Chapter 15: "Selected floors" module

Summary: For each "selected floors" pattern we can calculate a data table for UP traffic with averages for RTT's L & H, Cycle RTT's, DC5's and all other service qualities for a range of numbers of passengers in the cars. The "selected floors" module is a section of the calculated data structure that consists of all data tables for all "selected floors" patterns that are relevant for a specific group. The "selected floors" module enables making Comparative Performance Tables (CPT's) that show how different patterns (options) can satisfy specific UP traffic conditions. Service quality graphs give a "picture" of any CPT that is easier to "read" than the CPT itself.

Data tables

For **each trip** of a "selected floors" pattern the RTT, ATTC and all performance data for UP traffic can be calculated for any number of passengers. For these calculations we will assume that DOWN traffic and INTERFLOOR traffic are nil.

The RTT's for all trips of a pattern yield the average RTT L & H, the average Cycle RTT, the ATTC and data that enable calculation of all average performance parameters for a specific number of passengers and a specific pattern. Each data line of a CPT is the result of such calculations.

These calculations for a **range of numbers for passengers in the cars** produce a long table of data lines for UP traffic with a specific "selected floors" pattern. For this table this book uses the term: **Data table for "selected floors" = x**.

This chapter shows how for a group serving 13 floors a data table for pattern "selected floors" = 10 is made. This pattern consists of 13 H & L trips.

For this data table the number of persons in the car is varied from 3 to 16 in steps of 0.1 persons, i.e. the total number of steps is 131. "Selected floors" patterns are important for medium and heavy traffic conditions and for this reason car loads of 2 and 1 persons can be ignored.

The **131 calculations** of the average RTT's and ATTC's for each and every trip of pattern "selected floors" = 10 require 13 X 131 = 1703 calculations to produce the 131 data lines that form the **data table for this specific pattern.** These data lines were used in the CPT's of previous chapters to demonstrate the performance potential of intelligent destination elevators.

Calculation of the average RTT L & H, average Cycle RTT, DC5 and other service qualities of a specific "selected floors" pattern

Page 4 of this chapter shows three sections of the 131 data lines of the data table for "selected floors" = 10. The pattern below shows the floors served during 13 consecutive UP trips and the computer calculated RTT's and ATTC's of each trip for an assumed average car load of **11.3 passengers**. On page 4 the data line for 11.3 passengers has been marked. The 13 RTT's of trips 1 to 13 yield the average RTT L & H and the 13 ATTC's yield the ATTC of the marked data line.

Chapter 15: "Selected floors" module

The contract speed of the group is 2.5 m/s and all floor distances are 4 meters. The population of the floors served is 13 X 75 = 975 persons.

Trip number	1	2	3	4	5	6	7	8	9	10	11	12	13	
	Number of "selected floors" = 10													
Upper floors														
13		X	X	X		X	X	X		X	X	X	X	
12		X	X	X		X	X	X	X		X	X	X	
11		X	X	X	X		X	X	X		X	X	X	
10	X		X	X	X		X	X	X		X	X	X	
9	X		X	X	X		X	X	X	X		X	X	
8	X		X	X	X	X		X	X	X		X	X	
7	X	X		X	X	X		X	X	X		X	X	
6	X	X		X	X	X		X	X	X	X		X	
5	X	X		X	X	X	X		X	X	X		X	
4	X	X	X		X	X	X		X	X	X		X	
3	X	X	X		X	X	X		X	X	X	X		
2	X	X	X		X	X	X	X		X	X	X		
1	X	X	X	X		X	X	X		X	X	X		
0	X	X	X	X	X	X	X	X	X	X	X	X	X	Totals
RTT 's	117.1	126.7	126.7	126.7	120.3	126.7	126.7	126.7	123.5	122.8	126.7	126.7	126.7	1624.0
ATTC's	46.0	48.4	48.4	48.4	47.7	48.4	48.4	48.4	49.2	47.5	48.4	48.4	50.8	628.4
	X	"selected floors"					Omitted floors					Ch15dia1		

The RTT's and ATTC's are valid for a **car load of 11.3 persons**. The calculation method is explained in chapter 13. Below we show the calculation method of the RTT and ATTC of **trip number 1**. These methods imply that readers can check any data presented in this book.

Number of floors served: 10 ("selected floors")
Number of passengers in the car: 11.3
"Probable stops": 7.0 (6.96)
Average reversal floor: 9.6

UP trip if "probable stops" = 6			**UP trip if "probable stops" = 7**		
DDFT 0-1	9.6	seconds	DDFT 0-1	9.6	seconds
DDFT 1-6	16.0	seconds	DDFT 1-5	14.4	seconds
DDFT 6-7	9.6	seconds	DDFT 5-6	9.6	seconds
DDFT 7-8	9.6	seconds	DDFT 6-7	9.6	seconds
DDFT 8-9	9.6	seconds	DDFT 7-8	9.6	seconds
DDFT 9-10	9.6	seconds	DDFT 8-9	9.6	seconds
			DDFT 9-10	9.6	seconds
Total DDFT's UP	64.0	seconds		72.0	seconds
Return Trip 10-0	24.0	seconds		24.0	seconds
Total DDFT's	88.0	seconds		96.0	seconds
Pass. IN/OUT	22.6	seconds		22.6	seconds
RTT	110.6	seconds		118.6	seconds

Average RTT for "probable stops" 6.96 118.3 seconds
(118.6 less 0.04 X 8 seconds)
Time saving for av. reversal floor: 9.6 1.3 seconds
(1.6 meter /2.5 = 0.64 seconds for UP and DOWN trips)
Average RTT for trip number 1 is: **117.0 seconds**

The longest possible UP trip for trip NR 1 is	117.0 seconds,
less the return trip of	-23.4 seconds (24.0 - 0.64 = 23.4),
less the car loading time of	-11.3 seconds
Total	82.3 seconds.
The shortest possible UP trip is the DDFT 0-1	9.6 seconds.
Total longest + shortest	91.9 seconds

The **ATTC** is the longest + the shortest UP trip divided by TWO = **46.0 seconds**.

The computer calculated averages for RTT and ATTC are based on data for DDFT's, "probable stops" and reversal floor levels that are **not rounded**. For this reason the manually calculated data may not be identical with the computer calculated data of CPT's.

