NATSPEC// Construction Information

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Specifying Design and Construct for Mechanical services

This TECHreport outlines how NATSPEC may be used to prepare Design and Construct mechanical specifications. It discusses some of the issues and presents a range of approaches for preparing these specifications.
It does not address the suitability of a Design and Construct (D&C) approach to specific projects which depends on many factors including the type of project, the program, the contractor's design expertise and the principal's attitude to risk.

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SPECIFYING DESIGN AND CONSTRUCT FOR MECHANICAL SERVICES

1 INTRODUCTION

1.1 Design and Construct projects

What is Design and Construct?

The term Design and Construct (also known as D&C) is used to describe a wide variety of project delivery approaches. Consider the following options:

- A building project that starts with no fixed requirements other than the site and basic project parameters, e.g. Build a warehouse on this site to hold product X.
- A notionally fully documented building project where some trades and parts of trades are required to prepare shop drawings.
- A building project where the architectural and structural details are fully documented but the services are to be designed by the respective subcontractor to meet performance requirements such as indoor design conditions for air conditioning or lighting levels.
- The same project as above but with the systems designed in outline, plant located, types of components selected and so on. The contractor is required to make final selections, prepare detailed drawings, lay out light fittings and other equipment. This is sometimes referred to as Design Develop and Construct or DD&C.
- A plumber installing piping in a fully documented building project where the plumber has a degree of latitude, for example, the final location of the pipes, position of fixings and so on.
- A worker assembling a pump for a building project. This person is required to install the bolts holding the parts of the pump together exactly where the designer detailed them and nowhere else.

All except the last of these implies a degree of design flexibility and so involves Design and Construct, varying only in the degree of design by the contractor. It is for this reason that *0171 General requirements* defines that the term provide as follows:

> Provide and similar expressions mean supply and install and include development of the design beyond that documented.

What is the project?

In addition to the issue of what is meant by the term Design and Construct, the specifier faces a problem common to all projects – there is no standardised project. The Design and Construct requirements for a hospital will be different from the requirements for a complex of factory-warehouses and that in turn, will be different from a block of apartments.

What is the project delivery method?

Details of a Design and Construct specification will vary depending on the project delivery method, giving rise to questions such as the following:

- Is the work specified as a trade within a building specification? Is it a contract package within a larger project? Is the entire project to be Design and Construct with the design managed by a lead contractor? Or, is it perhaps some variation on these?
- Who, if anyone, is responsible for reviewing the design?
- Will there be incentives for reducing capital cost, recurrent costs, greenhouse gas emissions and so on?
- Will the contractor prepare a separate specification, with the Design and Construct specification being a form of design brief?

1.2 How NATSPEC can be used to create a Design and Construct specification

The range of unknowns outlined above raises the question of the extent to which a standardised specification system like NATSPEC can be used for Design and Construct projects. To answer that, one needs to consider the strengths and limitations of a system like NATSPEC:

- Editing: As for fully documented projects, NATSPEC worksections will be most effective in a Design and Construct project specification when they are selected and edited to suit the project. For example, if the project is to have two water cooled screw chillers, say so.
- Management systems: NATSPEC does not offer any management system other than in relation to *Preliminaries,* nor do NATSPEC worksection *Templates* deal with project specific requirements such as the number of copies of drawings submitted.
- Building quality: NATSPEC aims at a quality above the minimum mandated by the National Construction Code (NCC), sometimes characterised as good commercial quality. As with fully documented projects, Design and Construct documents may need to be adjusted to suit a higher or lower level of quality for all or part of the project.
- Design parameters: NATSPEC includes design parameters in some worksections and, as discussed later, provides a framework that can be used to create a Design and Construct specification. Because NATSPEC is generic, the design clauses are generic and must be modified and/or expanded to suit the project.

The NATSPEC system may be used for either a one-part or a two-part specification approach, as discussed later in clauses 6.2 and 6.3. See also *TECHreport TR 06 – Procurement: Past and present* for the use of NATSPEC for different Design and Construct contracting systems.

2 WRITING THE SPECIFICATION

2.1 Overview

This TECHreport provides suggestions for using NATSPEC to address the following common Design and Construct situations:

- Design and Construct specification within an otherwise fully documented project or trade specification.
- Design and Construct specification for a trade, based on a documented schematic design (sometimes referred to as Design Develop and Construct or DD&C).
- Design and Construct specification for a trade where there is no schematic design.
- Design and Construct specification as the basis for a design brief, e.g. for issuing to specialist design consultants responsible for the preparation of a fully detailed design.

