# STAGE 3




SPORT NEW ZEALAND

## Introduction

### General

The design, construction and operation of community sport and recreation facilities, especially aquatic facilities, are extremely challenging in harsh environments. It is recommended that an experienced professional consultant team be engaged and that the works be designed and constructed in accordance with all relevant codes and standards. General design procedures and criteria for the design of a community sport and recreation facility are presented in the following sections of this design brief. These cover procedures and materials commonly used in the design and construction of facilities of this type in New Zealand. They are recognised Acceptable Solutions and Verification Methods to establish compliance with the performance requirements of the Building Code.

Various options have been considered for the design and construction of these facilities, and it is noted that other options are also possible. No option has been ruled out as being unsuitable. Other options should be considered during the design phase of a project by your appointed professional consultant team, provided compliance with the Building Code can be demonstrated. This will be by way of an Acceptable Solution using recognised procedures and materials that are not necessarily specifically covered in this brief, or with an Alternative Solution as defined in the Building Code.

The design of a community sport and recreation facility will involve a consideration of the size, location and nature of the site and its surrounds, the facilities to be developed, the objectives of the facility, the primary user groups and the budget.

Implementing a facility design that suits the activities and the users is also a component of success. Responsive design can create a place where people come to play, meet and connect with the local community, that is inviting and stimulating, visually sensitive and expressive, and has a feel-good atmosphere for people of all ages and cultures.

### Building Act 2004

The Building Act covers the construction, alteration, demolition and maintenance of new and existing buildings throughout New Zealand. It sets standards and procedures for people involved in building work (including licensing of building practitioners) to ensure buildings are safe, healthy and built right first time. It covers how work can be done, who can do it, and when it needs to be consented and inspected. The Building Act as it relates to buildings is implemented by local district and city councils.

Under the Building Act, the Building Code defines the minimum standards that buildings must meet (to the extent required by the Act). In contrast to the plans prepared under the Resource Management Act 1991 (RMA), the Building Code provides a common set of minimum rules for the whole of New Zealand.

### Building Code/Codes of Practice/Standards

#### Building Code

All building work in New Zealand must comply with the Building Code, which is the first schedule to the Building Regulations 1992. It is a performance-based code, which means it states how a building must perform in its intended use rather than describing how the building must be designed and constructed.

The Building Code does not prescribe how work should be done but states, in general terms, how the completed building must perform in its intended use. The Building Code contains functional requirements and performance criteria that cover matters such as protection from fire, structural strength, moisture control and durability.

Building plans and specifications are assessed by building consent authorities (usually the local authority) to ensure that the completed building work complies with the Building Code. When the building consent authority (BCA) is satisfied, it will issue a building consent for the work to proceed.

The Building Code consists of two preliminary clauses and 37 technical clauses. Each technical clause, except for the 'C' clauses for protection from fire, contains:

1. **Objectives** – the social objectives that the completed building work must achieve.
2. **Functional requirements** – what the completed building work must do to satisfy the social objectives.

3. **Performance criteria** – qualitative or quantitative criteria with which buildings must comply in their intended use.

Clause C1 contains the Objectives for the Protection from Fire Clauses C2 to C6. Clauses C2 to C6 contain only Functional Requirements and Performances.

Acceptable Solutions and Verification Methods, relating to particular Building Code clauses, are produced by the Ministry of Business, Innovation and Employment (MBIE) to provide a means of establishing compliance with the Building Code. They provide information on materials, construction details and calculation methods that, if followed, must be accepted by a BCA as complying with the related Building Code provisions.

Acceptable Solutions and Verification Methods are only one way of complying with the Building Code. Alternative Solutions can also be used. An Alternative Solution is a building design, of all or part of a building, which differs from the design or method in an Acceptable Solution or Verification Method but still complies with the Building Code. It can include a material, component or construction method that differs completely or partially from those described in an Acceptable Solution or Verification Method. An Alternative Solution must be evaluated and accepted by the BCA when application is made for a building consent before it can be used.

### Codes of Practice and References

Codes of practice and sources of reference for New Zealand building construction are issued by MBIE and are provided to assist BCAs, building owners, designers and persons who carry out building work. They do not have the 'deemed to comply' status accorded to Acceptable Solutions and Verification Methods by the Building Act, and are not intended as means of establishing compliance with the Act or the Building Code.

### Standards

Standards are agreed specifications for products, processes, services and performance. If, for example, an electrical product is marked as meeting a standard, it means it meets the minimum safety requirements.

Every day, standards and standardisation make a difference in the lives of New Zealanders. Standards' solutions help to keep our homes, public buildings, playgrounds, electrical appliances and health services safe. They can also be used to protect people and our environment and to increase productivity and drive innovation. Standards are generally voluntary, but can be mandatory when cited in Acts, regulations and other legislative instruments.

Standards may also be referenced in regulations as one means of compliance or as an Acceptable Solution under those regulations, without being mandatory. Standards are a successful way to bridge government regulation and industry self-regulation.

### Building Consent

The Building Act specifies that building consent applications must be processed within 20 working days. The process goes on hold if the council has to ask for any more information and it doesn't start again until it receives it. If you get all your documents together before you lodge your application, the process should go quickly and smoothly.

An incomplete application will take council staff longer to process and you could be charged accordingly. The fees may be based on the value of the proposed building work and/or the time it takes to complete the assessment.

A council can grant or decline a building consent application. Generally, however, a consent must be granted by a council if it is satisfied that the provisions of the Building Code will be met.

If your application is approved, you should carefully read and be sure that you understand the conditions of your building consent. The consent directs you to build what is shown in your plans, and during inspections building officials will judge the work against those plans.

If your application is declined, the council will tell you the reasons why. You may need to seek help from your expert advisers or council staff.

If you believe the council is wrong you can ask MBIE for a determination, which is a legally binding decision on disputes or questions about the rules that apply to buildings. A determination can be appealed to the District Court.

Once a building consent has been obtained construction on the site can commence. There are, however, some other important points to note:

- Your building consent will lapse if you don't start your building work within 12 months unless you have made arrangements with the council for a longer period to apply. If the building consent lapses and you still want to do the work, you will have to apply for a new building consent

- The Building Act anticipates that building work will be completed and a CCC applied for within two years of the building consent being granted. An extension to this two-year period can be agreed with the council
- The council can issue a notice to fix if you don't comply with the Building Act, eg, if you don't follow your building consent or don't comply with the inspection process. A notice to fix requires you to put right any breaches of the Building Act. You could be fined if you, or your builder, fail to comply with a notice to fix.

### Code Compliance Certificate

When the project is complete, you must arrange for a final inspection and then apply to the council for a CCC. The council has 20 working days from the date of your application to decide whether to issue one. If the council requests further information, the process goes on hold until the information is received. A CCC is issued when the council is satisfied the completed building work complies with the building consent. It provides an assurance to both you and future owners that the building work was done to the appropriate standards.

If you don't submit an application for a CCC within two years of being granted your building consent, and you haven't agreed an extension with the council, it will follow up with you and may decide then whether to grant a CCC.

Because any resource consent you have is likely to relate not just to the activity of construction but to the ongoing use of the land or buildings, there are likely to be conditions in your consent that require ongoing compliance on your part, as well as potential monitoring obligations. Typically, these conditions relate to things such as a requirement to seal the driveway or paint a building in certain colours. In the event that you sell your property, the resource consent (in the case of a land use or subdivision consent) along with the obligation to comply with any conditions transfers automatically to the new owner.

### NZCIC Guidelines

The design of a building is a key stage in a development and the guidelines produced by NZCIC set a benchmark to which all parties involved in a project can refer. The careful identification of the client brief and needs, and advice from the professional design consultants to the client on the most advantageous outcomes, are important ancillary functions that should be linked to these guidelines.

The quality of design documentation is critical to the success of any building project. Buildings today are very complex in all facets, including form, structure, services and cladding, particularly those associated with aquatic facilities. Building elements are much more tightly designed than in the past. This has resulted in a situation where 'standard' building details often do not apply to a large portion of a project.

Design documents provide the critical ties between all parties in a building project. However, there has been a lack of definition of design documentation that all parties can rely on.

The purpose of the *NZCIC Design Guidance Guidelines* is to:

- Define clearly the design responsibilities from the outset and communicate these to all parties involved in the project
- Define the scope of design services with the client and communicate this to all parties to the design process
- Provide a 'level playing field' in achieving appropriate remuneration for the standard of design service required
- Provide a quality assurance reference for users.

The Guidelines differentiate the design process and deliverables can be used to define the responsibilities of the various parties throughout the design process (tick-boxes are provided for easy definitions of scope). The level of service provided by a 'designer' could be curtailed at any of the stages. The parties completing the design process will need to carry out the remaining steps in a coordinated manner to achieve an effective design.

The document has separate guidelines for the primary design disciplines of architecture, structure, HVAC services, fire protection, hydraulic services, fire engineering, electrical services and electrical ancillary services. The input from other specialist 'designers', such as geotechnical, acoustic, pool water services, vertical transportation and wind consultants, will need to be coordinated effectively with the design team. Separate guidelines have not been created for these specialist consultants.

www.nzcic.co.nz/resources/guideance-documents

## Design Phases/Stages

All building projects go through a similar design process irrespective of the building type, procurement methodology or programme. This design process is made up of a number of 'phases' or 'stages'. The key design phases of a building-type project include:

### Concept Design

Generally involves the application of a design 'idea' to the practical provision of a facility. It represents a phase where sufficient design concepts are developed for the client to be able to establish the feasibility of the project or the development potential of a site, or to select a particular conceptual approach that they wish to pursue. The concept design phase may be used to define or verify the brief and often involves the testing of different approaches/options. During this phase, ideas and concepts are more fully developed through open interaction and discussion between the project and design teams in regard to the key components of the project.

At the end of this phase, the basic building blocks of the project are defined in general terms and coordinated between the design disciplines.

Concept and preliminary design phases are often combined in less complex projects.

### Preliminary Design

Generally involves the further refinement of the preferred concept to facilitate testing it against inputs from the team, including cost estimates and regulatory approval. This may provide sufficient information for the communication of the design to a third party for marketing or consultation purposes.

During this phase the project concepts are developed into firm schemes, where the relationships and sizes of spaces and facilities are defined and coordinated between the design disciplines. However, the resolution of individual details that do not impact on the key elements is generally left for the next design phase. At the end of this phase, the project should be clearly defined.

### Developed Design

Is the phase where the scope of each component in the design is clearly defined and coordinated. This may involve the production of detailed information, including sketch details of all significant componentry and their interrelationships. The developed design phase is where the individual technical experts prepare the necessary documentation to define the scope of all building elements. Major input is required by all designers.

The completion of the developed design is a critical point in a project. The scope of the project is fully defined. As a result, cost estimates can be prepared on an elemental basis. Developed design generally provides sufficient information for the client/user to clearly understand the aesthetics and functionality of the building, internal spaces and facilities.

On some projects the developed design documentation is issued for building consent and/or guaranteed maximum price tender. Coordination between the design disciplines is therefore critically important at the end of this stage.

### Detailed Design

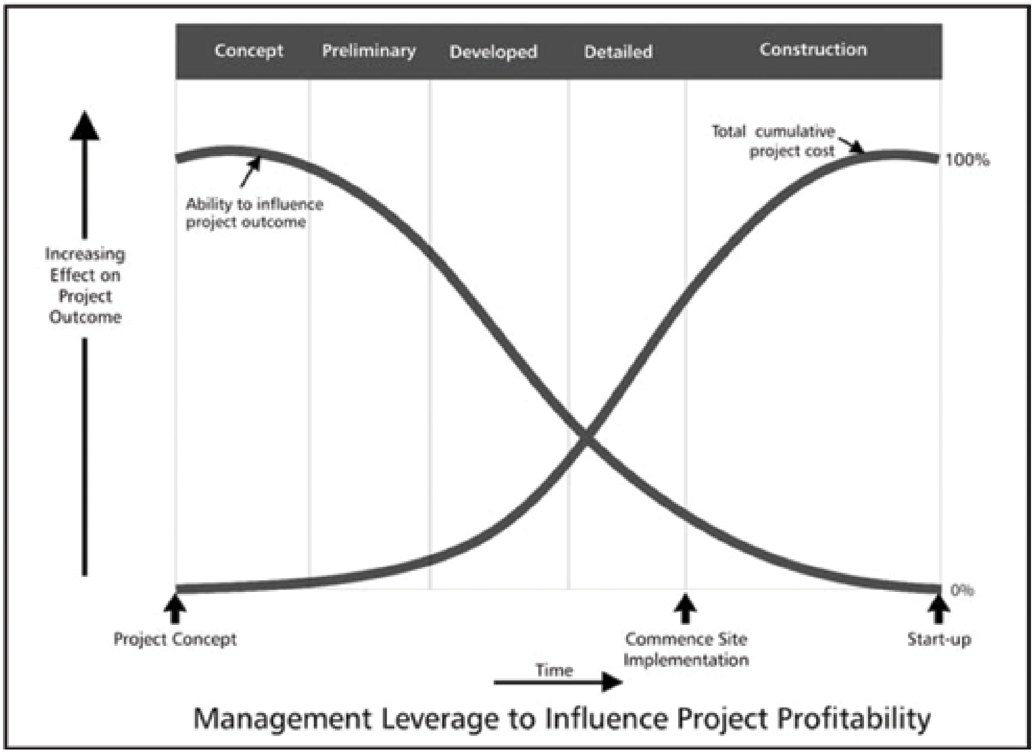
Generally provides a level of documentation that clearly defines the design, specifications and extent of all building elements. The design should be comprehensively coordinated with other disciplines. However, the documents produced in this phase may not directly be able to be 'built' from. Changes to anything but detail at this stage are very disruptive and expensive and often result in further problems as, by now, the project has become very complex and it is hard to identify all the ramifications of changes. Detailed design is the phase most commonly used to obtain a tender for the construction of the works.

### Construction Design

Is where the requirements defined in detailed design documents are integrated with changes that may occur during the tender and contract process, and with construction requirements such as site conditions, proprietary and performance design elements, erection requirements and fabricated shop drawings to create drawings that can be directly 'built' from. (Note: shop drawings are produced during this stage.) This stage is normally completed by the contractor and the specialist sub-trades/contractors. These documents are issued to the design team for review.

### Value Management

Value management (VM) reviews at the appropriate stage(s) of the design process may assist in achieving a successful project. However, reviews undertaken too late can be ineffective and adversely impact on the programme and costs. The sketch below graphically illustrates the opportunity of early reviews. Generally, VM reviews should be carried out at the end of the concept and/or preliminary design stage, when the design has been coordinated between the design disciplines and there is a consistent basis for a cost estimate. The necessary revisions that are identified as part of the VM review can then be input to the start of the next design phase.




## Safety in Design

Safety in Design (SiD) is a process that integrates hazard identification and risk assessment methods throughout the design. It commences early in the process to eliminate, isolate or minimise the risks of injury to those who will construct, operate, maintain, decommission or demolish the asset.

Most construction site safety-risk mitigation is aimed at isolating, informing or controlling the hazard. However, the opportunity to eliminate and/or substantially reduce/mitigate a hazard in the early design stages by involving decision-makers and considering the life-cycle of the project is invaluable.

SiD begins in the early feasibility, conceptual and planning phases of a project with an emphasis on making choices about the design, methods of construction, ongoing operation and maintenance provisions and materials used that enhance the safety of the project. The earlier in the design stages that you can begin the process, the easier and more efficient it is to make changes that benefit everyone. The design stage also offers the greatest opportunity to incorporate improvements that can produce time and cost savings during the life of the asset.

The hierarchy of hazard control when considering SiD is:

- Elimination
- Substitution
- Engineering
- Administrative
- Personal protective equipment.

This procedure applies to all architecture and engineering design and through all phases of the design process. As part of the design process consideration needs to be given to:

- Safety throughout the life-cycle of the project
- Involving the key stakeholders
- Reviewing hazards throughout the life-cycle of the constructed or commissioned works, including the ability to build, operate, maintain, occupy and decommission, as applicable.

Inform the client of any residual risks (carrying out a defined process of assessment is the easiest way to communicate the risks).

## Architectural

This section is intended to give the reader an understanding of the key components that may be provided in a community sports and recreation centre facility. It is divided into the following six sections:

- Site
- General facility components
- Aquatic components
- Dry sports components.

### Site

Careful consideration should be given to points of access to ensure a welcoming, customer-friendly and accessible approach to the building. A careful integration with the site will also ensure level accessibility and minimise changes required to the site topography.

The particular shape and dimensions of a site are likely to create a number of constraints that will affect the building and site layout; these include a consideration of:

- Service and public access
- In-ground services and infrastructure
- Environmental factors (contours, orientation and prevailing winds)
- Landscape and urban design issues
- Geotechnical conditions
- Future expansion
- Legal issues (easements)
- Regional and local planning regulations (RMA, district plans).

All constraints should be carefully considered in order to 'tailor' the design sensitively for the particular location. This should include discussions and consultation with local stakeholders and planning and environmental departments. The constraints should be considered early in the project development process and it is therefore important to engage appropriate design consultants for professional advice.

#### Site Design Process

- Procure the consultant team. Consultants typically required to inform and develop the site design include:

| | |
|---|---|
| Surveyor | To carry out site survey to enable consultant team to develop a design |
| Architect | To develop site master plan and concept design (for small sites may also include landscape design services) |
| Landscape architect | To provide landscape design strategy, often required for resource consent |
| Planner | To provide specialist resource consent advice |
| Civil engineer | To inform in-ground services infrastructure and stormwater system or consent requirements |
| Transport engineer | To inform parking numbers, road layouts, intersection designs, NZ Transport Agency (NZTA) liaison |

- Develop a long-term master plan for the site based on the facility design brief and be clear about the long-term vision
- Develop a concept design for the building and site based on the facility brief.

#### Access and Transport

Community facilities may be located adjacent to schools. Where this is proposed the design must consider the need to provide dedicated school entrances, and change, locker and marshalling spaces.

Public bus and school coach drop-off and parking spaces may be required and should be considered in the design of the road network and parking layout.

An appropriate provision of carparking is needed to suit the particular location and local planning requirements. The larger the facility the greater the requirements for carparking and coach and bus drop-off and pick-up points. Carparking design should consider best-practice sustainable drainage systems. The number of carparks should be informed by professional advice and they should typically not be sized based on worst-case-event mode overlays.

### Future Expansion/Staging/Integration

In-ground services, parking and building location and layout are all affected by the future expansion intentions of the facility. It is therefore critical to brief and develop a master plan for the selected site before the concept design is developed and building location is determined. The site master plan must consider the long-term vision for the site and facility. The master plan will inform the location of the building, carpark and associated infrastructure.

Refer to the reference facility example in Stage 4 Build, page 143 for an example of a master plan that considers potential staging and hubbing during the life of the facility.

### External Amenity

The site should be considered as an opportunity to provide further leisure and sports amenity. The landscape, urban and building design must carefully consider the site factors to sensitively 'tailor' the design to the particular location and enhance the local environment.

The public entrance to the building should encourage participation by promoting visibility of the sports through the use of external glazing. The landscaping design should create spaces for informal and formal outdoor play. Sheltered seating and BBQ areas may be considered in addition to providing basic seating adjacent to the pick-up and drop-off points.

## General Facility Components

### Entrance Lobby and Foyer

The main entrance to the facility should be located to consider the local site conditions, prevailing wind and solar orientation. Wind lobbies should be provided where entrances face prevailing wind directions or in climates where heat loss and/or cold draughts would be undesirable.

The foyer should provide sufficient area for large groups to queue or assemble while entering or exiting the building. For a typical-scale community facility, this will be up to one full school class or approximately 30 people. The provision of a large open space with lots of natural light is desirable. Foyer areas should be provided with seating for those waiting to collect others and for facility programme and general enquiries.

The foyer and entrance lobby should be physically and acoustically separate from the main sports areas but have strong visual connectedness. Reception staff should have clear views of the internal and external circulation routes. Visitors should be provided with views into the internal sports areas from the reception point.

Automatic access–control gates should provide controlled entry to the pool change process and fitness centre sports areas. Space for notice boards and signage should be provided to communicate facility programmes, activities and important notices.

### Reception, Administration and Staff Facilities

The reception area should be immediately apparent to those entering the facility and directly adjacent to the lobby and foyer. Adequate space for two people to operate behind the reception desk is typically required. The location should if possible provide supplementary, not primary, supervision of activity in the pool and sports areas so should be visually connected.

Offices for the functions of programme administration, facility operations and management should be provided and connected to, and ideally visible from, the reception area. A staff room with a kitchenette and space for the storage of food and personal belongings is required and should be large enough to hold informal staff meetings around a small table. Unisex staff change facilities should be provided, ideally with direct access from the staff room. A dry room or large cupboards is required for the storage of stationery and other office supplies.

### Meeting Room

A small, well appointed meeting room with capacity for up to 25 people is desirable. This room can provide hire space for use by regular facility users and groups wishing to conduct small meetings on-site. It is typically not allocated to any one group or organisation and would also be used for regular community group or facility staff meetings.

### Café/Food and Beverage Area

A facility to provide food and beverages is a core component of a successful community facility. The café or vending area should be sized to reflect local market conditions.

For small community facilities, a small vending area and space to sell ice creams and coffee should be integrated with, or adjacent to, the reception space. Tables and chairs should be provided for seating and viewing of the sports or pool halls, ideally with access to outdoor seating areas.

Larger community facilities may consider providing a dedicated café but this must be justifiable and is unlikely to be based solely on the size of the facility. Factors such as the type of location, high street or rural, the local competition and the user numbers all need to be assessed. The choice of tenant will inform the fit-out of the space and discussions with prospective tenants must therefore occur early in the design process to inform the brief. A typical café should provide a small kitchen space, a dishwashing and kitchen waste area and a servery and seating area and may total 100-200m$^2$. The servery should service and be highly visible from the main foyer, leisure water space and outdoor seating area.

### Retail

A facility to sell goods such as sports apparel is a core component of a successful community facility. Small community facilities should integrate a retail area within or locate one immediately adjacent to the main reception area. The provision of a change cubicle should be considered to improve swimsuit sales.

A larger community facility has the potential to justify a dedicated retail space. In this case the retail area should be clearly visible and ideally immediately adjacent to the main entrance and foyer.

### Public Toilets

Public toilets should be provided in close proximity to the main entrance foyer for use by spectators, non-sports participants and café patrons. These should provide male and female facilities and an accessible facility with baby change facilities as a minimum and be calculated in accordance with the Building Code Part G1.

### Cleaners' Stores

Cleaners' stores should be located in strategic locations and sized to reflect the scale of the facility. A large central cleaners' store with bucket sink and storage should be provided with smaller ancillary cleaners' cupboards located in each change area.

### First Aid Room

In small community facilities a first aid room is not required. First aid equipment should be integrated with key locations. The accessible change room with bed can often double as an emergency first aid room if required. In larger community facilities it may be necessary to provide a dedicated first aid room with a bed and a wash-hand basin. This should be located to service all facilities within the sports centre and have direct access to the pool facility and the general circulation. External access to an emergency vehicle access bay should be provided via a nearby door.

### Spectator Viewing

Separate spectator viewing and entry to the indoor courts and pool hall should be provided directly from the foyer. Locating the spectator viewing and entry process adjacent to a café and vending area is advantageous to maximise spectators' secondary spend.

### Accessibility

Providing disability access to all sports areas and swimming pools is an important consideration for sports facility design, which should include the inclusion of permanent ramp access to all pools. There could be cases where adding a spa pool to an existing facility makes it impossible to provide ramp access due to space constraints. In these situations, and other exceptional circumstances, of alternative forms of accessible access, such as hoists, may be considered. If using a hoist, consideration needs to be given to its location in terms of both the pool and space pool-side for wheelchairs to be parked. When providing ramp access to pools, the location and gradient of the ramp are important factors to ensure safe entry. A storage space for water wheelchairs also needs to be considered in the design stage to ensure there is an appropriate place for these to be located.

Refer to the *Barrier Free New Zealand Trust and Sport NZ Accessibility Design Guide and Self-Assessment Checklist* for a list of requirements for each space.

www.sportnz.org.nz/accessibilityguide

Sport wheelchairs are wider than normal wheelchairs and are not able to fit through 760mm clear door openings. All accessible routes should therefore provide 920mm minimum clear openings. Sliding doors are preferred to swing doors.

## Aquatic Components

### FINA

*"FINA or Fédération Internationale de Natation (International Swimming Federation) is the International Federation recognised by the International Olympic Committee for administering international competition in Aquatics. FINA currently oversees competition in five aquatics sports: swimming, diving, synchronised swimming, water polo and open water swimming."*

FINA publishes Facilities Rules that describe the requirements for swimming pools that will host events held under these rules. The FINA Facility Rules describe dimensional, temperature, lighting and automatic officiating equipment (touch panels) requirements.

