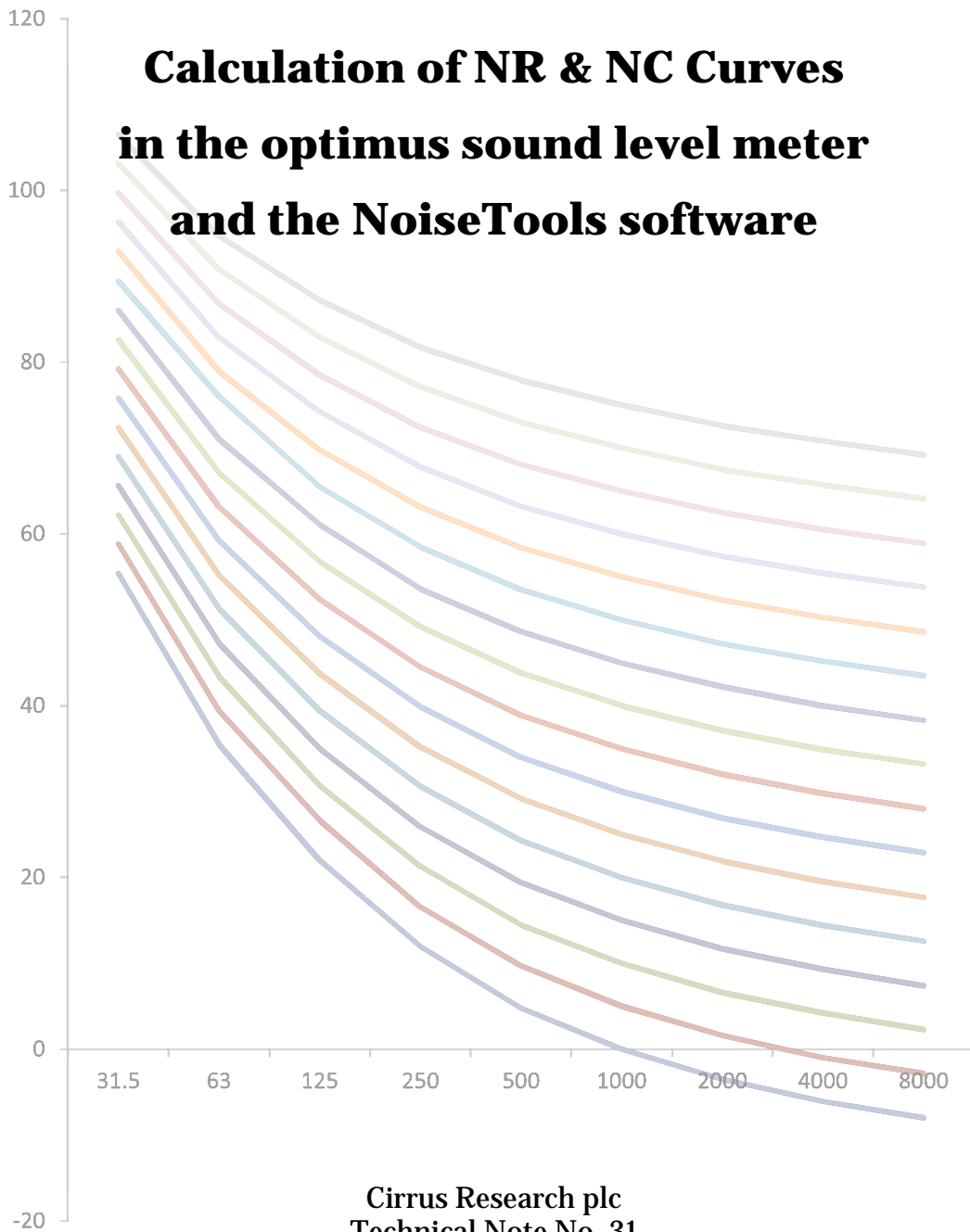


# Calculation of NR & NC Curves in the optimus sound level meter and the NoiseTools software



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Cirrus Research plc

Acoustic House

Bridlington Road

Hunmanby

North Yorkshire

YO14 0PH

United Kingdom

Tel: 0845 230 2434 (UK)

Tel: +44 1723 891655 (International)

Fax: +44 1723 891742

Email: [sales@cirrusresearch.co.uk](mailto:sales@cirrusresearch.co.uk)

Web: [www.cirrusresearch.co.uk](http://www.cirrusresearch.co.uk)

Twitter: @cirrusresearch

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## 1 What are NR & NC values?

