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石油海上数字地震采集拖缆系统 第3部分：中央记录系统

Marine seismic digital streamer system—
Part 3: Central recording system

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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3部分。

本部分的附录 A 是规范性附录。

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。

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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3部分：中央记录系统

1 范围

SY/T 6736 的本部分规定了海上石油数字地震采集拖缆中央记录系统（以下简称仪器）的组成、要求、试验方法、检验规则、标志、包装、运输和贮存。

本部分适用于仪器的制造、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。

GB/T 191 包装储运图示标志

GB/T 2421.1 电工电子产品环境试验 第1部分：总则（GB/T 2421.1—1999，idt IEC 60068-1：1988，Environmental testing—Part 1：General and guidance）

GB/T 15464 仪器仪表包装通用技术条件

GB/T 15479—1995 工业自动化仪表绝缘电阻、绝缘强度技术要求和试验方法

3 组成

中央记录系统的组成包括：

- a) 控制箱。
- b) 人机交互接口：PC 机或工作站。
- c) 质量监控系统：QA/QC 工作站。
- d) 记录设备。
- e) 绘图仪。
- f) 小型打印机。
- g) 辅助设备包括：激发源同步系统。

4 要求

4.1 环境条件

环境条件要求应包括：

- a) 工作温度：10℃～40℃。
- b) 贮存温度：-40℃～+70℃。
- c) 相对湿度：20%～80%。

4.2 技术性能

4.2.1 中央记录系统的技术要求应包括：

- a) 系统道容量：在 2ms 采样时的道数。
- b) 测线能力：测线条数。
- c) 记录长度。

- d) 记录格式: SEG 格式或其他标准格式。
- e) 辅助道: 道数。
- f) 磁带机接口类型。
- g) 移动存储设备的接口: USB、并行口等。
- h) 绘图仪接口: 并行口、Versatec 或其他高速接口。
- i) 数传能力: 2ms 采样时单条缆线采集最大道数。

4.2.2 基本功能要求应包括:

- a) 一般参数设置功能。
- b) 观测系统设置功能: SPS 或 OMNI 或 MESA 标准文件的文件输入。
- c) 采集功能: 24 位定点数据的采集和向 32 位 IEEE 浮点数据的转换。
- d) 记录功能: 记录参数设置和标准 SCSI 接口。
- e) 测试功能: 系统开机自检, 仿真测试, 仪器测试和在线测试。
- f) 激发源控制、管理功能: 根据施工要求可以对激发源进行控制。
- g) 操作员班报设计功能: 能够生成 SPS 或 OMNI 或 MESA 标准格式的文件。
- h) 数据回放功能: AGC, 回放滤波, 波形或变面积或显示功能。

4.2.3 激发源同步系统: 同步误差应不大于 1ms。

4.3 外观要求

外观要求应包括:

- a) 箱体或部件外表无划伤、裂纹或变形现象, 涂覆层不应起泡、脱落, 金属部件不应锈蚀。
- b) 所有操作开关、按键应灵活可靠, 紧固件无松动; 标志及指示灯应清楚。
- c) 铭牌粘牢, 字体应清晰端正。

4.4 安全要求

安全要求应包括:

- a) 仪器外壳与交流电源供电线路之间的绝缘电阻应大于 $100\text{M}\Omega$ (1000V 直流电)。
- b) 工作环境应有防静电措施, 地线安全可靠, 防静电手环对地电阻 $1\text{M}\Omega\sim 2\text{M}\Omega$ 。

4.5 可靠性要求

中央记录系统平均故障间隔时间 (MTBF) 应不少于 300h。

4.6 连续工作时间要求

中央记录系统和水听器组合拖缆连续工作时间应不少于 96h。

5 试验方法

5.1 环境条件试验

5.1.1 试验设备及条件

试验设备包括:

- 密闭空间, 降温和升温设备。
- 压力试验设备。
- 交流调压器。

试验条件为正常的大气条件。

5.1.2 工作温度试验

中央记录系统工作温度试验方法:

- a) 将被测中央记录系统放置温度仓内, 保持通电。
- b) 调节温度仓温度降至 4.1a) 要求的下限温度 10°C , 仪器达到热平衡后, 恒温 4h, 按 A.3.1 规定的方法对中央记录系统进行通电测试, 结果应符合 4.2.2 的相应要求。