In the context of a typical community facility the lap pool and associated pool hall are rarely fully FINA-compliant. The costs associated with increasing lighting levels to the required minimum 600 lux for competition, and 1,000 lux for broadcast, and providing the automatic timing equipment and scoring systems are not affordable for a typical community facility. The recommended approach is therefore to design the pool length to comply with FINA rules (FR2.2 and FR2.3) but stop short of meeting all the ancillary requirements.

Those developing sport and recreation facilities that are intended to be used for competition where scoring and timing equipment is required will need to consider and include additional capital for its inclusion as part of the facility fit-outs.

Indicative costs for an eight-lane, 25m pool and single-court multi-sports hall:

### System for 8-Lane Pool – Finish only – $105,087

The system elements make up the minimum requirements for an operational competition set of equipment. Provides mobile timing at one end of the pool and results on an eight-line scoreboard.

### System for 8-Lane Pool – Finish and 25m/50m – $175,984

The system elements make up the minimum requirement for an operational competition set of equipment. Provides mobile timing at two ends of the pool and results on an eight-line scoreboard.

### Sports Hall – Entry-Level Multi-sport Scoreboard and Scoring System – $15,520

A single court with baseline timekeeping and scoring equipment with scoreboard and two shot clocks. The controller comes pre-loaded with various software adapted to the following: basketball, volleyball, handball, hockey, netball, tennis, badminton, table tennis and indoor football. Does not include scorebench/seating

*Note: prices (2015) exclude GST, installation and changes due to exchange rates.*

### Pool Layout and Concourse Design

The layout of pools within a facility needs to be considered in the context of access, thoroughfares, use levels, water flows, depths, safety and future expansion potential.

The layout of the pools should consider the safety of patrons by grouping similar-depth water bodies together. Depth markers should be provided at key entry points, ie, ladders and steps. Access to the pool hall from the change rooms should deliver patrons at a shallow-depth water body to ensure the safety of children. Where this is not possible handrails should be provided in addition to clear pool depth signs to limit the risks associated with children and deep water. For example, a ramp to a main pool can provide a useful safety device to separate patrons from the deep main pool water.

Concourse widths should be in accordance with NZS 4441:2008 Swimming Pool Design Standard and the following points should also be noted:

- The 'joining' of pools together with a shared wall in order to save space may be considered, but the acoustic limitations of two adjacent pools should be recognised
- A 3m width shall typically be provided between pools and around the outside concourse area. The 3m width shall be measured from the edge of the pool roll-out channel to the wall or adjacent pool roll-out channel. This dimension can typically be reduced where concourse areas are used only for circulating purposes. For example, a reduction in concourse width adjacent to a pool ramp is often satisfactory
- Ideally, 4m should be provided at the starting end of the main pool for competition. Small community facilities with no competitive programmes may reduce this.

Pool-side showers should be provided adjacent to the spa pool and immediately adjacent to the change rooms to encourage patrons to shower before using the pools.

The height of the pool hall space should be considered in the context of the facility design, future expansion intentions and investment objectives. For example, a facility with a first-floor fitness centre, or intention to add one in the future, should consider and incorporate sufficient height to enable the fitness centre to overlook the pool hall. A consideration of the exposed mechanical air distribution systems will also affect the required pool hall height. For example, large-diameter air ducts should not be located less than 3m above the concourse. Competition intentions and spectator sight lines will also have an impact on the required ceiling height and therefore pool hall volume. Generally the smaller the volume, the lower the capital and operating costs. However, this must be balanced with the community leisure and amenity aspirations.

**Main Pool**

A typical community main pool consists of a 25m long pool, designed to FINA tolerances (ie, 25–25.03m) with 2.5m wide-lanes. Pool length tolerances should not be exceeded when touch panels are installed. A typical main pool is recommended to provide eight-lanes, which equates to a pool size of 25–25.03m long x 20m wide. Typically, the FINA requirement for "two spaces of at least 0.2 metres outside of the first and last lanes" is not considered necessary unless the community's primary investment objective is for a competition venue.

A fewer number of lanes may be considered in small communities where capital cost considerations are paramount and community use is low. Equally, in larger community facilities consideration should be given to providing a larger 10-lane main pool as this has additional programming benefits associated with being able to run 25m laps across the width of the pool, thereby allowing best use of the benching in the shallow and deep water for other programme uses. It is rarely feasible to extend an eight-lane pool, so the 10-lane option should be considered at the design stage and the benefits reviewed against the investment objectives. Upstand end walls and rest ledges should be provided in accordance with FINA regulations. Consideration should be given to using a glossy tile at water level to minimise the ongoing cleaning requirements of community pools.

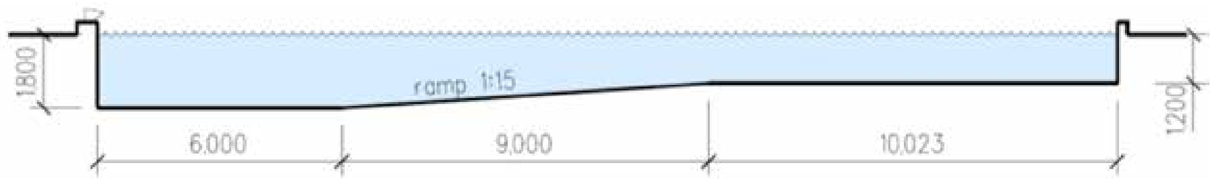
Access should be provided to every pool in accordance with the Sport NZ *Accessibility Design Guide and Self-Assessment Checklist* by providing a ramp. The ramp should not occupy any of the swimming lanes and should be separated from the main body of water with a wall. Three water depth options for the main pool floor are considered in the accompanying section diagrams.

## MAIN POOL CROSS-SECTIONS:

### A 1.8m deep end, 1.2m shallow end, benched both ends

This provides 120m² of usable benching in the deep end and 200m² of benching in the shallow end of the pool, which allows a combination of deep and shallow water programmes.

Ashburton Pool and Recreation Centre is a good example of this benching and depths.



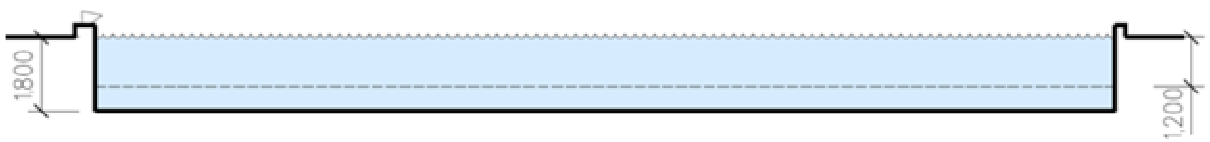

### B 1.8m deep end, 1.2m shallow end, maximised benching

Maximising the shallow end: and deep benching creates large, usable, level pool floor spaces in both the deep and shallow ends of the pool. However, a very steep ramp or step is required to connect the different-depth water bodies. The gradient does not comply with NZS 4441 and the safety of users must be considered and management policies put in place in this situation.

Karori Pool in Wellington has an example of this benching and depths to maximise the range of programme options.


### C 1.8m–2.2m deep, movable floor

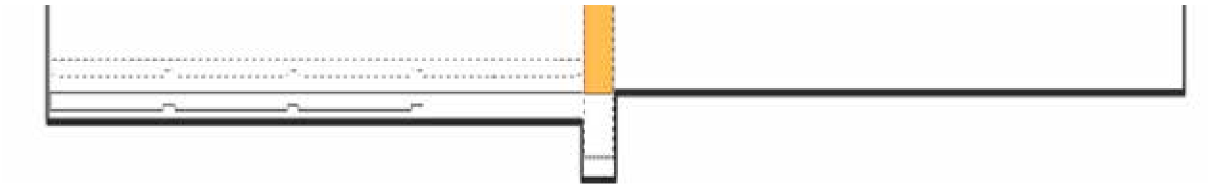
If a larger area of deeper water is required for skill development in aquatic sports such as water polo and underwater hockey, then consideration should be given to a movable pool floor. The addition of a movable pool floor allows the main pool to cater to all types of programme activity. This provides the ultimate flexibility but at a cost premium of about $2,000/m² of pool floor area which covers the deeper pool, technical components and equipment, additional fees and the like. The maximum pool depth of 1.8–2.2m meets the requirements of competitive swimming, lower-level water polo competition and the minimum depth for synchronised swimming training. A partial-coverage movable floor can provide flexible use to half of the pool and reduce the capital cost.



### Boom and Movable Floor Options

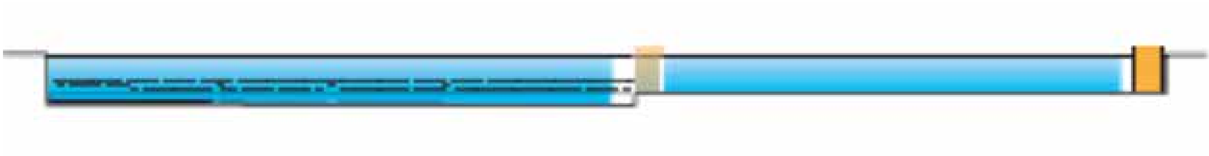
The length of the pool is increased by the boom width (1.5–2.0m) to accommodate the width of a movable boom.

**Submersible boom** – a submersible boom is housed in a recess in the floor of the pool. This allows the full length of the pool to be used when it is in the lower position, and the pool to be divided into two areas when it is raised.



Submersible boom with movable floor

**Transverse boom** – the length of the pool is increased by 1.5m to accommodate the width of the movable boom. It can be moved to various locations to separate the water into different proportions. When in the central position, two 25m lengths are created.



Transverse boom with movable floor

### Pool Control

A space to control the pool systems, audio visual equipment, water toys and leisure features is required. In small facilities this may be integrated with a control panel pool-side. The pool controls must be located where there is a direct line of sight to the water toys and pools. In larger community facilities, it is typical to provide a dedicated pool control room, which can also double as a pool competition timing room and is typically located overlooking the starting block end of the main pool.

### Main Pool Spectator Seating

The area to provide for seating can add significantly to the cost of a project, and the requirement for this and the frequency and level of any competitive events should be considered. The cost per seat is approximately $2,500-$3,000 including building area (based on 1m$^2$ per seat).

The number of pool-side spectator seats to be provided should be driven by the investment objectives of the facility. Typically, a medium-scale community pool will provide 250–300 seats on benches along one side of the main 25m pool, tiered over three levels. This can be supplemented with loose seating at concourse level around the other pool-sides.

Seating for customers, spectators and competitors should provide for easy access to the pool deck as well as good lines of sight to the pools. To ensure the appropriate seating is used, the requirements of users should be considered during the feasibility phase.

### Learn to Swim Pool

The ability to provide for a range of LTS classes is a fundamental community service and should be considered in all swimming pool facilities. LTS programmes can also be good income generators due to typically strong demand for classes. LTS typically takes the form of a dedicated pool due to the continuous programming and therefore inability to share its use with other groups.

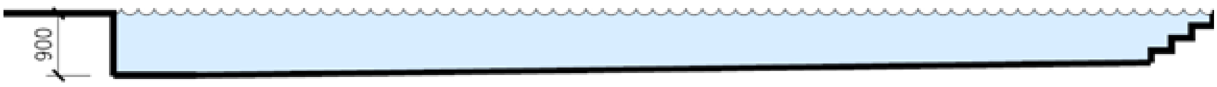
LTS is an area that continues to grow, especially as schools have moved away from providing these opportunities. Providing purpose-designed and -built facilities for LTS may be more financially astute than opting for a multi-purpose design that does not meet any needs adequately.

NZS 4441 specifies depths for LTS pools of between 700mm and 900mm:

*"Water depths may be from 700mm and 900mm. Pools for teaching babies to swim often have a bench recessed into a wall of the pool at up to 300mm below water level in a section of a pool that is 1,200mm deep. This can be used to allow an instructor/carer to stand in the water and encourage the baby to swim off the bench."*

The use of movable pool furniture, especially pool 'platforms', for LTS is increasing in popularity but is potentially dangerous. Pool design that negates the need for in-pool furniture/structures is recommended.

**LTS SECTION:**

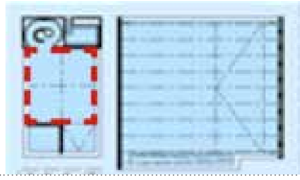
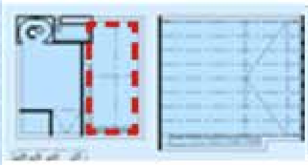
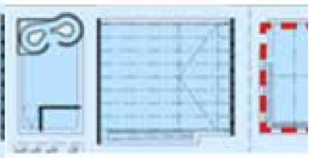



An LTS pool depth should slope gently from 700mm to 900mm. Fixed ledges should not be provided; instead removable furniture should be used if ledges are required for toddler LTS classes as this allows greater flexible use of the pool.

Access should be provided in accordance with the Sport NZ *Accessibility Design Guide and Self-Assessment Checklist* by providing a ramp. Accessible steps are also typically provided along the short side of the LTS pool.

The size of the LTS pool may vary from a small 60m$^2$ shared-use teaching area in a leisure or warm-water pool to a dedicated 200m$^2$ (10x20m) and acoustically separate LTS pool in high-demand communities. The table below describes three LTS scenarios. LTS pools should be capable of being divided into a minimum of four separate areas for classes. A single row of bench seating should be provided for parents along the long side of the LTS pool. The design of an accessible pool-side toilet adjacent to the LTS pool is considered best-practice.

## LTS Scenarios:

| SCENARIO | 1 | 2 | 3 |
|---|---|---|---|
| **Description** | LTS integrated with leisure water pool | Dedicated LTS pool located adjacent to leisure water pool | Dedicated LTS pool with ability to subdivide from pool hall |
| **Diagram** |  |  |  |
| **Comparative pool hall area** | 1,400m²* | 1,700m²* | 1,850m²* |
| **Capital cost** | LOW | MED | HIGH |
| **Programming** | POOR | GOOD | GOOD |
| **Acoustic separation** | POOR | POOR | GOOD |
| **Comments** | Integrating LTS classes with the leisure water pool compromises the programming of the LTS classes<br>Leisure pool water is typically colder than appropriate for LTS and therefore this is not as suitable for teaching smaller children as a dedicated pool | Locating the LTS and leisure water pool adjacent to one another with a shared wall results in a gross floor area saving of approximately 88m². Co-location of the LTS with the leisure water pool can compromise the audibility of instructors during busy periods. Good acoustic treatment of the pool hall will be critical to control the reverberation time to ensure instructors can be clearly heard. A benefit is the LTS pool can be used as overflow for the leisure water pool | A separate LTS pool allows dedicated use to maximise the programming for LTS classes. The separation from the pool hall and leisure activities provides the best acoustic option. Separation of the LTS pool allows space to become bookable as a birthday party room or used independently by school groups |

* pool hall areas are for comparative purposes only and exclude all associated support areas and plant.

### Programme Pool

A warm-water teaching pool, sometimes referred to as a 'hydrotherapy pool', typically caters to gentler programmes targeting slow-exercise injury rehabilitation to a mixture of young toddlers with parents, the mobility impaired and an older demographic. A warm-water pool is not typically a core component of a small community facility. The need to provide a dedicated warm-water programme pool must be driven by the needs analysis and investment objectives for the facility.

Accessible access should be provided in accordance with the Sport NZ *Accessibility Design Guide and Self-Assessment Checklist* by providing a ramp.

A warm-water pool where clinical hydrotherapy can be provided will benefit by proximity to healthcare providers. Consideration should be given to incorporating allied health and wellness treatment rooms as a way of introducing positive revenue streams to the facility. Warm-water-pool depths should vary from 1.4m in the shallow end to 1.5m for clinical hydrotherapy.

### Leisure Pool

A typical community facility, aiming to target a large demographic and contribute positive revenue streams, must provide a variety of leisure, health and wellness components.

### Leisure Components

Shallow leisure and recreation water can take many forms depending on the target market. Consideration must be given to the investment objectives and community demographic to identify the target audience. The table below illustrates a range of leisure components and categorises these by age group and whole-of-life cost.

The pricing policy should be considered as this will influence the selection and layout of leisure components.

A complementary analysis of surrounding facilities should be undertaken to determine the point of difference and therefore best mix of leisure components for a given community facility.

### 1-2 Year Age Group

Babies and toddlers should be provided with a separate safe, shallow and warm water area with a soft, resilient floor surface that is forgiving on children's feet, hands and knees. Moving water such as bubble jets, weirs and interactive features may be provided with a beach entry.

### 3-7 Year Age Group

Young children should be provided with a variety of water depths and features. A combination of lazy rivers, zero-depth playground equipment, indoor slides, jets and sprays should be capable of being supplemented with inflatable toys and games. Leisure space should be designed to provide a range of spaces to cater to girls and boys.

### 7-12 Year Age Group

Older children require deeper water and are typically targeted through a combination of slides, inflatables, swings and balance obstacles. Visual effects and theming of the space can enable spaces to be re-invented.

Also refer to the water slides note below.

### Teenage Age Group

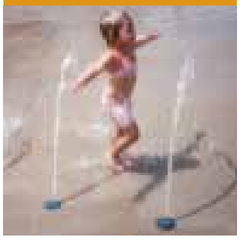
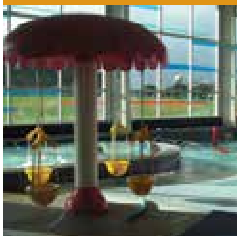
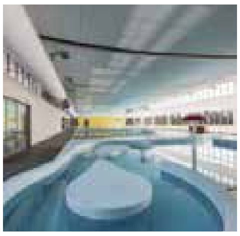
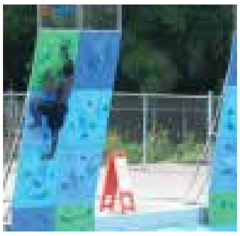
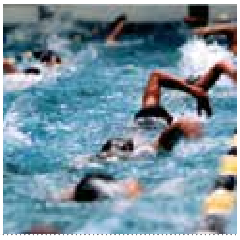
Design to target the teenage market requires careful consideration to ensure the leisure space is flexible and can be re-invented. The most successful features are often informal spaces that can be reconfigured in a number of ways and can incorporate inflatables, bombing platforms, climbing walls, rope swings and zip lines. Many of these activities need deeper water and therefore require early consideration to include as part of the main lap pool design.

Water slides are a specialist area and a business case for these should be considered in the context of the surrounding facilities, the pricing policy and the objectives of the facility. There is a trend towards family, raft-type slides where multiple people can share the experience. Where these are to be considered a comparative analysis of throughput and storage space should be carried out.

### Adult Age Group

Adult leisure trends cover a broad range of activities and spaces from relaxation to fitness. Key to attracting families to pools is the need to cater to the parents and this can be best achieved by providing a range of services in addition to the basic lap swimming, sauna, spa and lazy river offerings. Consider providing wellness services, massage, treatment rooms and a café.

## Leisure Components

| | COMMUNITY BASELINE | | LARGER FACILITIES | |
|---|---|---|---|---|
| WHOLE-OF-LIFE COST | LOW | MEDIUM | MEDIUM | HIGH |
| Age group:<br>1-2 years |  |  |  |  |
| 3-7 years |  |  |  |  |
| 7-12 years/family |  |  |  |  |
| Teenagers |  |  |  |  |
| Adults |  |  |  |  |

Innovative design and planning of the leisure water space will maximise its popularity and use. Cost need not be the primary driver of low-cost alternatives can add significant value, often with minimal or zero additional space allocation. Examples of features that have proved successful in community facilities are:

- Water features and dumping bucket
- Coloured lighting effects
- Water weirs
- Bombing platforms
- Indoor slides, rope swings, climbing walls.

Flexibility is key to allow the space to be re-invented once toys become old or outdated and to allow other pools within the facility to be converted to leisure during the school holidays. Standardised fixed water toy base plates and pump sizes allow toys to be interchanged. Pool-side power points should be in multiple locations to allow inflatable toys to be set up.

When incorporating interactive leisure features into the facility design consider:

Location and appropriateness of features and pools

- Water flow, circulation and treatment requirements
- Location and accessibility of controls and safety switches
- Accessibility for maintenance
- Ease of supervision and lifeguarding
- Impact upon other facility users
- Ability to be 'closed' to users
- Spare plant space capacity for pumps
- Future provision for in-ground pipes.

Note that water features, jets and sprays increase the humidity in the immediate area of the toys. Consideration should therefore be given to ensuring their separation from glass and other surfaces that are prone to condensation and there is good airflow around the pool water toys.

Consider providing space within plant rooms and casting in critical in-ground pipework to allow water slides to be added in future without impacting the base building. Anchor points at high levels allow zip lines and rope swings to be added at minimal cost if considered at the design stage.

While outdoor pools have been successful overseas the New Zealand climate, temperature and wind limit these facilities to seasonal use. A careful consideration of the prevailing wind direction, orientation and period of use is therefore needed to ensure the feasibility of outdoor pools.

Shallow leisure water, beach entries and zero-depth leisure facilitation should be located adjacent to the café and seating area. A café servery should service both the pool-side and the public foyer side if possible.

The table below describes three leisure facility projects in order of ascending scale. They successfully cater to a wide demographic and contribute positive revenue streams by providing a combination of toddler, child and adult leisure water components with health, fitness and retail facilities.

## Illustrative Examples of Leisure Facilities

| SCALE | SMALL | MEDIUM | LARGE |
|---|---|---|---|
| **NZ and Australian precedents** | Graham Condon Recreation & Sport Centre | H$^{2}$O Xtream, Upper Hutt | WaterMarc, Melbourne, Australia |
| **Features** | • Water toys<br>• Water jets<br>• Splash pad<br>• Spas<br>• Sports hall<br>• Fitness centre | • Water toys<br>• Water jets<br>• Water slides<br>• Rope swing<br>• Wave pool<br>• Lazy river<br>• Spas<br>• Pool-side café | • Zero-depth AquaPlay<br>• Water toys<br>• Raft slides<br>• Spas<br>• Saunas<br>• Steam room<br>• Pool-side café<br>• Fitness centre<br>• Childcare |
| **Image** | <br> | <br> | <br> |
| **Commentary** | Good integration of shallow water, water jets, water toys, separate pre-school and school-aged play spaces and a pool-side café | Good integration of modest-scale water slides, tipping buckets, rope swing and pool-side café into a community-scale facility | Good integration of zero-depth water play with raft water slides, and a pool-side café into a community-scale facility |

### Leisure Pool

The leisure pool should have a minimum water surface area of 150m$^2$ and the water depth should vary from 0mm to 1,200mm and provide ease of access for persons with disabilities or mobility difficulties. Depending on the design, size and dimensions selected for the main pool, additional space at 1.2m in this area may need to be considered to provide a range of structured fitness programmes and activities in water operated at a higher temperature.

This pool should provide outlets and equipment that facilitate interactive water play and fun activities that will be attractive to families and children. A minimum of six water features is recommended and these should be designed and installed in such a way that they are easily interchangeable. Features include moving water, small slides, geysers, fountains, pipes and waterfalls, spouts and sprays. The range of interactive water features should be developed to complement rather than compete with those provided elsewhere.

A separate balance tank, circulation and filtration system provided and roll-out and overflow channels flush with the concourse and separated from pool water flow return. Pool surfaces should be tiled and non-slip where people's feet come in to contact with the pool floor. Given the nature of activity, a pool membrane safety surface such as the Natare pool system may be worthwhile. An area of spectator seating should be incorporated.

### Spa, Steam and Sauna Areas

The provision of a family spa should be considered against the proposed pricing policy for the facility, as entry to spa, steam and sauna rooms can often be controlled and priced as an extra service. In a very small facility, cost-effective, off-the-shelf, proprietary or concourse solutions may be considered, although the limited lifespans of these products should be recognised and evaluated against more expensive options. Integrating a bubble jet/spa area with one end of the warm-water/programme pool can often be an innovative way of minimising the capital expenditure associated with providing a dedicated separate spa pool and filtration systems. Where a dedicated spa pool is provided it should have capacity for 15 people and be provided with ramped access in accordance with the Sport NZ *Accessibility Design Guide and Self-Assessment Checklist*. The spa should be located adjacent to the leisure pool and in close proximity to a cold pool-side shower.

Where steam or sauna rooms are provided, consider co-locating these adjacent to the spa area and warm-water pool to create an adult wellness area. Acoustic separation of a warm-water/adult wellness cluster should be considered.

### Toddlers' Pool

A toddlers' pool adjacent to but physically separate from the shallow-water area of the leisure pool should have a water surface area of not less than 30m$^2$ and vary in depth from 300mm to 400mm. As the pool is designed to cater for children under five years it should be easily accessible.

The pool should have its own balance tank, circulation and filtration system. Pool surfaces should be non-slip pool tiles of safety surface membrane.

Parent and caregiver seating should be located in close proximity to this pool.

### Other Pool Users

It is not within the scope of this document to explore diving facilities. Diving demands deep water and is therefore very rarely compatible with community facilities. 1.8m-deep water would meet the minimum depth requirements for shallow diving and race starts.

### Pool Change Facilities

The change room facility provision should be calculated in accordance with the Building Code Part G1 and benchmarked with similar community facilities.
The following change areas should be provided:

- Separate family change rooms
- Separate male change rooms
- Separate female change rooms
- Dedicated accessible change room(s).

