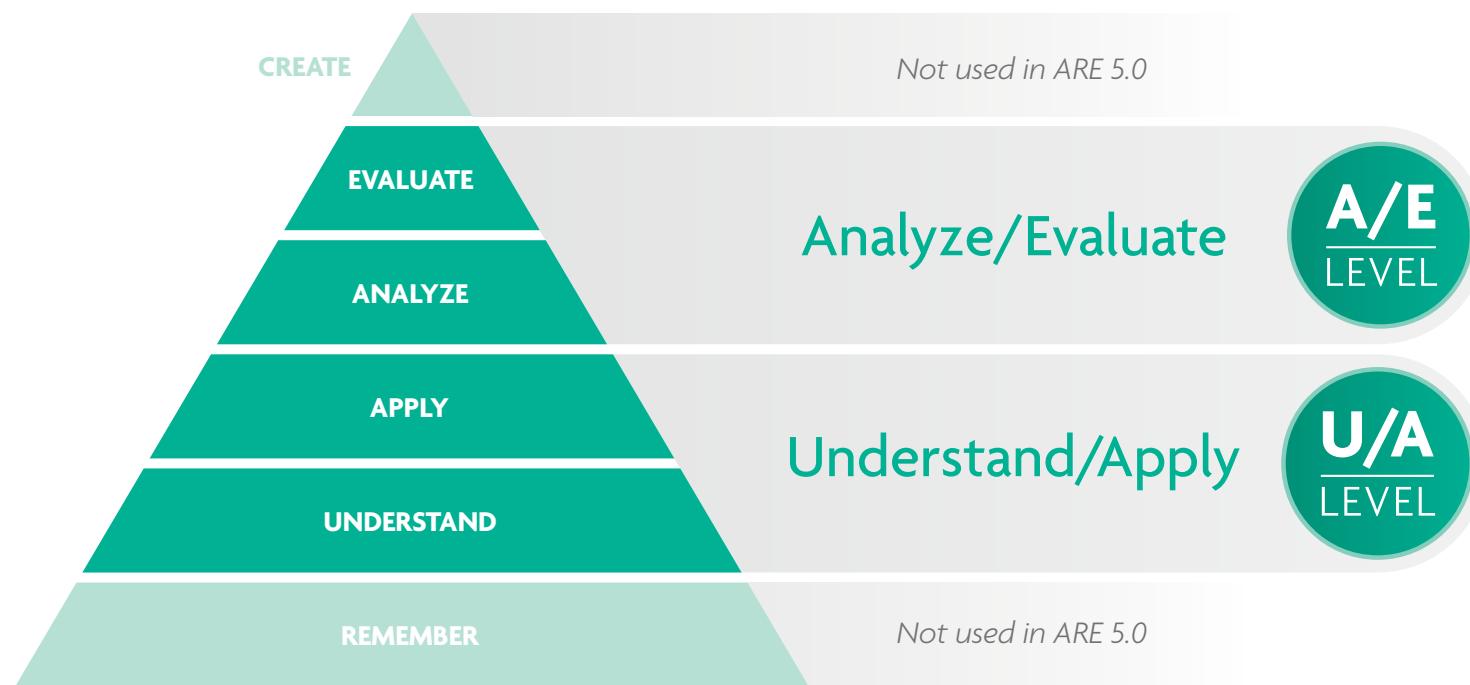
Analyze/Evaluate: reduction of overall concept into component parts, determination of how parts relate to one another and to the overall structure, arrival at judgments based on given criteria.

- Requires integration of new information with existing information
- May require the prioritization of information
- Often focuses on non-standard situations

INTRODUCTION

Understanding ARE 5.0

ARE 5.0 avoids the use of “Remember,” the lowest level of cognitive complexity, or “Create,” the highest level of cognitive complexity, as they are not appropriate for the assessment of a newly licensed architect.



Throughout this handbook you will see a cognitive complexity designation after each objective. All of the sample items in this handbook contain an explanation of what makes the item a certain cognitive level.

Understanding the expected level of cognitive complexity for each objective should help you self-assess your knowledge and skills and better prepare for each division.

Practice Management

Practice Management (PcM)

This division will assess objectives related to the management of architectural practice, including professional ethics, fiduciary responsibilities, and the regulations governing the practice of architecture. The division will focus on issues related to pre-contract tasks including negotiation, human resource management, and consultant development. Candidates must demonstrate an understanding of and abilities in business structure, business development, and asset development and protection.

| | |
|---|-----------|
| SECTION 1: Business Operations | 10 |
| SECTION 2: Finances, Risk, & Development of Practice | 15 |
| SECTION 3: Practice-Wide Delivery of Services | 19 |
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| Practice Management References | 26 |

DIVISION DESCRIPTION

Practice Management

DIVISION DETAILS

| ITEMS | TEST DURATION | APPOINTMENT DURATION* |
|-------|---------------|-----------------------|
| 80 | 2 hr 45 min | 3 hr 30 min |

*Appointments allow for introductory screens, a break if you choose, and closing screens.

The 80 items will assess you on four sections related to Practice Management. The number of items from each section will vary based on the targeted percentage of items within each section.

SECTION DETAILS

| SECTIONS | EXPECTED NUMBER OF ITEMS | TARGET PERCENTAGE |
|--|--------------------------|-------------------|
| SECTION 1: Business Operations | 16-21 | 20-26% |
| SECTION 2: Finances, Risk, & Development of Practice | 23-28 | 29-35% |
| SECTION 3: Practice-Wide Delivery of Services | 17-23 | 22-28% |
| SECTION 4: Practice Methodologies | 13-18 | 17-23% |

This division will test a candidate's ability to protect the public's health, safety, and welfare by:

- Applying competent delivery of professional architectural services
- Applying the laws and regulations of architectural practice
- Evaluating legal, ethical, and contractual standards in the performance of architectural tasks

Business Operations

In this section you will need to understand that running a business requires attention to staffing, regulations, insurance, ethics, and the appropriate Standard of Care.

OBJECTIVE 1.1

Assess resources within the practice (A/E)

You will need to be able to analyze the staffing needs of a practice and recommend criteria and protocols for hiring, staffing assignments, staff evaluations, staff scheduling, and professional development.

OBJECTIVE 1.2

Apply the regulations and requirements governing the work environment (U/A)

You will need to demonstrate your understanding of laws, regulations, and insurance that apply to running a practice, including health insurance, worker's compensation, general liability, and labor laws.

OBJECTIVE 1.3

Apply ethical standards to comply with accepted principles within a given situation (U/A)

You will determine the appropriate responses to given situations which demonstrate your understanding of laws, rules of conduct, and ethics in responding to client requests and business practices. This could include issues such as plagiarism, copyright or intellectual property infringement, exaggeration, and libel or slander.

OBJECTIVE 1.4

Apply appropriate Standard of Care within a given situation (U/A)

You will need to understand the Standard of Care and its implications on providing professional services, the impact of errors and omissions, and how to appropriately respond to unknown conditions in order to protect the health, safety, and welfare of the public.

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SAMPLE ITEM 1

| Name | Title | Licensed in Jurisdiction of Office Location | Licensed in Jurisdiction of Apartment Complex | Years of Experience | Current Utilization Rate | Work Experience |
|------------|----------------------|---|---|---------------------|--------------------------|---|
| Employee A | Principal / Co-owner | Yes | Yes | 30 | 75% | Museums, Hotels, K-12 Education, Higher Education |
| Employee B | Principal / Co-owner | Yes | No | 28 | 45% | Healthcare |
| Employee C | Architect | Yes | Yes | 19 | 85% | Hotels, Condominiums |
| Employee D | Architect | Yes | No | 14 | 50% | Museums, Healthcare |
| Employee E | Architect | Yes | Yes | 13 | 25% | Healthcare, Hotels, Condominiums, Residential |
| Employee F | Architect | Yes | No | 7 | 75% | Healthcare, Higher Education |
| Employee G | Architect | No | Yes | 3 | 95% | Sports and Recreation |
| Employee H | Project Manager | Yes | Yes | 15 | 47% | Hotels, Condominiums |
| Employee I | Project Manager | No | Yes | 12 | 88% | Healthcare |
| Employee J | Project Manager | No | No | 8 | 96% | K-12 Education, Higher Education, Residential |

An architecture firm has been selected to design a 4-story apartment complex in a neighboring jurisdiction. The office-staffing leader is in the process of assigning dedicated architecture staff to the project.

Click on the name of the employee in the staff list above who is most appropriate to be the project architect and responsible for the overall design and development of the apartment complex.

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| Name | Title | Licensed in Jurisdiction of Office Location | Licensed in Jurisdiction of Apartment Complex | Years of Experience | Current Utilization Rate | Work Experience |
|------------|----------------------|---|---|---------------------|--------------------------|---|
| Employee A | Principal / Co-owner | Yes | Yes | 30 | 75% | Museums, Hotels, K-12 Education, Higher Education |
| Employee B | Principal / Co-owner | Yes | No | 28 | 45% | Healthcare |
| Employee C | Architect | Yes | Yes | 19 | 85% | Hotels, Condominiums |
| Employee D | Architect | Yes | No | 14 | 50% | Museums, Healthcare |
| Employee E | Architect | Yes | Yes | 13 | 25% | Healthcare, Hotels, Condominiums, Residential |
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| Employee I | Project Manager | No | Yes | 12 | 88% | Healthcare |
| Employee J | Project Manager | No | No | 8 | 96% | K-12 Education, Higher Education, Residential |

RATIONALE: The process for assigning staffing resources within an architecture firm is discussed in *The Architect's Handbook of Professional Practice*. First, you must evaluate firm staff on availability, experience, and credentials. You must also verify alignment with the roles and responsibilities of the position with the project requirements. Employee E is licensed in the project's jurisdiction, is only charging 25 percent of their time to firm projects, and has work experience on related project types. Based on the information provided, this makes them the most appropriate choice to serve as project architect for the new apartment complex.



This is an **A/E level** item requiring you to evaluate firm resources and determine staffing based on the requirements of a building project.

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SAMPLE ITEM 2

Which of the following types of insurance policies help protect an architectural firm? **Check the three that apply.**

- Builder's Risk Insurance
- Commercial General Liability Insurance
- Health Insurance
- Life Insurance
- Professional Liability Insurance
- Workers' Compensation Insurance

CORRECT RESPONSE

Which of the following types of insurance policies help protect an architectural firm? **Check the three that apply.**

- Builder's Risk Insurance
- Commercial General Liability Insurance**
- Health Insurance
- Life Insurance
- Professional Liability Insurance**
- Workers' Compensation Insurance**

RATIONALE: *The Architect's Handbook of Professional Practice* describes the different types of insurance and their importance to the practice of architecture. Commercial General Liability Insurance covers nonprofessional aspects of a practice, including property damage, bodily injury, and advertising injury. Professional Liability Insurance, also referred to as Errors and Omissions Insurance, helps protect a firm against negligence in the performance of their professional duties. Workers' Compensation Insurance provides medical benefits and wages to an employee injured on the job in exchange for the employee's right to sue the employer for negligence, eliminating the need for litigation. All three of these help protect the firm. Builder's Risk Insurance is typically carried by owners or contractors to cover liability and loss during building construction. Although an architecture firm may provide employees health and life insurance as benefits to employees, they do not directly protect the firm.



This is a **U/A level** item that requires an understanding of the different types of insurance and how they apply to an architectural practice.

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SAMPLE ITEM 3

Using an integrated project delivery methodology, what can the owner expect from an architect?

- The architect's and consultant's drawings will be free of errors
- The architect will guarantee the quality and completeness of the building design
- The architect will perform services in accordance with the highest industry standards
- The architect will provide service in a reasonable and prudent manner

CORRECT RESPONSE

Using an integrated project delivery methodology, what can the owner expect from an architect?

- The architect's and consultant's drawings will be free of errors
- The architect will guarantee the quality and completeness of the building design
- The architect will perform services in accordance with the highest industry standards
- The architect will provide service in a reasonable and prudent manner**



RATIONALE: According to *The Architect's Handbook of Professional Practice*, providing services in a reasonable and prudent manner aligns with the professional standard of care for architects, while limiting the architect's liability exposure. The architect and consultants are not required to perform services perfectly and free of errors, nor is it a realistic expectation. Avoiding building design guarantees and standards higher than what are required by law will also limit the architect's liability.

This is a **U/A level** item that requires you to understand standard of care within the practice of architecture and how it applies to project execution and owner expectations.

Finances, Risk, & Development of Practice

This section is about how running and developing a practice requires attention to finances, mitigating risk and liability, and negotiating services and contracts. This is the largest section within the Practice Management division.

OBJECTIVE 2.1

Evaluate the financial well-being of the practice (A/E)

You will need to be able to analyze financial data, business strategies, and the firm's strategic priorities to identify actions that position the practice appropriately.

OBJECTIVE 2.2

Identify practice policies and methodologies for risk, legal exposures, and resolutions (U/A)

You will need to understand the implications of various types of projects, client types, and contract terms as they relate to risk, legal exposure, and insurance coverage. The application of conflict resolution techniques to various situations that arise within a practice is also a necessary component.

OBJECTIVE 2.3

Select and apply practice strategies for a given business situation and policy (U/A)

You will need to understand the impact of and apply decision-making related to negotiations of services, contracts, and scope adjustments, as well as protecting intellectual property in a given business situation.

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SAMPLE ITEM 4

Refer to the exhibit.

Office leadership at an A/E firm is performing an evaluation of the efficiency of their office and overall effectiveness of each employee.

Based on the information provided, what is utilization rate of Architect A?

%

| ARCHITECT A | | | |
|-------------|---------------------------------|------------------------------|----------------------|
| ID | PROJECT NAME | TASK/ROLE | AVERAGE WEEKLY HOURS |
| 01886.01 | Westside Community Center | Project Manager | 20 |
| 02778.06 | City View Rehabilitation Clinic | Project Manager | 7.5 |
| 01994.02 | Parkside Apartments | Drawing Review/ Redlining | 4.5 |
| 03020.00 | Northview Gymnasium | Responding to RFP | 4.5 |
| 02001.02 | Office Operations | Firm Staffing | 2.5 |
| 09012.01 | Continuing Education | Varies | 1 |

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80 %

RATIONALE: According to *The Architect's Guide to Small Firm Management* and *The Architect's Handbook of Professional Practice*, utilization rate is a measure of the effective use of labor and is calculated by dividing an employee's direct labor by their total labor. First, you need to identify the direct labor hours for Architect A (**Step 1**). Time spent on the Westside Community Center, City View Rehabilitation Clinic, and Parkside Apartments is all direct labor because it is charged to each project. Hours spent on responding to an RFP, firm staffing, and continuing education are considered indirect labor (**Step 2**). By dividing the direct labor hours by the total hours, you determine that Architect A's utilization rate is 80% (**Step 3**). Because the % symbol is given next to the answer box, you know the correct answer should be represented as a percentage, not a decimal.

| ARCHITECT A | | | |
|-------------|---------------------------------|--------------------------|----------------------|
| ID | PROJECT NAME | TASK/ROLE | AVERAGE WEEKLY HOURS |
| 01886.01 | Westside Community Center | Project Manager | 20 |
| 02778.06 | City View Rehabilitation Clinic | Project Manager | 7.5 |
| 01994.02 | Parkside Apartments | Drawing Review/Redlining | 4.5 |
| 03020.00 | Northview Gymnasium | Responding to RFP | 4.5 |
| 02001.02 | Office Operations | Firm Staffing | 2.5 |
| 09012.01 | Continuing Education | Varies | 1 |

Step 1: 20 hrs. + 7.5 hrs. + 4.5 hrs. = 32 hrs.

Step 2: 32 hrs. + 4.5 hrs. + 2.5 hrs. + 1 = 40 hrs.

Step 3: 32 hrs. / 40 hrs. = .8 which is 80%



This is an **A/E level** item requiring you to analyze an employee's use within an architecture office to determine the effectiveness of their labor.

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SAMPLE ITEM 5

A client has requested to use their own design services agreement. During contract negotiations, which of the following should the architect ensure are included in the contract to minimize risk? **Check the four that apply.**

- A stipulated monetary penalty for the architect's late performance
- Architect's right to rely on the accuracy and completeness of owner-furnished information
- Architect's right to suspend services and terminate the agreement for the owner's failure to make payments
- Architect's warranty of building performance
- Architect's relief of responsibility for construction means and methods
- Owner's consultants must maintain professional liability insurance

RATIONALE: Evaluating an owner-generated agreement and negotiating changes to a contract can protect an architect from unnecessary risk. According to *The Architect's Handbook of Professional Practice*, relying on the accuracy and completeness of owner-furnished information protects the architect from being liable for services and drawings provided by the owner. The architect's right to suspend or terminate services for the owner's failure to make payments protects the architect from financial loss. Relief of responsibility for construction means and methods protects the architect from construction-related deficiencies that are a result of contractor error. Requiring the owner's consultants to maintain professional liability insurance protects the architect from errors and omissions in the consultants' work. Including a monetary penalty for the architect's late performance and an architect's warranty in the contract would unnecessarily increase the architect's liability risk.

CORRECT RESPONSE

A client has requested to use their own design services agreement. During contract negotiations, which of the following should the architect ensure are included in the contract to minimize risk? **Check the four that apply.**

- A stipulated monetary penalty for the architect's late performance
- Architect's right to rely on the accuracy and completeness of owner-furnished information**
- Architect's right to suspend services and terminate the agreement for the owner's failure to make payments**
- Architect's warranty of building performance
- Architect's relief of responsibility for construction means and methods**
- Owner's consultants must maintain professional liability insurance**



This is an **U/A level** item that requires you to understand and identify contract terms and conditions in order to reduce risk when dealing with an owner-generated contract.

Practice-Wide Delivery of Services

In this section you will need to look at projects in the context of their impact on the overall running of a practice.

OBJECTIVE 3.1

Analyze and determine response for client services requests (A/E)

One of the most important things you will need to do as an architect is assess the scope of services needed, completeness of requests, public interest conflicts, and fee proposal based on client requests.

OBJECTIVE 3.2

Analyze applicability of contract types and delivery methods (A/E)

You will also need to differentiate between the appropriate types of contracts and agreements, estimate the impact and risk of changes to contracts, and understand the impact of various delivery options for a given project.

OBJECTIVE 3.3

Determine potential risk and/or reward of a project and its impact on the practice (A/E)

You must be able to evaluate projects to assess their value, liability, risk, opportunity, and anticipated benefit to the practice as a whole.

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SAMPLE ITEM 6

An architecture firm is expanding into the healthcare market and has been selected to design a new hospital building on a previously undeveloped site. The client requires a design-bid-build delivery method be used.

When preparing the proposal for professional services, which factors should the architect consider?

Check the three that apply.

- Capabilities of the contractor
- Requirements for a brownfield site assessment
- Level of risk associated with the project
- Project schedule
- Guaranteed maximum price (GMP)
- Specialty consultants required

CORRECT RESPONSE

An architecture firm is expanding into the healthcare market and has been selected to design a new hospital building on a previously undeveloped site. The client requires a design-bid-build delivery method be used.

When preparing the proposal for professional services, which factors should the architect consider?

Check the three that apply.

- Capabilities of the contractor
- Requirements for a brownfield site assessment
- Level of risk associated with the project**
- Project schedule**
- Guaranteed maximum price (GMP)
- Specialty consultants required**

RATIONALE: The preparation of a proposal for professional services, including the factors that can affect level of services, is discussed in *The Architect's Handbook of Professional Practice*. It is important for the architect to consider the schedule and its impact on project costs and project scope. The architect must also consider the level of risk associated with the project type or similar factors. Finally, the need for specialty consultants will influence the project design fee. Because this is a design-bid-build project, the capabilities of the contractor would not be a factor to consider when preparing the proposal. A GMP is typically a component of the construction manager as constructor delivery method and not applicable to this proposal. Since this is a previously undeveloped site, a brownfield site assessment is not required.

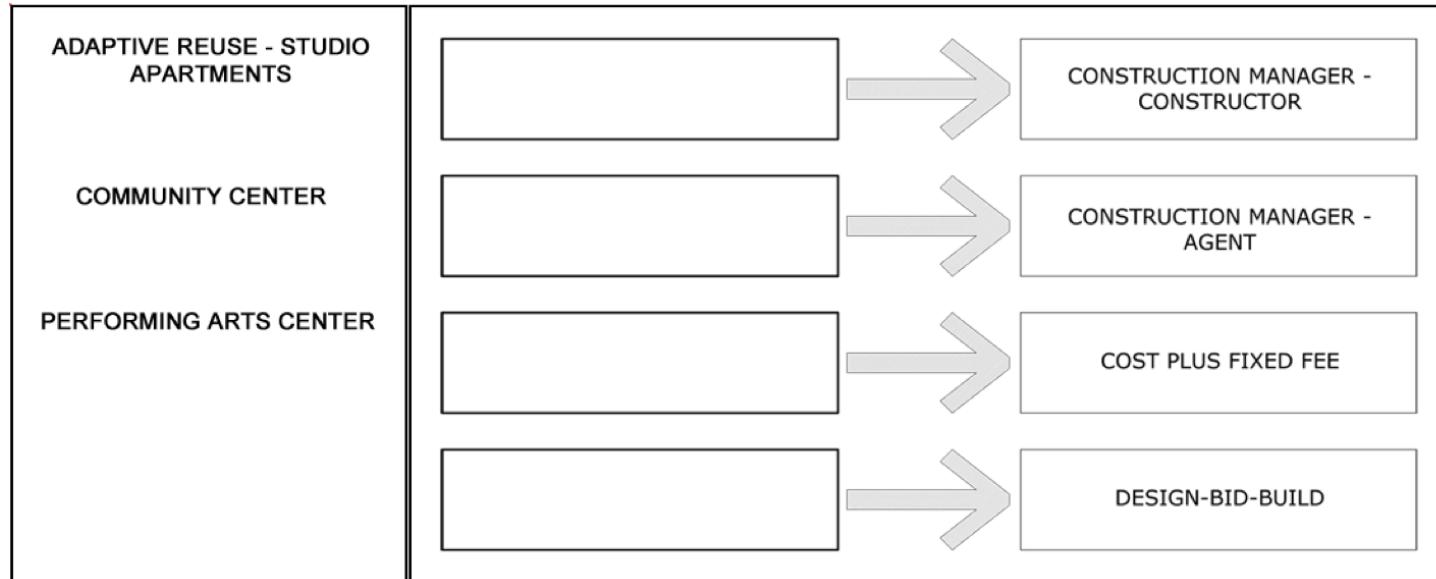


This is an **A/E level** item requiring you to determine the factors and information that are critical to the preparation of a professional services proposal.

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SAMPLE ITEM 7



An architecture firm has been awarded the following projects:

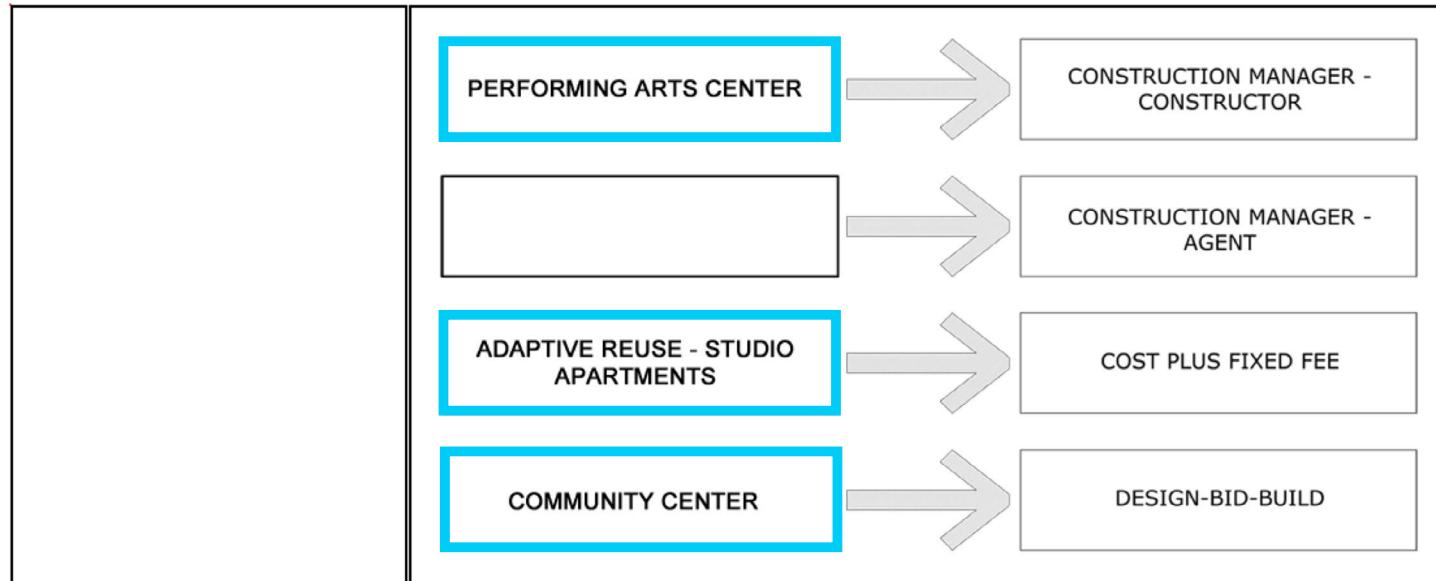
- A community center with a simple program, fixed budget, and the client's desire for contractor competition.
- A performing arts center with an aggressive schedule and the client's need to know a final construction cost during the design phase.
- The adaptive reuse of an existing industrial building, which contains multiple unknown conditions, into studio apartments.

Drag the project names from the left into the boxes of the most appropriate delivery method for each project.

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SAMPLE ITEM 7 - CORRECT RESPONSE



RATIONALE: Methods of project delivery and their characteristics are discussed in *Professional Practice: A Guide to Turning Designs into Buildings* and *The Architect's Handbook of Professional Practice*. In the design-bid-build methodology, project cost is a primary driver because contractors submit fixed price bids, allowing the owner to select a contractor at or under the owner's budget. This delivery method fulfills the community center's requirement of a fixed budget and contractor competition. In the construction manager as constructor delivery method, the contractor can provide technical advice early in the design process and a guaranteed maximum price (GMP) based on early design documents. They are also able to implement a fast track schedule with multiple construction documentation packages, fulfilling the requirements of the performing arts center. The construction manager as agent delivery method can provide the owner with early construction consulting, but does not provide a final construction cost during the design phase. Since the adaptive reuse project contains unknown conditions, a cost plus fixed fee delivery method would be the most appropriate because it disconnects the contractor's profit from any increase in project costs that may occur during construction.



This is an **A/E level** item because it requires the evaluation of different project goals and their alignment with various methods of project delivery.

Practice Methodologies

In this section you will need to analyze how a practice is structured to achieve their goals and how to coordinate various projects and services within a practice. This section is the smallest of the four sections in the Practice Management division.

OBJECTIVE 4.1

Analyze the impact of practice methodologies relative to structure and organization of the practice (A/E)

Architects must be able to examine various ways to structure a practice to achieve the firm goals. This requires you to have an understanding of the various business structures and the role evidence-based design plays in order to achieve the firm goals.

OBJECTIVE 4.2

Evaluate design, coordination, and documentation methodologies for the practice (A/E)

You must also be able to evaluate the impact of various methodologies and analyze how these methodologies impact quality control and security throughout all phases of a project.

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SAMPLE ITEM 8

Two architects are forming a new architectural design firm and need to choose a business entity. One architect anticipates bringing several existing clients while the other architect is leaving a larger firm and is unable to bring clients. They will initially only conduct business in one state and have no plans to add additional employees. The architects would like to protect their personal assets and maximize their tax benefits.

Which legal entity should the architects establish for their practice?

- Limited Liability Partnership
- General Partnership
- Sole Proprietorship
- Sub C Corporation

CORRECT RESPONSE

Two architects are forming a new architectural design firm and need to choose a business entity. One architect anticipates bringing several existing clients while the other architect is leaving a larger firm and is unable to bring clients. They will initially only conduct business in one state and have no plans to add additional employees. The architects would like to protect their personal assets and maximize their tax benefits.

Which legal entity should the architects establish for their practice?

- Limited Liability Partnership
- General Partnership
- Sole Proprietorship
- Sub C Corporation

RATIONALE: According to *Law for Architects: What You Need to Know* and *The Architect's Handbook of Professional Practice*, partners of a Limited Liability Partnership (LLP) are not personally liable for obligations of the LLP, but may be liable for their own personal negligence. LLP's are not required to pay federal taxes, as income and losses are reported on each individual's tax return. A Sole Proprietorship and General Partnership provide no liability protection for personal assets. Although Sub C Corporations protect stockholders' personal assets, both the corporation and stockholders pay federal taxes.



A/E
LEVEL

This is an **A/E level** item that requires you to compare and align goals of an architectural practice with business and legal structures.

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REFERENCES**SAMPLE ITEM 9**

A small architecture firm that specializes in educational and recreational facilities is developing a new quality control policy.

Which of the following should the policy require to manage the quality of project documentation? **Check the three that apply.**

- All construction details come from the firm's library of standard details
- A project team meeting at the completion of each phase
- Completion of a LEED checklist
- In-house third-party document reviews
- Completion of a deliverable checklist for each phase
- Use of the design-bid-build delivery method

CORRECT RESPONSE

A small architecture firm that specializes in educational and recreational facilities is developing a new quality control policy.

Which of the following should the policy require to manage the quality of project documentation? **Check the three that apply.**

- All construction details come from the firm's library of standard details
- A project team meeting at the completion of each phase**
- Completion of a LEED checklist
- In-house third-party document reviews**
- Completion of a deliverable checklist for each phase**
- Use of the design-bid-build delivery method

RATIONALE: *The Architect's Handbook of Professional Practice* discusses quality control relative to project execution, including documentation. Project team meetings at the completion of each phase would provide the team an opportunity to discuss the project moving forward, ways to improve the drawing set, areas needing further attention, and lessons learned. In-house third-party document reviews allow architectural staff who have not previously been involved in the project to check the drawings for potential errors or conflicts missed by the design team. This is particularly beneficial before deliverables are issued. Checklists at each phase are an effective method of tracking and ensuring the completeness of project-specific tasks and documentation requirements. Completion of a LEED checklist and use of the design-bid-build delivery method may be required for a particular project or client, but are not appropriate for all project types and clients. A firm's standard detail library may improve documentation efficiency and the quality of specific details, but it could also place limitations on the project, design team, and building program.



A/E
LEVEL

This is an **A/E level** item requiring you to determine tasks appropriate for a quality control policy.

PcM References

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PUBLICATIONS

The following sources are provided as the top references to assist candidates in preparation for this division. For a more comprehensive list of potential reference material, please see the [Reference Matrix](#) at the end of this handbook.

**The Architect's Guide to Small Firm Management:
Making Chaos Work for Your Small Firm**

Rena M. Klein, FAIA
The American Institute of Architects
John Wiley & Sons, 2010

The Architect's Handbook of Professional Practice

The American Institute of Architects
John Wiley & Sons, latest edition

Law for Architects: What You Need to Know

Robert F. Herrmann and the Attorneys at Menaker & Herrmann LLP
W. W. Norton, 2012

AIA CONTRACT DOCUMENTS

The following list of AIA Contract Documents have content covered in the Practice Management division.

