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E-01 船用电线电缆

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前言

本指南是 CCS 规范的组成部分，规定船舶入级产品，授权法定产品检验适用技术要求，检验和试验要求。

本指南由 CCS 编写和更新，通过网页 <http://www.ccs.org.cn> 发布，使用相关方对于本社指南如有意见可反馈至 ps@ccs.org.cn

本指南参照和引用了《钢质海船入级规范》和 IEC60092-350(2008-02)、IEC60092-351(2004-04)、IEC60092-354(2003)、IEC60092-359(1999-08)等规范和标准。目前除《钢质海船入级规范》相关章节以外，IEC60092-350 已更新至 2014-08 第 4.0 版，IEC60092-351 与 IEC60092-359 合并成新标准 IEC60092-360(2014-04)，IEC60092-354 已更新至 2014-08 第 3.0 版。

鉴于我社尚未将上述最新版本 IEC 标准的要求纳入《钢质海船入级规范》及其修改通报，因此本指南的相关内容未作更新，仍然可以作为我社对电缆厂进行船用电缆工厂认可的技术依据，同时也可以接受电缆厂采用上述最新版本的 IEC 标准作为认可依据。

历史发布版本及发布时间

本版本主要修改内容及生效时间：

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船用电线电缆

1 一般规定

1.1 适用范围

1.1.1 本指南适用于在船舶和海上设施上固定敷设、使用的电缆的检验和认可。

1.1.2 船用电缆包括：

- (1) 电力电缆；
- (2) 控制和仪表电路用电缆，等。

1.2 规范性引用文件

1.2.1 本指南适用的船用电缆认可和检验依据如下：

1.2.2 产品及性能标准

CCS《钢质海船入级规范》第4篇第3章第5节

IEC 60092-350(2008-02) Electrical installations in ships - Part 350: Shipboard power cables - General construction and test requirements

IEC 60092-351(2004-04) Electrical installations in ships - Part 351: Insulating materials for shipboard and offshore units, power, control, instrumentation, telecommunication and data cables

IEC 60092-353(2011-08) Electrical installations in ships - Part 353: Power cables for rated voltages 1 kV and 3 kV

IEC 60092-354(2003-06) Electrical installations in ships - Part 354: Single- and three-core power cables with extruded solid insulation for rated voltages 6 kV ($U_m = 7.2$ kV) up to 30 kV ($U_m = 36$ kV)

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- IEC 60092-359(1999-08) Electrical installations in ships - Part 359: Sheathing materials for shipboard power and telecommunication cables
- IEC 60092-376(2003-05) Electrical installations in ships - Part 376: Cables for control and instrumentation circuits 150/250 V (300 V)
- IEC 60228(2004-11) Conductors of insulated cables

1.2.3 试验方法标准

- IEC 60331-1(2009-05) Tests for electric cables under fire conditions - Circuit integrity - Part 1: Test method for fire with shock at a temperature of at least 830 °C for cables of rated voltage up to and including 0,6/1,0 kV and with an overall diameter exceeding 20 mm
- IEC 60331-2(2009-05) Tests for electric cables under fire conditions - Circuit integrity - Part 2: Test method for fire with shock at a temperature of at least 830 °C for cables of rated voltage up to and including 0,6/1,0 kV and with an overall diameter not exceeding 20 mm
- IEC 60331-11(2009-07) Tests for electric cables under fire conditions - Circuit integrity - Part 11: Apparatus - Fire alone at a flame temperature of at least 750 °C
- IEC 60331-21(1999-04) Tests for electric cables under fire conditions - Circuit integrity - Part 21: Procedures and requirements - Cables of rated voltage up to and including 0,6/1,0 kV
- IEC 60331-23(1999-04) Tests for electric cables under fire conditions - Circuit integrity - Part 23: Procedures and requirements - Electric data cables