- c) 将温度仓内温度升至 4.1a) 要求的上限温度 40°C ，仪器达到热平衡后，恒温 4h，按 A.3.1 规定的方法对中央记录系统进行通电测试，结果应符合 4.2.2 的相应要求。

5.1.3 贮存温度试验

中央记录系统贮存温度试验方法：

- a) 将放置中央记录系统的温度仓内温度降至 4.1b) 要求的下限温度 -40°C ，仪器达到热平衡后，恒温 4h，恢复至室温 24h 后，按 A.3.1 规定的方法对中央记录系统进行通电测试，结果应符合 4.2.2 的相应要求。
- b) 将放置中央记录系统的温度仓内温度升至 4.1b) 要求的上限温度 $+70^{\circ}\text{C}$ ，仪器达到热平衡后，恒温 4h，恢复至室温 24h 后，按 A.3.1 规定的方法对中央记录系统进行通电测试，结果应符合 4.2.2 的相应要求。

5.2 技术性能测试

5.2.1 中央记录系统技术性能测试按 A.3.1 和 A.3.2 进行，并符合 4.2.2 的要求。

5.2.2 激发源同步系统性能测试按 A.3.3 的规定与中央记录系统联调，工作正常，应符合 4.2.3 的要求。

5.3 外观检查

用目测的方法检查，检查结果应符合 4.3 的要求。

5.4 安全性能试验

安全性能试验方法：

- a) 按 GB/T 15479—1995 中的要求进行仪器绝缘电阻试验，试验结果应符合 4.4a) 的要求。
- b) 用多用数字表检测防静电设备接地电阻，测试结果应满足 4.4b) 的要求。

5.5 可靠性试验

推荐采用中央记录系统和水听器组合拖缆组成系统，多机同时工作，对被试仪器按 A.3.4 进行测试，中央记录系统平均无故障工作时间 (MTBF) 应符合 4.5 的要求。

5.6 连续工作试验

中央记录系统和水听器组合拖缆连接组成系统，按 A.3.5 的规定进行试验，试验结果应符合 4.6 的有关要求。

6 检验规则

6.1 出厂检验

6.1.1 中央记录系统应逐台按表 1 的规定要求进行检验。

6.1.2 仪器检验合格后，方准予出厂。

6.2 型式检验

6.2.1 仪器属下列情况之一者，应进行型式检验。

- a) 新产品试制定型鉴定。
- b) 产品的结构、工艺、材料有较大改变，影响产品性能时。
- c) 产品停产两年以上恢复生产时。
- d) 出厂检验结果与上次型式检验有较大差别时。
- e) 国家或上级质量监督机构提出进行型式检验要求时。

6.2.2 型式检验应在合格产品中随机抽取，仪器数量为 1 台，进行连续工作试验时水听器组合拖缆工作段不少于 10%，至少为 1 条。

6.2.3 中央记录系统按表 1 规定的相关项目进行型式检验。

6.2.4 型式检验不通过时，应查明故障的原因。若为偶发性故障，经整改后可重新进行型式检验；若为设计、制造质量问题，则判为产品型式检验不合格。

表 1 中央记录系统检验项目表

检验项目	检验要求	试验方法	试验分类	
			出 厂	型 式
工作温度	4.1a)	5.1.2	●	● ^b
贮存温度	4.1b)	5.1.3	○ ^a	●
技术性能	4.2	5.2	●	●
外观	4.3	5.3	●	●
安全	4.4	5.4	●	●
可靠性试验	4.5	5.5	○	●
连续工作试验	4.6	5.6	●	●
* “○”表示可以不检项目。				
^b “●”表示应检项目。				

7 标志、包装、运输和贮存

7.1 标志

7.1.1 产品标志应有：制造厂（公司）名称地址、商标、出厂日期、执行标准、仪器型号、名称及编号。

7.1.2 包装标志应有：仪器单件出厂时，应在包装箱上加标志。除标以产品名称、生产厂名及出厂日期外，包装标志应符合 GB/T 191 的规定。

7.2 包装

7.2.1 产品标志应符合 GB/T 15464 的规定。

7.2.2 单件出厂时，应用专用包装箱包装。

7.2.3 仪器随机文件应包括：合格证、使用说明书、安装图及相应的验收手册、装箱单和备附件清单。

7.3 运输

仪器适用于各种交通工具运输。运输中应避免剧烈振动，防潮防尘，且不应倒置。

7.4 贮存

仪器应贮存在通风、干燥、无腐蚀性气体的环境中。长期贮存应定期（不超过 6 个月）通电检查。

附 录 A
(规范性附录)
技术性能试验

A.1 适用范围

本规程适用于海上石油数字地震采集拖缆中央记录系统的调试及检验。

A.2 测试大气条件

测试环境正常的试验大气条件按 GB/T 2421.1 的规定执行,其条件为:

- a) 温度: $15^{\circ}\text{C} \sim 35^{\circ}\text{C}$ 。
- b) 相对湿度: $45\% \sim 75\%$ 。
- c) 大气压力: $86\text{kPa} \sim 106\text{kPa}$ 。

A.3 基本技术性能测试

A.3.1 中央记录系统性能自检测试

A.3.1.1 系统开机自动诊断

以内置程序启动系统诊断,在屏幕上指示“通过”或“故障”。

A.3.1.2 仿真数据采集和处理

中央记录系统执行数据采集处理测试,即由程序控制输入已知的数字化的仿真信号脉冲和正弦波信号,检查中心站采集、处理、记录和回放各系统的工作情况,并得到脉冲和正弦波的硬拷贝纸记录,由此判定仿真数据采集和处理的正确性。

A.3.2 系统性能测试

A.3.2.1 测试条件

建立单线或多线排列,在道容量允许的范围内,选定系统采样率和采集道数。

A.3.2.2 系统功能检测

按 A.3.1 的方法,按菜单顺序检查以下功能:

- a) 一般参数设置 (General parameter)。
- b) 观测系统设置 (Preplan)。
- c) 采集功能 (Acquire)。
- d) 记录功能 (Record)。
- e) 测试功能 (Test)。
- f) 班报设计 (Daily plan)。
- g) 处理 (Noise edit)。
- h) 数据回放 (Playback)。

A.3.2.3 在线的例行测试

本测试项目主要用于系统在线的例行测试,连接中央记录系统和水听器组合拖缆组成单线或多线排列系统,按需要选择进行例行测试,将测试结果存于磁盘或直接打印。

A.3.3 激发震源同步系统试验

在仪器距激发点一定距离的条件下,系统工作正常,检查激发震源同步系统性能的可靠性及重复性。

A.3.4 可靠性试验

本试验主要用于中央记录系统的可靠性试验。求取中央记录系统的平均故障间隔时间 (MTBF)

应按以下的方法执行：

- a) 可选取多台仪器在正常工作条件下同时进行试验。
- b) 试验过程中，仪器应处于工作状态，每隔 4h 对被试仪器按 A. 3. 2 进行系统性能测试。
- c) 当被试仪器发生故障时，应停止试验，排除故障，故障排除后，再重新投入试验。
- d) 累计所有被试仪器每次试验的无故障工作时间，即故障间隔时间，依次为 t_1, t_2, \dots, t_N ；平均故障工作时间按式 (A. 1) 计算：

$$MTBF = \frac{1}{N} \sum_{i=1}^N t_i \quad \dots\dots\dots (A. 1)$$

式中：

$MTBF$ ——平均故障间隔时间，单位为小时 (h)；

$\sum_{i=1}^N t_i$ ——所有被试仪器的累计工作时间，单位为小时 (h)；

N ——试验过程被测试仪器故障的总次数， N 为自然数。

- e) 如在规定的试验过程中，当所有被试仪器没有发生故障时，平均故障间隔时间应等于所有被试仪器无故障工作时间的总和。

A. 3. 5 系统连续工作考核试验

本测试项目主要用于系统连续工作考核测试。连接中央记录系统和水听器组合组成单线排列系统，对中央记录系统按 A. 3. 1 进行一次自检测试，测试通过后，每隔 4h 按 A. 3. 2. 3 对水听器组合进行一次测试，打印测试结果，统计评价系统的连续工作时间。

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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 part is the Part 3 of SY/T 6736

Annex A of this part is normative.

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 Off-

shore 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. C.

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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 3: Central recording system

1 Scope

This part of SY/T 6736 stipulates composition of marine seismic digital streamer system central recording unit (abbreviated hereinafter as “instrument”) as well as its requirements, testing methods, inspection rules, marking, packaging, transport and storage.

This part is applicable to the manufacturing, testing and quality evaluation of the Instrument.

