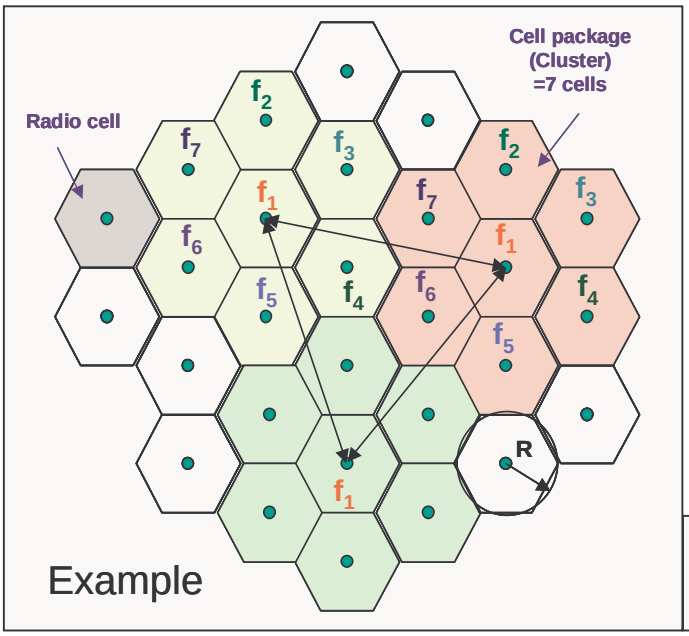
Appendix Technique 6: Frequency agreements

To provide a radio covered area a so called network - composed of particular cells - is necessary. Every cell is covered by a base station with an own down link and up link frequency. By using different frequencies in the neighbourhood cell no interfering will take place in theory. An interference free repeating of the same frequency is possible by the scheme - shown below. By using such a scheme you can cover a wide area - interference free - by repeating the cluster. In our example by using only 7 frequencies.
In reality you do not have a flat ground and no angled areas. You will see an overlapping as well as not covered areas.
You have to comply with limits, given by law or from international agreements. Special problem is the use of DMO within a network; also helicopters and aeroplanes will have a wide covering range and perhaps will disturb the network**.**

