Technical challenges involved with designing the vertical transportation in a large football stand

Philip Pearson

Pearson Consult Ltd, 31 Middleton Road, Lichfield, Staffordshire, UK

Keywords: Stadium, football stand, wheelchair, evacuation lifts, firefighting lifts, accessible stadia, ambulant disabled evacuation.

Abstract.

This paper discusses the vertical transportation aspect of a project of replacing the main stand of a stadium for a Premier League Football Club, from design concept to completion. It looks at how the design incorporated the multi-use of lifts and the Vertical Transportation (VT) requirements for both general admission and corporate hospitality guests. Compliance with The Accessible Stadia; Sports Ground & Stadia Guide [1], firefighting and wheelchair evacuation provision was required.

The paper examines the implication of time constraints when moving passengers with vertical transportation. Where appropriate these were evaluated against overcrowding, potential pinch points within the access and egress times.

In addition to this Local Authority requirements were addressed in regard to non-ambulatory attendees and evacuation procedures in case of emergency. The design development included working with football club officials to ensure that the lifts were only used as directed.

A fundamental aspect of the project design brief was to minimise the number of lifts in the stand. The project included working with the club and the main contractor to ensure all vertical transportation equipment was installed and commissioned in time for test events and first match.

The project was completed successfully within the set timeframe and budget with no significant issues at completion. The vertical transportation system has operated successfully since it's installation.

1 INTRODUCTION

A Premier League Football Club planned to replace their existing main stand with a much larger 'New Main Stand'. The New Main Stand was to comprise of general admission spectators and corporate guests. The accessible stadia requirements were to be met by providing facilities for a large number of supporters using wheelchairs.

The project involved developing the concept design through to the completed operational stand.

The design included the multiuse of lifts to minimise the number of lifts on the stand and evaluation of the use of escalators in place of lifts to move able bodied General Admission (GA) spectators up to the upper concourse.

The design development included working with the football club to obtain City Council Building Control approval of the firefighting lift provision and supporters using wheelchairs evacuation and grant a licence.

The on-site duties included working with the club and main contractor to ensure all vertical transportation equipment was installed and commissioned in time for test events and first match.

2 PROPOSAL SUBMISSION

A request for a fee proposal (RfP) submission for a replacement of the main stand at a Premier League Football Club with a much larger one was received. It is an iconic football ground and the vertical transportation design needed to meet their stringent requirements and the level of service required to be commensurate with the football club image.

As part of the fee proposal submission it was required that a lift strategy document was prepared. This strategy document included commentary and observations on the on the RfP proposal drawings. Part of the strategy document that was submitted was the initial considerations on positions and arrangements of the lifts - this took the form of sketches marked on the RfP drawing.

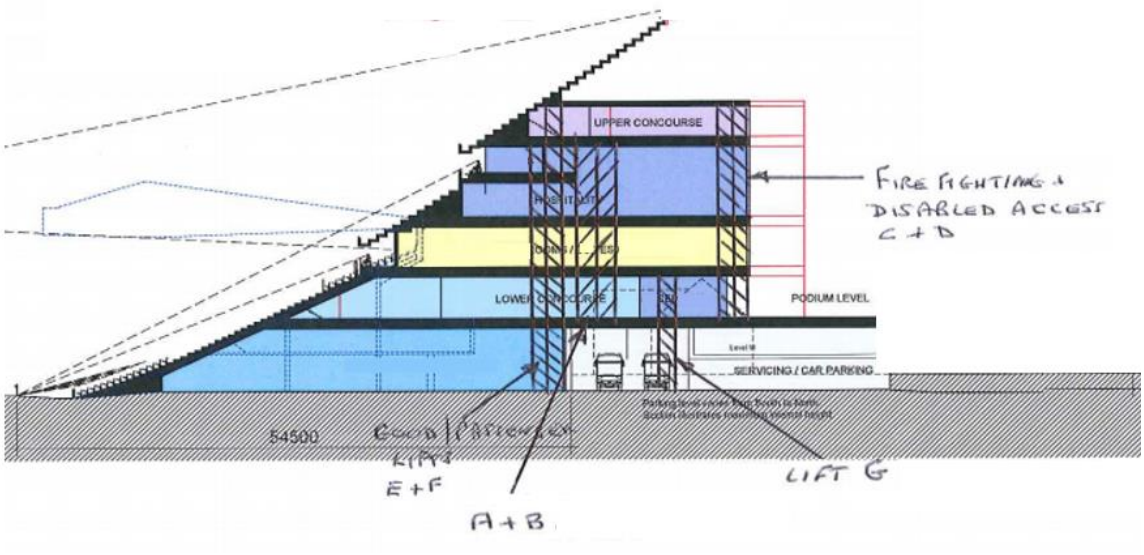

Figure 1: Initial considerations on vertical locations.

