Chapter 16: Module for heavy simultaneous UP and DOWN traffic

Summary: Each data line of a "selected floors" data table can be extended with assumed numbers of additional stops and passengers during the DOWN trip and the revised data for the amended round trip. This method enables creation of an extended data table for any "selected floors" pattern. The module for heavy simultaneous UP and DOWN traffic consists of extended data tables for all patterns that are relevant for a specific group. A complete module may consist of many thousands of data lines; however, this chapter will show that a complete module is of little importance. This module enables "Intelligent destination" controls to select the permitted number of stops for UP and DOWN trips or direct-trip modes for anticipated traffic densities.

Extended data tables

When the last UP passenger has left the car on the reversal floor the DOWN trip commences. Each DOWN going passenger and each additional stop during the DOWN trip increases the average Round Trip Time Low and High (RTT L & H) and affects the Cycle RTT, the transport capacities DC5 and TC5 and other service qualities of the group.

By extending a "selected floors" data table with columns for numbers of DOWN passengers and numbers for possible additional stops during the DOWN trip a new type of data table is created. The term **extended data table** will be used for this table. The module that consists of all extended data tables that are relevant for a specific group enables evaluation of group performance during simultaneous UP and DOWN traffic conditions.

Extended data table for a "collective selective" group

To envisage extended data tables please consider the **identical data lines** below for a 4-car group serving 13 floors, contract load 1600 KG, "collective selective" control, for traffic that requires the group to deliver its maximum DC5 of 12.6 %.

Number of upper floors served	Floor designation highest floor	Total zone population	Total travel in meters	Contract speed in m/sec.	Average car load in persons	Number of "selected floors"	Number of "probable stops"	Average RTT Low & High trips	Average Travel Time in the car	Average time for group to serve all floors once	% of population distributed into building by 4 elevators in 5 min.	Average Time To Destination in seconds (= AWT + ATTC)	Average departure INTERVAL from floor zero	Cycle INTERVAL: INTERVAL for AWT calculation	Theoretical minimum Average Waiting Time (AWT) in seconds
Nr flrs served	Top floor	Pop.	Trav.	Contr. speed	Car load	Sel. floors	Prob. stops	Av. RTT L & H	ATTC	Cycle RTT	DC5 4-cars	ATTD	Dep. INT	Cycle INT	AWT
Contract load 1600 KG (20 persons)														Ch16dia1	
13	13	975	52	2.5	16	13	9.4	155.7	60.6	155.7	12.6	80.1	38.9	38.9	19.5
13	13	975	52	2.5	16	13	9.4	155.7	60.6	155.7	12.6	80.1	38.9	38.9	19.5
13	13	975	52	2.5	16	13	9.4	155.7	60.6	155.7	12.6	80.1	38.9	38.9	19.5
13	13	975	52	2.5	16	13	9.4	155.7	60.6	155.7	12.6	80.1	38.9	38.9	19.5

The extended data table **repeats the above lines** on the **left-hand side;** the **right-hand side** of the extended table consists of additional data columns as shown below:

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Number of DOWN going passengers	Number of additonal stops belowreversal floor and above floor zero	Revised average RTT Low & High trips	Average Travel Time in the Car (ATTC) for UP trip	Revised average RTT for group to serve all floors once	Total Transport Capacity (TTC) per 5 minutes in % of population (DC5 + TC5)	Revised DC5 (UP Distribution Capacity per 5 min.)	TC5 (DOWN Transport Capacity per 5 min.)	Revised Average Time To Destination for UP trip (ATTD)	Revised Average departure INTERVAL from floor zero	Revised Cycle INTERVAL: INTERVAL for AWT calculation	Revised theoretical minimum average Waiting Time for UP passengers (AWT)
Nr pas.	Addit.	Rev. av.	ATTC	Rev. Cycle	TTC5	Rev.		Rev.	Rev.	Rev.	Rev.
DOWN	stops	RTT L&H	UP trip	RTT	4-cars	DC5	TC5	ATTD	Dep.	Cycle	AWT (UP)
								UP trip	INT	INT	Ch16dia2
0	0	155.7	60.6	155.7	12.6	12.6	0.0	80.1	38.9	38.9	19.5
1	0	157.7	60.6	157.7	13.3	12.5	0.8	80.3	39.4	39.4	19.7
1	1	165.7	60.6	165.7	12.6	11.9	0.7	81.3	41.4	41.4	20.7
2	0	159.7	60.6	159.7	13.9	12.3	1.5	80.6	39.9	39.9	20.0
2	1	167.7	60.6	167.7	13.2	11.7	1.5	81.6	41.9	41.9	21.0
2	2	175.7	60.6	175.7	12.6	11.2	1.4	82.6	43.9	43.9	22.0

The top line of above table extension begins with zero DOWN passengers and zero additional stops to integrate the "selected floors" module into the extended data table.

