

Plan Review Techniques for Infrastructure Projects

An Online Continuing Education Course for Engineers

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Plan Review Techniques for Infrastructure Projects

Engineers convey their intentions on a project through the use of a set of drawings and specifications, assembled in a recognizable format, so that a project may be constructed in a direct manner. No two sets of plans for similar projects are exactly alike. They may both be prepared for a similar type of infrastructure to be constructed beneath a roadway surface, and may differ by a street name, the stationing interval or a single digit in a funding code, but they will not be exactly alike. Using one set as a guide for the review of the other set may not always provide suitable results.

The staff of two design teams or two construction teams working on similar projects might not be the same. They may have the same project manager or superintendent, but it is possible for one of the team members to be re-assigned from another project, and for that member to have more or less experience than the other team members.

No single checklist of items will cover all types of sets of infrastructure or roadway plans. Some checklist phrase or suggested review comment can trigger an awareness of another item that might need to be checked, while other comments might generate revisions on sheets that have not been submitted for review, or change the selection of a construction detail or the title of a pay item. A firm or agency may have a published Quality Guidelines Manual which might indicate that reviews will be performed, could include checklists for verification and might require that reviewers of drawings will use color codes to ensure that items have been checked, corrected or approved. In most instances, the actual process for checking, and the potential anomalies that might occur, are generally not part of the publication.

Each line on each sheet must be followed from edge-to-edge of the sheet, as well as checking at the match lines of each sheet to ensure that the line did not change or get overlooked. The line symbol and label cannot change from sheet to sheet. Using stationing at the match lines for each sheet rather than using sheet numbers will alleviate last minute corrections. The relative size or volume of the item represented by each line needs to be understood, since a two-inch gas service line might look the same as a sixty-inch force main. The two items would not occupy the same space. Conflicts and contradictions can be seen if line work is compiled in the logical order of construction operations. Line symbols added to sheets in the latter stages of development often change from sheet to sheet, or are not labeled the same from one sheet to the next, leading to an apparent contradiction and potential loss of communication to the contractor.

Reviews can be performed by upper management, construction staff or by a team of peers with similar experience. The design team might have anticipated that construction will be sequenced in a particular order, but if that order is not made mandatory by a Special Provision, the contractor may submit a different sequence or staging, the staging might be approved, and a change order may be needed in order to accommodate the approved staging.

Personal pride and ego will often contribute more to contradictions and anomalies remaining in a set of contract documents than anything else. No one wants to have their work shown to be deficient, or have their work questioned. This tendency in some organizations will cause a team to withhold their portion of work until the last minute,

hoping that it can get submitted too late for any revisions, or without having to defend their work. This action prevents an objective review of the completed work, and might lead to contradictions within a set of plans. Anyone can agree that “errors”, which may simply be a contradiction or an anomaly in the data displayed differently on two or more sheets of the set of plans for the same location that cannot reasonably be explained are possible in the practice of any discipline of engineering. The key is for those “errors” to be found prior to submittal, and for the firm to refrain from criticism of the “error”, and to view the finding as a positive action which avoided a potential costly situation.

Even the most objective, best-intentioned review can result in a confrontational situation, most likely caused by a bruised ego or a protective over-reaction to the discovery of a flaw. There are various ways to prevent confrontations, such as: with-holding opinions, commentaries, anecdotes and comparisons; avoiding the urge to justify a review comment or re-design an anomaly; and, ensuring that the observed anomaly is in fact displayed on the final product and does not represent work in progress. A simple circling of an element on a sheet does not convey a message, unless that message relates to a misspelling or contradiction on the same sheet. The use of encouragement rather than criticism will aid the process and may lead to more opportunity for the plan reviewer to render further assistance in the preparation and review of other plan documents. Avoidance of the use of editorial comments in the review, or the use of words such as “never”, “should” and “don’t” will also help foster an educational experience rather than a critical one. The reviewer will be in the position to apply knowledge based on experience, and must not be placed in a position of defending comments that are made on an obvious anomaly.

Field Check

One of the most direct methods that can be used to review a set of contract drawings is to conduct a plan-in-hand field check, verifying every line and symbol that is shown on the sheet, and looking at the project limits to see what is being matched at each end of the construction limits. A second method would involve reviewing a photo-log or video of the project site, but the coverage of the photography may not be as thorough as needed to ensure seeing all items.

If time and budget permitted, the entire design team, or at least the project engineers representing each discipline, and at the very minimum, the project manager, could read the scope of work, and then walk the project from end-to-end prior to beginning design activities. Each person sees the project from the perspective of their design specialty, and would generate ideas, questions or make educated decisions based on the knowledge derived from the field. Pavement designers would note the type of paved surfaces, driveways, parking lots and roadside appurtenances. Drainage designers would note the indications of an enclosed drainage system, standing water or overland flow routes. Landscape designers would see the types of trees or the condition of existing plantings in order to assess the ability of the project site to sustain growth of proposed materials. This single event can avoid many of the review comments that are received from the client, and can preserve labor dollars in the budget.

