



# 中华人民共和国石油天然气行业标准

SY/T 6736.1—2008

中文/English

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## 石油海上数字地震采集拖缆系统 第 1 部分: 水听器技术条件

Marine seismic digital streamer system —

Part 1: Standards for specifying hydrophone parameters

(Geophysics, 52, no. 02, 242 – 248, 1987, SEG Standards  
for marine seismic hydrophones and streamer cables —

Part I : Standards for specifying hydrophone parameters, MOD)

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## 前 言

SY/T 6736《石油海上数字地震采集拖缆系统》分为三个部分：

- 第1部分：水听器技术条件；
- 第2部分：水听器拖缆技术条件；
- 第3部分：中央记录系统。

本部分是 SY/T 6736 的第1部分。

本部分修改采用国际地球物理家学会 SEG Geophysics, 52, no. 02, 242 - 248, 1987, Part I 《海上数字拖缆标准 第1部分》。

本部分根据国际地球物理家学会 SEG Geophysics, 52, no. 02, 242 - 248, 1987, Part I 重新起草。在附录 B 中给出了本部分章条编号与 SEG Geophysics, 52, no. 02, 242 - 248, 1987, Part I 条款对照一览表，以供参考。

由于我国石油勘探工业的特殊需要，本标准在采用国际标准时进行了修改。有关技术性差异已编入正文中并在它们所涉及的条款的页边空白处用垂直单线标识。在附录 C 中给出了本部分与 SEG Geophysics, 52, no. 02, 242 - 248, 1987, Part I 技术性差异及其原因一览表，以供参考。

本部分的附录 A、附录 B 和附录 C 是资料性附录。

本部分由石油仪器仪表专业标准化技术委员会提出并归口。

本部分起草单位：中海油田服务股份有限公司物探事业部、中国石油天然气集团东方地球物理勘探有限公司西安物探装备分公司、石油工业仪器仪表质量监督检验中心、国土资源部广州海洋地质调查局。

本部分主要起草人：于湛海、何国信、尹振国、张在陆、李佩昌、褚荣英、曹占全、汉泽西、陈洁、韩晓泉、赵伟、连艳红。

本部分以中文和英文两种文字出版，当英文和中文两种版本有歧义时，以中文版本为准。

# 石油海上数字地震采集拖缆系统

## 第 1 部分：水听器技术条件

### 1 范围

SY/T 6736 的本部分规定了石油海上地球物理勘探中通用的三种类型水听器（压电水听器、带集成前置放大的水听器、带耦合变压器的水听器）的组成、要求和校准方法。

本部分适用于水听器的制造、检验和质量评价。

### 2 规范性引用文件

下列文件中的条款通过 SY/T 6736 的本部分的引用而成为本部分的条款。凡是注日期的引用文件，其随后所有的修改单（不包括勘误的内容）或修订版均不适用于本部分，然而，鼓励根据本部分达成协议的各方研究是否可使用这些文件的最新版本。凡是不注日期的引用文件，其最新版本适用于本部分。

ANSI S 1.1—1976 声学专用术语

ANSI S 1.8—1974 声学级的常用基准量

ANSI S 1.20—1988 水下压电传感器标定程序

ANSI Y 10.11—1959 声学专用字母符号

ASTM 标准公制实用指南

ASTM E 380—79 美国材料试验协会名称规定（ANSI Z210.1—1976）

### 3 符号、单位、术语和定义

下列符号、单位、术语和定义适用于 SY/T 6736 的本部分。

#### 3.1

##### 字母符号

本部分使用的字母符号符合 ANSI Y 10.11—1959，ANSI S 1.1—1976，ANSI S 1.8—1974，ASTM《标准公制实用指南》ASTM E 380—79（ANSI Z210.1—1976）的规定。

