## INCE Classification of Subjects in Noise Control Engineering

Below is the classification system (version 7.0) used by the Institute of Noise Control Engineering of the USA (INCE/USA) and the International Institute of Noise Control Engineering (I-INCE). An explanation of this classification system appeared in *Noise/News International,* **2,** 12-24, March 1994.

# GENERAL

## 01 International INCE

- 01.1 INCE/USA (US)
- 01.2 Acoustical Society of Denmark (DK)
- 01.3 Acoustical Society of Norway (NO)
- 01.4 Acoustical Society of Japan (JP)
- 01.5 Schweizerische Gesellschaft fuer Akustik (CH)
- 01.6 Acoustical Society of America (US)
- 01.7 Normenauschuss Akustik, Laermminderung & Schwingungstechnik (DE)
- 01.8 South African Acoustics Institute (ZA)
- 01.9 Australian Acoustical Society (AU)

## 02 International INCE (continued)

- 02.1 The Institute of Noise Control Engineering of Japan (JP)
- 02.2 Nederlands Akoestisch Genootshap (NL)
- 02.3 Committee on Acoustics of the Polish Academy of Sciences (PL)
- 02.4 Canadian Acoustical Association (CA)
- 02.5 Acoustical Commission of the Hungarian Academy of Sciences (HU)
- 02.6 Association Belge des Acousticiens (BE)
- 02.7 Acoustical Commission of the Romanian Academy of Sciences (RO)
- 02.8 Acoustical Society of Sweden (SE)
- 02.9 Institute of Acoustics, United Kingdom (GB)

## 03 International INCE (continued)

- 03.1 Acoustical Society of China (CN)
- 03.2 Acoustical Society of Finland (FI)
- 03.3 Acoustical Society of Korea (KR)
- 03.4 Associazione Italiana di Acoustica (IT)
- 03.5 Osterreichischer Arbeitsring fuer Laermbekaempfung (AT)
- 03.6 Noise Section, Environmental Engineering Society Singapore (SG)
- 03.7 Groupe Acoustique Industrielle et Environnement (FR)
- 03.8 Sociedade Brasileira de Acustica (BR)
- 03.9 New Zealand Acoustical Society (NZ)

## 04 International INCE (continued)

- 04.1 Hungarian Society for Optics, Acoustics and Filmtechnics (HU)
- 04.2 East European Acoustical Association
- 04.3 Deutche Gesellschaft fuer Akustik (DE)
- 04.4 Lithuanian Acoustical Society

## 05 Publications (other than technical articles)

- 05.1 Books
- 05.2 Book reviews

05.3 Editorials
05.4 Announcements and calendars
05.5 Biographical and personal notes
05.6 Bibliographies
05.7 Patents
05.8 Errata and addenda

**06 History and philosophy**

**07 Education**

**08 Noise programs**

08.1 National governments
08.2 State governments
08.3 Local governments
08.4 Universities
08.5 Industries
08.6 Trade associations

**09 Definitions and descriptors**

## EMISSION: NOISE SOURCES (Noise generation and control)

**10 General**

**11 Noise-generating devices (including components and subassembles)**

11.1 Mechanical devices (noise generated mechanically)
*11.1.1 Bearings*
*11.1.2 Cams*
*11.1.3 Gears*
*11.1.4 Belts and belt pulleys*
*11.1.5 Drive trains*
*11.1.6 Stepping mechanisms*
*11.1.7 Clutches*
*11.1.8 Actuators*
*11.1.9 Chains*

11.2 Electrical elements (noise generated electrically)
*11.2.1 Resistors, capacitors, inductors, diodes*
*11.2.2 Transformers*
*11.2.3 Ballasts*
*11.2.4 Solenoids*
*11.2.5 Switches*
*11.2.6 Circuit breakers*