In line 2 of the table extension the **revised average RTT L & H** has been increased by 2 seconds for ONE passenger with destination floor zero who boards a car on the reversal floor. This passenger does not change the total of all DDFT's and the additional "time cost" is the standard time cost of 2 seconds per passenger for entering and leaving the car.

In line 3 one DOWN going passenger enters the car on a lower floor. In this case the average RTT L & H increases by 10 (2 + 8) seconds. The 8 seconds is the additional time cost for each **additional stop** assuming the contract speed is 2.5 m/s. The average time cost per stop for higher speeds depends on the contract speed and the number of stops. The calculation method is described in chapter 13. A real group will obtain these data from analysis of real traffic.

By varying the number of DOWN passengers and the number of additional stops all possible combinations of passengers and destinations during the DOWN trip are included in the revised RTT's L & H in the **data table extension**. Please note that the revised ATTD for UP going passengers increases in line with the revised AWT for the UP trip. The AWT for DOWN passengers of traditional groups cannot be calculated for reasons explained on pages 4 and 5.

The extended data table of our example is valid for "collective selective" (traditional) groups and consequently the Cycle RTT and RTT L & H are identical in all data lines.

Appendix 1 shows the full width and structure of the data table extension for **one line** of the pattern for "selected floors" = 13. The entire table extension would consist of 143 data lines: ONE data line for zero passengers and zero additional stops. TWO data lines for ONE passenger and none or just one additional stop. THREE data lines for TWO passengers and up to 3 stops. This goes on to 13 data lines for 16 passengers and 12 additional stops. Empty lines in Appendix 1 indicate positions where data lines were omitted.

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Chapter 16: Module for heavy simultaneous UP and DOWN traffic

The data table "selected floors" = 13 for UP traffic of the previous chapter consists of 131 lines because the range of average car loads of 3 to 16 passengers was increased in steps of 0.1 passengers. To simplify the description of the **module for simultaneous UP and DOWN traffic** only round numbers are used for UP and DOWN passengers.

On this basis the extended data table for "selected floors" = 13 would consist of 14 lines on the left side for 3 to 16 passengers in steps of 1 passenger and 143 lines on the right side for 1 to 16 passengers in steps of 1 passenger, i.e. a total of 14 X 143 = 2'002 data lines.

Extended data tables for groups of intelligent destination elevators

Extended data tables for "selected floors" = 12, 11, etc. are "constructed" in the same manner. Please note that the maximum number of possible additional stops during DOWN trips equals the number of "selected floors" minus ONE.

For "intelligent elevators" the Cycle RTT = the RTT L & H multiplied by the number of trips of the relevant pattern and divided by the number of times each floor is served during the pattern.

The **Total Transport Capacity (TTC5)** is the total number of passengers transported UP and DOWN by all cars in 5 minutes. The DC5 and TC5 are calculated by **dividing the TTC5 pro rata to the number of UP and DOWN passengers**.

Each extended data table may consist of many thousand data lines; however, the majority of these lines do not define heavy simultaneous UP and DOWN traffic that demands direct trip modes of car operations <u>or</u> patterns with high numbers of omitted floors.

Module for heavy simultaneous UP and DOWN traffic

This module is a single table that consists of all extended data tables for the "selected floors" patterns that are relevant for this type of traffic for a specific group. This module can be sorted, for example, according to TTC5 and DC5 to create a calculated data structure that can instantaneously deliver options for modes of car operation for any combination of simultaneous UP and DOWN traffic densities.

With an example this chapter will show how an "intelligent destination" group control will use this module for evaluation of simultaneous UP and DOWN traffic. The example shows why the corresponding module of the operational data structure can be **a memory for recurring traffic conditions** and the modes of car operation(s) of car operations to serve these traffic conditions.