#### 3.2

##### 专用术语

本部分使用的专用术语符合 ANSI S 1.1—1976 和 ANSI S 1.20—1988 的规定。

#### 3.3

##### SI 单位制单位

本部分使用的单位制按 SI 公制系统单位制和 SEG 公制分委会 1981 年发布的公制试行标准执行。

#### 3.4

##### 压电水听器 piezoelectric elements

由一个或多个压电单元组成的在水中接收地震波的传感器，可以是裸露的，也可以带有封装。

#### 3.5

##### 带集成前置放大水听器 elements with integral preamplifiers

一种带有一个集成前置放大器的压电水听器。该集成放大器可以放大压电水听器的输出信号，其输出阻抗低于直耦压电单元的输出阻抗，放大器所需功率来自外部电源或内部电池，此前置放大器可

以是电压、电荷和电流类型。

### 3.6

#### 带耦合变压器水听器 elements with coupling transformers

由一个变压器带单个或多个压电单元组成的水下地震传感器。在工作频带内带变压器耦合水听器输出阻抗比直耦压电单元的输出阻抗低。

### 3.7

#### 压电水听器正极 positive polarity of piezoelectric elements

压电水听器在正声压（增加声压）作用下，压电水听器显示正极性电压或电荷的端子，一般用红色表示。

## 4 要求

### 4.1 物理特性

对物理特性共同的要求主要包括：

- 尺寸：应提供传感器形态图，单位为厘米（cm）。
- 材质：制造厂商应提供对水听器材质的规定，说明与其接触的压载物之间的化学兼容性，并说明替代材质的指标。
- 质量：单位为克（g）。
- 排水量：单位为立方厘米（cm<sup>3</sup>）。
- 温度：工作及存储温度范围，单位为摄氏度（℃）。

### 4.2 电气特性

对电气特性共同的要求主要包括：

- 引脚：应说明电引脚的类型和长度。
- 极性：应以色码或其他标志标示正极，宜用红色标出。
- 电容：应给出水听器输出端间电容，单位为微法（μF），并带有容差，如±X%。
- 电阻：水听器输出端间的直流电阻，在规定的温度及湿度条件下应大于100MΩ。

### 4.3 性能指标

性能指标包括如下内容：

- 自由场电压灵敏度：对应频率的自由场电压灵敏度，单位为分贝（dB）（以1V/μPa为0dB），并应给出精度范围±XdB。确定灵敏度的频率应予以说明（即自由场电压灵敏度——XXX dB re 1V/μPa ±XXdB@XXHz）。一般应为-194dB。
- 机械谐振：应提供在自由场条件下，最低主谐振频率。
- 灵敏度与频率关系：应提供开路自由场电压灵敏度与频率关系的曲线或说明。
- 灵敏度与深度关系：应提供开路自由场电压灵敏度与深度关系的曲线或说明。
- 灵敏度与温度关系：应提供在整个工作温度范围内灵敏度的最大变化。
- 加速度灵敏度：应说明沿三个正交轴中的每一个轴的加速度灵敏度，还应给出测量方法。
- 最大工作深度：应提供水听器没有受到损坏或灵敏度没有永久性改变（<1dB）时的最大工作深度，单位为米（m）。
- 最大工作压力：应提供水听器能承受多次抗压试验，使得水听器特性不出现大于1dB永久性改变时的最大声压。
- 自由场电荷灵敏度：自由场电荷灵敏度用传感器的电容和自由场电压灵敏度来计算，单位为分贝（dB）（以1nC/μPa为0dB），并应给出精度范围（±XdB）。该参数为一选项。

### 4.4 带集成前置放大的水听器的附加参数

带集成前置放大的水听器的附加参数主要包括：

- a) 阻抗：标称输出阻抗，单位为欧 [姆] ( $\Omega$ )，应提供输出阻抗幅度、相位与频率关系图件，还应提供前置放大器最小负载阻抗及最大负载电容。
- b) 频率响应：应图示在开路条件下自由场电压灵敏度与频率关系，并提供振幅及相位响应图。
- c) 功率：应给出前置放大器需要的电压、电流。如电池供电，应给出电池类型及预期工作和存储寿命。
- d) 限幅压力：应提供在前置放大器饱和状态时的峰值压力，单位为分贝 (dB) (以  $1\mu\text{Pa}$  为 0dB)。
- e) 谐波畸变：应给出当输入声信号达到限幅压力某一规定百分比时，对给定频率的总谐波畸变。
- f) 噪声：应提供在噪声源隔离条件下，带灵敏元件的前置放大器噪声输出谱密度图，此图的纵坐标应以等效声压电平输入表示，单位为分贝 (dB) (以  $1\mu\text{Pa}/\text{Hz}$  为 0dB)。