11.3 Hydraulic/pneumatic elements
*11.3.1 Valves*
*11.3.2 Orifices and nozzles*
*11.3.3 Piping*

11.4 Air-moving and distribution devices
*11.4.1 Axial fans*
*11.4.2 Centrifugal blowers*

*11.4.3 Mixed-flow devices*
*11.4.4 Diffusers and grilles*
*11.4.5 Dampers*
11.5 Electric power devices
*11.5.1 Electric motors*
*11.5.2 Electric generators*
*11.5.3 Power supplies*
11.6 Other power devices
*11.6.1 Air motors*
*11.6.2 Compressors (air, gas, vapor)*
*11.6.3 Pumps (oil, water, other liquids)*
*11.6.4 Engines*
*11.6.5 Gas and steam turbines*
*11.6.6 Power transmissions*
11.7 Rolling contact noise sources
*11.7.1 Tires and road-tire interactions*
*11.7.2 Metal wheels and wheel-rail interactions*
*11.7.3 Rollers*
11.8 Stick-slip motional noise sources
*11.8.1 Brake squeal*
*11.8.2 Clutch squeal*
*11.8.9 Other friction squeal sources*
11.9 Signaling devices
*11.9.1 Bells*
*11.9.2 Horns*
*11.9.3 Whistles*
*11.9.4 Sirens*
*11.9.5 Fog horns*
*11.9.6 Impulsive devices*
*11.9.9 Other warning devices*

## 12 Stationary noise sources

12.1 Large equipment (indoor and outdoor; major source dimension greater than 1 meter)
*12.1.1 Electric power transformers*
*12.1.2 Cooling towers and heat exchangers*
*12.1.3 Chillers*
*12.1.4 Motors and generators*
*12.1.5 Primary power sources (diesel engines, gas turbines)*
*12.1.6 Furnaces, burners, boilers and incinerators*
*12.1.7 Stacks and flares*
*12.1.8 Large rotating electrical equipment*
12.2 Construction and demolition equipment (stationary)
*12.2.1 Pneumatic and hydraulic tools*
*12.2.2 Air compressors*
*12.2.3 Pile drivers*
*12.2.4 Concrete mixers*

13.2 Highway vehicles
*13.2.1 Automobiles*
*13.2.2 Motorcycles*
*13.2.3 Buses*
*13.2.4 Trucks*
*13.2.5 Recreational vehicles*
*13.2.6 Snow plows and snow removal equipment*
13.3 Off-road vehicles
*13.3.1 Snowmobiles*
*13.3.2 All terrain vehicles*
*13.3.3 Motorcycles*
*13.3.4 Snow cats*
*13.3.5 Modified automobiles*
*13.3.6 Racing vehicles*
13.4 Railbound vehicles
*13.4.1 Railway trains (locomotives, coaches, freight cars)*
*13.4.2 Underground and elevated trains*
*13.4.3 Street rail vehicles (streetcars, trams, etc.)*
*13.4.4 Monorails*
13.5 Ships and marine vehicles
*13.5.1 Craft for inland waterways, including pleasure boats*
*13.5.2 Transoceanic vessels*
*13.5.3 Recreational water craft*
*13.5.4 Hovercraft, hydrofoils, and surface effect vehicles*
13.6 Small engine-powered equipment
*13.6.1 Lawn mowers*
*13.6.2 Agricultural and garden care equipment*
*13.6.3 Snow blowers*
*13.6.4 Leaf blowers*
*13.6.5 Shredders/grinders*
*13.6.6 Log splitters*
*13.6.7 Electric-powered equipment*
13.7 Large engine-powered mobile equipment (non-highway)
*13.7.1 Construction and earth-moving equipment*
*13.7.2 Materials handling equipment*
13.8 Sources inside moving vehicles, including ships and aircraft
13.9 Spacecraft

## 14 Specialized industrial machinery and equipment

14.1 Machinery used in manufacturing industries
*14.1.1 Tobacco processing (SIC 21)*
*14.1.2 Textile mills (SIC 22)*
*14.1.3 Apparel and related products (SIC 23)*
*14.1.4 Lumber and wood products (SIC 24)*
*14.1.5 Furniture and fixtures (SIC 25)*
*14.1.6 Paper and allied products (SIC 26)*
*14.1.7 Printing and publishing (SIC 27)*