Conventional Family

B101-2007
Standard Form of Agreement Between Owner and Architect

C401-2007
Standard Form of Agreement Between Architect and Consultant

Project Management

Project Management (PjM)

This division will assess objectives related to the management of architectural projects, including organizing principles, contract management, and consultant management. The division will focus on issues related to office standards, development of project teams, and overall project control of client, fee, and risk management. Candidates must demonstrate an understanding of and abilities in quality control, project team configuration, and project scheduling. In addition, candidates must demonstrate the ability to establish and deliver project services per contractual requirements in collaboration with consultants.

| | |
|---|-----------|
| SECTION 1: Resource Management | 30 |
| SECTION 2: Project Work Planning | 34 |
| SECTION 3: Contracts | 38 |
| SECTION 4: Project Execution | 42 |
| SECTION 5: Project Quality Control | 47 |
| Project Management References | 50 |

DIVISION DESCRIPTION

Project Management

DIVISION DETAILS

| ITEMS | TEST DURATION | APPOINTMENT DURATION* |
|-------|---------------|-----------------------|
| 95 | 3 hr 15 min | 4 hr |

*Appointments allow for introductory screens, a break if you choose, and closing screens.

The 95 items will assess you on five sections related to Project Management. The number of items from each section will vary based on the targeted percentage of items within each section.

SECTION DETAILS

| SECTIONS | EXPECTED NUMBER OF ITEMS | TARGET PERCENTAGE |
|---|--------------------------|-------------------|
| SECTION 1: Resource Management | 6-12 | 7-13% |
| SECTION 2: Project Work Planning | 16-22 | 17-23% |
| SECTION 3: Contracts | 23-29 | 25-31% |
| SECTION 4: Project Execution | 16-22 | 17-23% |
| SECTION 5: Project Quality Control | 18-23 | 19-25% |

This division will test a candidate's ability to protect the public's health, safety, and welfare by:

- Administering contract requirements and competent delivery of project services
- Organizing a team to design and produce contract documents
- Coordinating project team activities and project budget
- Communicating information to all constituents throughout the project delivery process
- Developing a project schedule that defines tasks and meets milestones

Resource Management

Once you have a signed contract, it's time to determine what resources will be needed to execute the project. In this section, you will need to determine the composition of the project team and how each team member's time will be managed and allocated in order to execute the project.

OBJECTIVE 1.1

Determine criteria required to assemble team (U/A)

You will need to determine what internal staff and outside consultants will be needed to complete the project and fulfill the contract. This will include understanding fees related to the project and consultants. You will need to anticipate the specific responsibilities of the team being assembled.

OBJECTIVE 1.2

Assess criteria required to allocate and manage project resources (A/E)

As the project proceeds, you will also need to assess appropriate levels of staffing relative to the project needs and fees. This will require tracking the progress of the project based on personnel, hours, fees, and schedule.

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SAMPLE ITEM 1

An architect is responding to an RFP for an architect-led design-build multi-building office park project. Which of the following will be the primary responsibilities of the architect while managing the project? **Check the four that apply.**

- Direct the engineering consultants in the selection of building systems
- Develop and maintain a project schedule
- Assume responsibility for the accuracy of the consultant's work
- Develop and maintain the project budget
- Schedule and control means and methods of construction
- Develop staffing assignments for all project team members

CORRECT RESPONSE

An architect is responding to an RFP for an architect-led design-build multi-building office park project. Which of the following will be the primary responsibilities of the architect while managing the project? **Check the four that apply.**

- Direct the engineering consultants in the selection of building systems
- Develop and maintain a project schedule**
- Assume responsibility for the accuracy of the consultant's work**
- Develop and maintain the project budget**
- Schedule and control means and methods of construction**
- Develop staffing assignments for all project team members

RATIONALE: *The Architect's Handbook of Professional Practice* explains that in an architect-led design-build project, the architect has overall responsibility for keeping the project on schedule and on budget, coordinating the design and working drawing process with consultants, and scheduling and controlling means and methods of construction. Directing the engineering consultants in their selections is a team process that relies on the consultant's expertise. Developing staffing assignments for all project team members would include consultants and should be done by the head team member from each discipline.



This is a **U/A level** item requiring you to understand managing a team in an architect-led design-build project versus a contractor-led design-build project and the work of the team member and their teams.

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SAMPLE ITEM 2

An architect has a total design budget of \$300,000. To estimate the weekly hours for each member of the architectural design team, the following criteria must be considered:

- The design schedule for the project is 16 weeks long at 40 hours per week.
- 30% of the total design fee is allocated to design consultants.
- Firm goal is to achieve a 3.0 multiplier for all employees.
- 25% of the Principal's time will be devoted to the project.
- Utilization of the Project Architect and Architectural Designer should be maximized.

Drag the weekly hour allocations for each design team member from the left on to the labor schedule. Not all allocations will be used.

| Available Staff | Direct Rate | Weekly Person-Hours |
|------------------------|-------------|---------------------|
| Principal | \$95 | |
| Project Manager | \$40 | |
| Project Architect | \$40 | |
| Architectural Designer | \$25 | |

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SAMPLE ITEM 2 - CORRECT RESPONSE

RATIONALE: To determine the number of hours to allocate for each design team member, begin by calculating the weekly direct rate budget and removing 30% for design consultants. This is done by dividing the maximum labor budget with design consultant fees removed by the company multiplier, then dividing by the weeks of the project (**Step 1**). Allocate the Principal's weekly hours to the project (**Step 2**). The utilization rates of both the Project Architect and the Architectural Designer are to be maximized; meaning each of these project team members will allocate 40 hours per week on the project (**Step 3**). This will provide you the remaining weekly budget to allocate to the Project Manager (**Step 4**). Divide the \$825 remaining by the Project Manager's rate (Step 5). The remaining \$25 each week can be used to buy each team member a latte.

$$\text{Step 1: } (\$300,000 \times .70) / 3 = \$70,000$$

$$\$70,000 / 16 \text{ weeks} = \$4,375 \text{ per week}$$

$$\text{Step 2: } .25 \times 40 \text{ hrs.} = 10 \text{ hours}$$

$$10 \times \$95 = \$950 \text{ per week}$$

$$\text{Step 3: } (\$40 + \$25) \times 40 \text{ hrs.} = \$2600 \text{ per week}$$

$$\text{Step 4: } \$4375 - \$2600 - \$950 = \$825 \text{ remaining}$$

$$\text{Step 5: } \$825 / \$40 = 20.625 \text{ hours}$$

| | Available Staff | Direct Rate | Weekly Person-Hours |
|----|------------------------|-------------|---------------------|
| 10 | Principal | \$95 | 10 |
| 15 | Project Manager | \$40 | 20 |
| 20 | Project Architect | \$40 | 40 |
| 25 | Architectural Designer | \$25 | 40 |
| 30 | | | |
| 35 | | | |



This is an **A/E level** item because it requires the evaluation of the design budget, the allocations for consultants, and the company multiplier in order to determine the appropriate number of hours for design team members.

Project Work Planning

In this section, you will evaluate effective ways to develop and communicate a work plan with the assembled project team in order to complete the project.

OBJECTIVE 2.1

Develop and maintain project work plan (U/A)

You will need to use resources such as Gantt charts or critical path schedules, to identify key activities and milestones in a project and how they can be achieved. You will also need to be able to modify schedules and work plans to incorporate feedback or changes to the project.

OBJECTIVE 2.2

Determine criteria required to develop and maintain project schedule (A/E)

Prioritizing tasks and evaluating their impact on a balanced workload is a critical aspect of this section. You will need to assess how outside impact factors like client reviews, regulatory submissions, and testing, on impact work plans and schedules.

OBJECTIVE 2.3

Determine appropriate communication to project team – owner, contractor, consultants and internal staff (U/A)

Architects must also determine the type and content of documents needed to communicate during the work planning phase of a project. These include documents such as agendas, meeting minutes, emails, and memos.

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SAMPLE ITEM 3

A construction manager will best be used by joining the team during which phase of a fast track project?

- Schematic Design
- Construction Documents
- Bidding
- Construction Administration

CORRECT RESPONSE

A construction manager will best be used by joining the team during which phase of a fast track project?

- Schematic Design**
- Construction Documents
- Bidding
- Construction Administration

RATIONALE: *The Architect's Handbook of Professional Practice* identifies that an owner will gain the greatest advantage from a construction manager by including him/her during the Schematic Design phase and for the remainder of the project. This will provide continuity to the project in terms of a project design, budget and schedule. A construction manager adds technical and cost estimating advice, so their joining the team early increases their value to the project and reduces risks associated with a fast track project. The other three phases are all typically occur after the design has been set.

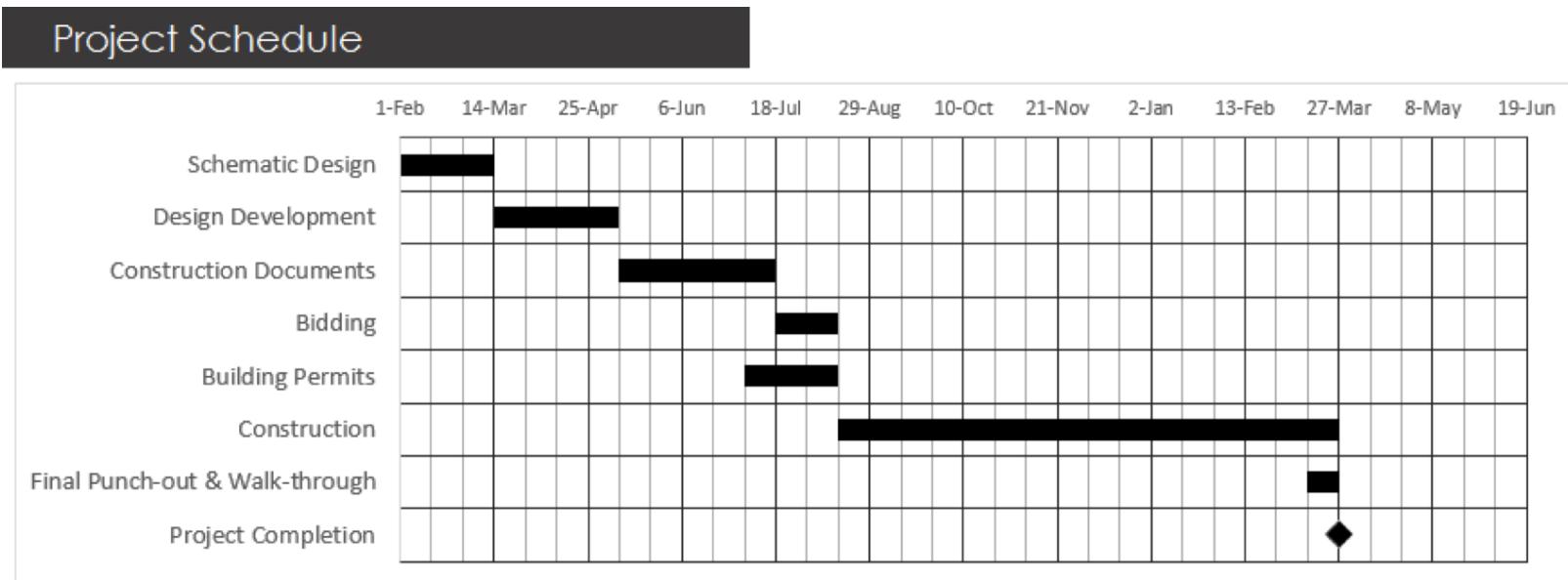


This is a **U/A item** because it requires you to understand the relationship between a construction manager and the owner, as well as the role of a construction manager as it applies to the phases of a fast track project.

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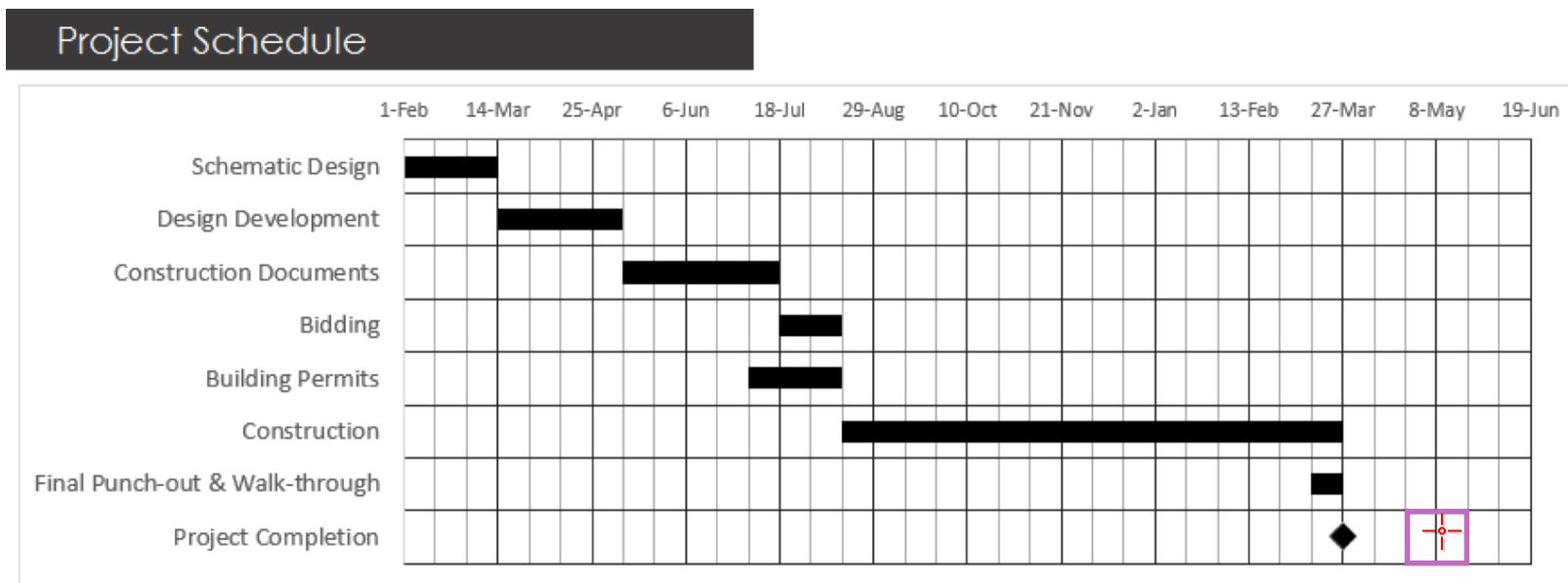
During the construction document phase, the owner requests changes that will delay permitting by three weeks, delay bidding by two weeks, and add an additional three weeks to the construction schedule. Click on the project completion point that reflects the impact of these changes. Each vertical line on the schedule represents two weeks.



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SAMPLE ITEM 4 - CORRECT RESPONSE



RATIONALE: Delays to permitting will cause other items to be delayed and the overall schedule will need to be adjusted. The delays to bidding and permitting are concurrent, so they push back the start of construction by three weeks. An additional three weeks must be extended to the construction timeline. The new completion date will be six weeks later.



This is an **A/E item** because it requires you to analyze the impact of each of the delays and determine their impact on the overall project completion.

Contracts

In this section, you will analyze the contracts that establish relationships between the architect, owner, contractors, and consultants.

OBJECTIVE 3.1

Evaluate and verify adherence to owner/architect agreement (A/E)

AIA Document B101 is the primary document in this relationship. You should have a clear understanding of each article and be able to verify adherence to the agreement. You will need to determine proper services and delivery method based on standard contract requirements.

OBJECTIVE 3.2

Interpret key elements of, and verify adherence to architect/consultant agreement (U/A)

AIA Documents C401 is the primary document in this relationship. You will need to identify contract requirements related to completing a project, additional services, and payment schedules.

OBJECTIVE 3.3

Interpret key elements of the owner/contractor agreement (U/A)

AIA Documents A101 and A201 are the primary documents for this relationship. You will need to understand the architect's role to the owner when working with a contractor across various delivery methods.

OBJECTIVE 3.4

Interpret key elements of the owner/consultant agreement to integrate the consultant's work into the project (U/A)

AIA Document C401 is also the primary document here. You will need to understand how consultant's work affects project deliverables. This requires identifying how to sequence, integrate, and coordinate consultant's work in the overall project.

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SAMPLE ITEM 5

The A/V consultant is installing the wiring and equipment for the office intranet and notices conflicts with the HVAC ductwork. According to AIA Document C401, what should the A/V consultant do?

- Notify the architect only
- Notify the mechanical consultant only
- Notify both the architect and mechanical consultant
- Work around the ducts to complete the work

CORRECT RESPONSE

The A/V consultant is installing the wiring and equipment for the office intranet and notices conflicts with the HVAC ductwork. According to AIA Document C401, what should the A/V consultant do?

- Notify the architect only**

- Notify the mechanical consultant only
- Notify both the architect and mechanical consultant
- Work around the ducts to complete the work

RATIONALE: According to AIA Document C401-2007, a consultant is not responsible for errors on the part of other consultants, but if they become aware of any conflicts they should promptly notify the architect.



This is a **U/A item** because you need to understand and apply the details of the contract to this situation.

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SAMPLE ITEM 6

According to AIA Document A201, for which of the following activities is the contractor responsible? **Check the three that apply.**

- Compiling a comprehensive punch list
- Providing the notice of substantial completion
- Preparing the final change order
- Issuing the certificate of occupancy
- Providing the notice of final completion
- Preparing the certificate of final payment

CORRECT RESPONSE

According to AIA Document A201, for which of the following activities is the contractor responsible? **Check the three that apply.**

- Compiling a comprehensive punch list**
- Providing the notice of substantial completion**
- Preparing the final change order
- Issuing the certificate of occupancy
- Providing the notice of final completion**
- Preparing the certificate of final payment

RATIONALE: According to AIA Document A201-2007, the contractor is responsible for compiling a punch list, providing notice of substantial completion, and providing notice of final completion. The architect is responsible for preparing any change orders and the certificate of final payment. The building department issues the certificate of occupancy.



This is a **U/A item** because it requires you to know the different roles of contractors and architects regarding notices and certificates throughout the execution of this standard contract.

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SAMPLE ITEM 7

At the end of the design development phase for an office park, the owner reports that a major tenant had backed out of the project. The owner delays the project two months to find a new tenant or secure additional funding.

Working under AIA Document B101, which of the following should the architect do during the two-month project suspension? **Check the three that apply.**

- Request payment for design development
- Request two-month advance fee for construction documents
- Prepare final bid package before ceasing work
- Assist the owner in lining up a new tenant
- Request payment for expenses incurred in the interruption of the architect's services
- Submit revised schedule for when the project resumes

RATIONALE: According to AIA Document B101, if the owner suspends a project, the architect is entitled to payment for all expenses incurred up to that point. The architect can also request payment for expenses incurred because of the interruption. And, if the project resumes, a revised schedule can be submitted. When an owner suspends a project, the architect should suspend work on the project, so requesting an advance or completing other work is unwise for the architect. While assisting the owner in lining up a tenant may get the project back on track, it is beyond the scope of a standard owner/architect relationship and is not the role of the architect.

CORRECT RESPONSE

At the end of the design development phase for an office park, the owner reports that a major tenant had backed out of the project. The owner delays the project two months to find a new tenant or secure additional funding.

Working under AIA Document B101, which of the following should the architect do during the two-month project suspension? **Check the three that apply.**

- Request payment for design development**
- Request two-month advance fee for construction documents
- Prepare final bid package before ceasing work
- Assist the owner in lining up a new tenant
- Request payment for expenses incurred in the interruption of the architect's services**
- Submit revised schedule for when the project resumes**



This is an **A/E item** because it expects you to understand this contract and how the delay results in both a suspension of work and consequences for both parties.

Project Execution

This section assesses management of the project's execution. It is not about the design-related decisions, but rather the necessary administrative procedures throughout the project.

OBJECTIVE 4.1

Evaluate compliance with construction budget (A/E)

Architects must confirm all items in construction estimates to ensure they align with the budget. You must also evaluate estimates throughout the course of the project to mitigate changes in material or scope to comply with the budget.

OBJECTIVE 4.2

Evaluate and address changes in scope of work and scope creep (A/E)

You will need to be able to analyze changes in scope to determine the impact on fees, schedules, and owner financing

OBJECTIVE 4.3

Evaluate project documentation to ensure it supports the specified delivery method (A/E)

As an architect, you must also be able to determine the appropriate documentation needed for projects, including consultant documents. You must also be able to coordinate close-out and construction administration documentation.

OBJECTIVE 4.4

Identify and conform with the requirements set forth by authorities having jurisdiction in order to obtain approvals for the project (U/A)

Lastly, you will need to be able to identify which authorities have jurisdiction over projects and determine what submittals are required for project approvals. This includes properly responding to questions or feedback from these authorities. Authorities could include zoning commissions, neighborhood review boards, or plan reviewers.

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SAMPLE ITEM 8

Which of the following items would typically be part of a site plan documentation submittal between the owner and the city planning department? **Check the four that apply.**

- Building footprint
- Legal boundary survey
- Building construction type
- Civil engineer's storm water management plan
- Landscape planting plan
- Building life safety plan

CORRECT RESPONSE

Which of the following items would typically be part of a site plan documentation submittal between the owner and the city planning department? **Check the four that apply.**

- Building footprint**
- Legal boundary survey**
- Building construction type
- Civil engineer's storm water management plan**
- Landscape planting plan**
- Building life safety plan

RATIONALE: *The Architect's Handbook of Professional Practice* discusses how most municipalities require an extensive description of a project proposal, including all aspects of the architectural design, landscape design, and engineering studies for storm water and traffic management. The building construction type and a building's life safety plan are generally included in the permitting documents.



This is a **U/A item** requiring you to understand different types of documentation used in a project and determine which ones relate to site planning submittals to a city planning department.

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During the construction phase, the owner requests changes that will require 10 additional footings. The contractor has supplied the following cost information:

- Size of each footing: 4.5 ft. x 4.5 ft. x 36 ft.
- Crew labor cost: \$175 per cubic yd.
- Material cost including reinforcing: \$225 per cubic yd.
- Miscellaneous equipment cost: \$3.00 per cubic yd.
- Contractor's overhead & profit: 10%

The construction budget is \$10,000,000 and the current construction costs is \$9,900,000.

How much over budget will this requested change place the project? Round to the nearest whole dollar.

\$

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SAMPLE ITEM 9 - CORRECT ANSWER

\$ 19,691

RATIONALE: The requested modification by the owner will increase the current construction budget. The architect must first determine the total cost of the requested change. To do so, determine the total volume of the additional footings (**Step 1**). Then determine the total cost of the footings, including labor, materials, and miscellaneous equipment costs (**Step 2**). The contractor's overhead and profit must all be included in the increased costs. (**Step 3**) The total cost of the additional footings and the current construction costs must then be compared to the construction budget amount (**Step 4**). Because the \$ is in front of the answer box, only the numerals need to be entered into the box. Round to the nearest whole number as stated.

Step 1: $(4.5 \text{ ft.} \times 4.5 \text{ ft.} \times 36 \text{ ft.}) \times 10 \text{ locations} = 7,290 \text{ cu. ft.} = 270 \text{ cu. yd.}$

Step 2: $(\$175 + \$225 + \$3) \times 270 \text{ cu. yd.} = \$108,810$

Step 3: $\$108,810 \times 110\% = \$119,691$

Step 4: $(\$119,691 + \$9,900,000) - \$10,000,000 = \$19,691$



This is an **A/E level** item because it requires you to analyze the information given and calculate the increase in labor and materials compared to the current project budget.

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SAMPLE ITEM 10

An owner has purchased a 50,000 sq. ft. parcel of undeveloped land located near an older neighborhood undergoing revitalization. The owner wants to develop the land into a five-home subdivision. Working under AIA Document B101, what steps should the architect take once the owner supplies an initial budget amount for the project? **Check the three that apply.**

- Analyze the budget against UniFormat for design cost management
- Evaluate the budget against the program
- Negotiate a higher budget for risk mitigation
- Analyze the budget against the schedule
- Begin development of design documents based on the budget
- Evaluate the budget against market conditions

RATIONALE: According to AIA Document B101-2007, the architect should always evaluate a budget amount with respect to the stated program, anticipated schedule, and market conditions. The architect should not begin the development of design documents without first understanding the budget amount and its impact. Negotiating a higher budget as a risk mitigation technique is not a wise strategy and may jeopardize the project. UniFormat is a classification system used for estimating construction costs and does not apply to project budgeting.

CORRECT RESPONSE

An owner has purchased a 50,000 sq. ft. parcel of undeveloped land located near an older neighborhood undergoing revitalization. The owner wants to develop the land into a five-home subdivision. Working under AIA Document B101, what steps should the architect take once the owner supplies an initial budget amount for the project? **Check the three that apply.**

- Analyze the budget against UniFormat for design cost management
- Evaluate the budget against the program**
- Negotiate a higher budget for risk mitigation
- Analyze the budget against the schedule**
- Begin development of design documents based on the budget
- Evaluate the budget against market conditions**



This is a **U/A item** because it requires an understanding of the budget process and the relationship between the owner and the architect.

Project Quality Control

The last section in this division analyzes quality control methods, procedures, and review processes in order to maintain the proper standard of care throughout the entire project. As with the previous sections, this section is not about the design-related decisions, but rather the necessary administrative procedures throughout the project.

OBJECTIVE 5.1

Apply procedures required for adherence to laws and regulations relating to the project (U/A)

You will need to be able to identify the government agencies who have jurisdiction on the project and determine what permits and procedures will be required throughout the project duration. This also includes establishing protocols to maintain compliance on the project site.

OBJECTIVE 5.2

Identify steps in maintaining project quality control, and reducing risks and liabilities (A/E)

As an architect, you will also need to analyze and apply firm standards to documentation and quality control. You will need to establish review processes to be utilized throughout the project to evaluate quality control, assess risk and liabilities, and identify level of completion of at each phase of the project

OBJECTIVE 5.3

Perform quality control reviews of project documentation throughout life of project (A/E)

You will need to carry out the review steps and procedures identified and established in the previous objective with regards to quality control and risk.

OBJECTIVE 5.4

Evaluate management of the design process to maintain integrity of design objectives (A/E)

As an architect, you must ensure design objectives are continually monitored and met across all phases of design. In this this division it is not about the design details, but the process of communicating the design objectives.

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SAMPLE ITEM 11

During a peer-review of design documents for the local university's new business school building, the reviewer notes conflicting code references for means of egress on the life safety sheet. **The architect should design to which of the following?**

- The adopted code of the local jurisdiction
- The adopted state building code
- The ICC and NFPA model building codes
- Whichever adopted code is most stringent

CORRECT RESPONSE

During a peer-review of design documents for the local university's new business school building, the reviewer notes conflicting code references for means of egress on the life safety sheet. **The architect should design to which of the following?**

- The adopted code of the local jurisdiction
- The adopted state building code
- The ICC and NFPA model building codes
- Whichever adopted code is most stringent

RATIONALE: *The Architect's Handbook of Professional Practice* discusses how most jurisdictions across the United States have adopted building codes based on the ICC family of codes. At the same time, both states and local jurisdictions have the authority to make changes to portions of the building codes. As the architect, you have a legal duty to design in compliance with all the codes that govern the type and location of the project. Researching the jurisdictions and requirements for a specific project is the responsibility of the architect. When multiple codes conflict, the most stringent code always takes precedence.



This is a **U/A level** item because it requires you to understand the relationship between codes and jurisdictions and then to apply them to a specific project.

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SAMPLE ITEM 12

During the review of bid documents for a renovation project, the architect notices that several details are missing information due to concealed building conditions. The full scope of this work cannot be identified until demolition work is in progress. To control project costs and limit cost increases during construction, which strategies should the architect choose as part of the bid documents? **Check the two that apply.**

- Contingencies
- Unit Prices
- Change Orders
- Addenda
- Bid Alternates
- Supplemental Instructions

CORRECT RESPONSE

During the review of bid documents for a renovation project, the architect notices that several details are missing information due to concealed building conditions. The full scope of this work cannot be identified until demolition work is in progress. To control project costs and limit cost increases during construction, which strategies should the architect choose as part of the bid documents? **Check the two that apply.**

- Contingencies
- Unit Prices**
- Change Orders
- Addenda
- Bid Alternates**
- Supplemental Instructions

RATIONALE: Often on renovation projects there are unknown elements or quantities until demolition occurs. Strategies to minimize this risk should be discussed with the owner and incorporated into the documents. Unit prices establish a cost for performing additional work by the contractor when encountering unknown conditions. Bid alternatives define a change in cost for scope or quality of materials during the bidding process. This provides the owner options to reduce the overall construction costs as necessary in order to maintain the project budget. Contingencies should be a part of a project budget and cost estimate, but are not a strategy for controlling costs. Change orders are issued during construction to identify changes in the contract but are also not an effective cost control. Addenda modify the bid documents during the bid phase but do not control costs. Supplemental Instructions are modifications to the general conditions of a contract and typically have a limited impact on costs.



This is an **A/E item** because it requires you to understand where you are in the development phase of a project and also how one can deal with known costs without a definite scope.

PjM References

PUBLICATIONS

The following sources are provided as the top references to assist candidates in preparation for this division. For a more comprehensive list of potential reference material, please see the [Reference Matrix](#) at the end of this handbook.

The American Institute of Architects Official Guide to the 2007 AIA Contract Documents

The American Institute of Architects
John Wiley & Sons, 2009

The Architect's Handbook of Professional Practice

The American Institute of Architects
John Wiley & Sons, latest edition

Professional Practice: A Guide to Turning Designs into Buildings

Paul Segal, FAIA
W. W. Norton, 2006

AIA CONTRACT DOCUMENTS

The following list of AIA Contract Documents have content covered in the Project Management division.

Conventional Family

A101-2007

Standard Form of Agreement Between Owner and Contractor where the basis of payment is a Stipulated Sum

A201-2007

General Conditions of the Contract for Construction

A701-1997

Instructions to Bidders

B101-2007

Standard Form of Agreement Between Owner and Architect

C401-2007

Standard Form of Agreement Between Architect and Consultant

Programming & Analysis

Programming & Analysis (PA)

This division will assess objectives related to the evaluation of project requirements, constraints, and opportunities. The division will focus on issues related to programming, site analysis, and zoning and code requirements. Candidates must demonstrate an understanding of and abilities in project type analysis, the establishment of qualitative and quantitative project requirements, evaluation of project site and context, and assessment of economic issues.

| | |
|---|-----------|
| SECTION 1: Environmental & Contextual Conditions | 54 |
| SECTION 2: Codes & Regulations | 58 |
| SECTION 3: Site Analysis & Programming | 61 |
| SECTION 4: Building Analysis & Programming | 66 |
| Programming & Analysis References | 73 |

DIVISION DESCRIPTION

Programming & Analysis

DIVISION DETAILS

| ITEMS | TEST DURATION | APPOINTMENT DURATION* |
|-------|---------------|-----------------------|
| 95 | 3 hr 15 min | 4 hr |

*Appointments allow for introductory screens, a break if you choose, and closing screens.