#### 4.5 变压器耦合水听器附加参数

变压器耦合水听器附加参数主要包括：

- a) 阻抗：标称输出阻抗，单位为欧 [姆] ( $\Omega$ )，应提供阻抗幅度与相应频率关系图。
- b) 直流电阻：单位为欧 [姆] ( $\Omega$ )，并带容差  $\pm X\%$ 。
- c) 正常频率：应提供水听器电路灵敏度最大值时的频率，单位为赫 [兹] (Hz)，以  $(XX \pm X\%) \text{ Hz}$  表示。
- d) 频率响应：应提供在开路条件和至少一个并联电阻时，自由场电压灵敏度与频率的关系图件，及提供两种条件下的振幅、相位响应图。
- e) 谐波畸变：应给出总谐波畸变在规定频率超过一个规定百分比时的最大声压。

#### 5 水听器校准方法

水听器校准方法应符合 ANSI S 1.20—1988，如果使用其他校准方法，应给出“标定的标准水听器”的源或校准方法。

水听器特性记录格式已在附录 A 中给出。

附 录 A  
(资料性附录)  
水听器特性记录

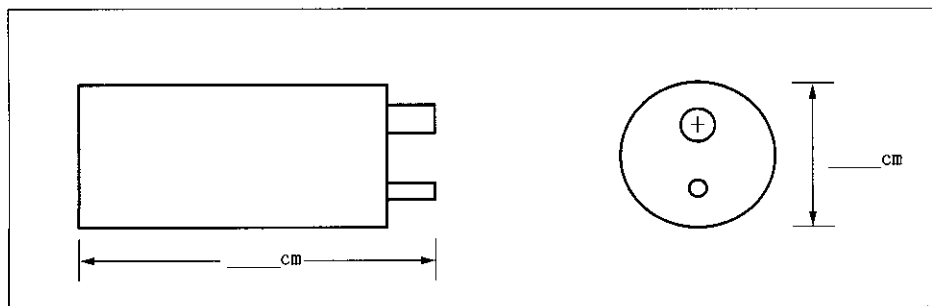
水听器特性记录范例：

公司名称\_\_\_\_\_

水听器型号特性\_\_\_\_\_

适用范围：适用于电荷耦合前置放大器的水听器或是带变压器耦合水听器的拖缆系统。

物理特性：



材料：表面材料，为\_\_\_\_\_和\_\_\_\_\_，与常用的压载物之间存在化学兼容性。

质量：\_\_\_\_\_ g。

排水量：\_\_\_\_\_ cm<sup>3</sup>

工作温度范围：\_\_\_\_\_ °C至\_\_\_\_\_ °C。

最高存储温度：\_\_\_\_\_ °C。

最大深度：\_\_\_\_\_（电压灵敏度持久改变<1dB）。

电气特性：（电路开路值）

电容：\_\_\_\_\_ μF ± \_\_\_\_\_ % @ \_\_\_\_\_ Hz。

电阻：> \_\_\_\_\_ MΩ @ \_\_\_\_\_ °C @ \_\_\_\_\_ %湿度。

引脚：正极标注为“+”并加红点。

性能指标：

电压灵敏度：- \_\_\_\_\_ dB 参考 1V/μPa ± \_\_\_\_\_ dB @ \_\_\_\_\_ Hz。

最低机械响应频率：\_\_\_\_\_ Hz。

电压灵敏度与频率：<3 dB 变化从 \_\_\_\_\_ Hz 到 \_\_\_\_\_ Hz。

要求绘图显示：

电压灵敏度与温度：<3 dB 变化从 \_\_\_\_\_ °C 到 \_\_\_\_\_ °C @ \_\_\_\_\_ m & \_\_\_\_\_ Hz。

电压灵敏度与深度：<3 dB 变化从 0 到 \_\_\_\_\_ m。

电荷灵敏度：\_\_\_\_\_ re 1nC/μPa @ \_\_\_\_\_ m & \_\_\_\_\_ °C（计算值）。

加速度灵敏度：在三个主轴任意轴向的加速度输出值 < \_\_\_\_\_ mV/g，实验环境为空气中，  
\_\_\_\_\_ Hz & \_\_\_\_\_ g。

