UPPEAK REVISITED

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Abstract

It was once thought that the only way to efficiently service uppeak traffic was to force cars to return to the main terminal after every trip. However, there are a number of techniques (made possible by modern computer technology), which now make this oversimplification invalid. These include uppeak Subzoning (divide the building into two); uppeak Sectoring (give each lift a set of floors to serve) and Hall Call Allocation (find out where passengers want to go, before letting them into the car). A comparison is made of these three techniques and Hall Call Allocation with uppeak subzoning; using the conventional uppeak service regime as a reference.

1 TRAFFIC DESIGN

Lift systems are sized for the uppeak traffic pattern by using the following well known formulae (Barney & Dos Santos, 1985-p22), in order to obtain the system Round Trip Time (RTT), the Interval (INT) and the 5-minute Handling Capacity (HC):

$$RTT = 2.H.tv + (S+1)ts + 2.P.tp \qquad \text{... (1)}$$

$$INT = RTT/L \qquad \text{... (2)}$$

$$HC = 300.P/UPPINT \qquad \text{... (3)}$$

In addition it is possible to determine the average passenger waiting time (AWT) and the average passenger journey time (AJT).

Figure 5.20, (Barney & Dos Santos, 1985-p248) relates the average passenger waiting time (AWT) to car load and interval. For car loads from 50% to 80% the curve can be approximated as:

$$AWT = [0.4 + (1.8.P/CC - 0.77)^2]INT \qquad \text{... (4)}$$

For car loads less than 50% the AWT is given by: AWT = 0.4 x INT. Car loads above 80% have not been considered in this paper.

Passenger average journey time (AJT) is the time from the instant a passenger registers a hall call at the main terminal floor, until the instant of exiting at the destination floor. The passenger will be considered to exit at the stop corresponding to S/2, at a floor corresponding to H/2, by which time P/2 passengers will have left the car at other floors. Hence:

$$AJT = H.tv/2 + S.ts/2 + P.tp + P.tp/2 + AWT$$

$$= 0.5(H.tv + S.ts + 3.P.tp) + AWT \qquad \text{... (5A)}$$

For the Subzoning and Sectoring traffic control systems the AJT is calculated for a subzone or sector situated centrally in the zone being served. Thus, it is necessary to add the time to reach the first served floor of the subzone/sector, this is:

$$N.tv.(SL-1)/(2.SL) \quad \text{where SL is the number of subzones/sectors}$$

Thus:

$$AJT = 0.5(H.tv + S.ts + 3P) + N.tv.(SL-1)/(2.SL) + AWT \qquad \text{... (5B)}$$

Note: There are no parameters concerned with the lift traffic control algorithm in Equations (1) to (5).

2 REVIEW OF LIFT TRAFFIC CONTROL SYSTEMS

How do the modern techniques of uppeak Subzoning, uppeak Sectoring (or channelling) and Hall Call Allocation affect the sizing of a lift installation for the uppeak traffic condition ?

2.1 Conventional control

Once the uppeak traffic condition has been detected (eg. by load weighing, number of car calls registered, etc.) all cars are returned to the main terminal floor after their last passenger has exited at the high call reversal floor, with all down landing calls ignored or serviced only on an occasional basis. Sometimes called simple collective control.

Equations (1) to (5) are suitable to calculate the lift system characteristics.

2.2 Uppeak Subzoning

The most significant term (i.e. the largest) in Equation (1) is the middle term and if the stopping time (ts) can not be reduced, then the only other course of action is to reduce the number of stops (S). This can be achieved by subzoning, where the building zone is divided into two subzones, for the duration of the uppeak traffic period. This technique is generally only suitable for buildings with six to eight lifts in a group and for building zones with more than 16 floors. Thus an 18 floor building zone served by six cars could be subzoned into a lower subzone of ten floors served by three cars and an upper subzone of eight floors served by the three other cars. The cars are permanently allocated to a subzone and passengers are directed, to the subgroup that serves their destination, by illuminated signs.

2.3 Uppeak Sectoring

Uppeak subzoning can be extended by dividing a building into as many subzones or sectors as there are cars and directing the passengers to a car serving their destination. The effect is to reduce further the number of stops (S) a car will make. Again the technique is usually applied to buildings with more than six cars and 16 floors. Thus an 20 floor building zone served by six cars could be divided into five sectors of four floors. In order to provide an even service to all sectors the cars are not permanently allocated to a sector, but sectors are served in a "round robin" fashion as cars reach the main terminal floor. Thus passengers must ceaselessly examine continually changing destination signs by each car, in order to board the correct car.

