Writing better technical specifications

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ABSTRACT

Many contractual problems relating to performance can be traced back to inappropriate drafting of the technical specifications. The problems commonly relate to: inclusion of irrelevant or contradictory information, use of ambiguous or undefined terms, or concentrating on the means by which a result is to be achieved rather than on the performance required. Drafting specifications of this sort will maximise the probability of the supplier understanding what was intended and hence of providing what was actually required. It will also minimise the remedies available to the purchaser to resolve problems.

The approach advocated in this paper is to adopt a results oriented specification by which the vendor assumes most of the responsibility for determining the means of achieving these results. This does require greater care by the purchaser in evaluating tenders, but the end result will usually be more efficient and flexible plant and clearer lines of responsibility on the vendor if equipment does not perform as intended

INTRODUCTION

Many contracts run into difficulties because the technical specification has been written without sufficient care or consideration of what is really required. The commercial, administrative and 'standards' aspects of the contract are usually fairly well covered partly because they can be largely built out of standard clauses.

The technical specification is somewhat different. By its nature, it is usually a one-off document and is often written by a person who does not write them very often and mistakenly makes them over detailed. It is often forgotten that the more information that is provided to the supplier about the conditions under which the equipment is to work, i.e. the plant environment, feed conditions etc, the less flexible the piece of equipment supplied has to be. Thus it could be easier for the vendor to meet the letter of the specification while still not providing what the client really wants.

Examples of providing unnecessary or ambiguous information that has led to problems over responsibilities at a later stage include:

- Including background documents such as peripheral research reports and labelling them 'for reference' or 'for information only' or similar wording. The two sides will rarely agree in their interpretation of what this means. If the matter finds it way to arbitration, the vendor will almost certainly be able to establish they reasonably took it to mean that they were to refer to the document or to use it as a source of information or at the very least, it was intended as a guideline. Even changing the words to a form such as 'this document is for information and does not form part of the specification' will not necessarily avoid this problem. At the very least, if the equipment supplied does not work, the supplier will be in a position to say I deviated from my preferred choice because of the information that you supplied. Looked at sensibly, if this information is not part of the specification, it should not be included. If the supplier really does need to see the information, then it must be remembered that its inclusion will have an effect on his contractual responsibilities. In this case carefully spell-out the limited purposes for which the information is relevant and that it is not supplied for any other purpose.

- Including a 'notional' flow sheet of the equipment to be supplied on the drawing which shows the existing surrounding equipment. The purpose of this drawing should be to indicate termination points and where streams come from and go to so that new equipment can be designed accordingly. The inclusion of a notional flow sheet for the new equipment on this drawing gives an (unintended) indication to the supplier of what the purchaser wants and may readily cause him to deviate from supplying the most appropriate equipment.

- Ambiguous use of terms. The use of 'for reference' has already been noted. A more extreme example was the case of a contract for an electrical installation. All the items which were to be installed were listed in the specification, in most cases followed by the words 'to be provided'. The purchaser had intended this to be read as 'to be provided by the supplier'. The supplier however read it as 'to be provided by the purchaser'. In the end the work probably only cost a little more than it should have done (somebody would have had to pay for these items and presumably there were not originally included in the budget of the supplier when tendering for the work). However there were significant delays in completing the contract because no-one had even ordered the hardware until site work was about to start.

- One other extreme, which is possibly an apocryphal story, is of a company which placed an order which simply said 'one paper machine drive system to suit number X machine'. The supplier was very pleased to receive such a contract which was so vague that they thought they could fulfil it easily until the time came when they sought to sign-off and receive payment, when they were told "No, it doesn't suit the machine yet".

STRATEGIES

There are a number of basic rules which may be applied to avoid the type of problems described above and some other problems which will be described later on.

Ends v means

Whenever possible write the specification in terms of the performance that you require not in terms of the means of achieving this. For example, what you really want is a pump that will 'pump slurry for at least 5000 hours before replacing wear parts **not** one with wear parts made of material with a Brinell hardness of not less than 400' and certainly not 'one with wear parts made of UNS-F47003'. If you use the latter approach and the pump wears out too quickly, the problem is yours not the suppliers because he has supplied you with what you asked for, not with what you needed. In such a case a supplier will probably come and ask you what material you want. You can tell him what you have used in the past, but avoid making this part of the specification. Let him make the decision.