Preference should be given to:

- Separate shower cubicles within the male and female change areas instead of open shower areas
- A large, single, oversized accessible change room with enough space for three persons including a wheelchair instead of multiple smaller rooms. This accessible change room should be fitted with a fold-down, adjustable-height bed, hoist, accessible shower, WC and wash-hand basin. Refer to the Sport NZ *Accessibility Design Guide and Self-Assessment Checklist*

- Maximising the number of family change rooms. A minimum of four family change rooms should be provided with preference for 8-12 in larger community facilities. This is often most efficiently achieved by minimising the size of family change rooms by providing a bench and change table only, and providing pool-side toilets and showers
- Providing a combination of open-sided lockers in the pool hall and secure lockers in the circulation spaces.

It is best-practice to provide separate dry access into, and wet access from, the main pool change rooms. The separation of a dry and wet change room entry process minimises the incidence of dirt migration into the pool hall by keeping shoes out of the wet areas and results in better hygiene and cleaning of the facility.

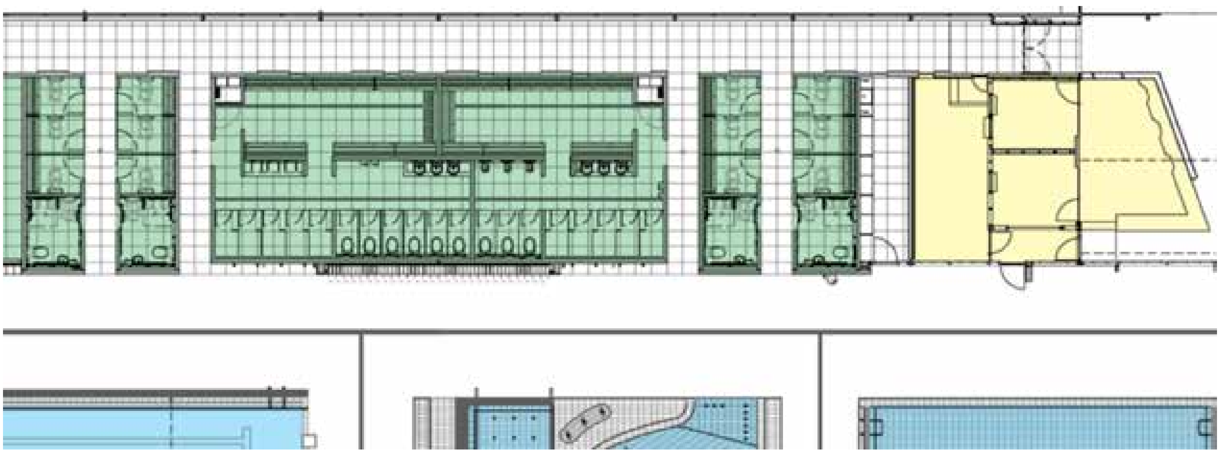
Facility examples that adopt a separate dry to wet change process include:

- Marlborough Lines Stadium 2000, Blenheim
- Selwyn Aquatic Centre, Christchurch
- Dudley Park Aquatic Centre, Rangiora.

Facility examples that adopt a pool hall wet change process include:

- Caroline Bay Trust Aoraki, Timaru
- Alpine Aqualand, Queenstown.

A reference facility change room layout from Marlborough Lines Stadium 2000 (Blenhiem):



**Pool Storage**

A wet equipment store both with direct access to the pool-side and external to the building should be provided. The minimum area for storage of pool equipment should be approximately 5 percent of the floor area of the pool hall. For example, if the pool hall is 2,000m$^2$, a storeroom of 100m$^2$ is required. The storage room should be well ventilated and provided with a drain and waterproof surfaces for wash-down.

Storage for pool covers should be provided in addition to the area noted above and must be accessible and easy to use by pool staff. Consider locations below seating or at a high level mounted on pool-side walls.

## Dry Sport Components

### Indoor Sports Court

Indoor sports halls should cater to a wide demographic and seek to target a wide cross-section of indoor sports.

Indoor sports hall dimensions are typically governed within New Zealand by the size of indoor netball and basketball courts. Reference should be made to the relevant National Sport Organisations for court dimensions and run-off zones for typical sizes of indoor sports courts. Run-off zones provide adequate allowance for structural columns, scoring tables and perimeter bench seating to ensure these are positioned clearly outside the run-off zones.

While sports halls should be designed predominantly for sports activities, they can be used for a range of other non-sporting events and activities at periods of low demand to ensure the building is used as much as possible.

A clear height of 9m is required to play international-competition-level netball and volleyball and premier and international-level badminton. A lower clear height of 7.5m is typically considered sufficient in community facilities where community, club or premier-level sports are the focus. Clear heights should not be impeded by lights, radiant heating, retractable basketball hoops, nets or other fixtures, fittings and equipment (FF&E), and it is therefore important to allow sufficient tolerances above these clear heights.

The optimum arrangement of the indoor courts will be impacted by the intended spectator seating numbers, the overlay of alternative sports court markings and the number of courts proposed in the master plan. Two relevant facility examples that incorporate good-practice design and sustainability principles are the:

- ASB Sports Centre – Wellington
- ASB Arena – Tauranga.

The maximum number of spectators allowed in the sports hall for an event will be determined by the fire engineering design of the building. The ultimate use of the space must therefore be considered and clearly communicated in the client brief to the design team to ensure the building design can be adapted to accommodate the eventual anticipated spectator numbers. Three courts are considered a good configuration for an event court set-up due to the ability to configure the centre court as the main event court supported by retractable seating from the sides.

The cost per retractable seat excluding any increase in the size of the building is $550-$650 (excluding the building costs), depending on seat type and system selected.

### Dry Sports Storage

A dry sports equipment store with direct access to the sports hall and external to the building should be provided in all facilities. This should be provided with power and data points to allow it to double as a kitchen preparation or plating area for other events. The minimum area of the dry storage room shall be 12.5 percent of the indoor courts' floor area. Flush-fitting 'up and over' doors or roller shutters should be provided to give wide, unobstructed access from the dry storage area to the courts and outdoor delivery area.

### Health and Fitness Centre

A health and fitness centre can be a successful complementary component of a community facility as it will contribute a positive revenue stream to the facility.

The fitness centre should be highly visible from the entry or foyer and from outside the facility. The location of the fitness centre will be determined by the particular site characteristics. On constrained sites it is typically located on the first floor where it can be provided with good visibility overlooking the pool hall. Careful consideration of acoustic issues is required where a fitness centre is located on the first floor. If the fitness centre is located on the ground floor it is often possible for it to share the sports hall change facilities.

A fitness centre should be considered in the smallest-scale community facilities, with a minimum size of 150m$^2$, to provide a range of fitness equipment stations. Programme classes should be provided in the shared sports hall. A typical community facility should consider approximately 300m$^2$ of fitness space, providing a mixture of equipment stations and aerobic exercise and fitness, room-based, programmes. Subject to catchment and local competition factors, a larger health and fitness centre with more stations will attract more 'members' and casual users, and improve the financial performance of the centre. A recommended area of 4.5m$^2$ is suggested per fitness station.

Movement and dance studios may be included in larger fitness centres in association with open-plan cardio and weights fitness areas. This can increase the range on offer to the fitness 'members' and when combined with massage/treatment rooms can cater to the 'wellness leisure' sector of the community.

### Dry Change Rooms

Consideration should be given to the intended frequency of use of the indoor court space for other function events, eg, conferences, shows and competition/spectator events. The use of the indoor court space will determine the number of change facilities required. It is inefficient to size the change facilities for large, infrequent spectator or conference events, so operational plans and in-ground infrastructure should consider the cost benefits of hiring mobile change blocks if large spectator events are to be held infrequently.

There is a trend for indoor sports participants to arrive already changed and to shower at home after playing. This can allow shower and change provisions to reduce accordingly.

The ASB Sports Centre in Wellington undertook stakeholder surveys that resulted in a reduced, optimised indoor change provision. It is therefore recommended that similar community-focused facilities consider their programmes and use and benchmark them with other facilities with high change provision utilisation rates to ensure they do not over-provide.

The change facilities should be designed to be used as group change or segregated male/female change spaces as required. The placement of dry-side change rooms should consider their ability to share use with the health and fitness centre where this is located on the ground floor. Accessible change facilities should be integrated at each location.

Lockers should be provided outside change rooms for ease of supervision, user convenience and flexibility.

### Roofing Systems and Materials

The following tables are designed to illustrate a range of materials and systems and their relevant implications from risk, service life and maintenance perspectives. The observations are general and subjective and take no account of specific site, client or facility conditions. The tables are not to be used as a substitute for specific project design consultants carrying out their own due diligence.

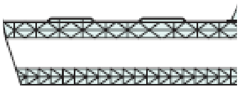
## Roof Types

| SYSTEM/PRODUCT | STANDING-SEAM ALUMINIUM WARM ROOF SYSTEM | COMPOSITE ROOF PANEL SYSTEM | TRADITIONAL COLD ROOF SYSTEM | MEMBRANE WARM ROOF |
|---|---|---|---|---|
| **Description** | Crimped standing-seam aluminium warm roof on structural liner, eliminating the need for purlins. Aluminium finish | Composite insulated panel. Available locally with steel face, ex-UK with aluminium face. Max lengths | Traditional built-up, colour-coated, sheet metal roof tray on purlins with insulation batts between. Multiple profiles from multiple suppliers available | Membrane over high-performance rigid insulation board, typically PIR (polyisocyanurate). Can be installed over structural tray liner, concrete or plywood deck |
| **Image** |  |  |  |  |
| **Warranty** | 20 years | 10 years | 10 years | 20 years |
| **Expected service life** | >50 years | 15 years (steel)<br>>35 years (alu) | 15 years (steel)<br>>40 years (alu) | 35 years |

# STAGE 3: DESIGN

| SYSTEM/PRODUCT | STANDING-SEAM ALUMINIUM WARM ROOF SYSTEM | COMPOSITE ROOF PANEL SYSTEM | TRADITIONAL COLD ROOF SYSTEM | MEMBRANE WARM ROOF |
|---|---|---|---|---|
| **Cost** | HIGH | LOW | MED | MED |
| **Replacement implications** | HARD | EASY | MED | MED |
| **Maintenance** | LOW | MED | MED | MED |
| **Construction risk** | LOW | MED | HIGH | MED |
| **Condensation risk*** | LOW | LOW | HIGH | LOW |
| **International history of use** | HIGH | HIGH | LOW | HIGH |
| **NZ history of use** | LOW | HIGH | HIGH | MED |
| **Comments** | Very long life expectancy and well proven internationally. Only one project in NZ (Wellington ASB Sports Centre). Single system/point of responsibility for performance of air, vapour, acoustic and weathertightness | Reliance on sealant at panel-to-panel joints. Single system/ point of responsibility for performance of air, vapour and weathertightness. Fast install time. Aluminium-faced panels come from UK | Traditional build-up as cold roof with associated condensation risks. Relies on good workmanship and coordination between multiple trades. No single point of responsibility for weathertightness and air barrier | Warm roof system with good thermal properties due to contiguous nature of insulation board. Single point of responsibility for air, vapour and weathertightness |

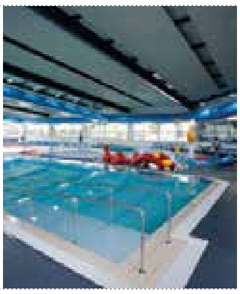
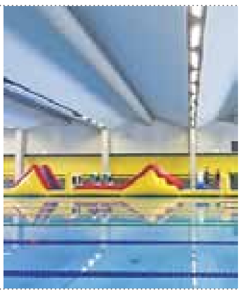
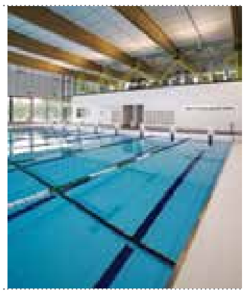
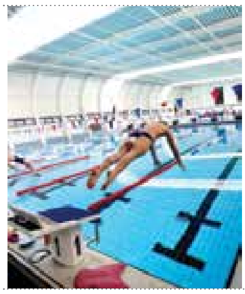
## Roof Light Types

| SYSTEM/PRODUCT | ETFE CUSHION | SINGLE-WALL POLYCARBONATE | MULTI-WALL POLYCARBONATE | GLASS |
|---|---|---|---|---|
| **Description** | Pneumatic inflatable plastic pillows | Single-skin polycarbonate roof light | Multi-wall polycarbonate roof light or similar | Argon-filled, double-glazed, low-E, thermally broken aluminium suite |
| **Image** |  |  |  |  |
| **Warranty** | 25 years | N/A for aquatic centres | Not warranted in aquatic centres | 10 years |
| **Expected service life** | 25 years | 25 years | 25 years | 50 years |

| SYSTEM/PRODUCT | ETFE CUSHION | SINGLE-WALL POLYCARBONATE | MULTI-WALL POLYCARBONATE | GLASS |
|---|---|---|---|---|
| **Replacement implications** | HARD | EASY | EASY | EASY |
| **Maintenance** | MED | MED | MED | LOW |
| **Construction risk** | HIGH | LOW | LOW | LOW |
| **Condensation risk*** | MED | HIGH | LOW | LOW |
| **International history of use** | MED | MED | HIGH | HIGH |
| **NZ history of use** | MED | HIGH | MED | MED |
| **Insulation value** | MED | LOW | HIGH | HIGH |
| **Comments** | Requires dedicated UPS (uninterruptible power supply), 3-phase power supply. Maintenance contract required to achieve 25-year warranty | Low insulation value and only suitable for unheated and well ventilated indoor stadiums. Recommend using multi-wall system over single skin | Only applicable for dry sports facilities as Kingspan does not warranty this in aquatic centres | Most suitable for aquatic centres. May still require washing with fresh air to control the condensation risk in a humid aquatic centre |

* Condensation risk relative to site location. Recommend interstitial condensation risk analysis to verify build-up.

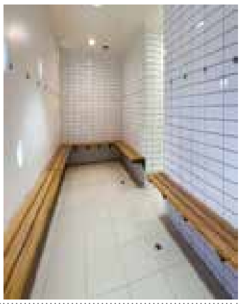
## Quality Benchmark of Facilities

| SPACE | POOL HALL ROOF | POOL HALL ROOF | POOL HALL ROOF | POOL HALL ROOF |
|---|---|---|---|---|
| **Quality** | BASELINE | MEDIUM | MEDIUM | PREMIUM |
| **Relevant precedent** | Graham Condon Recreation & Sport Centre (Christchurch) | EA Networks Centre (Ashburton) | St Cuthbert's College (Auckland)<br>Karori Pool (Wellington) | Loughborough University Swimming Pool (UK) |
| **Description** | Steel structural frame and purlins exposed to view with limited acoustic panels to undersides of purlins | Steel structure and LVL (laminate veneer lumber) purlins with suspended acoustic ceiling, corr-a-perf or ripplesound with polyester batts above | Glulam timber structure with Asona Triton Cloud panel infill to undersides of purlins | Kalzip or Kingzip perforated aluminium structural tray liner with integrated acoustic layer, vapour barrier and insulation |
| **Image** |  |  |  |  |

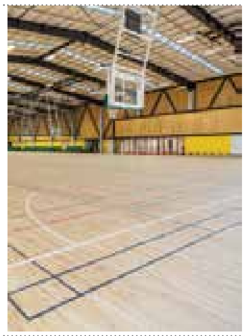
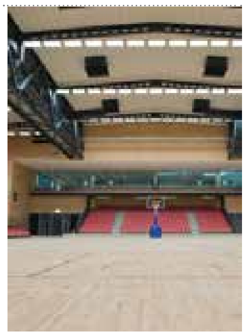
| SPACE | POOL HALL ROOF | POOL HALL ROOF | POOL HALL ROOF | POOL HALL ROOF |
|---|---|---|---|---|
| **Acoustic quality** | AVERAGE | VERY GOOD | VERY GOOD | GOOD |
| **Maintenance** | MED | MED | LOW | VERY LOW |
| **Cost** | LOW | MED | MED | HIGH |
| **Comments** | Steel structure typically with bolt connections, requires wash-down of paintwork to maintain warranty. Limited acoustic panel coverage results in average acoustics. Exposed structure allows for easy inspection | Ceiling structure requires careful detailing to reduce risk of stainless-steel stress corrosion cracking. Maintenance access/ catwalks required for inspection as steel and fixings hidden above ceiling. Allows steel to be repainted without closing pool. Increased surface area of ceiling provides excellent acoustics | Exposed structure with minimal fixings/ bolts/corners reduces maintenance and allows for easy inspection | Eliminates the need for purlins. Reduces amount of structural fixings requiring maintenance in the pool hall. Aluminium liners required. Not typically used in NZ due to poor availability |

## Quality Benchmark of Facility

| SPACE | CHANGE ROOMS | CHANGE ROOMS | CHANGE ROOMS | CHANGE ROOMS |
|---|---|---|---|---|
| **Quality** | BASELINE | MEDIUM | MEDIUM | PREMIUM |
| **Relevant precedent** | Graham Condon Recreation & Sport Centre (Christchurch) | EA Networks Centre (Ashburton) | Selwyn Aquatic Centre (Christchurch) | Marlborough Lines Stadium 2000 (Blenheim) |
| **Description** | Resco wall panels on lightweight framing<br>Suspended tile ceiling<br>Resin floor<br>Dotmar bench seating | Paint-finished fair-faced blockwork walls<br>Suspended prefinished fibre-cement tile ceiling<br>Resin floor<br>Futurewood bench seating | Paint-finished fair-faced blockwork walls<br>Flush-stopped fibre-cement ceiling<br>Resin floor<br>Dotmar bench seating | Paint-finished precast concrete or tiled walls<br>Flush-stopped fibre-cement ceiling<br>Tiled floor<br>Saligna hardwood timber seating |

| SPACE | CHANGE ROOMS | CHANGE ROOMS | CHANGE ROOMS | CHANGE ROOMS |
|---|---|---|---|---|
| **Image** |  |  |  |  |
| **Maintenance** | MED | LOW | LOW | VERY LOW |
| **Cost** | LOW | MED | MED | HIGH |
| **Comments** | Not as robust as alternatives<br>More suited to dry change areas | Indestructible walls. Services can run within blockwork cavity | Indestructible walls. Services can run within blockwork cavity | Indestructible walls. Difficult to reticulate hydraulic services. Timber seating aesthetic requires ongoing maintenance of coating. High-quality aesthetic |

## Quality Benchmark of Facility

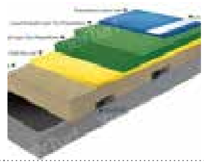
| SPACE | INDOOR COURTS | INDOOR COURTS | INDOOR COURTS | INDOOR COURTS |
|---|---|---|---|---|
| **Quality** | BASELINE | MEDIUM | MEDIUM | PREMIUM |
| **Relevant precedent** | Powernet sports arena (Balclutha) | Graham Condon Recreation & Sport Centre (Christchurch) | EA Networks Centre (Ashburton) | ASB Arena (Tauranga) |
| **Description** | Multi-use community facility | Multi-use community facility | Multi-use community facility. Regional hub for hosting competitions | Community facility with dedicated event court for competitions and conferences |
| **Image** |  |  |  |  |

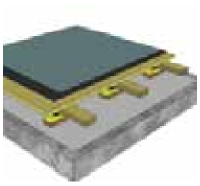
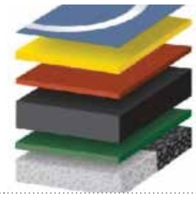
| SPACE | INDOOR COURTS | INDOOR COURTS | INDOOR COURTS | INDOOR COURTS |
|---|---|---|---|---|
| **Acoustic quality** | LOW | MED | GOOD | GOOD |
| **Maintenance** | LOW | LOW | MED | HIGH |
| **HVAC** | LOW | MED | LOW | HIGH |
| **Capital cost** | LOW | MED | HIGH | HIGH |
| **Operating cost** | LOW | MED | LOW | HIGH |
| **Comments** | Multi-purpose polyurethane floor. No acoustic panelling. Precast panels at low level. Good daylighting | Multi-purpose polyurethane floor. Limited acoustic panelling. Plywood at low level. No daylighting | High-performance sprung timber floor. Good acoustics due to the applied wall panels and exposed ceiling polyester batts. Good daylighting | High-performance sprung timber floor. Fully conditioned space. Retractable spectator seating, competition lighting and audio visual set-up. Good daylighting |

## Quality Benchmark of Facility

| SPACE | FITNESS CENTRE | FITNESS CENTRE | FITNESS CENTRE |
|---|---|---|---|
| **Quality** | BASELINE | MEDIUM | PREMIUM |
| **Description** | Low-level finishes and ceiling height | Mid-level finishes with exposed ductwork, structure and roof | High-quality finishes and systems |
| **Relevant precedent** | Jellie Park Recreation & Sport Centre (Christchurch) | EA Networks Centre (Ashburton) | Les Mills Britomart (Auckland) |
| **Image** |  |  |  |
| **Maintenance** | LOW | LOW | MED |
| **Cost** | LOW | MED | HIGH |
| **Comments** | | Economical structure and finishes. Exposed steel structure and concrete panels | High-quality audio visual system. Timber floors, coloured glass feature panels and finishes |

## Sports Floor Options

| SYSTEM | SPRUNG TIMBER FLOOR | SINGLE BATTEN SYSTEM | SINGLE BATTEN SYSTEM ON PLYWOOD | POLYPAINT ON RUBBER GRANULES | COMBINED SYSTEM |
|---|---|---|---|---|---|
| **Image** |  |  |  |  |  |
| **Description** | Professional sprung timber floor | Sprung timber floor | Plywood-reinforced sprung timber floor hybrid | Polyurethane paint coating on rubber granules | Polyurethane multi-purpose floor |
| **Construction type** | Area elastic | Area elastic | Area elastic (modified by ply layer) | Point elastic | Combined elastic |
| **Complies with German DIN 18032** | YES | YES | NO | YES | NO |
| **European standard BS EN 14904 class rating** | A4 | NO | NO | NO | NO |
| **Relevant precedent** | EA Networks Centre (Ashburton) (3,000$m^2$) | Solid Energy Centre (Westport) (1,400$m^2$) | The Trusts Arena (Auckland) (4,900$m^2$) | PowerNet Sports Arena (Balclutha) (3,500$m^2$) | Apollo Projects Centre (Christchurch) (~900$m^2$) |
| **Typical warranty** | Up to 25 years | 5 years | 5 years | 10 years | 7 years |
| **Maintenance** | MED | MED | MED | LOW | LOW |
| **Cost** | HIGH | MED | MED | MED | MED |
| **Level of competition** | International | Schools and training | Schools and training | Schools and training | Schools and training |
| **Comments** | Requires temporary protection if space is to be used for exhibitions and seated events<br>Closer blocking required for multi-purpose facilities | Not suitable for national-level events<br>Requires temporary protection if space is to be used for exhibitions and seated events | Not suitable for national-level events<br>Requires temporary protection if space is to be used for exhibitions and seated events | Multi-purpose synthetic surfaces are more suitable for sports such as tennis and futsal<br>Requires additional protection | Multi-purpose synthetic surfaces are more suitable for sports such as tennis and futsal<br>Requires little or no additional protection |

| SYSTEM | CLIP SPRUNG TIMBER FLOOR | COMBI STRANDBOARD | POLYPAINT ON POLYRUBBER | ACRYLIC PAINT ON CUSHIONED RUBBER | PLASTIC FLOOR TILES |
|---|---|---|---|---|---|
| Image |  |  |  |  |  |
| **Description** | Sprung timber floor (shallow depth) | Sprung single-batten system with polyurethane rubber top | Polyurethane paint coating on polyurethane rubber | Acrylic paint finish over cushioned rubber | Plastic tiles |
| **Construction type** | Area elastic | Combined elastic | Point elastic | Point elastic | |
| **Complies with German DIN 18032** | YES | NO | YES | YES | NO |
| **European standard BS EN 14904 class rating** | Not published | NO | Not published | Not published | NO |
| **Relevant precedent** | Dance studios typical use<br>Lincoln University Recreation Centre (220m²) | None within NZ | Papakura Leisure Centre<br>(1,200m²) | | Kilbirnie Recreation Centre (Wellington) |
| **Warranty** | 10 years | 5 years | Up to 10 years | 5 years | 5 years |
| **Maintenance** | MED | LOW | LOW | MED | HIGH |
| **Cost** | MED | HIGH | MED | LOW | LOW |
| **Level of competition** | International | Events training | Events training | Events training | Schools and training |
| **Comments** | Requires temporary protection if space is to be used for exhibitions and seated events. Closer blocking may be required for multi-purpose facilities | Multi-purpose synthetic surface. Extremely robust surface<br>Water/moisture tolerant surface. Not suitable for national-level events | Multi-purpose synthetic surfaces are more suitable for sports such as tennis and futsal. Requires little or no additional protection | Multi-purpose synthetic surfaces are more suitable for sports such as tennis and futsal. Requires little or no additional protection | Not suitable for national events. Ideal for indoor and outdoor with very poor bases. Low floor height. Easily removed |

Notes:

Construction tolerances are +-3mm over 3m for most of these floor systems.