附 录 B  
(资料性附录)

本部分章条编号与 SEG Geophysics, 52, no. 02, 242 – 248, 1987, Part I 条款对照

表 B.1 给出了本部分章条编号与 SEG Geophysics, 52, no. 02, 242 – 248, 1987, Part I 条款对照一览表。

表 B.1 本部分章条编号与 SEG Geophysics, 52, no. 02, 242 – 248, 1987, Part I 条款对照

本部分章条编号	SEG Geophysics, 52, no. 02, 242 – 248, 1987, Part I
1 范围	第 1 页 Scope 的第一句
2 规范性引用文件	P. 2: Definitions, terminology
3.1~3.3	P. 2: Definitions, terminology, metrication
3.4~3.6	第 1 页 Scope 第一句以后的全部内容
3.7	第 2 页: Electrical (2) Polarity
4 要求	第 2 页: Hydrophone sensor parameter standards
4.1 物理特性	第 2 页: Physical
4.2 电气特性	第 2 页: Electrical
4.3 性能指标	第 3 页: Performance
4.4 带集成前置放大的水听器的附加参数	第 3 页: Additional parameters for integral preamplifier hydrophone
4.5 变压器耦合水听器附加参数	第 4 页: Additional parameters for transformer coupled hydrophone
5 水听器校准方法	第 3 页: Hydrophone calibration method
附录 A 水听器特性记录	第 5 页: Data sheet



附 录 C  
(资料性附录)

本部分与 SEG Geophysics, 52, no. 02, 242 – 248, 1987, Part I 技术差异及其原因

表 C.1 给出了本部分与 SEG Geophysics, 52, no. 02, 242 – 248, 1987, Part I 技术差异及其原因一览表。

表 C.1 本部分与 SEG Geophysics, 52, no. 02, 242 – 248, 1987, Part I 技术差异及其原因

本部分章条编号	技术性差异	原因
1	删除了 SEG 标准的“目的 (purpose)”。	因为“目的”的表述已经不适用于我国标准的表述
2	将 ANSI 和 ASTM 等 6 项标准作为规范性引用文件	为了方便使用和编排的需要
3.4~3.7	三种水听器被编写为“定义”	为了方便使用和编排的需要
4.2d)	增加了对水听器输出端电阻应大于 100M $\Omega$ 的规定	为了便于实施和检查
4.3a)	增加了对水听器性能指标自由场电压灵敏度一般为 -194dB 的规定	为了便于实施和质量控制
5	单独编写为一章“水听器校准方法”	为了方便使用和编排的需要



**The People's Republic of China**  
**Standard of Petroleum and Natural Gas Industry**

**SY/T 6736. 1—2008**

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**Marine seismic digital streamer system—**  
**Part 1: Standards for specifying**  
**hydrophone parameters**

(Geophysics, 52, no. 02, 242 – 248, 1987, SEG Standards  
for marine seismic hydrophones and streamer cables—  
Part I : Standards for specifying hydrophone parameters, MOD)

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## Foreword

SY/T 6736 *Marine seismic digital streamer system* includes three parts:

—Part 1: *Standards for specifying hydrophone parameters*;

· Part 2: *Standards for specifying hydrophone streamer-cable characteristics*;

—Part 3: *Central recording system*.

This is the Part 1 of SY/T 6736.

This part is modified in relation to SEG *Standards for marine seismic hydrophones and streamer cables* (Geophysics, 52, no. 02, 242 – 248, 1987) *Part 1: Standards for specifying hydrophone parameters*.