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.

GB/T 191 *Marking and configuration for packing and shipping*

GB/T 2421.1 *Electric and electronic product environmental tests—Part 1: General principle* (GB/T 2421.1 1999, idt IEC 60068 - 1: 1988, *Environmental testing Part 1: General and guidance*)

GB/T 15464 *Packaging of apparatus and instrument, general specifications*

GB/T 15479—1995 *Technical requirements and test methods of insulation resistance and insulating strength for use in industrial process measurement and control instruments*

3 Composition

The compositions of central recording unit are as follows:

- a) Controller.
- b) Operator interface: PC or workstation.
- c) Quality control monitoring system: QA/QC workstations.
- d) Recording equipment.
- e) Plotter.
- f) Printer.
- g) Supplementary equipments including: Seismic source synchronous controller and communication radio.

4 Requirements

4.1 Environmental

Environmental specification for central recording unit:

- a) Specified operation temperature: e. g. ($10^{\circ}\text{C} \sim 40^{\circ}\text{C}$).
- b) Specified storage temperature: e. g. ($-40^{\circ}\text{C} \sim +70^{\circ}\text{C}$).
- c) Specified humidity: e. g. ($20\% \sim 80\%$).

4.2 Technical specification

4.2.1 Main specification for central recording unit:

- a) Channel capacity: channels in 2ms sample rate.
- b) Line capacity: number of lines.
- c) Recording length.
- d) Recording format: SEG format or others.
- e) Auxiliary channel.
- f) Tape interface.
- g) Removable storage interface: USB, parallel port, etc.
- h) Plotter of digital camera interface: parallel

port, versatec or other.

- i) Capacity of transmission: active channel per line in 2ms sample rate.

4.2.2 Basic function for central recording unit:

- a) Setup and control of general parameters.
- b) The survey setup: input of SPS, OMNI, or MESA files etc. .
- c) Acquisition function: data acquisition at 24 bits fixed point, and data format conversion to 32 bits IEEE floating point.
- d) Recording function: recording parameters setting and interfaces with SCSI etc; based on the operation.
- e) System test: Self - check and instrument performance testing.
- f) The source control and management based on the requirements of operation.
- g) The operator report set up: output of SPS, OMNI, or MESA files etc. .
- h) Play - back function: AGC, digital filter, waveform or area changing , and quality monitoring functions.

4.2.3 The source synchronous controller technical specifications:

Synchronization accuracy: equal or less than 1 ms.

4.3 Appearance of requirement

Appearance requirement including:

- a) The exterior surfaces of the instruments shall be without scratch, crack or deformation. Any coating shall not be embedded with air - bubble, and shall not be peeled off. Any metallic parts shall be shown no sign of rust or corrosion.
- b) All switches, keys and push buttons shall be responsive and reliable. Any fixed parts shall not become movable. All marking and indicator lights shall be clear and correct.
- c) Name plates shall be securely fastened, with clearly inscribed text characters that are easily discernible.

4.4 Safety requirements

Safety requirements including:

- a) The isolation resistance between the exterior case of the instrument and the AC power supply circuit shall be more than 100 MΩ at 1000 V (DC) .
- b) Antistatic - damage measures shall be provided on the working site. The isolation resistance between the antistatic ring and the ground shall be 1 MΩ~2 MΩ.

4.5 Reliability requirement

MTBF (Mean Time Between Failure) for central recording unit shall be no less than 300h.

4.6 Continuous operation time

Continuous operation time for both central recording unit and field station unit shall be no less than 96h.

5 Test methods

5.1 Environmental test

5.1.1 Test equipment and condition as follows:

The test equipment:

- Temperature chamber, which capable of adjusting temperature.
- Equipment for pressure testing.
- Alternating current regulator.

The test condition under the normal atmosphere condition.

5.1.2 Operating temperature test for central recording unit:

- a) Setting the central recording unit to be tested in the temperature cabinet , the central recording unit shall be power on during test period.
- b) Dropping down temperature in the temperature cabinet to 10℃ according to 4.1a), after heating balance, holding constant temperature for 4h, doing the test for central recording unit according to the method stated in A.3.1, the test result shall be accord with requirements of 4.2.2.
- c) Stepping up temperature in the temperature cabinet to 40℃ according to 4.1a), after heating balance, holding constant tempera-

ture for 4h, doing the test for central recording unit according to the method stated in A. 3. 1 of Annex A, the test result shall be in compliance with requirements of 4. 2. 2.