Sport England has developed planning guidance for sports halls including the process for selecting an indoor sports floor.

There are two DIN 18032 standards (the 1991 standard and the 2001 standard). A detailed comparison of the two can be found below:

http://asetservices.com/wp-content/uploads/2013/05/din-002_newdin.pdf

What is the difference between area elastic, point elastic and combined elastic?


The following guide lets developers understand the advantages of various types of aquatic flooring surface:

www.sportnz.org.nz/managing-sport/guides/guidelines-for-aquatic-flooring-surfaces

## Acoustics

### Introduction

A community sports facility must have appropriate acoustic conditions for its intended use. Participants, spectators and staff all benefit from sufficiently low background noise levels, as they make verbal communication easier to understand. This is especially critical for people with hearing impairments or learning difficulties, and also for training, teaching/learning situations and activities that are accompanied by music.

Compliance with district plan noise standards must also be achieved, or an appropriate case put forward to obtain consent to exceed those standards.

The acoustic conditions inside a community sports facility must be appropriate for the intended use. It is beneficial to all users that ambient noise levels are appropriately controlled and that verbal communication is easily intelligible, being especially critical for people with hearing impairments or learning difficulties. This is particularly important for training, teaching/learning situations and activities that are accompanied by music.

To achieve appropriate ambient noise levels and good speech intelligibility, the control of reverberation is a key factor. Another important factor is to achieve an appropriate reduction in noise intrusion from both outside the building and other spaces within the building such as plant rooms, fitness rooms and change rooms.

#### Reverberation Control

The acoustic quality of a room is most commonly described by its reverberation time. The reverberation time of a room is the time (in seconds) taken for an instantaneous sound event to decay by 60dB.

A room with a long reverberation time of several seconds will cause syllables to be prolonged so that they overlap and degrade speech intelligibility. Long reverberation times occur in large rooms with hard wall and ceiling surfaces. Adding sound-absorbent and diffusive materials will reduce the reverberation time and improve speech intelligibility.

Long reverberation times also increase the noise level within a room, which further decreases speech intelligibility. To compensate for this, people tend to increase their voice levels to make themselves heard over the reverberant noise, which further exacerbates the situation. This is a common feature of many community sports facilities with insufficient sound-absorbent surfaces.

To ensure that the reverberation times within a community sports facility are adequately controlled, design criteria and recommended locations of acoustic treatment are provided in Section 4 Build.

#### Internal Noise Levels

Elevated levels of noise within a community sports facility will cause greater masking of speech and therefore decrease intelligibility. It is possible to speak louder, but this effect is limited and can also lead to voice strain.

The two principal sources of noise within a community sports facility are likely to be external noise intrusion and noise from mechanical ventilation and building services. External noise intrusion is governed by the sound insulation of the building fabric and site conditions such as proximity to major roads and other sources of noise. Noise from mechanical ventilation and building services is dependent on the systems utilised. Design criteria for these sources are provided in Section 4 Build.

### Acoustic Separation Between Spaces

The provision of appropriate internal sound insulation, separating spaces that generate high levels of noise from those sensitive to noise intrusion, is important. Examples of spaces capable of generating high levels of noise are:

- Sports/pool halls
- Plant rooms
- Dance/fitness rooms
- Change rooms.

It is good practice, wherever possible, to separate these spaces from noise-sensitive receivers with buffer zones such as circulation spaces/corridors and storage areas. In most cases in these facilities, high-noise-level areas are separated in such a way. One direct adjacency that should be considered, however, is between the plant room and sports/pool halls. The primary aim should be to select plant with low noise-level emissions wherever possible. Once the plant has been selected, the appropriate sound insulation of the separating wall should be chosen to achieve the required noise criterion within the hall.

#### Control of External Noise Intrusion

Appropriate isolation from external noise sources such as traffic is desirable to minimise distraction and to create a comfortable environment. This is typically gained by assessing the external noise environment to determine the sound insulation performance of the building envelope necessary to achieve the internal noise-level criteria (refer Section 4– Build).

Other important considerations are noise generated from rainfall (discussed in Section 4 Build) and noise breakout from the facility to noise-sensitive neighbours. Designing the building envelope to control noise breakout depends on the proximity of noise-sensitive neighbours, the activities proposed to take place within the facility, operating hours etc. Further information on environmental noise limits is provided in the following section.

#### Planning Considerations

A community sports facility is usually required to meet environmental noise standards contained in the local district plan. These noise standards will vary depending on the zoning of the site and adjacent properties set out in the district plan.

Vehicle movements, external mechanical plant and outdoor activities are the primary sources of noise that usually require consideration. Generally, noise barriers such as earth bunds and solid fences can be used to mitigate noise from these sources effectively. Engaging a planning professional at an early stage to identify compliance requirements with local environmental noise standards is recommended.

Hosting amplified music events such as functions, wedding receptions and discos can sometimes be considered as an alternative income stream. However, the special design requirements necessary for such events to comply with relevant noise standards are generally not practicable for community sports facilities.

## Civil

The following types of drainage need to be carefully considered in the civil engineering design of any facility:

- Stormwater
- Wastewater
- Foul water.

The design of any drainage systems needs to meet the requirements set out in relevant design standards and codes, and also meet the special requirements of local authorities.

### Below-Ground Drainage

Detailed discussions will be required with the local territorial authority to establish the constraints for the drainage design.

The ability to discharge water to a public network depends on the location and invert of the network pipes relative to the site information, which can readily be obtained from the local authority. Important considerations include whether the site can drain by gravity or if a pumping station will be required.

The local authority can typically provide confirmation of the available capacity in the system to service the development.

a. Stormwater

The main issues with the surface-water drainage design will be common to those for any large building, ie, the volume of flow associated with:

- Run-off from carpark and other hardstand areas
- Roof drainage.

Depending on the site and surrounding drainage infrastructure, surface water may discharge:

- To a public stormwater system
- To a water body/river
- By infiltration to ground via soak pits (depending on ground conditions)
- Via a combination of the above.

If soak pits are used to dissipate surface-water flows, consideration must be given to future ground water levels and how these might affect the potential for floatation of the underground tanks.

b. Wastewater

Similar to stormwater drainage, the wastewater typically drains to a public network and similar considerations are required.

c. Foul Water

Foul water discharge may require a specific consent.

## Structural

### General Structural Considerations

Design life – 50 years is the typically adopted design life for new structures.

Importance level – new structures are designated an 'importance level', which helps to determine the various structural loadings that buildings are designed for. The importance level adopted for new buildings can depend on various factors, such as the number of occupants, size, use and post-disaster requirements. The importance level for sport and recreation facilities would most often be determined by the number of occupants who could congregate in a single area. A typical sport and recreation facility with areas where more than 300 occupants can congregate would be designed to importance level 3.

Limit states – new structures are required to be designed to two different levels defined below:

- Serviceability limit state (SLS) – considers the day-to-day loadings on the structure. Under this level of loading there should be no damage to the structure, and any deflections or vibrations of the structure would not be noticeable
- Ultimate limit state (ULS) – considers the life safety of the structure. Under this level of loading there could be significant damage to the structure and it may not be usable again, but there would be no collapse of the structure (or parts of it), allowing occupants to escape safely.

### Structural Design Standards

There are a number of codes and standards that need to be considered for the design of new buildings and swimming pool structures. It is expected that a competent design consultancy would be abreast of these required standards and would be able to apply them appropriately given the specific considerations of the chosen site.

We note that the facility owner may elect to have the building structures designed to a level greater than the minimum specified in the relevant codes and standards. This may depend on the specific conditions of and relative risks associated with each site. A competent design consultant can comment and make recommendations on this for each site as appropriate.

### Structural Design Loading

The following describes typical structural loadings that are required to be considered for the design of new structures. Design loads will need to be assessed for each project to take into account specific site conditions and building materials.

**Permanent and Imposed Loadings**

Gravity loads – includes all permanent material elements of the structure and building such as structural self-weight, building fabric, suspended services and ceilings and plant weight. The gravity load is calculated on a case-by-case basis depending on the type of building, its size and the types of materials.

Imposed loads – includes non-permanent or transient loads such as furniture, non-permanent partitions and people. The imposed loads vary depending on the use of the area, and are typically referred to as 'live loads'.

Variable loadings – snow, wind and earthquake loading will vary between sites throughout New Zealand and will therefore need to be assessed on a site-specific basis. A sites with a high snow, wind or earthquake loading will normally require an increase in the size of the structure to resist the higher loading.

The images below give an indication of the variability of snow, wind and earthquake loading throughout New Zealand. Red indicates a high-load zone, blue medium and yellow low. Site-specific design loadings will need to be determined for each facility on a case-by-case basis.

Snow loads

Wind loads

Seismic loads

Other loadings – others that may need to be considered, depending on the location and type of structure, include:

- Equipment
- Vehicle
- Soil-retention loads and hydrostatic pressures, particularly for pool structures.

## Materials

The three predominantly used construction materials for structural elements are:

**Reinforced Concrete**

Reinforced concrete will be used for building foundations in almost all circumstances, and can also be used for floors and above-ground structures.

**Structural Steel**

Structural steel is primarily used for above-ground structural elements.

**Structural Timber**

While timber is an extremely common residential construction material in New Zealand, its commercial and industrial application is not as common. However, advances in timber fabrication technology have meant that large structural timber applications are becoming more feasible. Structural timber is primarily used for above-ground structures.

## Site-specific Issues

Structural design is highly dependent on site-specific conditions, especially ground conditions, space constraints and geographic locations. These conditions influence the types of structural system and foundations chosen for a particular building form, which can in turn heavily influence the cost of construction and capital budgets. These site-specific conditions need to be carefully considered throughout the design, and even at the very early stages such as site selection. A number of structural options are presented for pool halls, pool tanks and sports halls below. These options are based on a number of general assumptions that would need to be considered on a site-specific basis for all new facilities. These site-specific issues are explained further below.

**Ground Conditions**

Ground conditions can be extremely variable throughout New Zealand, and even within cities. The options presented below assume:

- The ground has 'good' foundation-bearing capacity, ie, it is strong enough to support the foundations of the building, which in turn support the weight of the building. This type of ground would normally require cost-effective reinforced-concrete strip and pad footings underneath structural elements, embedded to a relatively shallow depth in the ground
- The site has a ground water level below the depth of any proposed building structures such as pool tanks and foundations. A site with a high water table can impose additional loads on structural elements of the building, especially pool tank structures, and can cause significant construction issues

- Liquefaction of the ground is not likely to occur during an earthquake. Liquefaction is a phenomenon that occurs when a site has a combination of a high water table and a loose, sandy-type soil when earthquake shaking occurs. Liquefaction can cause the ground to lose its strength, causing heavy structures (such as buildings) to sink, and light structures (such as in-ground pools and pipes) to become buoyant. As an example, widespread liquefaction occurred during the Canterbury earthquakes in 2010 and 2011, causing significant damage to many buildings and the below-ground infrastructure throughout the city.

It is strongly recommended that a geotechnical engineer be engaged to prepare a report on the ground conditions before any prospective site is purchased. Unfavourable ground conditions can lead to a significant increase in cost for a new sport and recreation facility.

### Building Size and Shape

The options presented below assume that the building is similar in size and shape to the reference facility (linear model) presented in this document:

- Relatively rectangular in shape
- Larger hall areas for the pool hall and sports courts, with lower-level ancillary areas for administration, plant rooms, change areas, storage and fitness areas
- The overall site is flat and has relatively generous space so that construction areas can be easily accommodated.

Other sites may be more space constrained and require more compact building arrangements requiring alternative types, or a mix, of building structures.

Many of the options presented are still applicable to different shapes and sizes building, but any influence of this would need to be considered by the design consultant on a case-by-case basis. Other options may be considered depending on the size, shape and use of the facility.

## Sports Hall

### Layout

Sports halls typically require relatively long-span structures to avoid columns disrupting court areas, and need to be high enough so that the roof structures do not impede the variety of sports that are often played in indoor court areas.

## Structural Elements

### Floor

The ground-floor structure for the sports hall would typically be a reinforced-concrete slab supported on the ground. This slab would need to be compatible with the chosen type of sports floor.

In some cases where the ground is good and a timber floor is chosen, this could be supported by a grid of short jack studs supported off the ground.

In cases where the ground is poor, the ground-floor structure may become integrated with the foundation system, in the form of a structural raft across the entire building footprint.

Some sports equipment, such as posts and goals, requires deep sockets within the floor slab. These are to enable the sports equipment to be put up and taken down as required to provide a flush floor surface when not in use. Localised foundations may be required for these specific locations and specific design will be required depending on the type of equipment needed.

Regardless of the specific site foundation requirements, special attention is needed to minimise potential cold bridging and to coordinate the floor structure with the foundations, the chosen sports floor, and any special sports equipment supports.

### Roof Structure

The roof structure typically comprises a lightweight cladding material supported on a series of purlins that are, in turn, supported by the main structural frame of the building.

The purlins could comprise either lightweight steel or timber, but lightweight steel is more commonly used due to its greater span capability.

The purlins would typically be designed to support any building services suspended from the roof structure such as air-conditioning ductwork, lights and fire sprinklers. Other suspended items such as sports equipment would need to be considered and designed for on a case-by-case basis.

### Walls

The wall cladding could comprise a number of different elements depending on the project-specific requirements. Structural elements of the walls are typically supported by the main building frame, and will need to be designed to support the cladding elements of the building and any sports equipment that needs to be fixed to the walls.

Wall structural elements could comprise lightweight steel girts supporting a light cladding, timber-framed walls or reinforced concrete panels depending on various requirements.

### Ancillary Areas

Ancillary areas of the building vary in size and include change rooms, entrance lobbies, storage areas, plant rooms, staff areas, fitness studios and the like. These areas are integral to the main structure, although they are typically lower in height.

These areas could be constructed from structural solutions similar to those outlined in the table below, and they would typically be structurally connected to the main sports hall structure.

## Other Specific Considerations

### Maintenance Issues

Special consideration should be given during the design to enable the structural elements, and the elements they support (such as suspended services), to be easily accessible for inspection and maintenance if necessary.

### Suspended Structures

Depending on the layout of the building, some suspended structures may be required. These structures could be in the form of mezzanine floors for plant areas or raised fitness studios. These areas would need to be considered on a case-by-case basis, with special consideration given to the structural layout to support the suspended floor and vibration of the floor if used for a fitness studio or similar activities.

## Pool Hall

### Layout

Pool halls typically require long-span structures to avoid columns disrupting pool areas, and need to be of moderate height to maintain the feeling of space and control humidity without having an uneconomical volume of air to heat/cooling.

The design of the building structures also needs to take into account the life span of the structure in conjunction with other elements of the building. In particular, it should be noted that the mechanical and electrical installations will probably have much shorter lives and full replacement might be expected at, say, 20-25 years. Ideally, the structural layout of the building should be designed to facilitate this.

### Early Design Considerations

In addition to the above, swimming pool buildings are very highly serviced with traditional mechanical and electrical installations, filtration equipment, associated balance tanks and distribution pipework, and specialist equipment associated with any competition use of the pool, eg, timing pads, movable floors and booms, underwater sound, lighting and cameras etc. Early meetings must take place with the client together with specialist consultants and sub-contractors to determine the effects that these elements could have on the structure and therefore cost. Accessibility requirements also need to be considered at the very early stages so that requirements can be incorporated into the pool tank arrangements.

## Structural Elements

### Floor

Care must be taken to allow room for the building foundations to be constructed without impeding the swimming pool tank areas.

## Other Specific Considerations

### Durability Maintenance Issues

Pool halls typically have very harsh, corrosive environments and special consideration should be given during the design to enable the structural elements, and the elements they support (such as suspended services), to be easily accessible for inspection and maintenance.

Care must be taken in the detailing of pool hall structures to avoid areas that could lead to the early onset of corrosion. Some examples of special considerations are:

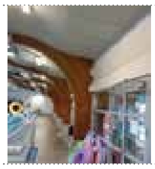
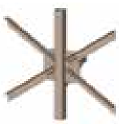
- Where possible, use hollow steel sections without sharp edges
- Columns in wet areas should be supported off a concrete nib that sits above floor level
- Concrete surfaces that meet steel elements should slope away from the steel elements to avoid moisture ponding against the steel elements
- A carefully considered paint system is required that is appropriate for the highly corrosive atmosphere
- All gaps and joints should be sealed with a suitable flexible sealant – careful consideration in the selection of sealants is required as many react with chlorine, leading to early failure
- Any suspended structures should be carefully detailed to limit potential corrosion or condensation that may not be readily visible.

### Stainless Steel and Galvanising in Swimming Pools

In general, stainless-steel should not be used for any structural application in swimming pools and associated wet areas without a very careful consideration of the grade used and the detailing of the proposed sections. Stainless steel is susceptible to stress corrosion cracking in warm, chlorine-laden atmospheres. This can cause rapid strength loss and sudden failure in members, in particular a failure of suspension hangers acting in tension. It should also be noted that stainless-steel exposed to a chlorine environment will stain with rust quickly if not cleaned on a daily basis. Note that stainless-steel is often used in structural situations where the structural engineer would not normally be consulted, eg, suspension rods for mechanical services, ceiling suspension systems, glazing brackets and wall ties/restraints, and similar considerations will apply.

Galvanising can readily be used in a pool atmosphere, but like stainless-steel it is prone to staining if not cleaned. Detailing of the galvanised steel is important in wet areas, as loss of galvanising can occur where metals with different electro-potentials touch.

## Sports and Pool Hall Main Framing Options

| TYPE | PORTAL FRAMES | | BRACED | | CANTILEVERED COLUMN | |
|---|---|---|---|---|---|---|
| **Description** | Comprises a series of structural frames regularly spaced along the length of the building. The rafters span the width of the building with no internal columns, and resist earthquake and wind loads by having a rigid 'knee' joint between each column and the rafter. Requires cross-bracing in the roof placed across the width of the building and down the walls of the building | | Comprises a series of columns around the perimeter of the building. The columns support a roof structure that spans the width of the building and could comprise deep steel rafters, steel trusses or timber beams. The columns are braced laterally to resist earthquake and wind loads, with either steel cross-bracing or reinforced-concrete panels acting as shear walls | | Comprises a series of columns around the perimeter of the building. The columns support a roof structure that spans the width of the building and could comprise deep steel rafters, steel trusses or timber beams. The columns have a rigid base connection and large foundations to provide resistance to earthquakes and wind | |
| **Material option** | Structural steel | Structural timber | Structural steel | Reinforced concrete | Structural steel | Reinforced concrete |
| **Image** |  |  |  |  |  |  |
| **Common construction type** | YES | NO | YES | YES | NO | NO |
| **Availability of material** | High | Medium | High | High | High | High |
| **Span capability** | High | Medium | High | High | High | High |
| **Column size** | Medium | Large | Small | Medium | Large | Large |
| **Rafter size** | Medium | Large | Large | Large | Large | Large |
| **Relative foundation size*** | Small | Small | Medium | Large | Large | Large |
| **Durability** | Average | Good | Average | Average | Average | Average |
| **Suitability in corrosive environment** | Medium | High | Medium | Medium | Medium | Medium |
| **Fire rating capacity** | Low | High | Low | Medium | Low | Medium |
| **Seismic resilience/ repairability** | High | Medium | High | Low | Low | Low |
| **Speed of construction** | Fast | Medium | Fast | Medium | Fast | Slow |

| TYPE | PORTAL FRAMES | | BRACED | | CANTILEVERED COLUMN | |
|---|---|---|---|---|---|---|
| **Ease of prefabrication** | High | Medium | Fast | Medium | High | Medium |
| **Aesthetics** | Medium | High | Medium | Low | Medium | Medium |
| **Relative cost** | Medium | High | Low | Medium | High | High |
| **Notes** | Cost-effective structural solution, requires high-spec paint system in pool atmosphere | Good durability performance. Several timber solutions available | Requires high-spec paint system. Can cause high, concentrated loads for foundations to resist | Good durability performance. Heavy structure causes large foundations and high earthquake loads | Structurally inefficient, large structural members required | Structurally inefficient, large structural members required |

Assuming 'good' ground each of the above options could be adopted in poor ground conditions, but the foundation system would need to be specifically designed to cope with the site-specific conditions of the ground and structure.

## Pool Tank Options

### General Engineering Requirements

As with any large structure, a swimming pool tank needs to be designed to cater for the traditional loads imposed for its location. Other specific loads also need to be considered and will depend on:

### Geotechnical Investigation

A comprehensive geotechnical study should be undertaken for all swimming pool projects. Where appropriate, this would also include a flood risk assessment. The investigation should include ground-water-level information.

If ground water levels are shallow then seasonal monitoring should be undertaken, as these levels will be critical in the assessment of potential floatation of the below-ground pool tanks when empty during planned maintenance shut-downs. The geotechnical investigation must also provide a detailed assessment of the likely differential settlement in the pool tank areas given the loading from the pool tanks.

### Differential Settlement and Movement

Different parts of the structure will be more or less tolerant to the settlement and movement of the structure. This should be assessed using traditional design methods, taking into account the finishes to the building. The swimming pool tanks will need to be considered separately. With 'level deck' construction the effects of any differential settlement around the pool tank are very visible. The design should allow for the effects of settlement when the pool tanks are emptied and filled, eg, taking into account the typically brittle nature of the finishes to the pool tank and the surrounds.

### Ground Conditions

This design guide assumes 'good', ground conditions, but if poor ground conditions are encountered they can have a significant effect on the designs and types of pool tank structure used. Specific considerations are needed for:

- Ground water level
- The effects of liquefaction and liquefaction-induced settlement
- Construction issues such as temporary retention of the ground and dewatering
- Ground improvement measures.

### Construction

Normal building tolerances will apply to the building generally, except where special finishes might be required, but special tolerances will apply to the pool tanks. If a pool tank is to be constructed as a competition pool, rather than as a community pool, more stringent tolerances would apply to the length of the tank and the flatness and verticality of the end walls. The level of competition should therefore be agreed with the client.

Once the level of tolerance has been determined, it is important for the design team to determine how this tolerance will be achieved. The final accuracy can be obtained using rendered finishes and the tiling, but to determine the size of the pool tank structure it is necessary to establish the type of finish early in the design process.

It is important to have a high level of on-site quality assurance, to ensure not only that tight tolerances are met but also that under-slab pipework is correctly installed and watertightness measures are adequately constructed. The design consultants may require a higher level of construction monitoring than is normally required for 'normal' buildings.

## Structural Engineering Considerations

### Foundations

The construction of foundations should allow for routing of underground services, especially filtration and drainage pipework.

The foundation solution needs to take into account the settlement requirements for the building frame and the additional, more onerous, requirements for any level deck channels. The foundation solutions for the two parts of the building may well be different based on the ground characteristics of the site. For example, the frame of the building might require a different foundation system from that of the pool tank to account for their different settlement requirements.

### Pool Tanks, Balance Tanks and Plant Rooms

As well as below-ground pool tanks, balance tanks and plant rooms may need to be constructed below ground level.

Elements that will need special consideration and coordination include:

- A well designed and detailed concrete tank, which would typically be designed for a life of 50 years. Some options, in particular the use of proprietary stainless-steel tanks, may have lifespans that are significantly shorter
- Filtration-associated works for the location and size of balance tanks, channels etc
- The arrangements for access to the pool so that the locations of steps, platform lifts, ladders, rest ledges etc can be incorporated into the pool tank design
- Details of any movable floors and/or booms (if any), which need to be understood at the very early stages of design
- The use of the pool and level of any competition requirement, which will need to be established at the early stages of design to enable the plan tolerances of the construction to be confirmed. High-impact water sports, such as canoe polo, can cause damage to the pool and finishes, which may have an influence on the type of pool structure and finish adopted
- The location and installation requirements of lane ropes (and their storage) and timing pads, as well as any fixings required for nets, goals, dive boards and the like required for multi-use aquatic facilities
- The falls to the pool surround slabs
- Other requirements that could affect the structure of the tank, including temporary starting blocks, underwater speakers, underwater lighting, underwater cameras, pool covers etc.

## Design of Swimming Pool Tanks

### Design

The design of the water-retaining elements must take into account conventional loadings applied to the structural elements and construction loads. Pool tanks need to be designed to be water retaining in accordance with specific design standards, and there are many specific loads that may need to be considered when designing to these requirements, such as:

- Earth pressure against tank wall and base
- Self-weight of the pool and supported structure
- Pool deck weight and associated live loads
- Seismic-induced loads on pool walls
- Frost heave pressure against pool slab (if in cold conditions)
- Liquefaction-induced loads and settlements (if in liquefaction-prone soil)
- Water pressures against tank wall and pool slab (if ground water level is high).

Pool surround slabs should be designed as water-retaining suspended slabs.