NR & NC values are a way of describing, as a single figure, a measured noise level that takes into account the frequency content of the noise.

They are often used in the measurement of noise from mechanical sources such as air conditioning systems in environments such hotels, cinemas and schools. Some examples of these are shown in the following sections.

The optimum sound level meters and the NoiseTools software can provide both NR and NC values.

### 1.1 NR or Noise Rating Curves

The Noise Rating or NR curves were developed by the International Organization for Standardization (ISO) to determine the acceptable indoor environment for hearing preservation, speech communication and annoyance.

NR curves are commonly used in Europe whereas NC curves are more commonly used in the US.

Some examples of NR values and their applications are:

Noise rating curve	Application
NR 25	Concert halls, broadcasting and recording studios, churches
NR 30	Private dwellings, hospitals, theatres, cinemas, conference rooms
NR 35	Libraries, museums, court rooms, schools, hospitals operating theatres and wards, flats, hotels, executive offices
NR 40	Halls, corridors, cloakrooms, restaurants, night clubs, offices, shops
NR 45	Department stores, supermarkets, canteens, general offices
NR 50	Typing pools, offices with business machines
NR 60	Light engineering works
NR 70	Foundries, heavy engineering works

### 1.1.1 Calculating an NR value

To calculate the NR value, the noise level in each 1:1 octave band is compared to the values in the NR table (see page 11) for each corresponding band.

The NR curve number which applies to each frequency band is the highest numerical value that is not exceeded in that band. The overall NR value is the highest of the individual NR values for the frequency bands.

For example, the following 1:1 octave bands have been measured:

Frequency	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz
Octave Band Level dB	74.1	75.3	68.9	59.6	49.3	42.9	41.0	35.8

These values can be compared to the NR table and for each frequency band the corresponding NR value can be obtained:

Frequency	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz
Octave Band Level dB	74.1	75.3	68.9	59.6	49.3	42.9	41.0	35.8
NR value	NR 49	NR 62	NR 61	NR 51	NR 49	NR 45	NR 47	NR 43

The highest of these is the NR 62 from the 125Hz band and therefore the overall NR value is 62.

The other method is when you know the NR value that must be achieved.

For example, if there is a requirement for the noise level in a room to be NR 25 or better, the octave band values can be read from the NR table as shown below:

	63Hz	125Hz	250HZ	500Hz	1kHz	2kHz	4kHz	8kHz
NR25	55.2	43.7	35.2	29.2	25.0	21.9	19.5	17.7

To meet NR25, the octave band values, measured as dB(Z) or dB(Lin), must be at or below each of these values.

## 1.2 NC or Noise Criterion Curves

Noise Criterion or NC Curves were established in the US for rating indoor noise such as noise from air-conditioning equipment etc.

The method consists of a set of criteria curves extending from 63 to 8000 Hz. The criteria curves define the limits of octave band spectra that must not be exceeded.

Some examples of these include:

Type of Room - Space Type	Recommended NC Level NC Curve	Type of Room - Space Type	Recommended NC Level NC Curve
<b>Residences</b>		<b>Hospitals and Clinics</b>	
Apartment Houses	25-35	- Private rooms	25-30
Assembly Halls	25-30	- Operating rooms	25-30
Churches	30-35	- Wards	30-35
Courtrooms	30-40	- Laboratories	35-40
Factories	40-65	- Corridors	30-35
Private Homes, rural and suburban	20-30	- Public areas	35-40
Private Homes, urban	25-30	<b>Schools</b>	
<b>Hotels/Motels</b>		- Lecture and classrooms	25-30
- Individual rooms or suites	25-35	- Open-plan classrooms	35-40
- Meeting or banquet rooms	25-35	Movie motion picture theatres	30-35
- Service and Support Areas	40-45	Libraries	35-40
- Halls, corridors, lobbies	35-40	Legitimate theatres	20-25
<b>Offices</b>		Private Residences	25-35
- Conference rooms	25-30	Restaurants	40-45
- Private	30-35	TV Broadcast studios	15-25
- Open-plan areas	35-40	Recording Studios	15-20
- Business machines/computers	40-45	Concert and recital halls	15-20
		Sport Coliseums	45-55
		Sound broadcasting	15-20

### 1.2.1 Calculating an NC value

The NC rating can be obtained by plotting the octave band levels for a given noise spectrum against the NC curves.

