EFFECTS OF BASEMENTS ON LIFT TRAFFIC ANALYSIS - A REVIEW

C. M. Pearce, University of Sydney, Australia.

ABSTRACT

The lift installation is a building system subject to much abusive comment by occupants. Usually traffic analysis and calculations are carried out from the lobby or arrival floor upwards in the building. Little or no account is taken of service to below lobby, or basement area. It is known that lift movement below the lobby severely disrupts service to high floors in the building. This paper investigates this problem, and suggest some means of overcoming it.

1 REVIEW REQUIREMENT

During the workshop session on basement service in Elevcon '93, the question was raised whether lift service to basements really needed any attention, since basements were considered to be an unimportant part of the overall lift system.

In many cases, statutory requirements call for a minimum lift service to basements to be provided, hence the basements are an integral part of any such installation. It was shown in the paper " Office Buildings From the Bottom Up" presented to that congress, that lift traffic studies provide scant and varied, if any, attention to the basement service, and the real effects do not appear to have been documented. As a result, such lift systems have been designed inadequately, and on unsubstantiated information. Often, the easy answer, that of providing a separate lift system to the basements, results in high costs, and inconvenience to the occupants of the buildings.

Specific basement arrangements are investigated in office buildings, in Sydney, Australia; the first being a single basement, and the others, multiple basements which are served by all lifts, to indicate the effects of the basement service on the overall system.

2 PASSENGER EXPECTATIONS

Persons joining the lifts in the basement, would not expect to enjoy the same standard of service as is available at the ground level terminal, at that time, however should be able to expect a lift to appear in a reasonable time from signalling their requirement. What constitutes a reasonable time for them, as related to the average up-peak interval of the lift system, is not defined. Opinions have been presented on theoretical effects of basements on the overall round trip time of the installation, however these have made assumptions on the average basement service, and do not appear to relate to the users' needs or expectations.

- In his book, "Vertical Transportation: Elevators and Escalators", G. R. Strakosch considers the serving of basements to be a problem, but does not offer any real solution to it. He divides the basement service into either more or less than 33 per cent of the critical traffic on the lifts, suggesting in the former case that time allowance should be made, while in the latter that consideration should be given to relocating the dispatching terminal to the basement.
- G. C. Barney and S. M. dos Santos, in "Elevator Traffic Analysis Design and Control" express concern at the disruption to the lift performance caused by basement service, and recommend either that such service be seriously restricted, or a separate basement lift service be used.
- In CIBSE GUIDE D, Part 3 "Planning and selection of equipment and performance of transportation systems", the authors expressed concern at the limitation in the number of lifts to basements as a cost reduction. They indicate

that, as well as creating passenger confusion, basement service can add 15 to 30 seconds to the round trip time during the up peak traffic condition, also they iterate a suggestion by J. Nahon in "Traffic Analysis for Small Scale Projects", that, where there are several basements, a similar calculation could be used as for the service above the main terminal, and the resultant figures combined to give an overall round trip time.

- The Elevator World "Guide to Elevatoring", merely suggests that alternative lift service to basements can save as much as 15 seconds per trip.
- Lama, the general lift design computer programme distributed by ACADS, the Australian computer aided design service, suggests the disconnection of basement service during up peak traffic periods; adding that if this can't be done, then their programme allows for a basement stop every third round trip.
- Programmes either obtained from, or discussed with, manufacturers appear to provide a simple add-on to the basic calculation, or disregard basements altogether.

These references would appear to indicate that the effects of basements are considered to be either too insignificant to calculate, and they are construed as being unworthy of special consideration.

3 MULTIPLE MAIN ENTRY LEVELS

A feature of buildings on sloping sites is often the use of two main entrance floors, level of entry to the lifts depending upon the side from which the building is approached. The design of the lift installation is required to either allow for the time required to stop and load at the lower level, or to create a situation where all building entrances direct to one common terminal lobby. This may be arranged by suitably designed ramps or stairs, and in situations where many people use the lower entry, the use of escalators may be worthy of consideration. In any case, adequate provision would be required to be made for handicapped people.