### Joints

The pool tanks and surrounds could have joints in the structural elements. These joints need to be carefully considered and detailed so that they maintain their watertight properties and the joints align with the aesthetic requirements of any finishes.

### Pool Tank Testing

Testing the pool tank is critically important, and an approved method of testing is set out in the relevant design standards. This method of testing should be followed precisely and the consequences of a failure of this test on the construction programme must be discussed with the main contractor. This may influence decisions made about the choice of sub-contractor and the proposed method of working.

## Pool Tank Options

The selection of a pool tank system must be considered in the context of the local site and ground conditions, the topography, the availability of experienced concrete pool contractors and future flexibility drivers, and then against the needs analysis and the facility's investment objectives.

The table below describes the two main options for commercial pool tank construction available in New Zealand.

| TYPE | REINFORCED CONCRETE | STAINLESS STEEL |
|---|---|---|
| **Description** | Most common method of pool tank construction for aquatic facilities worldwide. Consists of reinforced-concrete walls and a reinforced-concrete slab. Can be formed on-site, precast or constructed using the shotcrete method. Concrete pool tanks require a number of on-site trades | Prefabricated off-site and assembled quickly on-site, usually with integrated roll-out channels, drains and pipework. Tank walls generally comprise stainless-steel panels either bolted or welded together and the base of the tank made waterproof with a PVC (polyvinyl chloride) liner. This is a proprietary solution with one contractor providing design and installation services for the complete system. Also commonly used to retrofit existing pools |
| **History of use in NZ** | High | Medium |
| **History of use internationally** | High | High |
| **Difficulty of construction** | High | Medium |
| **Speed of construction** | Slow | Fast |
| **Expected lifespan** | 50+ years, many examples of concrete pools older than 50 years | 15-25 years, 1 – 2 examples internationally of stainless-steel pools approaching 50 years old |
| **Structural maintenance required** | Low | Low* |
| **Waterproofing** | Waterbars and sealants located at regular joint locations supplemented with additives in the concrete | Typically has PVC floor liner and either bare stainless-steel walls fully welded or bolted together with joints sealed or PVC liner over stainless-steel |
| **Waterproofing maintenance required** | Grout and sealant replacement every 10 years and intermittent repairs to damaged tiles | PCV liner replacement every 15-20 years |
| **Compatibility with poor ground**** | Poor | Poor |
| **Finish** | Generally tiled (unlimited selection) | Bare stainless-steel or PVC in limited colours – some applications can be tiled |
| **Suitability for sites with high water table** | Medium | Low |
| **Flexibility to create free forms** | Medium | High |
| **Mechanical/impact resistance** | Low | Medium |
| **Maintenance/repair ability of pipework** | Poor | Average |
| **Future flexibility** | Poor | Average |

* Additional protection may be required in aggressive ground conditions.

**Sites with poor ground such as liquefaction-prone soils and sloping sites generally require a special foundation design, regardless of the type of pool tank chosen.

## Mechanical HVAC Services

### Introduction

A typical community sport and recreation facility will require Heating Ventilation Air Conditioning and Circulation (HVAC) of typical community sports facilities. This section provides a brief overview of comfort conditions, appropriate types of system available, the usability of systems, and a brief assessment of each option outlining advantages and disadvantages.

A detailed description of HVAC system options for the various spaces and facilities is provided later in this section.

### Key Design Decisions

Sports facilities, in particular aquatic centres, are high users of energy and due to their corrosive environment can be high maintenance.

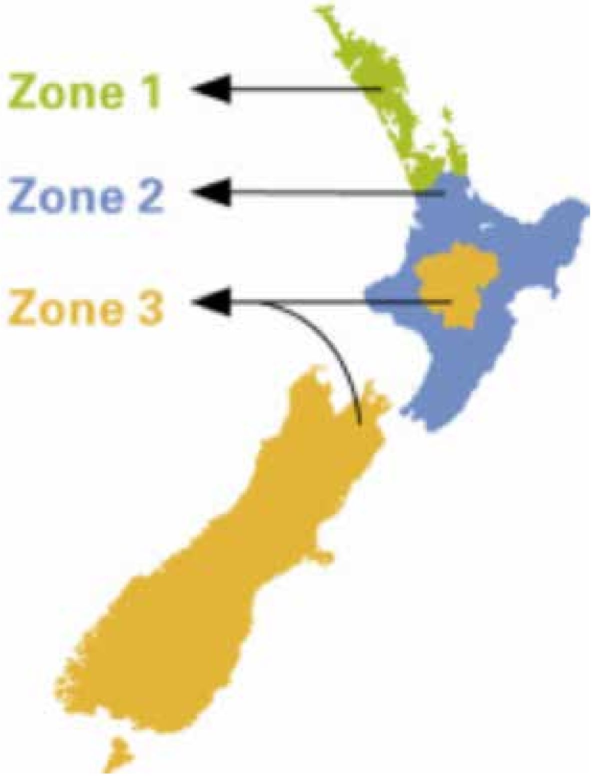
At the outset of the design some key design decisions need to be reviewed by the design team, such as:

- What are the appropriate systems to use that are robust, meet the client's performance criteria and can be serviced and maintained and replaced (some systems will not last for the life of the building) for the life of the building?
- What are the optimum systems for balancing the capital and running costs for the life of the facility? A lower capital cost may result in very high running costs for the facility, placing a high financial burden on the local community
- Consider engaging the design team to carry out a life-cycle cost analysis for the facility to reach a comfortable balance between capital and running costs
- Place special emphasis on the pool systems as they are the highest users of energy in the facility. Consider ESD (environmentally sustainable design) features such as reducing pool heating loads and building envelope heat losses/gains through the use of pool covers, pool hall ventilation, heat recovery and filter backwash systems.

### Design for External Conditions

External temperature conditions in both summer and winter vary considerably in different locations in New Zealand. The figure below, taken from NZS 4218 - Energy Efficiency - Small Building Envelope, shows assigned climate zones, generally relating to the typical winter external temperatures, with Zone 1 being the warmest and Zone 3 the coldest. Refer to the National Institute of Water and Atmospheric Research (NIWA) at www.niwa.co.nz for detailed weather data for each region/centre.

In choosing the most appropriate HVAC solution for each space within the sports facility, the location, prevailing winds and site microclimate should be assessed as these factors will affect the system type and performance.




Climate zones (source: NZS 4218)

- Zone 1: Northland, Auckland, Franklin District and the Coromandel Peninsula
- Zone 2: The North Island except the Central Plateau
- Zone 3: The Central Plateau of the North Island and all of the South Island

## Internal Design Conditions

There is a wide range of acceptable environmental conditions for sport and recreation facilities, with international bodies such as ASHRAE (the American Society of Heating, Refrigerating and Air-Conditioning Engineers) and CIBSE (the Chartered Institution of Building Services Engineers) providing a range of expectable indoor design temperatures and ventilation rates. These are summarised in the table below.

### Internal Design Conditions

| | INTERNAL DESIGN CONDITIONS | | | | |
|---|---|---|---|---|---|
| | TYPICAL OCCUPANCY DENSITIES ($M^2$/PERSON) | TYPICAL WINTER TEMP MIN | SUMMER TEMP MAX | MIN FRESH AIR L/S/PERSON | TYPICAL SCHEME |
| **Sports hall** | 20 (per court) | 12-16°C | 3-4°C above ambient | 12 | • Natural ventilation or mechanically assisted natural ventilation<br>• Heating system designed to work effectively in space up to 12-13m high |
| **Fitness centre** | 4-5 | 17-18°C | 24°C | 20 | • Heating and cooling + mechanical supply and extract ventilation with heat recovery<br>• Consider natural ventilation with ceiling fans and radiant heating |
| **Dry change rooms** | N/A | 16-20°C | N/A | >6 | • Heating only + mechanical supply and extract ventilation with heat recovery |
| **Wet change rooms** | N/A | 23-26°C | N/A | >6 (but no less than the extract air rate for wet change areas) | • Heating only + mechanical supply and extract ventilation with heat recovery |
| **Admin offices/retail** | 10 | 22°C | 24°C | 10 | • Heating and cooling + mechanical supply and extract ventilation with optional heat recovery<br>• Consider natural ventilation with ceiling fans and radiators, underfloor or radiant heating |
| **Café** | 1-2 | 20°C | 24°C | 10 | • Heating and cooling + mechanical supply and extract ventilation with optional heat recovery<br>• Consider natural ventilation with ceiling fans and radiators, underfloor or radiant heating |

## Ventilation

### Fresh Air Supply

For all occupied spaces, a form of ventilation is required to supply fresh air to suit the number of occupants and the activity to remove odours, prevent condensation and provide sufficient oxygen within the space. In addition, ventilation rates can be increased over and above the fresh air requirements to assist with cooling/limit gains, limit overheating and increase occupant comfort via temperature control and air movement.

The ventilation system could be designed to vary according to the occupants' needs at any given time, without introducing large volumes of cold air to the space that may cause discomfort and high heating loads.

### Extract Ventilation

Ventilation is required to remove contaminants and odours from rooms such as toilets, kitchens and change rooms. It is typically achieved through mechanical extract ventilation to guarantee sufficient air change rates under all conditions, but in some instances could be achieved through natural ventilation.

### Natural Ventilation

Natural ventilation can be used to provide the required outdoor air to the occupants and also to reduce overheating through increased air change rates. For an affordable sports facility, natural ventilation should be considered wherever possible in lieu of mechanical and/or air-conditioning systems due to lower capital, running and maintenance costs when compared with mechanical ventilation.

To maximise the use of natural ventilation, consideration should be given to less stringent internal conditions than those stated in the table above. However, as this could result in overheating/undercooling for a certain percentage of the year, it is imperative that this be communicated to and fully understood by all involved parties and it be agreed that the associated benefits outweigh the downsides.

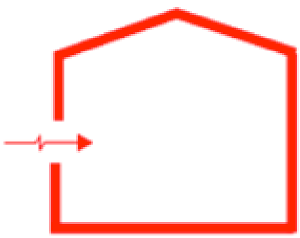
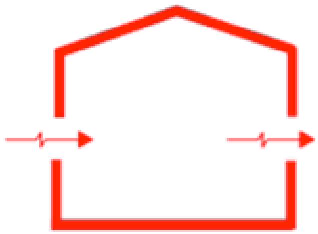
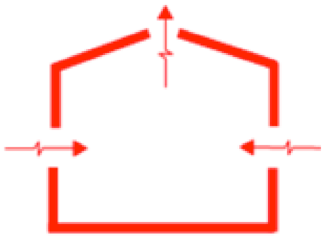
In principle, natural ventilation can be suitable for:

- Sports halls
- Health and fitness centres
- Offices
- Reception/entry/foyer.

Typically, natural ventilation is more suited to spaces located at the perimeter façade where operable windows and wind pressure are available.

During the design, the positioning and sizing of openings along with the operation strategy is critical to ensure that an appropriate natural ventilation scheme is applied to each specific space. The table below briefly covers the forms of natural ventilation and their suitability for the various sports facility spaces.

## Natural Ventilation Strategies

| | SINGLE-SIDED VENTILATION | CROSS-VENTILATION | STACK-EFFECT VENTILATION |
|---|---|---|---|
| |  |  |  |
| **Description** | Openings on one side of the room only | Openings on both sides of the room | Low-level inlets and high-level outlets |
| **Airflow achieved** | Limited airflow through one opening only | Good airflow, differential wind pressure on opposing façade increases airflow through space | High-level outlets located in the roof or high level of the façade increase the air movement due to buoyancy, which will be the driving air movement force on still days with little or no wind |
| **Suitable rooms** | Limited to shallow rooms, eg, offices | • Suitable for deeper rooms<br>• Larger offices<br>• Sports halls<br>• Gyms | • Suitable for rooms with high ceilings, eg:<br>- Sports halls<br>- Gyms |
| **Typical opening type** | Windows | Windows, louvres | • Windows, louvres, roof lights<br>• Proprietary ridge ventilators can be used, installed at the high point of the roof, eg, Colt |
| **Typical control** | Manually operable windows | Manually operable windows, or actuator-driven windows or louvres provide an automated system | Actuator-driven windows, roof lights and louvres provide an automated system |

The table below highlights the options for the control and operation of natural ventilation systems.

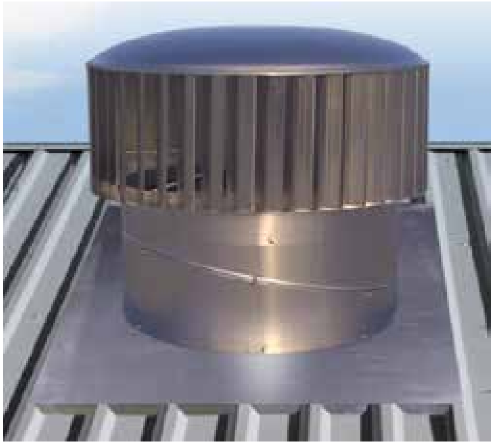
### Natural Ventilation Control Options

| | MANUAL OPERATION | AUTOMATED SYSTEMS |
|---|---|---|
| **Description** | Manual opening, closing and adjustment of windows or louvres to control temperature and account for weather changes | Actuators on inlets and outlets operate automatically to control internal temperatures and account for weather conditions. User override controls are typically provided via push buttons |
| **Cost** | Low | High |
| **Control** | Relies fully upon user interaction to open, close and adjust windows as required<br>Okay for small offices with low staff numbers<br>Can be onerous on staff in larger rooms. Often no ownership | Control doesn't solely rely on the users for operation<br>Actuators will operate before there is too much heat build-up that can result in high temperatures that are difficult to bring back down<br>Automated control can lead to complaints from occupants due to windows opening without perceived needs of occupant comfort |
| **Other** | | Facility for 'night venting' to utilise any exposed thermal mass, ie, opening the building overnight to purge the day's heat build-up and pre-cool the building for use the next day |

To maximise natural ventilation performance the following should be considered:

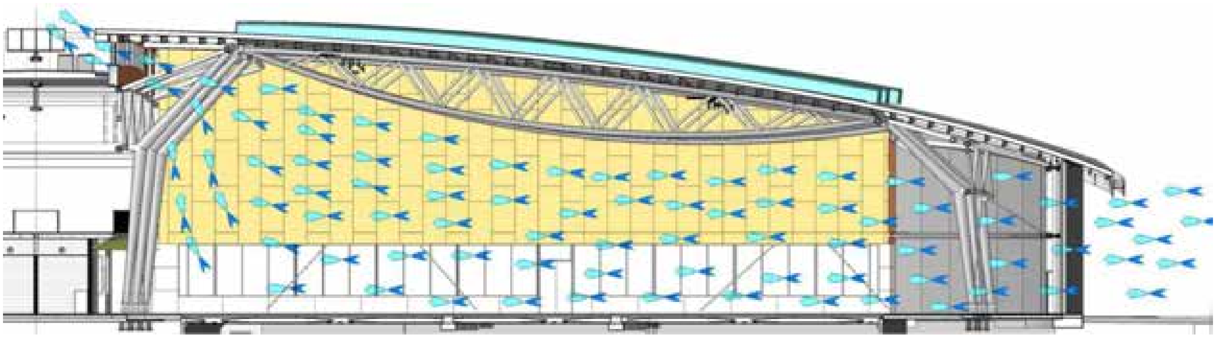
- Good façade thermal performance to limit solar gain in summer (sun high in the sky), but allow beneficial winter solar (sun low in the sky) gain where this is desirable. Achieved through external shading, glazing specification etc
- Good façade insulation performance, increased insulation than code minimum to both reduce heat loss in winter and reduce heat gain in summer. Consider light-coloured roof and walls to reflect solar heat gain
- Ensuring air movement through correctly sized and positioned openings to suit the room size, occupancy, shape and form
- Using thermal mass in a beneficial manner for concrete floors and/or walls, to increase mass and absorb some daytime heat gain. Owing to the New Zealand climate, a balance of thermal mass is required to allow for the building to absorb heat in summer but not be too heavy/slow to heat up in winter. In addition, New Zealand typically has a high summer daily temperature range (around 10°C) and this provides the opportunity for night cooling of mass through automated windows
- Using ceiling/wall-mounted fans to increase air movement and comfort levels, as occupants can tolerate higher temperatures with increased air velocity
- Air scoops, wind-driven turbines, wind pressure.

Passive ventilation air scope (source: Passivent)



Roof turbine (source: Edmonds Ventilation)

With suitable shading and sufficient openings, internal conditions can typically be kept down to within 3-4°C of external temperatures without mechanical cooling, but heating is still typically required. The addition of ceiling fans for increased air movement will also increase occupant comfort levels.



The ASB Sports Centre in Wellington has two six-court sports halls that are naturally ventilated.

Potential issues for consideration:

- Security of open windows
- Draught and wind issues causing discomfort
- Manual operation requires user interaction, automated operation can be costly
- External noise issues affecting users
- Noise emanating from the sports hall to adjacent properties, sports hall whistles etc
- Ventilation rates are not guaranteed as the external conditions affect performance.

## Mechanically Assisted Natural Ventilation

Consideration should be given to mechanically assisted natural ventilation where there is limited scope for openings in the façade or no opportunity for high-level openings.

The addition of a high-level mechanical extract system promotes airflow on still days when limited air movement occurs in a natural ventilated system. This can be useful where ceilings are lower and there is limited scope for warmer air to rise and stratify at a high level above the occupants.

## Full Mechanical Ventilation

In some instances natural ventilation will not be an appropriate solution and a full mechanical ventilation system will be required. Typical drivers are likely to be:

- Privacy required or external noise nuisance not acceptable – opening windows not acceptable
- Rooms located internally – no scope for openable windows
- High density of people cannot be cooled or ventilated adequately by natural ventilation.

## Heating and Cooling

Heating and cooling should be provided to achieve the internal design conditions as outlined earlier in this section, while accounting for the specific building form and site location. Refer to the HVAC options for individual spaces and the pros and cons of each system as outlined in this section.

## Primary Energy/Fuel Source

During the concept phase, local utilities should be contacted and the available fuel source options determined; this will then dictate the HVAC options considered.

Typical fuel source options are listed in the table below.

## Fuel Source Options

| | PIPED NATURAL GAS | LPG | ELECTRICITY | DIESEL | BIOMASS |
|---|---|---|---|---|---|
| **Description** | Below-ground piped natural gas network. Limited natural gas distributed nationwide | LPG in numerous 45kg bottle banks or bulk storage via large tank | Connection to grid | Diesel storage tank, refilled by fuel tanker | Locally sourced wood pallets or woodchips |
| **Key factors** | Provider to confirm available capacity in local network. New connection often free subject to location and estimated usage | Bulk storage tanks typically cost prohibitive. Delivery and replacement of 45kg cylinders can be costly – determine annual requirement and local costs | Provider to confirm available capacity in local network. Connection will be required for lighting and power regardless, but a transformer may be needed depending on requirements | Potential for diesel spillage may not be in keeping with environmental requirements of site. Usually considered as a back-up fuel source for gas boilers | Systems costly and require high level of user interface as well as time sourcing the fuel. Often reliant on a sole supplier for fuel. Considered carbon neutral |
| **Heating options** | Gas radiant heaters at high level (good for sports hall)<br>Gas boiler serves radiators or underfloor heating to ancillary areas. Low temperature hot water (LTHW) heating coils to air-handling units (AHUs) and mechanical ventilation systems, panel heating | As per natural gas | Electric radiant panels at high level (height limited)<br>Packaged roof-mounted heat pumps<br>Split heat pump systems<br>Variable refrigerant flow (VRF) systems<br>Local electric heaters | Diesel boiler serves radiators or underfloor heating to ancillary areas. LTHW heating coils to AHUs and mechanical ventilation system, pool heating | Wood boiler serves radiators or underfloor heating to ancillary areas. LTHW heating coils to AHUs and mechanical ventilation systems, pool heating |
| **Cooling options** | N/A | N/A | Packaged roof-mounted heat pumps<br>Split heat pump systems<br>VRF systems<br>Chillers | N/A | N/A |
| **Relative cost of energy** | Low | Medium | Low for cooling<br>Low-high for heating. Low for heat pumps, high for electric heaters | Low (but potential price volatility) | Low-high (can have large variations depending on location and availability) |

## HVAC Options for Individual Spaces

### Sports Hall

#### Design Considerations

Community sports halls are typically large-volume spaces with high ceilings/roofs and multiple external walls. They are used for a variety of activities at different times throughout the year.

Ventilation is required to remove the players' body heat and odours, supply fresh air, keep spectators cool (where applicable), maintain comfortable summertime conditions and prevent condensation. The ventilation system should be designed for controlled ventilation rates that can vary according to the occupants' needs at any given time, without introducing large volumes of cold air into the space that may cause discomfort and high heating loads.

As the internal temperature range for a sports hall is broad, with sufficient ventilation, strict control of internal temperatures should not be required. For some activities and/or in certain periods of the year heating will be required to maintain comfort conditions but, subject to the location and the building design, this could be for minimal periods only, in which case heating could potentially be viewed as a 'nice to have'.

As there is potential for the space to be used for sports such as badminton, a draught-free playing area should be considered with velocities less than 0.1m/s, which favours a well designed natural ventilation system.

#### HVAC Options

Gas-fired radiant overhead heaters are the preferred heating solution where piped natural gas is available. The heaters react quickly, heat surfaces rather than air (a similar heating method to the sun) so are ideal for large-volume spaces, are located at a high level to avoid court interference, and can be directional or zone-specific so they can serve side line spectators rather than the whole space if desired.

Such systems can be future-proofed by installing gas pipework, with the aim of installing the heaters at a later date should heating be required. Where retractable basketball rings form part of the sports hall, care should be taken in the positioning of the heaters.

Electric radiant heaters are an alternative, although running costs will be significantly higher (refer to the table below for heating comparisons).

Underfloor heating is not considered suitable for this type of space. However, given this does not integrate well with a sprung floor, the system is slow to react and the space heating requirements are likely to be intermittent.

Mechanically assisted natural ventilation, or full mechanical ventilation, with high-level extract fans should be also considered as an alternative as this can reduce the number of façade openings.

Air-conditioning with exposed ductwork, jet diffusers and fabric ductwork is an alternative where good temperature control is required. However, this is costly and more appropriate to a high-level or international sports facility with large volumes of spectator seating and tight temperature-control requirements.

With any option it is important to utilise solar shading and the thermal mass of the building to help keep the building at a comfortable temperature and control operational energy costs.

## Ventilation Strategies for Sports Halls

| ATTRIBUTE | NATURAL VENTILATION | MECHANICALLY ASSISTED NATURAL VENTILATION | MECHANICAL VENTILATION/AIR-CONDITIONING |
|---|---|---|---|
| **HVAC system** |  |  |  |
| **Description** | • Louvres are provided to assist in natural movement of air through the space<br>• Cross-ventilation and stack-effect required to be effective in all conditions<br>• Mechanically actuated low- and high-level louvres<br>• Can be driven by wind through optimising the orientation or air pressure differences between the internal and external air<br>• Aerofoil on the roof cover, natural ventilation openings in the centre ceiling to stop rain entering | • Mixed natural and mechanical ventilation system<br>• Supply air provided through windows or louvres<br>• Exhaust air fans at high level to assist with extracting exhaust air from a space<br>• Allows for smaller openings in one side only<br>• Provides a minimum level of air movement on still days<br>• High-volume, low-velocity ceiling fans can provide an increase in thermal comfort with this option | • Supply of conditioned air with exhaust fans within each space<br>• Can be integrated with heat recovery to pre-heat air supply from the exhaust air<br>• Air can be heated or cooled |
| **Cooling plant** | Cooling provided via passive natural ventilation | Cooling provided via passive natural ventilation with mechanical assistance from fans | Yes – can incorporate cooling |
| **Heating plant compatibility** | Works well with radiant-type heating systems | Works well with radiant-type heating systems | • Yes – air source heating via packaged heat pumps or AHUs with LTHW heating coils<br>• Heat recovery can be included |
| **Outdoor air ventilation control** | Poor ventilation control on still and windy days | This system can operate effectively as part of a natural ventilation system or mechanical ventilation system | Good control |
| **Building integration** | • Poor<br>• Numerous openings need to be coordinated with architecture | • Average<br>• Openings to be coordinated (note fewer façade openings required) | • Good<br>• Duct layout is flexible – space required for plant |
| **Relative capital cost** | Low | Low-medium (fewer façade openings required) | High (cost of plant and ductwork) |

| ATTRIBUTE | NATURAL VENTILATION | MECHANICALLY ASSISTED NATURAL VENTILATION | MECHANICAL VENTILATION/AIR-CONDITIONING |
|---|---|---|---|
| **Relative running cost** | Low | Medium (running cost of fans) | High (depends on level of control) |
| **Replacement period** | 50 years | 25 years | 15 years |

## Heating and Cooling Options for Sports Halls

| ATTRIBUTE | HIGH-LEVEL RADIANT HEATERS | HIGH-LEVEL DUCTED SUPPLY WITH JET DIFFUSERS |
|---|---|---|
| **HVAC system** |  |   |
| **Description** | Dependent on climate and use, halls may or may not need supplementary heating or cooling beyond the ventilation requirements<br>Options for heating are:<br>• Radiant heating panels can be located either on the ceiling or at a high level on the walls<br>• Require gas or direct electric heating, which can have high operating costs<br>• Good response time<br>• Can be directed to heat specific areas<br>• Works well with natural ventilation systems | • Ducts located at high level to meet heating, cooling and ventilation requirements<br>• Jet diffusers are typically mounted at high level on the wall and are effective to a depth of 20-30m<br>• The air supplied can be either hot or cold to meet the space requirements<br>• Can do 'free cooling' in full fresh air mode |
| **Cooling** | Natural ventilation | Chiller or packaged heat pump |
| **Heating** | Gas or electric heaters (gas preferred); this will be driven by regional availability in NZ | Boiler or packaged heat pump |
| **Aesthetics/ building integration** | Good (limited impact at high level) | Moderate (ducts, diffusers and plant to be coordinated) |
| **User comfort** | Moderate | Good |

| ATTRIBUTE | HIGH-LEVEL RADIANT HEATERS | HIGH-LEVEL DUCTED SUPPLY WITH JET DIFFUSERS |
|---|---|---|
| **Noise** | Low (care needed with gas-fired) | Low |
| **Relative capital cost** | Medium (gas)<br>Low (electric) | High |
| **Relative running cost** | Medium (gas)<br>High (electric) | High (can be very high if not operated carefully – staff must be knowledgeable) |
| **Estimated economic life** | 20 years | 15-20 years |

## Fitness Centre

### Design Considerations

Effective ventilation is usually the most critical factor because of the metabolic heat gains, body odour and humidity that can rapidly occur in such spaces. However, with fitness centres, gyms and studios the design set-points are often lower than those for sports halls and it is generally accepted that air-conditioning is required to meet the design conditions and the high level of activities.