Before doing so we must consider the greatest problem for high quality elevator services: <u>full cars</u>.

Full cars

For group controls **full cars should be warning signals** because full cars are the worst thing that can happen to a group. Once again we must return to the "collective selective" group. When a car of this group reaches full load on floor zero you can be

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sure that at least a few more people would have liked to join this car but could not get in. These passengers will have to wait another INTERVAL.

When a car of a group of "intelligent elevators" reaches full load on floor zero (or any other floor) it is a warning signal indicating that the "selected floors" pattern should have been changed earlier, alternatively that a direct trip pattern should have been selected for the expected traffic density. For the "First come first served" mode of car operation it means that the permitted maximum number of destinations for UP trips should have been reduced earlier.

A pattern change or reduction of the permitted number of stops is possible at any time, however, the NEXT car must serve UP passengers assigned to the NEXT car before the mode of car operation was changed. Cars NEXT 2 and 3 etc. will of course adhere to the changed mode of car operation.

The **prevention of full cars** is an important task of "intelligent destination" controls. The above shows that "intelligent elevators" will be able to react very quickly to changing traffic conditions. Likewise an immediate response is possible when traffic monitoring indicates lower traffic densities.

The essence of the data structures outlined in this chapter is: **Group performance is completely predictable for any traffic conditions**. Intelligent destination controls this information for achieving best possible performance.

The service qualities of "collective selective" groups are worst during heaviest simultaneous UP and DOWN traffic

During heaviest simultaneous UP and DOWN traffic the cars departing from and arriving at floor zero will be full. UP passengers may not always be able to use the next departing car but they will try to do so. This is an unpleasant and stressful period for UP passengers of "collective selective" elevators.

The UP going cars make many "probable stops" and the average UP trip is long. As cars become empty during UP trips they become more and more attractive for DOWN going passengers because after reversal cars may reach full load after few stops and may not be able to serve them during the DOWN trip.

When a full DOWN going car of a "collective selective" group is forced to by-pass DOWN service calls **waiting passengers will have to wait one or even two or more INTERVALS for the next car**. Under these circumstances the Cycle RTT and AWT that is valid for UP passengers is not valid for DOWN passengers.

The theoretical minimum AWT parameter of traditional traffic calculations for UP PEAK traffic does not consider the waiting times of DOWN passengers at all. This is another reason for calling the AWT parameter of traditional traffic calculations misleading.

Poor time-dependent service qualities are typical for traditional groups in office buildings at lunch time, in hotels at breakfast time.

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Performance data for heavy simultaneous UP and DOWN traffic of a "collective selective" group

The data line below defines the performance data for heavy UP traffic:

Nr flrs served	Top floor	Pop.	Trav.	Contr. speed	Car load	Sel. floors	Prob. stops	Av. RTT L & H	ATTC	Cycle RTT	DC5 4-cars	ATTD	Dep. INT	Cycle INT	AWT
Contract load 1600 KG (20 persons)															Ch16dia3
13	13	975	52	2.5	16	13	9.4	155.7	60.6	155.7	12.6	80.1	38.9	38.9	19.5

The data for heaviest simultaneous UP and DOWN traffic depend on the number of additional stops the cars will make prior to reaching full load. The data table extension below is a small part of the extended data table of Appendix 1.

Nr pas. DOWN	Addit. stops	Rev. av. RTT L&H	ATTC UP trip	Rev. Cycle RTT	TTC5	Rev. DC5	TC5	Rev. ATTD UP trip	Rev. Dep. INT	Rev. Cycle INT	Rev. AWT (UP)
Contract load 1600 KG (20 persons)											Ch16dia4
16	1	195.7	60.6	195.7	20.1	10.1	10.1	85.1	48.9	48.9	24.5
16	2	203.7	60.6	203.7	19.3	9.7	9.7	86.1	50.9	50.9	25.5
16	3	211.7	60.6	211.7	18.6	9.3	9.3	87.1	52.9	52.9	26.5
16	4	219.7	60.6	219.7	17.9	9.0	9.0	88.1	54.9	54.9	27.5
16	5	227.7	60.6	227.7	17.3	8.6	8.6	89.1	56.9	56.9	28.5
16	6	235.7	60.6	235.7	16.7	8.4	8.4	90.1	58.9	58.9	29.5

In case the cars make **3 additional stops** during the DOWN trip the number of boarding floors is 4, the reversal floor plus 3 additional stops. The boarding rate is 16 divided by 4 an average of 4 persons per boarding floor. For heavy DOWN traffic this is not an unusual boarding rate.