NATSPEC has design clauses for mechanical services worksections where the design component may be required contractually (but not, for example, for *Mechanical maintenance*). Consequently, this TECHreport uses mechanical services examples. The principles outlined may, however be adapted to other services and trades by the addition of appropriate design requirements to existing NATSPEC worksections.

2.2 Structure of mechanical services package

Before proceeding to the detailed cases, it is useful to outline the philosophy underlying the arrangement and content of the mechanical services worksections and the consequences for Design and Construct specifications.

The key worksections are:

0171 *General requirements*

In relation to design and construct, *0171 General requirements* includes as *Optional text* (blue text, shaded grey), **DESIGN** clauses that set out requirements for design applicable to all parts of a building project. These include responsibilities of designers, designer qualifications, design documentation, handling of alternatives and errors and omissions from the design. The *Optional text* also includes requirements for design document submission and consultation with stakeholders.

0701 *Mechanical systems*

This worksection includes a summary of the systems, design parameters relating to the mechanical systems and details common to more than one mechanical worksection. It will be included in almost all specifications prepared by specialist mechanical consultants. This worksection includes, as *Optional text* (blue text, shaded grey), **DESIGN** clauses that relate to mechanical systems as a whole. The *Optional text* also includes requirements for design document submission and consultation with stakeholders.

0702 *Mechanical design and install*

This worksection *Template* is applicable to simple mechanical installations that are to be designed and installed by the contractor.

Other mechanical worksections

Other mechanical worksections include a **DESIGN** clause, where appropriate. Because of possible conflict in fully designed projects, the design parameters are provided in NATSPEC as *Optional* style text. This text is provided as Microsoft Word Hidden text that does not normally print but can be easily converted to printable text to match the rest of the worksection text. The **DESIGN** clauses include typical design parameters relevant to that worksection.

The following extract from the **DESIGN** clause in *0701 Mechanical systems* illustrates this:

Air conditioning system design

Use this worksection to describe design parameters for mechanical systems as a whole. *Optional* style text for system component design parameters can be found in the **DESIGN** clauses in the respective worksections (e.g. *0741 Ductwork*) and should not be duplicated here. Similarly, some design parameters are specified in *0171 General requirements* (e.g. noise and seismic) and should not be duplicated here.

Selection parameters that can be included in the SELECTIONS schedules should not be repeated here. The schedules *Guidance* text includes suggestions for modifying them to suit Design and Construct projects.

General: Design systems as documented.

Requirement: Provide engineering design that:

- Maximises the functionality, performance, safety, flexibility and reliability of the mechanical services.
- Is technically sound.
- Can be constructed using currently accepted methods.

The next item may not be appropriate in some projects as it usually does not produce the lowest capital cost.

- That provide the lowest combined owning and operating cost over the design life of the systems.

The design life of the systems is documented below.

Outdoor design conditions

General: As documented.

Outdoor design conditions may be documented in the **Outdoor design conditions schedule**.

Indoor design conditions

General: As documented.

Indoor design conditions may be documented in the **Indoor design conditions schedule**.

Heat rejection equipment design conditions

Requirement: Select heat rejection equipment for the design conditions documented.

Document design conditions in the **Heat rejection equipment design conditions schedule**.

Cooling performance

Requirement: Maintain the air conditioned spaces, as measured at the points of control, within the documented cooling indoor design conditions at the highest cooling load due to the combination of the following:

- Loads imposed by the cooling outdoor design conditions.
- Other documented cooling loads are at their maximum.
- Full solar load.
- Loads due to system and other losses.

For situations such as tenancies where details of the final loads are not known, consider including details of how these are to be handled.

Heating performance

Requirement: Maintain the air conditioned spaces, as measured at the points of control, within the documented heating indoor design conditions at the highest heating load due to the combination of the following:

- Heating loads imposed by the outdoor design conditions.
- Other documented cooling loads are zero.
- Solar cooling load is zero.
- Loads due to system and other losses.

Temperature variation

Requirement: Limit the temperature difference in air conditioned spaces served by the same zone or system to 2°C as follows:

2°C is a typical value. Adjust if necessary to suit the required temperature tolerances for the project or parts of the project.

- Between any 2 points in the space from floor level to 1500 mm above floor level.
- > 2000 mm from cooking equipment and > 1000 mm from any other appliance.
- When the documented outdoor conditions are not exceeded.
- After the plant has been operating for one hour.
- With the temperatures measured in the same 5 minute period.

The temperature variation parameters above constitute a key test of the adequacy of the design and installation. The installation should not only maintain temperatures within the specified range at the temperature sensor, it should also limit temperature variations within the space. If the plant is incorrectly sized, badly zoned or the installation is defective, it will be evident in excessive temperature variations between parts of the air conditioned space.

