

Performance is the key

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IN 1968 the Institution of Chemical Engineers drafted a groundbreaking publication, the Model Form of Conditions of Contract for Process Plants Suitable for Lump Sum Contracts (Red Book). From the very start the IChemE drafting committee recognised the need to create a contract that dealt with the complex way in which the purchaser and the contractor divided the responsibility for the three phases of the project; namely design and construction, commissioning and handover (preparing for operation), and start-up and performance testing (operating to contractual requirements) of a new process plant. This complexity arises from the unique economic factors, the multidisciplinary technology involved and potential catastrophic risks associated with the process plants industry:

- a) The design responsibility is usually a combination of the proprietary technology design of the process licensor or purchaser and the detailed design of the contractor. There is no single point design responsibility.
- b) The financial standing of the purchaser usually far exceeds that of the contractor such that the purchaser most effectively bears any catastrophic losses.
- c) The timescale of a project from inception to beneficial operation can cross business cycles and changes in government often affecting priorities, with key risks shifting from those initially identified at the outset.
- d) Chemical, biochemical, oil, gas or nuclear plant all include complex dynamic processes that are a potential source of a catastrophic failure which can result in serious injuries, fatalities, pollution and serious property damage. The contractor and the purchaser must commit and adhere to first class quality control and assurance procedures and develop clear roles and responsibilities in the takeover period to ensure nothing is overlooked. It is therefore essential that particular care is taken during the initial stages of plant operation.

John Challenger and David McLurgh on why you should be using IChemE contracts in the way the drafters intended

IChemE forms of contract are the only standard suite of contracts that properly balance these factors; providing not only the legal terms but also, through the schedules and guidance notes, a framework for developing the level of detail needed to specify the sequence of events for the successful passage through commissioning, takeover, operation and performance testing.

Specification, schedules and guidance notes

IChemE recognises the very wide range of processes and varied industry requirements that need to be catered for by its contracts. Therefore, it seeks to provide a flexible framework for project execution which reflects the actual scope, complexity, size, sequence of construction and need for financial planning all within highly regulated safety and qualitative frameworks. While the contract aims to properly allocate risk based on an analysis of where this is best managed, the real challenge in contract formation is completing the 21 schedules that fully define the project.

The helpful and often neglected guidance notes included with each form of contract seek to highlight the need to provide a detailed specification and description of the works supported by completed schedules that cover all aspects of the project — in particular the completion, handover and testing regimes required. The adoption of inappropriate contracting strategies can lead to disputes, however the prime cause of most major contract problems is usually due to incomplete, vague or ambiguous scope definition linked with poorly drafted schedules. While most of the key considerations that should be addressed in the specification and schedules may appear obvious they are frequently incomplete and inadequately defined, thus leading to disputes.

Specification

Every process plant contract needs a specification which provides the technical definition of the plant that the contractor has agreed to design and construct. Therefore, both parties must expend the time and effort needed to provide sufficient detail in the specification to avoid any ambiguity in the definition of the requirements that the plant must meet.

The specification must incorporate the technical details for the plant together with a list of all the design standards and codes of practice, to which the plant is to be built, and such matters as corrosion allowances and the design life of the different elements or sections. Of equal importance is the inclusion of the output capacity and tolerances in schedule 17 (performance guarantees and damages for failure) against which the overall performance will be measured by the testing regime defined in schedule 16 (performance tests and procedures).

If a third party inspectorate will eventually rule on the sufficiency and suitability of the plant, then this should be stated in the specification. The specification should also address any work involving the modification or extension of and any impact on existing plant such as the need to maintain production, the condition of existing plant and all interfaces between old and new facilities. The parties should therefore jointly review in detail the specification and schedules prior to contract award to remove inconsistencies and ensure they hold a common understanding of what is required. A practice often neglected.

Schedules

Whilst the specification defines the plant, schedule 1 (description of the works) specifies the site and the extent and nature of the contractor's contribution to the project in terms of process technology, design work, engineering and other services including procurement, equipment items, materials of construction, field supervision, labour, tools, plant and temporary works. The schedule should include all the information that the contractor requires to carry out the works and make clear the dividing lines between the respective responsibilities and scope of work of the contractor and purchaser, thereby defining the limits of the contractor's responsibilities under the contract. All items must fall within the responsibility of either the purchaser or the contractor, whatever separate agreements either party may have with others in connection with the project.