When a car makes an average of 9.4 "probable stops" serving all floors during the UP trip but reaches full load after 3 additional stops during the DOWN trip the **revised Cycle RTT** and the **revised AWT and ATTD in above table are valid for UP passengers only**.

Under these circumstances the **Cycle RTT for DOWN passengers will be** about **3 times longer** than the 212 seconds above. The INTERVAL, AWT and ATTD for DOWN passengers increase accordingly. The ATTC for DOWN passengers will be short but will not compensate them for their much longer AWT. The long INTERVAL also explains the high boarding rate that was assumed above.

The situation described above is an inherent problem of "collective selective" groups during heavy simultaneous UP and DOWN traffic. It is in fact the main problem of traditional elevators, particularly in under-elevatored buildings. Problems of this type can only be solved by conversion to "intelligent destination" controls.

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Heaviest simultaneous UP and DOWN traffic for "intelligent destination elevators"

Appendix 2 shows a CPT with the DC5/TC5 maxima for a 4-car group of **1200 KG** "intelligent elevators" serving 13 floors. The table shows that a 4-car group of 1200 KG "intelligent elevators" can deliver high DC5's and TC5's.

In case the cars of the group operate in accordance with "selected floors" pattern 5/4/4 (4.33) and a car load of 12 persons the maximum DC5 of the group is 15.9 %. We assume that for heaviest simultaneous UP and DOWN traffic the group uses pattern 5/4/4. With a **car load of 10 passengers** the data for UP PEAK traffic are as follows:

Nr flrs served	Top floor	Pop.	Trav.	Contr. speed	Car load	Sel. floors	Prob. stops	Av. RTT L & H	ATTC	Cycle RTT	DC5 4-cars	ATTD	Dep. INT	Cycle INT	AWT
Contract load 1200 KG (15 persons)														Ch16dia5	
13	13	975	52	2.5	10	4.33	4.0	87.6	36.2	262.8	14.0	69.1	21.9	65.7	32.9

During heavy simultaneous UP and DOWN traffic the extended data table, assuming the number DOWN passengers is **10** as well, shows following data lines:

Nr pas. DOWN	Addit. stops	Rev. av. RTT L&H	ATTC UP trip	Rev. Cycle RTT	TTC	Rev. DC5	TC5	Rev. ATTD UP trip	Rev. Dep. INT	Rev. Cycle INT	Rev. AWT (UP) Ch16dia6
10	1	115.6	36.2	347.1	21.3	10.6	10.6	79.6	28.9	86.8	43.4
10	2	123.6	36.2	371.1	19.9	10.0	10.0	82.6	30.9	92.8	46.4
10	3	131.6	36.2	395.1	18.7	9.4	9.4	85.6	32.9	98.8	49.4
10	4	139.6	36.2	419.1	17.6	8.8	8.8	88.6	34.9	104.8	52.4
10	5	147.6	36.2	443.1	16.7	8.3	8.3	91.6	36.9	110.8	55.4

For additional stops = 3, i.e. the number of boarding floors = 4 and **identical with the "probable stops" of the UP trip,** the 1200 KG group delivers a DC5 and TC5 of 9.4 %. Under these conditions the **service qualities for UP and DOWN passengers are identical** because the DOWN trip is the "reflected image" of the UP trip.

The group **serves the selected floors** with 3 direct trips. The average **car load factor is 67 %** and compares favorably with the 80 % (= maximum) of the "collective selective" group. Even during the very high traffic densities assumed for above data lines the **cars of the small "intelligent elevators" do not reach full load**. This implies that all passengers to or from the "selected floors" can board the assigned cars.

The revised AWT, ATTC and ATTD stated in above table are realistic for both UP and DOWN passengers because the cars operate on the basis of realistic time tables for 3 direct trips.