The 95 items will assess you on four sections related to Programming & Analysis. The number of items from each section will vary based on the targeted percentage of items within each section.

SECTION DETAILS

| SECTIONS | EXPECTED NUMBER OF ITEMS | TARGET PERCENTAGE |
|--|--------------------------|-------------------|
| SECTION 1: Environmental & Contextual Conditions | 13-20 | 14-21% |
| SECTION 2: Codes & Regulations | 15-21 | 16-22% |
| SECTION 3: Site Analysis & Programming | 20-26 | 21-27% |
| SECTION 4: Building Analysis & Programming | 35-41 | 37-43% |

This division will test a candidate's ability to protect the public's health, safety, and welfare by:

- Evaluating qualitative and quantitative project requirements
- Analyzing environmental, social, and economic requirements of a project
- Synthesizing project requirements based on gathered information

Environmental & Contextual Conditions

In this section, you'll evaluate a project site and identify both the opportunities and constraints that may impact future development.

OBJECTIVE 1.1

Evaluate site-specific environmental and socio-cultural opportunities (A/E)

You will need to be able to analyze a project site and identify opportunities that could be incorporated into future site and building development. These opportunities include the potential use of sun, wind, shading, views, water, and the neighborhood context, along with other environmental, social, and cultural conditions.

OBJECTIVE 1.2

Evaluate site-specific environmental constraints (A/E)

You will need to be able to analyze a project site and identify constraints and hazardous conditions that could limit a building's location and future site development. These constraints include issues like a floodplain, unstable soil, radon, lead, a brownfield, abandoned structures, and other natural or built features.

OBJECTIVE 1.3

Determine optimal use of onsite resources by incorporating sustainability principles (U/A)

You must be able to analyze a project site based on sun, wind, water, topography, temperature, and other environmental site data to inform optimal building location, orientation, form and shape, footprint, and passive system design. You will also need to consider opportunities to minimize disturbance of the site and existing natural features.

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SAMPLE ITEM 1

An owner has selected a hilly site for a new two-story residence. The site is located in a temperate climate with winter winds predominantly from the northwest and summer winds from the southwest.

Which location on the site is a favorable microclimate for passive heating, cooling, and daylighting?

- Bottom of the north-facing slope
- Bottom of the south-facing slope
- Hilltop
- Midway up the south-facing slope

CORRECT RESPONSE

An owner has selected a hilly site for a new two-story residence. The site is located in a temperate climate with winter winds predominantly from the northwest and summer winds from the southwest.

Which location on the site is a favorable microclimate for passive heating, cooling, and daylighting?

- Bottom of the north-facing slope
- Bottom of the south-facing slope
- Hilltop

Midway up the south-facing slope



This is an **A/E level** item requiring you to analyze the environmental conditions to determine the site location that has the greatest potential to accommodate passive design.

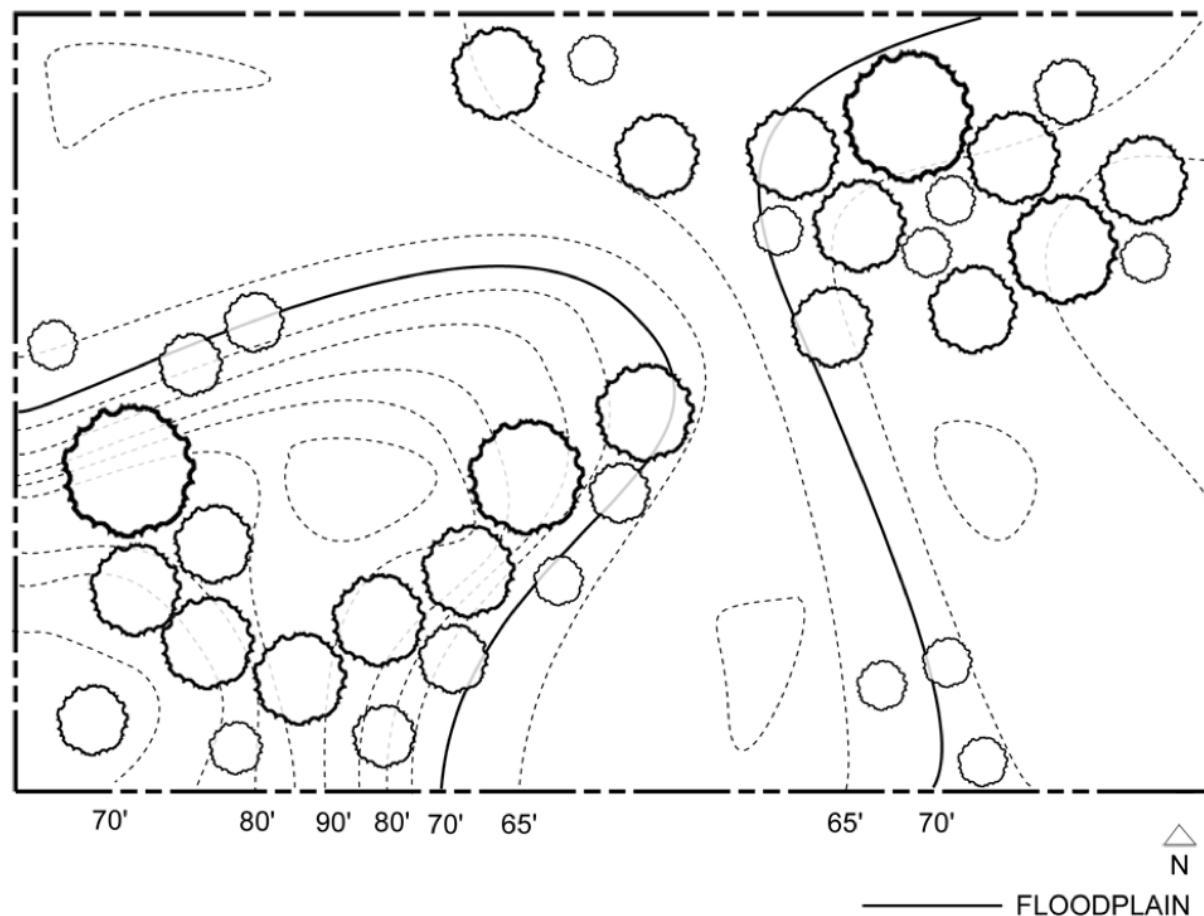
RATIONALE: According to *Sun, Wind & Light: Architectural Design Strategies*, locating the residence midway up the south-facing slope would be favorable for access to sun and summer winds, which are critical components of passive heating, cooling, and daylighting. The bottom of the slope would not be favorable due to cold air collection in the winter, and the top of the hill would provide limited wind protection during the winter months.

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REFERENCES**SAMPLE ITEM 2**

A parks and recreation society has approached an architect to construct a picnic pavilion, restroom facility, and recreational volleyball courts on a riverfront property. The client has requested the development of the site be environmentally responsive and cost effective.

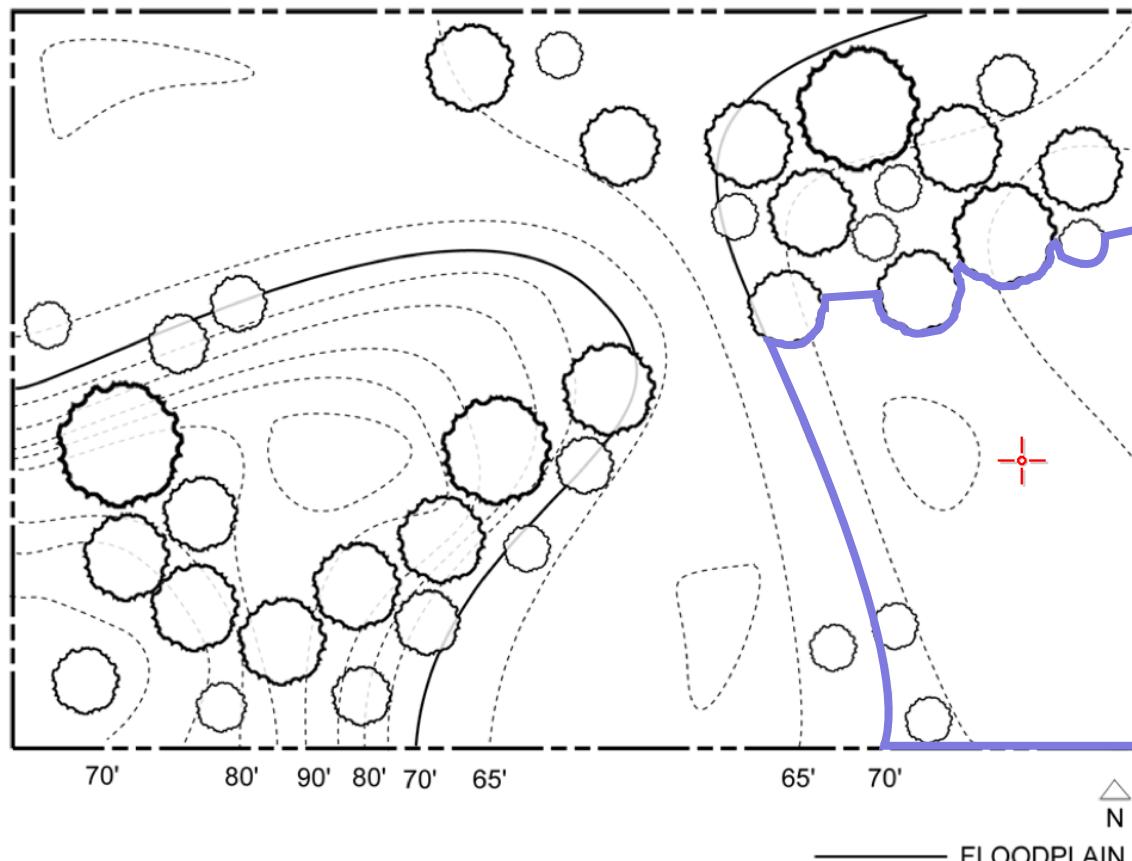
Click on the area of the site plan below where the architect should recommend the development be located.



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SAMPLE ITEM 2 - CORRECT RESPONSE



RATIONALE: The architect should recommend the southeastern region of the site. *The Site Planning and Design Handbook* discusses site analysis, sustainability, and development principles that can be directly applied to the evaluation of this riverfront property. The southeastern area of the site is relatively flat, limiting the amount of construction dollars dedicated to excavation and related site work. It is also located outside of the defined floodplain, reducing the potential risk of water damage to the buildings and recreational courts over time.

A/E
LEVEL

This is an **A/E level** item requiring you to evaluate the existing site constraints to determine which areas of the site may inhibit development. You must also determine which areas of the site present design opportunities that fulfill the client's requirements.

Codes & Regulations

In this section, you'll look at the codes and regulations appropriate to the initial analysis and programming phase of a project.

OBJECTIVE 2.1

Identify relevant code requirements for building and site types (U/A)

As an architect, you need to be able to determine and understand the codes and regulations that govern a specific project type and geographic region. This includes distinguishing relevant accessibility and ADA requirements, IBC, IRC, IGCC, and energy codes.

OBJECTIVE 2.2

Identify relevant zoning and land use requirements (U/A)

You need to be able to determine and understand requirements that limit the extent of site and building development. This includes issues like setbacks, footprint limitations, maximum building heights, FAR, parking requirements, easements, and other zoning and land use regulations. Recognizing situations where a special exception or variance is suitable and understanding the process for approval are also included in this objective.

OBJECTIVE 2.3

Identify relevant local and site-specific requirements (U/A)

You must be able to determine and understand local, environmental, and other specialty regulations and how they may impact the site and building development. These include wetlands, floodplains, historic preservation, and other specialty codes.

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SAMPLE ITEM 3

An architect has been selected to complete a major interior and exterior renovation of all areas within a three-story library building. The building was constructed in the early 1980's.

During the programming phase of the project, which of the following should the architect recommend to the client regarding accessibility?

- Only the public spaces need to be made accessible
- Only the primary function spaces need to be made accessible
- All areas of the library should be made accessible
- Since this is a renovation of an existing building, accessibility upgrades are not required

CORRECT RESPONSE

An architect has been selected to complete a major interior and exterior renovation of all areas within a three-story library building. The building was constructed in the early 1980's.

During the programming phase of the project, which of the following should the architect recommend to the client regarding accessibility?

- Only the public spaces need to be made accessible
- Only the primary function spaces need to be made accessible
- All areas of the library should be made accessible
- Since this is a renovation of an existing building, accessibility upgrades are not required

RATIONALE: The ADA Standards for Accessible Design require all altered elements and spaces within a renovation project to comply with the accessibility standards. Since this is a major renovation of all areas within the building, the architect should recommend that all areas of the library be made accessible.



U/A
LEVEL

This is a **U/A level** item requiring you to identify accessibility requirements that are applicable to a renovation project.

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SAMPLE ITEM 4

Setback rules, as prescribed by a zoning ordinance, can accomplish which of the following? **Check the three that apply.**

- Prescribe adjacent building uses
- Ensure availability of light and air circulation
- Establish a minimal degree of privacy
- Establish building exterior wall construction
- Minimize floor area ratio
- Provide space for maintenance of building exteriors

CORRECT RESPONSE

Setback rules, as prescribed by a zoning ordinance, can accomplish which of the following? **Check the three that apply.**

- Prescribe adjacent building uses
- Ensure availability of light and air circulation**
- Establish a minimal degree of privacy**
- Establish building exterior wall construction
- Minimize floor area ratio
- Provide space for maintenance of building exteriors**

RATIONALE: As described in *Building Construction Illustrated*, a setback in zoning is a prescribed distance in which a structure is set back from a property line or other identified element. Setbacks ensure access to air and light, provide building privacy, and provide space to perform building maintenance. Zoning ordinances typically address floor area ratio, adjacent building uses, and exterior wall construction; however, these are not accomplished through the implementation of setback rules.



This is a **U/A level** item requiring you to understand setbacks within zoning requirements, as well as what they can accomplish when applied to a building project.

Site Analysis & Programming

In this section, you'll need to analyze a project site relative to the program and project requirements.

OBJECTIVE 3.1

Evaluate relevant qualitative and quantitative attributes of a site as they relate to a program (A/E)

This objective assesses your ability to analyze a project site relative to the requirements in the program to determine if it is appropriate and feasible for development. You will need to consider the climate, topography, drainage, soil, built and natural features, utilities, access points, traffic patterns, easements, and other attributes relevant to the project and program.

OBJECTIVE 3.2

Synthesize site reports with other documentation and analysis (A/E)

In addition to analyzing the attributes of the site, you will also need to review and interpret site documentation such as geotechnical reports, landscape reports, existing conditions, utility surveys, topographic maps, demographics, traffic studies, environmental data, historic reports, and other site related reports. This is used to determine the feasibility of a project and verify the selection of site related consultants needed to execute the project.

OBJECTIVE 3.3

Analyze graphical representations regarding site analysis and site programming (A/E)

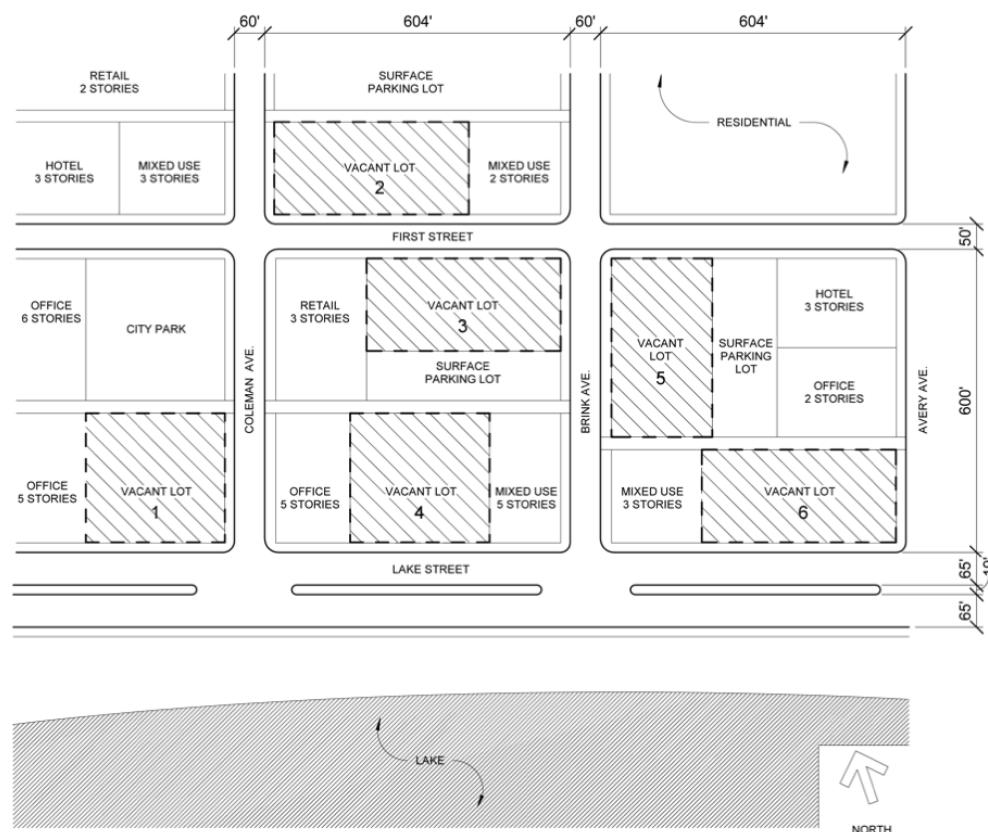
You must be able to evaluate and understand diagrammatic graphics and how they are used to represent and communicate site conditions, relationships, and program requirements. These graphics include topographic, programming, circulation, adjacency, environmental, views, and vegetation diagrams, which communicate site information and relationships

SAMPLE ITEM 5

An architect has been selected to design a new mixed-use development that includes retail spaces, parking, and apartments in an urban community. The client has provided the following programmatic requirements:

- The building should be five stories above grade and two stories below grade.
 - Access to daylight should be maximized for all spaces.
 - The number of apartments with balconies and a view should be maximized.
 - The building should be contextual within the community in regards to massing, scale, and detail.

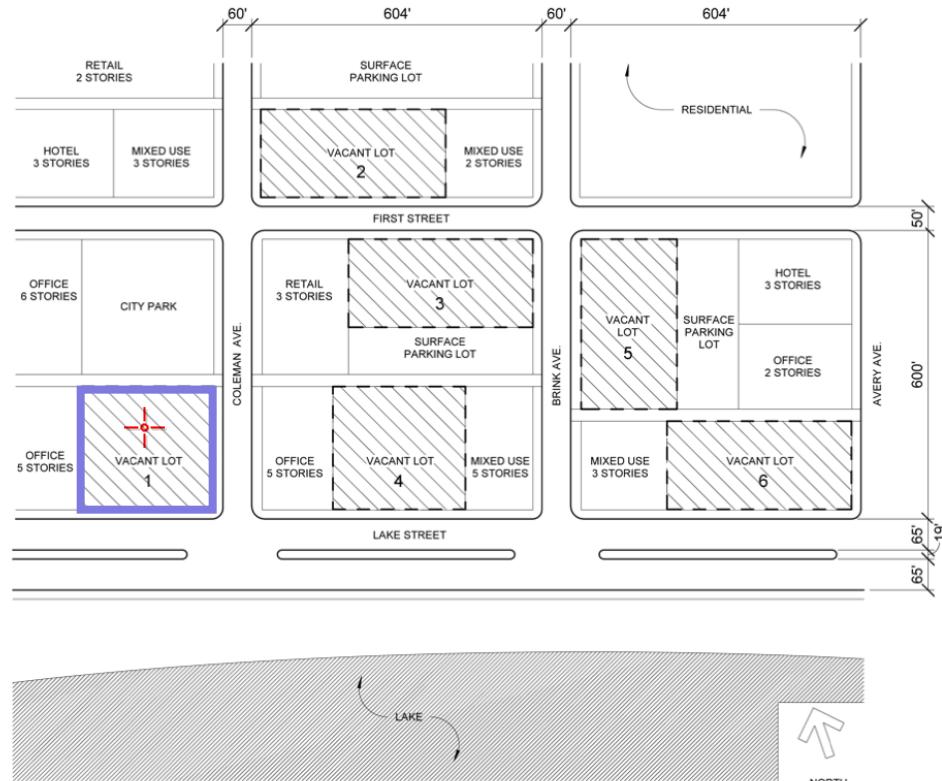
Click on the vacant lot in the site plan below that the architect should recommend to the client.



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SAMPLE ITEM 5 - CORRECT RESPONSE



RATIONALE: The architect should recommend Vacant Lot 1. To make this determination, you'll need to analyze the contextual conditions of each vacant lot, including both environmental conditions and site attributes. The client has requested that the five-story building fit contextually within the community from a massing, scale, and detail standpoint, making lots 1 and 4 most contextually appropriate because they are adjacent to five-story structures. Vacant Lot 1 has access to daylight on three sides with views to the city park to the north and the lake to the south, making it the most appropriate site for the development. Vacant Lots 2, 3, and 5 have limited views and are located adjacent to buildings of a smaller scale than the proposed development. Although Vacant Lot 6 has views to the south and access to daylight on three sides, the surrounding context is of a smaller scale.

A/E
LEVEL

This is an **A/E level** item requiring you to evaluate multiple sites relative to views, contextual scale, daylight, and client requirements.

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REFERENCES**SAMPLE ITEM 6**

An architect is completing a feasibility study for a small marine research facility. The following site information has been provided by the client:

- Located in a remote area near the seashore
- Undeveloped, except for a small storage building that will be demolished
- Contains a small area of wetlands
- Adjacent to an environmentally protected area

As part of the feasibility study, what documentation should the architect evaluate? **Check the four that apply.**

- FEMA maps
- Geotechnical report
- Traffic report
- Structural report
- Topographic survey
- Hydrologic conditions report

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REFERENCES**SAMPLE ITEM 6 - CORRECT RESPONSE**

An architect is completing a feasibility study for a small marine research facility. The following site information has been provided by the client:

- Located in a remote area near the seashore
- Undeveloped, except for a small storage building that will be demolished
- Contains a small area of wetlands
- Adjacent to an environmentally protected area

As part of the feasibility study, what documentation should the architect evaluate? **Check the four that apply.**

- FEMA maps
- Geotechnical report
- Traffic report
- Structural report
- Topographic survey
- Hydrologic conditions report

RATIONALE: According to the *Site Planning and Design Handbook*, evaluating FEMA maps, geotechnical reports, topographic surveys, and a hydrologic conditions report are critical in understanding the site's potential for coastal flooding, the makeup and stability of the soils, potential earthwork requirements, and how the presence of water and wetlands may impact development. Since this is an undeveloped and remote site, a traffic report and structural report would not be necessary for this feasibility study.



A/E
LEVEL

This is an **A/E level** item requiring you to analyze the site information provided and determine what documentation should be evaluated to assess the feasibility of the project.

Building Analysis & Programming

In this section, you'll analyze new or existing buildings relative to the program requirements, cost, and schedule. This is the largest section in the Programming & Analysis division

OBJECTIVE 4.1

Evaluate relevant qualitative and quantitative attributes of a new or existing building as they relate to the program (A/E)

As an architect, you will need to analyze an existing or new building relative to the requirements in a project program to determine if it is appropriate and feasible for renovation, repurposing, preservation, or demolition. You will consider the structural stability, spatial organization, MEP systems, views, solar exposure, hazardous materials, and other attributes relevant to the project and program requirements.

OBJECTIVE 4.2

Evaluate documentation, reports, assessments, and analyses to inform the building program (A/E)

Similar to the site analysis of Section 3, you will also need to review and interpret technical documentation including geotechnical reports, structural assessments, utility surveys, topographic maps, demographics, regional context, environmental data, historic reports, and other similar information. This is used to consider the feasibility of a project and how the building program may be positively or negatively affected.

OBJECTIVE 4.3

Identify and prioritize components of the building program (A/E)

As an architect, you must be able to review and understand the building program relative to the client's requirements. This includes the consideration of primary vs. subsidiary, back of house vs. front of house, occupied vs. unoccupied, as well as phasing and major circulation components. Understanding the area requirements of a building type relative to the program, including net square footage and gross square footage, is very important, as are how they relate to each other and the overall program requirements.

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REFERENCES**OBJECTIVE 4.4****Identify and prioritize components of the building program (A/E)**

Spatial organization is an important aspect of architecture, so reviewing and analyzing the building program relative to both horizontal and vertical spatial and functional relationships is an important assessment. You must consider the vertical relationships of shafts, stairs, conveying systems, atriums, and other multi-level spaces, as well as the horizontal relationships including circulation, entry, loading, assembly, MEP spaces, and other programmed spa.

OBJECTIVE 4.5**Recommend a preliminary project budget and schedule (U/A)**

As an architect, you must be able to analyze available project information (master plans, existing documentation, program requirements, site information, etc.) to determine a preliminary project schedule and cost. If the project budget and schedule have been defined by the client, you should be able to evaluate this information to determine the feasibility of the project and provide appropriate recommendations.

OBJECTIVE 4.6**Identify alternatives for building and structural systems for given programmatic requirements, preliminary budget, and schedule (U/A)**

You will need to understand various architectural, civil, structural, mechanical, electrical, and plumbing systems to determine the appropriateness of each based on factors such as building type, function, program, availability, schedule, and cost. Even before the selection of each system, you will need to be able to identify alternative systems that could fulfill the project requirements.

OBJECTIVE 4.7**Analyze graphical representations regarding building analysis and building programming (A/E)**

You will need to understand diagrammatic graphics and evaluate how they are used to communicate building relationships and other requirements. These can include programming, circulation, adjacency, spatial, environmental, views, or other relevant building components.

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Refer to the exhibit.

A preliminary budget for the adjacent program was estimated at \$3,000,000 with 60% building efficiency. The client has requested the preliminary cost be reduced by \$500,000 while maintaining the same program spaces and overall construction quality.

What overall building efficiency must the architect achieve to fulfill the client's preliminary cost goals?

%

| SPACE | SIZE (NET SF) | QUANTITY |
|-------------------|---------------|----------|
| Break Room | 600 | 1 |
| Conference Room | 400 | 4 |
| Open Work Area | 4000 | 1 |
| Private Office | 100 | 20 |
| Reception/Waiting | 300 | 1 |
| Restroom | 175 | 2 |
| Storage | 50 | 3 |

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72 %

RATIONALE: Prior to performing any calculations, you'll need to understand building efficiency as it relates to gross and net area. *Problem Seeking: An Architectural Primer* describes building efficiency as a ratio of the net assignable area to the building gross area. In the provided program, the net assignable area is 9,000 square feet with 60% overall building efficiency. Dividing the net assignable area by the building efficiency factor will give you the gross building area required (**Step 1**). Since the client has requested to maintain the program and construction quality, the current cost per square foot for construction must be determined (**Step 2**). If the preliminary budget is reduced to \$2,500,000 and the cost of construction remains constant, the client can only afford 12,500 gsf of area (**Step 3**). Dividing the net assignable area by the gross area that the client can afford will give you the building efficiency that the architect must achieve to stay on budget (**Step 4**). Because the % symbol is given next to the answer box, you know the correct answer should be represented as a percentage, not a decimal.

Step 1: $9,000 \text{ nsf} / .6 = 15,000 \text{ gsf}$

Step 2: $\$3,000,000 / 15,000 \text{ gsf} = \200 per sq. ft.

Step 3: $\$2,500,000 / \$200 \text{ per sq. ft.} = 12,500 \text{ gsf}$

Step 4: $9,000 \text{ nsf} / 12,500 \text{ gsf} = .72 \text{ which is } 72\%$

| SPACE | SIZE (NET SF) | QUANTITY |
|-------------------|---------------|----------|
| Break Room | 600 | 1 |
| Conference Room | 400 | 4 |
| Open Work Area | 4000 | 1 |
| Private Office | 100 | 20 |
| Reception/Waiting | 300 | 1 |
| Restroom | 175 | 2 |
| Storage | 50 | 3 |



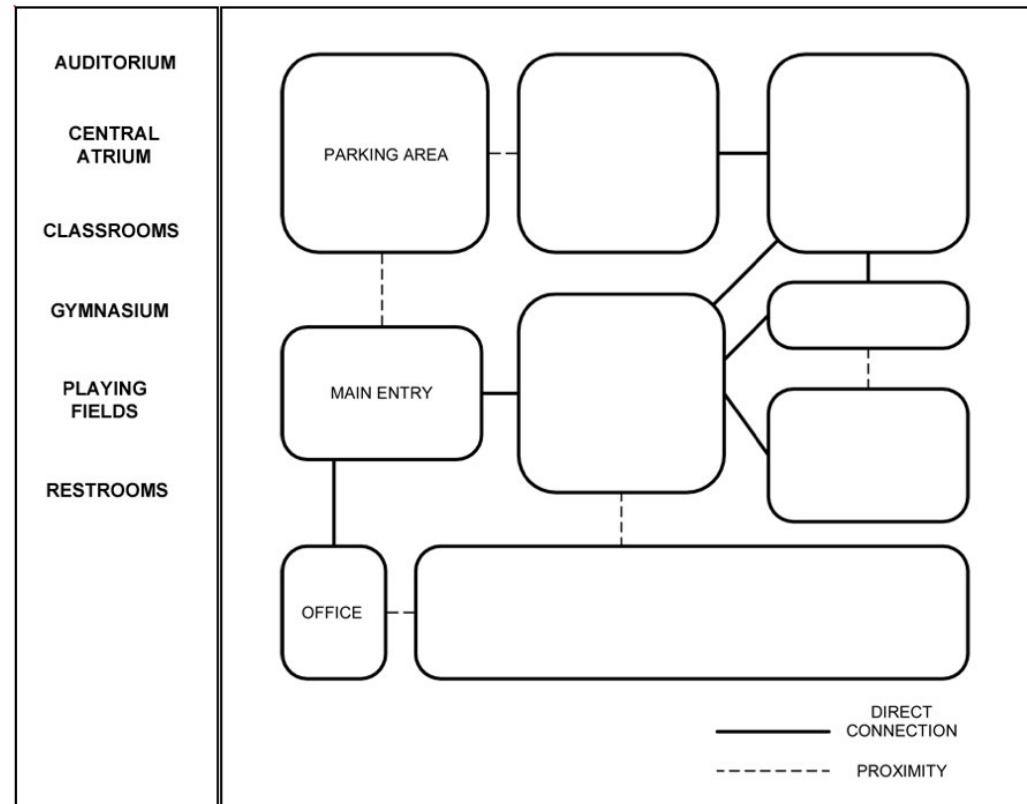
This is an **A/E level** item that requires you to evaluate and compare a preliminary budget and program to determine the required gross building area and overall building efficiency.

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REFERENCES**SAMPLE ITEM 8**

An architect is completing an adjacency diagram for a new high school in a rural community. The client has provided the following requirements:

- The Playing Fields will be used by the school and community for daytime and evening sporting events. Convenient access to the fields should be provided to all visitors.
- The Central Atrium needs to be a key gathering space during school hours, as well as host school and community related events in the evening. Additionally, it will serve as a pre-function space for events held in the Auditorium.
- The Restrooms need to be connected to both the Gymnasium and Central Atrium.
- The Office will provide faculty and student support throughout the school day.
- The Main Entry will be the secured point of entry for students and visitors.



