

Active sonar – Terminology

*How does the terminology used by the ICES community
compare to the 2017 international standard, ISO
18405?*



ICES
CIEM

International Council for
the Exploration of the Sea
Conseil International pour
l'Exploration de la Mer



International
Organization for
Standardization

Document revisions

Revision number	Date	Notes	Author(s)
1	21 st Apr 2021	Initial draft. Comparison of the most commonly used terms in MacLennan <i>et al.</i> (2002) with equivalent terms in Demer <i>et al.</i> (2015) and ISO (2017).	Toby Jarvis ¹
2	25 th Apr 2022	Comparison of more terms across MacLennan <i>et al.</i> (2002), Demer <i>et al.</i> (2015) and ISO (2017). For discussion during the 2022 ICES WGFAST meeting.	Toby Jarvis ¹

¹ Category A liaison between ICES WGFAST and ISO/TC43/SC3 (Apr 2020 – present)

Introduction

In the “fisheries acoustics” and related communities represented by the International Council for the Exploration of the Sea (ICES) Working Group on Fisheries Acoustics, Science and Technology (WGFAST), the popular contemporary reference texts for active-sonar terminology are assumed to be MacLennan *et al.* (2002) and Demer *et al.* (2015). Additional texts that may also be in use as terminology references include Urick (1983), ANSI (1994), Hall (1995), Simmonds and MacLennan (2005) and Ainslie (2015).

Since these texts were published, the International Organization for Standardization (ISO) has published the first edition of International Standard ISO 18405, entitled “Underwater acoustics – Terminology” (ISO 2017). It is therefore timely for WGFAST to review the terminology across the popular contemporary literature and ask,

1. Should the WGFAST community now endeavour to adhere to ISO 18405 (2017) rather than MacLennan *et al.* (2002) and/or Demer *et al.* (2015)?
2. Are there any additions, modifications, corrections or clarifications regarding ISO 18405 (2017) that WGFAST would like to request to ISO via the ICES-ISO liaison?
3. Is there anything about the ISO process that WGFAST would like to learn more about via the ICES-ISO liaison?

To facilitate discussion, this document provides,

- An overview of the current situation (in the remainder of this **Introduction** section)
- A tabulated comparison of the active-sonar terms and associated symbols and units between MacLennan *et al.* (2002), Demer *et al.* (2015) and ISO 18405 (2017) (in the section **Overview of terms, symbols and units by topic**)
- A preliminary analysis of the key similarities and differences between MacLennan *et al.* (2002), Demer *et al.* (2015) and ISO 18405 (2017) (in the section **Similarities and differences**)

Overview of ISO 18405

Ainslie *et al.* (2022) summarise ISO 18405 (2017) as follows,

- *The purpose of ISO 18405 ... is to provide a language for effective communication in underwater acoustics, whether to describe facts or opinions, hypotheses or theories, or any other concepts. Its adoption avoids the need to redefine basic terms ... each time these are used.*
- *ISO 18405 is based on the International System of Quantities (ISQ), which is described by the fourteen-part standard ISO/IEC 80000, of which **Part 3: Space and Time** ... was the most influential for the development of ISO 18405... Also relevant are ISO 80000-2:2009 **Mathematical Signs and Symbols to Be Used in the Natural Sciences and Technology** ..., ISO 80000-4:2006 **Mechanics** ..., and ISO 80000-8:2007 **Acoustics***
- **ISO 18405 is not a measurement standard:** *ISO 18405 provides conceptual definitions of physical quantities, independent of how these might be measured.*
- **ISO 18405 is not a processing standard:** *ISO 18405 provides conceptual definitions of processed quantities, independent of how the associated processing might be implemented.*
- **ISO 18405 is not a reporting standard:** *ISO 18405 provides conceptual definitions of physical or processed quantities, independent of how their values might be reported.*
- **ISO 18405 is not a repository of regulatory guidelines:** *ISO 18405 provides conceptual definitions of physical or processed quantities, but it does not provide guidance on acceptable values.*

Overview of terms, symbols and units by topic

The topics presented as sections below are based on the sections presented in ISO 18405 (2017).