The ATTD of 85.6 seconds and the AWT of 49.4 seconds in the CPT above are realistic for all passengers of the 4-car 1200 KG "intelligent destination" group because the cars do not reach full load and car operations are under control and coordinated. The ATTD of 87.1 seconds and the AWT of 26.5 seconds in the CPT on the previous page for the "collective selective" group are neither correct nor realistic because the group is out of control. The waiting times for DOWN going passengers will be a multiple of the waiting times for UP going passengers.

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All passengers of the "intelligent destination" group will reach their destinations earlier in cars that are less full. With a maximum carload of 10 passengers the average load factor of the "intelligent destination elevators" is 67 %.

Traffic simulation on the basis of traffic lists that reflect the traffic densities assumed for above comparisons **will confirm these logical conclusions**.

Under real operating conditions the average time for boarding and leaving the **full cars** of the "collective selective" group are likely to be longer than the 2 seconds assumed for all comparisons of this book. Such differences will enhance the comparative performance parameters of the "intelligent elevators".

Please note **how a few data lines provide the data and the solution for traffic conditions that are probably the heaviest** that the groups of our comparisons will ever experience. Sustained traffic densities of 9.4 % in both directions imply that the entire population can enter and leave the building in a 53 minutes period. The operational data structure, i.e. its module for simultaneous heavy UP and DOWN traffic, will enable groups to resolve and memorize solutions for **any number of specific heavy traffic conditions** this group may encounter.

A group that can satisfy the most demanding traffic conditions with best possible results will not be a worse performer under less demanding traffic conditions.

This chapter could show with a further example how a 6-car group of "intelligent elevators" with a contract load of 800 KG can serve **14 floors** and deliver even better service qualities than both the 4-car 1600 KG "collective selective" group **and** the above 4-car 1200 KG group of "intelligent destination elevators". Smaller cars are more efficient because fewer passengers reduce the number of "probable stops" and the time cost for boarding and leaving the cars. The first group (with large contract loads) to be converted to "Intelligent destination" control will demonstrate the improved service qualities and reduced car loads during heavy simultaneous UP and DOWN traffic much better than any calculated example.

Remarks

Smaller cars may not be desirable for tall buildings for reasons that have nothing to do with passenger traffic. Moving furniture or other goods is such a consideration. This transportation problem can be resolved by a few large service elevators.

For a group with intelligent destination controls the optimal contract load is defined by the number of cars in the group and the number of floors served and their populations. For a 6-car group the optimal contract load will be about 800 KG. Bigger contract loads and larger cars for better passenger comfort are of course possible, however, building owners should be aware that the bigger cars do not improve time-dependent service qualities. This implies that comfort can be improved at the expense of increased energy consumption and the cost of additional space requirements.

If a building owner or planner demands that the number of floors served must be increased this is possible too. In this case the contract load must be increased to deliver the increased transport capacities for the larger population. The time-dependent service qualities will decline accordingly.

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The planning of groups with intelligent destination controls will be an exact and rational exercise when the relativity of all service qualities and other characteristics is taken into consideration.

Correct estimates in respect of the future building population(s) and traffic conditions will remain the basis of building planning.

The most important feature of elevators with "intelligent destination" group controls is their dual functionality:

- Learning abilities in respect of traffic conditions
- Providing the logic and data for best possible and equitable service qualities during all traffic conditions.

The outstanding features of "intelligent destination elevators" are:

- Their flexibility in respect of the modes of car operations.
- Their ability to optimize service qualities by equalizing and minimizing Round Trip Times
- Their ability to control the optimal balance between required transport capacities and time-dependent service qualities.
- Their ability to satisfy heaviest simultaneous UP and DOWN traffic with service qualities that are equitable for all passengers.

When elevator contractors start to offer and guarantee the performance of 6-car groups with smaller contract loads and substantially shorter and more consistent AWT's, ATTC's and ATTD's **configurations with more but smaller passenger elevators will become the preferred solution for new buildings**.

The next and last chapter of this book describes the module for light and medium traffic densities.

Appendix 1: Example of an extended data table for simultaneous UP and DOWN traffic.

Appendix 2: CPT showing the maxima for DC5 (=TC5) for a 4-car group of "intelligent elevators" with a contract load of 1200 KG.