2.4 Hall Call Allocation

When calls are registered using the single hall call button at the main terminal floor, the traffic control system does not know where each passenger wishes to go. If destination floor information were available, the control algorithm could collect passengers with common destinations into one car, thus reducing the number of stops (S). To achieve this a different type of hall call registration panel would be needed, where each passenger could register calls for their destination on the landing before entering the car and then be told which car to board. A simple system of this type was proposed by Leo Port in 1961 and published in 1968. The system was based on relay technology, unlike modern day versions, and thus had limited call allocation abilities. An independent analysis was made by Closs in 1970.

It is also possible to subzone the building with Hall Call Allocation traffic control system. This again has the effect of reducing the number of stops a car makes.

3 METHOD OF ANALYSIS

There are six parameters required to solve Equation (1):

- Number of floors served (N)
- Rated capacity (CC)
- Rated speed (v)
- Interfloor distance (df)
- Cycle time (T) *
- Number of lifts (L)

[* time from instant of doors closing to instant doors 90% open at next adjacent floor]

Using N and CC it is possible to obtain values for H (highest reversal floor) and S by calculation or from tables for the number of passengers (P) to be carried. The parameter tv is obtained from the expression (df/v) and the parameter ts is obtained from the expression (T-tv). It was decided to set:

- The passenger transfer time (tp) to an average value of 1.0 s,
- The interfloor distance (df) to 3.3 m,
- The transit time (tv) to 18/N (to simplify the programming).

As the analysis is concerned with office buildings, the range of likely configurations determined the range of values for N, CC, L and T as:

- N: 10 to 25 floors;
- CC: 16, 21, 26 person;
- L: 4, 6, 8 cars;
- T: 8, 10, 12 s.

A suite of BASIC programs were written (REVISIT4; SECTOR1; HCALL1; HCALLSS1), to obtain the Handling Capacity (HC), passenger Average Waiting Time (AWT), passenger Average Journey Time (AJT) and percentage car load (%CC) during the uppeak traffic condition for four lift traffic control systems (Subzoning, Uppeak Sectoring, Hall Call Allocation and Hall Call Allocation with Subzoning.

The results were normalised against the conventional collective control system. For each configuration the values for HC, AWT and AJT were calculated for 80% car loadings. These numerical values were then used as the divisor for the results from the other four control systems to give a performance ratio. Thus the simple Collective system was used as a benchmark comparator.

The calculations for the Collective, Uppeak Subzoning and Uppeak Sectoring systems used Equations (1) to (5) and the Hall Call Allocation system used the modified Equations (6) and (7).

4 RESULTS FOR THE FOUR CONTROL SYSTEMS

Tables of results are presented as four groups of columns. The first group of columns gives the design parameters used: N, L, T and CC. The next three groups each give normalised values for HC, AWT, AJT and %CC. The second group gives the maximum possible performance of each configuration for cars loaded to 80% (max UPPHC). The third group gives the performance of each configuration for the same number of passenger arrivals as the conventional system (UPPHC=1). The fourth column gives the performance of each configuration for passengers waiting the same time as the conventional system (AWT=1)

4.1 Uppeak subzoning

The use of Equations (1) to (5) is suitable when calculating the lift systems performance. Each subzone is calculated separately and the total performance computed by adding or averaging the two results together.

For simplicity the building zone was divided into two equal subzones with the number of floors in each zone set to 12, 16, 20 and 24 floors giving a total of 108 configurations to be considered. Table 1 gives the results for T=10; N=12,18,24; that is for 27 systems.

4.2 Uppeak sectoring

The Equations (1) to (5) can be used to calculate the performance of each sector separately. Then the total lift system performance can be computed by adding or averaging the results together.

Uppeak sectoring divides a building zone into more than two subzones. Usually there are as many sectors as there are lifts up to 4 lifts with five sectors for 6 lifts and six sectors for 8 lifts. In order that each sector contained an integer and equal number of floors, the number of floors in each zone were set to 12, 16, 20 and 24 floors for four lifts; 10, 15, 20, and 25 for 6 lifts; and 12, 18 and 24 for 8 lifts. This gives a total of 99 systems. Table 2 gives values for T=10; that is 33 systems.

4.3 Hall Call Allocation

Traffic analysis of this system is usually be carried out using computer simulation techniques owing to the complexity of mathematically describing the actions of the control algorithm. However it is possible to modify the conventional equations so that calculations can be made and a good comparison of the systems carried out on a common basis.