In this example, the following 1:1 octave bands have been measured:

Frequency	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz
Octave Band Level dB	74.1	75.3	68.9	59.6	49.3	42.9	41.0	35.8

These values can be compared to those in the NC data table and a value obtained for each octave band. The NC value is the lowest NC curve which is not exceeded by each individual frequency band.

Frequency	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz
Octave Band Level dB	74.1	75.3	68.9	59.6	49.3	42.9	41.0	35.8
NC value	NC 50	NC 65	NC 65	NC 60	NC 50	NC 45	NC 45	NC 40

The highest of these is the 125Hz band with an NC value of 65 and therefore the overall NC for this measurement is NC 65.

## 2 Using an optimus sound level meter to measure NR & NC Curves

The following optimus sound level meters have the function to automatically calculate the NR and NC values from an octave band measurement:

- CR:162D Class 2 Optimus Red Sound Level Meter
- CR:161D Class 1 Optimus Red Sound Level Meter
  
- CR:172A Class 2 Optimus Green Sound Level Meter
- CR:171A Class 1 Optimus Green Sound Level Meter
- CR:172B Class 2 Optimus Green Sound Level Meter
- CR:171B Class 1 Optimus Green Sound Level Meter
- CR:172C Class 2 Optimus Green Sound Level Meter
- CR:171C Class 1 Optimus Green Sound Level Meter

To calculate the NR & NC data, make a measurement with any of the optimus sound level meters listed above. The optimus instruments will automatically measure all available parameters so the instrument does not need to be set to a specific screen or function.

At the end of the measurement, the optimus will use the 1:1 octave band data and the stored NR & NC curve data to calculate the overall NR & NC values and also to plot the NR & NC Curves on screen.

**Please note that the NR & NC values and curves are only available after the measurement has been stopped and are not available when the instrument is running.**

To view the NR & NC data, move to the Octave Review screen and select the following screens by pressing the up or down keys.

- Screen 5 displays the calculated NR & NC values with the highest 1:1 octave band indicated
- Screen 6 displayed the NR Curves
- Screen 7 displays the NC Curves