IEC 60331-25(1999-04)	Tests for electric cables under fire conditions - Circuit integrity - Part 25: Procedures and requirements - Optical fibre cables
IEC 60332-1-1(2004-07)	Tests on electric and optical fibre cables under fire conditions - Part 1-1: Test for vertical flame propagation for a single insulated wire or cable – Apparatus
IEC 60332-1-2(2004-07)	Tests on electric and optical fibre cables under fire conditions - Part 1-2: Test for vertical flame propagation for a single insulated wire or cable - Procedure for 1 kW pre-mixed flame
IEC 60332-1-3(2004-07)	Tests on electric and optical fibre cables under fire conditions - Part 1-3: Test for vertical flame propagation for a single insulated wire or cable - Procedure for determination of flaming droplets/particles
IEC 60332-3-10(2009-02)	Tests on electric and optical fibre cables under fire conditions - Part 3-10: Test for vertical flame spread of vertically-mounted bunched wires or cables - Apparatus
IEC 60332-3-21(2000-10)	Tests on electric cables under fire conditions - Part 3-21: Test for vertical flame spread of vertically-mounted bunched wires or cables - Category A F/R
IEC 60332-3-22(2009-02)	Tests on electric and optical fibre cables under fire conditions - Part 3-22: Test for vertical flame spread of vertically-mounted bunched wires or cables - Category A
IEC 60754-1(2011-11)	Test on gases evolved during combustion of materials from cables - Part 1: Determination of the halogen acid gas content

IEC 60754-2(2011-11)	Test on gases evolved during combustion of materials from cables - Part 2: Determination of acidity (pH measurement) and conductivity
IEC 61034-1(2005-04)	Measurement of smoke density of cables burning under defined conditions - Part 1: Test apparatus
IEC 61034-2(2005-04)	Measurement of smoke density of cables burning under defined conditions - Part 2: Test procedure and requirements
IEC60811-201ed1.0(2012-03)	Electric and optical fire cables – Test methods for non-metal materials – Part 201: General tests – Measurement of insulation thickness
IEC60811-202ed1.0(2012-03)	Electric and optical fire cables – Test methods for non-metallic materials – Part 202: General tests – Measurement of thickness of non-metallic sheath
IEC60811-203ed1.0(2012-03)	Electric and optical fire cables – Test methods for non-metallic materials – Part 203: General tests – Measurement of overall dimensions
IEC60811-401ed1.0(2012-03)	Electric and optical fire cables – Test methods for non-metallic materials – Part 401: Miscellaneous tests – Thermal ageing methods – Ageing in an air oven
IEC60811-412ed1.0(2012-03)	Electric and optical fire cables – Test methods for non-metallic materials – Part 412: Miscellaneous tests – Thermal ageing methods – Ageing in an air bomb
IEC60811-402ed1.0(2012-03)	Electric and optical fire cables – Test methods for non-metallic materials – Part 402: Miscellaneous tests – Water absorption tests

- IEC60811-502ed1.0(2012-03) Electric and optical fire cables – Test methods for non-metallic materials – Part 502: Mechanical tests – Shrinkage test for insulations
- IEC60811-503ed1.0(2012-03) Electric and optical fire cables – Test methods for non-metallic materials – Part 503: Mechanical tests – Shrinkage test for sheaths
- IEC60811-606ed1.0(2012-03) Electric and optical fire cables – Test methods for non-metallic materials – Part 606: Physical tests – Methods for determining the density
- IEC60811-403ed1.0(2012-03) Electric and optical fire cables – Test methods for non-metallic materials – Part 403: Miscellaneous tests – Ozone resistance test on cross-linked compounds
- IEC60811-404ed1.0(2012-03) Electric and optical fire cables – Test methods for non-metallic materials – Part 507: Mechanical tests – Hot set test for cross-linked materials
- IEC60811-508ed1.0(2012-03) Electric and optical fire cables – Test methods for non-metallic materials – Part 508: Mechanical tests – Pressure test at high temperature for insulation and sheaths
- IEC60811-509ed1.0(2012-03) Electric and optical fire cables – Test methods for non-metallic materials – Part 509: Mechanical tests – Test for resistance of insulations and sheaths to cracking (heat shock test)
- IEC60811-405ed1.0(2012-03) Electric and optical fire cables – Test methods for non-metallic materials – Part 405: Miscellaneous tests – Thermal stability test for PVC insulation and PVC sheaths