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Appendix 1: Example of an extended data table for simultaneous UP and DOWN traffic of a traditional group

Number of upper floors served	Floor designation highest floor	Total zone population	Total travel in meters	Contract speed in m/sec.	Average car load in persons	Number of "selected floors"	Number of "probable stops"	Average RTT Low & High trips	Average Travel Time in the car	Average time for group to serve all floors once	% of population distributed into building by 4 elevators in 5 min.	Average Time To Destination in seconds (= AWT + ATTC)	Average departure INTERVAL from floor zero	Cycle INTERVAL: INTERVAL for AWT calculation	Theoretical minimum Average Waiting Time (AWT) in seconds	Number of DOWN going passengers	Number of additonal stops belowreversal floor and above floor zero	Revised average RTT Low & High trips	Average Travel Time in the Car (ATTC) for UP trip	Revised average RTT for group to serve all floors once	Total Transport Capacity (TTC) per 5 minutes in % of population (DC5 + TC5)	Revised DC5 (UP Distribution Capacity per 5 min.)	TC5 (DOWN Transport Capacity per 5 min.)	Revised Average Time To Destination for UP trip (ATTD)	Revised Average departure INTERVAL from floor zero	Revised Cycle INTERVAL: INTERVAL for AWT calculation	Revised theoretical minimum average Waiting Time for UP passengers (AWT)
Nr flrs	Top	Pop.	Trav.	Contr.	Car	Sel.	Prob.	Av. RTT	ATTC	Cycle	DC5	ATTD	Dep.	Cycle	AWT	Nr pas.	Addit.	Rev. av.	ATTC	Rev. Cycle	TTC5	Rev.		Rev.	Rev.	Rev.	Rev.
served	floor			speed	load	floors	stops	L & H		RTT	4-cars		INT	INT		DOWN	stops	RTT L&H	UP trip	RTT	4-cars	DC5	TC5	ATTD	Dep.	Cycle	AWT (UP)
Contract load 1600 KG (20 persons)																								UP trip	INT	INT	Ch16dia7
13	13	975	52	2.5	16	13	9.4	155.7	60.6	155.7	12.6	80.1	38.9	38.9	19.5	0	0	155.7	60.6	155.7	12.6	12.6	0.0	80.1	38.9	38.9	19.5
13	13	975	52	2.5	16	13	9.4	155.7	60.6	155.7	12.6	80.1	38.9	38.9	19.5	1	0	157.7	60.6	157.7	13.3	12.5	0.8	80.3	39.4	39.4	19.7
13	13	975	52	2.5	16	13	9.4	155.7	60.6	155.7	12.6	80.1	38.9	38.9	19.5	1	1	165.7	60.6	165.7	12.6	11.9	0.7	81.3	41.4	41.4	20.7
13	13	975	52	2.5	16	13	9.4	155.7	60.6	155.7	12.6	80.1	38.9	38.9	19.5	2	0	159.7	60.6	159.7	13.9	12.3	1.5	80.6	39.9	39.9	20.0
13	13	975	52	2.5	16	13	9.4	155.7	60.6	155.7	12.6	80.1	38.9	38.9	19.5	2	1	167.7	60.6	167.7	13.2	11.7	1.5	81.6	41.9	41.9	21.0
13	13	975	52	2.5	16	13	9.4	155.7	60.6	155.7	12.6	80.1	38.9	38.9	19.5	2	2	175.7	60.6	175.7	12.6	11.2	1.4	82.6	43.9	43.9	22.0
13	13	975	52	2.5	16	13	9.4	155.7	60.6	155.7	12.6	80.1	38.9	38.9	19.5	3	0	161.7	60.6	161.7	14.5	12.2	2.3	80.8	40.4	40.4	20.2
13	13	975	52	2.5	16	13	9.4	155.7	60.6	155.7	12.6	80.1	38.9	38.9	19.5	3	1	169.7	60.6	169.7	13.8	11.6	2.2	81.8	42.4	42.4	21.2
13	13	975	52	2.5	16	13	9.4	155.7	60.6	155.7	12.6	80.1	38.9	38.9	19.5	3	2	177.7	60.6	177.7	13.2	11.1	2.1	82.8	44.4	44.4	22.2