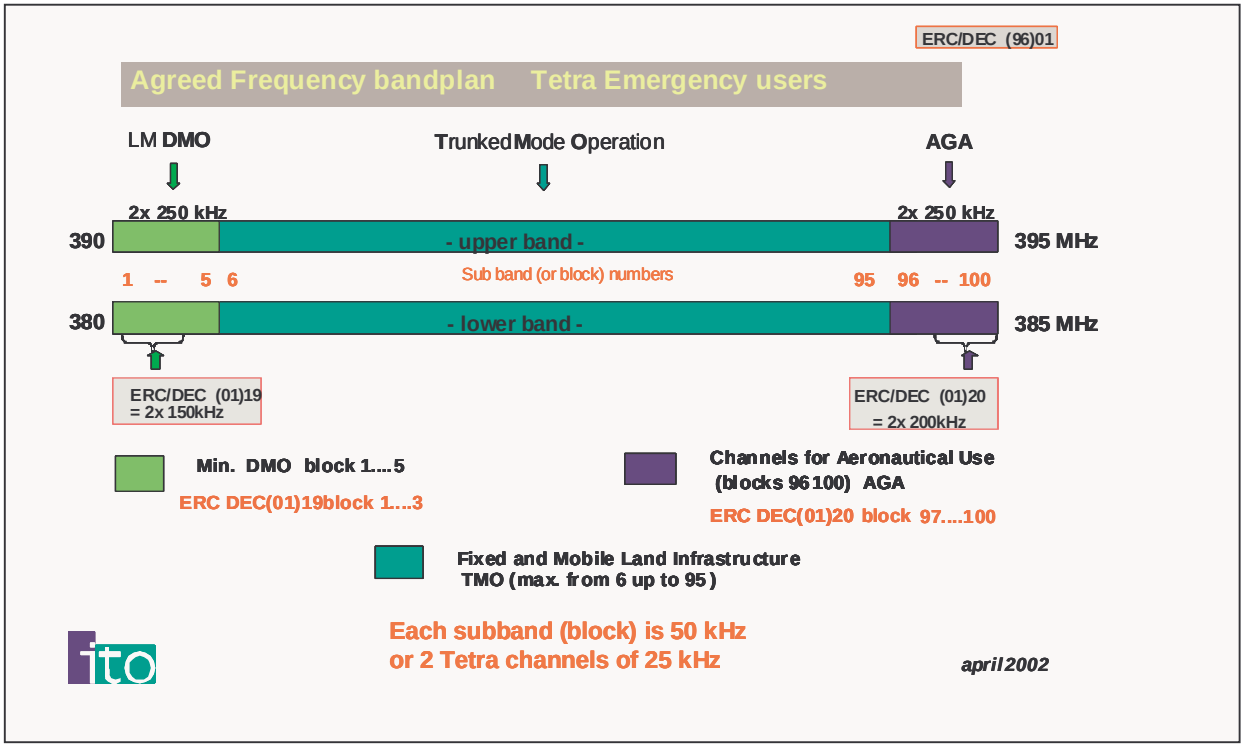


Network Structure with Cells and Clusters

Lots of problems are searching a solution:

- see the user requirements
- come to an international agreement for the coverage problems in border region
- splitting of the on disposal frequency band
- offer packages of channels for different usage
- find solutions in detail for “flying” radios

TMO

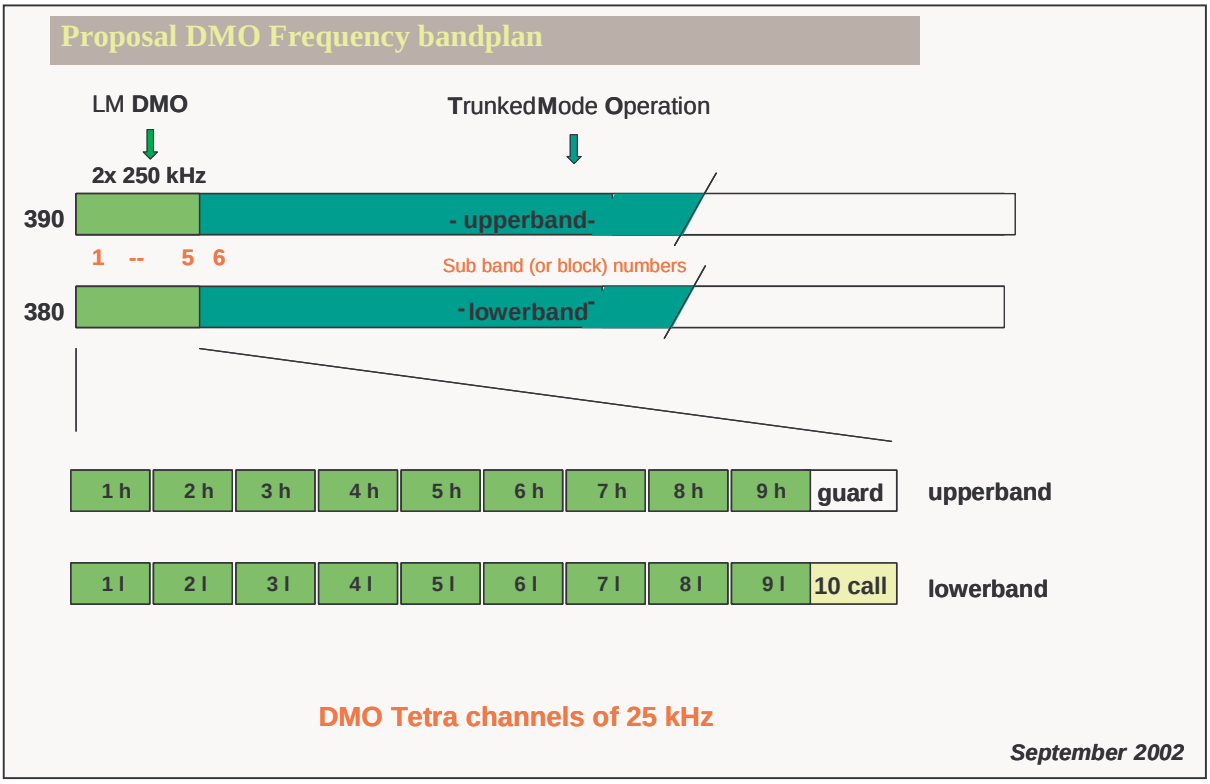


Conclusion – for Trunked Mode Operation (TMO):

