reference temperature of 290° K and the receiver noise figure with a factor added for external noise. The formula is:

$$E_{RX}(dB\mu V/m) = \Phi(dBW/m^2) + 145.8(dB)$$
$$= 145.8 + C/N + G_i(1m^2) - G_A + 10\log k + 10\log B$$
$$+ 10\log T_0 + F + N_{ext}$$

The minimum required field strength for the three TV bands using the parameters adopted for use in the US and given in FCC's sixth Report and Order is shown in Table B.3.2 below.

Table B.3.2

FCC Planning Parameters

Planning Parameter	Low VHF	High VHF	UHF
Geometric Mean Frequency (MHz)	69	194	615
C/N (dB)	15.19	15.19	15.19
k (dB)	-228.6	-228.6	-228.6
B (dB)	67.78	67.78	67.78
$G_i(1m^2)$ (dB)	-1.77	7.21	17.23
G_{dipole} (dB)	4	6	10
$G_{isotropic}$ (dB)	6.15	8.15	12.15
Line Loss (dB)	1	2	4
Receiver Noise Figure F (dB)	10	10	7
$10\log(T_0)$ (dB)	24.62	24.62	24.62
N_{ext} (dB)	included in noise figure	included in noise figure	0
$G_{A\,(dB)}$	5.15	6.15	8.15
E_{read}	27.8	35.8	40.8

B.3.3 Proposed Planning Parameters (Cdn)

The minimum required field strength for the three TV bands using the parameters proposed for the final Canadian allotment planning is given in Table B.3.3 below.

Table B.3.3

Proposed Canadian Planning Parameters

Planning Parameter	Low VHF	High VHF	UHF_{LNA}
Frequency (MHz)	69	194	615
C/N (dB)	19.5	19.5	19.5
k (dB)	-228.6	-228.6	-228.6
B (dB) (6 MHz)	67.78	67.78	67.78
$G_i(1m^2)$ (dB)	-1.77	7.25	17.23
$G_{dipole\ (dB)}$	6	8	10
$G_{isotropic\ (dB)}$	8.15	10.15	12.15
Line Loss (dB) α (numeric)	1.05 0.786	1.81 0.659	3.29 0.468
Balun 300/75 Loss (dB) α_{balun} (numeric)	0.5 0.891	0.5 0.891	0.5 0.891
Receiver Noise Figure (dB)	5	5	10
T_{rx}	627.1	627.1	2610
T_{line}	62.1	98.9	154.3
LNA Noise Figure (dB)	5	5	5
LNA Gain (dB)	20	20	20
T_{LNA}	627.1	627.1	627.1
T_{balun}	31.6	31.6	31.6
T_a	9972.1	569.1	neg

Planning Parameter	Low VHF	High VHF	UHF_{LNA}
$\alpha_{balun} T_a$	8885.1	507.1	neg
$T_{line}/\alpha G$	0.79	1.5	3.3
$T_{rx}/\alpha G$	7.98	9.52	55.8
T_e	9552.6	1176.8	717.8
$10\log(T_e)$	39.8	30.71	28.56
$G_{A\,(dB)}$	7.65	9.65	11.65
E_{recd}	35	33	39

B.4 Protection Ratios

The protection ratios are based upon the values resulting from the measurements and tests of the Grand Alliance DTV system, except those marked with an asterisk. Values marked with an asterisk * are estimates based on measurements made on earlier DTV systems which preceded the Grand Alliance system.

DTV System Protection Ratios[4]

Parameter	FCC or Measured Value (dB)	Previous	Proposed
Carrier-to-Noise Ratio	+15.19	16	[19.5]
Co-channel D/U Ratio			
DTV into NTSC	+34.44 (+33.81)**	34	[33.81]
NTSC into DTV	+1.81	7	[7.2]

[4] FINAL TECHNICAL REPORT, Federal Communications Commission, Advisory Committee on Advanced Television Service, draft October 30, 1995.

** Values recorded in original lab tests on the GA system.

Values in [ ] indicate planning values adopted for Canadian allotment planning purposes where different from FCC values. See section B.2.2 and B.2.3 for explanation.

DTV into DTV		+15.27	15	[19.5]
Adjacent Channel D/U Ratio				
Lower DTV into NTSC		-17.43 (-15.96)**	-17	[-15.96]
Upper DTV into NTSC		-11.95	-12	
Lower NTSC into DTV		-47.73	-48	
Upper NTSC into DTV		-48.71	-49	
Lower DTV into DTV		-41.98	-42	
Upper DTV into DTV		-43.17	-43	
Taboo D/U Ratio, DTV into NTSC				
N-2		-23.73	-24	
N+2		-27.93	-28	
N-3		-29.73	-30	
N+3		-34.13	-34	
N-4		-34.00*	-34	
N+4		-24.96	-25	
N-7		-35.00*	-35	
N+7		-34.00*	-34	
N-8		-31.62	-32	
N+8		-43.22	-43	
N+14		-33.38	-33	
N+15		-30.58	-31	
Taboo D/U Ratio, NTSC into DTV				
N-2		-62.45	-62	
N+2		-59.86	-60	
N-3	<	-61.79	-62	
N+3	<	-62.49	-62	
N-4		-58.00*	-58	
N+4		-58.00*	-57	
N-7		-58.00*	-58	
N+7		-58.00*	-60	

N-8		-58.00*	-58
N+8		-58.00*	-58
N+14		-58.00*	-58
N+15		-58.00*	-58

Taboo D/U Ratio, DTV into DTV

N-2		-60.52	)not used
N+2		-59.13	)
N-3	<	-60.61	)
N+3	<	-61.53	)
N-4		-58.00*	)
N+4		-62.00*	)
N-7		-63.00*	)
N+7		-63.00*	)
N-8		-63.00*	)
N+8		-63.00*	)
N+14		-63.00*	)
N+15		-63.00*	)

C. Transmitting Considerations

C.1 Transmitting System Requirements

The necessary ERP to produce the required field strength for the noise limited contour at a given distance depends on the ERP (transmitter power, antenna gain, transmission line loss) and antenna height above average terrain. The location availability factor, which is the ratio in dB of the field strength for a given percentage of the receiving locations to the field strength for 50% of the receiving locations, is obtained from ITU-R Recommendation P370-7 Figures 5 and 12 for an Δh of 50 metres. The time availability factor is determined from the FCC's F(50,50) and F(50,10) curves. The ERP required was determined from the F(50,50) curves and adjusted for the location and time availability factors.