The method of attack to derive these modifications is given in Schroeder (1990). Basically the control algorithm allocates each new passenger destination to each car in turn (Barney & Dos Santos, 1985-p139 *et seq*) and then selects the car with lowest cost (usually journey time). The conventional equations for the modified calculation of H and S thus become:

Conventional $$S = N\left[1-\left(1-\frac{1}{N}\right)^{P}\right] \qquad H = N - \sum_{i=1}^{N-1}\left(\frac{i}{N}\right)^{P} \qquad \text{... (6)}$$

Modified $$S = \frac{N}{K}\left[1-\left(1-\frac{1}{N}\right)^{K.P}\right] \qquad H = N - \sum_{i=1}^{N-1}\left(\frac{i}{N}\right)^{S} \qquad \text{... (7)}$$

Here the "look ahead" parameter K is the number of cars considered for call allocation (up to L) by the car allocation algorithm. Under low load K may be 1 or 2, but under high load K becomes equal to L. Calculations were carried out for 108 systems with values of K ("look ahead") of 2, 3 and 4. Results are presented in Table 3 for K=4; T=10; N=12,18,24; that is 27 systems.

4.4 Hall Call Allocation plus Subzoning

It was assumed that half the lifts were allocated to two equal subzones. This limits the "look ahead" to the number of lifts available. Under these circumstances the maximum value of the parameter K will be L/2. Calculations were made for K=2 (108 systems), K=3 (72 systems) and K=4 (36 systems). The results are given in Table 4 for K=2 and T=10; N=12,18,24; that is 27 systems.

4.5 Comparison of systems

Figures 1, 2 and 3 graphically indicate the relative performance of each traffic control system. The first set of graphs are for Subzoning followed by sets for Sectoring, Hall Call Allocation and Hall Call Allocation plus Subzoning. The graphs show an simple average value (black bar) and a range of values (dotted) for all the systems considered. Some systems exhibit wide ranges of values eg: AWT in Sectoring and some are sensitive to other parameters eg: AWT in HCA plus. Table 5 gives the average numerical values for the four traffic control systems.

4.6 Other effects

Other effects have been examined, which are not reported here (Barney, 1991), these include:

■ variations in T (8 s and 12 s)	- most improvement with 12 s systems
■ for sectoring: L sectors	- very long AWT's
■ for sectoring: four sectors only	- shorter AWT's; lower HC
■ different values of "look ahead" (K)	- as K gets larger HC increases

The employment of unequal subzones or sectors will not greatly affect the results.

5 CONCLUSIONS

All the systems can improve the overall handling capacity of a lift system over conventional traffic control. Sometimes the penalty for more handling capacity is an increased passenger waiting time. The outstanding system is the Hall Call Allocation system, which can provide 51% more handling capacity for the same waiting time, and a reduced journey time of 28%. However, in all cases the improvement must be judged against the extra cost involved either in passenger inconvenience or money.

