

CONSTRUCTABILITY REVIEW (A)

The Business Roundtable's Construction Industry Cost Effectiveness Project (CICE) identified constructability review as a major potential for improved project cost effectiveness.

Constructability review is the systematic application of management and construction expertise to the planning, design, and construction document process for the purpose of controlling and improving the coordination, accuracy, and clarity of the drawings and specifications.

The first phase of each constructability review that the contractor needs to implement is the review of the coordination of the various design disciplines. In these phases, the reviewer is checking for conflicts between the civil, structural, electrical, mechanical and architectural drawings.

The second phase of each constructability review that the contractor needs to implement is the assessment as to the bidability, suitability of materials selected, cost and accessibility, clarity of the drawings and details.

During each of the reviews the contract will submit detailed reports of the scope of each review and their recommendations for change or clarification of the design.

After these reviews are completed and the changes are adopted, a final look-back review is done when the drawings are 95% complete.

CONSTRUCTABILITY REVIEWS

The intent of a Constructability Review is to have the Construction Management team review the construction documents from the perspective of the construction industry and advise the A/E and Owner on how to make the project more efficient, more constructable and change order free. It is to be thought of as a process to make improvements in the documents and in the project.

For the purpose of this study, “constructability” is defined as “the ease with which a designed project can be built and the ease with which the contract document may be understood, bid, administered and enforced.

1. Constructability Considerations

A review of several recent large construction projects indicates that major disputes for additional cost or time extensions have resulted from:

- Major changes to suit the owner, made in an untimely manner after the start of the project. This includes delayed decisions needed for orderly planning and sequencing of work and late decisions affecting long-lead-time materials or equipment.
- Incomplete, undefined, or conflicting designs, as well as interferences between structural, mechanical, and electrical features or caused by insufficient space available for the quantity or size of items specified. The effect of this deficiency will be seen in a large number of requests for information and change order requests.
- Problems caused by new code requirements relating to civil, electrical, or mechanical systems. An example is more restrictive fire code requirements.
- Late deliveries caused by insufficient attention to scheduling of the submittals, approvals, fabrication and deliveries of long-lead-time materials and equipment. This has involved owner-furnished as well as contractor-furnished delivery problems.
- When contract phasing has been involved, the scheduling of area excavations, area demolitions, and operational moves has been the source of problems, particularly if existing drawings did not accurately represent as-built conditions.
- Late layouts, finish treatments, and material approvals have been the cause of delays and arguments as to the degree of owner versus contractor responsibility.

- Workmanship has also been the cause of disputes, particularly when specifications were not explicit, and construction features or materials are unique and not defined by standards of practice.

2. Work Descriptions

During the constructability review questions should be raised regarding approach, techniques, systems, and methods of documentation. The following list of questions is offered as a sample to stimulate the consultant's thoughtful review.

- What improvements could be made to help the contractor find his way around the documents more easily?
- What could be done to facilitate the contractor's task of preparing a bid proposal?
- Where are the documents less than clear as to what is required? Are there gaps, ambiguities, and confusion of intent?
- How can it be made clearer what is included in the work of each subtrade?
- Does the potential exist for a jurisdictional dispute between trades because of an overlap in responsibility or a gap in responsibility over some portion of the work (union or nonunion)?
- What construction problems can be anticipated based on these documents?
- Is the construction sequence and duration shown on the construction network schedule feasible and practical?
- Will there be installation difficulties with any of the building components or items of equipment?
- Are there materials or labor skills specified which are difficult to acquire or unnecessarily costly?
- Are there installation requirements which are unnecessarily difficult, and which could be accomplished in an easier or less costly manner?
- Are there components or utility systems that are in need of better coordination?
- Are there potential conflicts between drawings and specifications?

- Are there questions of access for construction equipment or suitability of staging areas?
- Is the required contract performance time reasonable?
- Are the contractor work measurement and payment conditions reasonable?
- Are the liquidated damages provisions and means of their documentation reasonable?
- Are the measures governing contractor claims reasonable?
- Are submittal and shop drawing requirements practical?
- Is the inspection program appropriate for this project?