Appendix 1 repeats above calculation for **trip NR 2. Appendix 2** shows the same calculation for **trip NR 10** because the omitted floors 10-11-12 influence the calculation.

During the 13 trips of pattern "selected floors" = 10 **all floors have 10 opportunities to be served**. The average RTT Low and High trips, ATTC, Cycle RTT, DC5, ATTD, INTERVAL and AWT are calculated as follows:

Total of the RTT's of all 13 trips	1624.0 seconds
Average RTT Low and High trips (3 Low and 10 High trips)	124.9 seconds
Cycle RTT, 1624 divided by 10	162.4 seconds
Cycle INTERVAL for 4-car group (Cycle RTT / 4)	40.6 seconds
Theoretical minimum AWT (Cycle INTERVAL / 2)	20.3 seconds
DC5: 300/124.9 X 11.3 X 4 / (975 /100)	11.1 %
Average departure INTERVAL from floor zero is 124.9 / 4	31.2 seconds
Total of all ATTC's of 13 trips is	628.4 seconds
Average Travel Time in the Car (ATTC = 628.4 / 13)	48.3 seconds
Average Time To Destination (ATTD = AWT + ATTC)	68.6 seconds

The 13 RTT calculations with a car load of 11.3 passengers yield one data line of the data table for "selected floors" = 10.

An average PC can produce the 13 X 131 = 1703 calculations for the 131 data lines of the data **table "selected floors" = 10**, shown on the next page, within seconds.

For the artificial experience of a specific intelligent group the data tables for all "selected floors" patterns that are of interest are permanent assets that derive from the mathematical model.

Chapter 15: "Selected floors" module

Data table for "selected floors" = 10

The tables below show the top, middle and bottom sections of the data table **"selected floors" = 10**. Please note the changing average car load in persons and how this change affects performance data.

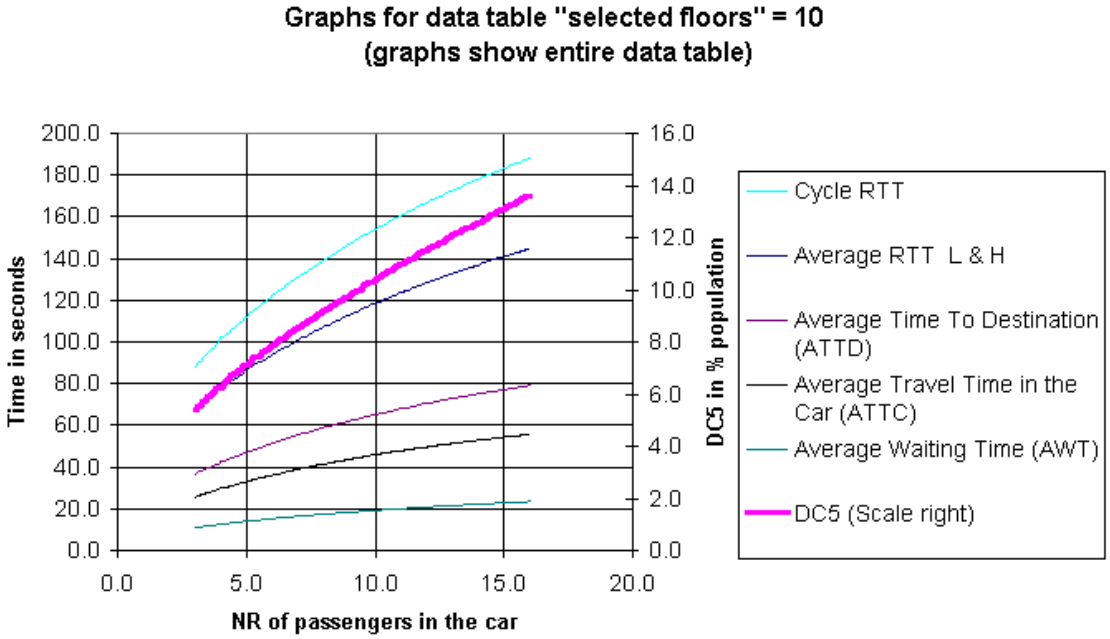
Number of upper floors served	Floor designation highest floor	Total zone population	Total travel in meters	Contract speed in m/sec.	Average car load in persons	Number of "selected floors"	Number of "probable stops"/destinations	Average RTT Low & High trips	Average Travel Time in the car	Average time 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	Top	Pop.	Trav.	Contr.	Car	Sel.	Prob.	Av. RTT	ATTC	Cycle	DC5	ATTD	Dep.	Cycle	AWT
served	floor			speed	load	floors	stops	L & H		RTT	**4-cars**		INT	INT	
13	13	975	52	2.5	3.0	10	2.7	67.9	25.6	88.2	5.4	36.6	17.0	22.1	11.0
13	13	975	52	2.5	3.1	10	2.8	68.9	26.0	89.5	5.5	37.2	17.2	22.4	11.2
13	13	975	52	2.5	3.2	10	2.9	69.9	26.4	90.8	5.6	37.7	17.5	22.7	11.4
13	13	975	52	2.5	3.3	10	2.9	70.9	26.8	92.1	5.7	38.3	17.7	23.0	11.5
13	13	975	52	2.5	3.4	10	3.0	71.8	27.2	93.4	5.8	38.8	18.0	23.3	11.7
13	13	975	52	2.5	3.5	10	3.1	72.8	27.6	94.7	5.9	39.4	18.2	23.7	11.8
13	13	975	52	2.5	3.6	10	3.2	73.8	28.0	95.9	6.0	39.9	18.4	24.0	12.0
13	13	975	52	2.5	3.7	10	3.2	74.8	28.3	97.2	6.1	40.5	18.7	24.3	12.1
13	13	975	52	2.5	3.8	10	3.3	75.7	28.7	98.4	6.2	41.0	18.9	24.6	12.3
13	13	975	52	2.5	3.9	10	3.4	76.7	29.1	99.7	6.3	41.6	19.2	24.9	12.5
13	13	975	52	2.5	4.0	10	3.4	77.6	29.5	100.9	6.3	42.1	19.4	25.2	12.6
13	13	975	52	2.5	11.0	10	6.9	123.5	47.8	160.5	11.0	67.9	30.9	40.1	20.1
13	13	975	52	2.5	11.1	10	6.9	124.0	48.0	161.1	11.0	68.1	31.0	40.3	20.1
13	13	975	52	2.5	11.2	10	6.9	124.4	48.2	161.8	11.1	68.4	31.1	40.4	20.2
13	13	975	52	2.5	11.3	10	7.0	124.9	48.4	162.4	11.1	68.7	31.2	40.6	20.3
13	13	975	52	2.5	11.4	10	7.0	125.4	48.5	163.0	11.2	68.9	31.3	40.8	20.4
13	13	975	52	2.5	11.5	10	7.0	125.9	48.7	163.6	11.2	69.2	31.5	40.9	20.5
13	13	975	52	2.5	11.6	10	7.1	126.3	48.9	164.3	11.3	69.4	31.6	41.1	20.5
13	13	975	52	2.5	11.7	10	7.1	126.8	49.1	164.9	11.4	69.7	31.7	41.2	20.6
13	13	975	52	2.5	11.8	10	7.1	127.3	49.3	165.5	11.4	69.9	31.8	41.4	20.7
13	13	975	52	2.5	11.9	10	7.1	127.8	49.4	166.1	11.5	70.2	31.9	41.5	20.8
13	13	975	52	2.5	12.0	10	7.2	128.2	49.6	166.7	11.5	70.5	32.1	41.7	20.8
13	13	975	52	2.5	15.0	10	7.9	140.8	54.3	183.1	13.1	77.2	35.2	45.8	22.9
13	13	975	52	2.5	15.1	10	8.0	141.2	54.4	183.6	13.2	77.4	35.3	45.9	22.9
13	13	975	52	2.5	15.2	10	8.0	141.6	54.6	184.1	13.2	77.6	35.4	46.0	23.0
13	13	975	52	2.5	15.3	10	8.0	142.0	54.7	184.6	13.3	77.8	35.5	46.1	23.1
13	13	975	52	2.5	15.4	10	8.0	142.4	54.9	185.1	13.3	78.0	35.6	46.3	23.1
13	13	975	52	2.5	15.5	10	8.0	142.7	55.0	185.6	13.4	78.2	35.7	46.4	23.2
13	13	975	52	2.5	15.6	10	8.1	143.1	55.1	186.0	13.4	78.4	35.8	46.5	23.3
13	13	975	52	2.5	15.7	10	8.1	143.5	55.3	186.5	13.5	78.6	35.9	46.6	23.3
13	13	975	52	2.5	15.8	10	8.1	143.9	55.4	187.0	13.5	78.8	36.0	46.8	23.4
13	13	975	52	2.5	15.9	10	8.1	144.2	55.5	187.5	13.6	79.0	36.1	46.9	23.4
13	13	975	52	2.5	16.0	10	8.1	144.6	55.7	188.0	13.6	79.2	36.2	47.0	23.5