This part was redrafted in accordance with SEG Geophysics, 52, no. 02, 242 – 248, 1987, Part I. In Annex B provides the table of comparison between the numbers of clause, sub-clause in this part and the provision in SEG Standards Geophysics, 52, no. 02, 242 – 248, 1987 Part I, for reference.

Owing to the special requirements of China petroleum exploration industry, while adopting SEG standards, this part was modified. The technical differences between this part and the SEG standards have been edited into the main article, and the discrepancies have been marked by the vertical side lines in the blank space by the edge of those pages respectively. In Annex C

(informative Annex) provides the table of the technical. In Annex C provides the table of the technical differences between this part and the SEG Geophysics, 52, no. 02, 242 – 248, 1987 Part I and the reasons, for reference.

Annex A, Annex B and Annex C of this part are informative.

This part was proposed by China National Offshore Oil Corporation.

This part is under the jurisdiction of The Committee of Petroleum Instrument Standardization.

This part was drafted by China National Offshore Oil Corporation, Don Fang Geophysical Exploration Incorporated Company, Petroleum Industry Instrument Quality Surveillance and Test Center and Guangzhou Marine Geological Survey Ministry of Land and Resources, P. R. China.

The main drafters of this part are Zhanhai Yu, Guoxin He, Zhenguo Yin, Zailu Zhang, Peichang Li, Rongying Chu, Zhanquan Cao, Zexi Han, Jie Chen, Xiaoquan Han, Wei Zhao, and Yanhong Lian.

This part is issued in both Chinese and English versions. In the event of any discrepancy between the texts, the Chinese versions shall prevail.

## Marine seismic digital streamer system— Part 1: Standards for specifying hydrophone parameters

### 1 Scope

This part of SY/T 6736 specifies the compositions, requirements and calibration for the three types of hydrophones commonly used in marine geophysical exploration: piezoelectric elements, elements with integral preamplifiers and elements with coupling transformers.

This standard is applicable to manufacturing, testing and quality evaluation of the hydrophones.

### 2 Normative references

The following normative documents contain provisions, which, through reference in the part of SY/T 6736, constitute provisions of the part. For dated references, subsequent amendments to, or revisions of, any of these publications (exclude errata) do not apply. However, parties to agreements based on the part are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies.

ANSI S 1.1—1976 *Acoustic terminology*.

ANSI S 1.8—1974 *Reference quantities for acoustical level*

ANSI S 1.20—1988 *Procedures for calibration of underwater electroacoustic transducers*

ANSI Y 10.11—1959 *Letter symbols for acoustics*.

ASTM *Standard metric practice guide*

ASTM E 380—79 *Designation* (also ANSI Z210.1—1976)

### 3 Letter symbols, metrication, terms and definitions

The following letter symbols, metrication, terms and definitions applicable to this part of SY/T 6736.

#### 3.1

##### letter symbols

Letter symbols used in this part comply with those given in ANSI Y 10.11—1959, ANSI S 1.1—1976, ANSI S 1.8—1974, and ASTM *Standard metric practice guide*, ASTM E 380—79 (ANSI Z 210.1—1976).

#### 3.2

##### terminology

Terminology used in this part is based on definitions given in ANSI S 1.1—1976 and ANSI S 1.20—1988.

#### 3.3

##### metrication

Metrication used in this part comply with Metric System and the tentative metric standard SEG has published. This publication, *SI Metric system of units and SEG tentative metric standard*, SEG Metrication Subcommittee, 1981, should be consulted.

#### 3.4

##### piezoelectric elements

Piezoelectric element hydrophone is a kind of underwater electroacoustic transducer, which consists of one or more piezoelectric elements. They may be bare or encapsulated.

#### 3.5

##### elements with integral preamplifiers

Elements with integral preamplifiers hydrophone consists of one or more piezoelectric elements with an integral preamplifier. The integral am-

plifier is generally included to provide a larger signal and/or lower output impedance than the direct coupled piezoelectric units. The integral preamplifier requires power from either an external power source or an internal battery. The preamplifier may be of the voltage, charge, or current mode type.