SAMPLE

CONSTRUCTABILITY CHECKLIST

Project Title_____ Project No._____

Reviewer's Signature_____ Date:_____

During the constructability review, questions should be raised regarding approach, techniques, systems, and methods of documentation. The following list of questions is offered as a sample to stimulate the contractor's thoughtful review.

GENERAL QUESTIONS:

- What improvements could be made to help the contractor find his way around the documents more easily?
- What could be done to facilitate the contractor's task of preparing a bid proposal?
- Where are the documents less than clear as to what is required? Are there gaps, ambiguities, and confusion of intent?
- How can it be made clearer what is included in the work of each subtrade?
- Does the potential exist for a jurisdictional dispute between trades because of an overlap in responsibility or a gap in responsibility over some portion of the work (union or nonunion)?
- What construction problems can be anticipated based on these documents?
- Is the construction sequence and duration shown on the construction network schedule feasible and practical?
- Will there be installation difficulties with any of the building components or items of equipment?
- Are there materials or labor skills specified which are difficult to acquire or unnecessarily costly?
- Are there installation requirements which are unnecessarily difficult, and which could be accomplished in an easier or less costly manner?
- Are there components or utility systems that are in need of better coordination?

- Are there potential conflicts between drawings and specifications?
- Are there questions of access for construction equipment or suitability of staging areas?
- Is the required contract performance time reasonable?
- Are the contractor work measurement and payment conditions clear and reasonable?
- Are the liquidated damages provisions and means of their documentation reasonable?
- Are the measures governing contractor claims appropriate?
- Are submittal and shop drawing requirements practical?
- Is the inspection program appropriate for this project?

The following review checklists are offered as a guide to stimulate questions on many aspects of the project. In addition to checking coordination, are there better methods, materials, sequences, etc. that could be employed? If so, please describe.

1. Preliminary Review

- a. Quickly look over all sheets, spending about 5-10 minutes per sheet to become familiar with the project.

2. Civil – Verify that:

| | <u>Coordinated</u> | | |
|---|---------------------------|-----------|------------|
| | Yes | No | N/A |
| a. New underground utilities (power, telephone, water, sewer, gas, storm drainage, fuel lines, grease traps, fuel tanks) have no interferences. | [] | [] | [] |
| <hr/> | | | |
| b. Existing power/telephone poles, pole guys, street signs, drainage inlets, valve boxes, manhole covers, etc., do not interfere with the new driveways, sidewalks, or other site improvements. | [] | [] | [] |
| <hr/> | | | |
| c. Limits of construction, clearing, grading, sodding, grass or mulch are shown and are consistent in other disciplines. | [] | [] | [] |
| <hr/> | | | |
| d. Fire hydrants and street light poles do not conflict with other above ground items. | [] | [] | [] |
| <hr/> | | | |
| e. Profile sheets show other underground utilities and avoid conflicts. | [] | [] | [] |

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|----|---|-----|-----|-----|
| f. | Horizontal distances between drainage structures and manholes match scale dimensions and stated dimensions on both plan and profile sheets. | [] | [] | [] |
|----|---|-----|-----|-----|
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|----|---|-----|-----|-----|
| g. | Building footprint and finished floor elevations match other disciplines. | [] | [] | [] |
|----|---|-----|-----|-----|
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3. Structural – Verify that:

Coordinated

Yes No N/A

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|----|--|-----|-----|-----|
| a. | Column grid lines on structural and architectural match. | [] | [] | [] |
|----|--|-----|-----|-----|
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|----|--|-----|-----|-----|
| b. | Column locations are the same on structural and architectural. | [] | [] | [] |
|----|--|-----|-----|-----|
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- | | | | | |
|----|---|-----|-----|-----|
| c. | Perimeter slab on structural matches architectural. | [] | [] | [] |
|----|---|-----|-----|-----|
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- | | | | | |
|----|--|-----|-----|-----|
| d. | Depressed or raised slabs are indicated and match architectural. | [] | [] | [] |
|----|--|-----|-----|-----|
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|----|--------------------------------------|-----|-----|-----|
| e. | Slab elevations match architectural. | [] | [] | [] |
|----|--------------------------------------|-----|-----|-----|
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|----|--|-----|-----|-----|
| f. | Foundation piers are identified and sized on a schedule or plan. | [] | [] | [] |
|----|--|-----|-----|-----|
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|----|--|-----|-----|-----|
| g. | Foundation beams are identified and sized on a schedule or plan. | [] | [] | [] |
|----|--|-----|-----|-----|
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|----|---|-----|-----|-----|
| h. | Locations of roof framing plan column lines and columns match foundation plan column lines and columns. | [] | [] | [] |
|----|---|-----|-----|-----|
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- | | | | | |
|----|---|-----|-----|-----|
| i. | Structural perimeter roof line matches architectural roof plan. | [] | [] | [] |
|----|---|-----|-----|-----|
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- | | | | | |
|----|---|-----|-----|-----|
| j. | Columns, floor beams, and roof beams are listed in column and beam schedules. | [] | [] | [] |
|----|---|-----|-----|-----|
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|----|--|-----|-----|-----|
| k. | Length of columns in column schedule matches the length shown in sections and the elevations shown on plans. | [] | [] | [] |
|----|--|-----|-----|-----|
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- | | | | | |
|----|--------------------------------|-----|-----|-----|
| l. | Sections are properly labeled. | [] | [] | [] |
|----|--------------------------------|-----|-----|-----|
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- | | | | | |
|----|--|-----|-----|-----|
| m. | Expansion joint locations match other disciplines. | [] | [] | [] |
|----|--|-----|-----|-----|

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|---|-------------|
| n. Dimensions match architectural. | [] [] [] |
| o. Drawing notes do not conflict with specifications. | [] [] [] |
| p. Openings or penetrations for stairs, elevators, ducts, conduits, and chases match other disciplines. | [] [] [] |

4. Architectural – Verify that:

Coordinated

Yes No N/A

- | | |
|---|-------------|
| a. Property line dimensions on survey or civil site plans match architectural. | [] [] [] |
| b. Building is located behind set-back lines. | [] [] [] |
| c. Locations of columns and bearing walls, and overall building dimensions match structural. | [] [] [] |
| d. Existing and new work is clearly identified on site plans. | [] [] [] |
| e. Building elevations match floor plans. In particular, check roof lines, window and door openings, louver openings, and expansion joints. | [] [] [] |
| f. Building sections match elevations and plans. | [] [] [] |
| g. Wall sections match architectural and structural building sections. | [] [] [] |
| h. Size of openings for windows and doors matches structural. Verify window glass types with specifications. | [] [] [] |
| i. Expansion joints are continuous throughout the building. | [] [] [] |
| j. Large scale partial floor plans match small scale floor plans. | [] [] [] |
| k. Reflected ceiling plans match architectural floor plans to ensure no variance with wall locations. Location of electrical and mechanical plans does not conflict with location on reflected ceiling plans. | [] [] [] |
| l. Room finish schedule information matches plan and elevation | [] [] [] |

information; including room numbers, names of rooms, finishes, and ceiling heights. Look for omissions and inconsistencies.

m. Door schedule information matches plan, and elevation information; including sizes, types, labels, etc. Look for omissions and inconsistencies. [] [] []

n. The location of the fire rated walls matches the location of fire and/or smoke dampers on mechanical plans. [] [] []

o. Cabinets will fit in available space and electrical outlets on cabinet walls are at the correct height. [] [] []

p. The locations of flag poles, dumpster pads, generator pads, transformers, cooling towers, vaults, and landscaping have been coordinated with other discipline site plans. [] [] []