Should the lower floor be used as a car park, then people not using vehicles should be discouraged from entering the lift system from that level. Disturbance and delay is created in the morning peak period when substantially filled lift cars arrive at the higher main arrival terminal. This is not necessarily a problem for the lift system designer, however he should be aware of the danger of the situation and advise his client accordingly.

The practice in some buildings on sloping sites has been to utilise the natural double entry by the installation of double decked cars. With suitable access between the terminal floors, some of the problems can be solved by this arrangement, although it can cause others, such as inter floor traffic difficulties, and unwanted delays while the other half of the car is loading or unloading. The peculiarities of, and requirements for double decked lift cars are a study in themselves, and have been considered to be outside the scope of this review.

The most suitable arrangement for sloped sites, from the point of view of the lift installation, is to design the building with normal personnel access only on one level, and to consider that as the lower terminal.

4 SINGLE BASEMENTS

A common arrangement for smaller buildings where the site is relatively level, and a single basement is provided for car parking, the basement is served by some, or all of the lifts provided. Under the conditions imposed by the Building Code of Australia, it is necessary in all buildings above 25 metres in height to have an emergency lift serving all floors.

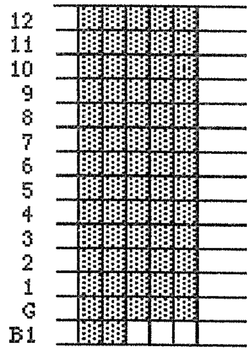


Fig. 1 - Single Basement System

In New South Wales, where more than one lift is installed in the building, then at least two are required to be emergency types, serving all floors.

This condition is indicated in Figure 1, where of the five lifts serving the building, two only are extended to the basement. The other three terminate at the ground floor, serving only the upper levels, and cause an obvious problem to personnel on the upper levels, wishing to travel directly to the basement.

The stated benefit of the system is the cost saving of three basement landing entrances, however this is offset in the overall project by the cost of one of the necessitated extra construction works created by the reduced entrance requirement, as follows:

- partially refilling and consolidating the pit excavation below the three higher terminating lifts,
- excavating a two level pit floor,
- building a false pit floor for the three higher terminating lifts.

Problems associated with this system, other than that stated in the previous paragraph, are created when the basement serving lifts are out of use, and no service is available to that level. The whole benefit of the lift service to the basement is lost, since the other lifts are incapable of providing support. The obvious recipient of blame for this eventuality is either the lift manufacturer, or the lift maintenance contractor.

There appears to be a strong case for lift manufacturers to argue strongly for each lift to have the capacity to serve a single basement, even to the extent of providing the extra service at the minimum cost. The benefits of being able to transfer basement service to any car in the group must be of great advantage, and it is always possible to restrict the basement service during peak traffic periods, through the control system, while being able to provide a continuous basement service. Under the Australian conditions, there would also be considerable benefit gained by having all lifts in that system sized and connected for emergency use.

The judicious programming of the control system should maintain a suitable average passenger waiting time for the up-peak condition, while providing an acceptable service to the basement. There appears to be little, if any, benefit gained by the use of a separate lift for a normal single basement.

Were the basement used for purposes other than parking, such as a restaurant, similar conditions would apply, excepting the potential impact on up-peak traffic. The major times of restaurant use are in the middle of the day and the evening, and these do not coincide with the up-peak traffic pattern. A strong impression is made on the mid day traffic peaks, due to the additive requirements of restaurant traffic, and those of the rest of the building. This impact would not be sufficient to make either of these peaks equivalent to the morning up-peak traffic condition. Little effect would be noticed in the evening, since restaurant operating times are later than the evening down-peak traffic condition.

Only under a requirement of building security, or the provision of completely isolated entrances for the restaurant and the office sections of the building, should a separate basement lift be considered as an acceptable system. With a separate entry, it may still be possible, depending upon the layout, to use a section of the lift system which may be physically isolated, or lifts with front and rear entry, for this purpose.

5 DEEP BASEMENTS

Deep basements are defined for the purpose of this study as those having any number of levels beyond four. An argument often voiced by building developers is their need to use the space under lifts in deep basements for additional car parking in lower basements, since there never appears to be sufficient space available in basements to cater for all requirements. The provision of the additional safety gear to make such usage possible, is an expensive exercise, and we try, consequently, to advise other means of achieving the space requirement.