Only specify the means of performing a task if it is truly essential. For example, one might say that a spray atemperator is not acceptable because of the fear of damage to a turbine downstream of it, but it might still be better to write the specification in terms of the particle/droplet content of the steam leaving the atemperator. However, it is very unwise to specify a particular type of equipment or a construction method simply because you have used it before or because you have been told it worked well elsewhere. This approach prevents you from benefiting from new technology because it will never be offered. However, there is nothing to prevent you from rejecting offers which you feel will be inadequate (giving the supplier a choice in specifying equipment can give you a better indication of his real understanding of the problem – and sometimes a better indication of your understanding of it).

You should be going to a supplier because you believe that they know their job, therefore it is unwise to try and do the job for them. A technical specification is not the place to show off your knowledge of equipment used for a particular task and to try and impress the supplier that you know more than he does. If things don't work, and matters come to arbitration, it is going to be very difficult to argue that the responsibility of getting the technology right was with the supplier who is the expert and claim that you are the innocent purchaser when you have specified what he is to supply in such detail.

Avoid the irrelevant

Avoid the inclusion of all irrelevant/marginal information. The supplier is justified in assuming that it has been included to give him instructions on what he is to do. If he follows this information and the plant does not perform, it is not his problem. If you don't like what the supplier offers, reject it and guide him towards what you want. But let it be the supplier who ultimately specifies what he will supply otherwise guarantees become of very limited value.

Ranges of operation

Pay particular attention to giving appropriate operating ranges. People drafting technical specifications usually consider variations in flow, operating temperature and pressure (if appropriate). However, it is very important to ensure that the range given is realistic. If the range over which equipment is required to work is too narrow, it is unlikely to result in a plant that works properly when other equipment is working slightly away from its optimum.

> For example, consider a four stage screening system. A change in rejects rate from say 10% to 11% together with a 10% increase in the feed rate has a very big effect - about a 60% increase in the rejects flow from the system. Does you rejects handling system allow for this?

Also it is not sufficient just to put an upper limit, one should also consider lower limits. Turn down can be very limited on some types of equipment. It can also help you notice whether the ranges that you are using look real. Just putting the expected and the maximum value can look reasonable, but if you bring in the bottom range as well, you can be aware that your conditions look either very asymmetrical or improbably broad. Very broad operating ranges lead to a dramatic increase in the cost of the plant or suppliers refusing to quote.

In particular it is important to be particularly careful with temperatures.

> There has been at least one case where for purposes of material selection, safety factors have been added to the upper but not lower temperature range for a pipeline. In the end what was given to the piping designer was merely a maximum operating temperature. Unfortunately this was so far removed from the real operating temperature, that what was supplied was a very expensive alloy which was capable of handling the gaseous form of the product flowing through the pipe. Unfortunately in the actual process, the product

was going to be a liquid and could have been adequately handled by a cheap polymer pipe. Sadly however, the alloy specified was quite unsuitable for the product in its liquid form. In this case we not only had an extreme cost blow-out, but the resulting pipe work corroded out within a few months.

It is also important to consider the ranges of compositions and physical forms of the flow streams to be handled by the equipment. We have seen technical specifications written for solids handling equipment with a particle size of a feed of the form shown in Table 1 (except there were actually more size fractions given).

Size range	%
>2.0	9.83
1.4-2.0	27.61
1-1.4	36.08
0.7-1.0	19.07
<0.5	7.41

Table 1 Inappropriate specification of particle size

Even writing 'typical' somewhere does not help very much in determining the range of particle size over which the supplied equipment should be expected to work. (It might persuade the arbitrator that instead of the feed being within ±0.01% it should be ±0.02%. Even rounding the size distributions off to the nearest whole number would only give you about plus or minus 1% on any size fraction if no other information were given. Anyone who has worked around a solids processing plant knows that when the plant is built it is very unlikely that it will ever actually operate within that range, therefore no guarantees or warranties are going to apply. Going to the other extreme and putting very wide bands on everything, results in suppliers declining to quote or offering equipment at very high prices.