In this example, the subclauses for **Outdoor design conditions** and **Indoor design conditions** are provided in *Normal* style text (i.e. not hidden) as they are customarily required in both fully documented, and Design and Construct specifications. In contrast, the subclauses for **Air conditioning system design** and **Cooling performance** are in *Optional* style text because they would not normally be included in a fully designed project, as it would be undesirable to give the contractor the opportunity to redesign the systems.

If the specifier wants the contractor to design the systems, the *Optional* style text must be converted into *Normal* style text (see NATSPEC QUICKstart for details on how to do this) and then edited to suit the project.

SELECTIONS schedules

In a fully designed project, the SELECTIONS schedules provide a location for inserting capacity and selection information. However, in a Design and Construct project, most capacity and selection information will not be known at the time the specification is prepared. The schedules do however provide a convenient location for defining those parameters that can be determined before the design is undertaken. These include such things as required materials, optional features (like high efficiency motors) and some basic quantities (e.g. two chillers, each 50% of the total capacity).

The *Guidance* text to the SELECTIONS schedules includes suggestions for modification to suit Design and Construct projects.

One approach to adapting the schedules is to insert whatever information is known or can be fixed at the specification writing stage. For those items in the schedules that cannot be completed, make sure that adequate design parameters have been specified elsewhere and insert suitable text, e.g. To documented requirements.

This approach allows the schedules to be kept intact so they can be used as the basis for contractor's **SUBMISSIONS.** It also provides a prompt to the specification writer to make sure that the parameters needed to complete the unknown items are covered in the worksection's **DESIGN** clause or in *0701 Mechanical systems* as appropriate.

For example, in specifying the provision of chillers under a Design and Construct contract, the specifier might:

- Include the parameters for calculating the total cooling load in *0701 Mechanical systems*.
- Complete the SELECTIONS schedules with chiller type, compressor type, acceptable refrigerants, chilled water temperatures and so on. For the capacity fields, only the percentage carried by each chiller would be inserted.

2.3 The designer

Qualifications and experience

Perhaps the most important factor in achieving a successful design, in a Design and Construct project, is the appropriateness of the designer to the project. For example, the mechanical services design for a hospital prepared by an experienced mechanical engineer employed by a contractor should be of the same quality as the design prepared for the same hospital by the same engineer employed directly by the client. The design outcome in both instances is dependent on the quality of the briefing documents and the competence of the designer. Similarly, a design prepared by an unqualified person, inexperienced in the work, or to a poor brief, is likely to be unsatisfactory, regardless of how that designer is employed.

0171 General requirements requires that the contractor use only appropriately qualified designers. What constitutes an appropriately qualified designer will depend on the design task and in some jurisdictions, statutory registration.

For engineering worksections the appropriately qualified designer would be a professional engineer. That is, engineering design must be carried out by, or under the supervision of, a professional engineer qualified and experienced in the relevant field. The term professional engineer is defined in *0171 General requirements* as being defined in the NCC. The NCC requires a professional engineer to be registered in the relevant field if legislation is applicable or, if no legislation is applicable, is either a corporate member of Engineers Australia or eligible to become one.

While this makes it relatively easy to verify the qualifications of proposed engineering designers, the qualifications of other designers may be more difficult to quantify or verify. The question of any designer's experience in the field should be carefully assessed.

Extent of the designer's involvement

A further issue is the extent to which the designer is involved. NATSPEC assumes that the qualified mechanical services designer will be involved in all stages of the design and requires that they sign all design documents. This is to avoid situations where the qualified designer is involved only to produce a schematic design leaving the detailed design to be undertaken by others, possibly with no involvement in amending the design to address issues that emerge during construction.

Professional indemnity insurance

0171 General requirements requires the contractor to provide evidence of the currency of the designer's insurance as design faults may not become apparent for years after the end of the defects liability period. This requirement may be deleted for simple straightforward projects.

2.4 Verification and validation of the design

Verification

A key issue to be addressed in both documentation and during construction is the method, if any, by which the design will be verified. There is little point in opting for Design and Construct if the client attempts to check every calculation and drawing the contractor produces. On the other hand, it would be naive to just hope that the contractor will understand the client's needs on matters that are not explicitly stated in the tender documents. Perhaps the most important need is for a convenient process for tracing the contractor's conformance with the specification.