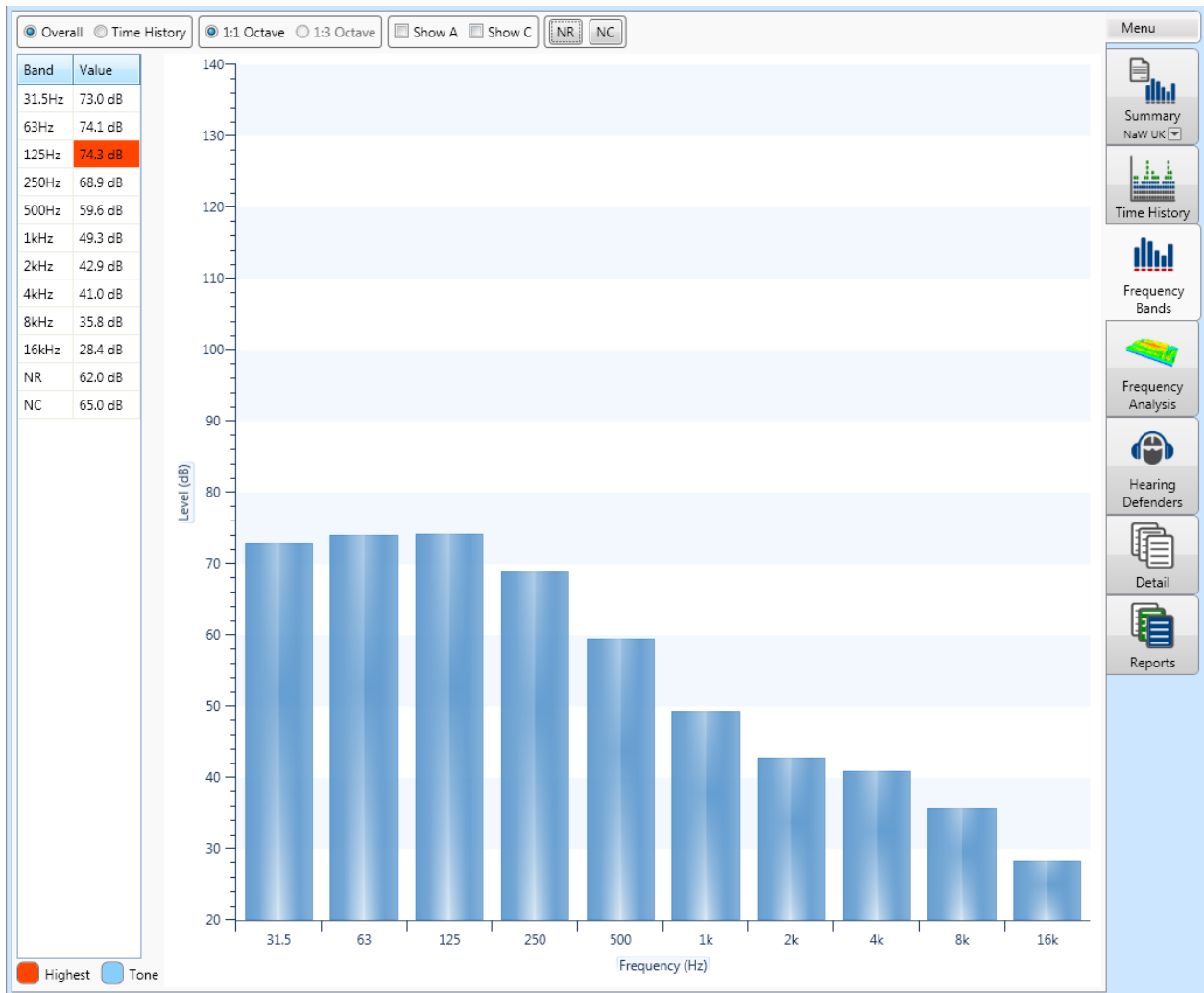
## 3 Calculation of NR & NC values in the NoiseTools software

The NoiseTools software that is supplied with the optimus sound level meters can calculate the NR & NC values and curves from 1:1 octave band data.

This allows the NR & NC values to be calculated from data from the optimus instruments listed in section 2 above as well as the CR:162C and CR:161C versions.

To view the NR & NC values, switch to the Frequency Bands tab and select the 1:1 Octave as shown below:





The overall NR & NC values are shown at the bottom of the table on the left side. The highest 1:1 octave band is highlighted in red as shown above.

In this example, the NR value is 62 and the NC value is 65. This is the same as shown on the screen of the optimus at the end of the measurement (as described in section 2 above).

To view the NR curves, click the NR box at the top of the screen as shown below.

The NoiseTools software will overlay the NR curves onto the 1:1 octave bands.



To view the NC curves, click the NC box at the top of the screen as shown below. NoiseTools will overlay the NC curves onto the 1:1 octave bands.



## 4 Reference Data

The following pages contain the tabular data for the NR & NC Curves and the graphs which can be used to plot the octave band data.