5. Mechanical and Plumbing – Verify that:

Coordinated
Yes No N/A

a. Plumbing floor plans match architectural floor plans. [] [] []

b. New gas, water, sewer, etc. lines connect to existing or new utilities on civil drawings. [] [] []

c. Plumbing fixtures match plumbing schedules and architectural roof plan. [] [] []

d. Roof drain locations and roof slopes match architectural roof plan. [] [] []

e. Pipes are sized sensibly and that all drains are connected and do not interfere with foundations. [] [] []

f. Wall chases are provided on architectural to conceal vertical piping. [] [] []

g. Plumbing fixtures match riser diagrams. [] [] []

h. HVAC floor plans match architectural. [] [] []

i. Sprinkler heads do not interfere with other ceiling items. [] [] []

j. Mechanical/plumbing ducts and pipes do not conflict with architectural features or structural members. [] [] []

-
- k. Adequate ceiling height exists at worst case duct intersection or largest beam. [] [] []

 - l. Structural supports required for mechanical equipment are indicated on structural drawings. [] [] []

 - m. Dampers are indicated at smoke and fire walls. [] [] []

 - n. Diffuser locations match architectural reflected ceiling plans. [] [] []

 - o. Openings for roof penetrations (ducts, fans, etc.) are indicated on structural roof plans. [] [] []

 - p. Ductwork is sized logically. [] [] []

 - q. Notes are referenced. [] [] []

 - r. Air conditioning units, heaters, and exhaust fans match architectural roof plan locations. [] [] []

 - s. Mechanical equipment will fit in spaces allocated and there is room for maintenance such as removing filters or tubes. [] [] []

 - t. Horsepower ratings, phases, and voltages of major items of equipment on mechanical and electrical drawings and specifications match. [] [] []

 - u. Thermostat locations have been coordinated with architectural drawings. [] [] []

6. Electrical – Verify that:

- | | <u>Coordinated</u> | | |
|--|---------------------------|-----------|------------|
| | Yes | No | N/A |
| a. Electrical floor plans match architectural and mechanical. Check that the location of floor mounted equipment is consistent between disciplines. | [] | [] | [] |
| <hr/> | | | |
| b. The location of light fixtures matches architectural reflected ceiling plan and that light fixtures do not conflict with the structure or mechanical HVAC system. | [] | [] | [] |
| <hr/> | | | |

- c. Major pieces of equipment have electrical connections and that horsepower ratings, phases, and voltages are consistent with other discipline schedules.

- d. Locations of panel boards are consistent with architectural, mechanical, and plumbing floor plans and that the panel boards are indicated on the electrical riser diagram.

- e. Notes are referenced.

- f. Locations of electrical conduit runs, floor trenches, and openings are coordinated with structural plans.

- g. Electrical panels are not recessed in fire rate walls.

- h. Exterior electrical equipment locations are coordinated with site paving, grading, and landscaping.

- i. Structural supports are provided for roof top electrical equipment.

7. Kitchen – Verify that:

Coordinated
Yes No N/A

- a. The equipment layout matches other discipline floor plans.

- b. Equipment is connected to utility systems.

- c. Equipment as scheduled on the drawings matches the kitchen floor plans and specifications.

- d. Floor depressions and floor troughs are coordinated.

- e. Equipment - availability, cost, replaceability, serviceability-local reps, availability of spare parts.

8. Specifications – Verify that:

The following specification issues often have created change orders and should be verified:

- a. Check that alternates or bid items explicitly state what is intended. Are they coordinated with the drawings? If there are insufficient funds to award the contract

on the base bid plus all bid items, then problems can occur. For example, consider a situation such as a project with an additive alternate bid item number 4 identified as “landscaping”. The landscaping drawings for this project contain an underground irrigation system. When the bids come in there are insufficient funds to pick up alternate number 4. The intent of the A/E is that the underground irrigation system is part of the base bid and not part of alternate 4. However, the contractor interprets the underground irrigation system as part of the landscaping since it was in the landscape drawings. A dispute such as this will usually be resolved in favor of any reasonable interpretation and the contractor will likely win the claim, regardless of what the specification writer may have intended. This could have been avoided if alternate number 4 indicated “all work indicated on the landscape drawings except the underground irrigation system which is part of the base bid”.