Characteristics of elevators and building

Speed	>	see table	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			Ch15dia2

Chapter 15: "Selected floors" module

The graphs below show the DC5, Average RTT L & H, Cycle RTT and the service qualities ATTC, AWT and ATTD for the **entire data table** "selected floors" = 10.



The above graphs demonstrate that the use of the pattern **"selected floors" = 10 improves the transport efficiency of the group because the DC5 increases at a higher rate than the average RTT L & H**. For lower numbers of "selected floors" the angle between the RTT L & H and the DC5 graphs will increase.

"Selected floors" module

For each group of intelligent destination elevators a number of "selected floors" patterns will be useful for the optimal control of car movements. The data tables of all patterns can be compiled into a single table. This combined **table that consists of the data tables of all patterns forms the "selected floors" module** for this specific group.

For a group serving 13 floors the **omitted floor patterns** "selected floors" = 13 to 8 and the **direct-trip patterns** "selected floors" = 7/6, 5/4/4 and 4/3/3/3 will be useful, i.e. a **total of 9 patterns**. For this example we ignore other possible patterns. The calculated data structure of a real group may include all patterns down to "selected floors" = 3, 3/2/2/2/2/2, 2 and 1.

When the combined data table, i.e. the "selected floors" module, is sorted according to DC5's the data lines with the same DC5's emerge automatically. This module enables an intelligent group to asses CPT's for any combination of predicted UP traffic conditions instantaneously.

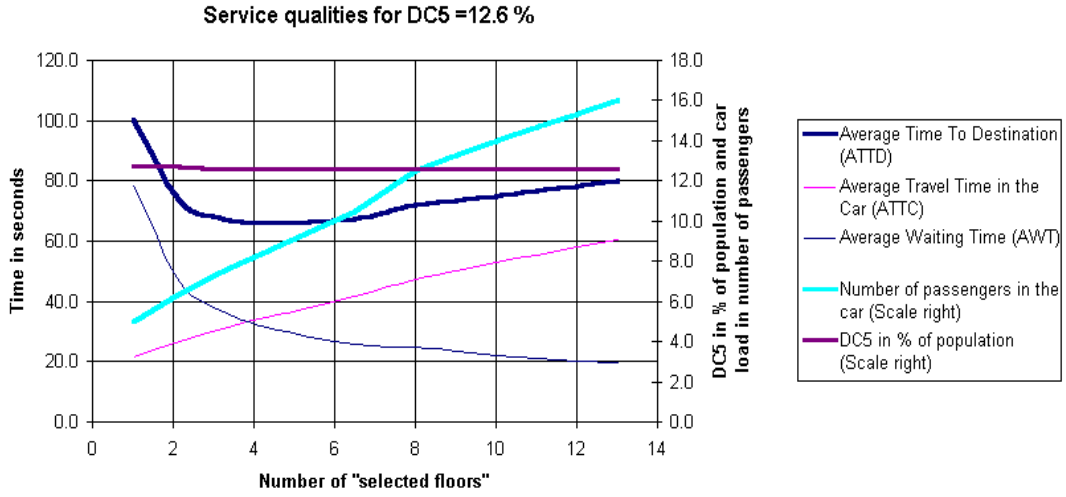
The **"selected floors" module** of this example for 9 patterns would consist of 9 data tables of 131 data lines each making a total of 9 X 131 = 1179 data lines.