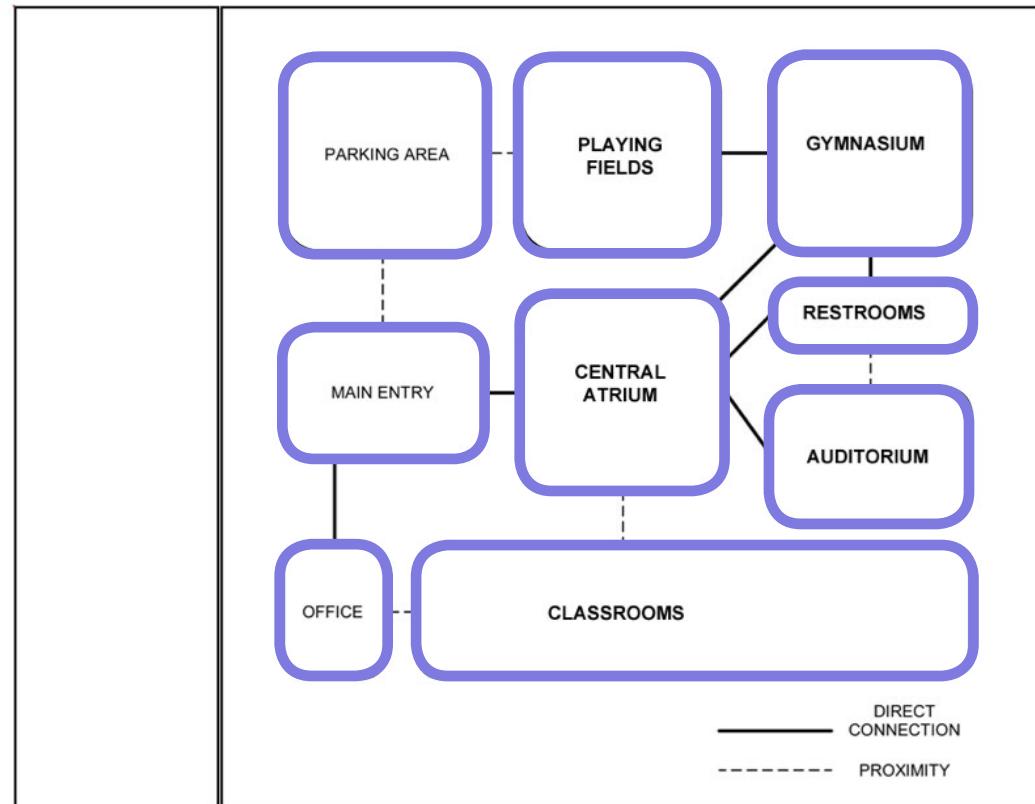
Drag the labels on the left into the appropriate bubbles to show the required programmatic relationships.

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SAMPLE ITEM 8 - CORRECT RESPONSE

RATIONALE: To complete this bubble diagram, you'll need to understand the spatial relationships of the high school as they relate to the program and the client's requirements. The Playing Fields require convenient access for both daytime and evening activities, making the best location within close proximity to the school as well as the Parking Area. The Central Atrium should be located central to the major program spaces with a connection to the Main Entry for secured access to evening events. Since the Central Atrium is also a pre-function space for the Auditorium, the spaces should be directly connected. The Restrooms have a direct connection between the Gymnasium and Central Atrium, while also being in close proximity to the Auditorium for use during performances and events. The Classrooms' proximity to the Office provides convenient access for faculty and student support throughout the school day.



A/E
LEVEL

This is an **A/E level** item requiring the analysis of horizontal functional relationships as they relate to the building program and client requirements.

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SAMPLE ITEM 9

As part of the programming phase, an architect is required to create a preliminary project schedule for the renovation of a 50,000 sq. ft. laboratory facility.

Which items should the architect consider when creating this schedule? **Check the three that apply.**

- Coordination meeting schedule
- Lead time for construction materials
- Project delivery method
- Project budget
- Regulatory requirements
- Shop drawings

CORRECT RESPONSE

As part of the programming phase, an architect is required to create a preliminary project schedule for the renovation of a 50,000 sq. ft. laboratory facility.

Which items should the architect consider when creating this schedule? **Check the three that apply.**

- Coordination meeting schedule
- Lead time for construction materials
- Project delivery method**
- Project budget**
- Regulatory requirements**
- Shop drawings

RATIONALE: According to *The Architect's Handbook of Professional Practice*, project delivery method, project budget, and regulatory requirements can have an impact on a project's schedule. Multiple project delivery methods exist today, each implementing a different process with specific requirements and deliverables. The project budget impacts the schedule directly, specifically regarding economic inflation over the duration of a project and staff hours required to complete a project. Regulatory requirements vary by jurisdiction and may contain a complex and time-consuming approvals process. A coordination meeting schedule, lead time for construction materials, and shop drawings would be unknown in the programming phase of a project.



U/A

LEVEL

This is a **U/A level** item requiring you to understand the factors that can influence a preliminary project schedule.

PA References

PUBLICATIONS

The following sources are provided as the top references to assist candidates in preparation for this division. For a more comprehensive list of potential reference material, please see the [Reference Matrix](#) at the end of this handbook.

Building Codes Illustrated: A Guide to Understanding the 2012 International Building Code

Francis D. K. Ching and Steven R. Winkel, FAIA, PE
John Wiley & Sons, 2012

Problem Seeking: An Architectural Programming Primer

William M. Peña and Steven A. Parshall
John Wiley & Sons, latest edition

Site Planning & Design Handbook

Thomas H. Russ
McGraw-Hill, 2nd edition, 2009

CODES

The following code and accessibility requirements have content covered in the Programming & Analysis division.

2010 ADA Standards for Accessible Design

U.S. Department of Justice, 2010

ICC A117.1-2009 Accessible and Usable Buildings and Facilities

International Code Council, 2010

International Building Code (2012)

International Code Council, 2011

AIA CONTRACT DOCUMENTS

None of the standard list of AIA Contract Documents related to the ARE have specific content covered in the Programming & Analysis division.

Project Planning & Design

Project Planning & Design (PPD)

This division will assess objectives related to the preliminary design of sites and buildings. The division will focus on issues related to the generation or evaluation of design alternatives that synthesize environmental, cultural, behavioral, technical and economic issues. Candidates must demonstrate an understanding of and abilities in design concepts, sustainability/environmental design, universal design, and other forms of governing codes and regulations.

| | |
|---|-----------|
| SECTION 1: Environmental Conditions & Context | 77 |
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| SECTION 4: Project Integration of Program & Systems | 89 |
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DIVISION DESCRIPTION

Project Planning & Design

DIVISION DETAILS

| ITEMS | TEST DURATION | APPOINTMENT DURATION* |
|-------|---------------|-----------------------|
| 120 | 4 hr 15 min | 5 hr |

*Appointments allow for introductory screens, a break if you choose, and closing screens.

This division will test a candidate's ability to protect the public's health, safety, and welfare by:

- Evaluating project design alternatives
- Determining if a design meets project parameters, including those defined by the client, the environment, and society
- Selecting the appropriate building systems and material to meet project goals and regulatory requirements
- Integrating technical knowledge and information to develop a design

The 120 items will assess you on five sections related to Project Planning & Design. The number of items from each section will vary based on the targeted percentage of items within each section.

SECTION DETAILS

| SECTIONS | EXPECTED NUMBER OF ITEMS | TARGET PERCENTAGE |
|--|--------------------------|-------------------|
| SECTION 1: Environmental Conditions & Context | 12-20 | 10-16% |
| SECTION 2: Codes & Regulations | 20-27 | 16-22% |
| SECTION 3: Building Systems, Materials, & Assemblies | 22-30 | 19-25% |
| SECTION 4: Project Integration of Program & Systems | 38-46 | 32-38% |
| SECTION 5: Project Costs & Budgeting | 9-17 | 8-14% |

Environmental Conditions & Context

In this section, you'll use the site information gathered in the programming and analysis phase of a project to plan the site and environmental aspects of a project.

OBJECTIVE 1.1

Determine location of building and site improvements based on site analysis (A/E)

Based on views, wind, topography, adjacencies, program, planning concepts, and other factors, you will need to be able to locate a new built project on its site. This can include the orientation of one building, the arrangement of multiple buildings, or the configuration of site improvements.

OBJECTIVE 1.2

Determine sustainable principles to apply to design (A/E)

An architect must use sun, wind, temperature, precipitation, and other climatic data to select building orientation and shape, building envelope design, and active and/or passive building systems. Sustainable principles also include considering recycled content and identifying opportunities to minimize waste when selecting building materials.

OBJECTIVE 1.3

Determine impact of neighborhood context on the project design (U/A)

You will need to consider the character of a site's neighborhood, including proximity to various modes of transit, nearby amenities, the scale of adjacent buildings, surrounding façade materials, historic precedent, and historic preservation requirements. Understanding how these impact a project is necessary.

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SAMPLE ITEM 1

A preliminary drainage analysis for a small land parcel in a cold, wet location indicates slopes of 1% or less. The land parcel is intended to be developed into a suburban shopping center. Which types of stormwater management systems should the architect recommend? **Check the three that apply.**

- An underground cistern, fed from rainwater collection on the shopping center roof
- Porous asphalt in the parking lot
- Foundation drainage around building perimeter
- A constructed stormwater wetland planted with native vegetation
- Onsite graywater treatment
- Diversion ditches between adjacent rows of parking spaces

CORRECT RESPONSE

A preliminary drainage analysis for a small land parcel in a cold, wet location indicates slopes of 1% or less. The land parcel is intended to be developed into a suburban shopping center. Which types of stormwater management systems should the architect recommend? **Check the three that apply.**

- An underground cistern, fed from rainwater collection on the shopping center roof**
- Porous asphalt in the parking lot**
- Foundation drainage around building perimeter
- A constructed stormwater wetland planted with native vegetation
- Onsite graywater treatment
- Diversion ditches between adjacent rows of parking spaces**

RATIONALE: All of these strategies are discussed in *Architectural Graphic Standards*. Runoff from impervious surfaces, such as roofs or paving, can cause erosion and flooding. The underground cistern will instead capture the rainwater, and porous paving will allow the water to seep back into the soil. Diversion ditches will collect any additional runoff from the parking area and divert it away from the built areas. Foundation drainage and graywater treatment options are not related to stormwater management and a constructed wetland is not appropriate for a small commercial site in a cold climate.



A/E
LEVEL

This is an **A/E level** item requiring the analysis of existing site conditions and stormwater management systems to determine the most appropriate strategies.

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SAMPLE ITEM 2

A new, one-story daycare center is being planned in a hilly, suburban location in a hot/humid climate. The prevailing winds are from the south. The client wants to use passive cooling. Which of the following strategies should the architect recommend? **Check the three that apply.**

- The building should be located at the top of the slope
- The building should be elongated along the north-south axis
- The playground should be located north of the building
- The building's main corridor should include operable transoms above the doors
- The building should include large openings on the north and south sides
- A line of shrubs should be planted west of the playground

RATIONALE: All of these strategies are discussed in *Sun, Wind, and Light*. Buildings in a hot/humid climate should be located at the top of a slope to catch cooling breezes. Large openings on the north and south sides and operable transoms in the corridor will allow for cross-ventilation. A north-south axis would actually limit the opportunities for cross-ventilation and expose the building to the hot afternoon sun. Placing the playground north of the building would provide limited shading but would block cooling breezes from reaching the playground. Planting shrubs west of the playground may provide visual interest but would not be effective in blocking the hot afternoon sun.

CORRECT RESPONSE

A new, one-story daycare center is being planned in a hilly, suburban location in a hot/humid climate. The prevailing winds are from the south. The client wants to use passive cooling. Which of the following strategies should the architect recommend? **Check the three that apply.**

- The building should be located at the top of the slope**
- The building should be elongated along the north-south axis
- The playground should be located north of the building
- The building's main corridor should include operable transoms above the doors**
- The building should include large openings on the north and south sides**
- A line of shrubs should be planted west of the playground



This is an **A/E level** item requiring analysis of existing site conditions and passive cooling strategies to determine the most appropriate strategies.

Codes & Regulations

In this section, you'll look at the codes and regulations relevant to the planning phase of a project.

OBJECTIVE 2.1

Apply zoning and environmental regulations to site and building design (U/A)

It is important to understand the regulations that govern the outside of a building, including standard and accessible parking requirements, allowable building size based on FAR, site coverage, and property line setbacks.

OBJECTIVE 2.2

Apply building codes to building design (U/A)

It is also important to assess the building code requirements that impact a project. This includes building height and area limits, maximum occupant load, fire separation, required egress, and accessibility. Architects must be able to compile this information into a code analysis and incorporate it into the design.

OBJECTIVE 2.3

Integrate multiple codes to a project design (A/E)

Multiple codes may govern a project, depending on the jurisdiction, funding stream, or other factors. You will need to understand the use of related codes, like energy, mechanical, and universal design; determine how multiple codes are used together; and discern which code governs when a conflict arises.

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SAMPLE ITEM 3

An office building is proposed for a rectangular suburban office park site measuring 300 feet by 600 feet. The program requires an uncovered grade level entrance plaza of 30,000 square feet, a 120,000 square foot below grade parking garage, plus 450,000 gross square feet of office space. Setbacks must be free of built site improvements.

What is the minimum total number of parking and office levels needed if the city requires a 20' setback on all sides?

CORRECT RESPONSE

5

RATIONALE: You'll first need to calculate the buildable areas. The below-grade buildable area equals the surface area of the site reduced by the required setbacks (**Step 1**). The above-grade buildable area equals the below-grade area, reduced by the required plaza (**Step 2**). Next, you'll calculate the number of levels required to accommodate the office space. This can be found by dividing the total office area by the above-grade buildable area (**Step 3**). Finally, you'll calculate the number of levels required to accommodate the parking garage, which is found by dividing the total parking area by the below-grade buildable area (**Step 4**). Remember that all partial levels should be rounded up to the nearest whole number. Add the above-grade and below-grade levels together to find the total answer (**Step 5**). The answer must be entered in the box as a numeral (5), not as text (five). Also note the units are already provided.

Step 1: $560 \text{ ft.} \times 260 \text{ ft.} = 145,600 \text{ sq. ft.}$

Step 2: $145,600 \text{ sq. ft.} - 30,000 \text{ sq. ft.} = 115,600 \text{ sq. ft.}$

Step 3: $450,000 \text{ sq. ft.} / 115,600 \text{ sq. ft.} = 3.9 \text{ levels}$

Step 4: $120,000 \text{ sq. ft.} / 145,600 \text{ sq. ft.} = .8 \text{ levels}$

Step 5: 4 levels + 1 level = 5 levels



This is a U/A level item requiring an understanding of zoning setbacks and building massing.

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SAMPLE ITEM 4

IBC contains requirements for the ventilation of attics and concealed roof spaces for which of the following reasons?

- To prevent heat transfer from the building into the spaces
- To prevent moisture accumulation and condensation in the spaces
- To eliminate the need for installation of an air barrier in the spaces
- To exhaust fire or smoke from the spaces

CORRECT RESPONSE

IBC contains requirements for the ventilation of attics and concealed roof spaces for which of the following reasons?

- To prevent heat transfer from the building into the spaces
- To prevent moisture accumulation and condensation in the spaces**
- To eliminate the need for installation of an air barrier in the spaces
- To exhaust fire or smoke from the spaces

RATIONALE: As shown in *Building Codes Illustrated: A Guide to Understanding the 2012 International Building Code*, when building materials are enclosed on both the exterior and interior side of a space, the concealed space—whether an attic or rafter space—becomes susceptible to moisture intrusion. Ventilation paths allow moist air to be exhausted from a concealed space. The other options, while important to consider when designing a building, are not relevant to this code requirement.



U/A
LEVEL

This is a **U/A level** item requiring an understanding of the code and strategies for meeting code requirements.

Building Systems, Materials, & Assemblies

In this section, you'll focus on other disciplines with which an architect must be familiar, along with the various components that make up the building.

OBJECTIVE 3.1

Determine mechanical, electrical, and plumbing systems (A/E)

You will need to evaluate mechanical, electrical, and plumbing systems, and select the appropriate system for a building based on function, cost, size, availability, programmatic needs, or other factors.

OBJECTIVE 3.2

Determine structural systems (A/E)

You will need to evaluate different structural systems and select the appropriate system and layout for a building based on its size, function, and structural loads. System cost and availability must also be considered.

OBJECTIVE 3.3

Determine special systems such as acoustics, communications, lighting, security, conveying, and fire suppression (A/E)

You will need to evaluate specialty systems and select the appropriate systems for a building based on the building type, function, and programmatic requirements.

OBJECTIVE 3.4

Determine materials and assemblies to meet programmatic, budgetary, and regulatory requirements (A/E)

You will need to select a building's envelope system, interior materials, and other assemblies based on cost, availability, program requirements, environmental conditions, or other factors.

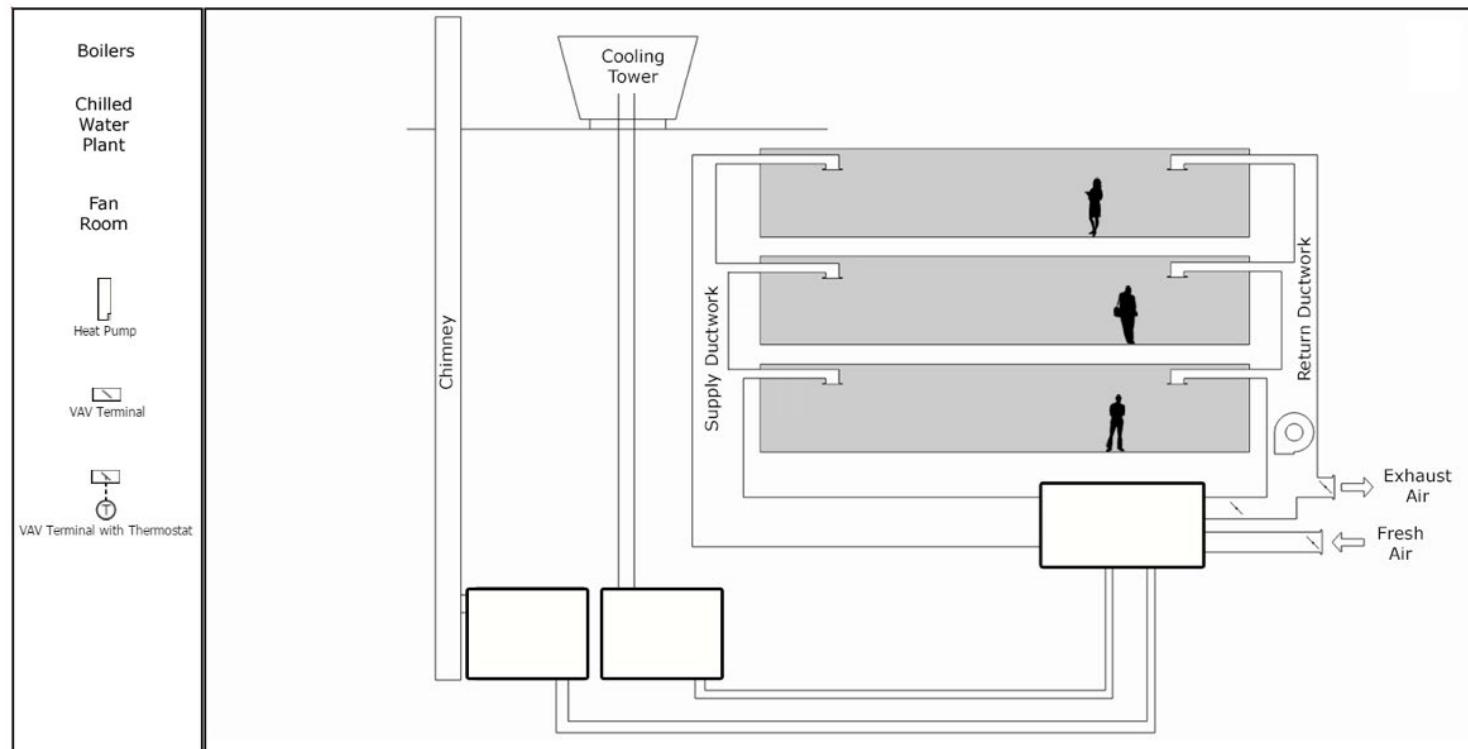
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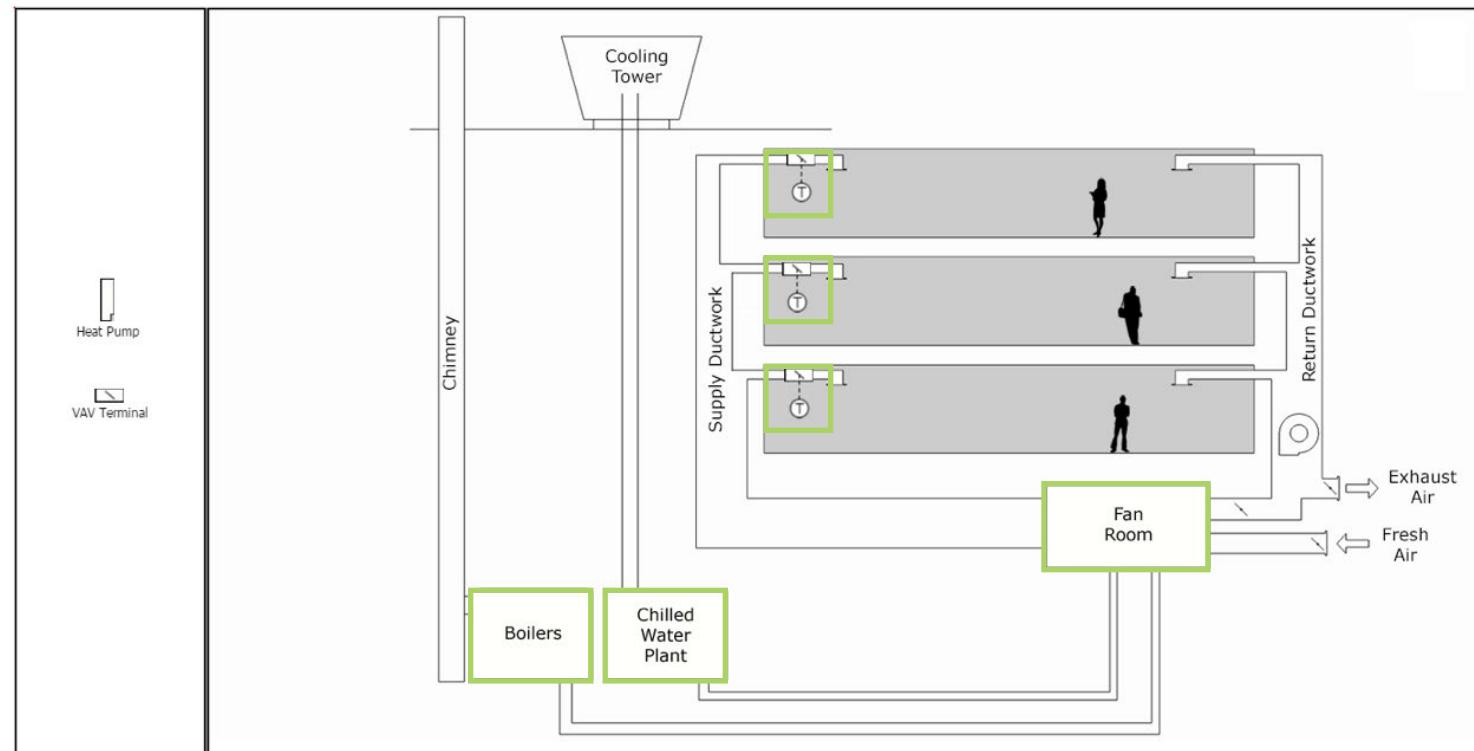
SAMPLE ITEM 5

The client for a new mid-rise office building desires a mechanical system that will have minimal operating cost and maintenance, allow maximum flexibility for office space layout, and provide individual control over the interior temperature.

Drag the labels and symbols from the area on the left onto the schematic layout of the recommended system below. Not all items will be used.



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RATIONALE: The single-duct, variable air volume (VAV) system, as described in *The Architect's Studio Companion*, meets all of the client's requirements. The Fan Room is the central hub for the system, conditioning the fresh air before distributing it through the building. Cooling is provided by the chilled water plant, which requires a cooling tower. Heating is provided by boilers, which exhaust through the chimney. Finally, each conditioned space requires a VAV terminal with a thermostat, providing both flexibility and temperature control within individual spaces.

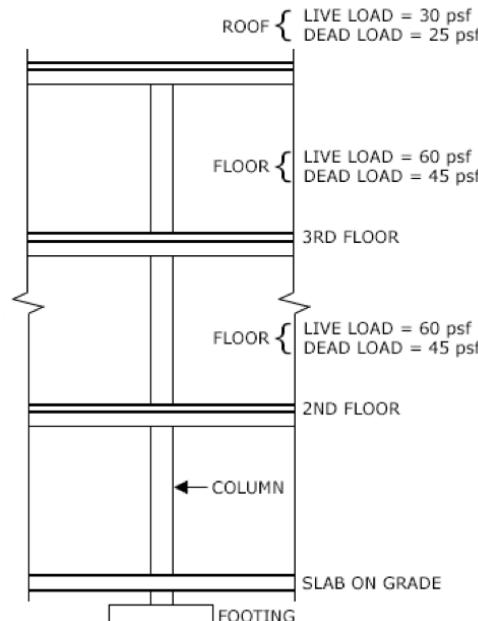
A/E
LEVEL

This is an **A/E level** item requiring analysis of the client requirements and an evaluation of system options.

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SAMPLE ITEM 6



Refer to the exhibit.

The cross section shown indicates an interior column. The tributary area for loading on the column equals 20 feet by 24 feet. Which of the following is the design live load for the footing? (Assume no live load reductions.)

- 43,200 lb
- 57,600 lb
- 72,000 lb
- 96,000 lb

CORRECT RESPONSE

- 43,200 lb
- 57,600 lb
- 72,000 lb
- 96,000 lb

RATIONALE: You'll first need to calculate the tributary area for the column (**Step 1**). Next, you must add up the live loads acting on the column (**Step 2**). The total live load multiplied by the tributary area (**Step 3**) will give you the design live load for the footing.

Step 1: $20 \text{ ft.} \times 24 \text{ ft.} = 480 \text{ sq. ft.}$

Step 2: $30 \text{ psf} + 60 \text{ psf} + 60 \text{ psf} = 150 \text{ psf}$

Step 3: $480 \text{ sq. ft.} \times 150 \text{ psf} = 72,000 \text{ lb}$

A/E
LEVEL

This is an **A/E level** item requiring you to analyze the information presented in the drawing and discern how to use the information to calculate the design load.

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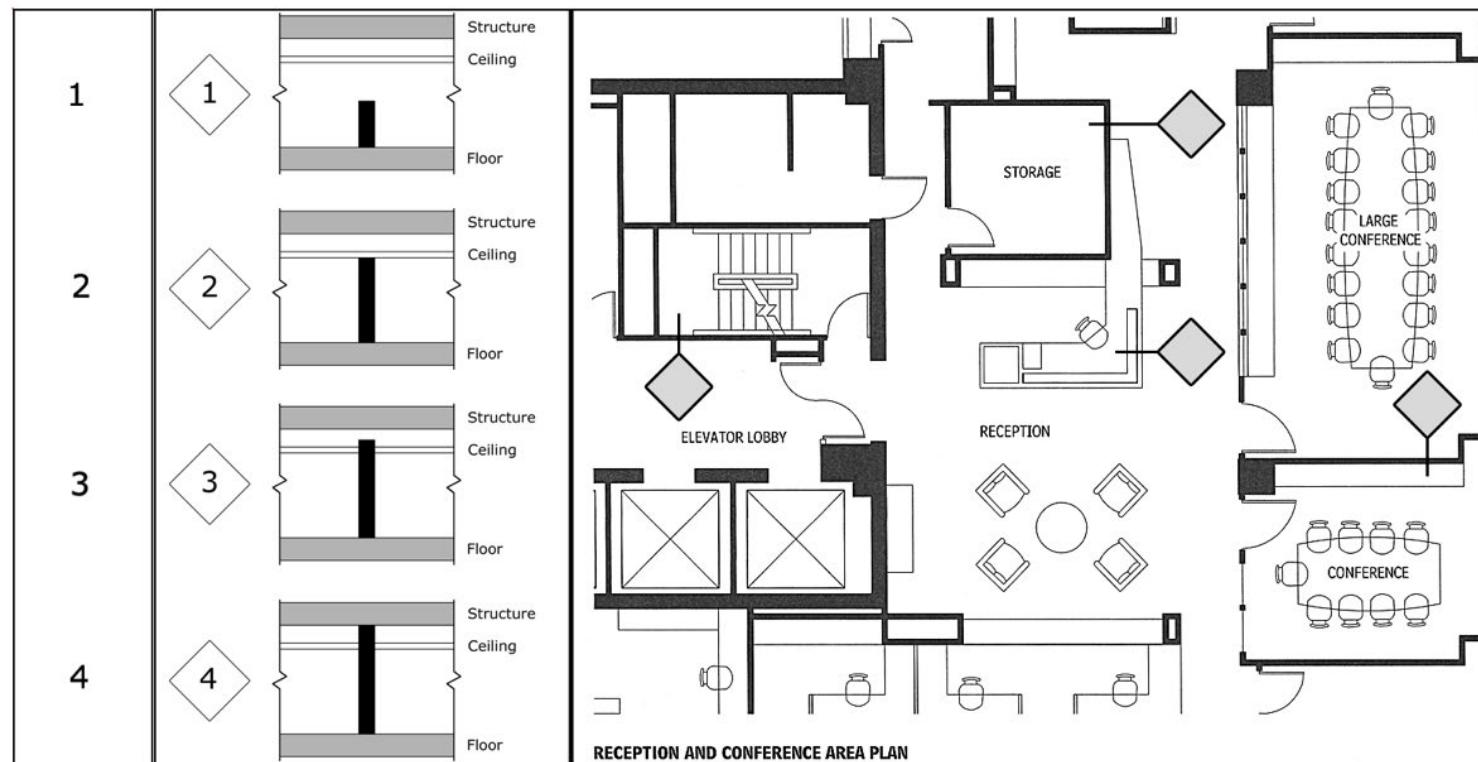
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SAMPLE ITEM 7

The partial schematic design plan for a new reception and conference area is shown below, along with the wall types to be used in the project. Specific requirements include:

- Conference rooms must include acoustic separation from each other and surrounding spaces.
- The Storage/Copy room must include the copy machine and space for office supplies.