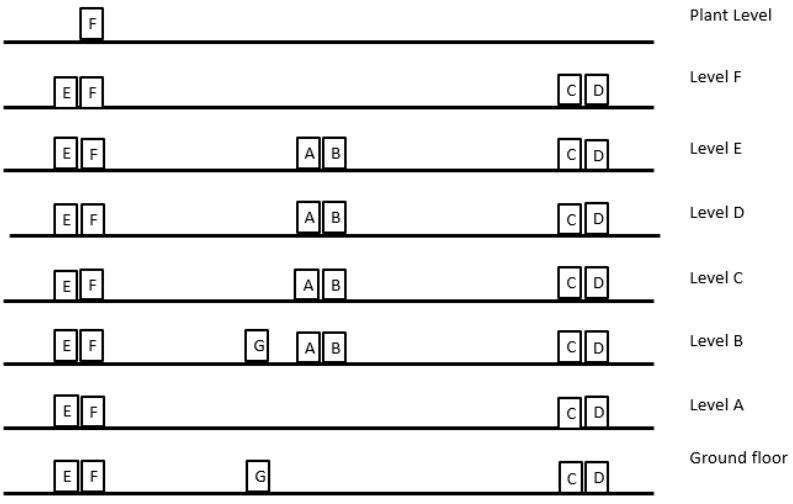

Figure 2: Initial considerations on floors served.

The submission was successful, and appointment made.

3 INITIAL DESIGN

Development of the overall vertical transportation strategy involved working with the football club and architect to design a scheme that would enable:

- Goods to be moved up to the concourses to supply the various units prior to an event and rubbish removal following an event,
- A large number of wheelchairs and ambulant disabled spectators to move up to their viewing positions on different locations and levels on the stand.
- A large number of General Admission (GA) spectators to move up the stand to the upper concourse and onto the upper terrace,
- Various grades of corporate guests to move up to their respective levels (various levels),
- Firefighting operations on the upper levels,
- Emergency evacuation of wheelchair users and ambulant disabled spectators.

4 MULTI-USE OF LIFTS TO MINIMISE THE NUMBER OF LIFTS

A fundamental aspect of the strategy was to minimise the number of lifts in the stand to control capital costs, this was achieved by multiuse of lifts e.g. the same lifts used for moving goods up the stand pre-match, wheelchair/disabled access to the upper levels viewing positions, emergency wheelchair/disabled evacuation, firefighters access, wheelchair egress and rubbish removal.

The Club has a very strong Health and Safety organisation and this provides the strict management control that this multi-use strategy of the lifts demands, thus ensuring that the lifts are in a satisfactory condition for the required application at the required time.

4.1 Lift usage

To facilitate the multi-use of the lifts they were sized to accommodate the following:

Goods delivery and rubbish removal:

Goods to be moved:

- 2 No. Euro pallets, *or*
- Approx. 6 No. roll cages, *or*
- 2 No. Beer palletisers, typically 1100mm x 1000mm (size depending on providing brewery), *or*
- 2 No. 1100 litre wheeled Eurobin.

Wheelchair and ambulant disabled movement:

2 No. wheelchairs and their companions and approx. 8 No. ambulant disabled persons at the same time - the number of ambulant disabled was based on practical experience. The wheelchair sizes were based on British Standards for manually operated Wheelchairs. [2]

Wheelchair and ambulant disabled emergency evacuation:

The lifts were designed to transport 2 No. wheelchairs and up to 8 ambulant disabled persons per trip. They complied with British Standard BS 9999 [3], as well as the applicable lift standards and codes [4].

Firefighting operations:

The lifts were designed to act as firefighting lifts complying with BS EN 81-72 [5] and BS 9999. [3].

Lift car capacity and size

These lifts are 21 person, 1600kg capacity, 1400mm wide x 2400mm deep.