When technology is licensed from a third party, whether by the purchaser directly or by the contractor as part of its obligations, care must be taken to define the role of licensor's personnel in checking and supervising design documentation, the provision of advice and interpretation of licensor documentation, role in training, construction and advising on and supervising start-up and any performance tests. The parties need to allocate responsibility for the performance of the licensor and the consequences of any defective performance or delay especially where the process design is provided by a licensor under a direct contractual arrangement with the purchaser. If the contractor offers a plant complete with process design then it takes full responsibility for this aspect even though the relevant information comes to it from a separate licensor.

Schedule 1 needs to include the site description covering location, topography, geo-technical surveys, site access and laydown areas, including documentation relating to the site with clear indication of any hazardous, environmentally sensitive or no-go areas. Usually the site belongs to, or is under the control of, the purchaser who will arrange for possession to transfer to the contractor. The contractor must ensure that any access way has the capacity required, both in terms of weight and clearances for passage of the largest loads to be brought onto and transported around the site. While it is the purchaser's duty to provide a suitable right of access, exactly what is suitable will need to be defined and agreed by the parties having regard to the equipment, materials and labour to be brought onto the site. Similar issues apply to the route to the site and to the use of utilities on the site.

Quality assurance is now widely accepted internationally as mandatory in the manufacturing and construction industries. As a minimum, the contents of a masterplan should be included in schedule 6 (quality assurance and validation), with a tabulation

of the responsibilities of the purchaser, contractor, subcontractors and supplier clearly allocated. Sections should be included on qualification activities which, when completed, will provide detailed documentation on all the checks that have been carried out during the project to ensure the robustness and reproducibility of the process when in operation.

Validation may be required as part of the overall quality assurance programme. The purpose of validation is to create documentary evidence providing assurance that the product from a manufacturing process will consistently meet its defined specifications and quality characteristics in all required circumstances. In particular the pharmaceutical, electronics, nuclear and aerospace industries apply rigorous techniques of this nature.

Transfer of responsibility and liability

From both a contractual and safety perspective, it is critical that responsibility for the plant should pass from the contractor to the purchaser in a clearly defined way. The following are some of the key factors to consider:

- a) Compliance with the specification and with the description of the works.
- b) Operational dependence of particular tasks or sections of the plant, thereby setting a logical sequence in the approved programme.
- c) Application of financial incentives or damages.
- d) Transfer of care, custody and control.
- e) Site management and health, safety and environmental requirements.
- f) Introduction of raw materials.
- g) Insurance cover and liabilities.

What constitutes completion of construction?

Terms within the sequence of construction and handover are often confused by individuals substituting their own definitions rather than using terms specifically defined in the contract. IChemE does not therefore use 'mechanical completion' because process plant contracts include work of many different engineering disciplines, neither are the terms 'start-up', 'pre-commissioning', 'commissioning', 'ready for commissioning' or 'ready for start-up' used.

'Completion of construction' is the important break point recommended by IChemE for establishing that the plant is physically complete in compliance with the specification. This can also be used for assessing delay and applying liquidated damages. As a result, great care should be taken in defining what constitutes completion of construction.

After this important stage has been reached, for a section of the plant or the plant as a whole, the work of takeover testing follows in accordance with the approved programme but importantly with no damages for delay. Schedule 15 (takeover procedures) should include all plant checks, inspection procedures, equipment tests and takeover tests, including documentation to be provided by the contractor. The purchaser needs to be precise when deciding how much of the work should be performed by the contractor prior to takeover. The contractor's retention of custody of the plant in the period prior to takeover enables the straightforward correction of minor defects identified by activities undertaken at this time.

It is emphasised that these activities are crucial to the ultimate success of the project and should not be rushed due to any pressure to start production. Instead, the contractor and the purchaser should thoroughly commission, inspect and test the plant ready for safe commencement of production. This time period should, where possible, be planned in considerable detail and may be extensive to meet both parties' requirements. The purchaser should only take over once the contractor has demonstrated that the plant is up to standard and ready for the raw material to be introduced.

Risks and dangers on initial start-up of the plant.

IChemE contracts provide for the purchaser conducting the performance tests in some form or other. The extent of such tests vary from simple mechanical, electrical and control system performance through to output and quality testing of a fully operating plant. The period from the first introduction of raw materials to completion of the performance test is vital, being the period when problems will become apparent such as defects in design and installation, or risk of damage from mis-operation or from debris in the event that the plant has not been properly cleaned. Further, while unsafe design and defective products can be a cause of catastrophic failures the most common reason for an accident is human error often linked to improper training and supervision.