C.1.1 Transmitted Power Parameter (FCC)

Table C.1.1 below gives the ERP required for an UHF channel providing service for the classes of stations used in Canadian planning. The required field strength for the UHF channel assumed is 40.8 dBμV/m as calculated for the FCC example in their sixth Report and Order. The table allows comparison of the FCC example and power requirements with proposed Canadian values.

Table C.1.1 ERP Required (FCC Case)
UHF Channel Replacement

Class of Station	Low VHF	High VHF	UHF C	UHF B	UHF A	Low Power
Grade B Distance (km)	89	82	70	45	25	12
EHAAT (m)	300	300	300	150	100	30
T(90) dB	9.5	8.7	6.4	3.1	1.0	0
L(70) dB	2.6	2.6	2.6	2.6	2.6	2.6
L(90) dB	7.1	7.1	7.1	7.1	7.1	7.1
E_{reqd} 40.8 dBμV/m						
ERP (50,50) kW	43.15	21.83	5.12	0.583	0.046	0.025
dBkW	16.35	13.39	7.09	-2.34	-13.37	-16.02
ERP (50,90) kW	384.6	161.8	22.34	1.191	0.056	0.025
dBkW	25.85	22.09	13.49	0.76	-12.37	-16.02
ERP (70,90) kW	699.8	294.4	40.64	2.168	0.105	0.0455
dBkW	28.45	24.69	16.09	3.36	-9.77	-13.42
ERP (90,90) kW	1972	829.9	114.6	6.109	0.297	0.128
dBkW	32.95	29.19	20.59	7.86	-5.27	-8.92

C.1.2 Proposed Transmitted Power Parameter (Cdn)

C.1.2.1 DTV Power assuming UHF Band replacement channel

In the Canadian planning case, the required field strength calculated for the UHF channel is 39 dBμV/m assuming UHF band replacement and is the value determined for use in the proposed final allotment planning. The location availability factor and time availability factor are determined as specified in section C.1. The ERP required was determined from the F(50,50) curves and adjusted for the location and time availability factors.

Table C.1.2.1 ERP Required

UHF channel Replacement

Class of Station	Low VHF	High VHF	UHF C	UHF B	UHF A	Low Power
Grade B Distance (km)	89	82	70	45	25	12
EHAAT (m)	300	300	300	150	100	30
T(90) dB	9.5	8.7	6.4	3.1	1.0	0
L(70) dB	2.6	2.6	2.6	2.6	2.6	2.6
L(90) dB	7.1	7.1	7.1	7.1	7.1	7.1
E_{reqd} 39 dBμV/m						
ERP (50,50) kW dBkW	28.51 14.55	14.41 11.59	3.38 5.29	0.385 -4.15	0.031 -15.09	0.016 -17.96
ERP (50,90) kW dBkW	254.1 24.05	106.8 20.29	14.75 11.69	0.786 -1.05	0.039 -14.09	0.016 -17.96
ERP (70,90) kW dBkW	462.4 26.65	194.5 22.89	26.85 14.29	1.43 1.55	0.071 -11.49	0.029 -15.36
ERP (90,90) kW dBkW	1303 31.15	548.3 27.39	75.68 18.79	4.03 6.05	0.200 -6.99	0.082 -10.86

C.1.2.2 DTV Power assuming High VHF Band replacement channel

The required field strength calculated for the high VHF channel is 33 dBμV/m assuming high VHF band replacement and is the value determined for use in the proposed final allotment planning. The location availability factor and time availability factor are determined as specified

in section C.1. The ERP required was determined from the F(50,50) curves and adjusted for the location and time availability factors.

Table C.1.2.2 ERP Required
High VHF Channel Replacement

Class of Station	Low VHF	High VHF	UHF C	UHF B	UHF A	Low Power
Grade B Distance (km)	89	82	70	45	25	12
EHAAT (m)	300	300	300	150	100	30
T(90) dB	6.0	5.2	4.4	2.2	0.9	0
L(70) dB	2.0	2.0	2.0	2.0	2.0	2.0
L(90) dB	6.1	6.1	6.1	6.1	6.1	6.1
E_{reqd} 33 dBμV/m						
ERP (50,50) kW dBkW	0.837 -0.77	0.391 -4.08	0.103 -9.87	0.023 -16.38	0.0035 -24.56	0.002 -26.99
ERP (50,90) kW dBkW	3.33 5.23	1.29 1.12	0.283 -5.47	0.038 -14.18	0.0043 -23.66	0.002 -26.99
ERP (70,90) kW dBkW	5.28 7.23	2.05 3.12	0.450 -3.47	0.068 -11.68	0.007 -21.66	0.003 -24.99
ERP (90,90) kW dBkW	13.58 11.33	5.27 7.22	1.156 0.63	0.156 -8.08	0.018 -17.56	0.008 -20.89

C.1.2.3 DTV Power assuming Low VHF Band replacement channel

The required field strength calculated for the low VHF channel is 35 dBμV/m assuming low VHF band replacement and is the value determined for use in the proposed final allotment planning. The location availability factor and time availability factor are determined as specified in section C.1. The ERP required was determined from the F(50,50) curves and adjusted for the location and time availability factors.