13	13	975	52	2.5	16	13	9.4	155.7	60.6	155.7	12.6	80.1	38.9	38.9	19.5	3	3	185.7	60.6	185.7	12.6	10.6	2.0	83.8	46.4	46.4	23.2
13	13	975	52	2.5	16	13	9.4	155.7	60.6	155.7	12.6	80.1	38.9	38.9	19.5	4	0	163.7	60.6	163.7	15.0	12.0	3.0	81.1	40.9	40.9	20.5
13	13	975	52	2.5	16	13	9.4	155.7	60.6	155.7	12.6	80.1	38.9	38.9	19.5	4	1	171.7	60.6	171.7	14.3	11.5	2.9	82.1	42.9	42.9	21.5
13	13	975	52	2.5	16	13	9.4	155.7	60.6	155.7	12.6	80.1	38.9	38.9	19.5	4	2	179.7	60.6	179.7	13.7	11.0	2.7	83.1	44.9	44.9	22.5
13	13	975	52	2.5	16	13	9.4	155.7	60.6	155.7	12.6	80.1	38.9	38.9	19.5	4	3	187.7	60.6	187.7	13.1	10.5	2.6	84.1	46.9	46.9	23.5
13	13	975	52	2.5	16	13	9.4	155.7	60.6	155.7	12.6	80.1	38.9	38.9	19.5	4	4	195.7	60.6	195.7	12.6	10.1	2.5	85.1	48.9	48.9	24.5
13	13	975	52	2.5	16	13	9.4	155.7	60.6	155.7	12.6	80.1	38.9	38.9	19.5	14	0	183.7	60.6	183.7	20.1	10.7	9.4	83.6	45.9	45.9	23.0
13	13	975	52	2.5	16	13	9.4	155.7	60.6	155.7	12.6	80.1	38.9	38.9	19.5	14	1	191.7	60.6	191.7	19.3	10.3	9.0	84.6	47.9	47.9	24.0
13	13	975	52	2.5	16	13	9.4	155.7	60.6	155.7	12.6	80.1	38.9	38.9	19.5	14	2	199.7	60.6	199.7	18.5	9.9	8.6	85.6	49.9	49.9	25.0
13	13	975	52	2.5	16	13	9.4	155.7	60.6	155.7	12.6	80.1	38.9	38.9	19.5	14	11	271.7	60.6	271.7	13.6	7.2	6.3	94.6	67.9	67.9	34.0
13	13	975	52	2.5	16	13	9.4	155.7	60.6	155.7	12.6	80.1	38.9	38.9	19.5	14	12	279.7	60.6	279.7	13.2	7.0	6.2	95.6	69.9	69.9	35.0
13	13	975	52	2.5	16	13	9.4	155.7	60.6	155.7	12.6	80.1	38.9	38.9	19.5	15	0	185.7	60.6	185.7	20.5	10.6	9.9	83.8	46.4	46.4	23.2
13	13	975	52	2.5	16	13	9.4	155.7	60.6	155.7	12.6	80.1	38.9	38.9	19.5	15	1	193.7	60.6	193.7	19.7	10.2	9.5	84.8	48.4	48.4	24.2
13	13	975	52	2.5	16	13	9.4	155.7	60.6	155.7	12.6	80.1	38.9	38.9	19.5	15	2	201.7	60.6	201.7	18.9	9.8	9.2	85.8	50.4	50.4	25.2
13	13	975	52	2.5	16	13	9.4	155.7	60.6	155.7	12.6	80.1	38.9	38.9	19.5	15	11	273.7	60.6	273.7	13.9	7.2	6.7	94.8	68.4	68.4	34.2
13	13	975	52	2.5	16	13	9.4	155.7	60.6	155.7	12.6	80.1	38.9	38.9	19.5	15	12	281.7	60.6	281.7	13.5	7.0	6.6	95.8	70.4	70.4	35.2
13	13	975	52	2.5	16	13	9.4	155.7	60.6	155.7	12.6	80.1	38.9	38.9	19.5	16	0	187.7	60.6	187.7	21.0	10.5	10.5	84.1	46.9	46.9	23.5
13	13	975	52	2.5	16	13	9.4	155.7	60.6	155.7	12.6	80.1	38.9	38.9	19.5	16	1	195.7	60.6	195.7	20.1	10.1	10.1	85.1	48.9	48.9	24.5
13	13	975	52	2.5	16	13	9.4	155.7	60.6	155.7	12.6	80.1	38.9	38.9	19.5	16	2	203.7	60.6	203.7	19.3	9.7	9.7	86.1	50.9	50.9	25.5
13	13	975	52	2.5	16	13	9.4	155.7	60.6	155.7	12.6	80.1	38.9	38.9	19.5	16	3	211.7	60.6	211.7	18.6	9.3	9.3	87.1	52.9	52.9	26.5
13	13	975	52	2.5	16	13	9.4	155.7	60.6	155.7	12.6	80.1	38.9	38.9	19.5	16	10	267.7	60.6	267.7	14.7	7.4	7.4	94.1	66.9	66.9	33.5
13	13	975	52	2.5	16	13	9.4	155.7	60.6	155.7	12.6	80.1	38.9	38.9	19.5	16	11	275.7	60.6	275.7	14.3	7.1	7.1	95.1	68.9	68.9	34.5
13	13	975	52	2.5	16	13	9.4	155.7	60.6	155.7	12.6	80.1	38.9	38.9	19.5	16	12	283.7	60.6	283.7	13.9	6.9	6.9	96.1	70.9	70.9	35.5