Comparative Performance Tables (CPT's)

We now assume that all data tables are available and the "selected floors" module has been compiled and sorted. The CPT below is a small part of this module and shows options and relevant performance parameters for an UP PEAK traffic density of 12.6 %.

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	Departure INT	Cycle INT	AWT
														Ch15dia3	
13	13	975	52	2.5	16.0	13.0	9.4	155.7	60.6	155.7	12.6	80.0	38.9	38.9	19.5
13	13	975	52	2.5	15.3	12.0	8.8	149.6	58.0	162.1	12.6	78.3	37.4	40.5	20.3
13	13	975	52	2.5	14.7	11.0	8.3	143.6	55.5	169.7	12.6	76.7	35.9	42.4	21.2
13	13	975	52	2.5	14.0	10.0	7.7	136.9	52.9	177.9	12.6	75.1	34.2	44.5	22.2
13	13	975	52	2.5	13.3	9.0	7.1	129.8	50.1	187.5	12.6	73.6	32.4	46.9	23.4
13	13	975	52	2.5	12.5	8.0	6.5	122.0	47.3	198.3	12.6	72.0	30.5	49.6	24.8
13	13	975	52	2.5	10.5	6.5	5.4	102.6	41.9	205.2	12.6	67.6	25.7	51.3	25.7
13	13	975	52	2.5	8.5	4.3	3.9	83.3	34.9	249.8	12.6	66.1	20.8	62.5	31.2
13	13	975	52	2.5	7.5	3.3	3.0	73.1	31.1	292.2	12.6	67.6	18.3	73.1	36.5
13	13	975	52	2.5	6.4	2.2	2.1	62.1	26.9	372.4	12.7	73.4	15.5	93.1	46.5
13	13	975	52	2.5	5.0	1.0	1.0	48.4	21.7	629.6	12.7	100.4	12.1	157.4	78.7
							Direct trips								

The graphs below show the service qualities of above CPT.



The top line of the CPT for DC = 12.6 % is valid for a 4-car **group of "collective selective" elevators** because the number of upper floors served equals the number of all upper floors. The theoretical minimum AWT of 19.5 seconds looks attractive, however, with an average car load of 16 passengers the full cars are out of control and the real AWT will probably be substantially higher. For a DC5 of 12.6 % the **minimum contract load** of the "collective selective" group **must be 1600 KG**.

The CPT and graphs demonstrate that intelligent destination elevators can deliver the expected maximum UP traffic density of 12.6 % with substantially less passengers in the cars, i.e. **smaller contract loads**.

Chapter 15: "Selected floors" module

Intelligent destination elevators achieve high DC5's in combination with shortest possible ATTC's, ATTD's and lowest possible average car loads, i.e. optimal comfort and service qualities for passengers. Theoretical minimum AWT's are longer but real AWT's will be the shortest possible and highly consistent. **Although the CPT shows increasing AWT's these are over-compensated by the shorter ATTC's.**
(Exception direct trips with selected floors 3.3, 2.2 and 1)

For heavy UP traffic of 12.6 % the option "selected floors" 7/6 (6.5) is probably the most attractive. A direct comparison of group control data shows why:

	Int. group	**Col. Sel. Group**
Contract load (minimum possible)	1200 KG	1600 KG
Number of "selected floors"	7/6 (6.5)	13
DC5	12.6 %	12.6 %
Av. number of passengers in the car	10.5	16
Load factor	70 %	80 %
"Probable stops" (permitted stops)	5.4	9.4
Theoretical minimum AWT	25.7	19.5 seconds
Average Travel Time in the Car (ATTC)	41.9	60.6 seconds
Average Time To Destination (ATTD)	67.6	80.0 seconds

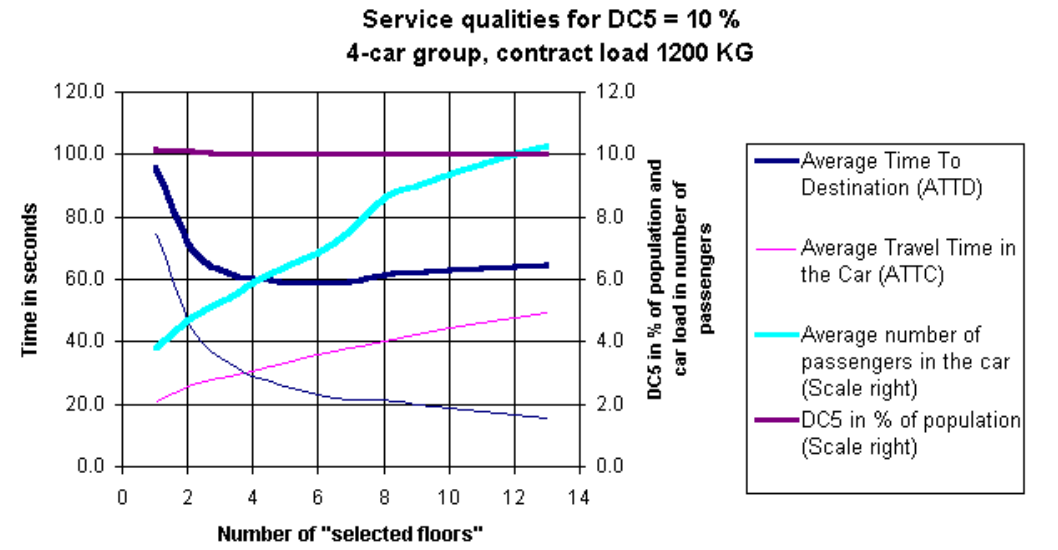
The above AWT of 19.5 seconds for the "collective selective" group is the unrealistic theoretical minimum. The AWT of 25.7 seconds of the intelligent destination elevators is realistic because the cars make **direct trips with few stops.** The RTT's of all cars are **minimized and equalized in accordance with the time table for the prevailing traffic conditions.**