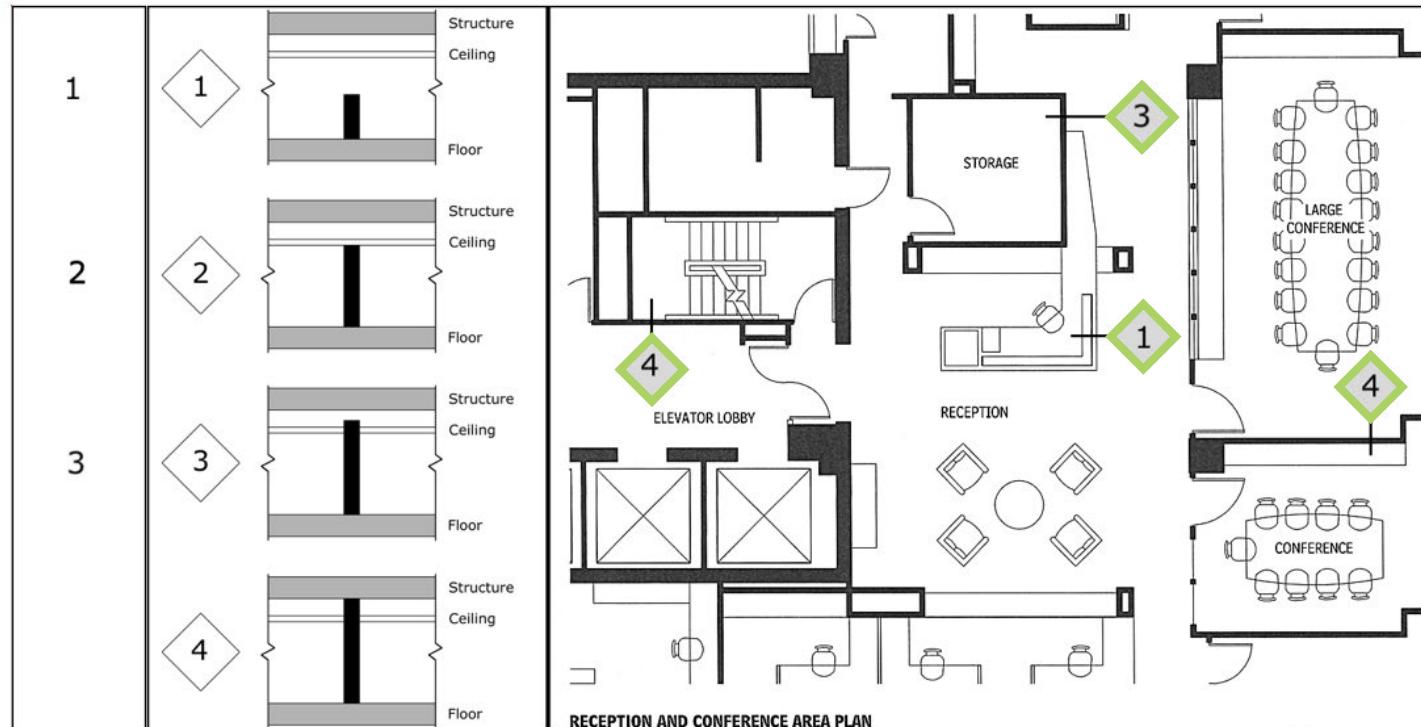
Drag the tag numbers from the area on the left onto the gray wall tags in the partial floor plan to indicate which wall type is required at each location. Not all tags will be used.



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SAMPLE ITEM 7 - CORRECT RESPONSE



RATIONALE: This image, adapted from *Architectural Graphic Standards*, includes a variety of conditions for which different wall types are required. As described in *Time Saver Standards for Architectural Design: Technical Data for Professional Practice*, fixed, rail-high walls are appropriate for an open reception desk that requires both vision and sound communication; framed walls that extend above the ceiling are appropriate where some sound attenuation from equipment such as a copy machine is desired; and partitions that extend from structure to structure are needed where a fire rating or complete sound attenuation are required, such as at egress locations and conference rooms. Wall type 2 is not used because none of the walls shown are appropriate to stop at the ceiling.

A/E
LEVEL

This is an **A/E level** item requiring an assessment of different wall types and the classification of various spaces in order to recommend wall types that will provide expected performance characteristics.

Project Integration of Program & Systems

In this section, you'll pull together all the decisions from the previous three sections regarding environmental conditions, code, systems, and assemblies. This is the largest section in the Project Planning & Design division.

OBJECTIVE 4.1

Determine building configuration (A/E)

As an architect, you will need to resolve the building's configuration based on program and code requirements, selected MEP and structural systems, site conditions, historic precedent, and principles of design logic.

OBJECTIVE 4.2

Integrate building systems in the project design (A/E)

Within this division is the beginning of systems coordination. You must consider how the selected systems fit together, both spatially and functionally, and how they are coordinated into the architectural design.

OBJECTIVE 4.3

Integrate program requirements into a project design (A/E)

Architects must be able to reconcile the relationships between various program requirements, evaluate the program's impact on cost and building systems, and assess how the program is affected by environmental factors.

OBJECTIVE 4.4

Integrate environmental and contextual conditions in the project design (A/E)

You will need to incorporate various design strategies, including those assessed in Section 1, into the project. This may include elements like view corridors, shading elements, building materials, and landscape design.

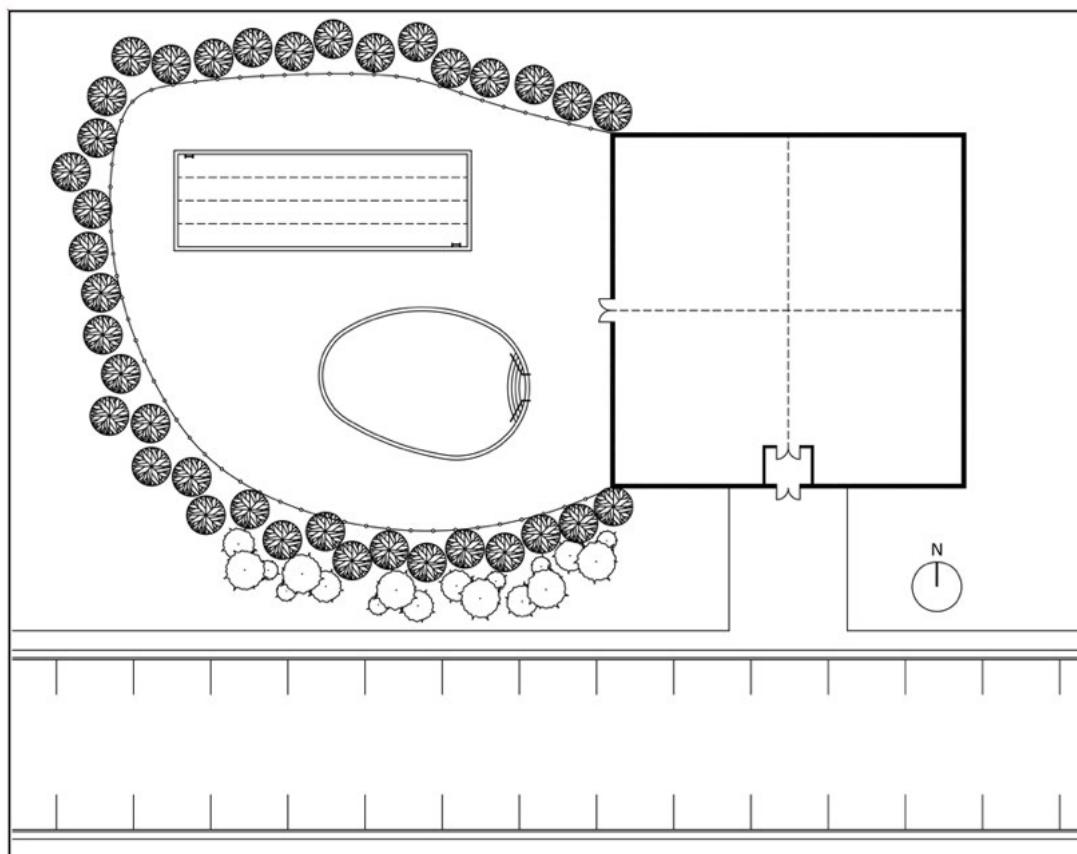
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The plan below shows a new community center planned for an existing apartment complex. The community center will include four main program areas with the following requirements:

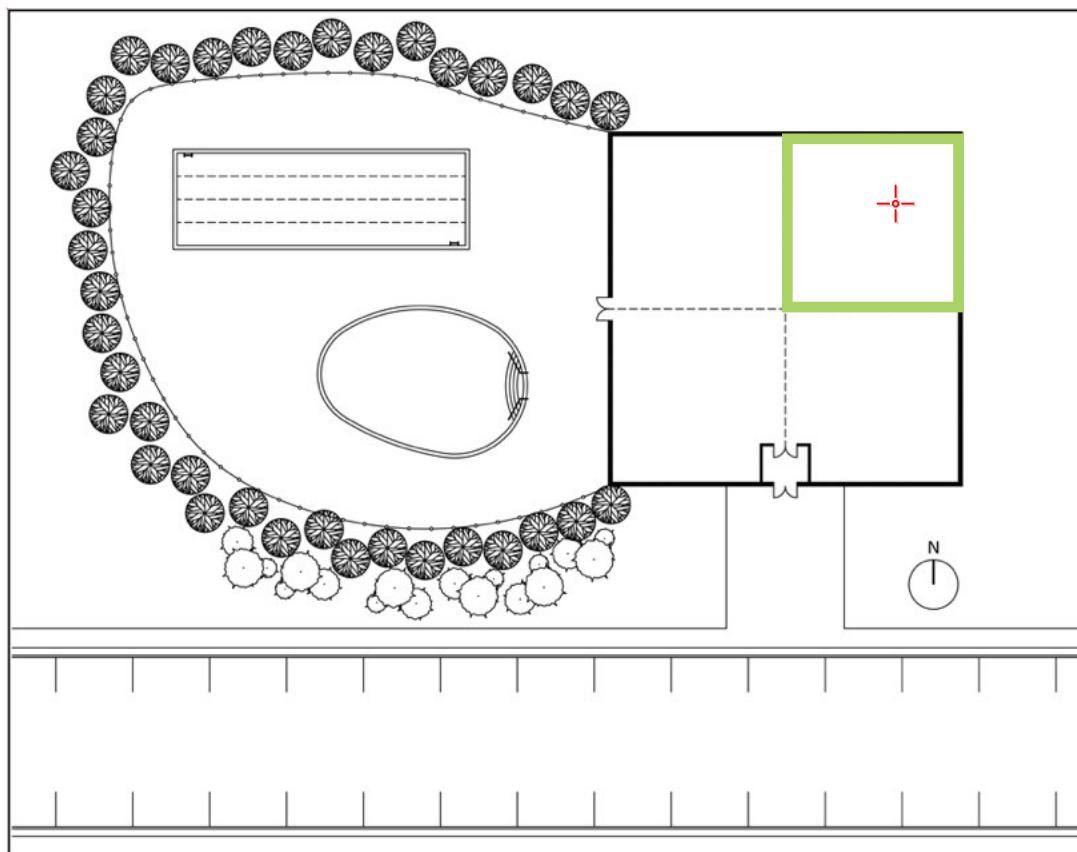
- Leasing Office - near Main Entrance
- Multipurpose Room - near Pool Deck
- Exercise Room - near Restroom/Locker Rooms
- Restrooms/Locker Rooms - near Pool Deck

Each program area will occupy one quadrant of the building. Click in the quadrant that is the most suitable location for the Exercise Room.



SAMPLE ITEM 8 - CORRECT RESPONSE

RATIONALE: By reviewing the site plan, you can see the locations of the Main Entrance and the Pool Deck. Based on their locations, you can then determine the locations of the various program spaces given the listed requirements. The Multipurpose Room and the Restrooms/Locker Rooms must both be on the west side of the building. The Leasing Office goes in the southeast corner of the building in order to be near the Main Entrance. This leaves the northeast quadrant for the Exercise Room location.

**A/E
LEVEL**

This **A/E level** item requires you to evaluate multiple pieces of plan and program information to provide an acceptable solution.

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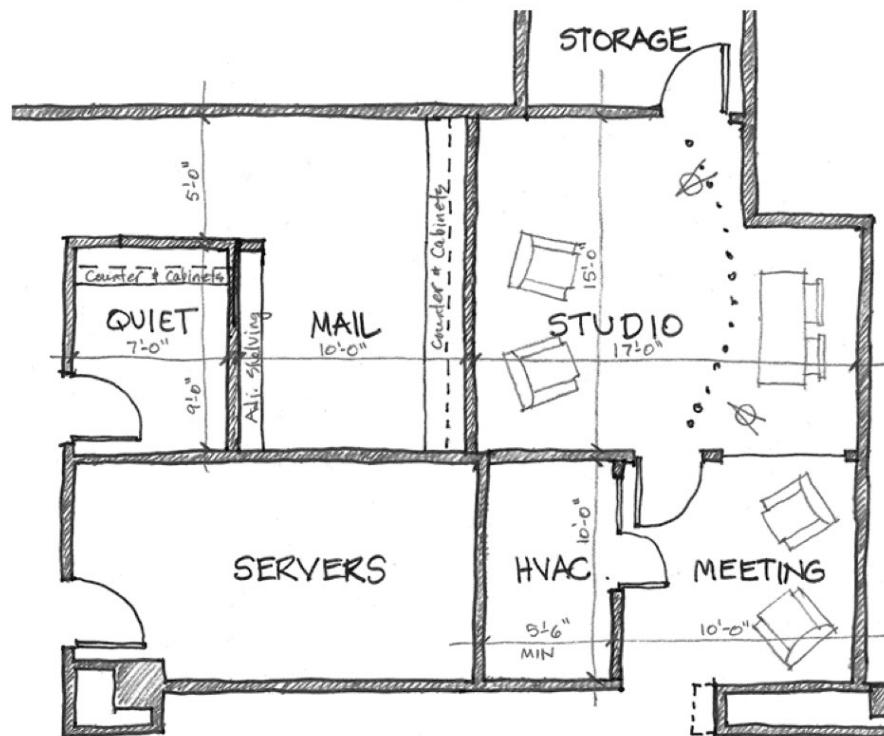
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SAMPLE ITEM 9

Refer to the exhibit.

The client for this partial office renovation has requested a new Studio to be used for video broadcasts. Due to existing conditions, the Studio must be located adjacent to the existing HVAC closet, Server Room, and Mailroom. Which of the following should the architect recommend to best minimize outside noise within the Studio?

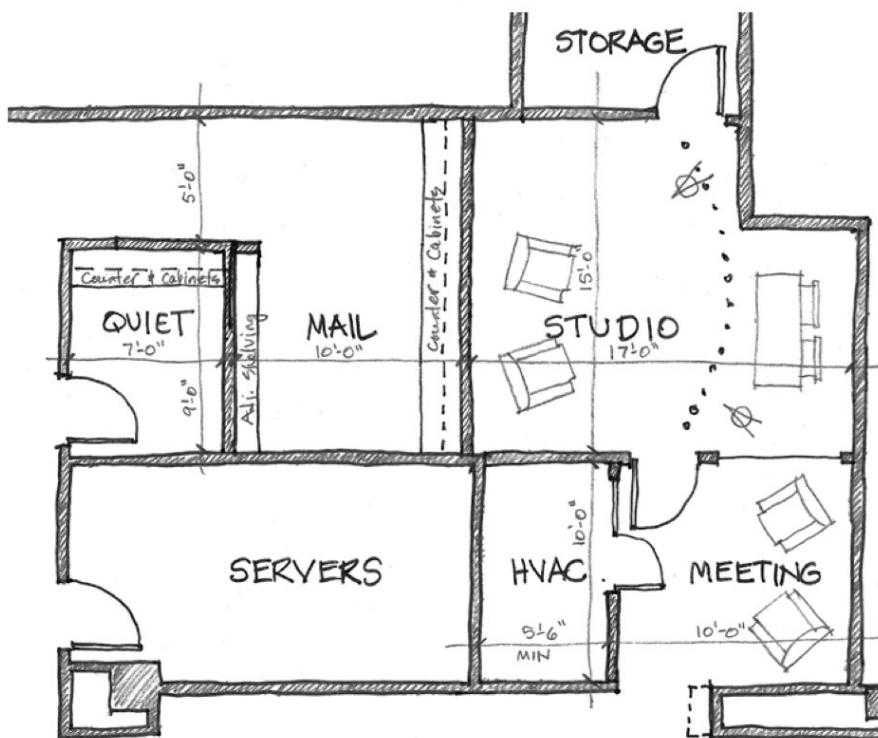
- ❑ Fabric wall panels in the Studio and on the shared walls between the HVAC closet, Server Room, and Mailroom
 - ❑ Internally line all HVAC ducts with sound absorptive material
 - ❑ Insulated double-stud partition walls between the Studio and the other rooms, extending to the structural deck above
 - ❑ Insulated shaft walls between the Studio and the other rooms, extending to the structural deck above



SAMPLE ITEM 9 - CORRECT RESPONSE

The client for this partial office renovation has requested a new Studio to be used for video broadcasts. Due to existing conditions, the Studio must be located adjacent to the existing HVAC closet, Server Room, and Mailroom. Which of the following should the architect recommend to best minimize outside noise within the Studio?

- Fabric wall panels in the Studio and on the shared walls between the HVAC closet, Server Room, and Mailroom
 - Internally line all HVAC ducts with sound absorptive material
 - Insulated double-stud partition walls between the Studio and the other rooms, extending to the structural deck above**
 - Insulated shaft walls between the Studio and the other rooms, extending to the structural deck above



RATIONALE: Based on *Plumbing, Electricity, Acoustics: Sustainable Design Methods for Architecture*, sound absorbing materials help reduce noise within a room. However, when noise comes from outside a particular room, the sound transmission into that room must be reduced. An insulated double-stud wall minimizes sound transmission in two ways: first, the separation between the studs provides an acoustic break from one side of the wall to the other; second, the insulation absorbs sound within the wall cavity. Extending the wall to the structural deck above will prevent the sound from transmitting over the top of the wall. While the fabric wall panels and duct lining will help with acoustic issues, they would not be the best choice in this situation. Shaft walls are not appropriate for a floor to ceiling wall type.



This is an **A/E level** item requiring you to analyze existing conditions and program requirements and evaluate various treatment options.

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Which of the following tree arrangements is best suited for optimal solar energy utilization and control for a house in the northeast region of the United States?

- Evergreens on the east and south; deciduous on the west
- Evergreens on the west and north; deciduous on the south
- Evergreens on the west and north; no trees on the south
- Evergreens on the north and south; deciduous on the east and west

CORRECT RESPONSE

Which of the following tree arrangements is best suited for optimal solar energy utilization and control for a house in the northeast region of the United States?

- Evergreens on the east and south; deciduous on the west
- Evergreens on the west and north; deciduous on the south**
- Evergreens on the west and north; no trees on the south
- Evergreens on the north and south; deciduous on the east and west



This is an **A/E level** item requiring you to evaluate the climate conditions of the region of the country and determine the appropriate trees and planting locations to meet both of the stated requirements.

RATIONALE: *Site Planning and Design Handbook* describes strategies for using trees to improve a building's energy efficiency. Since the site is in the northeast region of the United States, evergreen trees to the north and west will help to block winter winds, as well as the heat gain from western sunlight in the summer. Deciduous trees to the south allow winter sun, when it is desired for passive heat gain, but block summer sun, providing valuable shade.

Project Costs & Budgeting

In this last section, you'll consider the bottom line: how much does this project cost.

OBJECTIVE 5.1

Evaluate design alternatives based on the program (A/E)

As an architect, you will need to resolve the building's configuration based on program and code requirements, selected MEP and structural systems, site conditions, historic precedent, and principles of design logic.

OBJECTIVE 5.2

Perform cost evaluation (A/E)

It is important for you to evaluate various methods of estimating project costs, including those based on program type, square footage, or systems/assemblies. You must also be able to adjust the cost estimate as the design develops and reconcile the estimate with the project budget.

OBJECTIVE 5.3

Evaluate cost considerations during the design process (A/E)

Architects need to consider client priorities and life cycle costs when selecting materials and systems, and they must evaluate the cost effectiveness of various design decisions.

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Refer to the exhibit.

A developer has a budget of \$3,100,000 for an office building project.

A project completed in 2011 with a similar site and project size had a total cost of \$2,700,000. The present year construction cost index in the same city is 112.6. How much is the current project underfunded?

\$

HISTORICAL COST INDEX

| YEAR | NATIONAL AVERAGE | PROJECT LOCATION |
|------|------------------|------------------|
| 2015 | 107.3 | 105.1 |
| 2014 | 101.1 | 99.1 |
| 2013 | 97.8 | 96.2 |
| 2012 | 96.3 | 94.7 |
| 2011 | 95.0 | 93.8 |
| 2010 | 93.8 | 93.4 |

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SAMPLE ITEM 11 - CORRECT RESPONSE

\$ 140,000

RATIONALE: You'll first need to calculate the ratio between the cost indices by dividing the present year cost index by the historic cost index (**Step 1**). That ratio multiplied by the historic construction cost will give you the estimate for the current construction cost (**Step 2**). Finally, you'll subtract the budget from the current construction cost to determine the amount of underfunding (**Step 3**). Because the \$ is in front of the answer box, only the numerals need to be entered.

Step 1: $112.6 / 93.8 = 1.2$

Step 2: $\$2,700,000 \times 1.2 = \$3,240,000$

Step 3: $\$3,240,000 - \$3,100,000 = \$140,000$

| HISTORICAL COST INDEX | | |
|-----------------------|------------------|------------------|
| YEAR | NATIONAL AVERAGE | PROJECT LOCATION |
| 2015 | 107.3 | 105.1 |
| 2014 | 101.1 | 99.1 |
| 2013 | 97.8 | 96.2 |
| 2012 | 96.3 | 94.7 |
| 2011 | 95.0 | 93.8 |
| 2010 | 93.8 | 93.4 |



This is an **A/E level** item requiring you to review a cost index table, determine the appropriate cost indices to use in this situation, and apply historic and current year data to calculate estimated costs.

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SAMPLE ITEM 12

The mechanical engineer has proposed two different HVAC systems for a new project. Either system is suitable for the project type and location, but for tax purposes, the owner prefers a higher HVAC equipment depreciation cost over the lifecycle of the system. System A is a forced air heating and cooling system with an upfront cost of \$10,000, an anticipated useful life of 20 years, and a salvage value of \$1,000. System B is an electric packaged terminal unit with an upfront cost of \$7,500, an anticipated useful life of 15 years, and a salvage value of \$1,500. What is the annual depreciation of the system with the higher per year depreciation?

- \$300
- \$400
- \$450
- \$500



This is an **A/E level** item requiring an appraisal of life cycle costs as applied to mechanical systems and a comparison between the costs in order to recommend a system.

CORRECT RESPONSE

The mechanical engineer has proposed two different HVAC systems for a new project. Either system is suitable for the project type and location, but for tax purposes, the owner prefers a higher HVAC equipment depreciation cost over the lifecycle of the system. System A is a forced air heating and cooling system with an upfront cost of \$10,000, an anticipated useful life of 20 years, and a salvage value of \$1,000. System B is an electric packaged terminal unit with an upfront cost of \$7,500, an anticipated useful life of 15 years, and a salvage value of \$1,500. What is the annual depreciation of the system with the higher per year depreciation?

- \$300
- \$400
- \$450
- \$500

RATIONALE: Annual depreciation value is an important aspect of life cycle considerations. It can be determined by subtracting the salvage value from the initial investment (**Step 1**), then dividing by the estimated life span of the system (**Step 2**). Based on the results of each annual depreciation value, you determine that System A has a higher per year depreciation of \$450.

Step 1. System A: $\$10,000 - \$1,000 = \$9,000$

Step 2. System A: $\$9,000 / 20 = \450

Step 1. System B: $\$7,500 - \$1,500 = \$6,000$

Step 2. System B: $\$6,000 / 15 = \400

PPD References

PUBLICATIONS

The following sources are provided as the top references to assist candidates in preparation for this division. For a more comprehensive list of potential reference material, please see the [Reference Matrix](#) at the end of this handbook.

Architectural Graphic Standards

The American Institute of Architects
John Wiley & Sons, latest edition

Building Codes Illustrated: A Guide to Understanding the 2012 International Building Code

Francis D.K. Ching and Steven R. Winkel, FAIA, PE
John Wiley & Sons, 2012

Building Structures

James Ambrose and Patrick Tripenny
John Wiley & Sons, 3rd edition, 2012

Fundamentals of Building Construction: Materials and Methods

Edward Allen and Joseph Iano
John Wiley & Sons, latest edition

Mechanical & Electrical Equipment for Buildings

Walter T. Grondzik, Alison G. Kwok, Benjamin Stein, and John S. Reynolds,
Editors
John Wiley & Sons, latest edition

CODES

The following code and accessibility requirements have content covered in the Project Planning & Design division.

2010 ADA Standards for Accessible Design

U.S. Department of Justice, 2010

International Building Code (2012)

International Code Council, 2011

AIA CONTRACT DOCUMENTS

None of the standard list of AIA Contract Documents related to the ARE have specific content covered in the Project Planning & Design division.

Project Development & Documentation

Project Development & Documentation (PDD)

This division will assess objectives related to the integration and documentation of building systems, material selection, and material assemblies into a project. The division will focus on issues related to the development of design concepts, evaluation of materials and technologies, selection of appropriate construction techniques, and appropriate construction documentation. Candidates must demonstrate an understanding of and abilities in integration of civil, structural, mechanical, electrical, plumbing, and specialty systems into overall project design and documentation.

| | |
|---|------------|
| SECTION 1: Integration of Building Materials & Systems | 103 |
| SECTION 2: Construction Documentation | 110 |
| SECTION 3: Project Manual & Specifications | 116 |
| SECTION 4: Codes & Regulations | 120 |
| SECTION 5: Construction Cost Estimates | 125 |
| Project Development & Documentation References | 130 |

DIVISION DESCRIPTION

Project Development & Documentation

DIVISION DETAILS

| ITEMS | TEST DURATION | APPOINTMENT DURATION* |
|-------|---------------|-----------------------|
| 120 | 4 hr 15 min | 5 hr |

*Appointments allow for introductory screens, a break if you choose, and closing screens.

The 120 items will assess you on five sections related to Project Development & Documentation.

The number of items from each section will vary based on the targeted percentage of items within each section.

SECTION DETAILS

| SECTIONS | EXPECTED NUMBER OF ITEMS | TARGET PERCENTAGE |
|---|--------------------------|-------------------|
| SECTION 1: Integration of Building Materials & Systems | 37-45 | 31-37% |
| SECTION 2: Construction Documentation | 38-46 | 32-38% |
| SECTION 3: Project Manual & Specifications | 14-22 | 12-18% |
| SECTION 4: Codes & Regulations | 9-17 | 8-14% |
| SECTION 5: Construction Cost Estimates | 2-9 | 2-8% |

Integration of Building Materials & Systems

In this section, you'll focus on resolving and detailing architectural systems and assemblies, building materials, and engineering systems.

OBJECTIVE 1.1

Analyze the integration of architectural systems and technologies to meet project goals (A/E)

As an architect you will first need to be able to resolve and detail roof, curtain wall, cladding, window, floor, and other architectural systems, while also considering the detail requirements and capabilities of individual building materials.

OBJECTIVE 1.2

Determine the size of mechanical, electrical, and plumbing systems and components to meet project goals (U/A)

You must also be aware of related building systems to identify and develop mechanical, electrical, and plumbing systems, including calculating the size of some system components, based on system type, system requirements, programmatic requirements, and other factors.

OBJECTIVE 1.3

Determine the size of structural systems to meet project goals (U/A)

You will need to be able to identify and develop structural systems, including calculating the size of some structural components based on the system type, system requirements, programmatic requirements, and other factors.

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REFERENCES**OBJECTIVE 1.4**

Integrate specialty systems such as acoustics, lighting, fire suppression, conveying, security, and communications to meet project goals (U/A)

You will need to be able to identify, develop, and integrate individual specialty system components based on system type, system requirements, programmatic requirements, and other factors.

OBJECTIVE 1.5

Determine how to detail the integration of multiple building systems and technologies (U/A)

You must also be able to detail and resolve the intersection of roof, curtain wall, cladding, window, floor, structural, interior, and other architectural systems as they come together within a building project.

OBJECTIVE 1.6

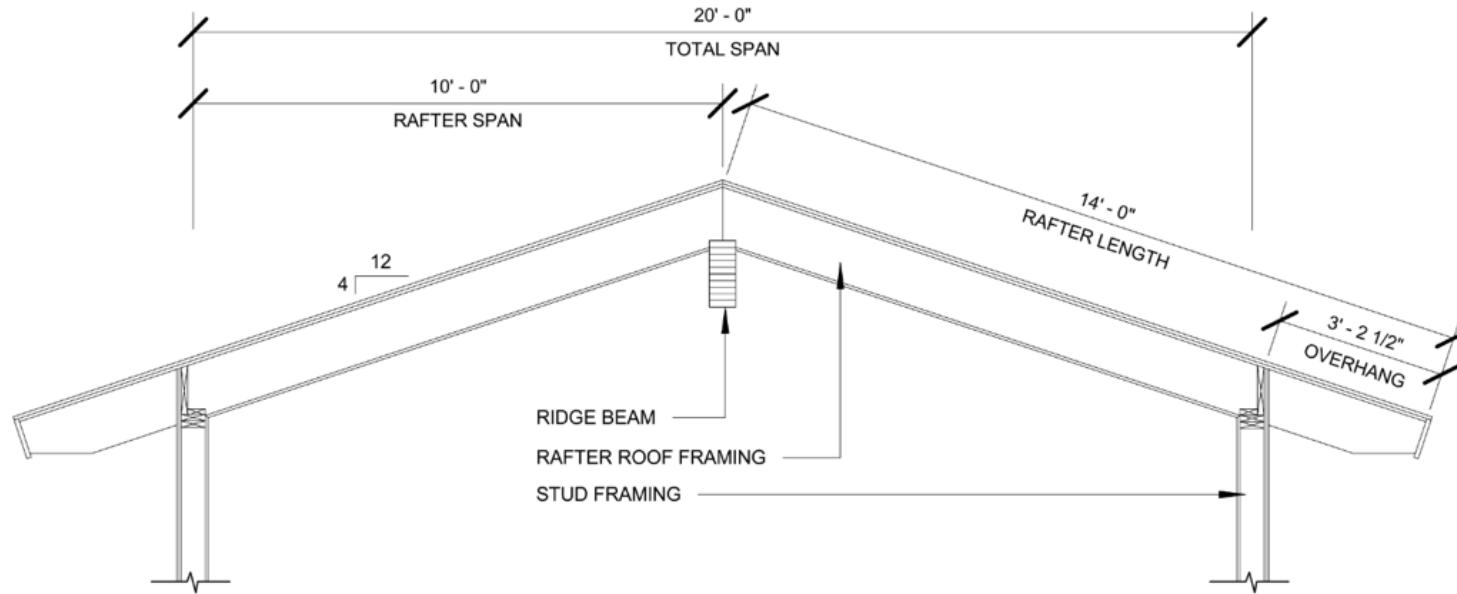
Coordinate mechanical, electrical, plumbing, structural, and specialty systems and technologies (U/A)

You must identify and resolve conflicts between engineering systems (mechanical, electrical, structural) and other specialty systems as they integrate into the project. This also includes coordinating engineering systems with the architectural design to fulfill programmatic, system, and other project requirements.

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SAMPLE ITEM 1



Refer to the exhibit.