Table C.1.2.3 ERP Required
Low VHF Channel Replacement

Class of Station	Low VHF	High VHF	UHF C	UHF B	UHF A	Low Power
Grade B Distance (km)	89	82	70	45	25	12
EHAAT (m)	300	300	300	150	100	30
T(90) dB	6.2	5.4	4.4	2.5	1.1	0
L(70) dB	2.0	2.0	2.0	2.0	2.0	2.0
L(90) dB	6.1	6.1	6.1	6.1	6.1	6.1
E_{reqd} 35 dBμV/m						
ERP (50,50) kW	1.671	0.831	0.260	0.075	0.012	0.0064
dBkW	2.23	-0.804	-5.85	-11.25	-19.21	-21.94
ERP (50,90) kW	6.966	2.884	0.716	0.133	0.015	0.0064
dBkW	8.43	4.60	-1.45	-8.75	-18.11	-21.94
ERP (70,90) kW	11.04	5.75	1.135	0.211	0.024	0.010
dBkW	10.43	7.60	0.55	-6.75	-16.11	-19.94
ERP (90,90) kW	28.38	11.75	2.92	0.543	0.063	0.026
dBkW	14.53	10.70	4.65	-2.65	-12.01	-15.84

C.1.3 Transmitted Power for US Planning

C.1.3.1 Transmitted Power for Replacement Stations (US)

In the US draft Table of Allotments for existing broadcasters, the DTV service is based on NTSC service replication which determines the required ERP and EHAAT for each DTV station. The ERP for each allotment is calculated to provide service area replication up to a maximum ERP of 5 megawatts.

C.1.3.2 Transmitted Power for Future Stations (US)

For new stations or allotments, maximum permissible ERP and EHAAT specifications were adopted by FCC'S 6th Report and Order. These specifications would allow an UHF station to serve a geographic area with a radius of 107 km. The maximum parameters for an UHF DTV station are given in Table C.1.3.2.

Table C.1.3.2
US Maximum Allowable ERP and Antenna Height for Future UHF DTV Stations

Antenna Height EHAAT (metres)	Effective Radiated Power ERP (kW)
610	316
580	350
550	400
520	460
490	540
460	630
425	750
395	900
365	1000

C.2 Realistic DTV Powers and Antenna Gains

The power required for a DTV transmitter is specified as average or RMS power in a linear operating mode whereas NTSC power are given in peak power in a class C operating mode. This places a limit on the maximum power available at the transmitter, typical transmitters are presently capable of delivering a maximum average power of 50-60 kW in a linear mode. The maximum ERP adopted by the FCC for UHF stations is 1000 kW. For Canadian planning, a maximum ERP of 1000 kW is proposed as the maximum limit which gives a margin of 6 dB over the maximum of 254 kW ERP needed to achieve the required field strength. A survey of

the industry is required to determine if these figures are realistic and achievable at economic prices.

C.3 Summary of DTV Powers and Classes for Planning

The specification for classes of station/service for DTV is based on the existing types of classes used in the NTSC service. Rather than specify maximum parameters for ERP and EHAAT as presently used, maximum values of the distance to the protected contour and of the EHAAT are used. The classes selected are given in Table C.3 below along with the transmitting ERP required to provide service at a (50,90) availability.

Table C.3

ERP for Classes of DTV Stations

TV Band	Class of Station	Protected Contour Distance km	EHAAT metres	DTV ERP (50,90)
	E_{reqd} 35 dBμV/m			
Low VHF	Low VHF	89	300	8.43 dBkW 6.97 kW
	Low VHF-HV	82	300	4.60 dBkW 2.88 kW
	Low VHF-C	70	300	-1.45 dBkW 716 W
	Low VHF-B	45	150	-8.75 dBkW 133 W
	Low VHF-A	25	100	-18.11 dBkW 15 W
	LP	12	30	-21.74 dBkW 6.7 W
	E_{reqd} 33 dBμV/m			

TV Band	Class of Station	Protected Contour Distance km	EHAAT metres	DTV ERP (50,90)
High VHF	High VHF-LV	89	300	5.23 dBkW 3.33 kW
	High VHF	82	300	1.12 dBkW 1.29 kW
	High VHF-C	70	300	-5.47 dBkW 283 W
	High VHF-B	45	150	-14.18 dBkW 38 W
	High VHF-A	25	100	-23.66 dBkW 4.3 W
	LP	12	30	-27.0 dBkW 2.0 W
	E_{reqd} 39 dBμV/m			
UHF	UHF-LV	89	300	24.05 dBkW 254.1 kW
	UHF-HV	82	300	20.29 dBkW 106.8 kW
	UHF Class C	70	300	11.69 dBkW 14.75 kW
	UHF Class B	45	150	-1.05 dBkW 0.786 kW
	UHF Class A	25	100	-14.09 dBkW 39 W
	UHF Class LP	12	30	-17.96 dBkW 16 W

D. Separation Tables

Separation distances provide an efficient and effective means for managing interference between NTSC stations and DTV allotments and we believe that such an approach can be used to determine the technical acceptability of DTV channel allotments. The separation tables are developed using the appropriate protection ratios, antenna discrimination and distances to protected and interfering contours for a specified service availability. They are based on an equal partitioning between noise and interference in the DTV to DTV case and to keep a degree of balance between interference from NTSC to DTV and the inverse. The tables give the separation distances required to protect the TV services of the different classes of stations and form the basis for allotting the frequencies to the DTV service areas.

Also, in developing the allotment plans, short spacings were used in order to satisfy all requirements. A study on the effect of short spacings on coverage was done to evaluate different percentages of possible reduction of spacings between stations. The study showed that the coverage was reduced with co-channel operation of different classes of stations at the presently used separations. As a result, a new set of taboos and separation distances was developed and the short spacing study was updated to reflect the new separations and incorporated into this document as Appendix 4. These new values will be used in future development of the Canadian allotment plan and are the values in the separation tables given in section D.3 for a service availability of (50.90) and in section D.4 for a service availability of (90.90).

D.1 Canadian Separation Distances used for Initial Planning

The following tables are based on an equal partitioning between noise and interference to keep a degree of balance between interference from NTSC to DTV and the inverse.