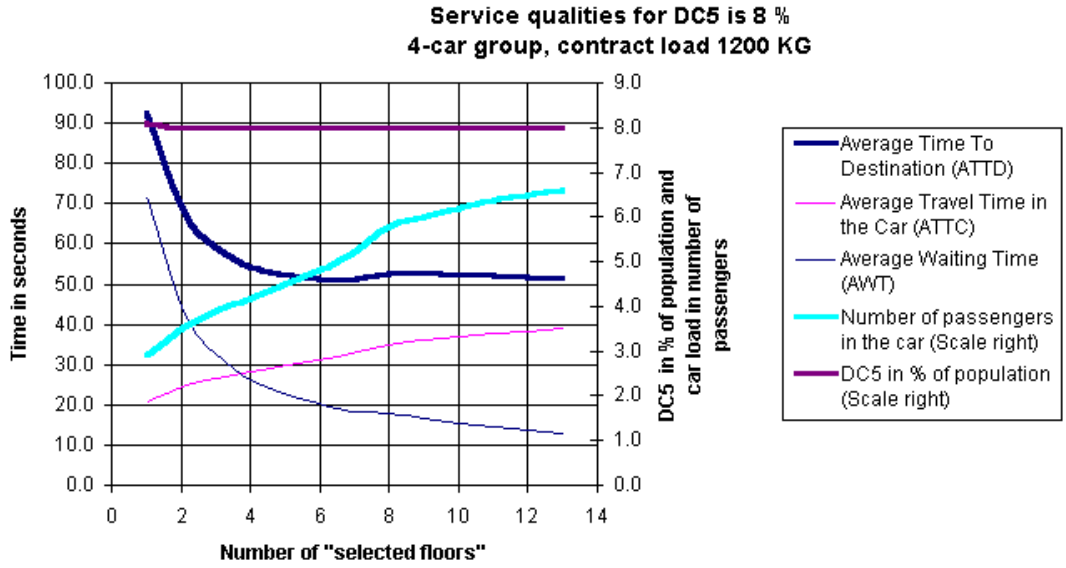
The average travel times in the cars are realistic for both groups and the **18 seconds differential** implies that passengers of the intelligent destination elevators enjoy a ride that is **30 % shorter** in a car with fewer passengers. The real ATTD for passengers of the "collective selective" group is probably not less than 90 seconds. The **longest travel time in the car for passengers of the "collective selective" group is 111.5 seconds**. The longest travel time in the car for passengers of the intelligent destination elevators is **79.8 seconds**. The improved service qualities for passengers of the smaller intelligent destination elevators result from their better efficiency that reduces the average number of permitted stops from 9.4 to 5.4, the numbers of passengers to 10.5 and the ATTC to 41.9 seconds.

Relationship between service qualities and traffic densities

The graph on page 6 shows the range of service qualities that are possible for an UP PEAK traffic density of 12.6 %. The "selected floors" module can deliver CPT's for any UP traffic density. **Appendix 3 presents CPT's for UP traffic densities of 10 and 8 %.** The service qualities graphs for these CPT's are shown on the next page.

The graphs show that lower traffic densities make the ATTD graph flatter, i.e. the possibility to reduce the ATTD by lowering the number of "selected floors" declines when the traffic density declines.

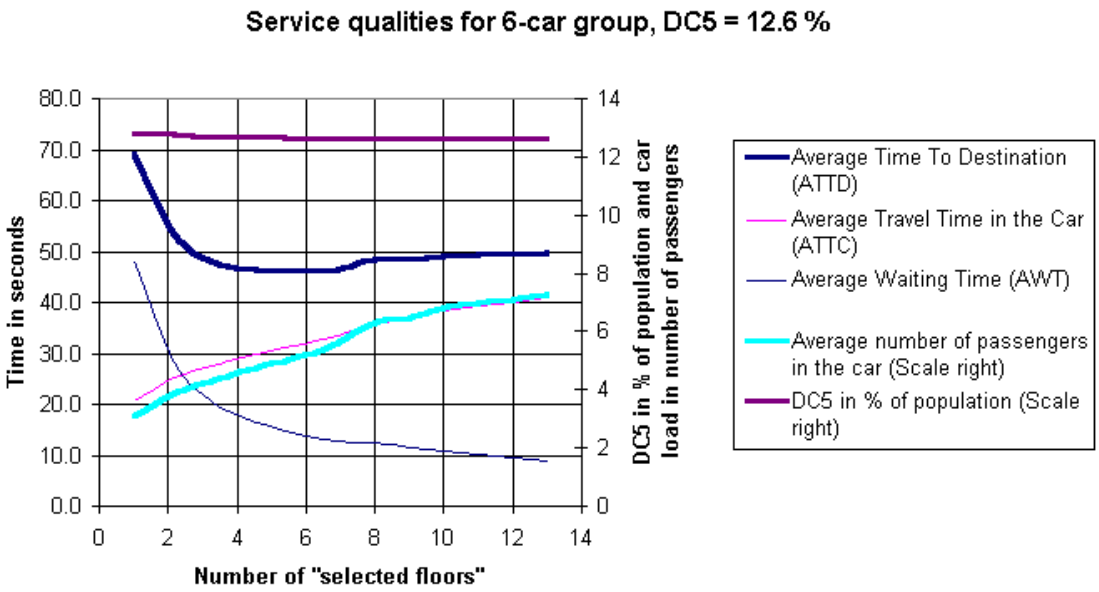




The graphs for DC5 = 10 % and 8 % above show that the ATTD is almost flat from "selected floors" = 4 and up, however, the direct trip options still offer **improved passenger comfort** because the average number of passengers in the cars is reduced and ATTC's are shorter.

Service qualities of a 6-car group of intelligent destination elevators serving 13 upper floors, contract load 800 KG

When we exchange the 4-car group above for a 6 car group the service qualities for all traffic conditions improve substantially. **Appendix 4** shows the CPT with the "selected floors" options for UP PEAK traffic conditions that require a DC5 of 12.6 %. The service quality graphs below represent the data of this CPT.