General, logarithmic frequency intervals and other

MacLennan et al. (2002)	Demer et al. (2015)	ISO 18405 (2017)
	<ul style="list-style-type: none"> ▶ Acoustic frequency, f (Hz) ▶ Acoustic frequency bandwidth, b_f (Hz) ▶ Acoustic wavelength, λ (m) ▶ Acoustic wavenumber, k (m⁻¹) ▶ Range, r (m) ▶ Reference range, r_0 (m) ▶ Water temperature, t_w (°C) ▶ Water salinity, s_w (psu) ▶ Water depth, d_w (m) ▶ Water pressure, p_w (Pa) ▶ Water density, ρ_w (kg m⁻³) ▶ Water sound speed, c_w (m s⁻¹) ▶ Water acoustic impedance, z_{aw} (kg m⁻² s⁻¹) 	<ul style="list-style-type: none"> ▶ sound ▶ ambient sound ▶ soundscape ▶ reverberation ▶ material element / sound particle ▶ one-third octave / one-third octave (base 2) ▶ one-third octave (base 10) / decade (ddec) ▶ force impulse, J_F (N s) ▶ pressure impulse, J_p (Pa s) ▶ sound pressure variance, μ_2 (Pa²) ▶ sound pressure skewness, γ_1 (—) ▶ sound pressure kurtosis, β (—) ▶ characteristic acoustic impedance / characteristic specific acoustic impedance, Z_c (Pa s/m) ▶ specific acoustic impedance, z (Pa s/m) ▶ signal ▶ noise ▶ acoustic self-noise ▶ ambient noise ▶ (sound speed, c) ▶ (range, r) ▶ (frequency, f)

Field quantities and levels

MacLennan et al. (2002)	Demer et al. (2015)	ISO 18405 (2017)
	<ul style="list-style-type: none"> ▶ Acoustic pressure, p (Pa) ▶ Reference acoustic pressure, p_{ref} (Pa) 	<ul style="list-style-type: none"> ▶ sound pressure, p (Pa) ▶ sound pressure spectrum, P (Pa/Hz) ▶ zero-to-peak sound pressure, p_{0-pk} / peak sound pressure, p_{pk} (Pa) <ul style="list-style-type: none"> • zero-to-peak sound pressure level, $L_{p,0-pk}$ / peak sound pressure level, $L_{p,pk}$ (dB re 1 μPa for Δt and Δf) ▶ compressional pressure, p_c (Pa) ▶ peak compressional pressure, $p_{pk,c}$ (Pa) <ul style="list-style-type: none"> • peak compressional sound pressure level, $L_{p,pk,c}$ (dB re 1 μPa for Δt and Δf) ▶ rarefactional pressure, p_r (Pa) ▶ peak rarefactional pressure, $p_{pk,r}$ (Pa) <ul style="list-style-type: none"> • peak rarefactional sound pressure level, $L_{p,pk,r}$ (dB re 1 μPa for Δt and Δf) ▶ peak-to-peak sound pressure, p_{pk-pk} (Pa) ▶ sound particle displacement, δ (m) ▶ sound particle velocity, u (m/s) ▶ sound particle acceleration, a (m/s²)