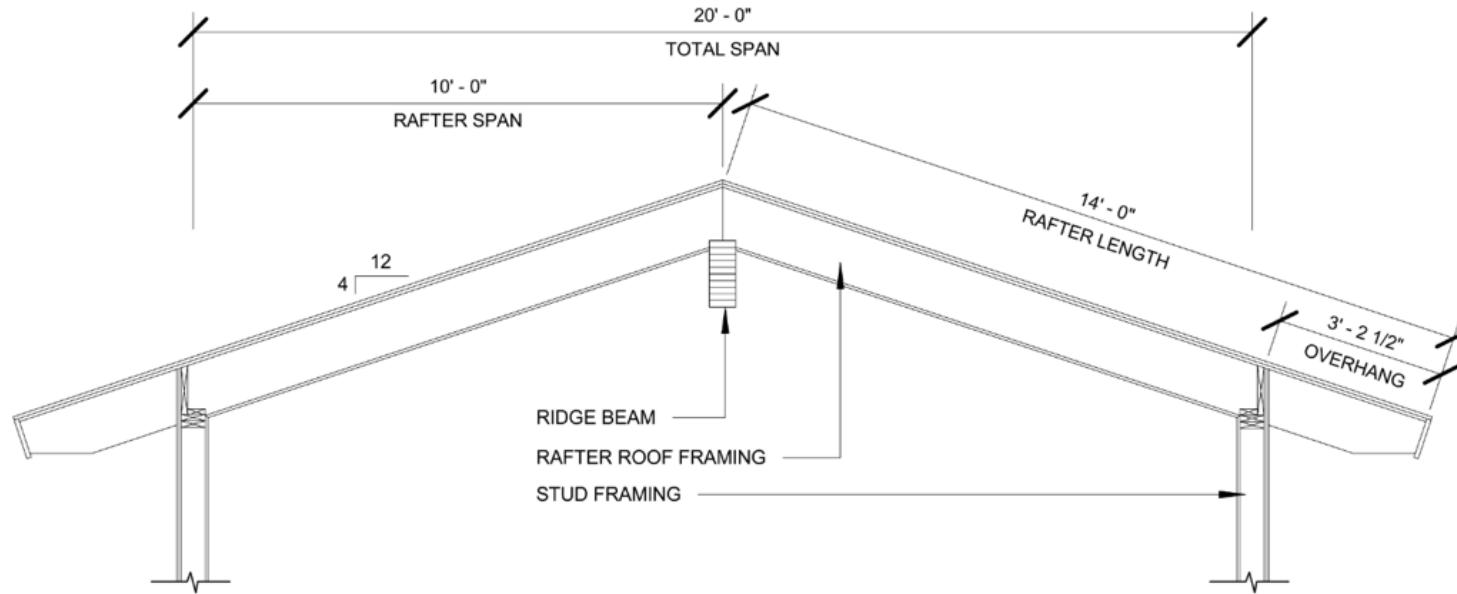
An architect is sizing a glue-laminated ridge beam for a wood-framed residential project. If the design snow load is 60 psf, what is the total snow load per linear foot on the ridge beam?

lb/ft

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SAMPLE ITEM 1 - CORRECT RESPONSE



600 lb/ft

RATIONALE: According to the *International Building Code*, design snow loads are assumed to act vertically on the horizontal projection of sloped surfaces. Considering this, you will need to multiply half the total span by the design snow load to determine the snow load on the ridge beam. Because the units are provided after the answer box, only the numerals should be entered in the box.

$$10'-0'' \times 60 \text{ psf} = 600 \text{ lb/ft}$$

**U/A
LEVEL**

This is a **U/A level** item requiring you to understand the application of live loads on wood-framed structures.

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SAMPLE ITEM 2

A hoisted hydraulic elevator has been selected for a new low-rise development. During project documentation, which of the following should the architect consider? **Check the three that apply.**

- Car support rails
- Counterweights
- Elevator pit
- Hoisting cables
- Penthouse machine room
- Piston and underground cylinder

CORRECT RESPONSE

A hoisted hydraulic elevator has been selected for a new low-rise development. During project documentation, which of the following should the architect consider? **Check the three that apply.**

- Car support rails**
- Counterweights
- Elevator pit**
- Hoisting cables
- Penthouse machine room
- Piston and underground cylinder**

RATIONALE: *Mechanical and Electrical Equipment for Buildings and Architectural Graphic Standards* discuss the critical components of each of the primary elevator systems. The car support rails extend from the pit floor to the top of the hoistway and guide the car within the hoistway. The elevator pit is an element of both traction and hydraulic elevators located at the base of the hoistway, extending below the lowest level served. It provides both overrun clearance and space for elevator equipment. Finally, the piston is located within the underground cylinder with one end connected to the elevator car. When hydraulic fluid is pumped into the cylinder, the piston and elevator car move up. Hoisting cables, counterweights, and a penthouse machine room are all components of traction elevators.

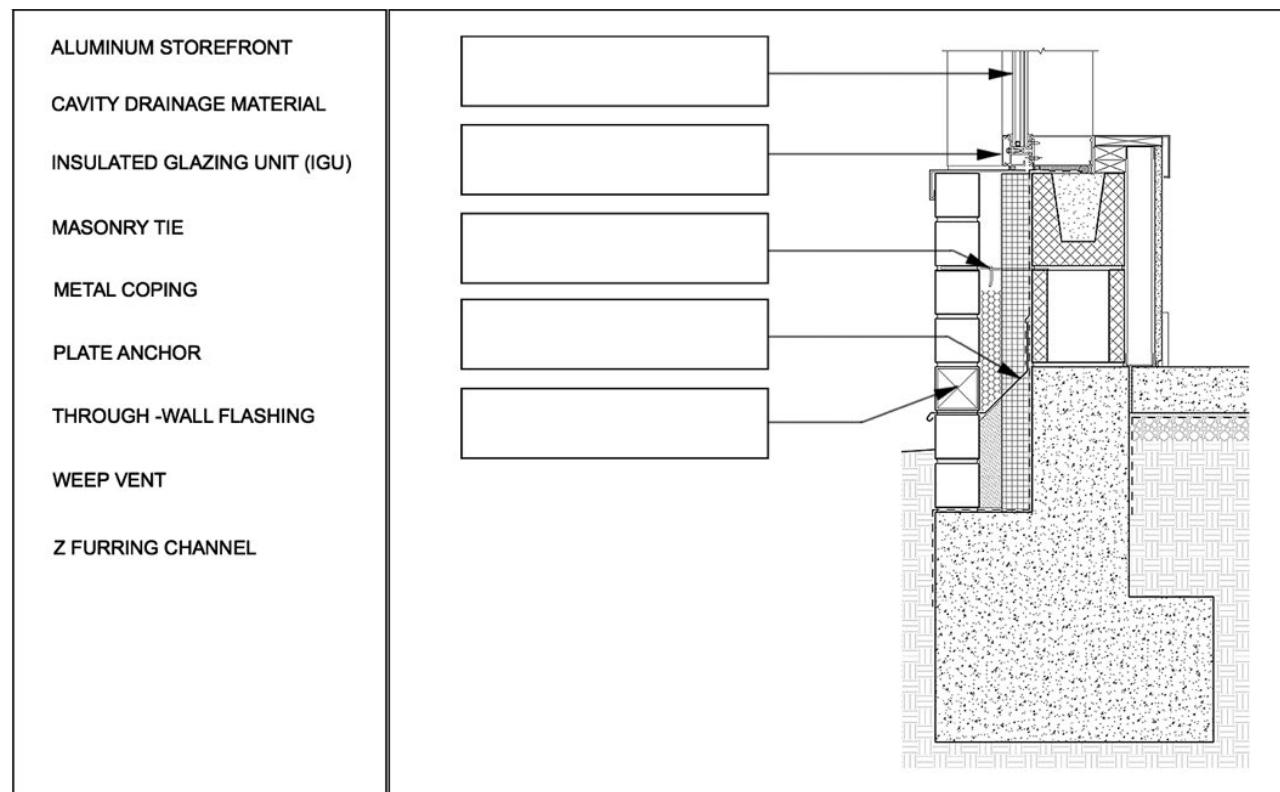


This is a **U/A level** item requiring you to have a detailed understanding of the main components of a conveying system.

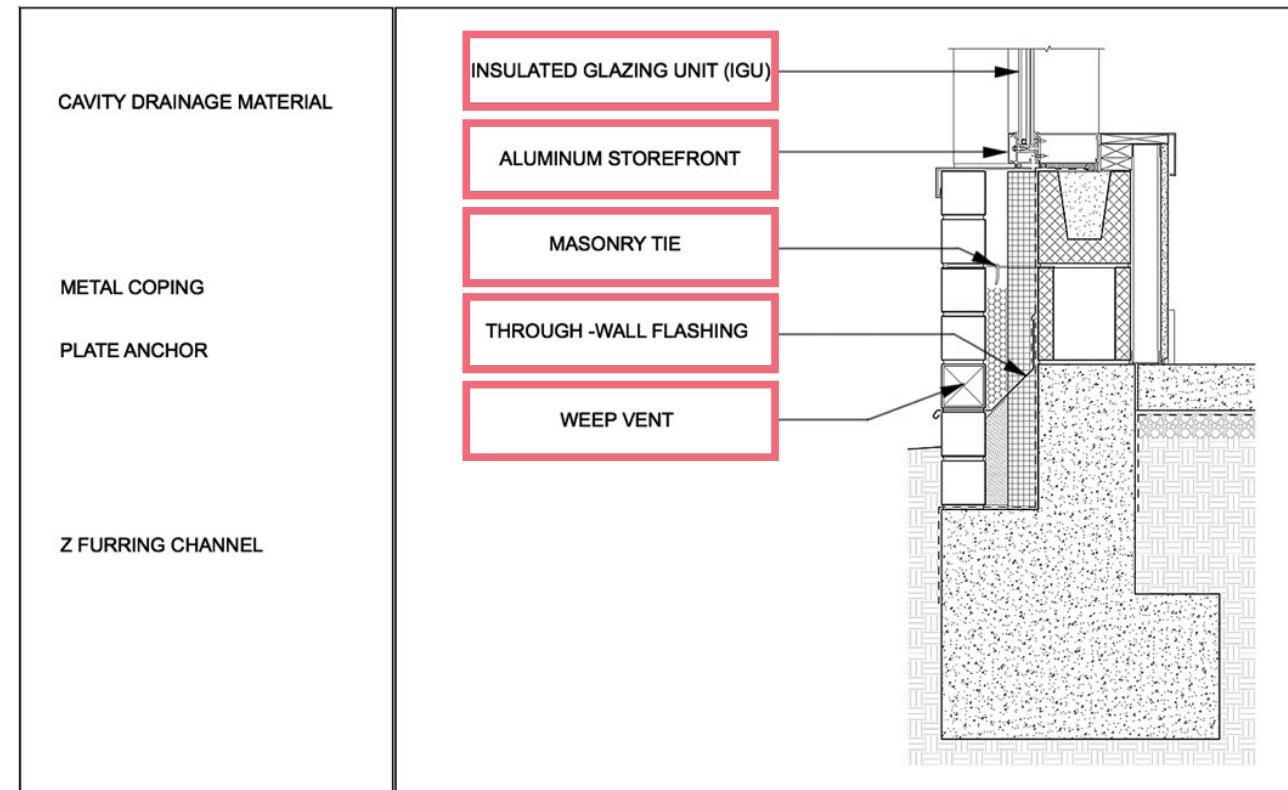
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REFERENCES**SAMPLE ITEM 3**

In the brick cavity wall section below, drag the material labels from the left into the boxes on the wall section detail. Not all material labels will be used.



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RATIONALE: The wall section detail provided represents a brick cavity wall with CMU backup construction. This type of wall system is illustrated and described in *Architectural Graphic Standards*. As part of this wall system, masonry ties are required to anchor the brick veneer to the backup wall. Through-wall flashing is required to divert moisture that has entered the wall cavity to the outside through weep vents or holes. The CMU backup wall supports a storefront system infilled with insulated glazing units (IGUs). The cavity drainage material is located in the air space above the through-wall flashing to ensure cavity wall moisture performance, but is not labeled in this section. Metal coping, plate anchors, and Z furring channels are essential elements of some wall systems, but are not part of this detail.



This is a **U/A level** item that requires you to understand the different components of an exterior wall assembly and how they integrate with other materials and systems.

Construction Documentation

In this section, you'll focus on project documentation necessary to assemble a set of drawings and update these drawings over the course of a project.

OBJECTIVE 2.1

Determine appropriate documentation of building design (A/E)

Architects must identify a drawing and documentation approach based on project complexity, materials and assemblies, delivery method, and other project or construction related requirements. Throughout project documentation, you must know how to refine, update, and make adjustment to the drawings to align with new or changing project requirements. Documentation must also indicate final selections of building materials, assemblies, and finishes.

OBJECTIVE 2.2

Determine appropriate documentation of site features (A/E)

Architects must also coordinate with civil engineers, landscape architects, and other consultants to verify the documentation of site drainage, utilities, pedestrian and vehicular circulation paths, parking, grading, and other site features and structures. It is critical to ensure site documentation is coordinated with all project disciplines.

OBJECTIVE 2.3

Determine appropriate documentation of detailed building drawings within individual architectural systems (A/E)

You will need to resolve, detail, and document individual architectural systems such as partition types, expansion joints, windows, doors, louvers, stairs, and other systems based on constructability, environmental, programmatic, and other building requirements.

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REFERENCES**OBJECTIVE 2.4****Apply standards required to assemble a set of clear and coordinated construction documentation (U/A)**

As an architect, you will also need to determine the necessary drawings required to communicate an architectural design based on the project delivery method. This requires assembling these drawings into a clear set of construction documents and ensuring the quality of the documentation meets the appropriate standard of care.

OBJECTIVE 2.5**Determine impact of project changes on documentation requirements and methods to communicate those changes to owner and design team (U/A)**

Architects must incorporate value engineering, changes in scope, and owner or project team comments into the drawing set, and determine the impact of these changes on the project delivery method and schedule. You will also need to recognize when changes in scope or owner/project team comments require the architect to perform additional services.

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SAMPLE ITEM 4

Glass is being used for the exterior storefront system of a clothing store located in a cold climate. The client has requested that the glass be neutral in color and as transparent as possible to allow maximum visibility into the store.

What type of glass should the architect specify for the storefront system?

- Single pane, gray glass with a low-e coating
- Double pane, insulating glass unit (IGU) with clear glass and a ceramic frit pattern
- Double pane, insulating glass unit (IGU) with clear glass
- Double pane, insulating glass unit (IGU) with low-iron clear glass and a low-e coating

CORRECT RESPONSE

Glass is being used for the exterior storefront system of a clothing store located in a cold climate. The client has requested that the glass be neutral in color and as transparent as possible to allow maximum visibility into the store.

What type of glass should the architect specify for the storefront system?

- Single pane, gray glass with a low-e coating
- Double pane, insulating glass unit (IGU) with clear glass and a ceramic frit pattern
- Double pane, insulating glass unit (IGU) with clear glass
- Double pane, insulating glass unit (IGU) with low-iron clear glass and a low-e coating

RATIONALE: Olin's *Construction: Principles, Materials, and Methods* describes architectural glazing in detail, including specific types, performance properties, and their integration into entrances, storefronts, or glazed curtain walls. Since the clothing store is located in a cold climate, double pane insulating glass with a low-e coating is important to minimize interior heat loss during the winter months. The client has requested the glass be neutral in color and as transparent as possible, making low-iron clear glass the best option because it has less of a green tint than standard clear glass. Single pane glass does not contain an internal insulating layer and would cause excessive heat loss, and a ceramic frit pattern would limit visibility into the store.



A/E
LEVEL

This is an **A/E level** item requiring you to evaluate the climate conditions and client requirements to complete the selection of final building materials.

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SAMPLE ITEM 5

During the review of the 95% construction documents cost estimate for a hospital project, construction costs are estimated to exceed the funds available for construction by 12%.

Prior to the bidding phase, what should the architect recommend to the owner?

- Incorporate design alternates into the documents
- Eliminate project contingencies budget
- Assume construction bids will be under budget
- Reduce the scope of the project

CORRECT RESPONSE

During the review of the 95% construction documents cost estimate for a hospital project, construction costs are estimated to exceed the funds available for construction by 12%.

Prior to the bidding phase, what should the architect recommend to the owner?

- Incorporate design alternates into the documents**
- Eliminate project contingencies budget
- Assume construction bids will be under budget
- Reduce the scope of the project

RATIONALE: *The Architect's Handbook of Professional Practice* discusses these concepts as they relate to project execution. Incorporating design alternates into the documents would be advantageous to the owner because doing so would provide them an opportunity to modify the project design and ensure the project stays within budget. This recommendation also allows the owner to select specific materials or design features after the actual construction costs are known. Project contingencies cover unforeseeable project conditions while addressing risk-related issues; therefore, it is not advisable to eliminate these values. Assuming construction bids will be under budget is extremely risky, especially since the cost estimate at 95% construction documents is 12% over the budget. Reducing the scope of the project is possible, but could contain schedule delays and be costly for the architect as this would require revising the construction documents.



This is a **U/A level** item requiring an understanding of how construction estimates can influence project documentation and how to address cost concerns prior to the bidding phase.

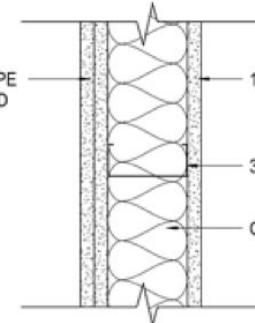
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REFERENCES**SAMPLE ITEM 6**

An architect is detailing a 2-hour rated wall assembly between a lecture hall and lobby corridor for a new business school. Wall thickness needs to be minimized, and acoustical separation between the spaces needs to be maximized.

Which interior wall assembly is appropriate for this location?

2 LAYERS 5/8" TYPE X GYPSUM BOARD



A.

1 LAYER 5/8" TYPE X GYPSUM BOARD

3 5/8" METAL STUD

GLASS FIBER INSULATION

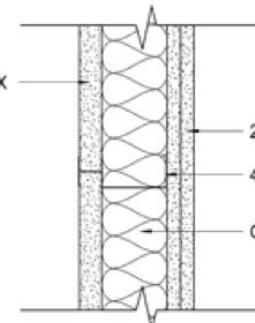
2 LAYERS 5/8" TYPE X GYPSUM BOARD, EACH SIDE

3 5/8" METAL STUD

GLASS FIBER INSULATION

C.

1 LAYER 1" TYPE X GYPSUM BOARD



B.

2 LAYERS 5/8" TYPE X GYPSUM BOARD

4" METAL C-H STUD

GLASS FIBER INSULATION

1 LAYER 1/4" GYPSUM BOARD, EACH SIDE

1 LAYER 5/8" TYPE X GYPSUM BOARD, EACH SIDE

2 1/2" METAL STUD

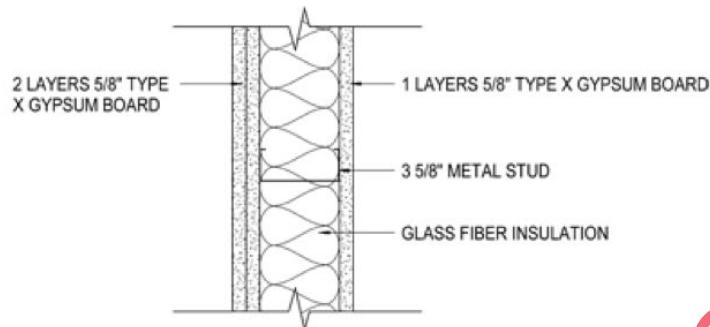
1 1/2" GLASS FIBER INSULATION

D.

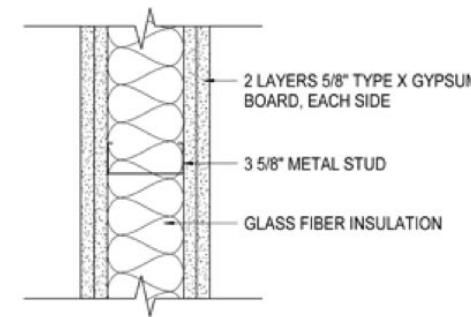
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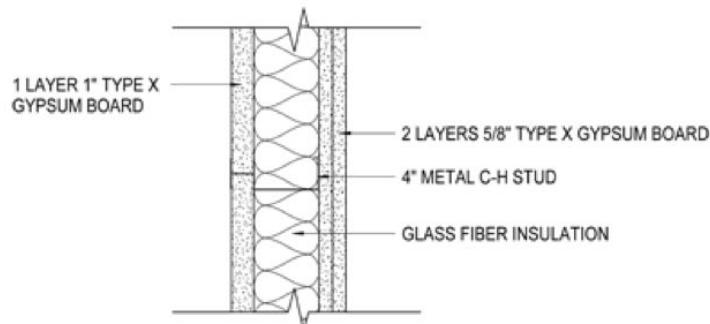
SAMPLE ITEM 6 - CORRECT RESPONSE



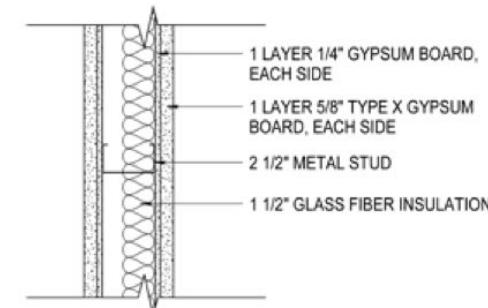
A.



C.



B.



D.

RATIONALE: According to the *International Building Code* and *Architectural Graphic Standards*, each of the interior wall assembly options provides at least an one-hour fire rating with good acoustical properties. Although options A and D provide sound transmission class (STC) ratings of up to 49 and 59, they are only constructed as 1-hour rated assemblies. Option B is a shaft wall assembly, which is not appropriate for this specific location in the business school. Option C provides a high STC rating and a 2-hour fire rating, making it the most appropriate wall assembly for the corridor partition.

**A/E
LEVEL**

This is an **A/E level** item requiring you to analyze the detailed interior wall assemblies as they relate to acoustics, fire rating, and location within the identified building.

Project Manual & Specifications

In this section, you'll focus on the development of documentation beyond construction drawings—the project manual and specifications.

OBJECTIVE 3.1

Identify and prioritize components required to write, maintain, and refine project manual (U/A)

You will need to be able to determine and assemble the content of a project manual, including the general conditions; instructions for procurement, bidding, and contracting; and project specific requirements. This also requires the identification and preparation of any additional exhibits or special conditions required for project execution.

OBJECTIVE 3.2

Identify and prioritize components required to write, maintain, and refine project specifications (U/A)

Project specification types will need to be established, and you will need to identify which divisions are necessary based on project requirements. You will also need to analyze, determine, and specify materials within a project, including general, product, performance, execution, and other specifications necessary to complete the project.

OBJECTIVE 3.3

Coordinate specifications with construction documentation (U/A)

You must also establish fully coordinated specifications with information found on the architectural construction drawings and consultant documents. This includes all materials, assemblies, hardware, methods, and other identified information.

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SAMPLE ITEM 7

A client representative for a publicly funded project has requested the specifications be written in a way to promote competition and maximize client value.

Which methods of specifying should the architect consider?

Check the three that apply.

- Descriptive
- MasterSpec
- Performance
- Proprietary
- Reference
- Restrictive

CORRECT RESPONSE

A client representative for a publicly funded project has requested the specifications be written in a way to promote competition and maximize client value.

Which methods of specifying should the architect consider?

Check the three that apply.

- Descriptive
- MasterSpec
- Performance
- Proprietary
- Reference
- Restrictive

RATIONALE: Specifications can be prepared in several different ways, each containing advantages and disadvantages. According to *The Architect's Handbook of Professional Practice*, descriptive specifications require descriptions of a material or product's characteristics; performance specifications describe the performance qualities of a material or product; lastly, reference specifications provide standards, which are published by industry associations. Since each of these specification methods do not list specific products and materials by name, they would promote competition among manufacturers and allow the owner to receive maximum value. Proprietary and restrictive specifications include product and material names, which will limit competition among manufacturers. MasterSpec is not a method of specifying; rather, it is a product used for producing specifications.



This is a **U/A level** item that requires you to understand the different types of specifications available, as well as determine which type is appropriate for a particular client and project type.

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REFERENCES**SAMPLE ITEM 8**

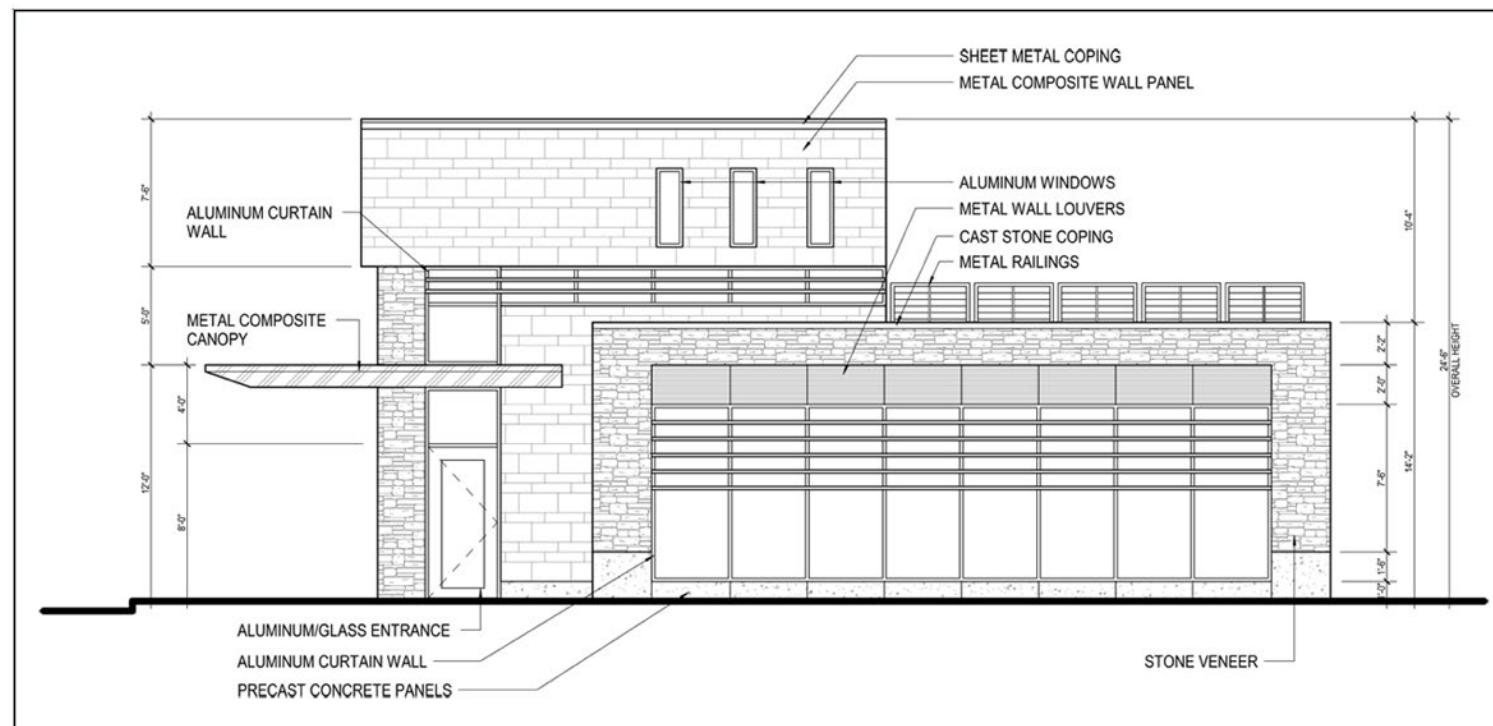
Refer to the exhibit.

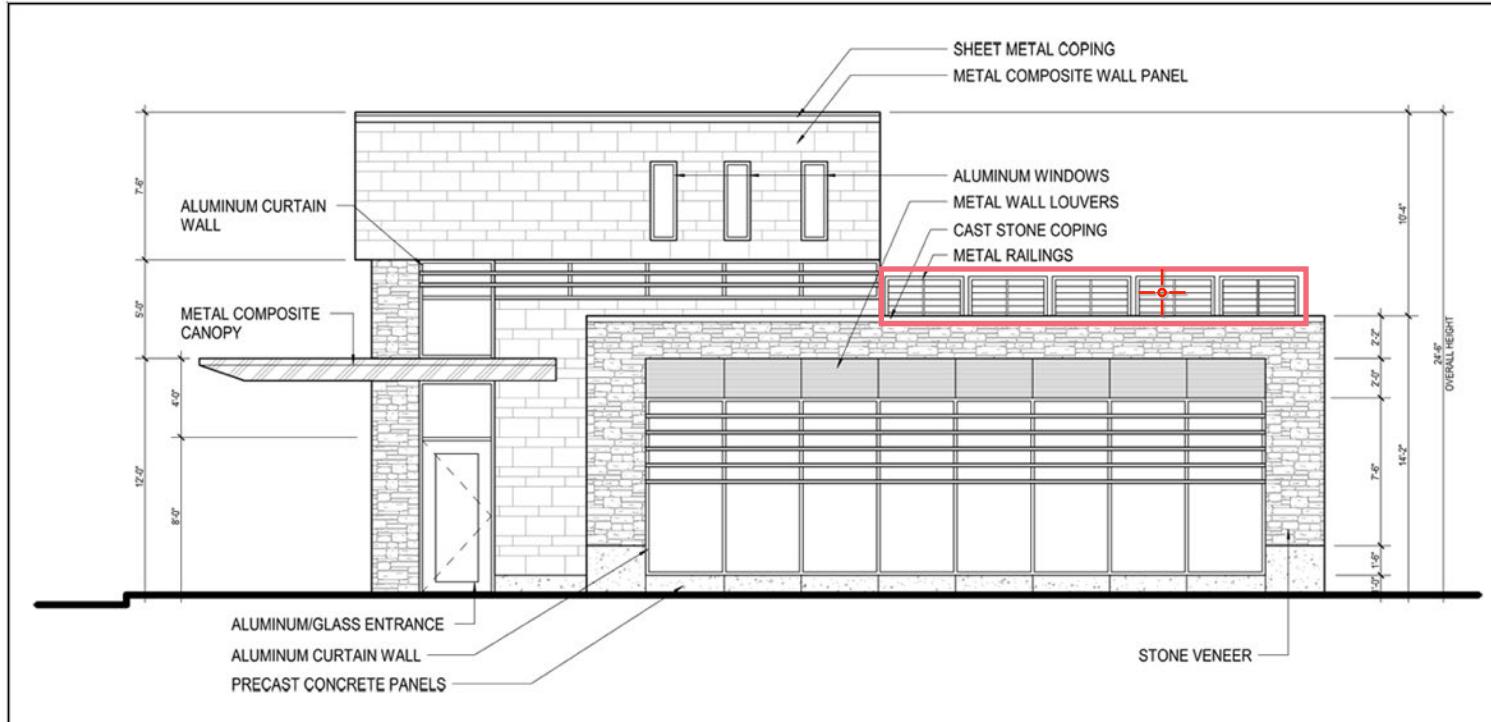
An architect is completing a coordination review of the exterior materials with the specifications received from their consultant spec writer.