Team Meetings

An understanding of the intended scope of work is crucial to communicate the nature of the project to each member of the design team. Changes in scope might take place during initial or subsequent negotiations or meetings that could have an effect on the work produced. The design criteria to be followed, the client’s preferences for sheet content, scale and format, and local construction expectations for layout and “incidental work” are

all issues that will need to be discussed so that all work can be assembled into one set of documents. Some team members might be more familiar with county projects, others with state projects and still others with federal-funded urban projects. All of the various types of funding programs might have particular preferences for sheet content, symbols and level of redundancy. A team meeting would be the appropriate time to raise questions about conflicting items that appear on the screen or might be shown on a data level that is not used by more than one discipline.

Often a design task will correspond with a budget line item. The budget usually provides the labor required to perform the design task one time. A contingency might be included in the budget for overall revisions, but each design task would not have a contingency. Assignment and follow-up of each design task will ensure that last minute revisions are avoided. Adding the term "by the Engineer" simply postpones the decision to a later date, and can result in a change order.

Sheet Reviews

When drawings were drafted by hand, each original sheet could be overlaid on another sheet to compare line-work using a light table or a window. This technique might not be feasible with reduced-scale plots that are generated by design software. At this time, computer-aided design and drafting software does not have the ability to verify accuracy. Each sheet will need to be reviewed by eye, and the contents compared with other sheets that show the same view. If a reviewer looks at the sheets in the CADD display, the sheet may not have all of the layers or levels turned on, since for instance a drainage design team member might turn off the water-main layers in order to have less clutter on the screen. If the layer that shows a conflicting item is turned off during design activities, and then the layer is not turned on, the conflict may go un-noticed and not be discovered or resolved.

Drawing review often leads to confrontation. No one wants their work questioned. No one wants their level of expertise exposed. The reviewer can only remark on what is seen, not on what was intended to be shown. Experience can be tapped from within the organization, or it can be gained from the project.

Each sheet in a set of plans will need to be reviewed as a stand-alone item, as well as an integral part of a complete set of contract documents. Cross-referencing to other sheets in the same set, or references to other drawings in other sets of plans needs to be precise.

Constructability or Bid Reviews

Once a set of plans is completed, or once it is sent out for bids, the construction team or the bidders will approach the plans using a variety of methods to ascertain staging, controlling items, access and required manpower to accomplish the work.

A constructability review performed by a member of the design team or by a bidder will concentrate on the plans with a logical approach to such items as staging, traffic control, controlling items, schedules and quantities. Reviews by these types of individuals can result in Requests for Information (RFI) to clarify an issue. The reviews are generally made using the entire set of plans, and for the most part, any anomalies or discrepancies that are found by a constructability review performed by the design team might be assumed to be taken care of during construction, whereas the bidder's discoveries could either be reflected in the bids, or result in change orders during construction. The method used by the bidders differs from that used by the design team, since it concentrates on the

work to be performed and the cost to achieve the desired results. In some respects, it is the most direct approach involving individuals skilled in plan review, and can often be performed in a shorter timeframe than that required for reviews during design.

Anomalies

Checklists may vary from firm to firm, or from agency to agency. No single list can be expected to cover all of the possible anomalies, contradictions or conflicting information that can appear in a set of contract documents. The following text illustrates examples of situations that were encountered, often repeatedly, during the reviews of hundreds of sets of preliminary engineering reports and contract plans over a span of nearly three decades. Rather than suggest that each element of a sheet be “checked”, “verified” or “reviewed”, each sheet is provided with a list of prompts to assist the reviewer in resolving anomalies that have been observed on various project. The reviewer can assemble a checklist or use the following list of prompts as a guide for applicable situations. The caution required involves checking an item thoroughly versus checking that an item exists.

