plying to paints, from which a quotation was made earlier in this paper. Separate specifications or a book containing all of their standards may be purchased from their office at 1315 Spruce St., Philadelphia, Pennsylvania. The standard specification of various State Highway Departments may also be advantageously used when preparing paint specifications.

Though possibly not properly a part of a discussion of paint specifications, there is sometimes an attempt or gesture at describing paint that should be mentioned. Under the heading “paint” in the specification for a project, there may be a statement that “the paint shall be such and such a brand” or that “the paint shall be the best grade manufactured by so and so’s company”. Apparently as a sort of after thought there may be added “or its equal”. Such statements should not be used as specifications. Usually they are an attempt to favor some particular dealer; but, granting that such is not the case and that the specification writer is conscientious and honest, how are you to know the kind of paint you may get? The formula and the quality of a brand may be changed at the will of the manufacturer. Also, suppose a competitor offered to supply the paint and you had to decide whether or not it was the “equal” of that named. How can you determine that any material is equal to another if you have no specific or definite standard for the first?

SPECIFICATIONS AND INSPECTION

By G. P. Springer, Assistant Professor of Civil Engineering, Purdue University

Specifications should be written for every part of every contract, regardless of how small the unit of the work may be, for only with proper specifications, carefully written, may the contractor fully understand each item proposed for the construction operation. From the specifications a bidder arrives at the nature and amount of work which he will be expected to perform, if he is the fortunate winner of the award. From the wording of the specifications, the contractor will draw his conclusions as to the fairness of the parties who drew the specifications, how well the engineer knows the details of the work contemplated, and what kind of treatment may be ex-
pected from those who will be in direct authority during the progress of the work.

The two most important requirements of good specifications are clearness and fairness.

It has been said facetiously that "a specification is a document the purpose of which is to set the contractor guessing at what the engineer means".

Any specification which is indefinite, indeterminate, ambiguous, or useless will cause uncertainties of interpretation and result in the contractor's adding certain amounts to his bid as self-protection. These sums will invariably be much in excess of what the cost would have been had the specifications been definite and exact. The exact and precise meaning of a sentence or a word in a specification should admit of no argument nor doubt as to the meaning. Each sentence should be so constructed that any reasonable person would read from it only the meaning intended by the engineer.

A specification is not the forum in which an engineer should show the extent of his knowledge, but it is the set of pages upon which he should set forth as clearly and exactly as he can the essential and practical limits required during the progress of the contract relative to the qualities of work and the materials needed. The specification should protect the job by definite, exact, proper requirements.

**Clearness**

Sacrifice everything for clearness. Words and technical terms should be defined and used in the sense which they have acquired through common and local usage. Their legal interpretation is on this basis. Do not substitute synonymous words; they are never exactly synonymous and the word having the exact meaning should be used as often as is necessary. Do not repeat except where really necessary, and then be careful that the repetition does not obscure rather than make the idea clear. Ideas must be identically duplicated, never varied; the language used must never have a double meaning.

To gain clearness, it is wise to follow certain rules—such rules as apply to all writing.

Prepare an outline. A good set of specifications cannot be written without one. This outline prevents repetition in the specifications and duplication between contract and specifications. It prevents contradiction in repeated clauses out of
which grows serious legal tangles and it prevents omissions of important clauses. Not all parts of the specifications are of equal importance but some parts are of such importance that their omission would seriously affect the validity or usefulness of the entire document. The outline prevents illogical arrangement of clauses.

Do not use long sentences. Use short, concise, exact statements. Be careful in the use of the comma. A misplaced comma might even reverse the entire meaning of the sentence.

Restrict your use of words to those which are likely to be in the vocabulary of the average intelligent foreman. Use of pronouns, especially the relative pronouns, should be reduced to a minimum. Repeat the noun for the purpose of clearness.

Give directions, not suggestions. The specifications should explicitly tell the contractor what he is or is not to do—do not intimate what he should or should not do.

Nothing is gained by an uncertainty in the specifications. A careful contractor will add a percentage to cover such contingencies and an unscrupulous contractor will have an opportunity to profit at the expense of the contract.