Verifying the design

One of the justifications for choosing a Design and Construct approach is that it reduces the cost of contract administration (although not, in theory, the cost of design), however, the specifier must consider how the design is to be verified. For example, how can the contract administrator be confident that the size of chiller and air conditioning zoning are likely to meet the specified performance? Correcting errors in these will be disruptive, if not impossible, if detected after the project is completed.

0171 General requirements requires provision of a design and documentation that can be verified and validated as conforming. The mechanical worksections with **DESIGN** clauses also include a **SUBMISSIONS** clause, requiring the submission of information which a competent contract administrator may use to independently verify the design. However, the fundamental responsibility for the design rests with the contractor where the contractor should also have adequate verification policies in place. This issue highlights the critical nature of appropriate designer selection.

Validating the design

Since Design and Construct specifications are based on specification of performance, it is desirable to validate the performance after construction is complete. For example, NATSPEC includes provisions for the use of data logs to validate that the temperature variations in occupied spaces are within tolerance. Other instrumentation may need to be specified to be provided, for example, data on energy consumption and plant running times if these design parameters have been specified.

Liability for design

The specifier is responsible for the specified design requirements while the contractor is responsible for designing in conformance with those provisions. For this reason, the contact administrator should not check the design as this potentially divides responsibility. The contractor's design document submissions are provided for information and not for checking or approval.

As with any other aspect of the specification, there is no point in specifying something that cannot be verified. The objective in the NATSPEC worksections

is to require submission of information that permits time-effective oversight of the design process. Of particular concern is verifying specification provisions that cannot be validated, for example allowance for spare capacity.

2.5 Specifications

Contractor prepared specifications

In some projects, the contractor may also prepare a specification. For example, in a large Design and Construct project, the head contractor may employ consultants to prepare a design and then use this, with a tailored specification, to call tenders for the subcontract works.

To make sure that such specifications are consistent with the original Design and Construct specification, *0171 General requirements* requires that specifications prepared for the contractor incorporate the original specification either wholly or by reference.

This approach has a number of advantages:

- It ensures consistency with the original specification.
- It reduces the cost of administering the contract as the contract administrator needs only to consider the identified departures from the original specification and does not need to go through a complex exercise to identify conformance and non-conformance with the contract.
- It reduces the risk of disputes that can result when the two specifications use different wording for the same thing.

Tracking changes to the specification

Because there is so much potential for change, both inadvertent and intentional, to the specification design requirements, *0701 Mechanical systems* **SUBMISSONS** requires that the contractor identify any changes to the specification requirements. Putting the onus on the contractor to identify such changes, removes the need for the contract administrator to undertake detailed comparison between the submitted documents and the specification. It also acts as a prompt to reduce the common tendency to ignore the specification after the contract is let.

Copyright issues

The nature of Design and Construct raises copyright issues relating to NATSPEC that are not present in conventional documentation approaches.

NATSPEC is licensed on a per-office basis. An office preparing a Design and Construct specification based on NATSPEC must have a current NATSPEC licence as is the case for a fully documented project. If the Design and Construct specification requires the contractor (or the contractor's consultants) to prepare a specification that is based on the original specifier's specification, the contractor's specification will also incorporate NATSPEC material and consequently, they too must be NATSPEC subscribers, as the licence does not transfer.

Similarly, it is not sufficient for the lead consultant (usually an architect) to be a NATSPEC subscriber, each subconsultant or subcontractor preparing a specification must also be a subscriber as the lead consultant's licence will not cover them.

3 DESIGN AND CONSTRUCT SPECIFICATION WITHIN A FULLY DOCUMENTED SPECIFICATION

3.1 Overview

Even in a nominally fully documented project, the contractor will still be required to undertake some design, most often in the preparation of shop drawings. NATSPEC has many instances where design is nominated explicitly and also situations where performance requirements imply a degree of design by the contractor, e.g. *0741 Ductwork* prohibits the substitution of flexible duct for rigid duct, arguably a change to the design.

3.2 Example 1: Design and Construct for automatic controls

Contractor design of automatic control systems is the industry norm. Edit one of the *Automatic controls* worksections (0771 or 0772) to suit the project (mainly deleting redundant material) and provide functional descriptions of the automatic control systems either in the specification or on the drawings. The contractor's automatic controls subcontractor then designs the automatic control systems to provide the documented functions.

Summary of worksections required:

- One of the *Automatic controls* worksections (*0771* or *0772*).
- Other mechanical worksections to suit the project.
- Other worksections to suit the project, e.g. *0171 General requirements.*

3.3 Example 2: Design and Construct for ductwork and air distribution

Here, there is a range of possibilities in an otherwise fully documented project. The designer could, for example:

- Size all plant, lay out the ducts in single line, un-sized and show the position of grilles and diffusers on the drawings with air quantities against each; or
- Size the plant including total air quantities for each zone then show on the drawings the outline of the zones served but no ducts, diffusers or grilles.