TABLE D.1.1

UHF BAND TABOOS - DTV -> DTV Separation distances in km

CLASS Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	A	A	A	A	A	A	B	B	B	B	B	B	C	C	C	C	C	C
CHAN.																		
-1	-25	-45	-70	-25	82	89	-45	-45	-70	-45	-82	-89	-70	-70	-71	-70	-83	-90
0	60	91	164	47	212	234	91	111	184	78	232	254	164	184	209	151	257	279
1	-25	-45	-70	-25	82	89	-45	-45	-70	-45	-82	-89	-70	-70	-71	-70	-83	-90

CLASS

Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	LP	LP	LP	LP	LP	LP	VU	VU	VU	VU	VU	VU	VL	VL	VL	VL	VL	VL
CHAN.																		
-1	-25	-45	-70	-12	82	89	-82	-82	-83	82	-88	-98	89	-89	-90	89	-96	-105
0	47	78	151	27	189	211	212	232	257	189	269	293	234	254	279	221	291	298
1	-25	-45	-70	-12	82	89	-82	-82	-83	82	-88	-98	89	-89	-90	89	-96	-105

A minus sign means that either co-siting or the indicated separation is OK.
Classes VU and VL have protected coverage equivalent to full power NTSC stations in the upper or lower VHF bands respectively, i.e. 82 or 89 km.
Channel -1 means lower first adjacent.
Protection was assessed in both directions and the greater separation distance was used.

TABLE D.1.2

UPPER VHF BAND TABOOS - DTV -> DTV Separation distances in km

CLASS

Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	A	A	A	A	A	A	B	B	B	B	B	B	C	C	C	C	C	C
CHAN.																		
-1	-25	-45	-70	-12	-82	-89	-45	-46	-71	-13	-83	-90	-70	-71	-72	-14	-84	-91
0	68	93	125	52	145	160	93	113	145	80	165	180	125	145	170	112	190	205
1	-25	-45	-70	-12	-82	-89	-45	-46	-71	-13	-83	-90	-70	-71	-72	-14	-84	-91

CLASS

Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	LP	LP	LP	LP	LP	LP	VU	VU	VU	VU	VU	VU	VL	VL	VL	VL	VL	VL
CHAN.																		
-1	-12	-13	-14	0	-15	-16	-82	-83	-84	-15	-85	-92	-89	-90	-91	-16	-92	-93
0	52	80	112	31	132	147	145	160	190	132	202	217	160	180	256	147	217	224
1	-12	-13	-14	0	-15	-16	-82	-83	-84	-15	-85	-92	-89	-90	-91	-16	-92	-93

TABLE D.1.3

LOWER VHF BAND TABOOS - DTV -> DTV Separation distances in km

To be revised

CLASS

Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	A	A	A	A	A	A	B	B	B	B	B	B	C	C	C	C	C	C

CHAN.

-1	-27	-47	-72	-26	-84	-91	-47	-48	-73	-46	-85	-92	-72	-73	-80	-71	-91	-98
0	81	125	177	68	207	230	125	145	197	112	227	250	177	197	222	164	252	275
1	-27	-47	-72	-26	-84	-91	-47	-48	-73	-46	-85	-92	-72	-73	-80	-71	-92	-99

CLASS																		
Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	LP	LP	LP	LP	LP	LP	VU	VU	VU	VU	VU	VU	VL	VL	VL	VL	VL	VL
CHAN.																		
-1	-26	-46	-71	-13	-83	-90	-84	-85	-92	-83	-97	-104	-91	-92	-99	-90	-104	-106
0	68	112	164	37	194	217	194	227	252	194	264	287	230	250	275	217	287	294
1	-26	-46	-71	-13	-83	-90	-84	-85	-91	-83	-97	-104	-91	-92	-98	-90	-104	-106

TABLE D.1.4

UHF BAND TABOOS - DTV -> NTSC Separation distances in km

CLASS																		
Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	A	A	A	A	A	A	B	B	B	B	B	B	C	C	C	C	C	C
CHAN.																		
-15	0	0	0	0	0	0	0	0	0	0	0	0	25	-45	-70	12	-82	-89
-14	0	0	0	0	0	0	0	0	0	0	0	0	25	-45	-70	12	-82	-89
-8	0	0	0	0	-25	25	0	0	-45	0	-45	-45	25	-45	-70	12	-82	-89
-7	0	0	-25	0	-26	26	0	0	-45	0	-45	-46	25	-45	-70	12	-82	-89
-4	0	0	-25	0	-26	26	0	0	-45	0	-46	-46	25	-45	-70	12	-82	-89
-3	0	0	-25	0	-25	26	0	0	-45	0	-45	-46	25	-45	-70	12	-82	-89
-2	0	0	-25	0	-26	28	0	0	-45	0	-46	-48	25	-45	-70	12	-82	-89
-1	-27	-47	-72	14	-84	-91	-46	-49	-74	16	-86	-93	71	-73	-80	22	-92	-99
0	71	91	136	58	181	202	103	123	156	90	201	222	169	189	214	156	226	247
1	-27	-47	-72	14	-84	-91	-46	-49	-74	16	-86	-93	71	-73	-80	22	-92	-99
2	0	0	-25	0	-25	26	0	0	-45	0	-45	-46	25	-45	-70	12	-82	-89
3	0	0	0	0	-25	25	0	0	0	0	-45	-45	25	-45	-70	12	-82	-89
4	0	0	-25	0	-26	28	0	0	-45	0	-46	-48	25	-45	-70	12	-82	-89
7	0	0	-25	0	-26	26	0	0	-45	0	-46	-46	25	-45	-70	12	-82	-89
8	0	0	0	0	-25	25	0	0	-45	0	-45	-45	25	-45	-70	12	-82	-89
14	0	0	-25	0	-26	27	0	0	-45	0	-46	-47	0	0	-70	0	-71	-72
15	0	0	-25	0	-26	28	0	0	-45	0	-46	-48	0	0	-70	0	-71	-73

CLASS						
Int.	A	B	C	LP	VU	VL
Prot.	LP	LP	LP	LP	LP	LP
CHAN.						
-15	0	0	0	0	0	0
-14	0	0	0	0	0	0
-8	0	0	0	0	12	12

-7	0	0	-12	0	12	13
-4	0	0	-12	0	13	13
-3	0	0	-12	0	12	13
-2	0	0	-12	0	13	15
-1	-26	-46	-71	-13	-83	-90
0	50	70	123	37	168	189
1	-26	-46	-71	-13	-83	-90
2	0	0	-12	0	12	13
3	0	0	0	0	12	12
4	0	0	-12	0	13	15
7	0	0	-12	0	13	13
8	0	0	0	0	12	12
14	0	0	-12	0	13	14
15	0	0	-12	0	13	15

A minus sign means that either co-siting or the indicated separation is OK.
Classes VU and VL have protected coverage equivalent to full power NTSC stations in the upper or lower VHF bands respectively, i.e. 82 or 89 km.
Channel -1 means lower first adjacent.
A separation of zero means that interference is unlikely at any separation.
Protection was assessed in both directions and the greater separation distance was used.