Power quantities and levels

MacLennan et al. (2002)	Demer et al. (2015)	ISO 18405 (2017)
	<ul style="list-style-type: none"> ▶ Acoustic power, p_a (W) ▶ Acoustic intensity, i (W m^{-2}) ▶ Reference acoustic intensity, i_{ref} (W m^{-2}) 	<ul style="list-style-type: none"> ▶ mean-square sound pressure, p^2 (Pa^2) • mean-square sound pressure level / root-mean-square sound pressure level, $L_{p,rms}$ / sound pressure level (SPL), L_p (dB re $1 \mu\text{Pa}^2$ for Δt and Δf) ▶ mean-square sound particle displacement, δ^2 (m^2) • mean-square sound particle displacement level / root-mean square sound particle displacement level, $L_{\delta,rms}$ / sound particle displacement level (SDL), L_δ (dB re 1 pm^2 for Δt and Δf) ▶ mean-square sound particle velocity, u^2 [$(\text{m/s})^2$] • mean-square sound particle velocity level / root-mean square sound particle velocity level, $L_{u,rms}$ / sound particle velocity level (SVL), L_u (dB re $1 \text{ nm}^2/\text{s}^2$ for Δt and Δf) ▶ mean-square sound particle acceleration, a^2 [$(\text{m/s}^2)^2$] • mean-square sound particle acceleration level / root-mean square sound particle acceleration level / sound particle acceleration level (SAL), L_a (dB re $1 \mu\text{m}^2/\text{s}^4$ for Δt and Δf) ▶ time-integrated squared sound pressure / sound pressure exposure / sound exposure, $E_{p,T}$ ($\text{Pa}^2 \text{ s}$) • time-integrated squared sound pressure level / sound pressure exposure level / sound exposure level (SEL), $L_{E,p}$ (dB re $1 \mu\text{Pa}^2 \text{ s}$ for Δt and Δf) ▶ time-integrated squared sound particle displacement, $E_{\delta,T}$ ($\text{m}^2 \text{ s}$) • time-integrated squared sound particle displacement level, $L_{E,\delta}$ (dB re $1 \text{ pm}^2 \text{ s}$ for Δt and Δf) ▶ time-integrated squared sound particle velocity, $E_{u,T}$ [$(\text{m/s})^2 \text{ s}$] • time-integrated squared sound particle velocity level, $L_{E,u}$ (dB re $1 [\text{nm/s}]^2 \text{ s}$ for Δt and Δf)

MacLennan et al. (2002)	Demer et al. (2015)	ISO 18405 (2017)
		<ul style="list-style-type: none"> ▶ time-integrated squared sound particle acceleration, $E_{a,T}$ [(m/s²)² s] <ul style="list-style-type: none"> • time-integrated squared sound particle acceleration level, $L_{E,a}$ (dB re 1 [μm/s²]² s for Δt and Δf) ▶ sound exposure spectral density / sound pressure exposure spectral density, E_f (Pa² s/Hz) <ul style="list-style-type: none"> • sound exposure spectral density level, $L_{E,f}$ (dB re 1 μPa² s/Hz for Δt and Δf) ▶ sound intensity / instantaneous sound intensity / Umov vector / Poynting vector / Umov-Poynting vector, I (W/m²) ▶ time-averaged sound intensity, I_{av} (W/m²) ▶ equivalent plane wave sound intensity, I_{eq} (W/m²) ▶ mean-square sound pressure spectral density, $(\overline{p^2})_f$ (Pa²/Hz) <ul style="list-style-type: none"> • mean-square sound pressure spectral density level, $L_{p,f}$ (dB re 1 μPa²/Hz for Δt and Δf) ▶ sound power, $W(t)$ (W) ▶ time-averaged sound power, W_{av} (—)

Sound sources and levels

MacLennan et al. (2002)	Demer et al. (2015)	ISO 18405 (2017)
		<ul style="list-style-type: none"> ▶ acoustic far field ▶ far-field sound pressure ▶ acoustic centre ▶ source waveform, $s(t)$ (Pa m) ▶ sound exposure source factor / energy source factor, $F_{S,E}$ ($\text{Pa}^2 \text{m}^2 \text{s}$ for Δf) <ul style="list-style-type: none"> • sound exposure source level / energy source level (ESL), $L_{S,E}$ (dB re $1 \mu\text{Pa}^2 \text{m}^2 \text{s}$ for Δf) ▶ source factor, F_S ($\text{Pa}^2 \text{m}^2$ for Δt and Δf) <ul style="list-style-type: none"> • source level (SL), L_S (dB re $1 \mu\text{Pa}^2 \text{m}^2$ for Δt and Δf) ▶ surface-affected source waveform / far-field signature, s' (Pa m for t_0 and r) ▶ source spectrum, $S(f)$ (Pa m/Hz) ▶ surface-affected source spectrum, $S'(f)$ (Pa m/Hz)