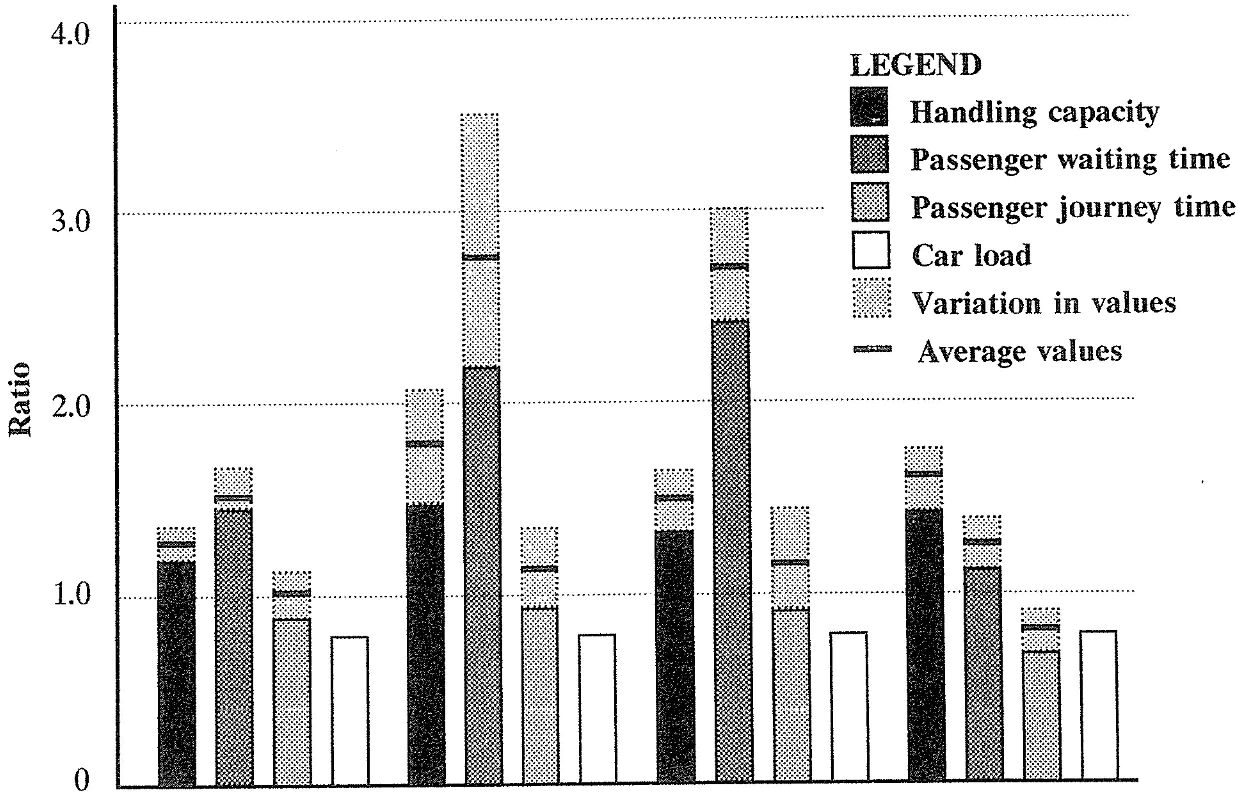

FIGURE 1: Maximum handling capacity

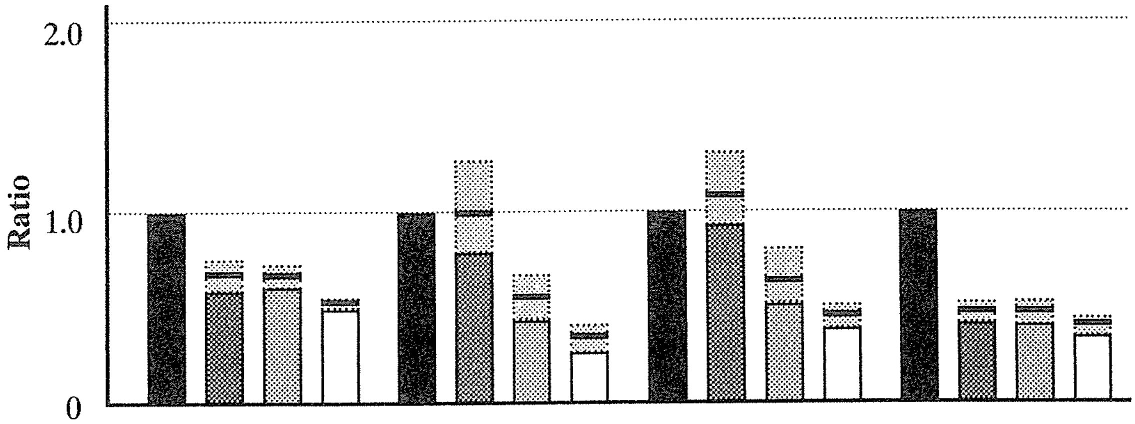

FIGURE 2: Equal handling capacity

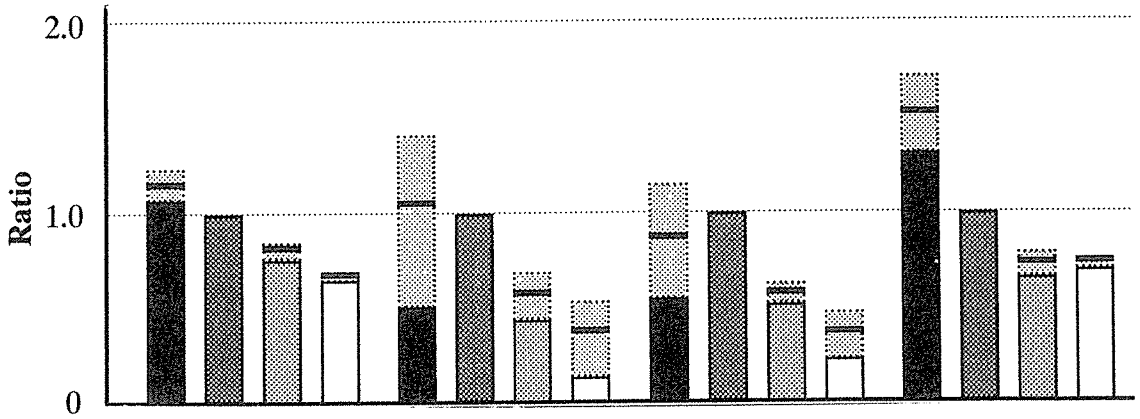

FIGURE 3: Equal passenger waiting time

TABLE 5: Comparison of systems

System	Max. Handling Capacity				Equal Handling Capacity				Equal Av. Waiting Time				
	HC	AWT	AJT	%CC	HC	AWT	AJT	%CC	HC	AWT	AJT	%CC	Notes
Subzoning	1.27	1.57	1.01	80	1.00	0.67	0.66	53	1.14	1.00	0.81	67	*
	1.22	1.64	1.04	80	1.00	0.67	0.66	53	1.11	1.00	0.82	67	tp=2.0
Sectoring	1.78	2.75	1.13	80	1.00	0.98	0.55	34	1.04	1.00	0.57	37	*
	1.58	3.10	1.25	80	1.00	0.98	0.55	34	1.03	1.00	0.57	37	tp=2.0
	1.84	2.97	1.18	80	1.00	1.05	0.56	33	0.92	1.01	0.55	32	Note (1)
	1.67	2.41	1.08	80	1.00	0.87	0.56	37	1.22	1.00	0.64	50	Note (2)
Hall Call Allocation	1.21	1.66	1.02	80	1.00	0.85	0.73	59	1.06	0.99	0.79	65	K=2
	1.37	2.20	1.08	80	1.00	0.92	0.65	50	1.05	0.99	0.68	54	K=3
	1.49	2.69	1.15	80	1.00	1.07	0.63	45	0.86	0.98	0.57	36	K=4 *
HCA plus subzoning	1.60	1.25	0.80	80	1.00	0.47	0.47	40	1.51	1.00	0.72	73	K=2 *
	1.80	1.11	0.69	80	1.00	0.41	0.39	34	1.76	1.00	0.66	77	K=3, L=6,8
	1.93	1.04	0.63	80	1.00	0.37	0.35	31	1.92	1.00	0.62	79	K=4, L=8

Note (1): as many sectors as cars
Note (2): only 4 sectors
* Shown in Figures 1, 2 & 3

It should be noted that the results presented represent possibilities rather than absolute values, as considerable variations can occur, when analysing specific installations. Specific cases should be calculated. The Author will supply to scientific researchers the full tables of results and the programs used to develop this paper on receipt of a 3.5 in. formatted disc and a self addressed envelope.

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Biographical details

Dr.G.C.Barney holds the degrees of B.Sc.(Dunelm), M.Sc.(Dunelm) and Ph.D.(Birm) and as a Chartered Engineer holds the professional qualifications of Fellow of the Institution of Electrical Engineers and Eur.-Ing. An energetic writer he has written, co-authored and edited some eight books and numerous papers on the topic of lift systems. Currently his activities include: Chairman, Lerch, Bates & Associates Ltd.; Visiting Senior Lecturer, UMIST; English Editor, Elevatori; Chairman, IAEE Steering Committee; and a recent member of the British Standards Institution, Technical Committee MHE/4.

TABLE 1: Uppeak subzoning perfomance for various values of N, L and CC.