Specifications serve as instructions to superintendents and to inspectors, telling them the requirements which they are to enforce. The inspector must carry out the clauses of the specifications. Where a clause is obscure and an appeal is taken to the engineer, he will decide with a reasonable interpretation of the specification and in so doing may reverse the decision of the inspector to the latter's embarrassment. This creates a loss of confidence in the specifications by the inspector and contractor, and a decided lowering of the usefulness of the inspector on that contract. Specifications should, therefore, be clearly written so that they will be interpreted by all parties concerned with the same meaning and understanding. The contractor, the superintendent, and the inspector should all draw the same meaning from independent reading of the specification clauses. This prevents disputes, arguments, ill will, etc., and adds to the efficiency and effectiveness of the supervision and the inspection.

**Fairness**

The specification clauses must be fair. The reputation an engineer builds up for fair dealing is a most valuable asset. In
the long run, it is worth far more than any reputation he may have for cleverness of words or extraordinary ability to ride the contractor. The engineer’s duties are three fold: legislative, executive, and judicial. Because he is employed by one party to the contract and must supervise the work of the other party to the contract, he is in a position where it is sometimes difficult to be impartial and strictly fair to both parties.

The fair dealing of the engineer is not limited to the period after construction work has started. The attitude of fairness which he has toward the contract is on display when he prepares the specifications. There is his primary contact with the contractor. Most complaints of contractors are not directed against the engineer and his interpretations of the specifications, but against unfair and ambiguous clauses which are written into these specifications.

The most important sources of complaint to be guarded against are in the use of indefinite words and phrases such as: “to the satisfaction of the engineer”; “a workmanlike job”; “acceptable to the engineer,” etc. The natural conclusion to be drawn from the free use of such clauses is that the engineer has not the ability to write a detailed specification, does not thoroughly know the project, or is just too lazy. It also gives the contractors who know the engineer and his temperament, prejudices, etc., an unfair advantage over others who do not.

Do not attempt to put all the risks upon the contractor. It is unfair and unwise, and increases the costs of the job. The responsible bidder will add enough to his costs to protect himself. The irresponsible bidder, having little to lose, will bid low. If lucky, he makes a profit; if not, he will probably abandon the contract to the bonding company.

It is wise to warn the contractor of any danger likely to be encountered. If dangers are known to the engineer and he conceals these facts, serious trouble to the owner may result. Low bids are not to be coveted where dangers are known or to be expected.

Do not put anything into the specifications unless you mean to enforce that specific item. An emergency clause to be used as a club may be a boomerang, bringing injury and disrepute to the engineer.

It is necessary that the engineer be able to exercise control over the work in order to get proper performance and com-
pletion in reasonable time, but he should not endeavor to deal arbitrarily or unnecessarily with any part of the contract work. The contractor must not be relieved of his responsibilities nor should management be usurped by the engineer.

Sometimes specifications seem to be written not only to protect the client but to hamper and harass the contractor. Specifications such as these result only in limited competition and higher costs. They make the contractors skeptical of good faith, and suspicious of fair treatment on the work.

Determine in advance the character of all work required and then describe each item clearly and accurately. The price schedule should include every item which can be foreseen, thus reducing "force account" and "extra work" to a minimum. Every price item should be covered by a concise detailed clause in the specification.

The specifications proper are made up of two distinctive parts: general clauses and specific clauses.

The specific clauses in the specifications describe or define the materials and the work from the standpoint of the engineer. These clauses might perhaps more truly be called technical clauses. These technical clauses which apply to materials and work to be done should be very carefully written so as to be perfectly clear, leaving no chance for substitution of materials, or possibility of any kind of work except that which is the best for the particular item described in that clause.

There are various phases of the work and certain possible contingencies under a variety of situations which might arise during the course of construction which must be provided for. Some of these may be only remotely related to the actual construction work but they do have a bearing upon the business and legal dealings of the parties who are concerned with the contract. These different matters are treated in a group called the general clauses.

These general clauses are required because of the fact that the specifications are drawn up before it is known who the contractor is to be. Many of these clauses appear as of a nature intending to keep the parties to the contract out of court, the intent being to prevent, if possible, lawsuits.

**General Clauses**

We will consider first the general clauses of the specification as they usually open the document.
Carefully describe the work proposed under the contract, noting exactly its beginning and end. Draw a sharp line of division between this contract and any other contract. Note the number, character, titles, dates of drawings already made, describe any to be made and by whom made or to be made.