The design parameters for each differs with the second approach requiring the parameters for locating grilles and diffusers and apportioning the zone total air quantity to each in addition to the design parameters of the first approach.

In addition to the design work outlined above:

- Edit *0701 Mechanical systems* to highlight the contractor's responsibility for the design.

- Include *0741 Ductwork, 0744 Ductwork insulation* and *0746 Air grilles*.
- Convert the hidden *Optional* text in the **DESIGN** clause in each of these worksections to *Normal* style text.
- Edit the **DESIGN** clauses to suit the project, e.g. by adding in the parameters for selecting and sizing diffusers.
- Complete the SELECTIONS schedules to suit the project, e.g. by inserting what duct materials, insulation and grille types are to be used and in which locations.

Summary of worksections required:

- *0701 Mechanical systems.*
- *0741 Ductwork.*
- *0744 Ductwork insulation.*
- *0746 Air grilles.*
- Other mechanical worksections to suit the project.
- Other worksections to suit the project, e.g. *0171 General requirements.*

4 DESIGN AND CONSTRUCT SPECIFICATION FOR A TRADE BASED ON SCHEMATIC DESIGN

4.1 Overview

While the preceding examples assumed that the rest of the mechanical work has been fully documented, in this case it is assumed that the design is rather more limited. Again, there is a range of possible approaches but for the purposes of illustration it will be assumed that the system design is fixed but without details such as sizing, layout, etc. For this example, the specifier is assumed to have:

- Selected the air handling system types and zoning and allocated the areas served.
- If there is a central plant, determined such things as the number of chillers and cooling method (water or air).
- Decided on energy sources, e.g. gas or reverse cycle for heating.
- Selected plant locations.
- Done enough preliminary design to complete the preceding items even though capacities will not be specified.
- Prepared contract documentation typically including the following:
  - Drawings of the building, possibly with only architectural details, although plant locations, zoning and such might be shown in block form.
  - Detailed briefing requirements like room data sheets, if available.
  - A Design and Construct mechanical specification.

4.2 The Design and Construct mechanical specification

The aim of the Design and Construct mechanical specification is to provide the information necessary for the contractor to complete the design and achieve the required quality. A Design and Construct mechanical specification may be prepared as follows:

0171 General requirements:

Edit *0171 General requirements* to suit the project.

0701 Mechanical systems:

- Edit *0701 Mechanical systems* to highlight the contractor's responsibility for the design.
- Include for example a description of the systems required in the **RESPONSIBILITIES** clause. This will be similar to the summary of work provided in a specification for a fully documented project, but more detailed.
- Convert the hidden *Optional* text in the DESIGN clause to *Normal* style text.
- Edit the **DESIGN** clause to suit the project.
- Review and edit the *Optional text* relating to submissions and consultation to suit the project and project stages. Convert the *Optional text* to *Normal* style text.
- Complete the SELECTIONS schedules to suit the project, adding, if necessary, design parameters to the **DESIGN** clause to enable the contractor to complete the scheduled information to meet the project quality objectives.

Other mechanical worksections:

The approach to other mechanical worksections is similar to that outlined for a Design and Construct worksection within an otherwise fully documented project. For most worksections the following will be required:

- Convert the hidden *Optional* text in the **DESIGN** clause to *Normal* style text.
- Edit the **DESIGN** clause to suit the project.
- Complete the SELECTIONS schedules to suit the project, adding, if necessary, design parameters to the **DESIGN** clause to enable the contractor to complete the scheduled information and meet the project quality objectives.

In some worksections (e.g. *0792 Mechanical maintenance*), there is no design component relating to the worksection, but there are SELECTIONS schedules that need attention. In others (e.g. *0784 Motors and starters*) there are no SELECTIONS schedules but there is a design component that requires attention.

Summary of worksections required:

- *0701 Mechanical systems.*

- Other mechanical worksections to suit the project, edited for design as described above.
- Other worksections to suit the project, e.g. *0171 General requirements.*

It should be noted that this summary includes only those worksections that relate to Design and Construct. Other worksections will be required to provide a complete specification depending on the contractual approach (e.g. trade package, trade-in-building, etc).