*21.3.3 Cavitation*
*21.3.4 Blast waves*
*21.3.5 Transient or impulsive noise*
*21.3.6 Noise from weapons*
21.4 Resonance, standing waves and normal modes (also 25.1)
*21.4.1 Vibrating air columns (one-dimensional)*
21.5 Interaction of a moving solid with a fluid
*21.5.1 Movement of solid body through fluid*
21.6 Flow noise, aerodynamic sound
*21.6.1 Produced by jets*
*21.6.2 Blade slap and blade-vortex interactions*
*21.6.3 Blade vortex interactions*
*21.6.4 Produced by turbulence; ingestion and boundary layers*
*21.6.5 Produced by fluid-boundary interactions*
*21.6.6 Flow-induced noise generation in ducts and pipes*
*21.6.7 Supersonic flow, shock waves, sonic booms*
*21.6.8 Nonlinear effects*
*21.6.9 Cavities*
21.7 Vibration excitation by mechanical and electrical sources
21.8 Non-audible sounds
*21.8.1 Infrasonic sound*
*21.8.2 Ultrasonic sound*

## 22 Natural sources of noise

22.1 Rain storms, including thunderstorms
22.2 Waterfalls and streams
22.3 Wind
22.4 Waves
22.5 Surf
22.6 Animate sources
*22.6.1 Birds*
*22.6.2 Insects*
*22.6.3 Barking dogs*
22.7 Other

## 23 Propagation, transmission & scattering of sound (general wave equation)

23.1 Radiating surfaces
23.2 Reflection and echoes
23.3 Refraction and focusing
23.4 Diffraction
23.5 Interference
23.6 Scattering
23.7 Reverberation
23.8 Directivity
23.9 Transmission

## 24 Sound propagation in the atmosphere

24.1 Divergence decrease

24.2 Absorption (attenuation) of sound in air
24.3 Effects of fog and precipitation
24.4 Reflection by and diffraction around obstacles
24.5 Topographical factors; effects of grass, shrubs and trees
24.6 Meteorological factors; effects of wind, temperature and humidity
24.7 Scattering by small-scale temperature and wind variations
24.8 Reflection and absorption at small angles over a ground surface
24.9 Effects of ground impedance and height above ground level

**25 Sound propagation in enclosed spaces**

25.1 Standing waves and normal modes
25.2 Steady-state response
25.3 Diffusivity
25.4 Reverberation and echoes
25.5 Decrease with distance from the source

**26 Sound propagation in ducts or pipes**

26.1 General theory of propagation in ducts or pipes
*26.1.1 Without fluid flow*
*26.1.2 With fluid flow*
*26.1.3 With hard, non-absorbing surfaces*
*26.1.4 With absorptive surfaces*
26.2 Radiation from duct terminations

## NOISE CONTROL ELEMENTS (for path noise control)

**30 General**

**31 Barriers and screens, shielding**

31.1 Outdoors
31.2 Partial-height partitions indoors
*31.2.1 Barriers in industrial halls*
*31.2.2 Barriers in open-plan offices*

**32 Enclosures for noise sources**

32.1 Sound absorptive materials in enclosures
32.2 Wall construction
32.3 Isolation of plumbing and other wall penetrations
32.4 Ventilation openings
32.5 Doors and access openings
32.6 Windows

**33 Sound isolating elements (including panels, partitions and curtains)**

**34 Filters, mufflers, silencers and resonators (conventional types)**

34.1 Dissipative type
34.2 Reactive type
34.3 Helmholtz resonators

**35 Absorptive materials**

35.1 Mechanisms of absorption - theory
35.2 Physical properties

*38.5.1 Smart structures*
*38.5.2 Material tailoring*
38.6 Seals for openings
*38.6.1 Absorptive seals (absorptive linings around openings)*
*38.6.2 Sealing cements, plastic & rubber mastics, foams, etc.*
*38.6.3 Sealing tapes and caulking materials*
*38.6.4 Foam and rubber ribbons and profiles*

# VIBRATION AND SHOCK: GENERATION, TRANSMISSION, ISOLATION AND REDUCTION

## 40 General

## 41 Characteristics of sources of vibration and shock

41.1 Periodic vibration, sinusoidal
41.2 Stationary random vibration
41.3 Transients and shocks, impacts
41.4 Non-stationary random vibration
41.5 Nonlinear vibrations