- use of 180 frequencies for TMO
  - divisible by different channel spacing
  - divisible by 2, 3 and 4 county border regions for preferential frequencies
- agreed preferential frequencies
- fixed block for a private network operator
- largest number of frequencies for TMO because this mode is the most powerful one in providing services

DMO

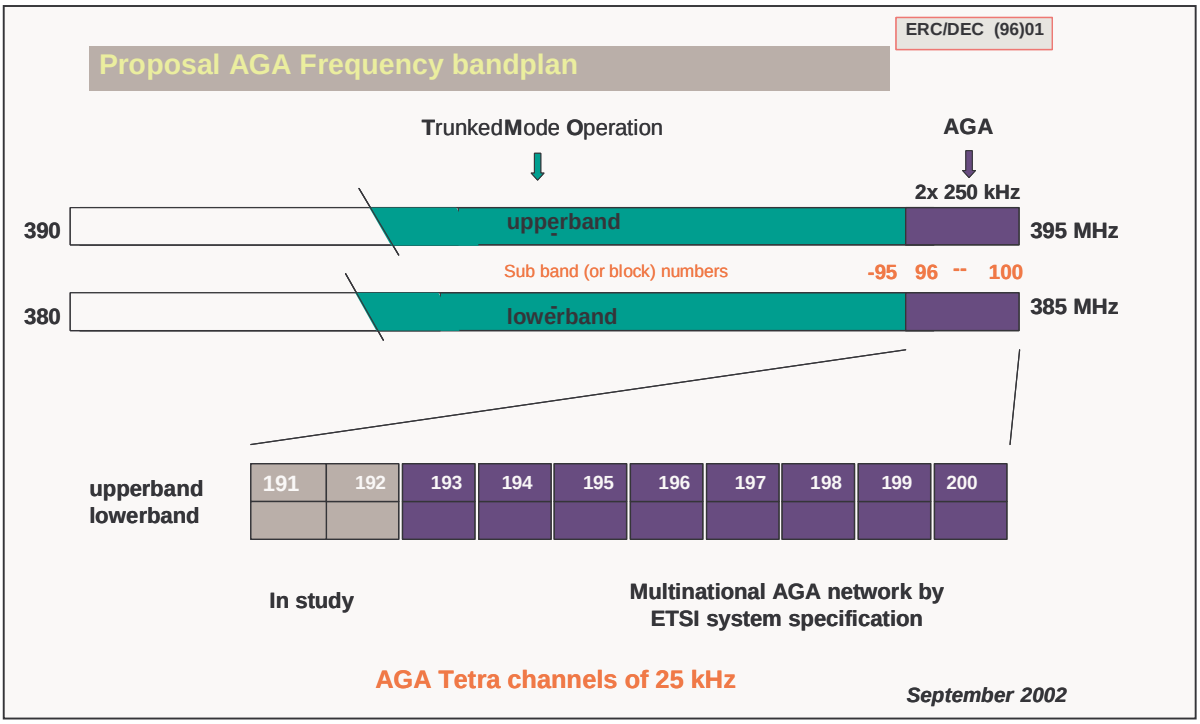
Direct communication between radios without using the network is possible by using the Direct Mode = DMO. This is an important issue to have communication in not covered areas as tunnel, deep inside buildings or below ground.