Hoist machinery arrangement

Due to the location of the lifts being under the rake of the upper seating terrace it was necessary to 'hand' the lifts at each end so that the hoist machinery was under the highest part of the area beneath the rake of the stand.

Lift car finishes

The lift car finishes will be suitable for passenger and goods movement with durable hard-wearing finishes, heavy duty door panels and operators. Handrails and bumper rails at below dado height and low level on all walls.

Location and number of lifts

An analysis was carried out of the required applications for the multi-purpose use of the lifts, including the following factors:

- Amount of goods and rubbish to be moved,
- Number of wheelchairs and ambulant disabled persons to be moved in normal and emergency evacuation modes (see wheelchair evacuation section below),
- Maximum wheelchair travel distances from viewing positions to the evacuation lifts,
- Constraints of firefighting operations e.g. hose run distances, access on Fire Service Access Level (FSAL) from fire protected access point to firefighting lifts,
- Availability of fire protected refuges for wheelchair and ambulant disabled persons.

The conclusion was that a single lift at each end of the stand satisfied the above requirements.

5 WHEELCHAIR AND AMBULANT DISABLED PERSONS

The Accessible Stadia [1] requirements and BS 8300 [6] were to be met by providing facilities for a large number of supporters using wheelchairs. To provide equal opportunities for wheelchair spectators to view the match/event from positions other than the traditional touch line, viewing positions are located at various levels and positions in the new stand.

There are separate viewing positions for GA wheelchair users and corporate wheelchair users. The access up the stand is separated but the emergency evacuation is combined.

In order to ensure the safe evacuation of all the wheelchair users the stand layout incorporated a number of fire protected refuges. The purpose of the refuges is to protect the wheelchair users from smoke and fire during the emergency evacuation of the stand. The principle is that wheelchair users move from one place of safety to another in a controlled manner during an emergency evacuation. The following are the fire protected refuges with a minimum one hour fire protection:

Table 1: Fire protected refuges

Level	Location of refuge	Refuge purpose	Size of refuge
Upper concourse	Adjacent to each exit from the viewing position on the terrace	To hold wheelchairs whilst GA spectators evacuate	Capable of holding at least all the wheelchairs using that exit
All levels	Adjacent to each lift	To hold wheelchairs waiting for the lift to evacuate them down to ground floor	Capable of holding at least all the wheelchairs users on that level

In order for the club to obtain an operator's licence from the City Council Building Control, stringent spectator and wheelchair emergency evacuation times were required to be complied with. Due to the locations of wheelchair viewing positions being on various levels and positions in the new stand and other factors including the evacuation of the able-bodied GA spectators, a report was prepared demonstrating the evacuation times for each of the levels wheelchair viewing positions were on, overall evacuation times and different scenarios such as:

- The loss of a lift due to being commandeered by the fire service,
- The loss of a lift due to breakdown/failure,
- Changes in the number of wheelchairs on different levels due to design changes.

The report was prepared and satisfied the City Council Building Control and the licence granted.

6 GA SPECTATOR MOVEMENT:

6.1 General admission spectators

The upper concourse is where the General Admission (GA) spectators access the upper concourse seating, the upper concourse is over the equivalent to 6 office floors above ground floor and the upper terrace seating rises above the upper concourse vomitory by a considerable amount, so it was considered by the design team that a means of vertical transportation would be required to assist moving the GA spectators up to the upper concourse. Due to the height rise of the upper concourse and the additional height of stairs on the upper terrace to the seating, the stair factor would be negligible.

Lifts

The original design concept was to use lifts only to move the GA spectators up to the upper concourse.

An aspect of the football club supporters is that they tend to live close the stadium and generally arrive at the last minute, which can result in the majority of the GA spectators arriving in the last hour before a match.

A lift traffic analysis was carried out using lift traffic analysis simulation software [7] which demonstrated that moving the require large number of GA spectators by lifts was not practical with the resulting time to move all the GA spectators being in excess of the required time even with a large number of lifts and the risk of lift failure could cause major issues.

Escalators

A report was prepared using calculations and reference to CIBSE Guide D Transportation in Buildings [8] which showed that escalators could handle this volume of spectators. Therefore the

most practical way of moving this volume of GA spectators in the required time constraints was by installing escalators.