Schedule 9 (training by the contractor) should detail the contractor's obligation to provide training for the purchaser's staff, together with the timing, duration and methods and procedures to be adopted in carrying out the training. Training covers a

broad field and the contractor may be called upon to provide basic training on various aspects of plant operation, health and safety, quality assurance, instrumentation, control systems and maintenance procedures. Where plant includes technology with which the purchaser's personnel are not familiar, induction courses and workshops should be arranged explaining the process, philosophy of design, control systems and start-up, shutdown and emergency procedures. The purchaser should appoint and make available the key operating and maintenance personnel before completion of construction and well before commissioning so that they can work alongside the contractor's personnel. The benefits of the purchaser conducting the performance tests include:

- a) The purchaser has expertise in operating plants.
- b) The purchaser's team has been trained to operate the plant.
- c) The purchaser wishes to operate the plant to meet its market or financial needs.

In the event that the purchaser operates the plant, difficulties can occur in attributing the responsibility for any faults that arise during the testing or completion of the plant. To reduce this kind of dispute, the contract includes for the appropriate notification by the party responsible for testing to invite the other party to attend and witness the tests.

The first attempts to start-up a plant may reveal weaknesses or omissions and it is therefore customary to plan the start-up in stages, so that if a shutdown or pause is required for rectification or adjustment, this can be done in an orderly manner at the minimum cost of time and resources. At this stage the plant must also have feedstocks, intermediate chemicals, catalysts and utilities and must be supervised by properly trained operating and maintenance teams. The purchaser is


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usually responsible for providing these resources. The contractor will provide expert commissioning personnel to provide guidance on matters arising.

An advantage of the purchaser's staff having responsibility for operating and maintaining the plant from the start is that it forms the culmination of their training and makes them concentrate on following precisely the contractor's instructions and procedures specified in the operation and maintenance manuals, which will incorporate information provided by the contractor, subcontractors and suppliers. If purchaser's staff fail to follow these instructions and the contractor can identify the cause of such failure, then it may be able to show that a defect is not its responsibility and make a case to be excused from achieving the guaranteed performance in any particular test.

Why undertake performance tests?

Performance tests are undertaken to determine if the finished plant meets the purpose as detailed in the specification. How the plant is to be prepared for the tests, the duration of tests, the performance criteria to be measured, conditions governing interruptions, changes in feedstock, prior operation, methods of measurement and analysis and tolerances should all be specified. Routines for measuring stocks at start and finish, recording, and interpreting readings on instruments and collecting and preparing samples should all be included. These procedures and the programme of tests need to dovetail with





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those included in other related agreements with the licensor and any key suppliers to ensure that the number of tests is limited, thus minimising disruption to the purchaser's ability to operate the plant beneficially. Many of these requirements affect the detailed design of the plant and so the design office needs to be aware of them. A plant will usually be required to operate satisfactorily over a range of conditions, and it may be desirable to provide corrections to the guarantees which can be applied if the performance test takes place under conditions differing from the basic design case.

Performance criteria to be tested will usually include plant capacity, details of consumption of raw materials and utilities and criteria for the quality of the products. In some cases guarantees may also be required for availability, reliability, the consumption of utilities (if these are a significant cost factor) and the quantity and quality of byproducts and polluting effluents. However, for performance guarantees to apply in full, details must be stated explicitly in schedule 17 and it is unwise to simply imply or infer such details. Schedule 17 should also state how the measurement tolerances should be considered in calculating the results of the tests for comparison with the guaranteed values. Performance tests are developed to show that the plant meets the stated performance and the contractor is under a strict liability obligation to keep working on the plant until it meets the

guaranteed performance levels and tolerances. Once a performance test has been passed then the purchaser will need to show there is a defect in the plant due to the fault of the contractor in order to make the contractor liable for the correction.

Conflicting needs of the purchaser and the contractor

The purchaser will want to operate the plant at its optimum performance and move rapidly to beneficial production. It will also wish to generate revenue to meet its ongoing financial exposure, such as operating costs, financing costs, supply contracts, take or pay raw material contracts, staff and management costs. The contractor wants to complete the performance tests at the earliest date, remove its team from site, be paid any outstanding monies and remove any bonds and liabilities from its books.