Conclusion – for DMO:

- one easy to use common call channel as meeting point
- DMO as fallback mode
  1 frequency in DMO = 1 talk-group
  1 frequency in TMO = up to 4 talk-groups
- DMO should not be used from fixed stations
  3 Watts maximum power
- DMO repeaters with repeater TX in the lower band should not be used
- The use of adjacent channels on the same location should be avoided

AGA



Operating Range extension

Well known is the maximum TMO radius of 56 km. There are possibilities to extend this range up to 80 km.
Within the specification for the terminals is defined the signal ramp up. The common ramp up needs 14 Bit length. If you would tighten the ramp up phase 6 Bits you would have 6 Bits more to extend the distance range.
This proposal is only a small step but more or less easy to realize. Requirements of 200 km range are an item of TETRA II.
Using the TETRA time division multiplex access technique a limited distance range will always be attendant. By shorten the ramp up - as described above - the limit is reached within the current TETRA network.
But comparing the maximum area the advantage is enormously. The covered area by using 80 km distance is more than the double as by using 56 km distance.
The suppliers were interested in this proposal and it seems to be able to realize. Not yet clear is the interoperability with equipment using 14 Bit ramp up as well as eventual extra costs.

Subscriber class

Within the ETSI TETRA specification some bits are foreseen for the subscriber class. Also there are some bits for distance measuring. Although present, these bits are not used now but they will be helpful for aeronautical use. Especially for roaming the field strength will not be the suitable criteria. Aeronautical radios should represent an own subscriber class. So you can define preferred cells for that class.

Some manufacturers propose to store a list of base stations into the radio. This solution is only opportune for use in small networks; but not suitable for larger networks in GB or Germany.
It seems that some implementations don't allow defining enough neighboring cells. These implementations also require that neighbors be defined symmetrically (e.g. if A is defined as a neighbor of B, B also needs to be defined as a neighbor of A). With this way of implementing, the use of subscriber class combined with preferred cells is very difficult to use for aeronautical use: For every "aeronautical base-station" (between 50-80km range) there will normally be between 50 and 100 neighboring "ground base-stations". This problem is very obvious when looking at "aeronautical" base-stations, but it is also present when using "umbrella" and "local" sites for the ground network. There will easily be between 20 and 50 neighboring "local" sites for every "umbrella" site. This shows that this implementation limitation has to be solved in any case and cannot be used as an argument against the use of subscriber-class for "aeronautical" base-stations. The subscriber class solution is recommended – a similar statement from the A2G Group is expected.

Speed
The TETRA system will operate with radios up to 500 km/h.

DMO
Based on the limited functionality DMO use is not sufficient for AGA communication. Same functionality (TMO) is required also for AGA.

RF frequency planning AGA
10 frequencies are foreseen for AGA use. With the extended range a network using 7 frequencies is described. The remaining 3 frequencies can be used as spare frequencies to solve problems in non-ideal environment such as mountain areas.

Conclusions:

- Using of Trunked Mode Operation
  (full performance)
- 80 km distance range
  (faster ramp up)
- Using of the distance measuring bits
- Using of the subscriber class bits

Basic TETRA for public safety frequency management principles

In the already mentioned MoU as well the European Decisions there are only matters concerning the spectrum described and the user-group and just in case of border situations to avoid conflicts and coordination activities.
It leaves always room to derogate in bi- or multilateral situations in accordance with the neighbouring countries. Even so there is no reference to technique or system except in the ERC-Dec(96)01 were the in general the band is indicated laying between 380 and 400 MHz and the term ‘harmonized’ system is used for the European Emergency Users.
These ERC-Decisions (CEPT) and the MoU of the Radio Administrations forms the base for the frequency-grid and planning and just only for in the border areas.
Of course it is a natural way to extend this principles also inland for small countries with long borderlines in relation to their surface. So for the Netherlands and Belgium it is no choise.

The Internationally agreed frequency plan below will explain more in detail the frequency division-plan, threshold values for protection and a reference to the Vienna Agreement for coordination.