Table 2: Escalator carrying capacity

Escalator width	Carrying capacity per hour
600mm	2,250 per hour
800mm	3,375 per hour
1000mm	4,500 per hour

The escalators were positioned at each end of the stand to handle half the GA spectators that would access the stand at the entrances at each end.

Table 3: Time taken to move required total population of GA spectators

Escalator width (one escalator each end of the stand)	Time to move total population
600mm	1 hour 40 minutes
800mm	1 hour 7 minutes
1000mm	50 minutes

As previously stated the GA spectators tend to live close the stadium and generally arrive at the last minute, which can result in the majority of the GA spectators arriving in the last hour before a match. By designing the escalators in 2 banks, one of 4 and one of 5 escalators, all with the same height rise, laid one on top of each other. To avoid bunching between escalators they were designed in a “walk around” arrangement.

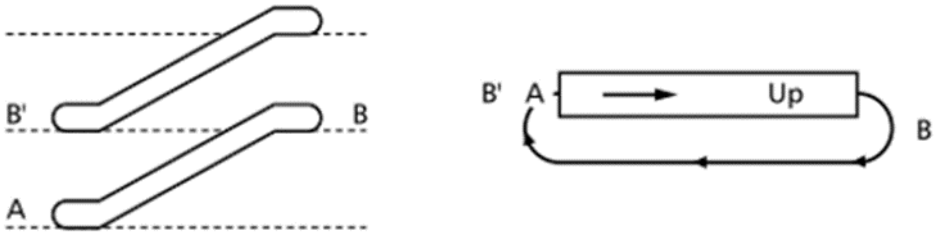

Figure 3: Walk around arrangement - schematic.

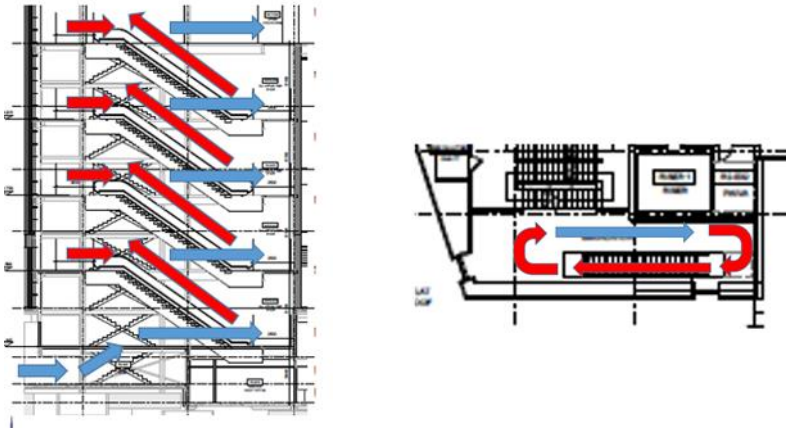

Figure 4: Walk around arrangement – applied to the scheme.

6.2 GA spectator normal egress and emergency evacuation

Normal egress

Following an event, the escalators will be reversed to assist with GA spectators' egress from the stand.

Emergency evacuation

The football stand emergency evacuation policy states that, in an emergency evacuation of GA spectators down from the upper concourse, the escalators shall be turned off and not used.

7 CORPORATE HOSPITALITY

7.1 Corporate hospitality guests

There are various grades of corporate guests in the stand with different hospitality offerings on various levels. There are a large number of corporate hospitality guests to be moved, the hospitality offering for each grade results in differing arrival times prior to an event. The number of wheelchair users for each level is identified.

To establish the likely demands on the vertical transportation system a review of the quantity of guests for each grade of hospitality and the time of arrival before an event was carried out and the results analysed. The results showed that arrival of corporate guest was spread over a period of time with the slightly larger peak nearer to the kick-off time for a match.

To evaluate whether to use lifts or escalators to move the guests a report was prepared using the information gathered above and calculation and references from CIBSE Guide D Transportation in Buildings [8], the performance of lifts and escalators was compared and concluded that escalators could move the largest group of corporate guests within the required time and lifts only did not.

Additional benefits of using escalators as the main means of moving able-bodied guests up to their respective levels (various levels) is that it enhances the appearance of the corporate hospitality entrance and circulation areas.

The lifts will be used to move corporate guest wheelchair users and ambulant disabled guests to and from their respective levels and for emergency evacuation of both GA and corporate guest wheelchair users and ambulant disabled persons. The lifts are the same size and configuration as the GA multi-purpose lifts i.e. 21 person, 1600kg.