5.1.3 Storage temperature test method for Central recording unit:

- a) Setting the central recording unit to be tested in the temperature cabinet, dropping down temperature in the temperature cabinet to -40°C according to 4.1b), after heating balance, holding constant temperature for 4h, then comeback to room temperature for 24h, doing the test for central recording unit according to the method stated in A. 3. 1, the test result shall be accord with requirements of 4. 2. 2.
- b) Setting the central recording system to be tested in the temperature cabinet, stepping up temperature in the temperature cabinet to $+70^{\circ}\text{C}$ according to 4.1b), after heating balance, holding constant temperature for 4h, then comeback to room temperature for 24h, doing the test for central recording unit according to the method stated in A. 3. 1 of Annex A, the test result shall be in compliance with requirements of 4. 2. 2.

5.2 Technical performance test

5.2.1 Technical performance test for central recording unit shall be implemented according to the A. 3. 1 and A. 3. 2 of Annex A, The test result shall be in compliance with requirements of 4. 2. 2.

5.2.2 Technical performance test for source synchronous controller and communication radio shall be debugging (regulating) with central recording unit according to the prescribe of A. 3. 3. The result shall be working normally and in compliance with requirements of 4. 2. 3.

5.3 Appearance check

Check the appearance of the instrument visually, shall be in compliance with requirements of 4. 3.

5.4 Safety capability test

The test method for safety capability of the in-

struments:

- a) Test for safety capability of the instruments shall be implemented according to the test methods of insulation resistance of GB/T 15479—1995. The result shall be accord with requirements of 4. 4a) .
- b) Check grounding resistance of antistatic equipment using digital multimeter. The result shall be in compliance with requirements of 4. 4b) .

5.5 Reliability test

Recommended that the reliability test shall be implemented according to the prescribed A. 3. 4, which consisted with the central recording unit and the hydrophone streamer cables, multi-system working simultaneously. The reliability shall be in compliance with requirements of 4. 5.

5.6 Continuous operating test

Shall be combined central recording unit with hydrophone streamer cable. Continuous operating test shall be implemented according to the prescribed A. 3. 5. The test result shall be in compliance with requirements of 4. 6.

6 Rules of inspection

6.1 Delivery inspection

6.1.1 The central recording unit shall be 100% inspected according to items listed under Table 1.

6.1.2 Only instruments that passed all related delivery inspection can be shipped.

6.2 Type inspection

6.2.1 Type inspection shall be carried out for any of following situations:

- a) Evaluation of new product.
- b) When performance may be effected by substantial changes in structure, technology, and material, after production.
- c) The production line restarted after idling for more than two years.
- d) There is significant difference between current delivery inspection and last type inspection.
- e) Requested by the state or a higher level or-

ganization of quality assurance.

6.2.2 Random sampling from qualified products shall be used for type inspection. For the

central recording unit minimum 1 unit shall be sampled; for the hydrophone streamer cable, more than 10%, minimum 1 shall be sampled.

Table 1 Test items for the central recording unit

Inspection Items	Requirement	Inspection methods	Classification	
			Delivery inspection	Type inspection
Operating temperature	4.1a)	5.1.2	●	● ^b
Storage temperature	4.1b)	5.1.3	○ ^a	●
Technical specification test	4.2	5.2	●	●
Appearance	4.3	5.3	●	●
Safety	4.4	5.4	●	●
Reliability test	4.5	5.5	○	●
Continuous working test	4.6	5.6	●	●
^a “○” indicate optional. ^b “●” indicate mandatory inspection item.				

6.2.3 Type inspection items for the central recording unit shall be according to items listed under Table 1.

6.2.4 If the type inspection fails, shall check the reason of failure. If it is accidental then the type inspection can be resumed after the failure cause is fixed. If failure is caused by design flaw or manufacturing quality, the unit being test shall be disqualified from type inspection.

7 Marking, packaging, transport and storage

7.1 Marking

7.1.1 Product marking: Name of manufacturer (company), address, trademark, delivery date, applicable standards, type number, product name and serial number of the product shall be marked.

7.1.2 Packaging marking: When delivery independently, marking shall be applied to package box. Apart from listing product name, manufacturer name and delivery date, the marking shall be in compliance with requirements set out in GB/T 191.