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Appendix 2: CPT showing the maxima for DC5 (=TC5) for a 4-car group of "intelligent elevators" with a contract load of 1200 KG.

Number of upper floors served	Floor designation highest floor	Total zone population	Total travel in meters	Contract speed in m/sec.	Average car load in persons	Number of "selected floors"	Number of "probable stops"	Average RTT Low & High trips	Average Travel Time in the car	Average time for group to serve all floors once	% of population distributed into building by 4 elevators in 5 min.	Average Time To Destination in seconds (= AWT + ATTC)	Average departure INTERVAL from floor zero	Cycle INTERVAL: INTERVAL for AWT calculation	Theoretical minimum Average Waiting Time (AWT) in seconds
Nr flrs served	Top floor	Pop.	Trav.	Contr. speed	Car load	Sel. floors	Prob. stops	Av. RTT L & H	ATTC	Cycle RTT	DC5 4-cars	ATTD	Dep. INT	Cycle INT	AWT
Contract load 1200 KG (15 persons)															
13	13	975	52	2.5	12	13	8.0	136.1	46.9	136.1	10.8	63.9	34.0	34.0	17.0
13	13	975	52	2.5	12	12	7.8	134.0	46.0	145.2	11.0	64.1	33.5	36.3	18.1
13	13	975	52	2.5	12	11	7.5	131.4	44.9	155.2	11.2	64.3	32.9	38.8	19.4
13	13	975	52	2.5	12	10	7.2	128.2	43.6	166.7	11.5	64.4	32.1	41.7	20.8
13	13	975	52	2.5	12	9	6.8	124.5	42.2	179.8	11.9	64.7	31.1	45.0	22.5
13	13	975	52	2.5	12	8	6.4	120.1	40.6	195.2	12.3	65.0	30.0	48.8	24.4
13	13	975	52	2.5	12	6.5	5.6	107.8	37.6	215.5	13.7	64.5	27.0	53.9	26.9
13	13	975	52	2.5	12	4.33	4.1	92.8	31.7	278.3	15.9	66.5	23.2	69.6	34.8
13	13	975	52	2.5	12	3.25	3.2	83.6	28.0	334.5	17.7	69.8	20.9	83.6	41.8
13	13	975	52	2.5	12	2.17	2.2	73.6	23.9	441.6	20.1	79.1	18.4	110.4	55.2
13	13	975	52	2.5	12	1	1.0	62.4	14.4	811.6	23.7	115.8	15.6	202.9	101.4

Characteristics of elevators and building

Speed	>	see tabl	Distance 0 to 1	4	meters
Acceleration and deceleration rates	1	m/s^2	Typical floor distance	4	meters
Jerk rate	1	m/s^3	Population	75	pers./floor
Door closing time	2.5	seconds	Car load in persons	>	see table
Door opening time	2	seconds	Traffic	>	UP only
Time gain advanced door opening	0	seconds			
Time allowance car IN/OUT each pass.	2	seconds			Ch16dia8

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