7.2 Hospitality catering

The main catering kitchen for the corporate hospitality is on the ground floor with satellite kitchens on the corporate hospitality levels. To provide resilience and efficient service 2 No. 21 person, 1600kg lifts are provided, they are the same configuration as the GA multi-purpose lifts.

8 PLANT REPLACEMENT STRATEGY

The majority of the mechanical ventilation plant is located on the top floor of the stand above the upper concourse. To develop an effective plant replacement strategy involved devising a safe method of moving heavy plant from the plant level down to the ground floor to repair or replace it. Due to the close proximity of the rake of the upper seating terrace over the multi-purpose lifts at each end of the stand it was only possible to use these lifts for transporting the heavy plant down to the ground floor. To move the heavy plant from the top floor plant area to the upper concourse, it was necessary to install lifting beams and power hoists.

9 INSTALLATION AND COMMISSIONING

The installation was carried out during the construction of the stand with the escalators protected (entombed in wood) following installation and prior to commissioning.

Some of the lifts were used for beneficial use and refurbished and recommissioned following beneficial use.

The lift testing was carried out in an agreed sequence with witness testing taking place on completion of each lift.

10 OPERATION OF THE VERTICAL TRANSPORTATION SYSTEM

There were no escalators on the stadium prior to the New Main Stand construction and staff/steward operation and safety training was carried out.

Extensive staff/steward training took place prior to the first match at the stadium including two test events where stand evacuations took place. The equipment performed to the required standards without any issues.

11 CONCLUSIONS

The lifts and escalators were installed to the agreed design, the projects timescales were met and the project completed within agreed budgets.

The vertical transportation system in the New Main Stand worked well and met the requirements the club and local authority requirements.

12 LESSONS LEARNT

Some of the lessons learnt are:

- During the evacuation of the wheelchair users, the family members who had accompanied them to the stadium but were seated in GA seats came to the evacuation lift upper floor lobbies to ensure their wheelchair user relatives safely exited the stand, this increased to number of ambulant users of the lifts but the evacuation times were still satisfied.
- Extensive escalator operation training was essential for stewards and due to the nature of the stewards not being permanent members of staff and different stewards on the escalators each match.
- The multi-use of the lifts worked very successfully without any issues.

REFERENCES

Note: The project was designed and carried out between 2012 and 2015 and the codes and standards in the references below were current during this period with the *current codes and standards in italics.*

[1] Accessible Stadia: Sports Ground & Stadia Guide No.1. (2003). 1st ed. London: The Football Stadia Improvement Fund. *Guide edition is still current*.

[2] BS EN 12183:2009 - Manual wheelchairs. Requirements and test methods. (2010*). Current standard BS EN 12183:2014 - Manual wheelchairs. Requirements and test methods, (2014)*

[3] BS 9999:2008 Fire safety in the design, management and use of buildings. Code of practice. (2008). *Current standard 2. BS 9999:2017 Fire safety in the design, management and use of buildings. Code of practice. (2017).*

[4] BS EN 81 suite of lift safety and engineering standards.

[5] BS EN 81-72:2003 - Safety rules for the construction and installation of lifts. Particular applications for passenger and goods passenger lifts. Firefighters lifts. (2003). *Current standard BS EN 81-72:2015 - Safety rules for the construction and installation of lifts. Particular applications for passenger and goods passenger lifts. Firefighters lifts. (2017).*

[6] BS 8300-1:2009+A1:2010 Design of buildings and their approaches to meet the needs of disabled people. Code of practice. BSI, (2010). *Current standard BS 8300-1:2018 Design of an accessible and inclusive built environment. External environment. Code of practice. BSI, (2018).*

[7] Elevate lift traffic simulation software. Peters Research Ltd.

[8] CIBSE Guide D 2010 Transport Systems in Buildings, London CIBSE. *Current guide CIBSE Guide D 2015 Transport Systems in Buildings, London, CIBSE*

BIOGRAPHICAL DETAILS

Philip Pearson started his engineering career as a technician apprentice at GEC Power Engineering in the early 1970's and following a successful career in building services, got involved with the lift industry over 30 years ago. Since then he has run his own lift and escalator company, designed lifts and escalators and since 2001 has been in lift and escalator consultancy. In 2015 he founded his own consultancy practice Pearson Consult Ltd.