### 4.1 NR Table

NR	Octave Band Centre Frequency (Hz)							
	63.0	125.0	250.0	500.0	1000.0	2000.0	4000.0	8000.0
NR 75	94.70	87.20	81.70	77.90	75.00	72.60	70.80	69.10
NR74	93.90	86.30	80.80	76.90	74.00	71.60	69.80	68.20
NR 73	93.10	85.50	79.90	75.90	73.00	70.60	68.80	67.20
NR 72	92.40	84.60	78.90	75.00	72.00	69.50	67.70	66.10
NR 71	91.60	83.80	78.00	74.00	71.00	68.50	66.70	65.10
NR 70	90.80	82.90	77.10	73.00	70.00	67.50	65.70	64.10
NR69	90.00	82.00	76.20	72.00	69.00	66.50	64.70	63.10
NR68	89.20	81.10	75.20	71.00	68.00	65.50	63.60	62.00
NR67	88.40	80.30	74.30	70.10	67.00	64.50	62.60	61.00
NR66	87.60	79.40	73.30	69.10	66.00	63.50	61.50	59.90
NR65	86.80	78.50	72.40	68.10	65.00	62.50	60.50	58.90
NR64	86.00	77.60	71.50	67.10	64.00	61.50	59.50	57.90
NR63	85.20	76.80	70.60	66.10	63.00	60.50	58.50	56.90
NR62	84.50	75.90	69.60	65.20	62.00	59.40	57.40	55.80
NR61	83.70	75.10	68.70	64.20	61.00	58.40	56.40	54.80
NR60	82.90	74.20	67.80	63.20	60.00	57.40	55.40	53.80
NR59	82.10	73.30	66.90	62.20	59.00	56.40	54.40	52.80
NR58	81.30	72.40	65.90	61.30	58.00	55.40	53.40	51.70
NR57	80.50	71.60	65.00	60.30	57.00	54.30	52.30	50.70
NR56	79.70	70.70	64.00	59.40	56.00	53.30	51.30	49.60
NR55	78.90	69.80	63.10	58.40	55.00	52.30	50.30	48.60
NR54	78.10	68.90	62.20	57.40	54.00	51.30	49.30	47.60
NR53	77.30	68.10	61.30	56.40	53.00	50.30	48.30	46.60
NR52	76.60	67.20	60.30	55.50	52.00	49.20	47.20	45.50
NR51	75.80	66.40	59.40	54.50	51.00	48.20	46.20	44.50
NR50	75.00	65.50	58.50	53.50	50.00	47.20	45.20	43.50
NR49	74.20	64.60	57.50	52.50	49.00	46.20	44.20	42.50
NR48	73.40	63.70	56.50	51.50	48.00	45.20	43.10	41.40
NR47	72.60	62.90	55.60	50.60	47.00	44.20	42.10	40.40
NR46	71.80	62.00	54.60	49.60	46.00	43.20	41.00	39.30
NR45	71.00	61.10	53.60	48.60	45.00	42.20	40.00	38.30
NR44	70.20	60.20	52.70	47.60	44.00	41.20	39.00	37.30
NR43	69.40	59.40	51.80	46.70	43.00	40.20	38.00	36.30
NR42	68.70	58.50	51.00	45.70	42.00	39.10	36.90	35.20
NR41	67.90	57.70	50.10	44.80	41.00	38.10	35.90	34.20
NR40	67.10	56.80	49.20	43.80	40.00	37.10	34.90	33.20
NR39	66.30	55.90	48.30	42.80	39.00	36.10	33.90	32.20