Furthermore, these spaces can have a significantly higher occupancy density than sports halls and it is critical to meet the fresh air requirements of users who can range from a few people to many, and change in a very short period throughout the day.

Ventilation and thermal façade performance should be carefully considered to minimise the risk of condensation in these spaces specifically, given the low temperatures and high humidity levels associated with the activities within the space.

### HVAC Options

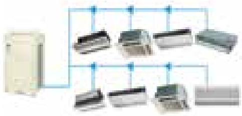
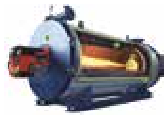
For smaller facilities, multi-heat pump systems (such as VRF) or small modular heat pumps (such as domestic-style split direct expansion air-conditioning [DX] systems) are a cost-effective solution to provide local zone temperature control. Mechanical ventilation will be required to work in conjunction with these systems in order to provide fresh air and achieve sufficient air change rates. This could be achieved through common AHU-ducted systems through walls or roof fans or fresh air units complete with in-built heat recovery solutions.

For larger sports centres, typically either variable air volume (VAV) or fan coil units are used to provide the air-conditioning. Both these systems provide good air movement and close temperature control. Also, both these systems require central air-handling plant along with central heating and cooling plant, which may not be appropriate for smaller facilities. Another large-space solution for open-plan health and fitness centres is a constant air volume system. Options include packaged ducted heat pump units providing both heating and cooling and AHUs with heating and cooling coils served via a central plant. Air-side free cooling or an economiser operation helps to assist in reducing cooling energy consumption. Heat recovery, $CO_2$ control and an economiser operation are all enhancements to these systems to conserve energy and reduce running costs and should be considered.

Natural ventilation or mechanically assisted natural ventilation complete with ceiling/wall-mounted fans could be considered as a cost-effective alternative to air-conditioning. Although internal temperature conditions will not always be maintained, user comfort could be increased through the increased air movement provided by ceiling- or wall-mounted fans. If natural ventilation is considered, site location and adjacent boundaries should be reviewed with respect to gym noise or music causing a nuisance to neighbours, particularly as these facilities operate extended hours and on weekends where council noise criteria become more onerous.

Where fitness rooms have distinct zones for cardio and weight training facilities, to reduce air-conditioning costs an alternative is spot cooling of cardio zones while allowing weight training areas to operate at higher temperatures that are more tolerated by the users.

## HVAC Options for Fitness Centre

| ATTRIBUTE | VRF WITH MECHANICAL VENTILATION | SPLIT OR MULTI-SPLIT HEAT PUMP WITH MECHANICAL VENTILATION | PACKAGED HEAT PUMP UNIT | FAN COIL OR VAV UNITS WITH CENTRAL PLANT |
|---|---|---|---|---|
| |  |  |  |    |
| **Cooling plant** | VRF – heat recovery energy savings can be possible | Split/multi-split heat pump | Heat pump | Chiller |
| **Heating plant** | VRF – heat recovery energy savings can be possible | Split/multi-split heat pump | Heat pump | Boiler or heat pump chiller |
| **Complexity** | Medium-high | Low (local contractors are familiar with these systems) | Medium | High |
| **Suitable-sized sports facility** | Medium | Small | Small-large | Large |
| **Aesthetics/ building integration** | Good<br>Minimal external plant | Moderate<br>Many small outdoor units | Moderate | Space for central plant required |
| **User comfort** | Good | Good | Good | Best-practice |
| **Noise** | Moderate | Moderate | Moderate | Moderate |
| **Relative capital cost** | Medium | Low | Medium | High |
| **Relative running cost** | Medium-low | Medium | Medium | Low |
| **Estimated economic life** | 12-15 years | 10-15 years | 15 years | 20 years |

## Change Areas and Toilets

Change rooms need to be mechanically or naturally ventilated to control odour and condensation issues. The change rooms need to be heated to provide thermal comfort to the users.

## HVAC Options

The following ventilation options can be considered for the change room:

- Natural ventilation – this should be considered for smaller, low-occupancy, perimeter change rooms
- Mechanical ventilation – this system should ideally be designed to achieve 10-15 air changes per hour in the change room area. Ideally, the change rooms should be zoned so that supply air is provided to the change areas and exhausted from the toilet and shower facilities. Supply air will be mechanically tempered supply air either drawn directly to the space from outside or, where appropriate, drawn from the surrounding rooms.

Space heating, if desired, within the change rooms can be achieved with one of the following options:

- High-level radiant heaters provide a lower-cost option with a quick response time. This system would require gas or direct electric heating and would not be able to take advantage of the low-cost heating energy available from any central heating and cooling plant. It works well for smaller, naturally ventilated change rooms. Owing to the high ventilation rates within change rooms this is the preferred choice from an energy efficiency point of view.

Less preferred heating options due to high change room ventilation rates removing the heated air are:

- Local wall-mounted radiators with temperature regulating valves, which provide good comfort levels and local control to each room. A central boiler is required to provide a high-temperature heat source.
- Underfloor heating system – this may not have the lowest operating and maintenance costs but it can provide a high-quality environment, minimising moisture build-up on the floor. Underfloor heating can be costly, and heat output can be limited in areas with higher internal temperatures such as wet change areas.

## Administration Areas/Offices/Retail Spaces

These spaces often require air-conditioning to meet the thermal requirements of each space, but with planning and locating these spaces on the perimeter, natural ventilation with perimeter heating should be considered. Outdoor air will be required to each space based on the occupancies, allowing for any intermittent usage factors.

## HVAC Options

- **VRF, split system and multi-split systems** – cost-effective solutions that provide good individual control and can be specified with small-scale central control monitoring systems. Simultaneous heating and cooling can be provided across rooms with heat recovery. Fresh air is provided via heat recovery ventilation units forming part of the system. Local installers are often familiar with these systems and have the skill-set to install these systems
- **Fan coil units** – this is the traditional method of providing air-conditioning to an office space and can provide a good level of individual control in cellular spaces. Requires central heating and chilled water generation and pipework distribution; not cost-effective for small facilities
- **Variable air volume system** – this system works well in areas where occupancy levels can vary significantly and may be appropriate for waiting areas and meeting rooms. Requires central heating and chilled water generation and is normally cost-effective only in larger facilities
- **Natural ventilation with perimeter heating through local radiators or underfloor heating** – this should be considered for perimeter zones, with careful design of the building mass, shading and windows to ensure overheating is somewhat reduced

## Reception, Foyer and Entry Areas

These spaces are transitory and as such temperature control of the whole space may not be required. This should be consulted on during the design stage to determine user and stakeholder requirements.

Natural ventilation with supplementary high-level ceiling/wall fans and radiant heating in occupied zones can work well in large-volume-type spaces.

Reception staff should be provided with local heating, and options such as wind lobbies and/or door curtains assist with reducing discomfort due to draughts. Wind lobbies are preferred over door curtains due to the very high energy use of air curtains.

Entry areas are often designed with large areas of glazing, and in such cases care should be taken to both mitigate potential cold down-draughts in winter and reduce overheating in summer. The location of these in respect to the site and prevailing winds should be considered early in the design process (ie, master planning stage).

Where areas are enclosed or densely occupied for significant periods, air-conditioning is likely required.

## Café Areas

The type of café can greatly influence the level of HVAC services. A 'heat and eat' type catering kitchen does not usually require a commercial kitchen extract hood, whereas kitchens with commercial cooking appliances such as deep fryers require commercial extract hoods and exhaust systems. This needs to be considered and agreed during the design by the users and stakeholders etc.

Seated café areas will require outdoor air and conditioning similar to the requirements of the administration and office areas. Where café seating forms part of a foyer, strategies as described above apply.

## Dry Storage Areas

Mechanical extract ventilation.

## Plant Areas

Natural ventilation via louvres in the façade to limit overheating. Provide high and low louvres in accordance with the gas standards where gas boilers are located in the plant room.

## Pool Hall Ventilation and Heating

Pool heating in aquatic centres encompasses pool water heating and pool hall space heating. It is critical for bather comfort and health while being a major consumer of energy. Pool hall space temperature and humidity are always a compromise between bather comfort, spectator comfort, pool-side staff expectations, condensation control and energy use.

To ensure an efficient aquatic facility it is critical that the façade elements are selected for a high level of thermal performance, such as high R values, effective provisions to avoid thermal bridging and airtightness.

### Pool Hall Temperature and Humidity

Pool hall indoor temperatures are typically around 1-3°C higher than the pool water temperature(s), with humidity in the 50-70 percent range. Typically, pool halls are not heated above 32°C due to occupant discomfort and the energy associated with maintaining the elevated hall temperature.

Lower pool hall humidity mitigates condensation control and increases occupant comfort. However, lower humidity means increases in pool water evaporation, pool heating demand, required air change rate to control humidity etc.

### Ventilation Air Movement

The main aspects to be addressed by HVAC systems for the pool hall are:

- Aim for uniform space conditions in the occupied zone to promote bather comfort
- Minimise draughts in the occupied zone
- Reduce the level of disinfection by-products (DBPs) in the pool hall air for improved bather amenity
- Minimise condensation on the building fabric.

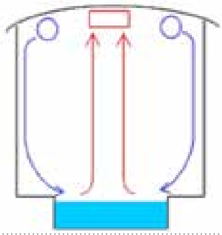
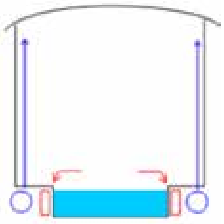
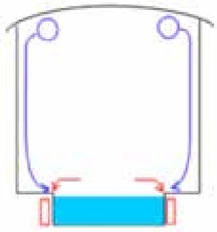
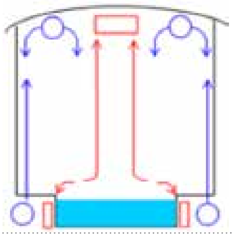
An awareness of the potential health effects associated with short- and long-term exposure to volatile DBPs is driving the current thinking of setting up the ventilation arrangement to assist in reducing the level of volatile DBPs in the bather zone. Some opportunities to improve the pool surface air quality are:

- Setting up the ventilation arrangement to assist in reducing the level of volatile DBPs in the bather zone
- Increasing the outside air intake for dilution and improved air quality.

Typically, pool hall ventilation systems have at least four to six air changes per hour to maintain appropriate humidity levels.

Pool halls should be maintained at a negative pressure with respect to the surrounding areas to minimise pool hall air migration to the dry areas of the facility. For the areas surrounding the pool halls, the respective HVAC systems shall be designed with a positive supply air ventilation system to minimise pool hall air ingress to these areas.

There are a number of traditional means of distributing ventilation air within the pool hall; the tables below discuss these in further detail.

| VENTILATION AIR DELIVERED | HIGH-LEVEL POOL HALL | LOW-LEVEL POOL CONCOURSE (DISPLACEMENT) | HIGH-LEVEL POOL HALL | HYBRID HIGH AND LOW LEVEL |
|---|---|---|---|---|
| EXHAUST AIR REMOVED | HIGH-LEVEL POOL HALL | LOW-LEVEL POOL EDGE | LOW-LEVEL POOL EDGE | HYBRID HIGH AND LOW LEVEL |
| |  |  |  |  |
| **Occupant comfort at pool concourse** | Average | Good | Average | Good |
| **Bather comfort/ effectiveness of DBP removal at pool surface** | Limited | Improved | Improved | Improved |
| **Effectiveness of mitigating condensation on façade** | Good – ductwork and diffusers can be directed to distribute air throughout the pool hall | Good where air vent is located below<br>Can be poor for high façade areas and ceiling structure | Good – ductwork and diffusers can be directed to distribute air throughout the pool hall | Excellent – mix of high and low-level air movement/ exhaust combines the best attributes of all systems |
| **Flexibility of air movement to tune system** | Usually excellent | Poor because ventilation air is often fixed to below floor tunnels/ducts | Poor because ventilation air is often fixed to below floor tunnels/ducts | Usually excellent |
| **Relative cost** | Low | Medium | Medium | High |
| **Buildability** | Traditional – therefore relatively easy | Increased complexity of build | Increased complexity of build | Increased complexity of build |
| **Impact on design** | Low – traditional design | High – pool edge drains require large duct connections<br>High – pool concourse requires large duct routes at low level, often introduces tunnels below concourse | High – pool concourse requires large duct routes at low level, often introduces tunnels below concourse | High – pool edge drains require large duct connections<br>High – pool concourse requires large duct routes at low level, often introduces tunnels below concourse |
| **Commonly used for community facilities** | Yes | No | No | No |

### Ventilation Ductwork Materials

Ductwork within the pool hall distributes the heated air throughout the pool hall; the table below outlines the options available.

| DUCT TYPE | GRP/PLASTIC DUCT* | PAINTED GALVANISED STEEL | FABRIC DUCTWORK | STAINLESS STEEL |
|---|---|---|---|---|
| **Relative cost** | High | Med | Low | High |
| **Maintenance requirements** | Low | Painted surface needs to be maintained | Low | Low |
| **Flexibility of air distribution** | Excellent | Excellent | Poor | Excellent |
| **Seismic bracing requirements** | Normal | Normal | Lower due to lower weight | Normal |
| **Specialist install** | Possibly | No | No | No |
| **Specialist suppliers** | Yes | No | Yes | No |
| **Commonly used** | No | Yes | Yes | No |
| **Expected life** | 20+ years | 15-20 years | 10-15 years | 20+ years |

* GRP – glass-reinforced polyester

### Air-Handling Units and Heat Recovery Options

AHUs are traditionally fan assemblies used to bring heated air into the pool hall and take exhaust stale air to the outside. AHUs typically consist of fans, air filters and heating transfer coils.

| TYPICAL AHU TYPES | PACKAGED ROOFTOP HEAT PUMP AHUS | PLANT-ROOM-BASED HEAT PUMP AHUS | PACKAGED PLANT-ROOM-BASED WATER HEATING AHUS |
|---|---|---|---|
| **Relative costs** | Medium | Medium | Medium |
| **Corrosion resistance** | Often factory-standard options offered. Careful consideration of durability of products needs to be checked with reference sites | Good, often units are specifically designed and fabricated as custom units so specific corrosion-resistant finishes can be carried out | Good, a number of local suppliers with proven history in NZ pools with specific corrosion-resistant finishes can be carried out |
| **Design flexibility** | Often limited factory options | Custom | Custom |
| **Local manufacture** | Often overseas supplied | Yes | Yes |
| **Typical life** | 15-20 years | 15-20 years | 20-25 years |
| **Ease of maintenance** | Good, but specialist parts may be required and reliance on local agent for support for life of product | Good, but specialist refrigeration staff often required to maintain system and provide support for life of product | Simple maintenance of common equipment such as fans, pumps and boilers |
| **Plant space requirements** | Roof plant space and structure required | Internal plant room space required | Internal plant room space required |
| **Possible integration of heat recovery** | Yes | Yes | Yes |
| **Common within NZ** | Yes | Yes | Yes |

Owing to the very high air volumes involved and the elevated air temperatures, pool hall ventilation systems are very energy intensive. Therefore a heat recovery system that transfers heat from the exhausted warm, damp air to the incoming fresh air and can save significant energy, reduce running costs and have relatively short pay-back periods is strongly recommended and should be considered during the design stage.

| COMMON AIR HEAT RECOVERY OPTIONS | RUN-AROUND COILS | AIR-TO-AIR HEAT EXCHANGERS | HEAT PUMP HEAT RECOVERY |
|---|---|---|---|
| **Relative efficiency** | Good | Good–excellent | Excellent |
| **Energy transfer medium** | Water | Air | Refrigerant |
| **Relative costs** | Low | Medium | High |
| **Co-location of fresh air and exhaust air streams** | No, design flexibility | Yes, design restriction | No, design flexibility |
| **Relative plant room spatial requirements** | Low | High | Medium |
| **Simplicity to operate** | Minimal moving parts consisting of a pump and control valves | No moving parts | Numerous moving parts within heat pump |
| **Simplicity to maintain** | Low | Very low | Medium-high |
| **Typical plant life expectancy** | 15-20 years | 15-20 years | 15-20 years |
| **Commonly used technology** | Common | Common | Common |

### Air-Heating Options

AHUs for pool halls typically require heating only. Heating can be provided in a number of ways and some options are discussed below:

| | HEAT PUMP | GAS-FIRED BOILER | BIOFUEL WOOD-BASED BOILER | GEOTHERMAL |
|---|---|---|---|---|
| **Energy source** | Electric | Natural gas or LPG | Wood (pellets or chips) | Geothermal |
| **Availability of energy source** | Good | Good | Depends on location | Depends on location |
| **Winter heating performance** | Poor–good | Good | Good | Good |
| **Heat recovery cooling option** | Yes | No | No | No |
| **Reliability** | Good | Good | Good | Good |
| **Typical plant life expectancy** | 10-15 years | 15-20 years | 15-20 years | 20+ years |
| **Capital cost** | Med | Low | High | High |
| **Maintenance** | Med | Low | Med–low | Low |

The use of pool covers is recommended for ventilation energy saving when the pools are not in use. The use of pool covers reduces the heating energy of the pool hall by reducing the amount of evaporation from the pool surface, which then

- Reduces the cooling effect to the pool hall air
- Reduces the humidity within the pool hall that, in turn, reduces the amount of ventilation air needed.

### Control Systems

The types of control system used will depend on the size and type of building services installed and their complexity. The size and complexity of the facility will dictate the capital cost-effectiveness of either system.

Proprietary control systems can be provided with most building services systems, but often have limited compatibility or flexibility to interface with other control systems. Another disadvantage is for a holistic site-wide observation or monitoring of system performance or energy usage. A site-wide building management system (BMS) provides a means of replacing numerous proprietary control systems by consolidating controls onto one building-wide platform that can be used to observe performance from a single central location.

## Hydraulic Design

Potable water used at sports facilities is typically separated into four main categories: make-up water for the swimming pools, the wet facility amenities, the indoor courts' amenities and any site irrigation. The volume of water used in each of these categories will vary significantly depending on local climate, number of users, the type of pool filter system provided and the level of non-potable water used on-site.

## Key Design Decisions

Combined sports and aquatic facilities use high volumes of domestic cold and hot water and discharge high volumes of waste water. Key design areas to focus on are:

- Utility potable water supply capacity within the street – initial pool filling usually dictates high water flow and pressure needed
- Utility sanitary waste water supply capacity to the street – pool filter backwash discharge flow rates are high whereas capacity at the street connection is lower
- Domestic hot water (DHW) generation – aquatic facilities have high shower use, whereas dry sports facilities rates can have intermittent shower use and a highly variable number of users.

## Aquatic Facility Water Usage

The water usage within pools comes from a number of areas such as make-up water for evaporation and maintaining pool water quality, pool water lost into the concourse drainage, patrons leaving the pools, patrons showering, pool filter backwashing and concourse washing.

### Indicative comparisons of potable water consumption are:

| FACILITY FUNCTION | TYPICAL WATER USE RANGE |
|---|---|
| Pool water make-up (including filter backwash) | 30-50% |
| Showers | 20-30% |
| Wash-hand basins | 5-8% |
| Toilet flushing | 5-10% |
| Urinals | 2-5% |
| Cleaning | 2-3% |
| Other (including cafés) | 3.5% |
| Leaks | Varies but can be significant in older facilities |

Perhaps more significant is the range in volumes of water used between best-practice and poor-mixed-use aquatic centres incorporating sports facilities, which is shown in the table below. This takes no consideration of pool water quality and should only be used for water efficiency comparisons.

### Indicative Comparisons of Potable Water Consumption (source: www.sydneywater.com.au)

| RATING | WATER USE |
|---|---|
| Best-practice | <10L/patron |
| Good | 10-25L/patron |
| Fair | 25-40L/patron |
| Poor | >40L/patron |

## Pool Water Connection Needs

Pools require large volumes of water and hence larger site water connections than typically associated with dry sports facilities.

The size and capacity of the incoming water main from the street need to be carefully considered against the client's desired pool water filling rate. Larger-volume pools can take longer to fill and this needs to be balanced with the acceptable pool shut-down period of a facility.

Swimming pool connections are typically deemed a high hazard, therefore compliance with the Building Code and local authority water connections is required.

## Minimising Pool Water Usage

Make-up water is required for the pool filter backwash process, for dilution control of contaminants and for make-up due to evaporation.

The volume of water discharged as part of the filter system can be reduced significantly depending on the type of backwash system installed, but typically the total make-up cannot be less than the make-up required for chemical dilution due to the bather load.

The table below shows that although each filter requires differing quantities of water for the backwash process and evaporation, the total make-up required generally depends on the bather load. The volumes stated below are for comparison purposes only; the pool filtration selected will determine the actual water requirement of each system.

| FILTER TYPE | MAKE-UP FROM BATHER LOAD ($M^3$/YEAR) [1] | MAKE-UP FROM BACKWASH AND EVAPORATION ($M^3$/YEAR) | MAKE-UP WATER REQUIREMENT[2] ($M^3$/YEAR) |
|---|---|---|---|
| **Sand filter** | 42,000 | 45,000 | 45,000 (125$m^3$/day) |
| **Sand filter with air-assisted backwash** | 42,000 | 15,000[3] | 42,000 (115$m^3$/day) |
| **Regenerative media** | 42,000 | 6,000 | 42,000 (115$m^3$/day) |

(1) Bather make-up is required to maintain chemical dilution levels in the pool due to evaporation and bather contaminants and is based on 30L/bather.
(2) The total make-up water is the maximum of the make-up from either the bather load or backwash and evaporation.
(3) Sand filters with air-assisted backwash can save up to 80 percent of the water used in backwash make-up compared to a conventional sand filter, based on Natare data.

Pool water usage can be managed with the best of intentions, but numerous outside influences can dictate the real reasons for higher water use, such as bather cleanliness and pool make-up mains water chemistry/composition. Some key focus areas that could be considered during the design period to minimise water consumption are:

- The types of pool filter used and type of backwash cycle employed
- The use of pool covers to mitigate evaporation during a period of no use
- The collection of backwash water for greywater usage in other areas of the facility, such as WC flushing, ie, recycle
- Installing water meters in key locations so that abnormal trends can be monitored and reacted to promptly.

### Indoor Courts' and Wet Facilities' Amenities

Possible areas to reduce water usage include:

- Reduce flow rates to the showers
- Have push buttons with adjustable timers on all showers
- Provide pool-side showers as this tends to reduce the amount of time patrons spend showering to just rinsing off rather than washing
- Installing water meters in key locations so that abnormal trends can be monitored and reacted to promptly.

### Irrigation

Ways in which to reduce the water demand for irrigation include:

- Planting drought-tolerant plants that require no additional watering once established
- Implementing a water-efficient irrigation system comprising subsoil drip systems and automatic timers with rainwater or soil moisture sensors
- Installing water meters in key locations so that abnormal trends can be monitored and reacted to promptly.

### Domestic Hot Water

The large consumers of DHW within such facilities are the shower amenities within the pool and dry sports areas.

Pool amenities typically have a higher patron usage of showers and more constant use, whereas dry sport amenities can have varying usage depending on the type of use, ie, local sports club night vs regional sports tournament.