Propagation

MacLennan et al. (2002)	Demer et al. (2015)	ISO 18405 (2017)
	<ul style="list-style-type: none"> ▶ Absorption loss, $-$ (m^{-1}) ▶ Absorption coefficient, α_a (dB m^{-1}) ▶ Spherical spreading loss, $-$ (m^{-2}) 	<ul style="list-style-type: none"> ▶ propagation factor, F_p (m^{-2} for Δt and Δf) ▶ sound exposure propagation factor / energy propagation factor, F_E (m^{-2} for Δf) ▶ transmission loss (TL), ΔL_{TL} (dB for a given level for Δt and Δf) ▶ propagation loss (PL), N_{PL} (dB re 1 m^2 for Δt and Δf) ▶ sound exposure propagation loss / energy propagation loss (EPL), $N_{\text{PL,E}}$ (dB re 1 m^2 for Δf)

Scattering quantities and levels (strengths)

The ISO scattering-related terms *sonar signal sound pressure / target echo*, *target echo level*, *equivalent target strength* and *target strength* have been moved here from the *Sonar equations* section below.

MacLennan et al. (2002)	Demer et al. (2015)	ISO 18405 (2017)
		<ul style="list-style-type: none"> ▶ sonar signal sound pressure / target echo <ul style="list-style-type: none"> • target echo level (EL), L_{TE} (dB re 1 μPa^2) • equivalent target strength (TS_{eq}), $N_{TS,eq}$ (dB re $r_0^2 = \text{dB re } 1 \text{ m}^2$) ▶ differential scattering cross section, $\sigma_{\Omega}(\theta_i, \phi_i; \theta_s, \phi_s)$ (m^2/sr) <ul style="list-style-type: none"> • target strength (TS), $N_{TS}(\theta_i, \phi_i; \theta_s, \phi_s)$ (dB re $1 \text{ m}^2 \text{ sr}^{-1}$) > monostatic target strength, $N_{TS}(\theta_i, \phi_i; \theta_i, \phi_i)$ (dB re $1 \text{ m}^2 \text{ sr}^{-1}$) ▶ total scattering cross section, $\sigma_t(\theta_i, \phi_i)$ (m^2) ▶ absorption cross section, σ_a (m^2) ▶ extinction cross section, σ_e (m^2) ▶ volume differential scattering cross section per unit volume, $\sigma_v(\theta_i, \phi_i; \theta_s, \phi_s)$ ($\text{m}^{-1} \text{ sr}^{-1}$) <ul style="list-style-type: none"> • volume scattering strength, $S_v(\theta_i, \phi_i; \theta_s, \phi_s)$ (dB re $1 \text{ m}^{-1} \text{ sr}^{-1}$) ▶ sea surface differential scattering cross section per unit area, $\sigma_s(\theta_i, \phi_i; \theta_s, \phi_s)$ (sr^{-1}) <ul style="list-style-type: none"> • sea surface scattering strength, $S_s(\theta_i, \phi_i; \theta_s, \phi_s)$ (dB re 1 sr^{-1}) ▶ sea bottom differential scattering cross section per unit area, $\sigma_b(\theta_i, \phi_i; \theta_s, \phi_s)$ (sr^{-1}) <ul style="list-style-type: none"> • sea bottom scattering strength, $S_b(\theta_i, \phi_i; \theta_s, \phi_s)$ (dB re 1 sr^{-1})

Sound signals

MacLennan et al. (2002)	Demer et al. (2015)	ISO 18405 (2017)
	<ul style="list-style-type: none"> ▶ Transmit voltage, u_{et} (V) ▶ Transmit current, i_{et} (A) ▶ Pulse duration, τ (s) ▶ Effective pulse duration, τ_{eff} (s) 	<ul style="list-style-type: none"> ▶ analytic signal, $q(t)$ (units dependent on signal) ▶ complex envelope, $\mu(t)$ (units dependent on analytic signal) ▶ effective signal duration, τ_{eff} (s) ▶ threshold exceedance signal duration, $\tau_{y, dB}$ (s) ▶ percentage energy signal duration, $\tau_{x\%}$ (s) ▶ effective signal bandwidth, ν_{eff} (Hz)

Sonar equations

The ISO scattering-related terms *sonar signal sound pressure / target echo*, *target echo level*, *equivalent target strength* and *target strength* have been moved to the **Scattering quantities and levels (strengths)** section above.