Define in clear terms of local meaning the words and phrases used in the specifications. This is to cut down the possibility of misunderstandings and argument as to what is meant. Define the term contractor and provide for power of attorney. Define owner, and provide for such a contingency as death, or change of political officers on a municipal or other public contract. Define engineer, resident engineer, division engineer, chief engineer, and give the line of delegated authority. Define the precise nature of such terms as "ton", "day", "cubic yard", "earth", "rock", etc.—words which are frequently used, but which cause much argument and misunderstanding.

Cover alterations carefully. By strict interpretation of law the making of any important alteration in the design after the signing of the contract is a breach of agreement and releases both parties to the contract and also releases the bondsmen. In practice, this is almost never insisted upon. The substance of these clauses should cover the engineer's authority to make reasonable changes, provide a method of adjusting differences in cost, and provide that changes allowed shall not affect the contract or bond.

Many cases arise involving inconsistencies between plans and specifications which if taken to court may be tedious and very expensive. The court would have to ascertain the intentions of the parties and would rule accordingly. All the many features of the design cannot be described in both the plans and the specifications; so it is wise to stipulate in the specifications that the plans and specifications are to be considered as mutually explanatory and supplementary; that features shown on one shall have the same effect as if shown on both; that anything essential, vitally necessary to the proper completion of the work, even though neither shown on the plans nor mentioned in the specifications, shall be done by the contractor without extra charge.

Should the contractor be expected to verify data or accept the responsibility for data furnished by the engineer? The engineer can do one of two things when preparing a specification for work where the data is uncertain—throw the responsibility for verification on the contractor, or assume responsi-
bility for the data furnished. If the data furnished prove insufficient, incomplete, or incorrect, upon whom should the burden fall? Cover such a contingency carefully in the specifications in order that the contract may be protected.

The duties of the engineer during construction should be carefully recorded, the principal ones being to lay out the work, give necessary lines, references, elevations, etc., to make all measurements necessary to determine payments to the contractor, to interpret the plans and specifications in cases of doubt or uncertainty, and to check materials and workmanship as furnished, noting that they meet the requirements of the specifications. It is customary to place all these matters directly or indirectly in the hands of the engineer. It is possible to draw up the clause giving the engineer too much power and authority and thereby placing the contractor in the position of agent to the owner. This must be avoided. Disputes and arguments arising over decisions and rulings of the engineer may be conveniently handled by setting up through the specifications provision for a board of arbitration. Such a board, while expensive, will prove less expensive and more satisfactory than recourse to court action.

A clause should be inserted mentioning the representative of the engineer on the work—the inspector and his power and authority as delegated from the engineer. Little should be said about the detail power and duties of the inspector in the specifications.

Rejected materials which require marking and immediate removal from the vicinity of the work should be covered by specifications. This material, being the property of the contractor, should in no manner be defaced or mutilated, and thus rendered unusable for other purposes.

Clauses should cover employment, discharge of employees, sale of intoxicants, sanitation, legal relations with employees, citizenship, hours of labor, wages, payment of wages, etc. Some of the states have very specific laws and statutes in connection with public works.

Personal and property damages should be most carefully covered. The contractor must be required to erect barricades, guards, signals, place lanterns, etc., to protect against personal damage. Property damages may be a responsibility of the owner or may be that of the contractor. These should be differentiated and the specifications should explicitly and
clearly place upon the contractor the responsibility for accident due to carelessness or neglect.

Unforeseen difficulties, obstructions, encumbrances, etc., will add to the cost of the work and delay the contract. A blanket clause will put the responsibility on the contractor and he, of course, will protect himself in his bid figures with regard to this clause.

The contractor must be required to assume the responsibility of compliance with local ordinances, getting permits, licenses, etc. Cover the use of patent rights in construction so the contractor will be required to pay the royalty fees or damages for infringement.

Insert a clause requiring the contractor to respect and to preserve survey points. The engineer must give lines and grades as desired by the contractor, but the contractor should be expected to give assistance in these operations, and, if a specific money forfeit clause be written into the specifications covering each survey point unnecessarily disturbed, there will be some incentive on the part of the employees to use care and preserve these points as set.

Progress of work should be covered by clauses fixing the time for the beginning of the work after signing of the contract. A time limit should be fixed for completion of the contract. A progress schedule may be drawn up if the construction be on a large and important piece of work, this schedule being based on normal progress.

Days and times when work is prohibited, such as Sundays and legal holidays, and night work of certain kinds prohibited because of noises, dangers, weather conditions, etc., must be specified.