DHW can be generated by numerous means and some typical examples are outlined below.

| | ELECTRIC CYLINDER | MODULAR WALL NATURAL GAS BOILER | CENTRAL NATURAL GAS BOILER | SOLAR HOT WATER BOOST | HEAT PUMP |
|---|---|---|---|---|---|
| **Capital cost comparison** | Low | Medium | Medium-high (however, can be combined with other facility heating need such as pool and air heating) | Medium-high | Medium-high |
| **Relative running cost** | High | Medium | Medium | Medium | Medium |
| **Energy source** | Electric | Gas | Gas | Solar + electric or gas boost | Electric |
| **Ease of operation and maintenance** | Simple | More complex | More complex | More complex | More complex |
| **Relative energy usage efficiency** | Poor | Good | Good | Good–excellent (sun dependent) | Excellent–good (climate dependent) |
| **Plant space requirements** | Hot water storage cylinder space required | Usually external wall for boilers | Usually plant room for boiler and pump system | North-facing roof space needed for panels of sufficient size/ area | Usually external plant space for heat pump |
| | | Hot water storage cylinder space required | Hot water storage cylinder space required | Areas of panels needed can be high depending on amount of hot water generated | Hot water storage cylinder space required |
| | | | | Hot water storage cylinder space required, often in multiple locations | |
| **Water storage requirements** | Large water volume storage typically needed to keep electrical demand reasonable | Lower storage volumes needed as gas system can be more instantaneous heater | Lower storage volumes needed as gas system can be more instantaneous heater | Large water volume storage typically needed to maximise storage of solar heat when available | Large water volume storage typically needed to keep electrical demand reasonable |

### Water Harvesting

Water usage can be reduced by recycling disposed potable water to re-use as a non-potable supply for WC flushing and irrigation.

The two large opportunities to collect water within a pool complex are:

- Collection of water discharge from the pool filter and dilution process
- Collection of rainwater from the building's roof systems.

Compared with other countries New Zealand has typically had low-cost water. Over time the cost of water may increase to improve the financial viability of greywater systems.

| | POOL WATER DISCHARGE | RAINWATER COLLECTION |
|---|---|---|
| **Water storage requirements** | Can be lower storage volumes because pool water discharge is usually fairly constant | Usually high volumes are needed to make use of water consumption in dry periods |
| **Pipework collection to tanks** | Simple because discharge is often piped under pressure | Difficult to reticulate roof collections via gravity from all roof areas into a central tank |
| **Point of use** | WC flushing<br>Long-term use of higher chlorinated water for irrigation should be checked with landscape consultant | WC flushing<br>Irrigation |
| **Typical pay-back period** | Often 15-20+ years | Often 15-20+ years |

Regional weather patterns in New Zealand have a high influence on rainwater harvesting being viable.

## Sanitary Drainage

Owing to the high flow rates of water discharged from typical pool filter backwash cycles, the utility mains within the street normally do not cope with the large flow rates of water discharged. Often detention tanks are needed to release the water into the street mains in a slower, controlled manner.

Some filter systems can release their filter media when backwashed. Such discharging of solids within utility drains is normally not permitted so alternative disposal methods are required.

## Pool Water Design

### Health and Safety

Under H&S requirements employers need to take all practicable steps to provide and maintain a safe working environment, provide and maintain facilities for the safety and health of employees at work, and ensure that actions at work do not result in harm to other people, including members of the public.

Employers must ensure that any action or inaction does not lead directly to any harm to employees, customers, volunteers or contractors while a sports facility is being used.

Typical design and operations H&S risks that designs are required to address are:

- Safe water quality
- Exposure to burns and chemicals
- Entrapment within the pool by such objects as water inlets/outlets, sumps and channels
- Entrapment via pool covers
- Electrical hazards, both permanent and temporary.

The above is not exhaustive and each facility design is required to have SiD processes carried out.

### Key Design Decisions

Sports facilities, in particular aquatic centres, are high users of energy and due to their corrosive environment can be high maintenance.

Refer to the key design decisions that need to be reviewed by the design team on page 92.

### Leisure Pool and Water Sport Requirements

The activity type will drive the various pool needs, such as physical size, lanes and water temperature, which will have been determined during the feasibility/concept stage of the project where the needs assessment and facility mix were considered (refer to Section 1).

While not always expected to be strict requirements for community aquatic centres due to budget restrictions, FINA provides guidance on pool requirements, water temperatures etc for different water sports and should be consulted on recommendations during the design process.

### Space Planning

Planning for the pool plant and services is required early in the design phase to create a facility that is safe to access and install equipment and encourages regular maintenance.

Examples of access considerations are detailed in the table below:

| EQUIPMENT/PLANT | SERVICE ACCESS REQUIREMENTS | | |
|---|---|---|---|
| Pool water circulating pumps | REGULARLY | | |
| Disinfection product delivery | REGULARLY | | |
| Filter media product delivery | | OFTEN | |
| Pipework isolating valve access | | OFTEN | RARELY |
| Pool filters | REGULARLY | | |
| Dosing/disinfection equipment | REGULARLY | | |
| Electrical board and controls | | OFTEN | |
| Pipework | | | RARELY |
| Heating systems | REGULARLY | | |
| Balance tank valves | | OFTEN | RARELY |
| Pool covers | DAILY | | |

### Resources Available

The local resources within the community should be considered early in the planning stage. Resources, both natural and commercial, that may influence the design and systems considered include:

- Utility water and drain capacities
- Availability of geothermal bore water
- Availability of local chemical water treatment products
- Local expertise to maintain and operate the installed systems.

### Pool Water Quality

The challenges to maintaining good pool water quality in indoor aquatic centres involve the management of the following processes as a system:

- Pool water filtration to remove particulates, pollutants and microorganisms
- Pool water disinfection to remove/inactivate infectious microorganisms as well as DBPs
- Pool water chemistry control
- Effective distribution of disinfectant throughout the pool
- Addition of clean fresh water to dilute substances that cannot be or have not been removed from the water by treatment
- Good bather hygiene practices
- Regular cleaning, including removal of biofilms and sediments.

### Pool Water Filtration

Filters remove particulate from the pool water as it is circulated through the water treatment system. The most common filtration systems within New Zealand's community pools are:

- Pressure sand filters
- Pressure or vacuum diatomaceous earth (DE) filters.

Some alternative filtration options within New Zealand are:

- Packaged vacuum sand filters
- Alternative media pressure filters (multi-media, Zeolite, recycled glass)
- Filter media such as cellulose and Perlite (alternative to DE filters).

### Medium-Rate Pressure Sand Filters

Pressure sand filter (source: Waterco)

Pressure sand filters are proven, cost-effective and very common in commercial pools internationally. The effectiveness of the filtration is dependent on the media bed depth, media grade and rate of flow, amongst other things. Typically, filtration levels are down to 10-15µm.

Pressure sand filters are cleaned periodically by backwashing, which discharges a significant volume of water. Some manufacturers provide additional features that can reduce the backwash water volume discharged.

### Pre-coat Type DE Filters – Pressure or Vacuum Type

These are also known as regenerative media systems using DE as the filter medium. These are available as vacuum DE or the more compact pressure DE systems and are common in the New Zealand aquatics industry. These filters utilise surface filtration, are able to filter down to 1-2µm and usually have very low water usage.

Vacuum DE filters (source: Ian Coombes Ltd)

Pressure DE filters (source: Ian Coombes Ltd)

There are some H&S operational and handling issues with some filter media such as DE that require careful consideration. A review of filter media material data sheets should be carried out and H&S risks and requirements understood.

DE powder is mainly amorphous silica and typically contains a component of crystalline silica. Crystalline silica has been associated with lung damage (silicosis) and is considered a human carcinogen. As such, the handling of this very fine powder requires dust suppression, and the associated perceived H&S issues for operators need to be addressed.

Disposal of the backwashed DE is also a consideration as the discharge of DE to sewers is usually prohibited.

Alternatives to DE are emerging to mitigate the H&S concerns. Some alternatives are cellulose and Perlite. Refer to filter manufacturers for the specific filter media and alternatives that could be used within the various filter systems.

**Alternative Media Pressure Filters**

Alternative media filters are similar to pressure sand filters, but with different media and often with different internal arrangements.

- Multi-media Pressure Filters

Multi-media filters typically utilise layers of coarse anthracite (top), sand (middle) and garnet (bottom), trapping coarse particulates at the top and finer ones at the bottom.

- Zeolite Media

Zeolite is a mineral medium, sold as a replacement for sand and claimed to provide filtration down to 3μm.

- Glass Media

Crushed recycled glass media are sold as a replacement for sand. The use of glass media is not common in the public pool arena. Concerns have been expressed about the potential issues for bathers, with the 'lighter' glass media carrying over into the pool in the event of filter failure.

**Packaged Vacuum Sand Filters**

Pre-engineered and prefabricated open-top vacuum sand filters complete with housing, media, internal partitioning/weirs, pump-well with pump, valves and grating with proprietary sand media are available, assembled and ready to be plumbed in, all in a compact construction.

Packaged vacuum sand filter (source: Natare)

Their main advantage is that they can be supplied as an integral pool water treatment and pool tank turnkey package. One supplier can provide the design and all products, filters, valves, pumps, pipework, pool tank and roll-out channels. The pool systems also function without a balance tank, using the rise and fall of pool surface-water height to take up displacement, amongst other features.

**New Zealand Filtration Trends**

Pressure sand filters have a long history of success in the pool industry internationally. They are used across the world for facilities of all types, including elite facilities such as the recent London Aquatics Centre.

NZS 4441 nominates the use of pressure sand filters, pressure-type multi-media filters and vacuum/ pressure-type pre-coat filters for use.

Pressure sand filters and DE-based vacuum/pressure-type pre-coat filters are commonly seen in New Zealand aquatic centres, with good operator familiarity and support.

Some examples of New Zealand aquatic centre filtration systems are listed below.

| FACILITY | FILTRATION TYPE |
|---|---|
| Baywave, Tauranga | Regenerative media filters (DE) |
| Dudley Park Aquatic Centre, Rangiora | Pressure sand filters |
| Geraldine Swimming Pool, Geraldine | Vacuum regenerative media filters |
| Graham Condon Recreation & Sport Centre, Christchurch | Pressure sand filters |
| Greerton Aquatic & Leisure Centre, Tauranga | Vacuum regenerative media filters |
| Hanmer Springs Thermal Pools & Spa, Hanmer Springs | Regenerative media filters (DE) |
| Hokitika Swimming Pool, Hokitika | Pressure sand filters |
| Jellie Park Recreation & Sport Centre, Christchurch | Regenerative media filters (DE) and pressure sand filters |
| Karori Pool, Wellington | Regenerative media filters (DE) and pressure sand filters |
| Keith Spry Pool, Wellington | Regenerative media filters (DE) and pressure sand filters |
| Mount Maunganui Hot Pools, Mt Maunganui | Regenerative media filters (DE) |
| Ocean Spa, Napier | Vacuum regenerative media filters |
| Oxford Community Aquatic Centre, Oxford | Pressure sand filters |
| Pioneer Recreation & Sport Centre, Christchurch | Regenerative media filters (DE) |
| Putaruru Pools, Putaruru | Regenerative media filters (DE) |
| Queen Elizabeth II Park, Christchurch (now demolished) | Regenerative media filters (DE) |
| Richmond Aquatic & Fitness Centre, Richmond | Pressure sand filters |
| Selwyn Aquatic Centre, Christchurch | Pressure sand filters |
| Solid Energy Centre, Westport | Pressure sand filters |
| Southland Hospital, Invercargill | Pressure sand filters |
| Splash Palace, Invercargill | Multi-media sand filters |
| St Cuthbert's College, Auckland | Vacuum sand filters |
| Thorndon Pool, Wellington | Vacuum regenerative media filters |
| TSB Pool Complex, Stratford | Vacuum regenerative media filters |
| Wellington Regional Aquatic Centre | Regenerative media filters (DE) and pressure sand filters |
| Whangarei Aquatic Centre, Whangarei | Pressure sand filters |

## Comparison of Filtration Options

| | DEEP-BED PRESSURE SAND | PACKAGED VACUUM SAND | PRE-COAT TYPE PRESSURE/ VACUUM DE | PRE-COAT TYPE PRESSURE WITH PERLITE MEDIA | PRE-COAT TYPE WITH CELLULOSE MEDIA |
|---|---|---|---|---|---|
| |  |  |   |  |  |
| **Filtration level** | ~10-15µm | 5µm | <5µm | <5µm | <5µm |
| **Cryptosporidium removal** | Possible with coagulation | Possible | Yes | Yes | Yes |
| **Filtration flow rate (pool water recirculation flow rate)** | Normal | Normal | Normal | Normal | Normal |
| **Cleaning regime** | Backwash | Backwash | Replenish media | Replenish media | Replenish media |
| **Pumping pressure** | Normal | Lower | Normal–lower | Normal | Normal |
| **Locational limitations from hydraulics aspect** | None | At or below pool water level | None for pressure type | None | Above pool water level (2-pump system) |
| **Plant room space requirements** | Normal | Higher | Similar for vacuum type/ lower for pressure type | Lower | Low |
| **Additional service requirements – day to day** | None | Compressed air | Slurry preparation, compressed air, used media disposal | Media top-up, compressed air, used media disposal | Media top-up, manual washing of filter elements |
| **Water usage for cleaning** | High | Medium | Low | Low | Low |
| **Filtration media economic life** | ~ 5-10 years | Claimed to be life-long | Regular replenishment | Regular replenishment | Regular replenishment |
| **Media cost** | Low | Low | Higher than sand | Higher than DE | Higher than DE/Perlite |

| | DEEP-BED PRESSURE SAND | PACKAGED VACUUM SAND | PRE-COAT TYPE PRESSURE/ VACUUM DE | PRE-COAT TYPE PRESSURE WITH PERLITE MEDIA | PRE-COAT TYPE WITH CELLULOSE MEDIA |
|---|---|---|---|---|---|
| **Day-to-day operation** | Simple | Simple – can require operator to climb down into filter | Complex – media require handling precautions | Can be simplified with automation | Needs manual cleaning/media handling |
| **Plant room – filter area** | Relatively dry as no exposed pool water | Open-top filters mean extra ventilation for humidity and corrosion | Dusty environment, extra ventilation for humidity and corrosion for vacuum type | Relatively dry as no exposed pool water, vacuum hose system for Perlite loading means lower dust issue | Extra ventilation for humidity and corrosion for vacuum type |
| **Operator familiarity expected** | Good | Good as standard technology | Good | Good as similar to pressure DE | Good as similar to vacuum DE |
| **General industry support expected** | Good | Acceptable as standard technology – local support will need to be ensured as filters are imported | Good | Local support will need to be ensured as filters are imported | Good as local manufacture |
| **Usage trends** | Used worldwide | Some use in US | Mainly in NZ | Popular in US | Less common |

### Pool Water Disinfection

Pool water disinfection plays a major role in helping to achieve acceptable pool amenity. Disinfection in the pool water treatment context can be split into:

- Primary disinfection to provide the base bactericidal effect, including continued residual protection in the pool, and
- Secondary disinfection as a supplemental potential to reduce harmful DBPs and to neutralise parasites such as cryptosporidium.

### Primary Disinfection

Pool water primary disinfection provides:

- Base bactericidal effect for disinfection during the passage of the pool water through the water treatment and hydraulic system
- A residual bactericidal effect to ensure continued protection in the pool itself.

In addition, it is desirable for the pool water treatment to include the potential to:

- Reduce harmful DBPs
- Kill parasites such as cryptosporidium.

These additional functions are considered to be 'supplementary disinfection' and are addressed later in the document.

There is no single disinfectant available that can provide all of the above functions under normal operation.

Chlorine is the predominant primary disinfectant in the commercial pools arena due to ease of use, operator familiarity and consistent performance.

Chlorine (or similar) dosing is required by the health regulations because it provides residual disinfection capacity in the pool in addition to disinfection during the passage of pool water through the treatment system. Chlorine is an effective disinfectant for a limited pH range and as such close control of pH is very important for chlorine-based systems.

Probable options to be considered suitable for community-based pools are:

- Delivered sodium hypochlorite (HYPO) solution stored on-site (low strength ~1 percent)
- Delivered sodium hypochlorite solution stored on-site (medium strength ~12-15 percent)
- On-site generation of sodium hypochlorite solution stored on-site – leased or owned.

A comparison of relative functionality and performance options are tabulated below:

| | LOW-STRENGTH (<1%) HYPO – BULK DELIVERED | MEDIUM-STRENGTH HYPO – BULK DELIVERED | ON-SITE GENERATION – LOW-STRENGTH HYPO – LEASED | ON-SITE GENERATION – LOW-STRENGTH HYPO – OWNED |
|---|---|---|---|---|
| **Concentration strength** | Low (~1%) | Medium (~12%) | Low (~0.85%) | Low (~1% OR 2.5%) |
| **pH effect** | Medium rise in pH | Higher rise in pH | Medium rise in pH | Medium rise in pH |
| **Total dissolved solids increase** | Higher | Medium | Higher | Higher for 'pipe cell' type; lower for 'membrane' type |
| **Day-to-day operation** | Simple | Simple | Simple maintenance and service to be managed by lessor. Involves salt handling | Complex. Involves salt handling using forklift or similar |
| **Plant room space and associated requirements** | Medium due to larger storage | Lower, but more stringent associated safety requirements | High due to the additional plant space for the generation plant | High due to the additional plant space for the generation plant |
| **Operator familiarity expected** | Good | Good | Less familiarity | Less familiarity |
| **General industry support expected** | Good | Good | Good | Will need to be ensured |
| Perceived operational risk level (toxicity and leakage aspects) | Low | Medium | Low | Medium |
| Usage trends | Common in NZ | Common in NZ | Common in NZ | Recent installations in Australia |

### Supplementary Disinfection

While chlorine-based disinfection provides the base bactericidal effect and residual disinfection, chlorine is not effective against protozoan parasites such as cryptosporidium. Further, chlorine reacts with organic matter in the pool water to create harmful by-products. Supplementary disinfectants assist with counteracting these deficiencies and help in improving water quality and reducing the potential for corrosion from the by-products.

Organic matter within the pool reacts with chlorine and produces chemicals called chloramines. These chloramines produce the strong odour that is commonly associated with swimming pools. NZS 5826 Pool Water Quality permits lower operating free chlorine levels for pools that use secondary (ie, supplementary) disinfection.

Typically, supplementary disinfection is predominantly carried out by UV within community-based pools. Supplementary disinfection is considered a must for modern-day indoor aquatic centres for improved bather health and amenity. One advantage seen from the use of UV is a better indoor air quality due to a reduced level of chloramines off-gassing.

| | CHLORINE ONLY (NORMAL OPERATION) | MEDIUM-PRESSURE UV + CHLORINE |
|---|---|---|
| **Oxidation power** | Low | Good |
| **Capability for destruction of protozoan parasites such as cryptosporidium** | Nil | Good |
| **Capability for removal of DBPs** | Nil | Good |
| **Inherent micro-flocculation with sparkle to water** | None | None |
| **Day-to-day operation** | Simple | Simple |
| **Plant room space and associated requirements** | Base | Minor increase to accommodate UV units |
| **Operator familiarity expected** | Good | Good |
| **General industry support expected** | Good | Good |
| **Perceived operational risk level (toxicity and leakage aspects)** | Base | Low |
| **Usage trends** | No longer common for indoor public pool facilities | High adoption worldwide |

Other supplementary disinfection choices are available, such as ozone and proprietary chemical-based systems. However, these are not discussed because of their high cost/risk for community-based pools. They are generally expensive systems with an extremely high dependence on operation and maintenance by staff for the correct output.

### Pool Water Temperatures

The desired pool water temperature for bather comfort depends on the activity being undertaken and requirements of local sporting bodies and the likes of FINA. For competition or a lap swimming type of activity, a lower pool water temperature is desired. For activities such as diving where the patrons are continually moving in and out of water, warmer conditions are desirable. For pools to be used for therapy, a warmer water temperature is selected. A major component of pool heating load is evaporation heat loss

| POOL USE | TYPICAL WATER TEMPERATURE RANGE | NZRA-RECOMMENDED WATER TEMPERATURE | COMMENTS |
|---|---|---|---|
| **Competition pool** | 25-28°C | 27°C (+/- 2°C) | FINA requires 25-28°C |
| **Water polo/canoe polo** | 26-30°C | N/A | FINA nominates not less than 26°C for water polo |
| **Programme pool – LTS, therapy** | 30-31°C | 34°C (+/- 2°C) | Higher temperature may be required for therapy use |
| **Warm water pool – rehabilitation, therapy and relaxation** | 31-33°C | 34°C (+/- 2°C) | NZS 4441 suggests 30-33°C for therapy pools |
| **Leisure – leisure activities, families, play equipment** | 29-31°C | 32°C (+/- 2°C) | NZS 4441 suggests 30-33°C |
| **Toddlers' pool – small, shallow, sloping pool** | 30-33°C | 33°C (+/- 2°C) | NZS 4441 suggests 30-33°C |
| **Spa pool** | 38-40°C | 38°C (+/- 2°C) | NZS 4441 suggests 38°C to 40°C, with 40°C as a maximum |

### Pool Water Heating

Heated pools require year-round heating and as such are major consumers of energy. Some options for the heating of pools are tabled below.

| | HEAT PUMP | GAS-FIRED BOILER | SOLAR | BIOFUEL WOOD-BASED BOILER | GEOTHERMAL |
|---|---|---|---|---|---|
| **Energy source** | Electric | Natural or LP gas | Sun | Wood | Geothermal |
| **Availability of energy source** | Good | Good | Seasonal | Good | Location dependent |
| **Winter heating performance** | Good-poor | Good | Good-poor | Good | Good |
| **Heat recovery cooling option** | Yes | No | No | No | No |
| **Reliability** | Good | Good | Good | Good | Good |
| **Typical plant life expectancy** | 10-15 years | 10-20 years | 15-20 years | 10-20 years | 20+ years |
| **Capital cost** | Med | Med | Med-low | High | High |
| **Maintenance** | Med | Low | Low | Med-low | Low |
| **Base heating or supplementary** | Base | Base | Supplementary | Base | Base |

### Water Play Features

Leisure pools incorporating water features, hydroslides and shallow beach areas are a key part of modern community pools, especially in New Zealand.

Various suppliers provide turnkey options for such features, including slides, fountains, spouts, water cannons etc. Such systems typically have separate pumping and hydraulic systems to allow specific control of water pressure and flow.

Consideration could be given to the interchangeability of different water features, allowing the pools' play areas to be re-invented and remain exciting to children. Pipe sizes, connection sizes, pump flow rate adjustment and the control adjustment of the water feature operation need to be considered to allow flexibility.

Careful consideration is required concerning the additional humidity generated within the pool hall air due to water feature spray droplets evaporating into this air. Such additional evaporation does increase heating and ventilation energy requirements.

### Pool Energy-Saving Options

Swimming pools are high users of resources, notably electricity, gas and water. Measures to reduce the use of such resources should be studied at the outset of the design and incorporated early. Some energy-reduction incentives can have short pay-back periods and should be considered.

Some ESD options for consideration and pay-back studies could be:

| | POOL COVERS | PUMP VSDS* | HEAT RECOVERY | WATER CONSERVATION |
|---|---|---|---|---|
| **Advantages** | Reduce water evaporation, ventilation energy, heating, corrosion potential in pool hall | Reduce pump energy costs when pools have no use | Can be integrated with other facility heating/cooling systems such as air-conditioning | Reduces potable water usage<br>Waste pool water could be used for greywater within building |
| **Disadvantages** | Staff required for installing and removing | Pump speed reduction needs to be balanced with pool water chemistry | Added complexity and maintenance | High capital costs compared with cost of water |
| **Relative cost** | Medium | Low | High | Medium |
| **Relative pay-back** | High | Medium-high | Medium | Low |

* VSDs – variable-speed drives

It is important that a design team is engaged to carry out ESD pay-back investigations early in the design programme. Significant energy savings can be seen for the life of the pools' running costs, and pay-back periods can often be short on the additional capital costs incurred.

# Lighting

## Introduction

Interior illuminance levels will be in accordance with the recommended guidelines in AS/NZS 1680.0 Interior Lighting: Safe Movement and AS/NZS 1680.1 Interior and Workplace Lighting: General Principles and Recommendations, internationally recognised best-practice as outlined in the CIBSE Lighting Guide 4: Sports Lighting (2006) and the requirements of the applicable New Zealand sports codes and other relevant technical codes for statutory compliance. This section does not attempt to repeat information found in other standards and guidance documents, but highlights the most crucial aspects in relation to the internal lighting of community, sport and recreation facilities.

Lighting design for sports facilities is about producing good visibility that meets the requirements of the sports being played. This approach should consider both natural and artificial lighting of the facility.

Where natural lighting is to be considered this should be undertaken from the earliest planning stages of a sports facility project. This is because the glazed areas of the building must be correctly positioned and sized to achieve uniform natural illumination, which avoids glare, reflections, unwanted solar gain and heat loss.