The correct approach is to put realistic bands of what you think the process might work in and specify that the equipment must meet the specified performance criteria whenever the feed is within this range. A good compromise between flexibility and cost is to recognise that when the plant deviates by a moderate amount from design conditions, i.e. some deterioration in performance can be accepted. In such cases two operating bands may be quoted, each with its own performance requirements and the performance requirements for the broader band being less stringent than those for the narrower band.

Retain flexibility

The reality is that process design is not an exact science and it is unlikely to become one within the lifetime of anyone currently practising. Experience suggests that many plants and particularly those processing natural materials, spend most of their time operating somewhat outside the range anticipated at the design phase. Therefore it is unwise to end up buying equipment which has a very high performance over a very narrow band and which performs very poorly outside this band. Your specifications should reflect this situation. Because most scientific and engineering calculations are less accurate than people think, plants do not operate where they are designed to. So it is essential that the plant that is built should have flexibility.

Adding this flexibility gives some increase in the capital cost. Reducing the flexibility leads to a very substantial reduction in profitability.

Even if the actual process design is very accurate, the raw materials to the plant will vary. This is particularly true in industries such as pulp and paper and mineral processing. The real determinant of profitability of a plant is not how it performs at the exact design conditions, but its efficiency, throughput and control over a moderate range of conditions such as will be encountered in normal operation. Figure 1 represents profit volume chart for a flexible design. Figure 2 represents what project managers and project accountants think they will achieve by taking the flexibility out of the plant and reducing its capital cost. Figure 3 is typical of the real profit volume chart for a plant which has been designed for low capital cost at the expense of operating flexibility.