5 DESIGN AND CONSTRUCT SPECIFICATION FOR A TRADE WHERE THERE IS NO SCHEMATIC DESIGN

5.1 Overview

This is the situation covered, in a much simpler case, in *0702 Mechanical design and install*. While there is no schematic design, some basic parameters need to be provided in the specification. As a minimum it needs to address what kind of services are to be provided and to which parts of the building, which parts will be air conditioned, which parts will be mechanically ventilated and which parts will be naturally ventilated. Further, in order to get meaningful tenders, the specification should define, or at least limit, the system options acceptable, e.g. multiple un-ducted split systems or a few ducted roof top packages.

5.2 The Design and Construct mechanical specification

A similar approach applies to that described in the example with a schematic design. As before, the following relates only to Design and Construct and other worksections will be required to provide a complete specification depending on the contractual approach (e.g. trade package, trade-in-building, etc). A Design and Construct mechanical specification may be prepared as follows:

0171 General requirements:

- Edit *0171 General requirements* to suit the project. Note that *0171 General requirements* provides a place for some general design parameters such as noise levels.

0701 Mechanical systems:

- Edit *0701 Mechanical systems* to highlight the contractor's responsibility for the design.
- Include a description of the kind of mechanical services required in the **RESPONSIBILITIES** clause, including the areas served and the types of systems acceptable.
- Convert the hidden *Optional* text in the **DESIGN** clause to *Normal* style text.
- Edit the **DESIGN** clause to suit the project.
- Review and edit the *Optional text* relating to submissions and consultation to suit the project and project stages.
- Complete the SELECTIONS schedules to suit the project, adding, if necessary, design parameters to the **DESIGN** clause to enable the contractor to complete the scheduled information to meet project quality objectives.

Other mechanical worksections:

The approach to other mechanical worksections is similar to that outlined for a Design and Construct worksection within an otherwise fully documented project. For most worksections the following will be required:

- Convert the hidden *Optional* text in the **DESIGN** clause to *Normal* style text.
- Edit the **DESIGN** clause to suit the project.
- Complete the SELECTIONS schedules to suit the project, adding, if necessary, design parameters to the **DESIGN** clause to enable the contractor to complete the scheduled information to meet project quality objectives.

In some worksections (e.g. *0792 Mechanical maintenance*), there is no design component relating to the worksection, but there are SELECTIONS schedules that need attention. In others (e.g. *0784 Motors and starters*) there are no SELECTIONS schedules but there is a design component that requires attention.

Summary of worksections required:

- *0701 Mechanical systems.*
- Other mechanical worksections to suit the project, edited for design as described above.
- Other worksections to suit the project, e.g. *0171 General requirements.*

6 NATSPEC AS THE BASIS FOR A DESIGN BRIEF

6.1 Overview

A design brief is arguably a form of Design and Construct specification, even if it is not a specification for construction. The design brief forms the basis for the specification for the project and so provides an opportunity to define the quality required. Recognising this, many building owners with large building portfolios, such as universities, use standard design briefs that combine design parameters with construction quality requirements. These include requirements in relation to ductwork such as:

- Duct design velocities.
- Allowance for increasing air flow by over-sizing risers.
- The requirement that ductwork conform to the AS 4254 series.

- The types of dampers to be used.
- Types of grilles to be used.
- The interior of ducts behind grilles to be painted black.

These are all reasonable requirements but the parts dealing with duct construction are covered much more comprehensively in NATSPEC worksections. The use of such standardised briefing documents, as with other standard specifications, carries with it the responsibility for maintenance.

A design brief that makes appropriate use of NATSPEC offers a number of advantages by:

- Providing a more comprehensive quality statement.
- Addressing the problem of updating.
- Providing the basis for a quality audit trail and simplifying verification since only departures from the base document need be identified and assessed.
- Reducing the cost of documentation since the same document can be used at all stages of the documentation process with the confidence that the same quality is being specified.

The following describes two approaches to using NATSPEC as a basis for a design brief. The one-part approach is potentially more comprehensive but it requires more maintenance and intervention. Importantly, a brief using either must also address management issues such as the consultation process, which is beyond the scope of NATSPEC.

6.2 The one-part approach

In a one-part brief, the brief consists of NATSPEC worksections with their **DESIGN** clauses converted to *Normal* style text and edited to suit the project requirements.

6.3 The two-part approach

This approach, which makes use of the NATSPEC reference books, simplifies the adaptation of existing design briefs that combine both design and construction quality requirements. In it, the quality aspects are dealt with in the NATSPEC *Services Reference* books, possibly supplemented with project specific requirements and the design parameters specified separately in the briefing document. The advantage of this approach is that there is minimal need to update the brief as quality requirements are regularly updated as part of the NATSPEC update cycle and incorporated into the *NATSPEC reference – Electrical services, NATSPEC reference – Hydraulic services* and *NATSPEC reference – Mechanical services* books.