The pit could be in excess of five metres deep for high rise lifts, and this constitutes a severe loss of basement space, regardless of whether the basements are served by the main lifts, or not.

The developers may complain also about the parking spaces lost in front of lift entrances in basements. This is acknowledged to be a potential problem, however will always arise at any lift or stairway entrance, and lift system designers should argue that the building design should not be so tight as to allow the problem to occur. Regardless of the lift systems and arrangements used, there will always be a severe intrusion by the lifts into the basements of any building. As is applicable to upper floors, the developer should be encouraged to design with the lift requirements in mind, and include the most satisfactory lift system for the building, in the overall design.

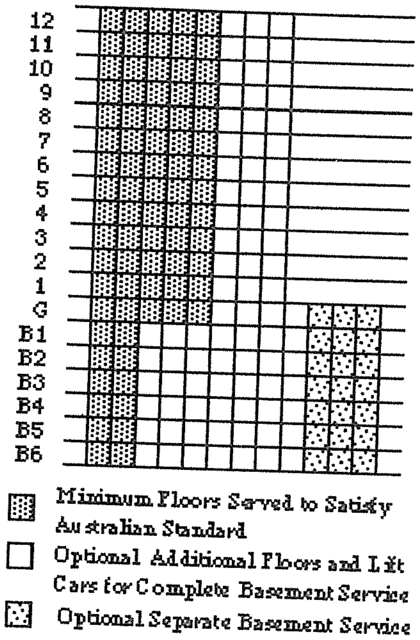


Fig. 2 - Alternative Arrangements for Six Basements.

A common, and indeed irrelevant comment from developers, is the high cost of additional lift entrances in the basements. We are all aware of the minute increase in the overall cost of a lift installation, caused by an additional entrance. This is an area that should be considered carefully, since the developer may be under a misapprehension.

The feature of greatest relevance to lift system designers, particularly with deep, multilevel basements is the cost and convenience difference between extending part or all of the main system, and a separate service to the basements.

These alternatives are indicated in Figure 2, and show that to maintain an equivalent above ground service, it would be necessary to install three additional lifts, unless the control system was set to restrict the number of lifts serving the basements during the morning up-peak traffic condition. Even with this control restriction, and depending upon the level of restriction, it would be necessary to install at least one additional lift to allow for the time taken for the large number of basement stops.

Allowing two or three dedicated basement lifts would provide an acceptable service to the basements, at a fraction of the cost. The major inconvenience would be the need to change lifts at the ground floor, however this would be minimised if all lifts terminated in a large common lobby. The lobby should be as large as possible to cater for passengers egression from the basement lifts, adding to the people waiting to go to upper levels.

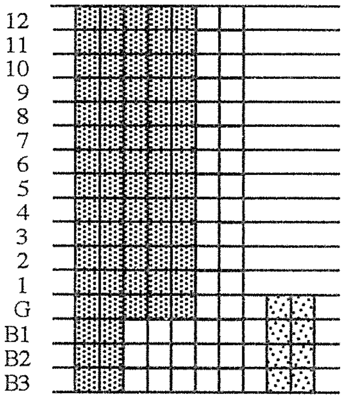
In considering such basement service in Australia, attention would be given also to the statutory requirement for emergency lifts to serve all floors of the building. Should these lifts be retained for goods service, and not form part of the general passenger lift system, then they are not considered to be part of the exercise, unless they were intended to be used for basement service during the morning up-peak condition, to reduce the number of dedicated basement lifts.

The dangers of allowing some of the normal passenger lifts to serve the basements, are the conflict of intention between passengers wishing to leave the cars to join a separately zoned bank of lifts, and those intending to enter the cars; and the arrival at the ground terminal of cars substantially filled in the basements, during the up-peak period.

Since deep basements are related generally to multi zone lift systems, and it is rarely feasible to extend all lifts to each basement level, then a suitably designed separate basement service is normally the most attractive system for the designer to offer. The basement area below the lift pits is not used, and is commonly an extension of the foundation rock with the lower basements excavated around it.