Click on the element in the elevation below that is missing from the specifications.

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| | |
|---|--|
| Division 02 - Existing Conditions | Division 09 - Finishes |
| Division 03 - Concrete | Division 10 - Specialties |
| Division 04 - Masonry | Division 12 - Furnishings |
| Division 06 - Wood, Plastics, and Composites | Division 21 - Fire Suppression |
| Division 07 - Thermal and Moisture Protection | Division 22 - Plumbing |
| Division 08 - Openings | Division 28 - Electronic Safety and Security |





RATIONALE: Based on The Construction Specifications Institute's (CSI) MasterFormat divisions, Section 05 – Metals is missing from the Table of Contents provided by the consultant spec writer. This division includes metal handrails and railings, which are noted on the above elevation. The remainder of the exterior materials labeled are found in the specification list provided.



This is a **U/A level** item requiring you to understand the MasterFormat specification divisions and verify that materials shown on architectural drawings are properly specified.

Codes & Regulations

Codes and regulations appear in several divisions, but in this division, you'll look at codes and regulations at a detail level and determine how they pertain to project documentation.

OBJECTIVE 4.1

Determine adherence to building regulatory requirements (IBC) at detail level (U/A)

It is critical to be able to apply the International Building Code to the design and documentation of a project, specifically building use and occupancy, means of egress, heights and areas, fire and smoke protection, MEP systems, and structural systems, as well as material and assembly requirements.

OBJECTIVE 4.2

Determine adherence with specialty regulatory requirements at the detail level (U/A)

It is also important to be able to apply specialty regulations to the design and documentation of a project. This specifically refers to ADA requirements, energy codes, standards for historic preservation, IGCC, Fair Housing, environmental regulations, and the interpretation of provided local or site specific regulations.

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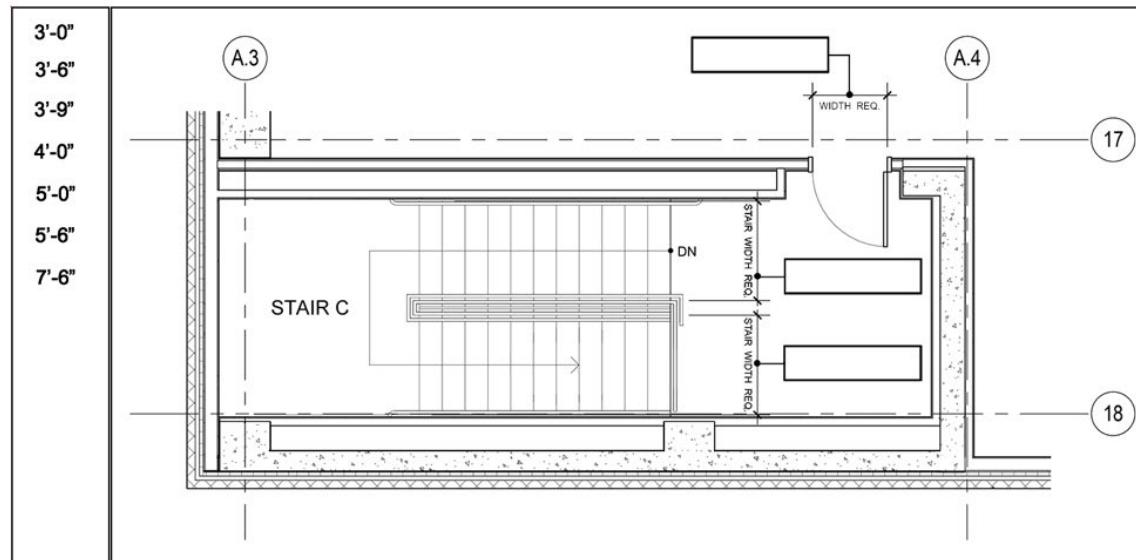
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SAMPLE ITEM 9

Refer to the exhibit.

The occupancy of the top floor of a museum project has increased from 800 to 1,200 occupants. The building contains an automatic fire sprinkler system, emergency communication system, and four stairwells to provide equally distributed egress from all floors.

Drag the dimensions from the left into the three boxes on the enlarged stair plan drawing to identify the minimum dimensions required for egress. Not all dimensions will be used.

SECTION 1005
MEANS OF EGRESS SIZING

1005.1 General. All portions of the *means of egress* system shall be sized in accordance with this section.

Exception: *Means of egress* complying with Section 1028.

1005.2 Minimum width based on component. The minimum width, in inches (mm), of any *means of egress* components shall not be less than that specified for such component, elsewhere in this code.

1005.3 Required capacity based on occupant load. The required capacity, in inches (mm), of the *means of egress* for any room, area, space or story shall not be less than that determined in accordance with Sections 1005.3.1 and 1005.3.2.

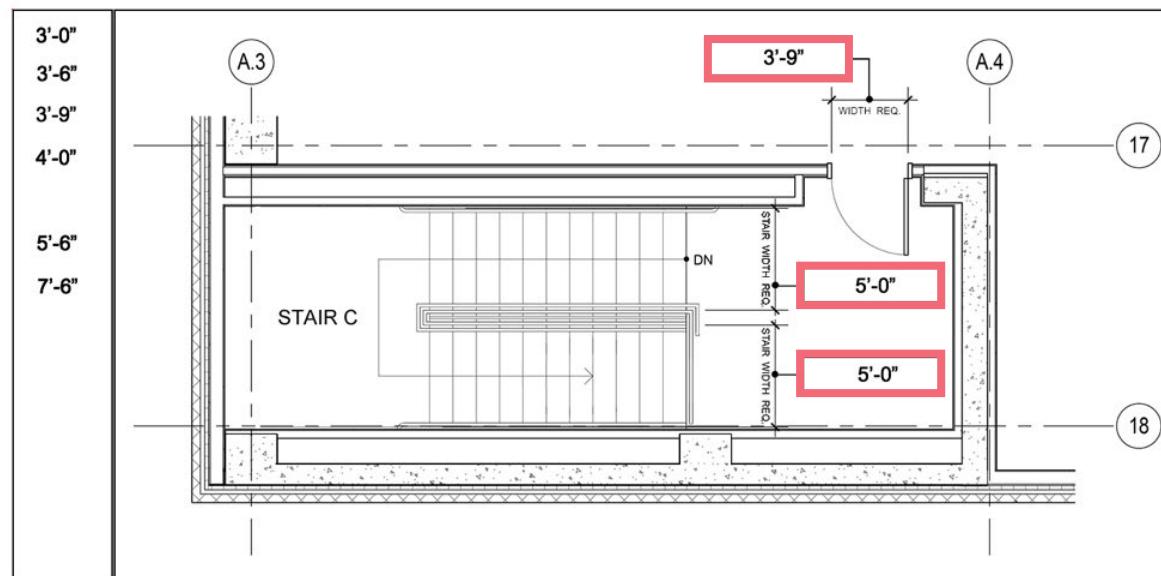
1005.3.1 Stairways. The capacity, in inches (mm), of *means of egress* stairways shall be calculated by multiplying the *occupant load* served by such *stairway* by a *means of egress* capacity factor of 0.3 inch (7.6 mm) per occupant. Where *stairways* serve more than one story, only the *occupant load* of each story considered individually shall be used in calculating the required capacity of the *stairways* serving that story.

Exception: For other than Group H and I-2 occupancies, the capacity, in inches (mm), of *means of egress* stairways shall be calculated by multiplying the *occupant load* served by such *stairway* by a *means of egress* capacity factor of 0.2 inch (5.1 mm) per occupant in buildings equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2 and an *emergency voice/alarm communication system* in accordance with Section 907.5.2.2.

1005.3.2 Other egress components. The capacity, in inches (mm), of *means of egress* components other than *stairways* shall be calculated by multiplying the *occupant load* served by such component by a *means of egress* capacity factor of 0.2 inch (5.1 mm) per occupant.

Exception: For other than Group H and I-2 occupancies, the capacity, in inches (mm), of *means of egress* components other than *stairways* shall be calculated by multiplying the *occupant load* served by such component by a *means of egress* capacity factor of 0.15 inch (3.8 mm) per occupant in buildings equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2 and an *emergency voice/alarm communication system* in accordance with Section 907.5.2.2.

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RATIONALE: Prior to calculating the required widths, you will need to determine the egress capacity factors for stairs and doors from the *International Building Code* exhibit provided. Since this building contains an automatic fire sprinkler system and emergency communication system, stairs require .2 inches per occupant and doors require .15 inches per occupant. If the top floor of the building has increased to 1200 occupants and has four stairwells providing equally distributed egress, each stair must egress 300 occupants (**Step 1**). By multiplying this occupant value by the egress capacity factor for doors (**Step 2**) and stairs (**Step 3**), you will calculate the minimum required width for each egress component.

Step 1: $1,200 / 4 = 300$ occupants

Step 2: $300 \text{ occupants} \times .15 \text{ inches per occupant} = 45'' = 3' - 9''$

Step 3: $300 \text{ occupants} \times .2 \text{ inches per occupant} = 60'' = 5' - 0''$



This is a **U/A level** item requiring you to understand means of egress requirements, as well as how to apply them at a detailed level to different egress components of a building.

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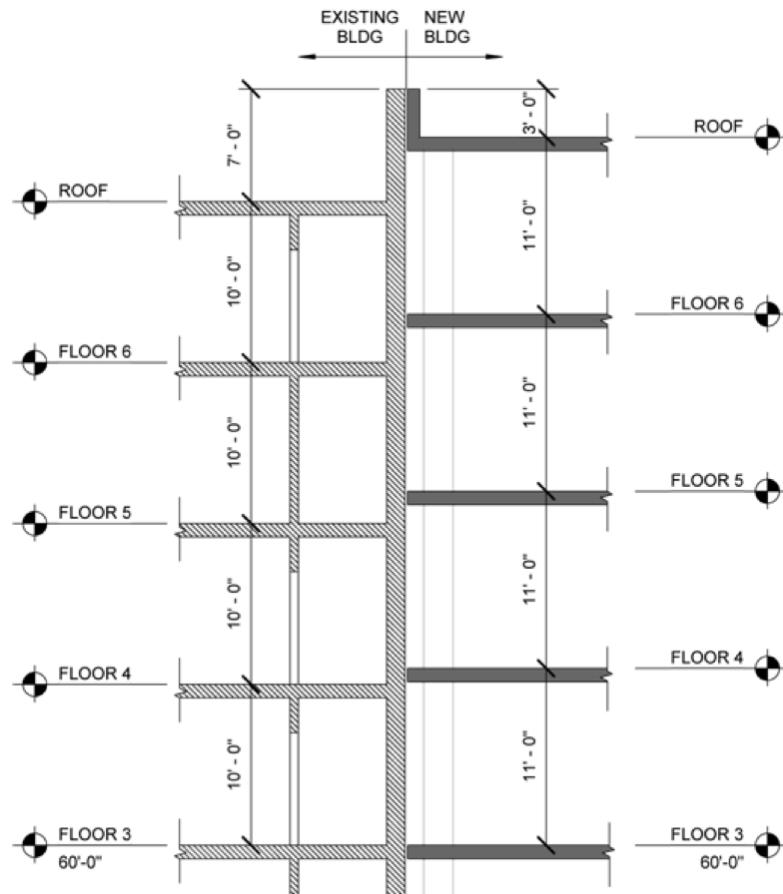
SAMPLE ITEM 10

Refer to the exhibit.

An architect is designing an addition to an existing medical research building. An accessible route between the buildings is required on all floors.

What is the minimum length of an unobstructed straight ramp system required to create an accessible route between the existing and new buildings on Floor 6 (including top and bottom landings)?

[] ft



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SAMPLE ITEM 10 - CORRECT RESPONSE

51 ft

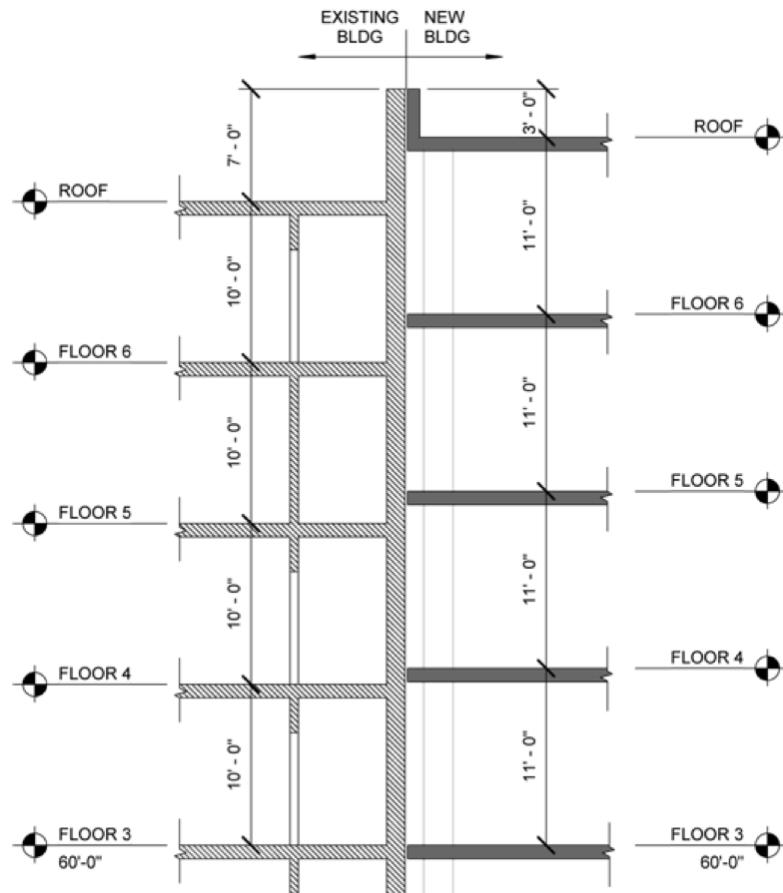
RATIONALE: In order to calculate the minimum length of ramp required, you will first need to determine that Floor 6 of the new building is 3'-0" higher than the same floor in the existing building (**Step 1**). Prior to performing a calculation, it is also important to understand that the ADA Standards for Accessible Design permit a maximum ramp slope of 1:12, a maximum ramp rise of 30", and a minimum landing length of 60" in a straight direction of travel. With this information in mind, you can determine that 3'-0" of vertical rise requires a minimum of 36'-0" of ramp length (**Step 2**). Since the rise is over 30" 30'-0" ramp and 6'-0" ramp sections are required (**Step 3**), as well as three 5'-0" landings (bottom, intermediate, and top). Adding the three landing lengths and the two ramp lengths together will give you 51'-0" (**Step 4**), the minimum length required for the ramp system. Because the unit ft is provided after the answer box, only the numerals 51 need to be entered in the box.

Step 1: $(11' - 0" + 11' - 0" + 11' - 0") - (10' - 0" + 10' - 0" + 10' - 0") = 3' - 0"$

Step 2: $3' - 0" \times 12 = 36' - 0"$ of ramp length

Step 3: $36' - 0" - 30' - 0" = 6' - 0"$

Step 4: $5' - 0" + 30' - 0" + 5' - 0" + 6' - 0" + 5' - 0" = 51' - 0"$



This is a **U/A level** item requiring you to understand the ADA requirements and apply them to accessible routes in buildings.

Construction Cost Estimates

In this last section, you'll consider the construction cost of a project by analyzing an estimate. This section contains only one objective and is the smallest section in the division.

OBJECTIVE 5.1

Analyze construction cost estimates to confirm alignment with project design (A/E)

As an architect, you will need to compare and modify a construction cost estimate based on the development of a project, including value engineering, substitution of materials, and alignment with the project documentation and requirements. You will need to utilize appropriate estimating techniques based on the project type, phase, delivery method, or other requirements.

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SAMPLE ITEM 11

| EXTERIOR WALL CONSTRUCTION TYPE | QUANTITY (SQ. FT.) | UNIT COST (\$/SQ. FT.) |
|--|--------------------|------------------------|
| Brick Veneer Cavity Wall, Metal Stud Backup | 30,000 | 60.00 |
| Thin Brick on Thin Set Mortar, Metal Stud Backup | | 49.00 |
| Precast Concrete Insulated Panels, Form Liner Exterior Finish | | 46.00 |
| Precast Concrete Insulated Panels, Thin Brick Exterior Finish | | 42.00 |
| Exterior Insulation Finishing System (EIFS), Metal Stud Backup | | 20.00 |

Refer to the exhibit.

An architect has received a construction cost estimate for an 85,000 gsf elementary school that is \$420,000 over the construction budget. The owner requests that the current brick veneer cavity wall system with a metal stud backup be replaced with a more cost effective system, while maintaining a similar exterior aesthetic. The contractor has provided pricing for alternative exterior systems.

Based on this pricing information, what system should the architect recommend to the client?

- Exterior Insulation Finishing System (EIFS), Metal Stud Backup
- Precast Concrete Insulated Panels, Form Liner Exterior Finish
- Precast Concrete Insulated Panels, Thin Brick Exterior Finish
- Thin Brick on Thin Set Mortar, Metal Stud Backup

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REFERENCES**SAMPLE ITEM 11 - CORRECT RESPONSE**

Refer to the exhibit.

An architect has received a construction cost estimate for an 85,000 gsf elementary school that is \$420,000 over the construction budget. The owner requests that the current brick veneer cavity wall system with a metal stud backup be replaced with a more cost effective system, while maintaining a similar exterior aesthetic. The contractor has provided pricing for alternative exterior systems.

Based on this pricing information, what system should the architect recommend to the client?

- Exterior Insulation Finishing System (EIFS), Metal Stud Backup
- Precast Concrete Insulated Panels, Form Liner Exterior Finish
- Precast Concrete Insulated Panels, Thin Brick Exterior Finish**
- Thin Brick on Thin Set Mortar, Metal Stud Backup

RATIONALE: Prior to calculating the cost savings of each exterior wall system, you will need to identify which systems can provide a similar exterior aesthetic. *Fundamentals of Building Construction: Materials and Methods* and *Architectural Graphic Standards* provide information on each of the identified systems. Both the exterior insulation finishing system (EIFS), which typically has a stucco-like exterior finish, and the precast concrete insulated panels, with a form liner exterior finish, differ from client's requirement for a brick aesthetic. Thin brick on thin set mortar with a metal stud backup visually would be appropriate, but does not reduce the project cost enough to meet the required budget ($30,000 \text{ ft}^2 \times \$11.00 \text{ savings}/\text{ft}^2 = \$330,000 \text{ savings}$). The precast concrete insulated panels with a thin brick exterior finish provide the desired aesthetic and reduce the project cost to a value below the construction budget ($30,000 \text{ ft}^2 \times \$18.00 \text{ savings}/\text{ft}^2 = \$540,000 \text{ savings}$).



This is an **A/E level** item that requires you to evaluate, compare, and recommend a replacement exterior wall system based on system cost and the client's aesthetic requirements.

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REFERENCES**SAMPLE ITEM 12**

An architect reviews the construction cost estimate for a financial institution located in a cold climate. The contractor needs to reduce the cost by at least \$26,000 and has included options that were presented by the curtain wall supplier. The building's energy performance is a top priority of the client.

Which cost savings options should the architect consider?

Check the three that apply.

- Change the tint of windows from brown to grey
(net savings of \$2,000)
- Reduce the air space from 3/4" to 1/4" on all IGUs
(net savings of \$13,000)
- Remove the interior entry vestibule
(net savings of \$13,000)
- Remove the low-e coating from the window glazing
(net savings of \$12,000)
- Revise custom hardware to the manufacturer's standard hardware
(net savings of \$5,000)
- Revise finish from a fluoropolymer coating to anodized aluminum finish
(net savings of \$20,000)

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REFERENCES**SAMPLE ITEM 12 - CORRECT RESPONSE**

An architect reviews the construction cost estimate for a financial institution located in a cold climate. The contractor needs to reduce the cost by at least \$26,000 and has included options that were presented by the curtain wall supplier. The building's energy performance is a top priority of the client.

Which cost savings options should the architect consider?

Check the three that apply.

- Change the tint of windows from brown to grey (net savings of \$2,000)**
- Reduce the air space from 3/4" to 1/4" on all IGUs (net savings of \$13,000)
- Remove the interior entry vestibule (net savings of \$13,000)
- Remove the low-e coating from the window glazing (net savings of \$12,000)
- Revise custom hardware to the manufacturer's standard hardware (net savings of \$5,000)**
- Revise finish from a fluoropolymer coating to anodized aluminum finish (net savings of \$20,000)**

RATIONALE: Since this is a cold climate, you need to recognize the options that may have a negative impact on the energy performance of the building, as well as those that will have a little to no effect. According to *Fundamentals of Building Construction: Materials and Methods*, reducing the air space and removing the low-e coating will have a negative impact on the thermal performance of glazing system, thus reducing the overall performance of the building envelope and occupant thermal comfort. Removing the entry vestibule would increase infiltration of air into the building, also causing thermal comfort and building performance issues. Changing the tint of the windows, revising custom hardware to manufacturer's standard hardware, and revising the finish to anodized aluminum are the most appropriate options to consider since they will primarily affect only the aesthetics of the building.



This is an **A/E level** item requiring you to evaluate and compare architectural systems in relation to cost and impact on overall building performance.

PDD References

PUBLICATIONS

The following sources are provided as the top references to assist candidates in preparation for this division. For a more comprehensive list of potential reference material, please see the [Reference Matrix](#) at the end of this handbook.

Building Construction Illustrated : A Guide to Understanding the 2012 International Building Code

Francis D. K. Ching and Steven R. Winkel, FAIA, PE
John Wiley & Sons, 2012

Building Construction Illustrated

Building Construction Illustrated
John Wiley & Sons, latest edition

Mechanical & Electrical Equipment for Buildings

Walter T. Grondzik, Alison G. Kwok, Benjamin Stein,
and John S. Reynolds, Editors
John Wiley & Sons, latest edition

Olin's Construction Principles, Materials, and Methods

H. Leslie Simmons,
John Wiley & Sons, 2007

Steel Construction Manual

American Institute of Steel Construction
Ingram, latest edition

CODES

The following code requirements have content covered in the Project Development & Documentation division.

International Building Code (2012)

International Code Council, 2011

Minimum Design Loads for Buildings and Other Structures (7-10)

American Society of Civil Engineers, 2013

AIA CONTRACT DOCUMENTS

None of the standard list of AIA Contract Documents related to the ARE have specific content covered in the Project Development & Documentation division.

Construction & Evaluation

Construction & Evaluation (CE)

This division will assess objectives related to construction contract administration and post-occupancy evaluation of projects. The division will focus on issues related to bidding and negotiation processes, support of the construction process, and evaluation of completed projects. Candidates must demonstrate an understanding of and abilities in construction contract execution, construction support services (including construction observation and shop drawing or submittal review), payment request processing, and project closeout. In addition, candidates must also demonstrate an understanding and abilities in project evaluation of integrated building systems and their performance.

| | |
|---|------------|
| SECTION 1: Preconstruction Activities | 134 |
| SECTION 2: Construction Observation | 138 |
| SECTION 3: Administrative Procedures & Protocols | 142 |
| SECTION 4: Project Closeout & Evaluation | 146 |
| Construction & Evaluation References | 150 |

DIVISION DESCRIPTION

Construction & Evaluation

DIVISION DETAILS

| ITEMS | TEST DURATION | APPOINTMENT DURATION* |
|-------|---------------|-----------------------|
| 95 | 3 hr 15 min | 4 hr |

*Appointments allow for introductory screens, a break if you choose, and closing screens.

The 95 items will assess you on four sections related to Construction & Evaluation. The number of items from each section will vary based on the targeted percentage of items within each section.

SECTION DETAILS

| SECTIONS | EXPECTED NUMBER OF ITEMS | TARGET PERCENTAGE |
|--|--------------------------|-------------------|
| SECTION 1: Preconstruction Activities | 16-22 | 17-23% |
| SECTION 2: Construction Observation | 30-36 | 32-38% |
| SECTION 3: . Administrative Procedures & Protocols | 30-36 | 32-38% |
| SECTION 4: Project Closeout & Evaluation | 6-13 | 7-13% |

This division will test a candidate's ability to protect the public's health, safety, and welfare by:

- Delivering professional services during project construction
- Translating construction documents and specifications to communicate and bring clarity to design intent
- Coordinating construction activities to meet design intent
- Evaluating completed projects

Preconstruction Activities

In this section, you'll focus on the construction planning and activities that occur prior to the start of construction.

OBJECTIVE 1.1

Interpret the architect's roles and responsibilities during preconstruction based on delivery method (U/A)

Understanding the key elements of bidding is an important aspect of preconstruction activities. This includes the required documents, typical procedures, selection of the contractor, and applicable standard AIA contracts. The architect's responsibilities for each of these may vary depending on the project delivery type.

OBJECTIVE 1.2

Analyze criteria for selecting contractors (A/E)

You will need to be able to establish the criteria for reviewing contractors' bids, including accuracy and completeness. Based on these criteria, you will then need to evaluate contractors' bids and compare contractors' qualifications to each other.

OBJECTIVE 1.3

Analyze aspects of the contract or design to adjust project costs (A/E)

You must evaluate opportunities to reduce the project cost, project scope, quality, or schedule. This will include considering the contractual implications of the changes and their impact on the design and overall budget.

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SAMPLE ITEM 1

Which of the following should the contractor submit to the owner, through the architect, during the preconstruction phase of a traditional design–bid-build project? **Check the three that apply.**

- Certificates of required insurance
- Schedule of values
- Product submittals for long lead time items
- Application for first payment
- List of proposed subcontractors
- Lien releases from subcontractors

CORRECT RESPONSE

Which of the following should the contractor submit to the owner, through the architect, during the preconstruction phase of a traditional design–bid-build project? **Check the three that apply.**

- Certificates of required insurance
- Schedule of values
- Product submittals for long lead time items
- Application for first payment
- List of proposed subcontractors
- Lien releases from subcontractors

RATIONALE: These items are discussed in *The Project Resource Manual: CSI Manual of Practice*. Certificates of required insurance, the schedule of values, and a list of proposed subcontractors are three of many items that the contractor is required to submit prior to starting construction. Product submittals cannot be submitted until the list of subs is approved and subcontracts are awarded. No payment is due to the contractor until work has actually started, and lien releases are required before final payment.



This is a **U/A level** item requiring an understanding of various construction-related documents and the phase at which they must be reviewed.

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REFERENCES**SAMPLE ITEM 2**

The architect is completing the bid documents for a new mixed-use building. The owner requests the architect to include in the specifications several items that are not yet fully defined.

Drag the labels from the left onto the item descriptions below to identify how each of the unknown items should be included in the bid specification. Not all labels will be used.

| | | |
|------------|----------------------|---|
| Allowance | <input type="text"/> | Automated irrigation system at vegetated roof areas in addition to tamper-proof hose bibs. |
| Alternate | <input type="text"/> | Cost to manage, excavate, and dispose of hazardous materials, at the direction of the Owner's environmental consultant. |
| Unit Price | <input type="text"/> | Earthwork materials, including base course, fill, and drainage course, as associated with utility installation. |
| | <input type="text"/> | Occupancy sensors in all conference rooms in lieu of standard wall switches. |

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SAMPLE ITEM 2 - CORRECT RESPONSE

| | | |
|------------|------------|---|
| Allowance | Alternate | Automated irrigation system at vegetated roof areas in addition to tamper-proof hose bibs. |
| Unit Price | Allowance | Cost to manage, excavate, and dispose of hazardous materials, at the direction of the Owner's environmental consultant. |
| | Unit Price | Earthwork materials, including base course, fill, and drainage course, as associated with utility installation. |
| | Alternate | Occupancy sensors in all conference rooms in lieu of standard wall switches. |

RATIONALE: According to *The Project Resource Manual: CSI Manual of Practice*, allowances and unit prices allow the architect to incorporate into the contract documents information that can't be fully specified or drawn. Alternates, on the other hand, are a way to price options for the work so the owner can finalize the scope of work after evaluating the bids. In this case, the hazardous materials cost is an allowance because the full cost is unknown at the time of bidding, but the work needs to be included in the project. The earthwork cost is a unit price because the basic scope is understood, but the extent of the work is unknown. The irrigation system and occupancy sensors are both alternates because they are "in addition to" or "in lieu of" other parts of the work.



This is an **A/E level** item requiring the classification of different scope items in order to recommend the appropriate use of contract variables.

Construction Observation

This section addresses visiting the job site throughout the course of construction and the architect's roles and responsibilities.

OBJECTIVE 2.1

Evaluate the architect's role during construction activities (A/E)

This objective assesses the architect's responsibilities to the owner during construction site visits and subsequent documentation. You must recognize the contractor's responsibilities to the architect, including change orders, applications for payments, shop drawings, and other required submittals. You must also know the difference between the architect's design intent and the contractor's means and methods.

OBJECTIVE 2.2

Evaluate construction conformance with contract documents, codes, regulations, and sustainability requirements (A/E)

You will need to be able to analyze the contractor's completed work against the project requirements and identify non-conforming construction on site. This may also require evaluating the impacts of unforeseen conditions and material substitutions against code, quality, and program requirements.

OBJECTIVE 2.3

Determine construction progress (U/A)

Construction observation also requires the review of work in place against the contractor's construction schedule and schedule of values, and understanding the impact of delays along the critical path.

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SAMPLE ITEM 3

During a routine site visit, the owner tells the architect to change the layout of two interior framed walls the contractor has already framed based on the construction documents. The framing changes will not have an impact on any code-related issues.

The owner is adamant the walls be reframed per their new request. Which of the following should the architect do?

- Ask the contractor to schedule a meeting onsite with the owner, architect, and framing subcontractor to review the changes
- Review the expected effect on construction cost and schedule with the contractor, then prepare a change order for owner review
- Issue a construction change directive, with a requirement for time and material invoices to be submitted for the work
- Include documentation of the discussion and a drawing of the revised framing in the field report of the site visit

RATIONALE: Per AIA Document A201-2007, General Conditions of the Contract for Construction, a construction change directive is appropriate when a change must take place regardless of time or cost impacts. Reviewing the expected costs ahead of completing the work is unnecessary in this situation. On the other hand, a field report alone is inadequate, because this change certainly has both time and cost impacts. Finally, an onsite meeting with the sub is unnecessary, as the requested changes can be fully documented by the architect.

CORRECT RESPONSE

During a routine site visit, the owner tells the architect to change the layout of two interior framed walls the contractor has already framed based on the construction documents. The framing changes will not have an impact on any code-related issues.

The owner is adamant the walls be reframed per their new request. Which of the following should the architect do?

- Ask the contractor to schedule a meeting onsite with the owner, architect, and framing subcontractor to review the changes
- Review the expected effect on construction cost and schedule with the contractor, then prepare a change order for owner review
- Issue a construction change directive, with a requirement for time and material invoices to be submitted for the work**
- Include documentation of the discussion and a drawing of the revised framing in the field report of the site visit



This is an **A/E level** item requiring an assessment of a built condition in order to determine the appropriate contract change.

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REFERENCES**SAMPLE ITEM 4**

During a construction observation site visit to a new townhouse development, the architect reviews the contractor's installation of the roof sheathing.