The lighting design for all sports facilities needs to be holistic and incorporate the daylight system, artificial system and control system. Maximising the use of natural light promotes energy efficiency, but it cannot eliminate the need for artificial lighting and associated controls. Evaluating artificial lighting options involves considering quality of light, visual comfort, uniformity of illumination, lighting type, position (ceiling-mounted uplighters and/or downlighters and/or wall/track-mounted lights), energy efficiency, length of life, radiation of heat, initial and ongoing costs, and ease of cleaning and replacement.

Achieving uniformity of illumination in these spaces is important and requires eliminating dark areas.

Apart from such special requirements, consideration should be given to standardising the light fittings as much as possible to reduce the quantities and varieties of spares that must be stored on-site so as to simplify maintenance and replacement. It is recommended that the lamp sources to be used throughout these facilities be LED (light-emitting diode), except where in specialist circumstances light fittings using LED technology are not available. LED fittings can provide benefits in relation to significantly reduced energy consumption and longer lamp-life maintenance costs. They may incur a larger initial capital cost (this aspect is now reducing significantly with the technology advancement and popularity of the use of LEDs), but they will provide better value over the lifetime of the building (whole-of-life cost) and generally pay-back in less than 10 years. Fittings installed within a common area are to be specified with LEDs from the same manufacturing batch to ensure commonality of colour, temperature and performance.

In all instances, provision must be made for safe access to the lighting and to glazed areas, such as roof lights, for cleaning, maintenance, repair and replacement.

## Lighting in Aquatic Facilities

### General

Swimming pool lighting caters for a variety of visual tasks. The competitive swimmer has a much different seeing task from other swimmers where the main attention is focused on staying in the lane and the turning point at the end of the lane. Water polo players need lighting with a good ambient lighting effect. Swimming instructors, coaches, pool attendants and spectators all need to see across the pool and into the water to identify swimmers and situations. For recreational swimming pools and water leisure spaces, themed or decorative lighting effects may be required (these can be provided by pre-wired, weatherproof outlets at strategic locations, allowing the connection of themed lighting in the future or for special events).

The recommended levels of illuminance for swimming pools are 300 lux for most activities and 500 lux for competition. For international events, FINA requires 600 lux at the start and turn ends of the pool and this will be significantly more to accommodate TV broadcasting. As this document is focused on community facilities, the additional lighting requirements for international events and broadcasting are not covered further.

There are a number of specific design aspects to be considered for lighting pools and aquatic facilities. These include:

- Reflectance and glare
- Luminaire types
- Access for maintenance
- Direct lighting
- Indirect lighting.

Lighting, whether artificial or natural, must minimise glare and reflections from the surface of the pool. H&S guidance stresses the importance of lifeguards having good visibility beneath the water and suggests a minimum number of lifeguards being on duty for programmed and unprogrammed swimming sessions.

Light from directly above the pool surround should cause no problems if the angle of incidence to the water surface is high (greater than 50°) and there are high levels of light reflectance from the internal walls and floor surfaces of the pool basin. Problems generally occur when the luminaires or windows are located in the side walls, so that the angle of incidence causes problems for attendants and spectators.

When the angle of incidence is low, and combined with the wave action on the water, the reflection patterns on the water surface can make it impossible for lifeguards to see swimmers below the water surface who might be in difficulty. This will depend upon the geometry of the pool hall and the location of glazing and should be considered at an early design stage.

Karori Pool, Wellington

### Light Fittings

Light fittings must be located and angled to avoid glare and reflection, from the points of view both of bathers in the water and of staff in the pool surrounds.

The selection of the type of luminaire is important. Indirect lighting is preferable to avoid specular reflection. Lights require regular maintenance and ensuring an easy and safe means of access to fittings should be a priority, particularly if they are located over the pool.

Consider the position of light fittings in relation to the routing of air-handling ductwork and other services so that light distribution is not adversely affected.

The emergency lighting system should ideally be a maintained system. This is a battery-operated system capable of maintaining safe levels of illumination in the event of the failure of the main electricity supply.

### Underwater Lighting

Underwater lighting can reduce the effect of veiling reflections on the pool surface and improve the general evenness of illumination below the surface of the water. This can increase pool safety and help coaches to study the techniques of swimmers. There are two basic types of underwater lighting: 'dry niche' and 'wet niche'. Dry niches contain luminaires behind watertight portholes and wet niches are recessed into the walls of the pool.

### Key Considerations for Pool Lighting Design

The lighting design of a pool is a complex challenge; it will require a compromise between the following interconnected considerations:

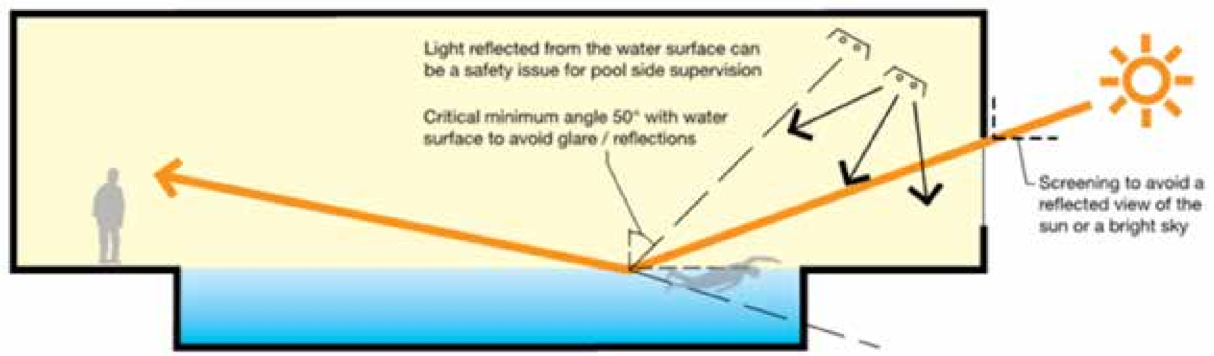
- The design should aim to direct light into the pool tank in order to provide a clear view of bathers to spectators and lifeguarding staff
- Angles of attack of fittings should aim to be >50° from horizontal; this will minimise the direct glare from fittings to bathers and reflections off the water obscuring the view for lifeguards and spectators
- Turbulent water changes the angle of the surface in relation to the fittings and viewer, and therefore in some instances a higher threshold than 50° should be considered
- Light fittings should ideally be located above the pool surrounds and not above the pool tank for ease of maintenance
- Indirect and diffuse light sources can reduce transmission of light into the pool tank and produce reflections
- Underwater lighting can help reduce the risk of reflective glare, and the additional cost must be balanced against its benefits (it does not normally form part of an affordable scheme).

Lighting larger or wider pools (eight-lanes or more) and achieving the 50° rule without locating luminaires over the pools is often difficult or not achievable. In these situations the following alternative solutions should be assessed by the professional consultant team in relation to the specific drivers for the project, the pool's uses and the maintenance strategy:

- Access to fittings provided by a roof gantry
- Access to fittings provided by a pulley system. For a swimming pool, the field of play should include lighting to the underwater volume.

### Materials and Corrosion

Corrosion of materials can be a major problem when they are located in the humid atmosphere of a swimming pool hall. This problem is further increased due to the corrosive environment, with the atmosphere within the pool hall containing by-products of the water disinfection/treatment system, ie, chlorination. Experience has shown that all metals, including stainless-steel and aluminium, need high-quality protection and effective maintenance to avoid corrosion. This can be provided by the application of a paint system, or in the case of aluminium the provision of deep anodising. A great deal of attention should be paid to all parts of the installation, including cable trays, trunking, conduit, bracketing and fixings. Contact between dissimilar metals in a humid atmosphere can lead to very rapid corrosion. It is recommended that luminaires be constructed to a minimum standard of IP54 (Ingress Protection).




## Multi-purpose Sports Hall Lighting

### Introduction

The purpose of lighting an indoor court, sports hall or gymnasium is to provide appropriate lighting that allows a sport to take place safely (ie, designed to suit the speed of play and size of any objects used in the sport) and provide good viewing conditions, both in the visibility of the sports action by the participants and in the comfort of the audience. The creation of an appropriate visual environment is therefore a fundamental requirement in sports facility design, with the effective integration of the artificial lighting system being considered as a standard part of a modern sports facility.

The use of natural light in indoor sports spaces to supplement the artificial lighting system that would normally be required is an issue that often generates conflicting interests. For some sports codes, natural lighting of indoor spaces is completely unacceptable. The sun or areas of bright sky seen either directly through windows or by reflection from bright surfaces within the sports hall can lead to a level of distraction, disability or discomfort glare that will be unacceptable or even dangerous. Any proposal to use natural light requires very careful consideration of how glare can be controlled and how reasonably stable and uniform levels of lighting can be ensured. Some of the issues can be improved within the design of the roof lights themselves, but generally this will incur additional capital costs. They should be carefully considered against the possible energy savings and other benefits that might be accrued during the life of the building. Roof lights can be designed with screening layers to diffuse the incoming daylight and help distribute light evenly over the field of play. Automatic black-out blinds can also be incorporated to eliminate the risk of glare at times when critical sports are played.

The design of the lighting installation for multi-sports halls is a complex matter in which conflicts between the requirements of different sports need to be resolved. Many multi-purpose sports halls stage several differing sports and in an attempt to maximise the time and space allocation within a sports hall, some of these differing sports may take place at the same time. This has the potential to produce conflicts of interest in respect of simultaneous lighting requirements.

There must, however, be flexibility within a lighting installation that will allow selective switching and/or other methods of control to satisfy the demands of differing sports that may be played at varying levels of competition.

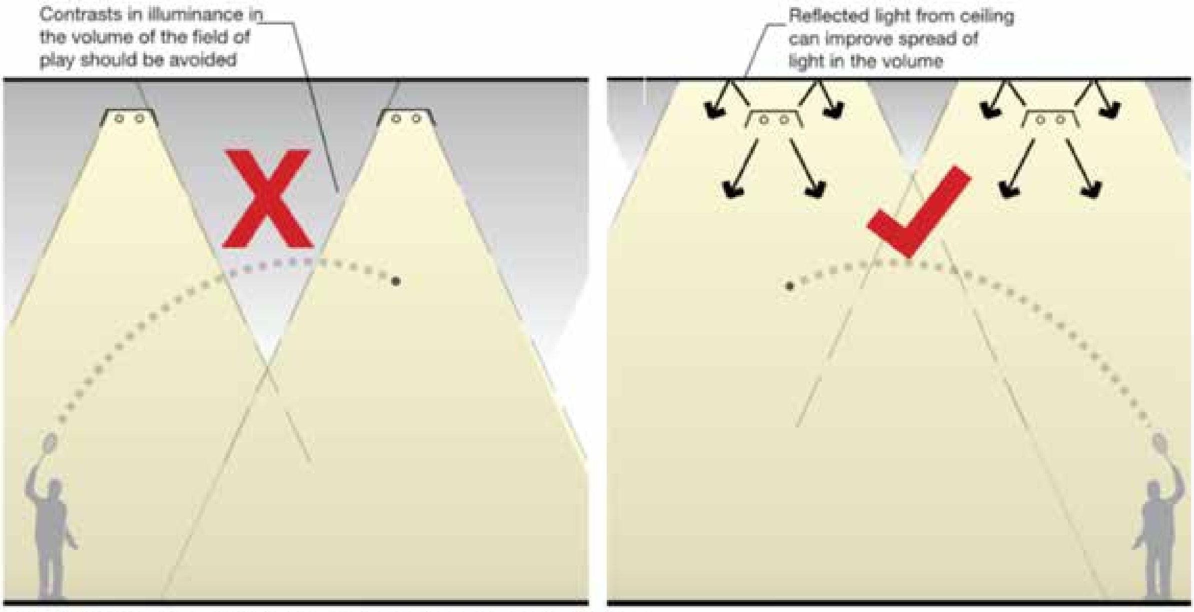
As a result of the often significant diversity of lighting requirements between sports within a multi-purpose sports hall, it is usually recommended that the activity with the most stringent lighting requirements be used as the basis for lighting design. The demands of other sports should, however, be met wherever practical. Where there is limited information on the likely usage of a sports hall, it is generally recommended that a scheme be designed to suit the most common use, usually basketball, netball or badminton. It is important to be aware that sport lighting requirements may involve luminaire placement, vertically and in the horizontal plane, as well as lighting levels. The requirements of different sports may well be incompatible and this can lead to a need for, effectively, multiple lighting installations in one hall. Switching arrangements for the simultaneous use of a sports hall for different sports are likely to be complex and will need to be considered carefully.

The recommended illumination for a general multi-sport indoor court/sports hall is 500 lux; this includes the provision to switch down to 300 lux as required and is considered to be the most appropriate for a facility that aims to cater for a full programme of community sporting activities, including training and competition. The options for adding further switchable lighting for badminton, volleyball and other key indoor sports should be considered and assessed during the needs analysis planning of the facility.

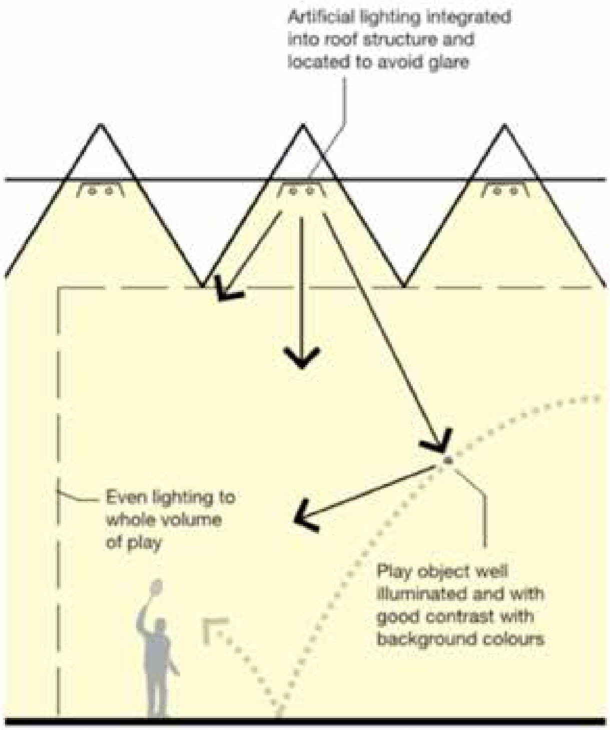
### Key Considerations for the Lighting Design

It is important that the lighting requirements of each sport proposed to be played in a multi-purpose sports hall are fully understood at the outset of the project. This requires an understanding of the nature of the sporting activity and key characteristics, eg, speed of play and size of objects (balls, shuttlecocks etc) as follows:

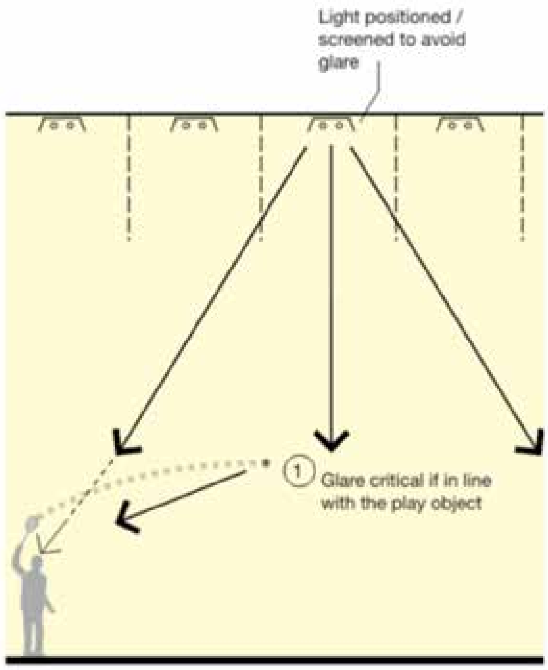
- **Level of illumination** – should be appropriate for a particular sport and should be checked with the requirements of the sports code or the organisation that is promoting a particular event. This can vary with the level of play and competition
- **Even illumination** – the full volume of the field of play should be illuminated evenly to create equal playing conditions for all players and a consistent level of visibility
- **Volume of the field of play** – with court/indoor sports the lighting design needs to consider the whole of the 3D volume above and including the field of play
- **Brightness and contrast** – suitable brightness and contrast over the playing area, sufficient light at all points, correct distribution of light and adequate control of glare. Playing objects will be seen because they contrast with their backgrounds in brightness, colour or both. The more marked the contrast, the more clearly objects are perceived in general. For instance, for badminton a reduction in illumination behind the court is preferred to achieve an acceptable background contrast
- **Colour rendering** – good colour rendering is essential to differentiate between opposing competitors or teams, and many sports use colour and colour contrast to improve the visibility of sports equipment or differentiate various aspects of the playing area or target
- **Glare** – as many sports also place restrictions on the positioning of luminaires with respect to the playing area to minimise glare and distraction, this requires careful design. For basketball and netball, the luminaires directly above the goal/net within a 4m diameter should not be switched on. For aerial sports, eg, badminton and volleyball, the positioning of luminaires outside the playing area may be necessary to avoid disability glare for players looking upwards.




**Even illumination is required in the full volume of the field of play**




**Natural and artificial lighting sources integrated with building structure**




**Lighting should not be located in direct line of sight of the player**

### Specific Luminaire Considerations

The selection of luminaires for multi-purpose sports halls needs to consider a number of key points. When a sport involves a fast-moving target, the elimination of any stroboscopic effect (where LED light sources are not used) from high-intensity discharge sources is important. Stroboscopic effects may make a moving object appear stationary, or make the object seem to jump from one position to another. For these sports, the use of high-frequency control gear is recommended.

Consideration should be given to the environment and the nature of the sport(s) to be played in the facility with respect to shielding the luminaires and/or the use of impact-resistant covers. If struck by a ball, a luminaire must withstand the impact and any damage that might otherwise cause component parts to fall to the ground. Care must be taken to ensure that the grid dimensions of the lamp enclosure are substantially smaller than objects that may be used, eg, balls or shuttlecocks, so that they cannot lodge in the fitting or its protective grille.

Luminaire mounting options need to be considered and integrated as part of the design process. The structural design of a sports facility may place restrictions, both in the positioning of luminaires and in luminaire weight, as some structures have limited weight-bearing capabilities. The lighting designer will be responsible for coordinating with the structural engineer.

### Lighting Control

For a multi-purpose sports hall, the base lighting scheme should include a flexible arrangement using manual switching to provide various configurations of light levels from 500 lux to 300 lux. The luminaires in the enhanced lighting scheme that achieves 500 lux, which are required to be switched on/off, should be arranged in separate circuits. A bank of labelled switches should be provided in a panel with the required lighting arrangements clearly marked.

Other enhanced automated options for controlling the lighting to a multi-purpose sports hall can be provided and, where possible, should be considered. These provide better control, flexibility and energy savings and include:

- **Fully addressable lighting control system** – a control system could be provided wherein each luminaire can be addressed individually and have a dimmable ballast. The lighting could then be controlled from a scene-setting switch panel with a range of buttons or with dimmable options
- **Energy-saving option** – the above system can be supplemented with occupancy sensors. The sensors detect the occupancy (presence/absence of people) in a space and automatically switch off the lighting after a pre-set period of inactivity
- **Daylight dimming option** – the above system can be supplemented with daylight dimming if natural lighting through roof lights, or similar, with automatic blinds is introduced to the space. The system measures the amount of daylight light present under each row of luminaires, and automatically adjusts the output of the luminaires so that the sum of the daylight and artificial light gives the required illumination as per the scene selected.

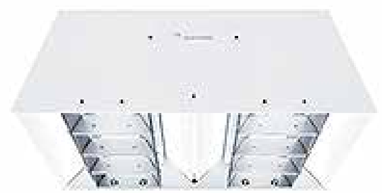
The following are the main advantages of having an automated lighting control system:

- The lighting circuit and wiring are much simpler than the manual control option
- Any changes to the system in terms of additional luminaires, different groupings of luminaires, different lighting levels etc can at a later date be accommodated easily, unlike manual control, which will be very difficult or not possible
- With lower-lux-level lighting set-ups and daylight dimming, the lamps will last longer, as they are being dimmed down and driven at lower output, thereby reducing energy and maintenance costs
- The system can be interfaced with an occupancy-sensing PIR insulation board in the sports hall, which will further enhance energy savings by switching off the lights after a fixed period of inactivity in the hall.

With manual switching the various lighting control arrangements will need a suitably rated contractor for switching the lighting circuit. With the lighting control system contactors are not required as the fittings are controlled independently to provide full flexibility with rearranging the lighting control zones.

### Typical Luminaire Types

The selection of luminaires for sport and recreation facilities that include aquatic facilities and sports halls needs to be specific for their environment. Below is a selection of luminaires recommended for these applications and environments.

| LUMINAIRE IMAGE | DESCRIPTION | LOCATION |
|---|---|---|
|  | **ERCO Parscoop:**<br>• A powerful asymmetrical LED light distribution for highly uniform wall washing and ceiling washlighting in indoor and outdoor areas<br>• The luminaire's different optics for light distribution of a wide or a deep beam and lumen output of 2,400-6,360 lumens, along with flexible adjustment and mounting options, mean that it responds well to many lighting requirements<br>• The housing, which is constructed of corrosion-resistant cast aluminium and a double powder-coated paint finish, ensures an optimised surface for reduced accumulation of dirt and a highly weather-resistant and stylish protection for installation in harsh environments | • Pool hall |
|  | **Zumtobel Craft:**<br>• The Zumtobel 'Craft' is a compact LED high-bay luminaire with an output of up to 12,000 lumens and efficiency of up to 136lm/W<br>• The luminaire has been specially developed with a widebeam optic for uniform and square illumination with no dark areas, which makes it ideal for sports halls and similar environments<br>• This robust and high-impact luminaire is constructed from a die-cast aluminium housing, is sealed to IP65 and is provided with cooling fins and a protective ball-proof louvre. The cooling fins provide optimum thermal management and assist in reducing dust accumulation | • Sports hall |

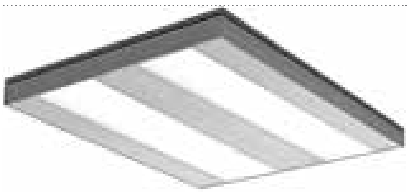
<table>
<tr><th>LUMINAIRE IMAGE</th><th>DESCRIPTION</th><th>LOCATION</th></tr>
<tr><td><br></td><td>

**RZB Ledona:**

- One of the most advanced recessed LED downlights available on the market, providing measurable benefits in terms of efficiency and light quality
- This luminaire range is extremely versatile and available in:
  - Square or round housings
  - 3 sizes
  - 4 luminance levels
  - Either IP20 or IP65 rating
- The IP65 version of the luminaire meets this IP rating in false ceilings as well, which means that the luminaire's reflector and LED are reliably protected against dust and dampness
- The luminaire is designed and constructed to be used in wet, harsh environments. It has a cast-aluminium profile that is designed for corrosive environments and also as a heat sink to dissipate the heat from the luminaire safely. The bezel ring is also constructed from die-cast aluminium with a powder-coated finish

</td><td>

- Aesthetic areas around a pool hall, ie, café area, lockers, showers etc
- Change facilities
- Administration areas
- Reception
- Café

</td></tr>
<tr><td><br></td><td>

**Energy Light REVALO 300 and 600:**

- The Energy Light 'REVALO' is an efficient, linear, LED-recessed luminaire. The luminaire has a high lumen output and provides the user with a good selection of outputs from 2,200 to 5,500 lumens
- The main luminaire body is of aluminium construction, providing a robust housing with an IP50 rating and also helping to provide a low-diode operating temperature. The tuned optical mixing chamber uses a high-performance reflector and diffuser to deliver an exceptionally efficient output
- The luminaire can be provided in a number of configurations to suit varying ceiling types, which include: 1,200x300mm, 600x300mm and 600x600mm modules and can be installed recessed in T-rail ceilings or plaster ceilings with a plaster mount kit, or suspended on wires

</td><td>

- Administration areas
- Reception

</td></tr>
</table>

| LUMINAIRE IMAGE | DESCRIPTION | LOCATION |
|---|---|---|
|  | **Thorn 'AquaForce II':**<br>• A durable, IP65-rated luminaire providing high-quality, low-energy lighting in wet, moist environments<br>• The LED range has a wide range of outputs that provides the highest level of efficiency and reliability in harsh, wet and dusty environments up to 6,400 lumens<br>• The moisture-resistant luminaire with polycarbonate canopy, polycarbonate diffusers and steel toggles is robust enough to withstand an impact and provides high resistance to corrosion | • Pool hall storerooms<br>• Utility spaces<br>• Loading bays<br>• Change rooms |
|  | **Thorn 'College':**<br>• A range of curved-profile, linear LED luminaires with clear, prismatic diffusers for surface or suspended mounting<br>• The body is constructed from white, galvanised, pre-painted steel and provided with a clear prismatic diffuser in tough polycarbonate for specific light control and impact resistance. The diffuser is retained along its length by screwed-on polycarbonate end caps for improved diffuser security and vandal/impact resistance. Overall, this provides an IP44 rating to the luminaire | • Dry change facilities<br>• Back-of-house areas |