6 INTERMEDIATE BASEMENTS

An intermediate number of basements is considered to comprise between two and four levels.



Minimum Floors Served to Satisfy Australian Standard

Optional Additional Floors and Lift Cars for Complete Basement Service

Optional Separate Basement Service

Fig. 3 - Alternative Arrangements for Three Basement Lift System.

These are usually the most difficult basement types for which to design a lift system, falling between the simple single basement system, and the separate deep basement type. The nature of the building; the number of floors above the ground terminal, the number of lift cars and their zoning, and the number of basements, are factors the lift system designer will use to make a choice of the system to be used. This is the area in which no single answer can be offered, and each case has to be considered on its merits. Buildings with this range of basements have many alternative arrangements, and the lift system may comprise anything from two cars in a single zone, to multiple zones in a high rise tower.

The lift system for such a building will be designed on the basis of the traffic analysis for the circumstances above the lower terminal floor. As in the case of the single basement building, it may be feasible to extend all lifts to the lower of two basements in a building, where there is a relatively simple lift system. In the event of a three basement building, the complexity of the lift system may warrant a separate basement system, or may allow it to be an addition to the main lift installation.

Cost will always be a most important issue regarding the final design of basement systems in office buildings, particularly when the guidelines are so limited. Neglecting costs, it may be fair to enquire how many lift system designers have given fair thought to these design considerations.

It would appear that design thinking has not always kept pace with the greater sophistication of control systems that is available today. The whole issue of lift service to basements needs serious rethinking, in the light of current development, not only in the control systems, but also in building usage.

There is no reason, with the information available today, why we cannot design a most suitable lift system above the main terminal. Consideration should be given now to whether the designer has sufficient information at his disposal to make a fair assessment of the basement requirements, usage, to provide the type of lift system that would best serve the whole building.

7 EMERGENCY LIFTS

A review of the Building Code of Australia, as amended for New South Wales, provides the following statutory requirements:

- For a building which has an effective height of more than 25 metres, at least one passenger lift, which is an emergency lift; or where there are two or more lifts, at least two passenger lifts, which are emergency lifts; to serve each storey of the building.

- The emergency lifts must be contained in at least two separate lift wells.

- Emergency lifts need not serve the topmost storey of the building if it comprises plant area only.

- In the above requirements, an emergency lift is one which is connected to a standby electrical power system, and includes a stretcher facility comprising a minimum clear interior area of 600 mm wide x 2000 mm long x 1400 mm high above the floor area. This means that one, or more, such lifts are required to serve all floors, including basements.

These requirements look upon the building as an integrated unit, from the view of emergency situations, and calls upon the lift system to satisfy it. As designers, we don't consider the building as such, concentrating our whole effort to the above ground conditions.

There may be some merit in both of these views. On the one hand, the building is constructed as an integrated unit, whereas on the other, the purposes of the above ground and the below ground sections are quite different. It would also appear, as the lift design data has ignored basements, considering them to be an appendage, the Building Code of Australia has integrated the operations and purpose of the basements as part of the "real" building.

As there is every reason to include the basements as part of the lift system design, there is doubt whether the Building Code of Australia is providing an ideal solution to the emergency problems of the building.

It is not impossible for an emergency situation to occur simultaneously in the basement and upper section of a building, and the emergency services can't be in both parts of the building at the same time, with a common lift system. In buildings with a large number of basements, it has been indicated that the most effective lift system may involve a completely separate basement service.

This case would indicate that the Australian statutory requirement may cause an artificial restriction in the lift design, in that at least two high rise lifts would be designed to serve all basements. Were those lifts provided for goods use under normal conditions, they would not be part of the main passenger lift system, and may not effect the design of it, however it may well be considered economically prudent to endeavour to build into the overall lift system the statutory requirement, and not look further at a separate basement service, since the designer would be already "stuck with" those lifts.