NR38	65.50	55.00	47.30	41.80	38.00	35.10	32.90	31.10
NR37	64.70	54.20	46.40	40.90	37.00	34.00	31.80	30.10
NR36	63.90	53.30	45.40	39.90	36.00	33.00	30.80	29.00
NR35	63.10	52.40	44.50	38.90	35.00	32.00	29.80	28.00
NR34	62.30	51.50	43.60	37.90	34.00	31.00	28.80	27.00
NR33	61.50	50.70	42.70	36.90	33.00	30.00	27.80	26.00
NR32	60.80	49.80	41.70	36.00	32.00	28.90	26.70	24.90
NR31	60.00	49.00	40.80	35.00	31.00	27.90	25.70	23.90
NR30	59.20	48.10	39.90	34.00	30.00	26.90	24.70	22.90
NR29	58.40	47.20	39.00	33.00	29.00	25.90	23.70	21.90
NR28	57.60	46.30	38.00	32.10	28.00	24.90	22.60	20.80
NR27	56.80	45.50	37.10	31.10	27.00	23.90	21.60	19.80
NR26	56.00	44.60	36.10	30.20	26.00	22.90	20.50	18.70
NR25	55.20	43.70	35.20	29.20	25.00	21.90	19.50	17.70
NR24	54.40	42.80	34.30	28.20	24.00	20.90	18.50	16.70
NR23	53.60	42.00	33.40	27.20	23.00	19.90	17.50	15.70
NR22	52.90	41.10	32.40	26.30	22.00	18.80	16.40	14.60
NR21	52.10	40.30	31.50	25.30	21.00	17.80	15.40	13.60
NR20	51.30	39.40	30.60	24.30	20.00	16.80	14.40	12.60
NR 19	50.50	38.50	29.70	23.30	19.00	15.80	13.40	11.60
NR 18	49.70	37.60	28.70	22.30	18.00	14.80	12.40	10.50
NR 17	48.90	36.80	27.80	21.40	17.00	13.70	11.30	9.50
NR16	48.10	35.90	26.80	20.40	16.00	12.70	10.30	8.40
NR 15	47.30	35.00	25.90	19.40	15.00	11.70	9.30	7.40
NR14	46.50	34.10	25.00	18.40	14.00	10.70	8.30	6.40
NR13	45.70	33.30	24.10	17.40	13.00	9.70	7.30	5.40
N12	45.00	32.40	23.10	16.50	12.00	8.60	6.20	4.30
NR11	44.20	31.60	22.20	15.50	11.00	7.60	5.20	3.30
NR10	43.40	30.70	21.30	14.50	10.00	6.60	4.20	2.30
NR9	42.60	29.80	20.40	13.50	9.00	5.60	3.20	1.30
NR8	41.80	29.00	19.40	12.50	8.00	4.60	2.10	0.20
NR7	41.00	28.10	18.50	11.50	7.00	3.60	1.10	-0.80
NR6	40.20	27.20	17.60	10.50	6.00	2.60	0.10	-1.80
NR5	39.40	26.40	16.70	9.50	5.00	1.60	-1.00	-2.90