7 MATTERS FOR CONSIDERATION

The following is a brief, which is far from a comprehensive list of matters that may need to be considered when preparing a Design and Construct specification or design brief. Some are addressed in the NATSPEC worksections but the worksection provisions in most cases will need editing to suit project requirements. Other matters are included in the referenced documents, for example, BS 8536.1 includes a design brief checklist and sample brief.

7.1 Selecting the most appropriate Design and Construct option

Each option described previously represents a point along a spectrum of the division of design, documentation and construction responsibilities. In essence, what has to be decided is the extent to which a design is resolved and documented before it is handed over from the design consultant to the party with primary responsibility for organising its construction – the contractor.

Project circumstances vary so much that it is impossible to set down clear-cut rules for determining the most appropriate hand-over point in every instance – ultimately it comes down to professional judgement based on experience and available information. Some factors that can be taken into consideration during decision-making are outlined below.

Scope, complexity and uniqueness of the design

Complex building systems with stringent performance requirements benefit from a greater degree of design resolution and documentation before handover to the contractor. Simple systems or subsystems of larger systems of standard design can be left to the contractor to resolve with less risk of performance or coordination problems.

Level of coordination required

If there are a large number of building services and other elements within confined areas, or there are doubts about available space for the work package being considered for Design and Construct, favour a greater degree of design resolution and documentation before handover to the contractor.

Knowledge of contractor design and documentation capability

Assuming contractors are selected primarily on their construction capabilities, the decision about the proportion of design and documentation responsibilities that can be assigned to them will be influenced by their capabilities in these areas. If a contractor has a proven track record, or a design consultant has a satisfactory working relationship with them in this regard, then there is less risk assigning a greater proportion of design and documentation to them.

Available time and resources

If the project programme is restricted, or a fast-track project delivery approach has been adopted, a greater proportion of Design and Construct may be necessary. The decision will also be influenced by the relative amount of design and documentation resources available to the design consultant and the contractor within the time frames dictated by the project.

Cost-time effectiveness versus risk

Ultimately the decision about the extent of appropriate Design and Construct comes down to balancing a number of factors including:

- The relative cost of the design consultant versus the contractor taking on responsibility for design and documentation activities.
- The time savings that can be achieved by not fully resolving design and documentation before contracting the work earlier in the project versus the risk of unsatisfactory performance or coordination problems resulting in re-designs, re-works and delays later.
- The certainty of pricing associated with greater design and documentation definition versus the risk that potential cost savings resulting from early contractor involvement in the design process may not be realised.

7.2 The design

If the NCC or Australian Standards include design parameters, these are incorporated into the worksections as minimum requirements. If it is intended to specify more stringent requirements (for example higher energy efficiency than the NCC), the worksections must be modified or extended.

What are the design priorities? Common considerations include:

- Long life.
- Low energy.
- Low maintenance.
- Flexibility for future changes.
- Sustainability.
- How will matters affecting durability be addressed, e.g. corrosion protection?
- What is the design life? How will it be documented, verified and enforced?
- Should there be allowances for spare capacity, standby, redundancy, etc? If so, how will it be verified that it has been provided?
- If whole of life evaluation is mandatory, how will it be assessed?
- How will energy and water conservation be mandated?
- How will life cycle cost analysis be undertaken?
- What are the system selection criteria? (Not required if the systems have been specified in concept.)
- Can external standards be referenced, e.g. Property Council of Australia building grades?
- Are there heritage issues and how will they be handled?
- Will there be restrictions on the location of plant and equipment, e.g. only roof mounted fans on roofs?
- Is standardisation of components required (for consistency with existing, for example)? How will it be achieved, e.g. by specification of mandatory brands and models?
- What supplementary briefing material will be provided, e.g. room data sheets and relationship diagrams?
- How will details of existing services be obtained, e.g. by provision of documentation, survey of existing systems, buildings, etc?
- What are the hours of operation?
- Are there restrictions on the overall design, e.g. prohibition on the use of plenum plant rooms?
- What is the procedure for rectification of design faults?
- Is tamper protection required?
- How will sustainability requirements be addressed? (See *NATSPEC TECHreport TR 01* on specifying ESD.)

7.3 The designer

- Can the designer's qualifications be specified more precisely than just by reference to the NCC definition of professional engineer, say, by requiring that they have completed at least two of this kind of project in the past five years?
- Should the designer have professional indemnity insurance?
- What is the extent of the designer's involvement after design is complete, e.g. to address problems that arise during construction?
- Who has liability for design? (Depends on the extent of design included in Design and Construct specification.)
- How will the design be certified, e.g. conformity to NCC?