MacLennan et al. (2002)	Demer et al. (2015)	ISO 18405 (2017)
	<ul style="list-style-type: none"> ▶ Voltage, u_e (V) ▶ Current, i_e (A) ▶ Electrical impedance, z_e (Ω) ▶ Electrical power, p_e (W) 	<ul style="list-style-type: none"> ▶ sonar signal voltage ▶ sonar reverberation <ul style="list-style-type: none"> • reverberation level (RL), L_R (dB re 1 μPa^2) ▶ background noise / acoustic noise ▶ non-acoustic self-noise ▶ self-noise ▶ sonar noise voltage ▶ sonar signal-to-noise ratio, R_{SN} ▶ probability of detection, p_d ▶ probability of false alarm, p_{fa} ▶ noise detector output ▶ signal plus noise detector output ▶ detection index, d ▶ equivalent mean-square sonar noise sound pressure, $p_{N,eq}^2$ (Pa^2 for a specified frequency band) ▶ detection threshold (DT), ΔL_{DT} (dB) ▶ signal excess, ΔL_{SE} (dB) ▶ sonar equation <ul style="list-style-type: none"> • passive sonar equation • active sonar equation <ul style="list-style-type: none"> > reverberation-limited active sonar equation ▶ array gain (AG), ΔL_{AG} / directivity index (dB) ▶ sonar noise level, L_N (dB re 1 μPa^2 for a specified frequency band for the <i>sonar noise voltage</i>) ▶ sonar processing gain (PG), ΔL_{PG} (dB for a specified frequency band for the <i>sonar noise voltage</i>)

Similarities and differences

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Annex A: Why care about terminology?

From MacLennan *et al.* (2002),

In any scientific field it is essential to be clear about the definition of physical quantities and naming conventions. In the case of fisheries acoustics there has been a long-standing problem mainly due to confusing descriptions of the various scattering measures that are central to biological observations using sonars and echointegrators. With the growing importance of acoustic methods in remote biomass estimation, many practitioners agree that a more consistent approach to acoustical terminology must be adopted in fisheries applications.

From Demer *et al.* (2015),

The names, symbols, and units of physical quantities must be precisely defined to assure effective scientific communication. However, different fields of study, e.g. physics, electrical engineering, radar, and sonar, often use different terms and symbols, and the same symbols may be used for different things, even within the same field. Furthermore, people generally have preferences for specific terms and symbols. Because universal consistency is not achievable, the aim for terms and symbols in this document is to define them uniquely and use them consistently.

From ISO (2017),

Vocabulary is the most basic of subjects for standardization. Without an accepted standard for the definition of terminology, the production of scientific and engineering publications in a technical area, including the development of standards for measurement, processing or modelling in that area, becomes a laborious and time-consuming task that would ultimately result in the inefficient use of time and a high probability of misinterpretation.

From Ainslie (2015),

No self-respecting science – or scientist – would tolerate a factor of four uncertainty in the interpretation of a reported measurement or model prediction, arising from poorly defined terminology alone, so why do we?

A Parting Plea: Underwater acousticians, myself included, have a responsibility to provide a clear, concise, and unambiguous language with which to communicate results and ideas about our science. The sooner we provide that language, the sooner industry, governments, and scientists will start to benefit from its use. We must not let them wait a minute longer than is necessary.

From Ainslie *et al.* (2022),

Applications of underwater acoustics include sonar, communication, geophysical imaging, acoustical oceanography, and bioacoustics. Specialists typically work with little interdisciplinary interaction, and the terminology they employ has evolved separately in each discipline, to the point that transdisciplinary misunderstandings are common.

By adopting a common language, we facilitate the effective communication of concepts and information in underwater acoustics, whether for research, technology, or regulation. In the words of William H. Taft, “Don’t write so that you can be understood, write so that you can’t be misunderstood.”