TABLE D.1.5

UPPER VHF BAND TABOOS - DTV -> NTSC Separation distances in km

CLASS																		
Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	A	A	A	A	A	A	B	B	B	B	B	B	C	C	C	C	C	C
CHAN.																		
-1	-27	-47	-72	-25	-84	-91	46	-50	-75	45	-87	-94	71	72	-85	70	-91	-104
0	86	106	131	73	145	150	113	143	168	110	180	187	200	220	245	187	257	264
1	-27	-47	-72	-25	-84	-91	46	-50	-75	45	-87	-94	71	72	-85	70	-91	-104

CLASS												
Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	LP	LP	LP	LP	LP	LP	VU	VU	VU	VU	VU	VU
CHAN.												
-1	-26	-46	-71	-13	-83	-90	83	87	-94	82	-104	-111
0	51	71	96	38	110	132	230	250	275	217	287	294
1	-26	-46	-71	-13	-83	-90	83	85	-97	82	-109	-116

TABLE D.1.6

LOWER VHF BAND TABOOS - DTV -> NTSC Separation distances in km

To be revised

CLASS																		
Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	A	A	A	A	A	A	B	B	B	B	B	B	C	C	C	C	C	C
CHAN.																		
-1	-27	-47	-72	-25	-84	-91	-46	-51	-76	-45	-88	-95	-71	-73	-80	-70	-92	-99
0	79	99	124	66	142	160	120	140	165	107	177	184	150	170	195	137	207	214
1	-28	-48	-73	-25	-85	-92	-46	-51	-76	-45	-88	-95	-71	-73	-81	-70	-93	-100

CLASS																		
Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	LP	LP	LP	LP	LP	LP	VU	VU	VU	VU	VU	VU	VL	VL	VL	VL	VL	VL
CHAN.																		
-1	-26	-46	-71	-13	-83	-90	83	-85	-89	82	-103	-110	90	92	-96	89	-106	-113
0	50	70	109	37	129	147	207	227	252	194	264	271	225	245	270	190	282	289
1	-26	-46	-71	-13	-83	-90	83	-85	-88	82	-105	-112	90	92	-95	89	-108	-115

TABLE D.1.7

UHF BAND TABOOS - NTSC -> DTV

CLASS												
Int.	A	B	C	LP	A	B	C	LP	A	B	C	LP
Prot.	A	A	A	A	B	B	B	B	C	C	C	C
CHAN.												
-15	0	0	0	0	0	0	0	0	-25	-45	-70	-12
-14	0	0	0	0	0	0	0	0	-25	-45	-70	-12
-8	0	0	25	0	0	0	-45	0	0	-70	-70	0
-7	0	0	25	0	0	0	-45	0	-25	-70	-70	-12
-4	0	0	25	0	0	0	-45	0	-25	-45	-70	-12
-3	0	0	25	0	0	0	-45	0	0	0	-70	0
-2	0	0	25	0	0	0	-45	0	-25	-45	-70	-12
-1	-27	-46	71	-26	-47	-49	-73	-46	-72	-74	-80	-71
0	71	103	169	50	91	123	189	70	136	156	214	123
1	-27	-46	71	-26	-47	-49	-73	-46	-72	-74	-80	-71
2	0	0	25	0	0	0	-45	0	-25	-45	-70	-12
3	0	0	25	0	0	0	-45	0	-25	-45	-70	-12
4	0	0	25	0	0	0	-45	0	-25	-45	-70	-12
7	0	0	25	0	0	0	-45	0	-25	-45	-70	-12
8	0	0	25	0	0	0	-45	0	0	-45	-70	0
14	0	0	25	0	0	0	-45	0	0	-45	-70	0
15	0	0	25	0	0	0	-45	0	0	-45	-70	0

CLASS												
Int.	A	B	C	LP	A	B	C	LP	A	B	C	LP
Prot.	LP	LP	LP	LP	VU	VU	VU	VU	VL	VL	VL	VL
CHAN.												
-15	0	0	0	0	-26	-46	-71	13	28	-48	-73	15
-14	0	0	0	0	-26	-46	-71	13	27	-47	-72	14
-8	0	0	12	0	-25	-45	-82	12	25	-45	-89	12
-7	0	0	12	0	-26	-46	-82	13	26	-46	-89	13
-4	0	0	12	0	-26	-46	-82	13	28	-48	-89	15
-3	0	0	12	0	-25	-45	-82	12	25	-45	-89	12
-2	0	0	12	0	-25	-45	-82	12	26	-46	-89	13
-1	14	16	22	-13	-84	-86	-92	-83	-91	-93	-99	-90
0	58	90	156	37	181	201	226	168	202	222	247	189
1	14	16	22	-13	-84	-86	-92	-83	-91	-93	-99	-90
2	0	0	12	0	-26	-46	-82	13	28	-48	-89	15
3	0	0	12	0	-25	-45	-82	12	26	-46	-89	13
4	0	0	12	0	-26	-46	-82	13	26	-46	-89	13
7	0	0	12	0	-26	-46	-82	13	26	-46	-89	13
8	0	0	12	0	-25	-45	-82	12	25	-45	-89	12
14	0	0	12	0	0	0	-82	0	0	0	-89	0
15	0	0	12	0	0	0	-82	0	0	0	-89	0

A minus sign means that either co-siting or the indicated separation is OK.
Classes VU and VL have protected coverage equivalent to full power NTSC stations in the upper or lower VHF bands respectively, i.e. 82 or 89 km.
Channel -1 means lower first adjacent.
A separation of zero means that interference is unlikely at any separation.
Protection was assessed in both directions and the greater separation distance was used.