7.4 The design process

- What is the program for design?
- Are there applicable CAD and other documentation standards?
- What design records are required? In what form?
- Is the designer encouraged to or discouraged from proposing alternatives?
- Is the contractor required to survey existing building services and systems before commencing the design?
- How will coordination be handled? (Physical coordination, coordination with other trades such as electrical, fire and BMS.)

- What assumptions have been made? Should they be included in the documents?
- Who are the stakeholders? They would include the principal, users, statutory authorities, neighbours, occupational health and safety regulator, Green Star or NABERS, etc? How will they be consulted and, if relevant, their agreement obtained? Who is responsible for obtaining it?
- How are statutory approvals and documentation to be handled? What is the extent of the contractor's authority and how is the contract administrator involved?
- Have all the statutory authorities been identified? Apart from the obvious, like local government, there are less obvious authorities such as occupation health and safety, and clean air that may need to be involved.
- Have all phases of the project been addressed, not just design? The brief should address matters normally arising in construction (e.g. variations), commissioning and maintenance.
- How will options and risks be identified and assessed?
- How will alternatives be identified and assessed? Will there be incentives?
- What is the role of the contract administrator in the design process?
- How will the design be verified?
- Will calculation methods be specified?
- How will construction coordination be managed?

7.5 Documentation

- What design documentation will be provided at each stage? A common phasing plan (not suitable for all projects) is:
  - Schematic design.
  - Design development.
  - Tender documentation.
- What information will be included on drawings, e.g. schedules of capacities?
- Will the contractor be required to prepare a specification?
- Will CAD drawing standards be required?
- Will there be additional documents for submission in addition to conventional design documents, e.g. schematics of system concepts, operational strategies?
- Are copies of design calculations required? What are the calculations? What is their function, e.g. to enable design verification or to facilitate future changes?
- Should standard identification procedures be documented, e.g. plant designation codes?
- Is NATSPEC adequately referenced?
- What seismic protection, if any, is required?

7.6 Building Information Modelling (BIM)

Where BIM is to be used on a project, the considerations outlined previously will affect modelling requirements, including the extent to which each stakeholder will be responsible for developing the model before handing it over to others for further work. Likewise, each stakeholder will want to know what to expect in the models provided to them by others at different stages of the project.

Level of Development

The concept of Level of Development (LOD) has been evolved as a method of describing the relative development of model elements or objects and their geometry that make up the complete model at any given time. Together, these aspects give an indication of how much that object can be relied upon for certain tasks. Although LOD is described by numbers, e.g. LOD 200, LOD 300, these numbers only provide a general guide. The requirements of projects vary so much that the project stakeholders need to define what they mean by them before modelling begins. This way, everyone can be clear about how much they can rely on the model at different stages of the project. These decisions are usually documented in an LOD Table. Other titles include Collaboration Matrix and Model Progression Specification.

The significance of LOD with regard to Design and Construct is that the extent of Design and Construct will be reflected in the LOD of subject elements. For example, in a model used for tendering:

- For fully documented systems: Most of the systems elements would be modelled to LOD 300 – LOD 350.
- For D & C systems based on schematic design: Most of the systems elements would be modelled to LOD 100 – LOD 200 or represented in 2D.
- For D & C systems based on a design brief or performance specification: The system is not modelled at all but a base model and any other relevant information should be provided for reference.

For more information on LOD, see *NATSPEC BIM Paper NBP 001: BIM and LOD*.

8 CONCLUSION

The strategies outlined in this TECHreport are adaptable to a wide range of project delivery methods. Although written specifically for mechanical services, the principles outlined are adaptable to other disciplines. Used appropriately, they have the potential to deliver quality, cost-effective projects. Used inappropriately, they have the potential to create cost overruns, lead to disputes, and make many people associated with the project dissatisfied.

This TECHreport has been prepared by NATSPEC in consultation with industry stakeholders. It is intended to be a living document and NATSPEC welcomes comments and suggestions for changes and improvements. If you would like to comment please email NATSPEC at mail@natspec.com.au.

9 REFERENCED DOCUMENTS

AS 4254.1:2021	Ductwork for air-handling systems in buildings – Flexible duct
AS 4254.2-2012	Ductwork for air-handling systems in buildings – Rigid duct
NCC 2019	National Construction Code
BS 8536.1:2015	Briefing for design and construction - Code of practice for facility management (Buildings infrastructure)
NBP 001	NATSPEC BIM Paper 001: BIM and LOD