Other parameter values: T=10 s; df=3.3 m; tv=N/18; tp=1.0; P=0.8.CC

N	L	T	CC	HC	AWT	AJT	%CC	HC	AWT	AJT	%CC	HC	AWT	AJT	%CC
12	4	10	16	1.28	1.56	1.06	80	1.00	0.70	0.68	54	1.14	1.00	0.83	67
12	4	10	21	1.32	1.51	1.02	80	1.00	0.65	0.65	52	1.18	1.00	0.82	67
12	4	10	26	1.35	1.49	1.00	80	1.00	0.62	0.62	50	1.21	1.00	0.81	68
18	4	10	16	1.23	1.62	1.10	80	1.00	0.72	0.70	55	1.10	1.00	0.84	66
18	4	10	21	1.28	1.57	1.05	80	1.00	0.66	0.65	52	1.15	1.00	0.83	67
18	4	10	26	1.31	1.53	1.02	80	1.00	0.63	0.63	51	1.18	1.00	0.81	67
24	4	10	16	1.19	1.67	1.13	80	1.00	0.74	0.71	56	1.08	1.00	0.85	65
24	4	10	21	1.23	1.62	1.09	80	1.00	0.68	0.67	53	1.12	1.00	0.83	66
24	4	10	26	1.27	1.58	1.05	80	1.00	0.64	0.64	51	1.15	1.00	0.82	67
12	6	10	16	1.28	1.56	1.00	80	1.00	0.70	0.68	54	1.14	1.00	0.81	67
12	6	10	21	1.32	1.51	0.96	80	1.00	0.65	0.65	52	1.18	1.00	0.80	67
12	6	10	26	1.35	1.49	0.95	80	1.00	0.62	0.62	50	1.21	1.00	0.79	68
18	6	10	16	1.23	1.62	1.04	80	1.00	0.72	0.69	55	1.10	1.00	0.82	66
18	6	10	21	1.28	1.57	0.99	80	1.00	0.66	0.65	52	1.15	1.00	0.80	67
18	6	10	26	1.31	1.53	0.96	80	1.00	0.63	0.63	51	1.18	1.00	0.79	67
24	6	10	16	1.19	1.67	1.07	80	1.00	0.74	0.71	56	1.08	1.00	0.83	65
24	6	10	21	1.23	1.62	1.03	80	1.00	0.68	0.66	53	1.12	1.00	0.81	66
24	6	10	26	1.27	1.58	0.99	80	1.00	0.64	0.64	51	1.15	1.00	0.80	67
12	8	10	16	1.28	1.56	0.96	80	1.00	0.70	0.68	54	1.14	1.00	0.80	67
12	8	10	21	1.32	1.51	0.93	80	1.00	0.65	0.65	52	1.18	1.00	0.78	67
12	8	10	26	1.35	1.49	0.91	80	1.00	0.62	0.63	51	1.21	1.00	0.78	68
18	8	10	16	1.23	1.62	1.00	80	1.00	0.72	0.69	55	1.10	1.00	0.81	66
18	8	10	21	1.28	1.57	0.96	80	1.00	0.66	0.65	52	1.15	1.00	0.79	67
18	8	10	26	1.31	1.53	0.93	80	1.00	0.63	0.63	51	1.18	1.00	0.78	67
24	8	10	16	1.19	1.67	1.03	80	1.00	0.74	0.71	56	1.08	1.00	0.82	65
24	8	10	21	1.23	1.62	0.99	80	1.00	0.68	0.66	53	1.12	1.00	0.80	66
24	8	10	26	1.27	1.58	0.96	80	1.00	0.64	0.64	51	1.15	1.00	0.79	67

TABLE 2: Uppeak sectoring perfomance for various values of N, L and CC.

Other parameter values: T=10 s; df=3.3 m; tv=N/18; tp=1.0; P=0.8.CC; L=4/SL=4; L=6/SL=5; L=8/SL=6

N	L	T	CC	HC	AWT	AJT	%CC	HC	AWT	AJT	%CC	HC	AWT	AJT	%CC
12	4	10	16	1.67	2.39	1.21	80	1.00	0.91	0.62	39	1.20	1.02	0.69	50
12	4	10	21	1.73	2.32	1.16	80	1.00	0.85	0.57	36	1.29	1.00	0.67	51
12	4	10	26	1.74	2.30	1.15	80	1.00	0.81	0.54	34	1.34	1.00	0.66	53
16	4	10	16	1.62	2.46	1.24	80	1.00	0.93	0.63	39	1.16	1.00	0.69	49
16	4	10	21	1.71	2.34	1.17	80	1.00	0.86	0.57	36	1.26	1.00	0.67	51
16	4	10	26	1.76	2.27	1.13	80	1.00	0.81	0.54	34	1.34	1.00	0.66	53
20	4	10	16	1.57	2.56	1.28	80	1.00	0.95	0.64	40	1.10	1.00	0.68	46
20	4	10	21	1.67	2.40	1.19	80	1.00	0.87	0.58	37	1.22	1.01	0.67	50
20	4	10	26	1.74	2.31	1.14	80	1.00	0.81	0.54	35	1.31	1.00	0.66	52
24	4	10	16	1.51	2.65	1.33	80	1.00	0.96	0.65	41	1.05	1.00	0.68	45
24	4	10	21	1.62	2.48	1.23	80	1.00	0.88	0.59	37	1.20	1.03	0.69	50
24	4	10	26	1.70	2.36	1.16	80	1.00	0.82	0.55	35	1.27	1.00	0.66	51
10	6	10	16	1.80	2.78	1.14	80	1.00	1.04	0.58	35	0.86	0.99	0.55	29
10	6	10	21	1.82	2.75	1.12	80	1.00	0.97	0.54	33	1.08	1.00	0.55	36
10	6	10	26	1.80	2.78	1.12	80	1.00	0.93	0.51	32	1.18	1.00	0.56	40
15	6	10	16	1.78	2.81	1.14	80	1.00	1.05	0.59	36	0.87	1.00	0.55	29
15	6	10	21	1.86	2.69	1.08	80	1.00	0.96	0.53	33	1.09	1.00	0.55	37
15	6	10	26	1.89	2.64	1.05	80	1.00	0.91	0.49	31	1.27	1.00	0.56	43
20	6	10	16	1.71	2.93	1.18	80	1.00	1.08	0.60	37	0.86	1.00	0.55	29
20	6	10	21	1.82	2.75	1.10	80	1.00	0.98	0.54	33	1.04	1.00	0.55	35
20	6	10	26	1.89	2.65	1.05	80	1.00	0.91	0.50	31	1.22	1.00	0.56	41
25	6	10	16	1.63	3.06	1.23	80	1.00	1.10	0.62	38	0.85	1.00	0.55	29
25	6	10	21	1.76	2.85	1.13	80	1.00	1.00	0.55	34	1.00	1.00	0.55	34
25	6	10	26	1.85	2.71	1.07	80	1.00	0.92	0.50	31	1.15	1.00	0.55	39
12	8	10	16	1.90	3.15	1.08	80	1.00	1.16	0.55	33	0.57	0.99	0.45	16
12	8	10	21	1.94	3.09	1.05	80	1.00	1.07	0.50	30	0.77	0.99	0.45	22
12	8	10	26	1.94	3.09	1.04	80	1.00	1.01	0.47	29	0.95	0.99	0.45	27
18	8	10	16	1.86	3.23	1.09	80	1.00	1.19	0.56	34	0.65	0.99	0.45	18
18	8	10	21	1.96	3.06	1.03	80	1.00	1.08	0.50	30	0.81	1.00	0.45	23
18	8	10	26	2.01	2.98	0.99	80	1.00	1.00	0.46	28	0.99	1.00	0.46	28
24	8	10	16	1.76	3.40	1.14	80	1.00	1.23	0.58	35	0.68	1.00	0.45	19
24	8	10	21	1.90	3.16	1.05	80	1.00	1.10	0.51	31	0.82	1.00	0.45	23
24	8	10	26	1.99	3.02	1.00	80	1.00	1.01	0.47	29	0.96	1.00	0.46	27