TABLE D.1.8

UPPER VHF BAND TABOOS - NTSC -> DTV

CLASS															
Int.	A	B	C	LP	VU	A	B	C	LP	VU	A	B	C	LP	VU
Prot.	A	A	A	A	A	B	B	B	B	B	C	C	C	C	C
CHAN.															
-1	-27	46	71	-26	83	-47	-50	72	-46	87	-72	-75	-85	-71	-92
0	86	113	200	51	230	106	143	220	71	250	131	168	245	96	275
1	-27	46	71	-26	83	-47	-50	72	-46	87	-72	-75	-85	-71	-92

CLASS															
Int.	A	B	C	LP	VU	A	B	C	LP	VU	A	B	C	LP	VU
Prot.	LP	LP	LP	LP	LP	VU	VU	VU	VU	VU	VL	VL	VL	VL	VL
CHAN.															

-1	-25	45	70	-13	82	-85	-88	-101	-83	-109	-92	-95	-108	-90	-116
0	73	110	187	38	217	145	180	257	110	287	150	187	264	132	294
1	-25	45	70	-13	82	-84	-87	-97	-83	-104	-91	-94	-104	-90	-111

TABLE D.1.9

LOWER VHF BAND TABOOS - NTSC -> DTV

To be revised

CLASS																		
Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	A	A	A	A	A	A	B	B	B	B	B	B	C	C	C	C	C	C
CHAN.																		
-1	-28	-46	-71	-26	83	90	-48	-51	-73	-46	-85	92	-73	-76	-81	-71	-88	-95
0	79	120	150	50	207	225	99	140	170	70	227	245	124	165	195	109	252	270
1	-27	-46	-71	-26	83	90	-47	-51	-73	-46	-85	92	-72	-76	-80	-71	-89	-96

CLASS																		
Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	LP	LP	LP	LP	LP	LP	VU	VU	VU	VU	VU	VU	VL	VL	VL	VL	VL	VL
CHAN.																		
-1	-25	-45	-70	-13	82	89	-85	-88	-93	-83	-105	-108	-92	-95	-100	-90	-112	-115
0	66	107	137	37	194	212	142	177	207	129	264	282	160	184	214	147	271	289
1	-25	-45	-70	-13	82	89	-84	-88	-92	-83	-103	-106	-91	-95	-99	-90	-110	-113

D.2 US Tables

The following is an excerpt from FCC 96-317.

a. Geographic Spacing Approach. Spacing standards have proven to be an efficient and effective means for managing interference between NTSC stations and we believe that such an approach could be used to determine the technical acceptability of DTV channel allotments. We note that geographic spacing approach provides considerable flexibility in the specification of station operating parameters such as power and antenna height. Based on the engineering performance characteristics used in developing the initial DTV Table proposed herein, we have developed the following DTV spacing standards. If we adopt a geographical spacing approach, we would propose to permit the addition or modification of DTV allotments provided such allotments meet the following spacing standards.[5]

[5] Proposals for new DTV allotments would also be subject to other requirements and standards for new allotments set forth in Sections 73.610 and 73.611 of our rules, see 47 CFR §§73.610

Channel Relationship		Separation Requirement
VHF Channels 7-13		
Co-channel, DTV to DTV		
	Zone I	152 miles (244.6 km)
	Zones II & III	170 miles (273.6 km)
Co-channel, DTV to NTSC		
	Zone I	152 miles (244.6 km)
	Zone II & III	170 miles (273.6 km)
Adjacent Channel		
DTV to DTV		No allotments permitted between:
	Zone I	25 miles (40.2 km) and 60 miles (96.6 km)
	Zones II & III	30 miles (48.3 km) and 60 miles (96.6 km)
DTV to NTSC		No allotments permitted between:
	Zone I	7 miles (11.3 km) and 71 miles (114.3 km)
	Zone II & III	11 miles (17.7 km) and 91 miles (146.4 km)
UHF Channels		
Co-channel, DTV to DTV		
	Zone I	122 miles (196.3 km)
	Zone II & III	139 miles (223.7 km)
Co-channel, DTV to NTSC		
	Zone I	135 miles (217.3 km)
	Zone II & III	152 miles (244.6 km)
Adjacent Channel		

and 73.611. The DTV to NTSC minimum spacing requirements would apply only during the transition period.

DTV to DTV		No allotments permitted between:
	All Zones	20 miles (32.2 km) and 55 miles (88.5 km)
DTV to NTSC		No allotments permitted between:
	All Zones	6 miles (9.7 km) and 55 miles (88.5 km)
Taboo Channels, DTV to NTSC only (+/- 2, +/- 3, +/- 4, +/- 5, +/- 7, +/- 8, +/- 14 and +/- 15 channels)		No allotments permitted between:
	Zone I	15 miles (24.1 km) and 50 miles (80.5 km)
	Zone II & III	15 miles (24.1 km) and 60 miles (96.6 km)

D.3 Proposed Canadian Tables (50,90 Service Availability)

TABLE D.3.1

UHF BAND TABOOS - DTV -> DTV Separation distances in km

Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	A	A	A	A	A	A	B	B	B	B	B	B	C	C	C	C	C	C
CHAN.																		
-1	-26	-45	70	-12	82	89	-46	-47	-72	14	84	91	71	-72	-77	18	-88	-95
0	58	114	204	56	258	283	114	111	185	126	239	264	204	185	207	216	254	276
1	-26	-46	71	-13	83	90	-45	-47	-72	14	84	91	70	-72	-77	19	-89	-96

Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	LP	LP	LP	LP	LP	LP	VU	VU	VU	VU	VU	VU	VL	VL	VL	VL	VL	VL
CHAN.																		
-1	-13	14	19	0	24	27	83	84	-89	17	-94	-101	90	91	-96	21	-101	-104
0	56	126	216	30	270	296	258	239	254	270	266	288	283	264	276	296	288	295
1	-12	14	18	0	24	26	82	84	-88	24	-94	-101	89	91	-95	27	-101	-104

A minus sign means that either co-siting or the indicated separation is OK.
Classes VU and VL have protected coverage equivalent to full power NTSC stations in the upper or lower VHF bands respectively, i.e. 82 or 89 km.
Channel -1 means lower first adjacent.
Protection was assessed in both directions and the greater separation distance was used.