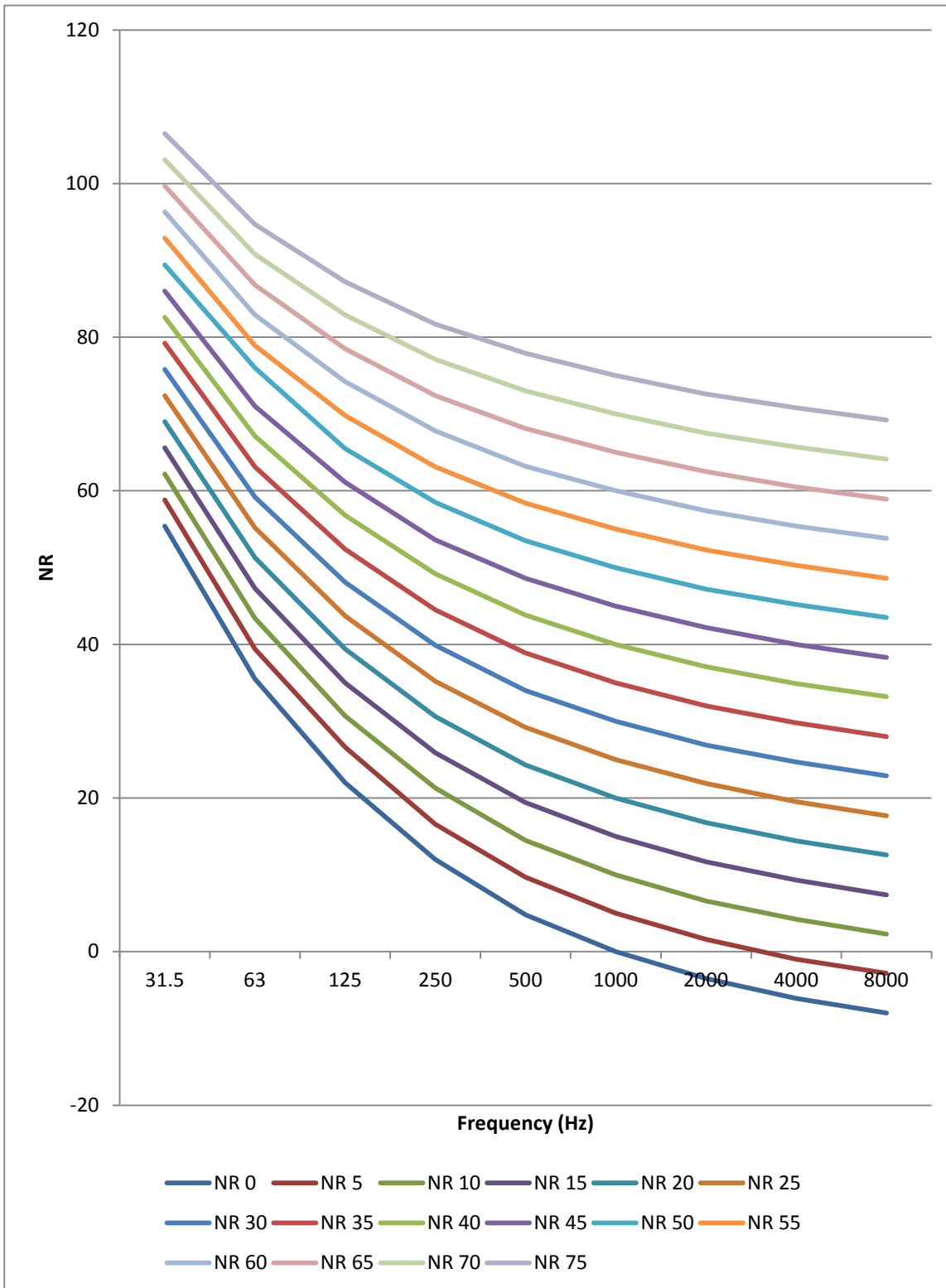
From ISO/R 1996:1971

## 4.2 NC Table

Criteria	Octave Band Numbers							
	63	125	250	500	1000	2000	4000	8000
NC 20	51	41	33	26	22	19	17	16
NC 25	54	45	38	31	27	24	22	21
NC 30	57	48	41	35	31	29	28	27
NC 35	60	53	46	40	36	34	33	32
NC 40	64	57	51	45	41	39	38	37
NC 45	67	60	54	49	46	44	43	42
NC 50	71	64	59	54	51	49	48	47
NC 55	74	67	62	58	56	54	53	52
NC 60	77	71	67	63	61	59	58	57
NC 65	80	75	71	68	66	64	63	62
NC 70	83	79	75	72	71	70	69	68

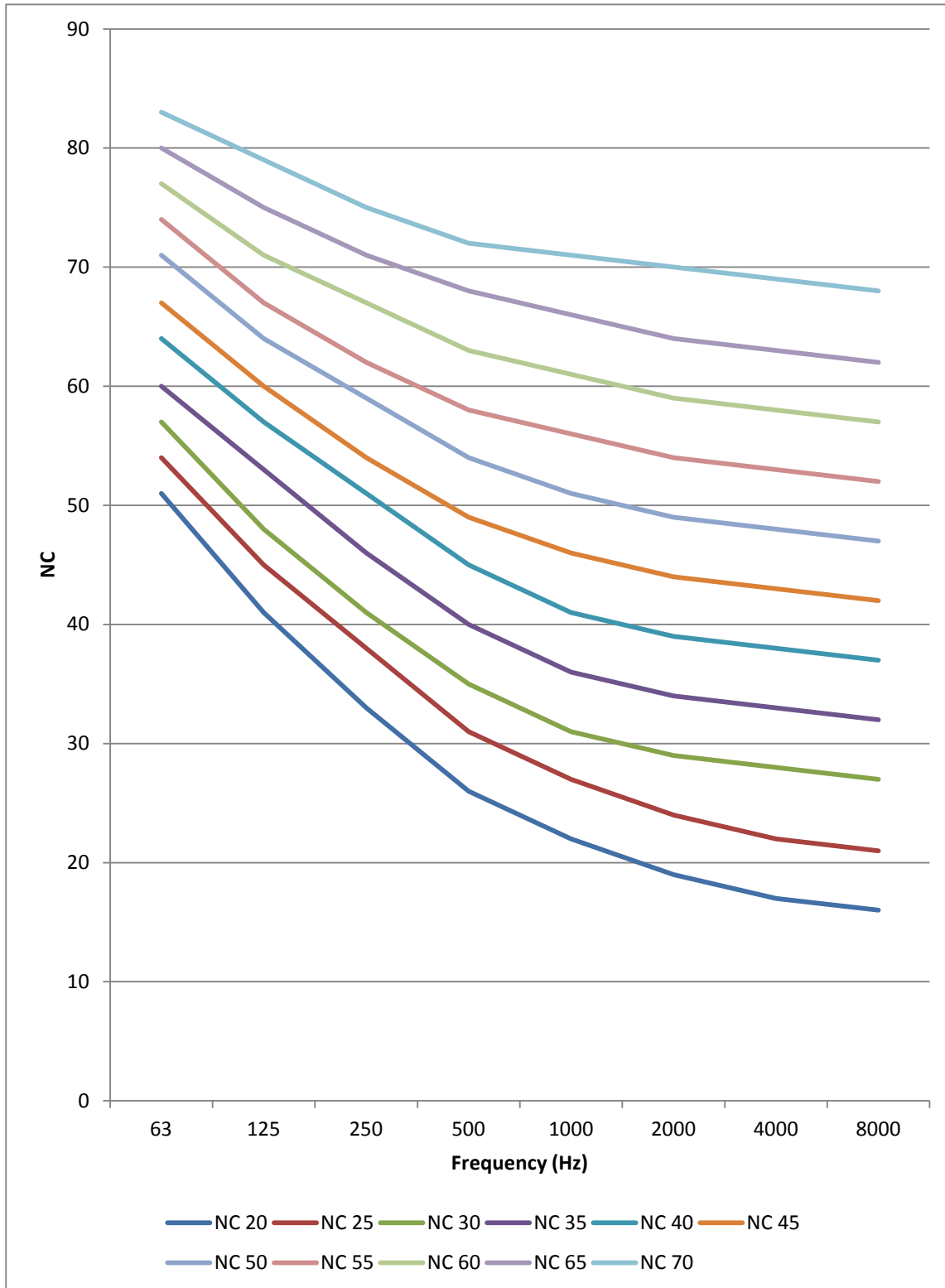
From Beranek, L.L., "Revised criteria for noise in buildings." Noise Control 3, 19-27 (1957).