TABLE 3: Uppeak hall call allocation perfomance for various values of N, L and CC.
Other parameter values: T=10 s; df=3.3 m; tv=N/18; tp=1.0; P=0.8.CC; K=4

N	L	T	CC	HC	AWT	AJT	%CC	HC	AWT	AJT	%CC	HC	AWT	AJT	%CC
12	4	10	16	1.46	2.74	1.32	80	1.00	1.13	0.71	48	0.66	0.98	0.59	28
12	4	10	21	1.52	2.64	1.26	80	1.00	1.05	0.66	45	0.82	0.98	0.60	34
12	4	10	26	1.54	2.60	1.24	80	1.00	1.01	0.63	43	0.95	0.98	0.61	40
18	4	10	16	1.43	2.80	1.35	80	1.00	1.14	0.72	48	0.73	0.98	0.60	31
18	4	10	21	1.52	2.64	1.26	80	1.00	1.04	0.66	44	0.88	0.98	0.61	37
18	4	10	26	1.58	2.54	1.21	80	1.00	0.98	0.61	42	1.03	0.98	0.62	43
24	4	10	16	1.37	2.91	1.40	80	1.00	1.16	0.74	49	0.75	0.99	0.61	31
24	4	10	21	1.47	2.72	1.30	80	1.00	1.05	0.67	45	0.88	0.98	0.61	37
24	4	10	26	1.55	2.58	1.23	80	1.00	0.98	0.62	42	1.01	0.98	0.62	42
12	6	10	16	1.46	2.74	1.15	80	1.00	1.12	0.66	48	0.66	0.98	0.54	28
12	6	10	21	1.52	2.64	1.10	80	1.00	1.05	0.61	45	0.82	0.98	0.56	34
12	6	10	26	1.54	2.60	1.08	80	1.00	1.01	0.58	43	0.95	0.98	0.57	40
18	6	10	16	1.43	2.80	1.18	80	1.00	1.13	0.67	48	0.73	0.98	0.55	31
18	6	10	21	1.52	2.64	1.10	80	1.00	1.04	0.61	44	0.88	0.98	0.57	37
18	6	10	26	1.58	2.54	1.06	80	1.00	0.97	0.57	41	1.03	0.98	0.58	43
24	6	10	16	1.37	2.91	1.23	80	1.00	1.17	0.70	50	0.75	0.99	0.56	31
24	6	10	21	1.47	2.72	1.14	80	1.00	1.05	0.62	45	0.88	0.98	0.57	37
24	6	10	26	1.55	2.58	1.08	80	1.00	0.98	0.58	42	1.01	0.98	0.58	42
12	8	10	16	1.46	2.74	1.05	80	1.00	1.13	0.63	48	0.66	0.98	0.52	28
12	8	10	21	1.52	2.64	1.01	80	1.00	1.05	0.58	44	0.82	0.98	0.53	34
12	8	10	26	1.54	2.60	0.99	80	1.00	1.00	0.56	42	0.95	0.98	0.54	40
18	8	10	16	1.43	2.80	1.07	80	1.00	1.14	0.65	48	0.73	0.98	0.53	31
18	8	10	21	1.52	2.64	1.01	80	1.00	1.04	0.59	44	0.88	0.98	0.54	37
18	8	10	26	1.58	2.54	0.97	80	1.00	0.98	0.55	42	1.03	0.98	0.55	43
24	8	10	16	1.37	2.91	1.12	80	1.00	1.17	0.67	50	0.75	0.99	0.53	31
24	8	10	21	1.47	2.72	1.04	80	1.00	1.06	0.60	45	0.88	0.98	0.54	37
24	8	10	26	1.55	2.58	0.99	80	1.00	0.99	0.56	42	1.01	0.98	0.55	42