Annex B: Terminology guidelines and approaches

From MacLennan *et al.* (2002),

The first requirement is to adopt a set of names which are unique for each quantity having a specific physical definition. Furthermore, quantities which are scaled by factors other than powers of 10 should have different names, like degrees and radians in the case of angles. Given a non-confusing and widely accepted set of names, the symbols are less of a problem, or at least those which have dimensions. In that case, SI units are the norm, with 10ⁿ scaling factors as needed. On the other hand, it is not necessary to cover every quantity which might be expressed with non-decadal scaling.

We suggest that the following conventions should be adopted. To a large extent they correspond to current practice.

1. *Linear measures have symbols beginning with
 - a. *Brush script "L" for scattering lengths;*
 - b. *Greek "σ" for cross-sections; and*
 - c. *Lower case Roman "s" for volume, area, and line coefficients.**
2. *Logarithmic measures have symbols beginning with a capital Roman letter.*
3. *The final subscript letters, the case is immaterial, indicate the context, e.g. bs for backscattering. They are not normally relevant to the particular quantity or the units of measurement.*
4. *In the case of area scattering only the subscript case is significant. s_a and s_A refer to the area-backscattering coefficient and the NASC, respectively. This convention has been adopted to conform to current practice and to be consistent with the vast amount of archived historical data.*

From Demer *et al.* (2015),

*The following terminology, based mostly on MacLennan *et al.* (2002), follows the Le Système International d'Unités (SI system). Symbols should uniquely represent a term. All symbols for variables should be italicized. Any symbol for a variable (*x*) that is not logarithmically transformed should be lower case. Any symbol for a logarithmically transformed variable, e.g. $X = 10\log_{10}(x/x_{ref})$, with units of decibels referred to x_{ref} (dB re x_{ref}), should be capitalized. Deviations from these rules should be noted.*

From ISO (2017),

The underlying philosophy followed in preparing this document is to define quantities independently of how they are measured.

The ISO House Style is available at,

<https://www.iso.org/ISO-house-style.html>

Of greatest relevance to terminology, it provides guidance on,

- [Abbreviated terms, abbreviations and contractions](#)
- [Numbers, values and dates](#)
- [Symbols](#)

The ISO House Style "is intended to be used alongside the ISO/IEC Directives, Part 2 and generally does not duplicate its content". The ISO/IEC Directives, Part 2 is available at,

<https://www.iso.org/sites/directives/current/part2/index.xhtml>

Of greatest relevance to terminology, it provides guidance on,

- [Numbers, quantities, units and values](#)



- [Terms and definitions](#)
- [Symbols and abbreviated terms](#)
- [Mathematical formulae](#)
- [Quantities and units](#)

Annex C: Alphabetical index of terms

MacLennan et al. (2002)	Demer et al. (2015)	ISO (2017)
<ul style="list-style-type: none"> ▶ Acoustic absorption coefficient ▶ Absorption cross-section ▶ Area backscattering coefficient ▶ Area backscattering strength 	<ul style="list-style-type: none"> ▶ Absorption coefficient ▶ Absorption loss ▶ Acoustic frequency ▶ Acoustic frequency bandwidth ▶ Acoustic intensity ▶ Acoustic intensity at r_0 ▶ Acoustic power ▶ Acoustic pressure ▶ Acoustic wavelength ▶ Acoustic wavenumber ▶ Area backscattering coefficient 	<ul style="list-style-type: none"> ▶ Absorption cross section ▶ Acoustic centre ▶ Acoustic far field ▶ Acoustic noise ▶ Acoustic self-noise ▶ Active sonar equation ▶ Ambient noise ▶ Ambient sound ▶ Analytic signal ▶ Array gain
<ul style="list-style-type: none"> ▶ Backscattering cross-section ▶ Backscattered intensity 	<ul style="list-style-type: none"> ▶ Backscattering cross-section 	<ul style="list-style-type: none"> ▶ Background noise
<ul style="list-style-type: none"> ▶ Cartesian coordinates 	<ul style="list-style-type: none"> ▶ Current 	<ul style="list-style-type: none"> ▶ Characteristic acoustic impedance ▶ Characteristic specific acoustic impedance ▶ Complex envelope ▶ Compressional pressure
<ul style="list-style-type: none"> ▶ Differential scattering cross section 	<ul style="list-style-type: none"> ▶ Directional angles 	<ul style="list-style-type: none"> ▶ Decidecade ▶ Detection index ▶ Detection threshold ▶ Differential scattering cross section
<ul style="list-style-type: none"> ▶ Echo-trace area ▶ Extinction cross-section 	<ul style="list-style-type: none"> ▶ Effective pulse duration ▶ Effective receiving area ▶ Electrical impedance ▶ Electrical power ▶ Equivalent two-way beam angle 	<ul style="list-style-type: none"> ▶ Effective signal bandwidth ▶ Effective signal duration ▶ Energy propagation factor ▶ Energy propagation loss ▶ Energy source factor ▶ Energy source level ▶ Equivalent mean-square sonar noise sound pressure ▶ Equivalent plane wave sound intensity ▶ Equivalent target strength ▶ Extinction cross section
		<ul style="list-style-type: none"> ▶ Far-field signature ▶ Far-field sound pressure ▶ Force impulse
	<ul style="list-style-type: none"> ▶ Gain 	
<ul style="list-style-type: none"> ▶ Incident intensity ▶ Intensity 		<ul style="list-style-type: none"> ▶ Instantaneous sound intensity