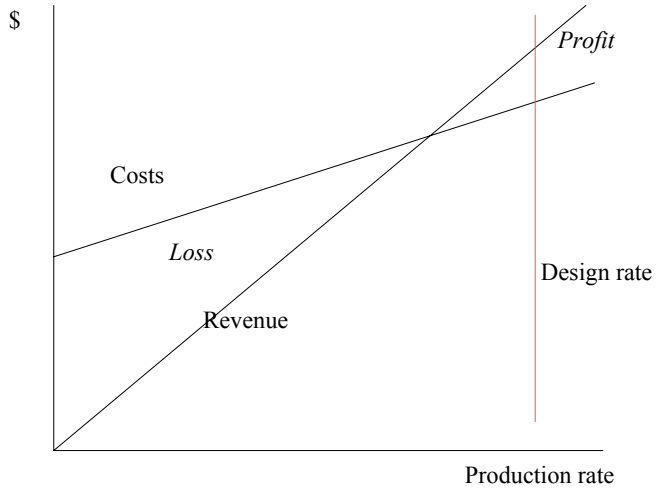

Figure 1. Flexible design

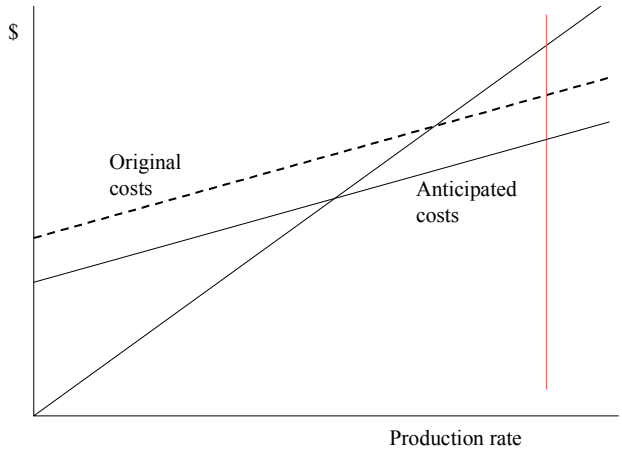

Figure 2. Optimistic specification

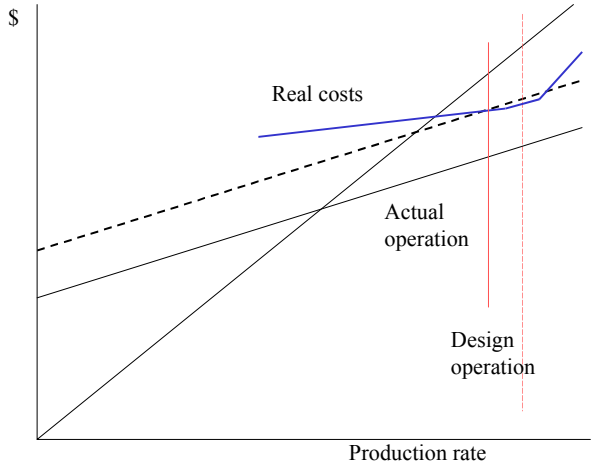

Figure 3. Actual performance of optimistic specification

Precise performance specifications

As has been stated several times already, the critical point of the technical specification is what the plant is to achieve, not the means by which it is to be achieved. Therefore the technical specification should be very precise on the performance criteria. It should give consideration to such matters as how performance is measured, where it is measured and when it is measured.

> For example, when specifying the environmental control in the machine room, what part of the room are you referring to? Or is it all of the room? What elevation above floor level?

In this case it is fairly obvious what things should be considered. In other cases it is very easy to write a technical specification in which the supplier can fulfil his contractual requirements without giving you what you really want. Similarly give consideration to the requirements for stability of operation when measuring the performance of the plant. It is very nice to be able to specify the average performance over a period of 24 hours or 7 days of stable operation, but such a requirement may well work against your interests. In practice you may not be able to keep the plant stable for such a long period, and this is most likely to be the case when the equipment is not working well – i.e. in the circumstances in which a performance trial is really important. You will then never be able to establish poor performance as defined in the contract specification. All you will do is get into all sorts of arguments with the supplier over whose fault it is that the plant isn't stable.

Company standards

Avoid invoking company engineering standards except when these are really necessary. This is particularly for things such as painting standards unless these standards exist because of an unusual corrosive environment around the plant. At first instance at least, permit the vendor to offer alternatives (these will often be the standard for the equipment and therefore cheaper and quite likely better than your company standard).

A problem is that company engineering standards do not get updated often enough. They usually describe what was good 5 to 20 years ago and/or seek to save on spare parts inventories. The result is that the quality of what you are supplied is fixed in the past, with expensive, lower quality equipment (the exact opposite of what was intended).

> For example, a mill sought a quote for its standard pump which is of mild steel but with a stainless steel shaft. The vendor offered as an alterative another brand of pump which was all stainless steel, more efficient and cost less than one-third of the standard pump price. Despite this it was still difficult for the engineer to obtain approval to buy it.
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> In another case, a short life pilot plant was to be built. For industrial relations reasons it had been agreed from the start that mill personnel on the site adjacent to the pilot plant site would never have responsibility for the maintenance of the plant. Despite this, the company instrument and electrical departments were able to insist that the plant have all electrical and instrument equipment to the mill standard which was designed for uniformity for spare parts and for a long operating life in a much for adverse environment. This made a considerable increase in the cost of the plant which in fact never was maintained or

otherwise touched by the mill personnel up to the point when it was demolished.

Tender evaluation

One important consequence of writing specifications in terms of results rather than means is that greater care is required at the tender evaluation stage. Permitting the vendor to offer what he thinks will be best for the duty means that at least some of the solutions offered should be better than is the means had been specified by a non-expert. However, tenders will sometimes include unsatisfactory solutions. It is important to evaluate the tenders carefully to ensure that inappropriate offers are rejected.

More often, different suppliers will offer equipment or processes which have different benefits and a very careful evaluation is required.

> A process for producing chlorine dioxide was selected on the basis of capital cost and fit with existing plant operations. However, it was recognised that the materials of construction were unlikely to give a long plant life.
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> An alternative tender offered better materials of construction and hence a longer plant life, but the products of the plant were far less suited to the requirements of the existing plant.
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> The shorter life plant was selected and functioned well. The material life problem was overcome by replacing corroded PVC components with titanium components.

CONCLUSION

In summary, when writing technical specifications, do not try and use a simple formula approach. Do not be over detailed in the means required. Instead, put the emphasis on what is to be achieved. Be careful in evaluating tenders to ensure that the means proposed by the vendor are consistent with meeting your objectives (but remember, he should know his job better than you do, otherwise why are you using him?). Finally don't stick too closely to these or any other suggestions. Instead think about what is really required in the case you are dealing with.