Additionally, the question may be raised whether the Australian statutory requirement, although well intended, really provides the best emergency service for buildings with several basements. With a separate lift system to the basements, the building becomes divided between upper and basement levels, and each lift installation serves its related section. Provided all lifts serve the exterior accessible floor for emergency situations, it may well be argued that a separated tower/basement system provides the greatest flexibility, and the statutory demand for two all embracing lifts may be counter productive.

8 SUBSTANDARD LIFT SYSTEMS

Substandard lift installations, with their associated building construction cost benefits, can help create a convenient argument to be proffered by developers, to convince the site owners of the viability of their proposal. As a consequence, the building design and construction will proceed, and the completed building will be occupied.

When the initial excitement of new building occupancy is over, and people consider disappointing features, the difficulties with a substandard lift service become a major problem to them. Time loss and inconvenience to staff can cause a company to look seriously at the possibility of relocating to a better equipped building. When a city is oversupplied with office space, buildings with inadequate services are the ones which remain under-utilised, and lifts are a very noticeable service, when inadequate..

Vacant office space is an expensive commodity, both from the view of lost revenue, and from the reputation of the building. To attract tenants, the rental is reduced, and the initial purpose for the building may never be achieved. With less than intended income, less finance is available for building maintenance, the appearance starts to deteriorate, and the building becomes even less attractive to potential occupants.

This is not an unrealistic example of the fate of a building with substandard services in times of economic recession, and is common for most countries. Particularly relevant to it is a situation where the recession has followed a time of intense building activity, and several of the building tenants have ceased to exist. Potential tenants are in a strong position to find a building which satisfies all of their requirements, and it is always the building which has the best available services within their cost range, which will attract them.

For too long, lift companies have allowed developers, with an eye to profit rather than good building development, to dictate the standard of the lift system. Associations, such as the International Association of Elevator Engineers, spend a great deal of capital, time and effort, endeavouring to bring to notice the best practises in lift design and installation. Their effort is wasted if the industry is not prepared to take a stand on fair quality in these areas, particularly as the censure for a substandard lift system falls mostly on the manufacturer or installer. The developer has long passed from the scene, and a poor building may have passed through many hands since it was first opened.

9 PREFERRED LAYOUTS

The suggestion has been made in this study that the most preferable arrangement for effective vertical movement of people in an office building with several basements, is a separate service to the basements, with entrances in the same lobby as the lifts to the upper levels of the building. Obviously, in a building not containing a separate basement lift system, this situation does not arise.

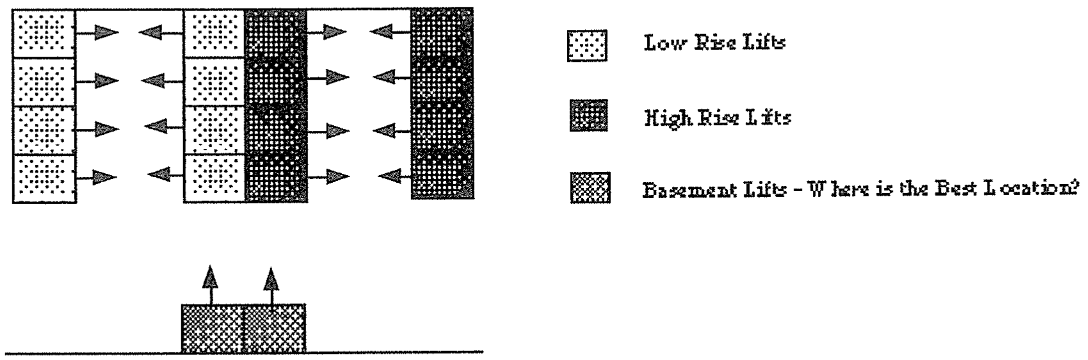


Fig. 4 - Two Zone Lift System With Separate Basement Lifts

Having agreed the need, in buildings with a large number of basement levels, for separate basement lifts with a common ground terminal lobby, as indicated in Figure 4, the next matter of concern is the location of the basement lifts. In that diagram they have been indicated in a location where it is reasonable to suppose that they will provide ready access to either of the lift zones, while not causing undue inconvenience to passengers waiting to use the lifts in either zone.

Depending upon the layout, space and access to the lobby, the final location of the basement lifts is quite flexible. They could, for example, be located immediately adjacent to the main lift wells, perhaps with their entrances facing away from them, or in any position outside the main traffic access.