MacLennan et al. (2002)	Demer et al. (2015)	ISO (2017)
<ul style="list-style-type: none"> ▶ Line backscattering coefficient ▶ Line backscattering strength 		
<ul style="list-style-type: none"> ▶ Mean volume backscattering strength, MVBS 		<ul style="list-style-type: none"> ▶ Material element ▶ Mean-square sound particle acceleration ▶ Mean-square sound particle acceleration level ▶ Mean-square sound particle displacement ▶ Mean-square sound particle displacement level ▶ Mean-square sound particle velocity ▶ Mean-square sound particle velocity level ▶ Mean-square sound pressure ▶ Mean-square sound pressure level ▶ Mean-square sound pressure spectral density ▶ Mean-square sound pressure spectral density level ▶ Mean-square weighted sound pressure level
<ul style="list-style-type: none"> ▶ Nautical area scattering coefficient (NASC) ▶ Nautical area scattering strength 	<ul style="list-style-type: none"> ▶ Nautical area backscattering coefficient 	<ul style="list-style-type: none"> ▶ Noise ▶ Noise detector output ▶ Non-acoustic self-noise
<ul style="list-style-type: none"> ▶ Occupation volume 	<ul style="list-style-type: none"> ▶ Omni-directional transmit acoustic intensity ▶ On-axis gain ▶ On-axis received power 	<ul style="list-style-type: none"> ▶ One-third octave ▶ One-third octave (base 10) ▶ One-third octave (base 2)
	<ul style="list-style-type: none"> ▶ Pulse duration 	<ul style="list-style-type: none"> ▶ Passive sonar equation ▶ Peak compressional pressure ▶ Peak compressional sound pressure level ▶ Peak rarefactional pressure ▶ Peak rarefactional sound pressure level ▶ Peak sound pressure ▶ Peak sound pressure level ▶ Peak-to-peak sound pressure ▶ Percentage energy signal duration ▶ Pressure impulse ▶ Probability of detection ▶ Probability of false alarm ▶ Propagation factor ▶ Propagation loss