Questions for Reviewers

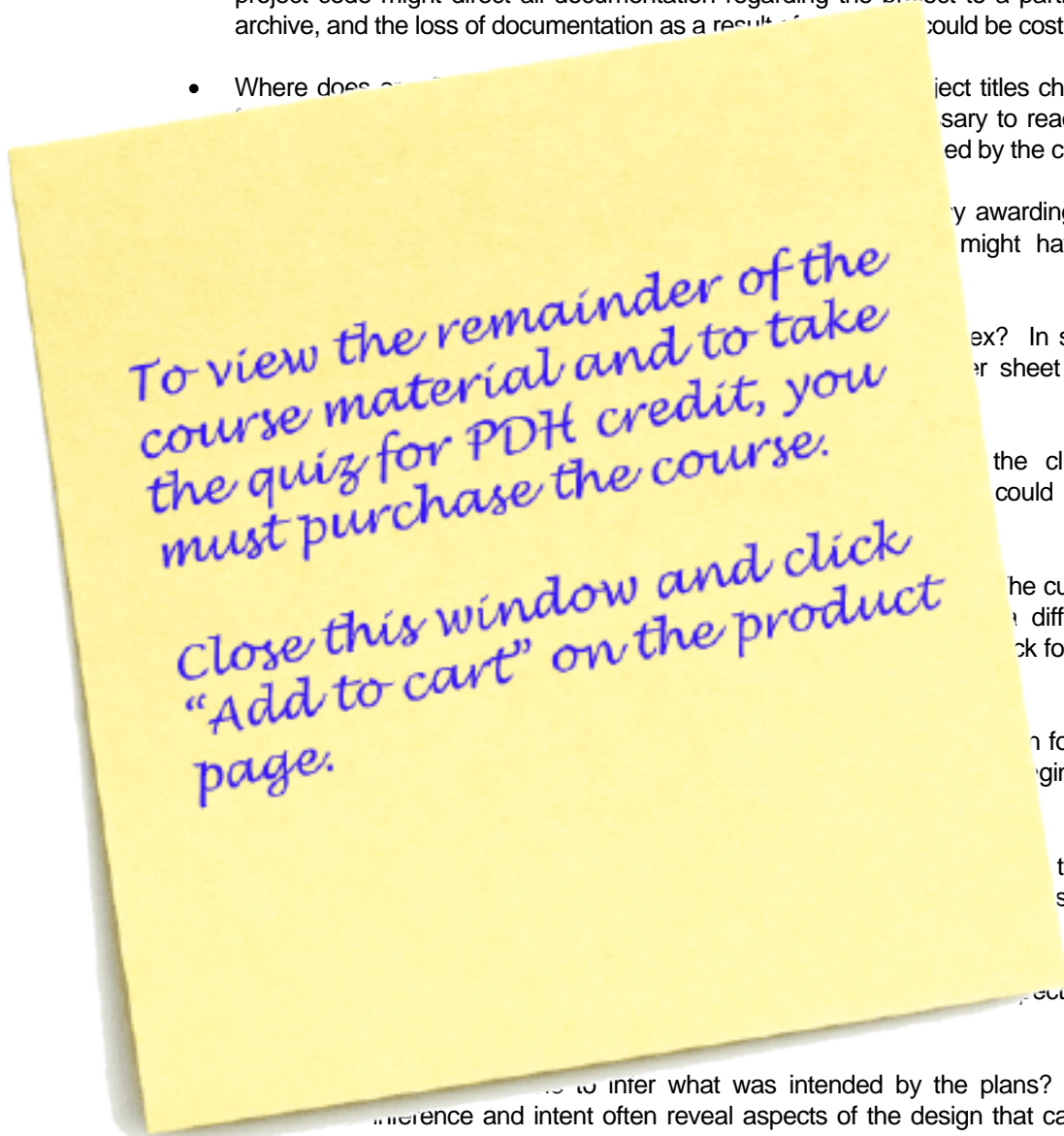
During the course of a career, a person might have the opportunity to review hundreds of sets of contract plans. Over the years, the number and type of questions that arise can continue to grow. Some plan reviewers prepare checklists. However, the content of a checklist may vary, and often cannot be all-encompassing. No singular class or seminar can produce a complete list of situations that can arise on the various sheets of a set of plans. Questions from the staff, the client and from internal reviewers can help to produce a set of contract documents that contains fewer contradictions, anomalies or conflicts, and the questions can also be used as a training aid.

Questions that can arise at various stages of plan preparation include:

- Who should sign and seal the plans? In most licensing jurisdictions, the person who seals the plans is the person under whose direction the plans were prepared. In some smaller firms, the decision on sealing plans is based on the insurance coverage carried by the firm. A person would be best-served by reading the engineering licensing law that governs their particular jurisdiction. In some situations, the application of a seal remains valid for many years, and can be affected by changes in a firm’s ownership. If a person seals a set of plans and leaves the organization, the seal and any professional liabilities attached might remain that person’s responsibility.
- Why is a professional seal needed on a set of plans? A set of plans for an infrastructure project is designed to serve the public good. The licensing act or law establishing the jurisdiction for the practice of engineering will be very clear on this issue, as well as on many other issues pertaining to the application of a seal.
- Why can’t the client always sign the plans? In some jurisdictions, professional liability insurance is calculated based on the number of sets of plans or the total construction value – the amount of potential liability – that a person might have. It would therefore be in a client’s best interest to limit their exposure, in the event that they decided to enter private practice and begin sealing their own plans.
- What difference does it make if the client’s title is not exact? For some agencies or jurisdictions, the issue of professional liability takes precedence. There may be

a clause in the enabling legislature that mentions a specific stake-holder as the identified party to whom all issues of liability will defer. Identifying a person other than the one intended could result in legal complications that could be costly and time-consuming to resolve.

- What difference does it make if the designation of the project does not match the designation in other documents? Some agencies are very particular when matters of project designations are concerned. For instance, a single digit in a project code might direct all documentation regarding the project to a particular archive, and the loss of documentation as a result of this could be costly.
- Where does one find project titles change necessary to read the intended by the client.



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to infer what was intended by the plans? The
ference and intent often reveal aspects of the design that can be
revised to avoid any misconception or interpretation during construction.

- Do italics convey the inflection that is meant to emphasize a point in the text? It is often difficult for some to say what they mean or to express their intent.

The answers to these questions might not be applicable from one agency to another agency or from agency to agency within the same state. A plan reviewer can still perform a review based on a generalized approach to the task.