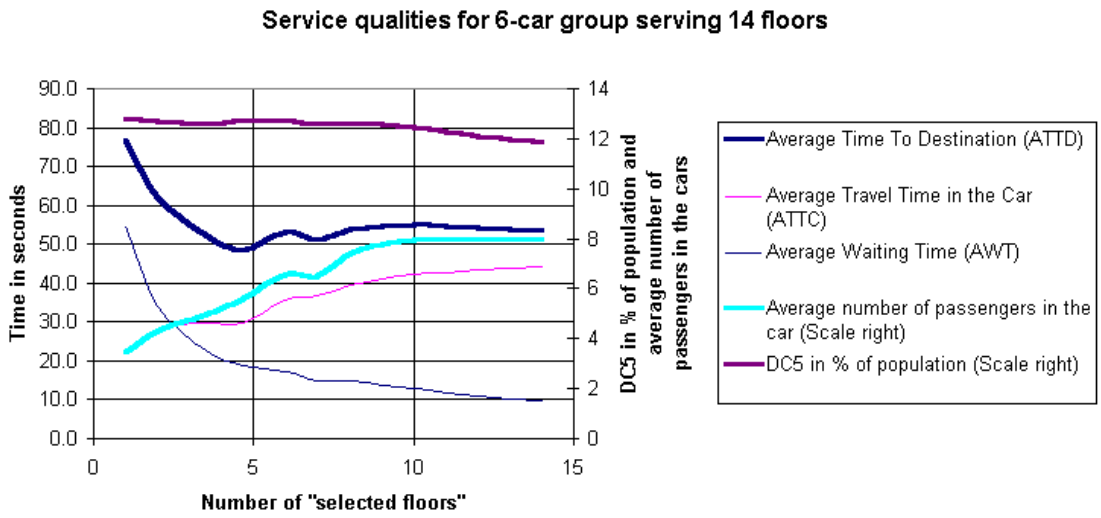
For UP PEAK traffic the pattern "selected floors" = 7/6 (6.5) delivers the most attractive service qualities. A direct comparison of this option of the 6-car group with the 4-car "collective selective" group, the most common group in existing tall buildings, shows the exiting new possibilities of groups with intelligent destination controls.

	Int. group	**Col. Sel. Group**	
Contract load	800 KG	1600 KG	
Number of cars in the group	6	4	
Footprint (see Chapter 5)	32 M^2	32 M^2	
Number of "selected floors"	7/6 (6.5)	13	
DC5	12.6 %	12.6 %	
Number of passengers in the car	5.4	16	
Load factor	54 %	80 %	
"Probable stops"	3.9	9.4	(see page 7)
Theoretical minimum AWT	13.2	19.5	(see page 7)
Average Travel Time in the Car (ATTC)	32.9	60.6	(see page 7)
Average Time To Destination (ATTD)	46.1	80.0	(see page 7)

The 6-car group will be more expensive than the 4-car group but its service qualities are incomparable. The 6-car group will consume less power, maintenance costs will be higher.

The 6-car group has ample transport capacity and could as well serve **14 upper floors**. This would be a substantial compensation for their extra capital cost. The CPT for 14 floors and DC5 12.6 is stated too in Appendix 4. The graphs on the next page show the options for car operations for UP traffic densities of 11.9 to 12.8 %.

The direct trip patterns "selected floors" = 7 and 4.67 (5/4/4) deliver very good ATTD's and AWT's in combination with low average numbers of passengers. This means this group too can increase its transport capacity whereas the 4-car traditional group with contract load 1600 KG cannot improve its DC5 of 12.6 %.



Please note that the option "selected floors" = 6 is a bit less efficient than the direct trip pattern "selected floors" = 7. Consequently in a real control the option "selected floors" = 6 will probably be ignored.

Module for "First come first served" passenger assignment for UP traffic

The CPT on page 6 enables an interesting reversal of the headings as shown below.

					Probable car load		Number of permitted destinations								
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	INT	Cycle INT	AWT
														Ch15dia7	
13	13	975	52	2.5	16.0	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	15.3	12	8.8	149.6	58.0	162.1	12.6	78.3	37.4	40.5	20.3
13	13	975	52	2.5	14.7	11	8.3	143.6	55.6	169.7	12.6	76.8	35.9	42.4	21.2
13	13	975	52	2.5	14.0	10	7.7	136.9	52.9	177.9	12.6	75.1	34.2	44.5	22.2
13	13	975	52	2.5	13.3	9	7.1	129.8	50.2	187.5	12.6	73.6	32.5	46.9	23.4
13	13	975	52	2.5	12.5	8	6.5	122.0	47.3	198.3	12.6	72.1	30.5	49.6	24.8

In the above CPT we have reversed TWO headings as shown because the RTT can be controlled by setting the maximum number of destinations that the NEXT departing car will accept. If the group control decides to accept a maximum of 7 destinations for car NEXT 1 and car NEXT 2 and so on it is likely that these cars will have an average car load of approximately 13 passengers. Groups with "intelligent destination" controls will learn the relationship between the permitted number of destinations and car loads by monitoring their operations. Although the Cycle RTT's in above CPT may be slightly higher on account of the slightly higher average reversal floor (see Appendix Chapter 14), the **"First come first served"** mode of car operation will reduce waiting times because service refusal, if any, is delayed till the latest possible moment. The ATTC will not be affected but ATTD's will be reduced because the Average Waiting Time (AWT) is reduced.

Chapter 15: "Selected floors" module

The operational data structure

The calculated data structure is well defined in the chapters of this book. It discloses the theoretical performance potential of groups. Its purpose is to prove that the performance of groups can be greatly improved.

The operational data structure will be similar to the calculated data structure; however, this book will not attempt to present a very detailed format. That will be the task of the developers of intelligent destination controls. The operational data structure is the memory of group operations. It can do much more than the calculated data structure. It will disclose the real performance potential of a group. For example: Calculated data assume a two seconds allowance for each passenger to enter and leave the car. The operational data structure will disclose the actual dwell times of stops and their averages for various traffic conditions. The data learned from actual operations will enable corrections of the calculated data structure that will make this data structure even more valuable.

The analysis of dwell times will also show up round trips that were affected by doors that were not allowed to close by passengers or technical reasons. This information will prevent that incorrect data affect the calculated- or the operational data structures.

The ability to assess calculated- and operational data structures and service call frequencies and anticipated traffic conditions forms the basis of the "brain power" of groups with intelligent destination controls.

Appendix 1: Calculation of the RTT and ATTC of **trip number 2** for pattern selected floors" = 10.
Appendix 2: Calculation of the RTT and ATTC of **trip number 10** for pattern "selected floors" = 10.
Appendix 3: CPT's for DC5 = 10 % and 8 %.
Appendix 4: CPT's for 6-car groups serving 13 and 14 upper floors, DC5 = 12.6 %, minimum contract load 800 KG.