Leaving aside normal wear and tear, the contractor will also be concerned over the natural deterioration in process plant performance over time with continued operation by the purchaser, while certain replaceable parts may approach or reach the end of their working life (for example, filter cloths with a short working life given the excessive cost of a more durable alternative). IChemE contracts balance these conflicting requirements on the following basis:

- a) The purchaser takes over prior to operation.
- b) The control of the operating plant should be in the hands of the purchaser.
- c) The purchaser has incurred significant cost in the development of the plant so it should be entitled to operate the plant to meet its commercial interests (recognising that health and safety is a given priority).
- d) The purchaser controls the operation and timing of all performance tests with safeguards to protect the contractor.
- e) The contract includes specific maximum time periods for starting the tests (performance test commencement period) and for completing the tests (performance test period). The purchaser compensates the contractor for additional costs if the purchaser causes these time periods to be breached.
- f) There is a back-stop for performing the performance tests after which if never commenced then they are deemed to have been passed by the purchaser.
- g) Process plant performance deteriorates with operation (for example, catalysts, absorbents, compressors and so on). The contract includes two protections for the benefit of the contractor to address this specific issue for process plants; (i) the effect of prior performance on the results is taken into account in their assessment, and (ii) parts with a limited working life are only guaranteed for the working life so stated.
- h) The contractor investigates the reason for any performance test failure and makes adjustment to the plant, and the purchaser must allow the contractor to do this within a reasonable time.

Remedies

IChemE recognises the right of rejection of the plant and that its removal is not workable for a major process plant. Remedies are therefore limited to rectification of any faulty parts or sections and the application of damages. For each guaranteed parameter defined, liquidated damages can be applied that define the amount of money to be deducted for each unit or percentage of failure. Such liquidated damages are intended as agreed compensation for the purchaser's increased operating costs, loss of product and so on, as a result of the plant's poorer performance. These should be no more than a genuine pre-estimate of the loss which would be suffered by the purchaser in operating the plant under such conditions in practice. Though it

is not practicable here to make detailed recommendations, the following is a useful aide-mémoire.

- a) Raw material consumptions, utility consumptions, yields and efficiencies represent direct running costs. Liquidated damages could be set at a figure equalling the extra costs for a certain period of time. Periods of between one and three years at design flowsheet rate have been used as a basis for calculation.
- b) Groupings of different running costs elements can be used to identify savings in one item that can offset excess costs of another.
- c) Credit or additional damages for out of specification byproducts can be considered.
- d) A true appraisal of the purchaser's losses caused by any shortage of capacity is very difficult to make, as it is affected by its ability to make full use of the capacity available, but amounts of liquidated damages as a percentage of the contract price proportional to the deficiency have often been used.
- e) It is sometimes possible to relate the value of a substance to its purity and to set liquidated damages for running costs. If there were two or more products, their interrelation should be considered and credits in the quality of one product set off against shortcomings in another. Maximum permitted limits of impurities may, however, be used to impose restrictions.
- f) Excesses in effluent quantity and quality may result in higher disposal costs, to which liquidated damages could be related plus absolute limits may be imposed by statutory authorities or other bodies.
- g) It is important to consider whether, and the extent to which, different criteria of performance should be taken together. For instance, a plant may fall slightly short of the promised output, but be more efficient.

In any event, IChemE considers that performance guarantees should only apply to the really essential parameters. Damages should be unambiguous with respect to any grouping of criteria and should be defined in a way to make their calculation simple. Certain parameters will be subject to absolute minimum performance criteria which must be met by the contractor. If all else fails the project manager assesses a fair level of compensation taking into account all the circumstances.

Conclusions

This article has only begun to touch upon the many and complex issues that need in-depth consideration before entering a contract for a process plant. The format of IChemE contracts is such that there is a high degree of integration between each component of the contract linking the contract agreement, general conditions of contract, specification and schedules. Extreme care must be taken in any redrafting to ensure that it does not have a detrimental effect on the contract as a whole.

IChemE contracts are geared to the unique challenges of contracting for dynamic performance-based plant and the overriding message is for both parties to spend adequate time pre-contract to thoroughly draft the specification and schedules. IChemE guidance notes are invaluable in guiding the parties through this process. There is no shortcut to this task and the IChemE drafting committee deplores the introduction of tendering companies' proposals into the contract as a shortcut to completing the important sections that are needed to support the legal terms and conditions.

Purchasers often wonder why they lose control of projects or a plant does not perform to their expectation when they have not been prepared to invest in the drafting of quality documents by appropriately qualified people. As a consequence the misunderstanding is often made that the contracts are not of a co-operative nature. In fact, the whole basis has to be cooperative since the success of the contracts is based on the competent input by both parties, particularly at the pre-contract stage followed up by competent and qualified project and technical management. This assertion is best borne out by the extremely low incidence of disputes in projects executed under IChemE conditions of contract.

The current IChemE UK and international forms of contract are the culmination of over 40 years of work by members gathered from all sections of the process plant industry. The philosophies followed therein represent a thorough analysis of what works best for this unique business line. They reflect the need for co-operation and flexibility, while fairly allocating risk — considering both the ability to control and manage an issue and to meet any resulting financial exposure.



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