Internationally agreed frequency plan

upper Frequency	block nr	Regional Plan												block nr	lower Frequency
		A	B	G	O	P	C	F	N	Q	D	E	H		
390,0250	1	C	C	C	C	C	C	C	C	C	C	C	C	1	380,0250
390,0750	2	C	C	C	C	C	C	C	C	C	C	C	C	2	380,0750
390,1250	3	C	C	C	C	C	C	C	C	C	C	C	C	3	380,1250
390,1750	4	C	D	SUI	F	HOL	C	C	C	C	C	C	C	4	380,1750
390,2250	5	F	HOL	F	F	HOL	HOL	F	F	IRL	HOL	F	F	5	380,2250
390,2750	6	D	D	D	F	HOL	D	D	F	IRL	HOL	F	SUI	6	380,2750
390,3250	7	BEL	BEL	SUI	BEL	BEL	D	D	G	G	BEL	BEL	SUI	7	380,3250
390,3750	8	LUX	HOL	F	G	G	HOL	F	G	G	BEL	BEL	F	8	380,3750
390,4250	9	F	HOL	F	F	HOL	HOL	F	F	IRL	HOL	F	F	9	380,4250
390,4750	10	D	D	D	G	G	D	D	F	IRL	HOL	F	SUI	10	380,4750
390,5250	11	BEL	BEL	SUI	BEL	BEL	D	F	G	G	BEL	BEL	SUI	11	380,5250
390,5750	12	LUX	BEL	D	G	G	HOL	D	G	G	BEL	BEL	F	12	380,5750
390,6250	13	F	HOL	F	F	HOL	HOL	F	F	IRL	HOL	F	F	13	380,6250
390,6750	14	D	D	D	BEL	BEL	D	D	F	IRL	BEL	BEL	F	14	380,6750
390,7250	15	BEL	BEL	SUI	BEL	BEL	HOL	D	G	G	BEL	BEL	SUI	15	380,7250
390,7750	16	LUX	D	SUI	G	G	D	F	G	G	BEL	BEL	SUI	16	380,7750
390,8250	17	F	HOL	F	F	HOL	HOL	F	F	IRL	HOL	F	F	17	380,8250
390,8750	18	D	D	D	F	HOL	D	D	F	IRL	HOL	F	SUI	18	380,8750
390,9250	19	BEL	BEL	SUI	BEL	BEL	D	D	G	G	BEL	BEL	SUI	19	380,9250
390,9750	20	LUX	HOL	F	G	G	HOL	F	G	G	BEL	BEL	F	20	380,9750
391,0250	21	F	HOL	F	F	HOL	HOL	F	F	IRL	HOL	F	F	21	381,0250
391,0750	22	D	D	D	G	G	D	D	F	IRL	HOL	F	SUI	22	381,0750
391,1250	23	BEL	BEL	SUI	BEL	BEL	D	F	G	G	BEL	BEL	SUI	23	381,1250
391,1750	24	LUX	BEL	D	G	G	HOL	D	G	G	BEL	BEL	F	24	381,1750
391,2250	25	F	HOL	F	F	HOL	HOL	F	F	IRL	HOL	F	F	25	381,2250