Appendix 1

Calculation of the RTT and ATTC of **trip number 2**

Number of floors served: 10 ("selected floors")
Floor designations of floors served: 0-1-2-3-4-5-6-7-11-12-13
Omitted floors: 8-9-10
Number of passengers in the car: 11.3
"Probable stops": 7.0 (6.96)
Average reversal floor: 9.6 (level 12.6)

UP trip if "probable stops" = 6			**UP trip if "probable stops" = 7**		
DDFT 0-1	9.6	seconds	DDFT 0-1	9.6	seconds
DDFT 1-6	16.0	seconds	DDFT 1-5	14.4	seconds
DDFT 6-7	9.6	seconds	DDFT 5-6	9.6	seconds
DDFT 7-11	14.4	seconds	DDFT 6-7	9.6	seconds
DDFT 11-12	9.6	seconds	DDFT 7-11	14.4	seconds
DDFT 12-13	9.6	seconds	DDFT 11-12	9.6	seconds
			DDFT 12-13	9.6	seconds
Total UP tr.	68.8	seconds		76.8	seconds
Return Trip 13-0	28.8	seconds		28.8	seconds
Total DDFT's	97.6	seconds		105.6	seconds
Pass. IN/OUT	22.6	seconds		22.6	seconds
RTT	120.2	seconds		128.2	seconds
Average RTT for "probable stops" 6.96 (128.6 less 0.04 X 8 seconds)				127.9	seconds
Time saving for reversal floor: 9.6 (1.6 meter /2.5 = 0.64 seconds for UP and DOWN trips)				1.3	seconds
Average RTT				126.6	seconds

The longest possible UP trip for trip NR 2 is	126.6 seconds,
less the return trip of	-28.2 seconds (28.8 - 0.64 = 28.2),
less the car loading time of	-11.3 seconds
Total	87.1 seconds.
The shortest possible UP trip is the DDFT 0-1	9.6 seconds.
Total longest plus shortest	96.7 seconds

The **ATTC** of trip NR 2 is 96.7 seconds divided by TWO is **48.4 seconds**.

Chapter 15: "Selected floors" module

Appendix 2

Calculation of the RTT and ATTC of **trip number 10**

Number of floors served: 10 ("selected floors")
Floor designations of floors served: 0-1-2-3-4-5-6-7-8-9-13
Omitted floors: 10-11-12
Number of passengers in the car: 11.3
"Probable stops": 7.0 (6.96)
Average reversal floor: 9.6

UP trip if "probable stops" = 6			**UP trip if "probable stops" = 7**		
DDFT 0-1	9.6	seconds	DDFT 0-1	9.6	seconds
DDFT 1-6	16.0	seconds	DDFT 1-5	14.4	seconds
DDFT 6-7	9.6	seconds	DDFT 5-6	9.6	seconds
DDFT 7-8	9.6	seconds	DDFT 6-7	9.6	seconds
DDFT 8-9	9.6	seconds	DDFT 7-8	9.6	seconds
DDFT 9-13	14.4	seconds	DDFT 8-9	9.6	seconds
			DDFT 9-13	14.4	seconds
Total UP tr.	68.8	seconds		76.8	seconds
Return Trip 13-0	28.8	seconds		28.8	seconds
Total DDFT's	97.6	seconds		105.6	seconds
Pass. IN/OUT	22.6	seconds		22.6	seconds
RTT	120.2	seconds		128.2	seconds

Average RTT for "probable stops" = 6.96 127.9 seconds

Time saving for reversal floor = 9.6 requires special attention because the "floor" distance between level 9 and level 13 is 16 meters. The time saving for the average reversal floor must be calculated for a distance of 0.4 X 16 = 6.4 meters. The UP and DOWN trips are reduced by 6.4/2.5 = 2.6 seconds and the RTT by 5.2 seconds

Average RTT 122.7 seconds

The longest possible UP trip for trip NR 10 is	122.7 seconds
less the return trip of	-26.2 seconds (28.8 - 2.6 = 26.2),
less the car loading time of	-11.3 seconds
Total	85.2 seconds.
The shortest possible UP trip is the DDFT 0-1	9.6 seconds.
Total shortest plus longest	94.8 seconds

The **ATTC** of trip NR 10 is 94.8 seconds divided by TWO is **47.4 seconds**.

NB: For small numbers of passengers the average reversal floor might be, for example, 8.6. The distance 8 to 13 is 20 meters and the car may reverse at floor 8 or 9 or 13. For this situation the mathematical model calculates the average floor height for possible reversal floors as 10 meters and calculates the time saving on basis of the distance: 1.4 X 10 = 14 meters.

Appendix 3: CPT's for DC5 = 10 % and 8 %
Applicable for 4-car group with contract load 1200 KG serving 13 upper floors.