### 3.6

#### elements with coupling transformers

Elements with coupling transformers of hydrophone is underwater Electroacoustic transducer include a transformer with one or more piezoelectric elements. Transformer-coupled hydrophones provide lower output impedance than direct coupled piezoelectric units within the operating frequency band.

### 3.7

#### positive polarity of piezoelectric elements

The color code or other marking to indicate positive polarity voltage or charge for a positive (increase in) acoustic pressure should be designated. Red is the preferred color for the positive terminal.

## 4 Requirements

### 4.1 Physical

The physical characteristic common to all three hydrophone types:

- a) Dimensions: A drawing of the sensor configuration should be provided with dimensions given in centimeters (cm);
- b) Materials: Materials shall be specified by the manufacturer to allow judgments as to chemical compatibility with fluids that the hydrophone assembly may contact (e.g., ballast fluids in seismic streamers). A statement assuring materials compatibility may be substituted for the materials specification;
- c) Weight: Weight shall be given in g;
- d) Displacement: Displacement should be given in cubic centimeters (cm<sup>3</sup>);
- e) Temperature: The operating and storage temperature ranges should be given in degrees

Celsius (°C) .

### 4.2 Electrical

The Electrical characteristic are common to all three hydrophone types;

- a) Leads: The type and length of electrical leads should be stated;
- b) Polarity: The color code or other marking to indicate positive polarity voltage or charge, red is the preferred color for the positive terminal;
- c) Capacitance: Capacitance across the hydrophone output terminals should be given in microfarads ( $\mu\text{F}$ ) with tolerance expressed as  $\pm X\%$ ;
- d) Resistance: The DC resistance across hydrophone output terminals should be given and expressed as greater than  $100\text{M}\Omega$  at stated conditions of temperature and humidity.

### 4.3 Performance

The performance standards are common to all three hydrophone types:

- a) Free-field voltage sensitivity: Free-field voltage sensitivity should be given in decibels (dB) referenced to 1 volt per micropascal with accuracy expressed as  $\pm X$  dB. The frequency at which the sensitivity is determined shall be stated (e.g., Free-field voltage sensitivity - XXX dB re 1 V per  $\mu\text{Pa}$   $\pm XX$  dB @ XX Hz), the nominal value shall be -194dB;
- b) Mechanical resonance: The lowest major mechanical resonant frequency for free-field conditions should be stated;
- c) Sensitivity versus frequency: A curve or statement should be furnished showing open-circuit free-field voltage sensitivity versus frequency;
- d) Sensitivity versus depth: A curve or statement should be furnished showing open-circuit free-field voltage sensitivity versus depth;
- e) Sensitivity versus temperature: Maximum change in sensitivity over the operating tem-

perature range should be stated;

- f) Acceleration sensitivity: A statement should be given as to acceleration sensitivity along each of the three major orthogonal axes. The measurement method should be given;
- g) Depth capability: Depth excursion in meters (m) to which the hydrophone can be subjected without destruction or significant permanent change in sensitivity ( $< 1$  dB) should be stated;
- h) High dynamic pressure capability: The maximum acoustic pressure that the hydrophone can withstand a specified number of cycles without permanent change in characteristics greater than 1 dB should be stated if intended for such usage;
- i) Free-field charge sensitivity: Free-field charge sensitivity can be computed from the capacitance and free-field voltage sensitivity of the sensors. Free-field charge sensitivity should be stated in decibels referenced to 1 nanocoulomb per micropascal ( $1\text{nC}/\mu\text{Pa}$  as 0 dB) with accuracy of  $\pm X$  dB. Statement of this parameter is optional.

#### 4.4 Additional parameters for integral preamplifier hydrophone

These parameters apply to hydrophones with integral preamplifiers only: .