upper Frequency	block nr	Regional Plan A	B	G	O	P	C	F	N	Q	D	E	H	block nr	lower Frequency
391,2750	26	D	D	D	F	HOL	D	D	F	IRL	HOL	F	F	26	381,2750
391,3250	27	BEL	BEL	SUI	BEL	BEL	HOL	D	G	G	BEL	BEL	SUI	27	381,3250
391,3750	28	LUX	D	SUI	G	G	D	F	G	G	BEL	BEL	SUI	28	381,3750
391,4250	29	F	HOL	F	F	HOL	HOL	F	F	IRL	HOL	F	F	29	381,4250
391,4750	30	D	D	D	F	HOL	D	D	F	IRL	HOL	F	SUI	30	381,4750
391,5250	31	BEL	BEL	SUI	BEL	BEL	D	D	G	G	BEL	BEL	SUI	31	381,5250
391,5750	32	LUX	HOL	F	G	G	HOL	F	G	G	BEL	BEL	F	32	381,5750
391,6250	33	F	HOL	F	F	HOL	HOL	F	F	IRL	HOL	F	F	33	381,6250
391,6750	34	D	D	D	G	G	D	D	F	IRL	HOL	F	SUI	34	381,6750
391,7250	35	BEL	BEL	SUI	BEL	BEL	D	F	G	G	BEL	BEL	SUI	35	381,7250
391,7750	36	LUX	BEL	D	G	G	HOL	D	G	G	BEL	BEL	F	36	381,7750
391,8250	37	F	HOL	F	F	HOL	HOL	F	F	IRL	HOL	F	F	37	381,8250
391,8750	38	D	D	D	BEL	BEL	D	D	F	IRL	BEL	BEL	F	38	381,8750
391,9250	39	BEL	BEL	SUI	BEL	BEL	HOL	D	G	G	BEL	BEL	SUI	39	381,9250
391,9750	40	LUX	D	SUI	G	G	D	F	G	G	BEL	BEL	SUI	40	381,9750
392,0250	41	F	HOL	F	F	HOL	HOL	F	F	IRL	HOL	F	F	41	382,0250
392,0750	42	D	D	D	F	HOL	D	D	F	IRL	HOL	F	SUI	42	382,0750
392,1250	43	BEL	BEL	SUI	BEL	BEL	D	D	G	G	BEL	BEL	SUI	43	382,1250
392,1750	44	LUX	HOL	F	G	G	HOL	F	G	G	BEL	BEL	F	44	382,1750
392,2250	45	F	HOL	F	F	HOL	HOL	F	F	IRL	HOL	F	F	45	382,2250
392,2750	46	D	D	D	G	G	D	D	F	IRL	HOL	F	SUI	46	382,2750
392,3250	47	BEL	BEL	SUI	BEL	BEL	D	F	G	G	BEL	BEL	SUI	47	382,3250
392,3750	48	LUX	BEL	F	G	G	HOL	F	G	G	BEL	BEL	F	48	382,3750
392,4250	49	D	D	D	F	HOL	D	D	F	IRL	HOL	F	F	49	382,4250
392,4750	50	BEL	BEL	SUI	BEL	BEL	HOL	D	G	G	BEL	BEL	SUI	50	382,4750

upper Frequency	block nr	Regional Plan A	B	G	O	P	C	F	N	Q	D	E	H	block nr	lower Frequency
392,5250	51	LUX	D	SUI	G	G	D	F	G	G	BEL	BEL	SUI	51	382,5250
392,5750	52	D	D	D	F	HOL	D	D	F	IRL	HOL	F	SUI	52	382,5750
392,6250	53	BEL	BEL	SUI	BEL	BEL	D	D	G	G	BEL	BEL	SUI	53	382,6250
392,6750	54	LUX	HOL	D	G	G	HOL	D	G	G	BEL	BEL	F	54	382,6750
392,7250	55	D	D	D	G	G	D	D	F	IRL	HOL	F	SUI	55	382,7250
392,7750	56	BEL	BEL	SUI	BEL	BEL	D	D	G	G	BEL	BEL	SUI	56	382,7750
392,8250	57	LUX	BEL	D	G	G	HOL	F	G	G	BEL	BEL	F	57	382,8250
392,8750	58	F	HOL	F	F	HOL	HOL	F	F	IRL	HOL	F	F	58	382,8750
392,9250	59	F	HOL	F	F	HOL	HOL	F	F	IRL	HOL	F	F	59	382,9250
392,9750	60	F	HOL	F	F	HOL	HOL	F	F	IRL	HOL	F	F	60	382,9750
393,0250	61	F	HOL	F	F	HOL	HOL	F	F	IRL	HOL	F	F	61	383,0250
393,0750	62	F	HOL	F	F	HOL	HOL	F	F	IRL	HOL	F	F	62	383,0750
393,1250	63	F	HOL	F	F	HOL	HOL	F	F	IRL	HOL	F	F	63	383,1250
393,1750	64	F	HOL	F	F	HOL	HOL	F	F	IRL	HOL	F	F	64	383,1750
393,2250	65	F	HOL	F	F	HOL	HOL	F	F	IRL	HOL	F	F	65	383,2250
393,2750	66	F	HOL	F	F	HOL	HOL	F	F	IRL	HOL	F	F	66	383,2750
393,3250	67	F	HOL	F	F	HOL	HOL	F	F	IRL	HOL	F	F	67	383,3250
393,3750	68	F	HOL	F	F	HOL	HOL	F	F	IRL	HOL	F	F	68	383,3750
393,4250	69	F	HOL	F	F	HOL	HOL	F	F	IRL	HOL	F	F	69	383,4250
393,4750	70	LUX	HOL	F	F	HOL	HOL	F	F	IRL	HOL	F	F	70	383,4750
393,5250	71	LUX	HOL	F	F	HOL	HOL	F	F	IRL	HOL	F	F	71	383,5250
393,5750	72	LUX	HOL	F	F	HOL	HOL	F	F	IRL	HOL	F	F	72	383,5750
393,6250	73	LUX	D	D	G	G	D	D	F	IRL	HOL	F	F	73	383,6250
393,6750	74	LUX	D	D	G	G	D	D	F	IRL	HOL	F	F	74	383,6750
393,7250	75	LUX	D	D	G	G	D	D	F	IRL	HOL	F	F	75	383,7250