Abandonment of work must be covered by very carefully worded clauses. This situation may be handled by either declaring the contract null and void and the contractor discharged, or by letting the contract remain in force while the owner or bondsmen complete the work at the contractor’s expense.

While the work is under way, it may be necessary because of certain contingencies for the owner to request the contractor to shut down. If such a shutdown is due to no fault of the contractor, then provision should be made for reimbursement because of the losses due to the enforced suspension of the work.
Extensions of time may or may not be justified. Some delays due to weather or owner justify an extension, but delays due to the faults of the contractor do not. Specify what things will be considered legitimate reasons for extension of time and what things will not be so considered.

Should the contractor fail to complete within the contract period, the recourse of the owner is to sue for breach of contract, but a suit at law is unsatisfactory. To avoid appeal to court action, insert a clause in the specifications noting a certain per diem sum, as “agreed and liquidated damages” suffered by the owner because of noncompletion of the contract on time. Do not arrange the wording so that the sum appears as a “penalty”; the courts are very jealous of their rights at law. The amount named for damages should be reasonable and show good faith in attempting to estimate the actual damage suffered because of the delay.

A bonus clause should be inserted to offer incentive to the contractor to do good and speedy work.

Payments, terms, source of funds, nature of funds available are often controlled by local statutes, laws, sale of bonds, assessments, taxes, etc. Incorporate this information plainly into the specifications.

A contractor may not desire to do all the work upon the contract; the specifications should cover very clearly the rights of the owner with respect to sub-letting and assignment, what parts may be sub-let or assigned, and what parts may not be.

During the time of the construction, it may be advisable or necessary to make changes in the plans, or to require extra work which will necessitate a greater outlay of labor and materials by the contractor. If the work is such as is covered by unit prices, the extra work involves only a simple adjustment. A change of plan might require a “supplemental contract” covering the additional work. On private work there can be no criticism, but on public work the supplemental contract is open to attack and objection as having been entered into without competition.

A clause should provide for “extra work”. Do not, under the belief that you have covered every point, specify that there shall be no extra work. It is not always possible to draw a clear-cut line between what is a part of the contract and what is not. Specify that all extra work shall be ordered
in writing either by the owner or by his authority; that it shall be paid for at cost plus a percentage; that the contractor must furnish all information, time books, bills, etc., to enable the engineer to determine the correct cost; that the contractor shall make all extra claims at certain fixed intervals, clearing up these claims while the extra work is fresh.

The frequency and amount of payments of earned money made to the contractor must be provided for. Payments are made in certain fixed, specified sums or in progress payments at fixed intervals. The method of measurement of work for estimating the earned money due should be clearly set forth. The method of payment should be described, the percentage to be held back against the contract noted, and provision made for deferring the estimate to the next time period whenever the earned sum is less than a certain fixed amount. The conditions for final inspection, final check of work, and rendering of final estimate all should be clearly set forth.

Specific Clauses

The specific clauses should be separated from the general clauses and be given a proper heading. They should be arranged for convenience in the natural order in which the work is done. This does not necessitate nor mean that the contractor must follow the order of the clauses in performing the work required by the contract.

In handling earth in excavation, the cubic yard, which is the general unit of measurement, needs qualifications. The measurement is made in one of three ways: measure in place before disturbing; measure in transit, on wagon, truck or car; measure in fill. Different volumes will be arrived at by these methods and the plan of measurement must be known.

The difference between earth excavated and rock excavated should be carefully noted. Rock may be loose, soft or solid. What constitutes each class should be specified and the method of measurement for each class given in detail.

Use exceeding care in the earth and rock specification clauses, for it is in connection with these items that a great amount of unpleasant feeling and lengthy expensive litigation frequently occurs.

Use care in writing the clauses relative to concrete. Specify exactly the quantities of cement, sand, and stone required for a mix. Is it a mix by volume or by weight? There is a great
difference in the quantities of material required. If the volume is the unit of measure, is it loose or rammed? The contractor might bid according to one interpretation, the engineer on construction might require another, the result being an addition of many dollars to the construction costs. See that the concrete mix can be interpreted in but one way.

The various materials like lumber, steel bars, shapes, flats, pipes, cables, etc., are carried in standard commercial sizes. These sizes should be used on plans and in specifications, effecting a saving on the contract costs.

Very carefully avoid specifying any special brands or patented articles. Any such specification will only cause trouble, monopoly for the one material, suspicion on the part of others, and charges of collusion and graft. Give the contractor an option in the supplying of materials. Require a certain grade or test, but not a brand.