MacLennan et al. (2002)	Demer et al. (2015)	ISO (2017)
<ul style="list-style-type: none"> ▶ Range 	<ul style="list-style-type: none"> ▶ Range ▶ Received electric power ▶ Receiver electrical impedance ▶ Receive voltage sensitivity ▶ Reciprocity parameter ▶ Reference acoustic intensity ▶ Reference acoustic pressure ▶ Reference range 	<ul style="list-style-type: none"> ▶ Rarefactional pressure ▶ Reverberation ▶ Reverberation level ▶ Reverberation-limited active sonar equation
<ul style="list-style-type: none"> ▶ Scattered intensity ▶ Spherical polar angle coordinates ▶ Spherical scattering cross-section 	<ul style="list-style-type: none"> ▶ Sampled area ▶ Sampled volume ▶ Scatterer abundance ▶ Scatterer areal density ▶ Scatterer biomass ▶ Scatterer volume density ▶ Signal-to-noise ratio ▶ Source intensity ▶ Source level ▶ Sphere density ▶ Sphere compressional wave sound speed ▶ Sphere shear wave sound speed ▶ Spherical scattering cross-section ▶ Spherical spreading loss ▶ Surface backscattering coefficient ▶ Surface backscattering strength ▶ Survey area 	<ul style="list-style-type: none"> ▶ Sea bottom differential scattering cross section per unit area ▶ Sea bottom scattering strength ▶ Sea surface differential scattering cross section per unit area ▶ Sea surface scattering strength ▶ Self-noise ▶ Signal ▶ Signal excess ▶ Signal plus noise detector output ▶ Sonar equation ▶ Sonar noise level ▶ Sonar noise voltage ▶ Sonar processing gain ▶ Sonar reverberation ▶ Sonar signal sound pressure ▶ Sonar signal voltage ▶ Sonar signal-to-noise ratio ▶ Sound ▶ Sound exposure ▶ Sound exposure level ▶ Sound exposure propagation factor ▶ Sound exposure propagation loss ▶ Sound exposure source factor ▶ Sound exposure source level ▶ Sound exposure spectral density ▶ Sound exposure spectral density level ▶ Sound intensity ▶ Sound particle acceleration ▶ Sound particle displacement ▶ Sound particle velocity ▶ Sound power ▶ Sound pressure ▶ Sound pressure exposure ▶ Sound pressure exposure level ▶ Sound pressure exposure spectral density

MacLennan et al. (2002)	Demer et al. (2015)	ISO (2017)
		<ul style="list-style-type: none"> ▶ Sound pressure kurtosis ▶ Sound pressure level ▶ Sound pressure skewness ▶ Sound pressure spectrum ▶ Sound pressure variance ▶ Soundscape ▶ Source spectrum ▶ Source factor ▶ Source level ▶ Source waveform ▶ Specific acoustic impedance ▶ Surface-affected source spectrum ▶ Surface-affected source waveform
<ul style="list-style-type: none"> ▶ Target strength ▶ Total scattering cross-section 	<ul style="list-style-type: none"> ▶ Target strength ▶ Transducer angle sensitivity ▶ Transducer beamwidth ▶ Transducer beamwidth offset ▶ Transducer directivity ▶ Transducer directivity pattern ▶ Transducer efficiency ▶ Transducer electrical impedance ▶ Transmit current ▶ Transmit acoustic power ▶ Transmit current sensitivity ▶ Transmit electric power ▶ Transmit intensity ▶ Transmit pressure ▶ Transmit voltage ▶ Transmit voltage sensitivity 	<ul style="list-style-type: none"> ▶ Target echo ▶ Target echo level ▶ Target strength ▶ Threshold exceedance signal duration ▶ Time-averaged sound intensity ▶ Time-averaged sound power ▶ Time-integrated squared sound particle acceleration ▶ Time-integrated squared sound particle acceleration level ▶ Time-integrated squared sound particle displacement ▶ Time-integrated squared sound particle displacement level ▶ Time-integrated squared sound particle velocity ▶ Time-integrated squared sound particle velocity level ▶ Time-integrated squared sound pressure ▶ Time-integrated squared sound pressure level ▶ Total scattering cross section ▶ Transmission loss
<ul style="list-style-type: none"> ▶ Volume backscattering coefficient ▶ Volume backscattering strength 	<ul style="list-style-type: none"> ▶ Voltage ▶ Volume backscattering coefficient ▶ Volume backscattering strength 	<ul style="list-style-type: none"> ▶ Volume differential scattering cross section per unit volume ▶ Volume scattering strength
	<ul style="list-style-type: none"> ▶ Water acoustic impedance ▶ Water density ▶ Water depth ▶ Water pressure ▶ Water salinity 	

MacLennan et al. (2002)	Demer et al. (2015)	ISO (2017)
	<ul style="list-style-type: none">▶ Water sound speed▶ Water temperature	
		<ul style="list-style-type: none">▶ Zero-to-peak sound pressure▶ Zero-to-peak sound pressure level