## 42 Vibrating surfaces and structures (beams, plates, shells)

## 43 Propagation in structures (solid-borne noise)

43.1 Decrease due to spreading
43.2 Transmission and attenuation in solid structures
*43.2.1 Mechanical constructions (internal damping)*
*43.2.2 Buildings, civil engineering constructions*
*43.2.3 Earth (geoacoustics)*
*43.2.4 Foundations/soil interactions*
43.3 Reflections and interference
43.4 Vibration breaks
43.5 Structural intensity

## 44 Balancing of rotating and reciprocating machines

## 45 Reduction of impact forces; shock isolation and absorption

## 46 Vibration isolators and attenuators

46.1 Theories of vibration isolation and isolators
46.2 Vibration isolators
46.3 Foundation analysis and design
46.4 Active vibration control

## 47 Vibration-damping materials and structures

47.1 Mechanisms of damping - theory
47.2 Constrained layer damping
47.3 Damping of structures and panels
47.4 Dynamic absorbers

## 48 Vibration generators, shake tables

## 49 Effects of vibration and mechanical shock (on man, on structures)

49.1 On man

49.2 On structures and machines
*49.2.1 Vibration induced effects*
*49.2.2 Noise induced effects*
*49.2.3 Designs to withstand high noise levels*
49.3 Criteria
*49.3.1 Criteria for vibration of human body and organs*
*49.3.2 Criteria for machine vibrations*
*49.3.3 Criteria for shock in transportation of goods*
49.4 In buildings

# IMMISSION: PHYSICAL ASPECTS OF ENVIRONMENTAL NOISE (Multiple sources and multiple paths)

## 50 General

## 51 Building noise control

51.1 Sound fields in rooms and enclosed spaces
5*1.1.1 Industrial halls and plants*
*51.1.2 Concert or other halls for audiences or performances*
*51.1.3 Special spaces (corridors etc).*
*51.1.4 Classrooms*
*51.1.5 Hospitals*
*51.1.6 Churches*
51.2 Reduction of noise levels by increased absorption
51.3 Sound transmission thru windows, doors, walls, ceilings, floors
51.4 Sound-insulating structures, transmission coefficients and transmission loss
51.5 Flanking and impact transmission
51.6 Heating, ventilating and air conditioning (HVAC) systems
51.7 Landscaped (open plan) offices and lobbies
51.8 Elevators and escalators
51.9 Plumbing and piping noise

## 52 Community noise control

52.1 Community noise levels
52.2 Airport noise
*52.2.1 Commercial airports*
*52.2.2 Military airfields*
*52.2.3 General aviation airports*
*52.2.4 Heliports*
*52.2.5 Police*
*52.2.6 Hospitals*
*52.2.7 Military*
52.3 Road traffic noise
52.4 Rail vehicle noise
52.5 Industrial noise (incl. noise around plants and power stations)
52.6 Construction noise

52.7 Sport and recreation areas and events
52.8 Residential area noise due to lawn mowers, air conditioners, etc
52.9 Planning for noise control, zoning, land use and urban planning
*52.9.1 Ambient sound levels*

**53 In-plant noise control**
53.1 In-plant noise levels
53.2 Exposures of workers
53.3 Planning, design and construction for noise control
53.4 Booths and control rooms

**54 Shipboard and offshore platform noise control**
54.1 Noise control in ship spaces
54.2 Noise control on offshore platforms
54.3 Underwater noise

**55 Outdoor plant noise control design and construction**

**56 Noise surveys**
56.1 Outdoors
56.2 Indoors
56.3 Soundscapes

# IMMISSION: EFFECTS OF NOISE

**60 General**

**61 Perception of sound**
61.1 Biomechanics of the ear
61.2 Theories of hearing
61.3 Hearing levels and hearing thresholds of populations
61.4 Presbycusis and sociocusis
61.5 Critical bandwidths, masking
61.6 Just noticeable differences
61.7 Head-related transfer function