The least acceptable location would be for the basement lifts to be in the same line as either of the main lifts zones. By feeding into the same sub-lobby as the main lifts, the waiting and car entering problem with crowding would be accentuated.

10 COMMON PROBLEMS

Many existing buildings show a lack of serious consideration toward the design of lift services to the basement levels. Often, the lift system is expected by the building designer to fit in with what he has decided to be a convenient building layout. It is rare to find separate basement lifts serving the lift lobby at the lower terminal of the main lifts, hence serious inconvenience is created for the users of the building.

In some buildings, the basement lifts do not even serve the level at which the main lifts terminate, and basement users are required to use supplementary escalators or stairs between the lift systems. As well as making basement use impossible for physically impaired people, this arrangement causes frustration to all persons using the building parking facilities.

The use of goods lifts capable of serving all floors of the building may overcome this problem, however the peak traffic periods often coincide with the movement of freight, and those lifts may not be available when required for the movement of basement users.

Arguably the worst situation, during the morning peak traffic period, occurs when the lower zone lifts only serve the basement, and a traffic block occurs, when a number of passengers are attempting to leave the car at the ground floor to use lifts in another zone, while occupants of the lobby are trying to enter the car. The obvious solution to these problems resides in the effective movement of people within a building, by endeavouring to move as many as possible in a similar direction, at any particular time. Well designed lift installations will always tend towards that aim, while providing the most acceptable, economic system.

11 SAMPLE CALCULATION FOR A BASEMENT SERVICE

11.1 Assumed Data

Using data, tables and formulae from Sections 3 and 11 of CIBSE Guide D
Area per floor - 1220 m^2 net
Number of floors above main terminal - 12
Number of basements - 3
Population density - 10m^2 per person (Table 3.1)
Floor to floor distance - 3.3 metres throughout building
Required Interval is 25 seconds (Table 3.2)

11.2 Calculations

(a) UP SERVICE FROM TERMINAL

H = 11.7, S = 9.2 (Table 3.5)

RTT = 2 x 11.7 x 1.32 + (9.2 + 1) x 5.5 + 2 x 16.8 x1.2 (Equation 3.3)
= 29.57 + 56.1 + 40.32
= 125.99 seconds

An up-peak interval of 25 seconds is required

No. of cars = $\frac{125.99}{25}$ = 5.04 UPPINT = $\frac{125.99}{5}$ = 25.20 seconds (acceptable)

UPPHC = $\frac{300}{125.99}$ x 16.8 x 5 = 200.02 persons per 5 minutes (c.f. 176 required)

(b) UP SERVICE FROM BASEMENTS

Number of floors is 3 Using the same lift system as above, and allowing 2 stops per trip

Allow H = 3, S = 2, allow $t_{p(in)}$ to be 4.0 secs and $t_{p(out)}$ to be 1.5 secs (Clause 11.3.3.6)

RTT = $(2 H t_v) + (S + 1) t_s + t_{p(in)} + t_{p(out)}$
= (2 x 3 x 1.32) + (2 x 7.98) + 4.0 + 1.5
= 7.92 + 15.96 + 5.5
= 29.38 seconds

Therefore: Total Round Trip Time for lift system
= 29 38 + 125.99
= 155.37 seconds, which would require the number of lifts to be increased

to 7 to maintain the required 25 seconds up-peak interval.

(c) SEPARATE BASEMENT SERVICE

A separate lift service to the basements, allowing similar parameters, would have a lower car speed, since it would be serving only the three basements and the main terminal. Allow, from Table 3.7, a contract speed of 1.0 metre per second, similar door times to main lifts, and allow for all lifts to reach the main terminal at 80% of their capacity.

Therefore: $t_v = 3.3$, $t_s = 7.5$. Allow H = 3, S = 2.

RTT = 2 x 3 x 3.3 + (2 + 1) x 7.5 + 2 x 16.8 x1.2 (Equation 3.3)
= 19.8 + 22.5 + 40.32
= 82.62 seconds

But, from Clause 3.10.2, DNPINT is about 67% of the UPPINT, which is directly proportional to RTT. Hence, since a basement up-peak is the same as an above terminal down-peak condition, then we can consider the basement RTT to be 67% of 82.62, or 55.36 seconds.