- a) Impedance: The nominal output impedance of the device should be specified in ohms ( $\Omega$ ) . Plots of output impedance amplitude and phase versus frequency should be provided. The minimum load impedance and maximum load capacitance for the preamplifier should also be specified;
- b) Frequency response: The free-field voltage sensitivity as a function of frequency should be plotted for the open circuit condition. Both amplitude and phase plots should be provided;
- c) Power: The voltage and current requirements of the preamplifiers should be given. If battery powered, the battery type and ex-

pected operating and storage life should be given;

- d) Clipping pressure: The peak pressure level at which preamplifier saturation occurs should be stated in dB (re  $1\mu\text{Pa}$  as 0 dB);
- e) Harmonic distortion: The total harmonic distortion should be given for a specified frequency when the input acoustic signal is at a specified percentage of the clipping pressure;
- f) Noise: A plot of the preamplifier noise output spectral density with the sensitive element isolated from noise sources should be provided. The Y coordinate of the plot should be expressed in terms of the equivalent sound pressure level input, i. e. , dB (re  $1\mu\text{Pa}/\text{Hz}$  as 0 dB) .

#### 4.5 Additional parameters for transformer coupled hydrophone

These parameters apply to hydrophones with transformer coupled only;

- a) Impedance: The nominal output impedance of the device should be given in ohms. The curve of impedance amplitude and phase versus frequency should be provided;
- b) Dc resistance: Resistance should be given in ohms with tolerance expressed as  $\pm X\%$ ;
- c) Natural frequency: The frequency at which the hydrophone circuit sensitivity is greatest, specified as  $(XX \pm X\%)$  Hz;
- d) Frequency response: The curve of free-field voltage sensitivity as a function of frequency, and the amplitude and phase response should be provided for both of the open circuit condition and at least one shunt resistance circuit;
- e) Harmonic distortion: When total harmonic distortion exceeds a stated percentage at a stated frequency, the maximum acoustic pressure should be given.

#### 5 Hydrophone calibration method

The hydrophone calibration method should conform to methods described in ANSI SI.20 -



1988.

If a secondary calibration method is employed, the “calibration-standard-hydrophone” source or

method of calibration should be given.

Hydrophone specifications data sheet has been given in Annex A.

**Annex A**  
**(Informative)**  
**Data sheet**

Example of hydrophone data sheet:

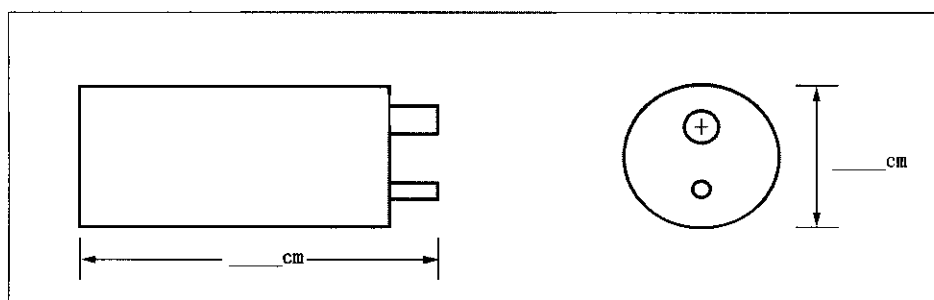
XYZ Corportion

Model \_\_\_\_\_ Hydrophone specifications

Intenode use:

For use in streamer-cable systems with charge coupled amplifiers or transformer coupling;

Physical specifications:



Materials: Surfaces exposed to streamer fluids are \_\_\_\_\_ and \_\_\_\_\_ which are compatible with all commonly used ballast liquids.

Height: \_\_\_\_\_ g

Displacement: \_\_\_\_\_ cm<sup>3</sup>.