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 trip	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	Top	Pop.	Trav.	Contr.	Car	Sel.	Prob.	Av. RTT	ATTC	Cycle	DC5	ATTD	INT	Cycle	AWT
served	floor			speed	load	floors	stops	L & H		RTT	**4-cars**			INT	
CPT for DC5 = 10 %															
13	13	975	52	2.5	10.3	13	7.3	126.5	49.1	126.5	10.0	64.9	31.6	31.6	15.8
13	13	975	52	2.5	10.0	12	7.0	123.2	47.6	133.5	10.0	64.3	30.8	33.4	16.7
13	13	975	52	2.5	9.7	11	6.6	119.5	46.0	141.3	10.0	63.7	29.9	35.3	17.7
13	13	975	52	2.5	9.4	10	6.3	115.6	44.3	150.3	10.0	63.1	28.9	37.6	18.8
13	13	975	52	2.5	9.0	9	5.9	110.8	42.3	160.0	10.0	62.3	27.7	40.0	20.0
13	13	975	52	2.5	8.6	8	5.5	105.5	40.1	171.5	10.0	61.5	26.4	42.9	21.4
13	13	975	52	2.5	7.2	6.5	4.5	88.8	36.7	177.5	10.0	58.9	22.2	44.4	22.2
13	13	975	52	2.5	6.1	4.33	3.4	74.8	31.9	224.5	10.0	60.0	18.7	56.1	28.1
13	13	975	52	2.5	5.4	3.25	2.8	66.7	29.0	266.7	10.0	62.3	16.7	66.7	33.3
13	13	975	52	2.5	4.8	2.167	2.0	58.5	26.0	350.9	10.1	69.9	14.6	87.7	43.9
13	13	975	52	2.5	3.8	1	1.0	46.0	21.1	598.4	10.2	95.9	11.5	149.6	74.8
CPT for DC5 = 8 %															
13	13	975	52	2.5	6.6	13	5.3	101.6	38.9	101.6	8.0	51.6	25.4	25.4	12.7
13	13	975	52	2.5	6.5	12	5.2	100.0	38.3	108.6	8.0	51.9	25.0	27.2	13.6
13	13	975	52	2.5	6.4	11	5.0	98.1	37.6	116.5	8.0	52.2	24.5	29.1	14.6
13	13	975	52	2.5	6.3	10	4.9	96.0	36.9	125.6	8.0	52.6	24.0	31.4	15.7
13	13	975	52	2.5	6.1	9	4.6	92.9	35.9	135.3	8.0	52.8	23.2	33.8	16.9
13	13	975	52	2.5	5.9	8	4.4	89.5	34.8	146.8	8.0	53.2	22.4	36.7	18.4
13	13	975	52	2.5	5	6.5	3.7	76.6	31.9	153.2	8.0	51.0	19.2	38.3	19.1
13	13	975	52	2.5	4.3	4.33	2.9	66.5	28.8	199.4	8.0	53.7	16.6	49.8	24.9
13	13	975	52	2.5	4	3.25	2.5	61.2	27.0	244.6	8.0	57.6	15.3	61.2	30.6
13	13	975	52	2.5	3.6	2.167	1.9	55.5	25.1	333.2	8.0	66.8	13.9	83.3	41.7
13	13	975	52	2.5	2.9	1	1.0	44.2	20.7	575.0	8.1	92.6	11.1	143.7	71.9

Characteristics of elevators and building

Speed	>	see table	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			Ch15dia4

Chapter 15: "Selected floors" module

Appendix 4: CPT's for 6-car groups serving 13 and 14 upper floors, DC5 = 12.6 %, minimum contract load 800 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	Top	Pop.	Trav.	Contr.	Car	Sel.	Prob.	Av. RTT	ATTC	Cycle	DC5	ATTD	INT	Cycle	AWT
served	floor			speed	load	floors	stops	L & H		RTT	**6-cars**			INT	
Contract load 800 KG					**6-car group**										
13	13	975	52	2.5	7.3	13	5.8	106.8	41.0	106.8	12.6	49.9	17.8	17.8	8.9
13	13	975	52	2.5	7.1	12	5.5	104.4	40.1	113.1	12.6	49.5	17.4	18.8	9.4
13	13	975	52	2.5	7	11	5.4	102.4	39.3	121.0	12.6	49.4	17.1	20.2	10.1
13	13	975	52	2.5	6.8	10	5.1	99.4	38.3	129.2	12.6	49.1	16.6	21.5	10.8
13	13	975	52	2.5	6.5	9	4.8	95.5	37.0	138.0	12.6	48.5	15.9	23.0	11.5
13	13	975	52	2.5	6.3	8	4.6	92.0	35.9	149.6	12.6	48.4	15.3	24.9	12.5
13	13	975	52	2.5	5.4	6.5	3.9	79.0	32.9	158.0	12.6	46.1	13.2	26.3	13.2
13	13	975	52	2.5	4.7	4.33	3.1	68.5	29.6	205.6	12.7	46.7	11.4	34.3	17.1
13	13	975	52	2.5	4.3	3.25	2.6	62.5	27.5	249.8	12.7	48.3	10.4	41.6	20.8
13	13	975	52	2.5	3.9	2.17	2.0	56.3	25.4	337.9	12.8	53.6	9.4	56.3	28.2
13	13	975	52	2.5	3.1	1	1.0	44.6	20.8	580.2	12.8	69.1	7.4	96.7	48.3

Characteristics of elevators and building															
Speed							>	see table		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						Ch15dia5	

The CPT below shows the revised data for the 6-car group **serving 14 upper floors**.

Nr flrs	Top	Pop.	Trav.	Contr.	Car	Sel.	Prob.	Av. RTT	ATTC	Cycle	DC5	ATTD	INT	Cycle	AWT
served	floor			speed	load	floors	stops	L & H		RTT	**6-cars**			INT	
Contract load 800 KG					**6-car group**									Ch15dia6	
14	14	1050	56	2.5	8.0	14	6.3	115.5	44.2	115.5	11.9	53.8	19.3	19.2	9.6
14	14	1050	56	2.5	8.0	13	6.1	114.5	43.8	123.3	12.0	54.1	19.1	20.5	10.3
14	14	1050	56	2.5	8.0	12	6.0	113.3	43.4	132.2	12.1	54.4	18.9	22.0	11.0
14	14	1050	56	2.5	8.0	11	5.9	111.4	42.8	141.8	12.3	54.6	18.6	23.6	11.8
14	14	1050	56	2.5	8.0	10	5.7	109.5	42.3	153.4	12.5	55.1	18.3	25.6	12.8
14	14	1050	56	2.5	7.8	9	5.4	105.7	40.9	164.5	12.6	54.6	17.6	27.4	13.7
14	14	1050	56	2.5	7.4	8	5.0	100.7	39.4	176.2	12.6	54.1	16.8	29.4	14.7
14	14	1050	56	2.5	6.5	7	4.4	88.5	36.6	176.9	12.6	51.3	14.8	29.5	14.7
14	14	1050	56	2.5	6.6	6	4.2	89.3	35.8	208.3	12.7	53.2	14.9	34.7	17.4
14	14	1050	56	2.5	5.6	4.67	3.4	75.7	29.6	227.1	12.7	48.5	12.6	37.9	18.9
14	14	1050	56	2.5	5.0	3.5	2.8	68.0	29.7	272.2	12.6	52.4	11.3	45.4	22.7
14	14	1050	56	2.5	4.3	2	1.9	58.1	28.3	406.7	12.7	62.2	9.7	67.8	33.9
14	14	1050	56	2.5	3.5	1	1.0	47.0	21.8	658.4	12.8	76.7	7.8	109.7	54.9