To provide a service reasonably close to the required 25 seconds interval, it would be necessary to provide at least two lifts, however the indications are that an interval of greater magnitude than that required above ground, would be acceptable. This would be a less expensive alternative to the extension of the main lift system, however, depending upon the available location, may also be less convenient.

12 RESEARCH

The research intention is to investigate the means used to move people from the basements to the upper floors in a sample of buildings, and to check the effectiveness of them.

Electronic data of lift installations in some selected buildings have been obtained, and this is being used as a check against information recorded during the morning up-peak traffic condition in those buildings. This is an ongoing process, but has been rather restricted to this stage. Some building managers, and lift companies have indicated a reluctance to be involved in the project, expressing the concern that it may reflect adversely against their area of responsibility.

A questionnaire is in the process of preparation, to obtain an appreciation of what passengers would like, what they need, and what is reasonable for them to accept of the basement service, compared with their expectations of the above ground system.

This information, when received, will be tabulated, compared, and trends obtained. The data will be compared against known formulae and programs, and their validity will be established for basement conditions. It is hoped that a set of guidelines for lift systems to basements may be established as a direct result of this work.

13. CONCLUSIONS

The lift installation, and the lift designer, both have been subjected to much abuse by the public, and misuse by many building developers. The development of technology for lift systems above the lower terminal level has done much to solve that situation, and to indicate clearly problems which will eventuate if established parameters are not met.

Unfortunately, the same has not been the case for lift systems below that terminal, resulting in a multitude of arrangements, very few of which have given complete satisfaction. This investigation has indicated some of these and related them, but has shown that they do not provide a complete answer. It appears to be immaterial which formula, or group of formulae is used, if it has not been established which lift system will best serve the basements, in conjunction with the rest of the building. Further investigation should be carried out on the service to basements, in order that clearly defined parameters may be established, similar to those for lift services above ground.

The question remains whether there is any real benefit or interest in a study such as this to the lift manufacturer and installation contractor. In some circles, this Association has been accused of being overly theoretical in its approach to practical problems, however there has been a practice in the industry to provide the absolute minimum possible to complete a sale.

14. BIBLIOGRAPHY

ACADS: *Commercial Lift Design LAMA Version 2.1 Reference Manual,* Australian Computer Aided Design Service, Melbourne, Australia, 1992.

AUBRCC: *Building Code of Australia,* Australian Uniform Building Regulations Co-ordinating Council, Canberra, Australia, 1990.(updated to 1993)

Barney, G.C., and dos Santos, S.M.: *Elevator Traffic Analysis Design and Control,* Peter Perigrinus Ltd., Stevenage, England, Revised Second Edition, 1985.

CIBSE Guide D: *Transportation Systems in Buildings,* The Chartered Institution of Building Services Engineers, London, England, 1993.

Elevator World, Education Division: *Guide to Elevatoring,* Elevator World, Mobile, USA, 1992.

Strakosch, G.R.: *Vertical Transportation: Elevators and Escalators,* Wiley, New York, 1967.

BIOGRAPHICAL NOTES

The author, Craig Pearce, obtained his Diploma in Electrical Engineering from what is now the Caulfield campus of Monash University, Melbourne, Australia, in 1961, and spent the following 30 years in several countries, in Consulting Engineering, much of which was involved with lift system design. In 1990, he was invited to lecture part time in Vertical Transportation in a new Building Services post graduate course to be established at the University of Sydney. He also joined the course, and was the first graduate of it, as Master of Design Science (Building Services) in 1992.

In November 1991, he joined the university staff as a lecturer, developing and co-ordinating the vertical transportation, communications, and electrical services courses, fundamentally in the post graduate area of the Department of Architectural and Design Science, of the Faculty of Architecture.

He is currently endeavouring, in Australia, to encourage interest in lift systems design, and to educate both postgraduate and undergraduate architectural students on the importance of services in building design, while attempting research toward his Ph.D.