TABLE D.3.2

UPPER VHF BAND TABOOS - DTV -> DTV Separation distances in km

Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	A	A	A	A	A	A	B	B	B	B	B	B	C	C	C	C	C	C
CHAN.																		
-1	-26	-46	71	-25	83	90	-46	-47	-72	-45	84	91	71	-72	-74	70	-86	-93
0	68	100	154	63	191	215	100	120	162	103	193	215	154	162	187	166	218	240
1	-26	-46	71	-25	83	90	-46	-47	-72	-45	84	91	71	-72	-74	70	-86	-93

Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	LP	LP	LP	LP	LP	LP	VU	VU	VU	VU	VU	VU	VL	VL	VL	VL	VL	VL
CHAN.																		
-1	-25	-45	70	-12	82	89	83	84	-86	82	-88	-94	90	91	-93	89	-95	-98
0	63	103	166	33	203	227	191	193	218	203	230	252	215	215	240	227	252	259
1	-25	-45	70	-12	82	89	83	84	-86	82	-88	-95	90	91	-93	89	-94	-98

TABLE D.3.3

LOWER VHF BAND TABOOS - DTV -> DTV Separation distances in km

Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	A	A	A	A	A	A	B	B	B	B	B	B	C	C	C	C	C	C
CHAN.																		
-1	-26	-46	71	-25	83	90	-46	-48	-73	-45	-85	92	71	-73	-78	70	-89	-96
0	86	127	180	74	214	236	127	147	201	124	234	256	180	200	225	181	259	281
1	-26	-46	71	-25	83	90	-46	-48	-73	-45	-85	92	71	-74	-78	70	-90	-97

Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	LP	LP	LP	LP	LP	LP	VU	VU	VU	VU	VU	VU	VL	VL	VL	VL	VL	VL
CHAN.																		
-1	-25	-45	70	-12	82	89	83	-85	-90	82	-93	-100	90	92	-97	89	-100	-103
0	74	124	181	40	216	239	214	234	259	216	271	293	236	256	281	239	293	300
1	-25	-45	70	-12	82	89	83	-85	-89	82	-93	-100	90	92	-96	89	-99	-103

TABLE D.3.4

UHF BAND TABOOS - DTV -> NTSC Separation distances in km

Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	A	A	A	A	A	A	B	B	B	B	B	B	C	C	C	C	C	C
CHAN.																		

-15	-26	-46	-71	-13	-83	-90	-28	-48	-73	-15	-85	-92	-33	-53	-78	-20	-90	-97
-14	-26	-46	-71	-13	-83	-90	-28	-48	-73	-15	-85	-92	-33	-53	-78	-20	-90	-97
-8	-26	-46	-71	-13	-83	-90	-28	-48	-73	-15	-85	-92	-33	-70	-78	-20	-90	-97
-7	-26	-46	-71	-13	-83	-90	-28	-48	-73	-15	-85	-92	-33	-70	-78	-20	-90	-97
-4	-26	-46	-71	-13	-83	-90	-28	-48	-73	-15	-85	-92	-33	-70	-78	-20	-90	-97
-3	-26	-46	-71	-13	-83	-90	-27	-47	-72	-14	-84	-91	-31	-71	-76	-18	-88	-96
-2	-26	-46	-71	-13	-83	-90	-45	-48	-73	-15	-85	-92	-70	-71	-77	-19	-89	-95
-1	-28	-48	73	-15	85	92	-46	-51	76	-18	88	95	-71	-72	-85	-27	97	104
0	99	100	143	111	192	215	162	144	169	174	181	197	241	223	240	254	252	259
1	-28	-48	73	-25	85	92	-46	-51	76	-45	88	95	-71	-73	-86	-70	98	105
2	-26	-46	-71	-13	-83	-90	-27	-47	-72	-14	-84	-91	-31	-71	-76	-18	-88	-95
3	-26	-46	-71	-13	-83	-90	-27	-47	-72	-14	-84	-91	-31	-70	-76	-18	-88	-95
4	-26	-46	-71	-13	-83	-90	-45	-48	-73	-15	-85	-92	-70	-71	-78	-20	-90	-97
7	-26	-46	-71	-13	-83	-90	-28	-48	-73	-15	-85	-92	-33	-70	-78	-20	-90	-97
8	-26	-46	-71	-13	-83	-90	-28	-48	-73	-15	-85	-92	-33	-53	-78	-20	-90	-97
14	0	-25	-27	0	-29	-30	0	-45	-47	0	-49	-50	0	-70	-72	0	-74	-75
15	0	-26	-27	0	-30	-31	0	-46	-47	0	-50	-51	0	-71	-72	0	-75	-76

Int.	A	B	C	LP	VU	VL
Prot.	LP	LP	LP	LP	LP	LP
CHAN.						
-15	-25	-45	-70	-12	-82	-89
-14	-25	-45	-70	-12	-82	-89
-8	-25	-45	-70	-12	-82	-89
-7	-25	-45	-70	-12	-82	-89
-4	-25	-45	-70	-12	-82	-89
-3	-25	-45	-70	-12	-82	-89
-2	-25	-45	-70	-12	-82	-89
-1	-26	46	71	-13	83	90
0	68	79	155	80	204	227
1	-26	46	71	-13	83	90
2	-25	-45	-70	-12	-82	-89
3	-25	-45	-70	-12	-82	-89
4	-25	-45	-70	-12	-82	-89
7	-25	-45	-70	-12	-82	-89
8	-25	-45	-70	-12	-82	-89
14	0	-12	-14	0	-16	-17
15	0	-13	-14	0	-17	-18

A minus sign means that either co-siting or the indicated separation is OK.
Classes VU and VL have protected coverage equivalent to full power NTSC stations in the upper or lower VHF bands respectively, i.e. 82 or 89 km.
Channel -1 means lower first adjacent.
A separation of zero means that interference is unlikely at any separation.
Protection was assessed in both directions and the greater separation distance was used.