- b. Check specifications for phasing of construction. Are the phases clear? Anything that impacts on the contractor’s freedom to schedule the work should be clear. For example, if the contractor has a project to provide an asphalt overlay to an existing parking lot that serves several large retail stores, it may not be possible to close the entire parking lot at one time for the work to be performed. If this is the case the specifications should be very specific about phasing of the work. Mobilization and de-mobilization by a contractor is costly if not precisely specified.
- c. Compare architectural finish schedule to specification index. Ensure all finish materials are specified. By checking all of the floor, wall, and ceiling materials on the finish schedule against the specification index, a material is often discovered that is on the schedule but not specified.
- d. Check major items of equipment and verify that they are coordinated with contract drawings. Pay particular attention to horsepower ratings and voltage requirements. If quantities of equipment, horsepower ratings, voltages, and phases are indicated on schedules in the drawings, they should not be repeated in the specifications. If they are repeated, make sure they are the same.
- e. Verify that those items specified “as indicated” or “where indicated” in the specifications are, in fact, indicated on the contract drawings. Items specified “as indicated” or “where indicated” and not shown on the drawings make it impossible for the contractor to bid since he doesn’t know the installation location. Under these circumstances, the contractor is relieved of the requirement. Avoid this pitfall by ensuring items specified “as indicated” or “where indicated” are shown on both the drawings and the specifications.
- f. Verify that the index and sections contained in the body of the specifications match. Check that all specification sections in the body of the specification are indexed. Also, rapidly glance through all specification pages and look for references to other specification sections. Verify that these references are in the specification index. Often references are to “phantom” sections that don’t exist.
- g. Verify thickness of materials or quantities of materials in specifications. These items are often best shown on the drawings and should not be repeated in the specifications. For example, it is a good idea to avoid indicating the thickness of drywall or gypsum wallboard in the specifications if it is already indicated on architectural sections and details. Another example concerns kitchen equipment. Very often the kitchen equipment specification will list the number of deep fat fryers and other equipment, and at the same time the dietary or kitchen drawings will have

a schedule that includes the same information. It is best not to repeat information that will increase the opportunity for contradictions.

| | <u>Coordinated</u> | | |
|---|--------------------|-----|-----|
| | Yes | No | N/A |
| a. Check that bid items explicitly state what is needed. _____ | [] | [] | [] |
| b. Check specifications for phasing of construction. _____ | [] | [] | [] |
| c. Compare architectural finish schedule to specification index. _____ | [] | [] | [] |
| d. Check major items of equipment and verify that they are coordinated with contract drawings. _____ | [] | [] | [] |
| e. Verify that the items specified "as indicated" or "where indicated" in the specifications are in fact indicated on contract drawings. _____ | [] | [] | [] |
| f. Verify the index and sections contained in the body of the specifications match. _____ | [] | [] | [] |
| g. Verify thickness of materials or quantities of materials in specifications. _____ | [] | [] | [] |

SAMPLE - Constructability Review Comments

Date _____
 Reviewer _____
 Company _____

Project Name _____
 Design Submittal _____
 Discipline _____

| Item No. | Drawing Sht./ Spec. Paragraph | Comments | Type | Designer Response |
|----------|-------------------------------|----------|------|-------------------|
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |
| 5 | | | | |
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| 16 | | | | |

COMMENT TYPE:
 'F' - FATAL FLAW MUST BE REVISED
 'S' - SERIOUS PROBLEM, NEEDS TO BE ADDRESSED. COULD ESCALATE TO 'F' IF LEFT UNATTENDED.
 'C' - COORDINATION PROBLEM. DISCIPLINE NEEDS TO TALK.
 'N' - NOTE TO DESIGNER, ITEM, NOT SERIOUS, NO NEED TO INCORPORATE, BUT COULD RESULT IN A BETTER PRODUCT IN FUTURE.