Do not specify the impossible either in materials or in workmanship. Require good materials and good workmanship, but do not expect absolute perfection. Use the grades of material suitable for the work planned. Sometimes a grade lower than No. 1 will answer the purpose equally well and at a considerable saving in cost. For every purpose there is the one most economic material which can be used; do not expect or specify higher; it only adds to the contract cost.

Specify for results, not methods, of contract activity. Your aim is to produce a finished structure. Leave the methods of work to the contractor. If you try to specify methods, it will be hard to hold the contractor to definite results.

The important and essential features of the contract plans should be given the most careful and full treatment in the specifications. Items requiring much labor and expense should be given the greatest detailed explanation. Touch minor operations with only a few words.

Engineering specifications cover almost every phase of industrial activity and no individual can be prepared to write, from his own knowledge and experience, suitable specifications for all the multitude of engineering works and processes for which specifications are needed. Even though the specifications to be prepared lie within the experience and knowledge of the writer, and though he may have prepared similar documents, there will be differences in conditions, improvements in methods, special economies possible, etc. These will re-
quire readjustment of ideas and changes of clauses which have been used in previous specifications. Where new conditions and new methods are involved, every source of information should be investigated, and even then these may be found too limited to satisfy the requirements of full explanation.

**Inspection**

During the process of construction, in order that there may be assurance that the work is progressing according to the plans and specifications, there are placed upon the work one or more inspectors. By definition the inspector is "an authorized representative of the engineer assigned to the job to make detailed inspection of any or all work performed and of materials furnished by the contractor".

The duties of the inspector are set forth in the specifications, basically being to see that the work is completed according to the specifications. Instructions to the inspector should be in writing, so as to form a permanent record and a future reference. The inspector should measure and check, check and measure, at all times. He should never make hasty decisions, should not be too ready to accept suggestions from the contractor or from others. He should carefully study the specifications to increase his knowledge of the requirements of the work and his efficiency. An assumption of knowledge which he does not possess can only lead to trouble and embarrassment. He should approve or reject all materials as received. He should inspect all work as performed to see that the various parts are according to the specifications. He does not have authority to alter, revoke, enlarge, or relax any of the provisions of the specifications, nor to change the plans in any particular, nor can he approve or accept any part of the finished work. He will keep the engineer informed as to the progress of the work, the manner in which it is performed, the quantity and quality of materials used. He will warn the contractor of any failure to follow plans and specifications. He has the authority to prevent any material being used and to stop all work if he believes that the work at that time is not being done according to the plans and specifications, and not to allow work to be resumed until correction of methods has been made or the engineer has had opportunity to inspect the materials and work. The inspector shall have access at all times to any part of the work, and the contractor
is required to furnish information and assistance as needed for his inspection.

With a carefully written set of specifications, all parts of the work being covered therein concisely and explicitly to the best of the engineer’s knowledge and ability, and with an inspector on the work who is both careful and conscientious in the performance of his duties, the contract work should go through to completion with the minimum amount of friction and discussion between the contractor, inspector, and engineer, and arrive at final inspection, acceptance, and payment with the best of feelings upon the part of all parties to the contract.

THE WORK OF THE STATE MOTOR POLICE ON HIGHWAY TRAFFIC REGULATION

By Otto G. Fifield, Secretary of State, Indianapolis

On March 7, 1917, a law was passed creating a state highway commission, providing for the construction, reconstruction, maintenance, repair, and control of public highways and providing for co-operation with the federal government in the construction of rural post roads.

On March 10, 1919, this 1917 law was repealed and a new law was passed which is the state highway law of today with but few changes. This law provided that the state highway commission should at the earliest possible moment proceed to lay out a system of state highways which should reach each and every county seat of the state and each and every city or town of over five thousand inhabitants; and connect county seats and cities of over five thousand inhabitants with improved trunk highways of adjoining states.

The highway commission has functioned well. Five thousand sixty-five miles of roads are now designated as state roads. Two thousand four hundred twenty-five miles are of hard surface, concrete, brick, or asphalt. Three hundred and two miles were constructed last year. Every foot of our roads is paid for. We are not handing down a debt to our children and grandchildren, as most other states are doing. Money for the building of these roads comes from auto license tax, from gasoline tax, and from federal aid. The license tax for this last year amounted to $6,245,838. Five million, nine hun-