# NR Curves



From ISO/R 1996:1971

### 4.3 NC Curves



From Beranek, L.L., "Revised criteria for noise in buildings." Noise Control 3, 19-27 (1957).

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### Main Office

Cirrus Research plc  
Acoustic House  
Bridlington Road  
Hunmanby  
North Yorkshire  
United Kingdom  
YO14 0PH

Telephone: +44 (0)1723 891655  
Fax: +44 (0)1723 891742  
E-mail: [sales@cirrusresearch.co.uk](mailto:sales@cirrusresearch.co.uk)  
Web Site: [www.cirrusresearch.co.uk](http://www.cirrusresearch.co.uk)

### Germany

Cirrus Research plc Deutschland  
Arabella Center  
Lyoner Strasse 44 – 48  
D-60528 Frankfurt  
Germany  
Tel: +49 (0)69 95932047  
Fax: +49 (0)69 95932049  
E-mail: [vertrieb@cirrusresearch.de](mailto:vertrieb@cirrusresearch.de)  
Website: [www.cirrusresearch.de](http://www.cirrusresearch.de)

### Spain

Cirrus Research SL  
Travesera de Gràcia, 62 4o 7a  
Barcelona  
España  
Teléfono: (+34) 93 362 28 91  
E-mail: [info@cirrusresearch.es](mailto:info@cirrusresearch.es)  
Web: [www.cirrusresearch.es](http://www.cirrusresearch.es)

### France

Cirrus Recherche Ltd  
40 Bis Avenue Gabriel Fauré  
09500 Mirepoix  
France  
Tel: +33 5 61 67 40 01  
Fax: +33 5 61 67 40 56  
Email: [sales@cirrusresearch.fr](mailto:sales@cirrusresearch.fr)  
Web: [www.cirrusresearch.fr](http://www.cirrusresearch.fr)

### Cirrus Environmental

Unit 2 Bridlington Road Industrial Estate  
Hunmanby  
North Yorkshire  
YO14 0PH  
United Kingdom

Tel: +44 (0) 1723 891722  
Email: [sales@cirrus-environmental.com](mailto:sales@cirrus-environmental.com)  
Web: [www.cirrus-environmental.com](http://www.cirrus-environmental.com)