upper Frequency	block nr	Regional Plan A	B	G	O	P	C	F	N	Q	D	E	H	block nr	lower Frequency
393,7750	76	D	D	D	G	G	D	D	G	G	HOL	F	F	76	383,7750
393,8250	77	D	D	D	G	G	D	D	G	G	HOL	F	F	77	383,8250
393,8750	78	D	D	D	G	G	D	D	G	G	HOL	F	F	78	383,8750
393,9250	79	BEL	BEL	SUI	BEL	BEL	HOL	D	G	G	BEL	BEL	SUI	79	383,9250
393,9750	80	BEL	BEL	SUI	BEL	BEL	HOL	D	G	G	BEL	BEL	SUI	80	383,9750
394,0250	81	BEL	BEL	SUI	BEL	BEL	HOL	D	G	G	BEL	BEL	SUI	81	384,0250
394,0750	82	BEL	BEL	SUI	BEL	BEL	D	D	G	G	BEL	BEL	SUI	82	384,0750
394,1250	83	BEL	BEL	SUI	BEL	BEL	D	D	G	G	BEL	BEL	SUI	83	384,1250
394,1750	84	BEL	BEL	SUI	BEL	BEL	D	D	G	G	BEL	BEL	SUI	84	384,1750
394,2250	85	BEL	BEL	SUI	BEL	BEL	D	F	G	G	BEL	BEL	SUI	85	384,2250
394,2750	86	BEL	BEL	SUI	BEL	BEL	D	F	G	G	BEL	BEL	SUI	86	384,2750
394,3250	87	BEL	BEL	SUI	BEL	BEL	D	F	G	G	BEL	BEL	SUI	87	384,3250
394,3750	88	D	D	D	G	G	D	D	G	G	BEL	BEL	SUI	88	384,3750
394,4250	89	D	D	D	G	G	D	D	G	G	BEL	BEL	SUI	89	384,4250
394,4750	90	D	D	D	G	G	D	D	G	G	BEL	BEL	SUI	90	384,4750
394,5250	91	D	D	D	G	G	D	D	G	G	BEL	BEL	SUI	91	384,5250
394,5750	92	D	D	D	G	G	D	D	G	G	BEL	BEL	SUI	92	384,5750
394,6250	93	D	D	D	G	G	D	D	G	G	BEL	BEL	SUI	93	384,6250
394,6750	94	LUX	BEL	SUI	BEL	BEL	HOL	F	F	IRL	BEL	BEL	SUI	94	384,6750
394,7250	95	LUX	BEL	SUI	BEL	BEL	HOL	F	F	IRL	BEL	BEL	SUI	95	384,7250
394,7750	96	LUX	BEL	SUI	BEL	BEL	HOL	F	F	IRL	BEL	BEL	SUI	96	384,7750
394,8250	97	C	C	C	C	C	C	C	C	C	C	C	C	97	384,8250
394,8750	98	C	C	C	C	C	C	C	C	C	C	C	C	98	384,8750
394,9250	99	C	C	C	C	C	C	C	C	C	C	C	C	99	384,9250
394,9750	100	C	C	C	C	C	C	C	C	C	C	C	C	100	384,9750