7.2 Packaging

7.1.1 Packaging shall comply with GB/T 15464.

7.1.2 When delivery independently, products shall have package box specially built for each product.

7.1.3 Documents to accompany ex-factory instruments shall include as followings:

- Certificate of qualification;
- User manual, installation drawings;
- Acceptance manual;
- Packing list;
- List of spare parts and accessories.

7.3 Transport

The instruments are suitable for transport by any vehicle. During transport, care shall be exercised to avoid severe vibration or upside down placement. Humid and dusty environment shall also be avoided.

7.4 Storage

The instruments shall be stored in environment that is ventilated, dry, and free from corrosive gas or strong magnetic field. For prolonged storage, the instruments shall be powered on regularly (not longer than 6 months).

Annex A (Normative)

Technical performance test

A. 1 Scope of application

This annex is applicable to the test and inspection for the central recording unit of marine seismic digital streamer system.

A. 2 Atmospheric conditions for testing

Normal atmospheric conditions for test environment shall comply with requirements of GB/T 2421. 1 as followings:

- a) Temperature : 15℃~35℃.
- b) Relative humidity : 45%~75%.
- c) Atmosphere pressure : 86kPa~106kPa.

A. 3 Basic technical performance test

A. 3. 1 Central recording unit performance self-inspection

A. 3. 1. 1 The system self-diagnosis after power on

Starting the system diagnosis by means of built-in program, “pass” or “fault” shall be shown on the screen.

A. 3. 1. 2 Simulation data acquisition and processing

The central recording unit performs the data acquisition and processing tests, that is to input known digitized simulation pulse signal and sine wave signal by means of built-in program to check various functions: data acquisition, data processing, data recording and data playback on the central recording system. The system shall provide the simulation pulse signal and the sine wave of hardcopy records so that a correct evaluation for the simulation data of acquisition and processing can be made.

A. 3. 2 The system performance testing

A. 3. 2. 1 Testing condition

The central recording unit and the streamer ca-

bles are connected as the single line spread or multi-lines spread system, the sampling rate and acquisition channels shall be selected in accordance with the permissible channel capacity.

A. 3. 2. 2 System function testing

System function shall be checked according to A. 3. 1 and the sequence in the menu as followings:

- a) General parameter setting.
- b) Preplan setting.
- c) Acquire function.
- d) Recording function.
- e) Testing function.
- f) Daily plan design.
- g) Noise edit.
- h) Data playback.

A. 3. 2. 3 The system online routine testing

This test is used for the system online routine testing. The central recording unit and the streamer cables are connected as the single or multi-lines spread system, the needed selective online routine testing shall be performed according to the requirements. The testing results shall be saved on various memory media or output hardcopy.

A. 3. 3 Source synchronization system testing

The source synchronization system testing shall be performed to check up on the reliability and repeatability with fixed distance between the sources and the instrument under the normal function.

A. 3. 4 Reliability testing

This test is used for central recording unit reliability testing. The MTBF (mean time between failure) can be calculated by the following procedure:

- a) Select multiple instruments to be tested simultaneously under the normal working condi-

tion.

- b) During the test, the instruments shall be powered on, doing the system performance test according to the procedure in A. 3. 2 every 4 h.
- c) If any instrument encounters failure during the test, the test shall be stopped, continue the test after the failure is removed.
- d) Accumulate the time between failures for all tested instruments as t_1, t_2, \dots, t_N , the *MTBF* is then calculated according to formula (A. 1):

$$MTBF = \frac{1}{N} \sum_{i=1}^N t_i \quad \dots\dots\dots (A. 1)$$

where:

MTBF —Mean time between failures, unit;
hour (h);

$\sum_{i=1}^N t_i$ —Sum of the normal working time of

the total tested instruments, unit;
hour (h);

N—Total failure number of the tested instruments during the test, *N* is a natural number;

- e) If there is no failure for all the tested instruments during the test, the *MTBF* shall be equal to the sum of the normal working time of the total tested instruments.

A. 3. 5 System continuous operating testing

This test is used for the system continuous operating testing. The central recording unit and the streamer cables are connected as an single line spread system, The central recording unit shall be performed self-testing in accordance with A. 3. 1 in one time. After the testing passed, the system online routine testing shall be performed every 4h. By means of A. 3. 2. 3 evaluating the system normal continuous operating testing.