Operating temperature: \_\_\_\_\_ °C to \_\_\_\_\_ °C

Maximum depth : \_\_\_\_\_ m (<1dB permanent change in voltage sensitivity)

Electrical specifications (Open-circuit values):

Capacitance: \_\_\_\_\_ μF ± \_\_\_\_\_ % @ \_\_\_\_\_ Hz

Resistance: > \_\_\_\_\_ MΩ @ \_\_\_\_\_ °C @ \_\_\_\_\_ % humidity

Terminals: Positive polarity marked “+” and with Rea dot

Performance:

Voltage sensitivity : - \_\_\_\_\_ dB re 1V/μPa ±

\_\_\_\_\_ dB @ \_\_\_\_\_ Hz

Lowest mechanical resonant frequency: \_\_\_\_\_ Hz

Voltage sensitivity vs frequency: <3dB change from \_\_\_\_\_ Hz to \_\_\_\_\_ Hz

Plots are available on request:

Voltage sensitivity vs temperature: <3dB from \_\_\_\_\_ °C to \_\_\_\_\_ °C @ \_\_\_\_\_ m & \_\_\_\_\_ Hz

Voltage sensitivity vs depth: <3dB change from 0 to \_\_\_\_\_ m

Change sensitivity: \_\_\_\_\_ dB re 1nC/μPa @ \_\_\_\_\_ m & \_\_\_\_\_ °C (computed)

Acceleration sensitivity: Output is < \_\_\_\_\_ mV/g due to acceleration in any of the three major axes. Tests made in air at \_\_\_\_\_ Hz & \_\_\_\_\_ g.

**Annex B**  
**(Informative)**

**Comparison between the numbers of clause, sub-clause in this part and the provision in  
SEG Geophysics, 52, no. 02, 242 – 248, 1987 Part I**

Table B.1 provides the comparison between the the provision in SEG Geophysics, 52, no. 02, numbers of clause, sub-clause in this part and 242 – 248, 1987, Part I .

**Table B.1 Comparison between the numbers of clause, sub-clause in this part and the provision in  
SEG Geophysics, 52, no. 02, 242 – 248, 1987 Part I**

The numbers of clause, sub-clause in this part	SEG Geophysics, 52, no. 02, 242 – 248, 1987, Part I
1 Scope	P. 1: Scope; the 1 <sup>st</sup> sentence
2 Normative references	P. 2: Definitions, terminology
3.1~3.3	P. 2: Definitions, terminology, metrication.
3.4~3.6	P. 1: Scope : all after the 1 <sup>st</sup> sentence
3.7	P. 2: Electrical (2) polarity
4 Requirements	P. 2: Hydrophone sensor parameter standards
4.1 Physical	P. 2: Physical
4.2 Electrical	P. 2: Electrical
4.3 Performance	P. 3: Performance
4.4 Additional parameters for integral preamplifier hydrophone	P. 3: Additional parameters for integral preamplifier hydrophone
4.5 Additional parameters for transformer coupled hydrophone	P. 4: Additional parameters for transformer coupled hydrophone
5 Hydrophone calibration method	P. 3: Hydrophone calibration method
Annex A (Informative Annex) Data sheet	P. 5: Annex A Data sheet

**Annex C**  
**(Informative)**

**Technical differences and the reasons between this part and the SEG  
Geophysics, 52, no. 02, 242 – 248, 1987, Part I**

Table C. 1 provides the Technical differences between this part and the SEG Geophysics, 52, no. 02, 242 – 248, 1987 Part I and the reasons.

**Table C. 1    Technical differences between this part and the SEG Geophysics, 52, no. 02,  
242 – 248, 1987, Part I and the reasons**

The numbers of clause, sub - clause in this part	Technical differences	reasons
1	The “purpose” in part I of the SEG standards has been deleted in this part.	It is not suitable for the standard statement in China
2	Six ANSI standards have been revised editorially as the normative references.	This is for convenience of the application and the editorial requirements
3. 4~3. 7	The three types of hydrophones have been revised editorially as the definitions.	This is for convenience of the application and the editorial requirements
4. 2d)	This part has been supplemented with the regulation that the dc resistance across hydrophone output terminals should be greater than 100MΩ	This is for convenience of the operation and the inspection
4. 3a)	This part has been supplemented with the regulation that the nominal value of hydrophone free-field voltage sensitivity shall be - 194dB	This is for convenience of the operation and quality control
5	Hydrophone calibration method has been revised editorially as clause 5	This is for convenience of the application and the editorial requirements