Click on the material in the photo that contributes to the required fire separation between adjacent townhouses.



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RATIONALE: In a group of townhouses, each townhouse must be considered a separate building from its neighbors. According to the *International Residential Code*, in order to provide the appropriate separation, using fire-retardant treated wood, along with a class C roof covering, is an acceptable alternative to using a parapet.

A/E
LEVEL

This is an **A/E level** item that requires you to consider the code implications of a particular building type in order to interpret the photograph for evidence of code compliance.

Administrative Procedures & Protocols

The previous section is about the onsite responsibilities of an architect. This section is about the documentation necessary to the construction process. Clear written communication is essential aspect of the construction process.

OBJECTIVE 3.1

Determine appropriate additional information to supplement contract documents (U/A)

You will need to be able to evaluate contractor requests for additional information and communicate design revisions due to a scope change, schedule delay, or unforeseen condition.

OBJECTIVE 3.2

Evaluate submittals including shop drawings, samples, mock-ups, product data, and test results (A/E)

Architects must assess the contractor's understanding of the project scope based on their submittals. They also must determine appropriate responses to the contractor and evaluate requests for substitutions.

OBJECTIVE 3.3

Evaluate the contractor's application for payment (A/E)

Reviewing the contractor's application for payment against the completed work is a critical component of the construction process. This is done based on observations during construction site visits and approved change orders.

OBJECTIVE 3.4

Evaluate responses to non-conformance with contract documents (A/E)

After non-conforming work is identified during site observations, you must be able to determine the source of the non-conformance; analyze the cost, schedule, and design implications; evaluate possible resolutions of the non-conformance; and communicate the selected solution to the team.

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SAMPLE ITEM 5

The contract indicates the completion time for a project is 465 calendar days, including 45 days for weather days. Extremely bad weather delayed construction by 65 days. The contractor has requested an extension in the number of contract days due to the extremely bad weather. What should the architect advise the owner?

- Issue a supplemental instruction to extend the schedule by 20 days
- Extend the contract by 20 days via change order
- Ask the contractor to accelerate the construction schedule
- File a claim for damages against the contractor

RATIONALE: Per AIA Document A201-2007, General Conditions of the Contract for Construction, if the contractor is delayed by causes beyond the contractor's control, then the contract time shall be extended via change order. Weather delays are certainly outside the contractor's control. A supplemental instruction is not appropriate because this extension affects contract time and cost. Accelerating the construction schedule or filing a claim for damages are not reasonable options based on standard contract terms.

CORRECT RESPONSE

The contract indicates the completion time for a project is 465 calendar days, including 45 days for weather days. Extremely bad weather delayed construction by 65 days. The contractor has requested an extension in the number of contract days due to the extremely bad weather. What should the architect advise the owner?

- Issue a supplemental instruction to extend the schedule by 20 days
- Extend the contract by 20 days via change order
- Ask the contractor to accelerate the construction schedule
- File a claim for damages against the contractor



This is a **U/A level** item requiring an understanding of standard contract terms and their application to a viable scenario.

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REFERENCES**SAMPLE ITEM 6**

After construction has started, the contractor finds that the specified carpet has been discontinued. The budgeted cost was \$17/sq. yd., with a total of 3,500 sq. yd. of carpet needed.

The carpet subcontractor suggests an alternate carpet, which is acceptable to the owner. It's \$18/sq. yd., but the price would drop to \$15/sq. yd. with a 4,500 sq. yd. minimum. Due to the delay in finding the replacement carpet, the order must be expedited, which adds a \$1/sq. yd. premium.

Using the most cost-effective option, what will the cost difference be for the new carpet?

\$

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SAMPLE ITEM 6 - CORRECT RESPONSE

\$ 7,000

RATIONALE: You'll first need to calculate the original cost of the carpet (**Step 1**). Next, you'll calculate the cost of the two alternates: the higher price at the specified yardage (**Step 2**), and the discounted price at the increased yardage (**Step 3**). In both cases, the premium for expedited the order must be included. After deciding on the more cost effective option, you'll subtract the original cost from the cost of the alternate to determine the cost difference (**Step 4**). Because the \$ is included next to the answer box, you know the answer must be provided in dollars.

Step 1: $3,500 \text{ sq. yd.} \times \$17/\text{sq. yd.} = \$59,500$

Step 2: $(\$18/\text{sq. yd.} + \$1/\text{sq. yd.}) \times 3,500 \text{ sq. yd.} = \$66,500$

Step 3: $(\$15/\text{sq. yd.} + \$1/\text{sq. yd.}) \times 4,500 \text{ sq. yd.} = \$72,000$

Step 4: $\$66,500 - \$59,500 = \$7,000$



This is an **A/E level** item requiring you to analyze cost and specification information to evaluate product alternates.

Project Closeout & Evaluation

In this section, you'll focus on post-construction activities. This is the smallest section of the division but covers several important aspects of completing a project.

OBJECTIVE 4.1

Apply procedural concepts to complete close-out activities (U/A)

Project close-out documents may include warranties, record drawings, and a final application for payment, which must be submitted by the contractor. You must be able to understand these documents and review the completed work to verify the building has reached substantial completion.

OBJECTIVE 4.2

Evaluate building design and performance (A/E)

You will need to be able to use building commissioning, user surveys, and other related tools to assess the building's performance during its first year of use.

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REFERENCES**SAMPLE ITEM 7**

The contractor notified the architect that the project was ready for substantial completion. The architect inspected the work and prepared the following list of incomplete work.

Click in the box next to the item that **MUST** be completed before the architect can issue the certificate of substantial completion.

Punch List**PROJECT:** Parkview Garden Apartments**DATE:** March 15**PERSONNEL PRESENT AT SITE:** Sue Greene, SG Architects & Assoc.
Mike Smith, MS Construction, Inc.**Lobby**

- Paint touch up needed on west wall
- Replace damaged baseboard on east wall (approx. 4' section)
- Wrong threshold material at entry door

Apartment 103

- Paint touch up needed next to window in living room
- Bathtub doesn't drain properly
- Paint touch up needed on bedroom door

Apartment 201

- Paint touch up needed in bathroom
- Replace light bulb in kitchen fixture

Apartment 202

- Paint touch up needed in bedroom closet
- Replace HVAC filter and damaged grill

Apartment 304

- Paint touch up needed in kitchen
- Missing window screen in bedroom
- Missing shelf bracket in bedroom closet

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SAMPLE ITEM 7 - CORRECT RESPONSE

Punch List**PROJECT:** Parkview Garden Apartments**DATE:** March 15**PERSONNEL PRESENT AT SITE:** Sue Greene, SG Architects & Assoc.
Mike Smith, MS Construction, Inc.**Lobby**

- Paint touch up needed on west wall
- Replace damaged baseboard on east wall (approx. 4' section)
- Wrong threshold material at entry door

Apartment 103

- Paint touch up needed next to window in living room
- Bathtub doesn't drain properly
- Paint touch up needed on bedroom door

Apartment 201

- Paint touch up needed in bathroom
- Replace light bulb in kitchen fixture

Apartment 202

- Paint touch up needed in bedroom closet
- Replace HVAC filter and damaged grill

Apartment 304

- Paint touch up needed in kitchen
- Missing window screen in bedroom
- Missing shelf bracket in bedroom closet

RATIONALE: According to *The Project Resource Manual: CSI Manual of Practice*, reaching substantial completion does not mean all the work is completed. However, any remaining work must not prevent the owner's use of the building. The only item on this punchlist that prevents full use of the building is the bathtub that doesn't drain properly.


**A/E
LEVEL**

This **A/E level** item requires you to evaluate a typical construction procedure and determine the required outcome.

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SAMPLE ITEM 8

Seven months after substantial completion for a new office building, the building owner contacts the architect to report that mold has been found in a basement utility room. It appears a mechanical exhaust fan has malfunctioned.

Which of the following should the architect do? **Check the two that apply.**

- Submit an additional service request to the owner
- Meet with the owner to review the building operations
- Advise the owner to file a claim for damages
- Advise the owner to notify the original contractor about the issue
- Advise the owner to hire a new contractor to fix the fan
- Specify a new fan for the owner to purchase as a replacement

RATIONALE: This item is based on two AIA Documents: A201-2007 and B101-2007. Per B101, the Standard Form of Agreement between Owner and Architect, the owner can request a meeting with the architect to review facility operations and performance at no additional cost for up to one year from the date of substantial completion. That is appropriate in this scenario, so the owner can fully review the mold issue with the architect. Per A201, General Conditions of the Contract for Construction, the contractor shall correct any work not found to be in accordance with the contract documents within one year of the date of substantial completion and after receipt of written notice from the owner. A201 also specifies that the owner must give the contractor an opportunity to correct the problem or the owner waives the right to file a claim for damages.

CORRECT RESPONSE

Seven months after substantial completion for a new office building, the building owner contacts the architect to report that mold has been found in a basement utility room. It appears a mechanical exhaust fan has malfunctioned.

Which of the following should the architect do? **Check the two that apply.**

- Submit an additional service request to the owner
- Meet with the owner to review the building operations**
- Advise the owner to file a claim for damages
- Advise the owner to notify the original contractor about the issue**
- Advise the owner to hire a new contractor to fix the fan
- Specify a new fan for the owner to purchase as a replacement



This is an **A/E level** item requiring you to analyze a post-construction situation and determine the correct response based on your understanding of contractual agreements.

CE References

PUBLICATIONS

The following sources are provided as the top references to assist candidates in preparation for this division. For a more comprehensive list of potential reference material, please see the [Reference Matrix](#) at the end of this handbook.

The American Institute of Architects Official Guide to the 2007 AIA Contract Documents

The American Institute of Architects
John Wiley & Sons, 2009

CSI MasterFormat

The Construction Specifications Institute
2004 edition

The Project Resource Manual: CSI Manual of Practice

The Construction Specifications Institute,
McGraw-Hill, 5th edition, 2005

AIA CONTRACT DOCUMENTS

The following list of AIA Contract Documents have content covered in the Construction & Evaluation division.

Conventional Family

A101-2007

Standard Form of Agreement Between Owner and Contractor where the basis of payment is a Stipulated Sum

A201-2007

General Conditions of the Contract for Construction

A701-1997

Instructions to Bidders

B101-2007

Standard Form of Agreement Between Owner and Architect

C401-2007

Standard Form of Agreement Between Architect and Consultant

Contract Administration and Project Management Forms

A305-1986

Contractor's Qualification Statement

G701-2001

Change Order

G702-1992

Application and Certificate for Payment

G703-1992

Continuation Sheet

G704-2000

Certificate of Substantial Completion

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ARE 5.0 References

This section of the handbook provides you with resources, formulas, and common abbreviations or terms that should help you in preparation for the ARE. You will also find a comprehensive list of publications and resources for each division, which many of the items on ARE 5.0 are drawn from.

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ARE 5.0 REFERENCES

Resources Available While Testing

The following is a list of resources that will be available during the exam by permission of the American Institute of Steel Construction and the International Code Council. You should become familiar with use of these resources to properly prepare for the exam.

| BEAM DIAGRAMS AND FORMULAS | SOURCE | PAGES |
|---|--------|-------------|
| Simple Beam: Diagrams and Formulas - Conditions 1-3 | A | 3-213 |
| Simple Beam: Diagrams and Formulas - Conditions 4-6 | A | 3-214 |
| Simple Beam: Diagrams and Formulas - Conditions 7-9 | A | 3-215 |
| Beam Fixed at Both Ends: Diagrams and Formulas - Conditions 15-17 | A | 3-218 |
| Beam Overhanging One Support: Diagrams and Formulas - Conditions 24-28 | A | 3-221 & 222 |

SOURCES

A

United States. American Institute of Steel Construction, Inc. Steel Construction Manual; 14th edition. Chicago, Illinois, 2011.

B

United States. International Code Council, Inc. 2012 International Building Code. Country Club Hills, Illinois, 2011.

ARE 5.0 REFERENCES

Resources Available While Testing

| DIMENSIONS AND PROPERTIES | SOURCE | PAGES |
|---|--------|--------------|
| W Shapes 44 thru 27: Dimensions and Properties | A | 1-12 thru 17 |
| W Shapes 24 thru W14x145: Dimensions and Properties | A | 1-18 thru 23 |
| W Shapes 14x132 thru W4: Dimensions and Properties | A | 1-24 thru 29 |
| C Shapes: Dimensions and Properties | A | 1-36 & 37 |
| Angles: Properties | A | 1-42 thru 49 |
| Rectangular HSS: Dimensions and Properties | A | 1-74 thru 91 |
| Square HSS: Dimensions and Properties | A | 1-92 thru 95 |
| Round HSS: Dimensions and Properties | A | 1-92 thru 95 |
| LIVE AND CONCENTRATED LOADS | SOURCE | PAGES |
| Uniform and Concentrated Loads: IBC Table 1607.1 | B | 340-341 |

SOURCES**A**

United States. American Institute of Steel Construction, Inc. Steel Construction Manual; 14th edition. Chicago, Illinois, 2011.

B

United States. International Code Council, Inc. 2012 International Building Code. Country Club Hills, Illinois, 2011.

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Typical Beam Nomenclature

| | |
|------------------------|--|
| E | Modulus of Elasticity of steel at 29,000 ksi |
| I | Moment of Inertia of beam, in ⁴ |
| L | Total length of beam between reaction point, ft |
| M_{max} | Maximum moment, kip-in |
| M₁ | Maximum moment in left section of beam, kip-in |
| M₂ | Maximum moment in right section of beam, kip-in |
| M₃ | Maximum positive moment in beam with combined end moment conditions, kip-in |
| M_x | Maximum at distance x from end of beam, kip-in |
| P | Concentrated load, kips |
| P₁ | Concentrated load nearest left reaction, kips |
| P₂ | Concentrated load nearest right reaction and of different magnitude than P ₁ , kips |
| R | End beam reaction for any condition of symmetrical loading, kips |
| R₁ | Left end beam reaction, kips |
| R₂ | Right end or intermediate beam reaction, kips |
| R₃ | Right end beam reaction, kips |
| V | Maximum vertical shear for any condition of symmetrical loading, kips |
| V₁ | Maximum vertical shear in left section of beam, kips |
| V₂ | Vertical shear at right reaction point, or to left of intermediate reaction of beam, kips |
| V₃ | Vertical shear at right reaction point, or to right of intermediate reaction of beam, kips |
| V_x | Vertical shear at distance x from end of beam, kips |

| | |
|------------------------|---|
| W | Total load on beam, kips |
| a | Measured distance along beam, in |
| b | Measured distance along beam which may be greater or less than a, in |
| l | Total length of beam between reaction points, in |
| w | Uniformly distributed load per unit of length, kips/in |
| w₁ | Uniformly distributed load per unit of length nearest left reaction, kips/in |
| w₂ | Uniformly distributed load per unit of length nearest right reaction and of different magnitude than w ₁ , kips/in |
| x | Any distance measured along beam from left reaction, in |
| x₁ | Any distance measured along overhang section of beam from nearest reaction point, in |
| Δ_{max} | Maximum deflection, in |
| Δ_a | Deflection at point of load, in |
| Δ_x | Deflection at point x distance from left reaction, in |
| Δ_{x1} | Deflection of overhang section of beam at any distance from nearest reaction point, in |

EXCERPTED FROM

A United States. American Institute of Steel Construction, Inc. Steel Construction Manual; 14th edition. Chicago, Illinois, 2011.

ARE 5.0 REFERENCES

Formulas Available While Testing

The following formulas will be available during the exam and may be of use. You should familiarize yourself with the use of each formula in preparation for testing.

STRUCTURAL

Flexural stress at extreme fiber

$$f = \frac{Mc}{I} = \frac{M}{S}$$

Flexural stress at any fiber

$$f = \frac{My}{I}$$

where y = distance from neutral axis to fiber

Average vertical shear

$$v = \frac{V}{A} = \frac{V}{dt}$$

for beams and girders

Horizontal shearing stress at any section A-A

$$v = \frac{VQ}{lb}$$

where Q = statical moment about the neutral axis of the entire section of that portion of the cross-section lying outside of section A-A
 b = width at section A-A

ARE 5.0 REFERENCES

Formulas Available While Testing

ELECTRICAL

$$\text{Foot-candles} = \frac{\text{lumens}}{\text{area in ft}^2}$$

$$\text{Foot-candles} = \frac{(\text{lamp lumens}) \times (\text{lamps per fixture}) \times (\text{number of fixtures}) \times (\text{CU}) \times (\text{LLF})}{\text{area in ft}^2}$$

$$\text{Number of luminaires} = \frac{(\text{foot-candles}) \times (\text{floor area})}{(\text{lumens}) \times (\text{CU}) \times (\text{LLF})}$$

where CU = coefficient of utilization
LLF = Light Loss Factor

$$DF_{av} = 0.2 \times \frac{\text{window area}}{\text{floor area}}$$

for spaces with sidelighting or toplighting with vertical monitors

$$\text{watts} = \text{volts} \times \text{amperes} \times \text{power factor}$$

for AC circuits only

$$\text{Demand charge} = \text{maximum power demand} \times \text{demand tariff}$$

ARE 5.0 REFERENCES

Formulas Available While Testing

PLUMBING

$$1 \text{ psi} = 2.31 \text{ feet of water}$$

$$1 \text{ cubic foot} = 7.5 \text{ U.S. gallons}$$

HVAC

$$\text{BTU/year} = \text{peak heat loss} \times \frac{\text{full-load hours}}{\text{year}}$$

$$\$/\text{year} = \frac{\text{BTU}}{\text{year}} \times \frac{\text{fuel cost}}{\text{fuel heat value}} \times \text{efficiency}$$

$$\text{BTU/h} = (\text{cfm}) \times (1.08) \times (\Delta T)$$

$$1 \text{ kWh} = 3,400 \text{ BTU/h}$$

$$1 \text{ ton of air conditioning} = 12,000 \text{ BTU/h}$$

ARE 5.0 REFERENCES

Formulas Available While Testing

HVAC - CONTINUED

$$\text{BTU/h} = (U) \times (A) \times (T_d)$$

where T_d is the difference between indoor and outdoor temperatures

$$U = 1/R_t$$

$$U_o = \frac{(U_w \times A_w) + (U_{op} \times A_{op})}{A_o}$$

where o = total wall, w = window, and op = opaque wall

$$U_o = \frac{(U_R \times A_R) + (U_S \times A_S)}{A_o}$$

where o = total wall, R = roof, and S = skylight

$$R = x/k$$

where x = thickness of material in inches

$$\text{Heat required} = \frac{\text{BTU/h}}{\text{temperature differential}} \times (24 \text{ hours}) \times (\text{DD } ^\circ\text{F})$$

where DD = degree days

ARE 5.0 REFERENCES

Formulas Available While Testing

ACOUSTICS

$$\lambda = \frac{c}{f}$$

where λ = wavelength of sound (ft)
 c = velocity of sound (fps)
 f = frequency of sound (Hz)

$$a = SAC \times S$$

where a = Absorption of a material used in space (sabins)
 SAC = Sound Absorption Coefficient of the material
 S = Exposed surface area of the material (ft^2)

$$A = \sum a$$

where A = Total sound absorption of a room (sabins)
 $\sum a$ = $(S_1 \times SAC_1) + (S_2 \times SAC_2) + \dots$

$$T = 0.05 \times \frac{V}{A}$$

where T = Reverberation time (seconds)
 V = Volume of space (ft^3)

NRC = average SAC for frequency bands 250, 500, 1000, and 2000 Hz

ARE 5.0 REFERENCES

Common Abbreviations

The following is a list of common abbreviations you may encounter while taking the ARE. You should familiarize yourself with each abbreviation in preparation for testing.

| PROFESSIONAL ORGANIZATIONS, SOCIETIES, AND AGENCIES | |
|--|--------|
| American Concrete Institute | ACI |
| American Institute of Architects | AIA |
| American Institute of Steel Construction | AISC |
| American National Standards Institute | ANSI |
| American Society for Testing and Materials | ASTM |
| American Society of Civil Engineers | ASCE |
| American Society of Heating, Refrigerating, and Air-Conditioning Engineers | ASHRAE |
| American Society of Mechanical Engineers | ASME |
| American Society of Plumbing Engineers | ASPE |
| Architectural Woodwork Institute | AWI |
| Construction Specifications Institute | CSI |
| Department of Housing and Urban Development | HUD |
| Environmental Protection Agency | EPA |
| Federal Emergency Management Agency | FEMA |
| National Fire Protection Association | NFPA |
| Occupational Safety and Health Administration | OSHA |
| U.S. Green Building Council | USGBC |

ARE 5.0 REFERENCES

Common Abbreviations

AIA CONTRACT DOCUMENTS

| | |
|---|-------------|
| A101-2007, Standard Form of Agreement Between Owner and Contractor - Stipulated Sum | A101 |
| A201-2007, General Conditions of the Contract for Construction | A201 |
| A305-1986, Contractor's Qualification Statement | A305 |
| A701-1997, Instructions to Bidders | A701 |
| B101-2007, Standard Form of Agreement Between Owner and Architect | B101 |
| C401-2007, Standard Form of Agreement Between Architect and Consultant | C401 |
| G701-2001, Change Order | G701 |
| G702-1992, Application and Certificate for Payment | G702 |
| G703-1992, Continuation Sheet | G703 |
| G704-2000, Certificate of Substantial Completion | G704 |

CODES AND REGULATIONS

| | |
|---|-------------|
| ADA Standards for Accessible Design | ADA |
| International Code Council | ICC |
| International Building Code | IBC |
| International Energy Conservation Code | IECC |
| International Existing Building Code | IEBC |
| International Mechanical Code | IMC |
| International Plumbing Code | IPC |
| International Residential Code | IRC |
| Leadership in Energy and Environmental Design | LEED |
| National Electrical Code | NEC |

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Common Abbreviations

| COMMONLY USED TERMS | | UNITS OF MEASURE |
|--|-----------------|-----------------------|
| Air Handling Unit | AHU | btu |
| Authority Having Jurisdiction | AHJ | cfm |
| Building Information Modeling | BIM | cfs |
| Concrete Masonry Unit | CMU | cu. ft. |
| Contract Administration | CA | ft³ |
| Construction Document | CD | cu. in. |
| Dead Load | DL | in³ |
| Design Development | DD | cu. yd. |
| Exterior Insulation and Finishing System | EIFS | yd³ |
| Furniture, Furnishings & Equipment | FF&E | dB |
| Floor Area Ratio | FAR | ft |
| Heating, Ventilating, and Air Conditioning | HVAC | fc |
| Insulating Glass Unit | IGU | gsf |
| Indoor Air Quality | IAQ | ICC |
| Indoor Environmental Quality | IEQ | in |
| Live Load | LL | nsf |
| Material Safety Data Sheets | MSDS | NRC |
| Photovoltaic | PV | lb |
| Reflected Ceiling Plan | RCP | plf |
| Schematic Design | SD | psf |
| Variable Air Volume | VAV | psi |
| Volatile Organic Compound | VOC | STC |
| | | sq. ft. |
| | | sf |
| | | ft² |
| | | sq. in. |
| | | in² |
| | | sq. yd. |
| | | sy |
| | | yd² |

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ARE 5.0 Reference Matrix

The ARE 5.0 Reference Matrix provides a comprehensive list of materials and publications used when developing items for each division of ARE 5.0.

| REFERENCE | PcM | PjM | PA | PPD | PDD | CE |
|--|-----|-----|----|-----|-----|----|
| 2009 ASHRAE Handbook: Fundamentals, I-P Edition ASHRAE, 2009 | | | | | | |
| 2010 ADA Standards for Accessible Design U.S. Department of Justice, 2010 | | | | | | |
| The American Institute of Architects Official Guide to the 2007 AIA Contract Documents The American Institute of Architects John Wiley & Sons, 2009 | | | | | | |
| The Architect's Guide to Small Firm Management: Making Chaos Work for Your Small Firm Rena M. Klein, FAIA The American Institute of Architects John Wiley & Sons, 2010 | | | | | | |
| The Architect's Handbook of Professional Practice The American Institute of Architects John Wiley & Sons, latest edition | | | | | | |
| Architectural Acoustics M. David Egan J. Ross Publishing, 2007 Reprint. Original publication McGraw Hill, 1988 | | | | | | |
| Architectural Graphic Standards The American Institute of Architects John Wiley & Sons, latest edition | | | | | | |

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|--|-----|-----|----|-----|-----|----|
| Architectural Graphic Standards for Residential Construction The American Institute of Architects John Wiley & Sons, latest edition | | | | | | |
| BIM and Integrated Design: Strategies for Architectural Practice Randy Deutsch, AIA, LEED-AP The American Institute of Architects John Wiley & Sons, 2011 | | | | | | |
| Building Codes Illustrated: A Guide to Understanding the 2012 International Building Code Francis D.K. Ching and Steven R. Winkel, FAIA, PE John Wiley & Sons, 2012 | | | | | | |
| Building Construction Illustrated Francis D. K. Ching John Wiley & Sons, latest edition | | | | | | |
| Building Structures James Ambrose and Patrick Tripenny John Wiley & Sons, 3rd edition, 2012 | | | | | | |
| Code of Ethics and Professional Conduct AIA Office of General Counsel The American Institute of Architects, latest edition | | | | | | |
| CSI MasterFormat The Construction Specifications Institute 2004 edition | | | | | | |
| Dictionary of Architecture and Construction Cyril M. Harris McGraw-Hill, 4th edition, 2006 | | | | | | |
| Fundamentals of Building Construction: Materials and Methods Edward Allen and Joseph Iano John Wiley & Sons, latest edition | | | | | | |

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|-------------------------------------|--|-----|-----|----|-----|-----|----|
| PRACTICE MANAGEMENT | Heating, Cooling, Lighting: Sustainable Design Methods for Architects Norbert Lechner John Wiley & Sons, 3rd edition, 2008 | | | | | | |
| PROJECT MANAGEMENT | The HOK Guidebook to Sustainable Design Sandra F. Mendler, William Odell, and Mary Ann Lazarus John Wiley & Sons, 2nd edition, 2006 | | | | | | |
| PROGRAMMING & ANALYSIS | ICC A117.1-2009 Accessible and Usable Buildings and Facilities International Code Council, 2010 | | | | | | |
| PROJECT PLANNING & DESIGN | International Building Code (2012) International Code Council, 2011 | | | | | | |
| PROJECT DEVELOPMENT & DOCUMENTATION | Landscape Architectural Graphic Standards Leonard J. Hopper, Editor John Wiley & Sons, 2007 | | | | | | |
| CONSTRUCTION & EVALUATION | Law for Architects: What You Need to Know Robert F. Herrmann and the Attorneys at Menaker & Herrmann LLP W. W. Norton, 2012 | | | | | | |
| ARE 5.0 REFERENCES | Mechanical & Electrical Equipment for Buildings Walter T. Grondzik, Alison G. Kwok, Benjamin Stein, and John S. Reynolds, Editors John Wiley & Sons, latest edition | | | | | | |
| | Mechanical and Electrical Systems in Buildings Richard R. Janis and William K. Y. Tao Prentice Hall, latest edition | | | | | | |
| | Minimum Design Loads for Buildings and Other Structures (7-10) American Society of Civil Engineers, 2013 | | | | | | |

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|--|-----|-----|----|-----|-----|----|
| Olin's Construction Principles, Materials, and Methods H. Leslie Simmons John Wiley & Sons, latest edition | | | | | | |
| Planning and Urban Design Standards American Planning Association John Wiley & Sons, 2006 | | | | | | |
| Plumbing, Electricity, Acoustics: Sustainable Design Methods for Architecture Norbert Lechner John Wiley & Sons, 2012 | | | | | | |
| Problem Seeking: An Architectural Programming Primer William M. Peña and Steven A. Parshall John Wiley & Sons, latest edition | | | | | | |
| Professional Practice: A Guide to Turning Designs into Buildings Paul Segal, FAIA W. W. Norton, 2006 | | | | | | |
| The Professional Practice of Architectural Working Drawings Osamu A. Wakita, Nagy R. Bakhoum, and Richard M. Linde John Wiley & Sons, 4th edition, 2012 | | | | | | |
| The Project Resource Manual: CSI Manual of Practice The Construction Specifications Institute McGraw-Hill, 5th edition, 2005 | | | | | | |
| Rules of Conduct National Council of Architectural Registration Boards, latest edition | | | | | | |
| Simplified Engineering for Architects and Builders James Ambrose and Patrick Tripney John Wiley & Sons, latest edition | | | | | | |

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ARE 5.0 Reference Matrix

| REFERENCE | PcM | PjM | PA | PPD | PDD | CE |
|---|-----|-----|----|-----|-----|----|
| Site Engineering for Landscape Architects Steven Strom, Kurt Nathan, and Jake Woland, Editors John Wiley & Sons, 2013 | | | | | | |
| Site Planning & Design Handbook Thomas H. Russ McGraw-Hill, 2nd edition, 2009 | | | | | | |
| Space Planning Basics Mark Karlen and Rob Fleming John Wiley & Sons, latest edition | | | | | | |
| Steel Construction Manual American Institute of Steel Construction Ingram, latest edition | | | | | | |
| Structural Design: A Practical Guide for Architects James R. Underwood and Michele Chiunini John Wiley & Sons, 2nd edition, 2007 | | | | | | |
| Structures Daniel Schodek and Martin Bechthold Pearson/Prentice Hall, latest edition | | | | | | |
| Sun, Wind, and Light: Architectural Design Strategies G.Z. Brown and Mark DeKay John Wiley & Sons, 2nd edition, 2001 | | | | | | |
| Sustainable Construction: Green Building Design and Delivery Charles J. Kibert John Wiley & Sons, 2005 | | | | | | |
| Time-Saver Standards for Architectural Design: Technical Data for Professional Practice Donald Watson and Michael J. Crosbie, Editors McGraw-Hill, 8th edition, 2004 | | | | | | |
| A Visual Dictionary of Architecture Francis D.K. Ching John Wiley & Sons, latest edition | | | | | | |

ARE 5.0 REFERENCES

ARE 5.0 Reference Matrix

The following list of AIA Contract Documents have content covered in the various divisions of ARE 5.0. Candidates can access AIA Contract Documents for free through their NCARB Record.

| CONVENTIONAL FAMILY | PcM | PjM | PA | PPD | PDD | CE |
|---|-----|-----|----|-----|-----|----|
| A101-2007 , Standard Form of Agreement Between Owner and Contractor where the basis of payment is a Stipulated Sum | | | | | | |
| A201-2007 , General Conditions of the Contract for Construction | | | | | | |
| A701-1997 , Instructions to Bidders | | | | | | |
| B101-2007 , Standard Form of Agreement Between Owner and Architect | | | | | | |
| C401-2007 , Standard Form of Agreement Between Architect and Consultant | | | | | | |
| CONTRACT ADMINISTRATION AND PROJECT MANAGEMENT FORMS | PcM | PjM | PA | PPD | PDD | CE |
| A305-1986 , Contractor's Qualification Statement | | | | | | |
| G701-2001 , Change Order | | | | | | |
| G702-1992 , Application and Certificate for Payment | | | | | | |
| G703-1992 , Continuation Sheet | | | | | | |
| G704-2000 , Certificate of Substantial Completion | | | | | | |