TABLE 4: Uppeak HCA plus subzoning perfomance for various values of N, L and CC.
Other parameter values: T=10 s; df=3.3 m; tv=N/18; tp=1.0; P=0.8.CC; K=2

N	L	T	CC	HC	AWT	AJT	%CC	HC	AWT	AJT	%CC	HC	AWT	AJT	%CC
12	4	10	16	1.59	1.25	0.85	80	1.00	0.49	0.49	41	1.50	1.00	0.75	73
12	4	10	21	1.65	1.21	0.82	80	1.00	0.45	0.45	39	1.57	1.00	0.74	74
12	4	10	26	1.67	1.20	0.81	80	1.00	0.43	0.43	37	1.60	1.00	0.73	75
18	4	10	16	1.54	1.30	0.88	80	1.00	0.49	0.50	42	1.43	1.00	0.76	72
18	4	10	21	1.63	1.23	0.82	80	1.00	0.45	0.45	39	1.54	1.00	0.74	74
18	4	10	26	1.69	1.19	0.80	80	1.00	0.43	0.43	36	1.62	1.00	0.73	75
24	4	10	16	1.47	1.37	0.92	80	1.00	0.51	0.51	43	1.35	1.00	0.77	71
24	4	10	21	1.57	1.28	0.86	80	1.00	0.46	0.47	39	1.47	1.00	0.75	73
24	4	10	26	1.64	1.22	0.81	80	1.00	0.43	0.43	37	1.56	1.00	0.73	74
12	6	10	16	1.59	1.25	0.80	80	1.00	0.49	0.49	41	1.50	1.00	0.72	73
12	6	10	21	1.65	1.21	0.77	80	1.00	0.45	0.45	39	1.57	1.00	0.70	74
12	6	10	26	1.67	1.20	0.77	80	1.00	0.43	0.43	37	1.60	1.00	0.70	75
18	6	10	16	1.54	1.30	0.83	80	1.00	0.49	0.50	42	1.43	1.00	0.73	72
18	6	10	21	1.63	1.23	0.78	80	1.00	0.45	0.45	39	1.54	1.00	0.71	74
18	6	10	26	1.69	1.19	0.75	80	1.00	0.43	0.43	36	1.62	1.00	0.69	75
24	6	10	16	1.47	1.37	0.86	80	1.00	0.51	0.51	43	1.35	1.00	0.75	71
24	6	10	21	1.57	1.28	0.81	80	1.00	0.46	0.46	39	1.47	1.00	0.72	73
24	6	10	26	1.64	1.22	0.77	80	1.00	0.43	0.43	37	1.56	1.00	0.70	74
12	8	10	16	1.59	1.25	0.77	80	1.00	0.49	0.49	41	1.50	1.00	0.70	73
12	8	10	21	1.65	1.21	0.75	80	1.00	0.46	0.45	39	1.57	1.00	0.69	74
12	8	10	26	1.67	1.20	0.74	80	1.00	0.44	0.43	37	1.60	1.00	0.68	75
18	8	10	16	1.54	1.30	0.80	80	1.00	0.49	0.50	42	1.43	1.00	0.71	72
18	8	10	21	1.63	1.23	0.75	80	1.00	0.45	0.45	39	1.54	1.00	0.69	74
18	8	10	26	1.69	1.19	0.73	80	1.00	0.43	0.43	36	1.62	1.00	0.68	75
24	8	10	16	1.47	1.37	0.83	80	1.00	0.50	0.51	43	1.35	1.00	0.73	71
24	8	10	21	1.57	1.28	0.78	80	1.00	0.46	0.46	39	1.47	1.00	0.70	73
24	8	10	26	1.64	1.22	0.74	80	1.00	0.43	0.43	37	1.56	1.00	0.68	74