**62 Physiological effects**
62.1 Hearing loss (temporary and permanent threshold shifts)
62.2 Extra-auditory effects (fatigue, blood pressure, heart rate)
62.3 Hearing conservation programs
62.4 Workers compensation; liability for hearing loss
62.5 Effects of noise on health

**63 Psychological effects**
63.1 Loudness
63.2 Perceived noisiness, annoyance
63.3 Speech intelligibility and interference, speech levels, speech communication
63.4 Sleep disturbance
63.5 Work interference and efficiency
63.6 Infrasonic noise
63.7 Sound quality

**64 Effects of noise on physical structures**

71.5 Waveform or frequency analyzers
71.6 Filters, analog and digital
71.7 Indicating devices
71.8 Data acquisition systems, recorders and data storage devices
71.9 Calibration; acoustical and electrical performance verification

## 72 Measurement techniques

72.1 Sound pressure level
72.2 Vibration level
*72.2.1 Surface contact methods*
*72.2.2 Non-contact methods (laser interferometry, holography)*
*72.2.3 Power flow*
72.3 Sound intensity
72.4 Sound power
72.5 Transmission loss
72.6 Reverberation time
72.7 Measurement of properties of materials
*72.7.1 Sound absorption*
*72.7.2 Acoustic impedance*
*72.7.3 Flow resistance; effect of airflow rate*
*72.7.4 Density*
*72.7.5 Porosity*
*72.7.6 Elasticity of structures*
*72.7.7 Propagation constants*
*72.7.8 Structure factor*
*72.7.9 Non-acoustical properties*
72.8 Impulsive noise measurements
72.9 Measurements of other quantities

## 73 Test facilities (design and qualification)

73.1 Free-field (anechoic rooms)
73.2 Free-field over a reflecting plane (hemi-anechoic rooms)
73.3 Reverberation rooms (diffuse field)
73.4 Outdoor test sites
73.5 Laboratory facilities (design and construction)
73.6 Other test environments (indoor and outdoors)
73.7 Scale models

## 74 Signal processing

74.1 Correlation and coherence analysis
74.2 Bursts and impulsive sounds
74.3 Digital processing and simulation
74.4 Automated data processing and reduction
74.5 Diagnosis and failure prediction
74.6 Source localization and transmission paths
74.7 Processing by microphone arrays
74.8 Frequency domain and spectral analysis
74.9 Other signal processing techniques

## 75 Methods of mathematical modeling

75.1 Statistical methods
75.2 Statistical energy analysis (SEA)
75.3 Finite element methods (FEM) and computation fluid models (CFM)
75.4 Computer algorithms including computer aided design
75.5 Boundary element methods (BEM)
75.6 Modal analysis
75.7 Imaging of acoustical and vibrational fields (holography, etc.)
75.8 Wave vector analysis
75.9 Analytical models

**76 Modeling, prediction and simulation**

76.1 Propagation models, noise models
*76.1.1 Road traffic noise*
*76.1.2 Rail traffic noise*
*76.1.3 Noise in communities around airports*
*76.1.4 External industrial noise*
*76.1.5 Factory halls, sound level contours indoors*
*76.1.6 Concert halls*
*76.1.7 Sources of noise generation and emission*
76.2 Small scale modeling
76.3 Building foundation modeling
76.4 Computer software programs
76.9 Other modeling, prediction and simulation methods

**77 Sampling, quality control procedures and measurement uncertainty**

**78 Audiometry, dosimetry and hearing measurements**

78.1 Audiometry
78.2 Dosimeters
78.3 Hearing measurements
78.4 Hearing aids

**79 Psychoacoustical evaluations and testing**

79.1 Speech quality
79.2 Preference testing
79.2 Small scale modeling
79.3 Building foundation modeling
79.4 Computer software programs
79.9 Other modeling, prediction and simulation methods

# REQUIREMENTS

**80 General**

**81 Standards**

81.1 National standards
81.2 International standards
*81.2.1 International Organization for Standardization (ISO)*
*81.2.2 International Electrotechnical Commission (IEC)*
*81.2.9 Other international standards*