TABLE D.3.5

UPPER VHF BAND TABOOS - DTV -> NTSC Separation distances in km

Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	A	A	A	A	A	A	B	B	B	B	B	B	C	C	C	C	C	C
CHAN.																		
-1	-27	-47	72	-25	84	91	-46	-50	-75	-45	87	94	-71	-72	-81	-70	-93	-100
0	93	113	138	97	150	167	139	147	171	150	183	190	206	206	231	218	243	250
1	-28	-48	73	-25	85	92	-46	-51	-76	-45	88	95	-71	-73	-82	-70	-94	-101

Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	LP	LP	LP	LP	LP	LP	VU	VU	VU	VU	VU	VU
CHAN.												
-1	-27	47	72	-14	84	91	-83	-84	-87	-82	-99	-106
0	64	84	121	70	155	178	243	239	264	254	276	283
1	-27	47	72	-14	84	91	-83	-85	-89	-82	-100	-107

TABLE D.3.6

LOWER VHF BAND TABOOS - DTV -> NTSC Separation distances in km

Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	A	A	A	A	A	A	B	B	B	B	B	B	C	C	C	C	C	C
CHAN.																		
-1	-29	47	72	-27	84	91	-49	-53	74	-47	86	93	-74	-78	-88	-72	96	102
0	93	137	193	70	227	249	116	157	213	109	247	269	171	191	238	172	272	294
1	-30	47	72	-27	84	91	-50	-53	74	-47	86	93	-75	-80	-93	-72	104	111

Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	LP	LP	LP	LP	LP	LP	VU	VU	VU	VU	VU	VU	VL	VL	VL	VL	VL	VL
CHAN.																		
-1	26	46	71	-14	83	90	-86	-90	-100	-84	-108	-114	-93	-97	-107	-91	-115	-121
0	82	136	194	47	230	253	198	218	250	199	284	306	214	234	259	216	291	313
1	26	46	71	-14	83	90	-87	-92	-105	-84	-116	-123	-94	-99	-112	-91	-123	-130

TABLE D.3.7

UHF BAND TABOOS - NTSC -> DTV

Int.	A	B	C	LP	A	B	C	LP	A	B	C	LP
Prot.	A	A	A	A	B	B	B	B	C	C	C	C
CHAN.												
-15	0	0	0	0	-26	-46	-71	-13	-27	-47	-72	-14
-14	0	0	0	0	-25	-45	-70	-12	-27	-47	-72	-14
-8	-26	-28	-33	-25	-46	-48	-53	-45	-71	-73	-78	-70
-7	-26	-28	-33	-25	-46	-48	-70	-45	-71	-73	-78	-70
-4	-26	-45	-70	-25	-46	-48	-71	-45	-71	-73	-78	-70
-3	-26	-27	-31	-25	-46	-47	-70	-45	-71	-72	-76	-70
-2	-26	-27	-31	-25	-46	-47	-71	-45	-71	-72	-76	-70
-1	-28	-46	-71	-26	-48	-51	-73	46	73	76	-86	71
0	99	162	241	68	100	144	223	79	143	169	240	155
1	-28	-46	-70	-26	-48	-51	-72	46	73	76	-85	71
2	-26	-45	-70	-25	-46	-48	-71	-45	-71	-73	-77	-70
3	-26	-27	-31	-25	-46	-47	-71	-45	-71	-73	-76	-70
4	-26	-28	-33	-25	-46	-48	-70	-45	-71	-73	-78	-70
7	-26	-28	-33	-25	-46	-48	-70	-45	-71	-73	-78	-70
8	-26	-28	-33	-25	-46	-48	-70	-45	-71	-73	-78	-70
14	-26	-28	-33	-25	-46	-48	-53	-45	-71	-73	-78	-70
15	-26	-28	-33	-25	-46	-48	-53	-45	-71	-73	-78	-70

Int.	A	B	C	LP	A	B	C	LP	A	B	C	LP
Prot.	LP	LP	LP	LP	VU	VU	VU	VU	VL	VL	VL	VL
CHAN.												
-15	0	0	0	0	-30	-50	-75	-17	-31	-51	-76	-18
-14	0	0	0	0	-29	-49	-74	-16	-30	-50	-75	-17
-8	-13	-15	-20	-12	-83	-85	-90	-82	-90	-92	-97	-89
-7	-13	-15	-20	-12	-83	-85	-90	-82	-90	-92	-97	-89
-4	-13	-15	-20	-12	-83	-85	-90	-82	-90	-92	-97	-89
-3	-13	-14	-18	-12	-83	-84	-88	-82	-90	-91	-95	-89
-2	-13	-14	-18	-12	-83	-84	-88	-82	-90	-91	-95	-89
-1	-25	-45	-70	-13	85	88	98	83	92	95	105	90
0	111	174	254	80	192	181	252	204	215	197	259	227
1	-15	-18	-27	-13	85	88	97	83	92	95	104	90
2	-13	-15	-19	-12	-83	-85	-89	-82	-90	-92	-96	-89
3	-13	-14	-18	-12	-83	-84	-88	-82	-90	-91	-95	-89
4	-13	-15	-20	-12	-83	-85	-90	-82	-90	-92	-97	-89
7	-13	-15	-20	-12	-83	-85	-90	-82	-90	-92	-97	-89
8	-13	-15	-20	-12	-83	-85	-90	-82	-90	-92	-97	-89
14	-13	-15	-20	-12	-83	-85	-90	-82	-90	-92	-97	-89
15	-13	-15	-20	-12	-83	-85	-90	-82	-90	-92	-97	-89