- IEC60811-409ed1.0(2012-03) Electric and optical fire cables – Test methods for non-metallic materials – Part 409: Miscellaneous tests – Loss of mass test for thermoplastic insulations and sheaths
- IEC60811-406ed1.0(2012-03) Electric and optical fire cables – Test methods for non-metallic materials – Part 406: Miscellaneous tests – Resistance to stress cracking of polyethylene and polypropylene compounds
- IEC60811-511ed1.0(2012-03) Electric and optical fire cables – Test methods for non-metallic materials – Part 511: Mechanical tests – Measurement of the melt flow index of polyethylene compounds
- IEC60811-605ed1.0(2012-03) Electric and optical fire cables – Test methods for non-metallic materials – Part 605: Physical tests – Measurement of carbon black and/or mineral filler in polyethylene compounds
- IEC60811-607ed1.0(2012-03) Electric and optical fire cables – Test methods for non-metallic materials – Part 605: Physical tests – Measurement of carbon black and/or mineral filler in polyethylene compounds
- IEC60811-607ed1.0(2012-03) Electric and optical fire cables – Test methods for non-metallic materials – Part 607: Physical tests – Test for the assessment of carbon black dispersion in polyethylene and polypropylene
- IEC60811-407ed1.0(2012-03) Electric and optical fire cables – Test methods for non-metallic materials – Part 407: Miscellaneous tests – Measurement of mass increase of polyethylene and polypropylene compounds
- IEC60811-408ed1.0(2012-03) Electric and optical fire cables – Test methods for non-metallic materials – Part 408:

- Miscellaneous tests – Long-term stability test of polyethylene and polypropylene compounds
- IEC60811-410ed1.0(2012-03) Electric and optical fire cables – Test methods for non-metallic materials – Part 410: Miscellaneous tests – Test method for copper-catalyzed oxidative degradation of polyolefin insulated conductors
- IEC60811-510ed1.0(2012-03) Electric and optical fire cables – Test method for non-metallic materials – Part 510: Mechanical tests – Methods specific to polyethylene and polypropylene compounds – Wrapping test after thermal ageing in air
- IEC60811-512ed1.0(2012-03) Electric and optical fire cables – Test methods for non-metallic materials – Part 512: Mechanical tests – Methods specific to polyethylene and polypropylene compounds – Tensile strength and elongation at break after conditioning at elevated temperature
- IEC60811-513ed1.0(2012-03) Electric and optical fire cables – Test methods for non-metallic materials – Part 513: Mechanical tests – Methods specific to polyethylene and polypropylene compounds – Wrapping test after conditioning
- IEC60811-501ed1.0(2012-03) Electric and optical fire cables – Test methods for non-metallic materials – Part 501: Mechanical tests – Tests for determining the mechanical properties of insulating and sheathing compounds
- IEC 60189-1(2007-05) Low-frequency cables and wires with PVC insulation and PVC sheath - Part 1: General test and measuring methods

IEC 60189-2(2007-05)	Low-frequency cables and wires with PVC insulation and PVC sheath - Part 2: Cables in pairs, triples, quads and quintuples for inside installations
IEC 60189-3(2007-05)	Low-frequency cables and wires with PVC insulation and PVC sheath - Part 3: Equipment wires with solid or stranded conductor wires, PVC insulated, in singles, pairs and triples
IEC 60684-2(2011-08)	Flexible insulating sleeving - Part 2: Methods of test
IEC 60885-2(1987-03)	Electrical test methods for electric cables. Part 2: Partial discharge tests

1.2.4 其他标准

IEC 60050-461(2008-06)	International Electrotechnical Vocabulary - Part 461: Electric cables
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1.3 定义

1.3.1 本指南采用的术语和定义与 IEC 60050-461(2008-06)一致。

2 图纸资料

2.1 提交 CCS 审查、批准的图纸、资料的一般要求如下；

2.2 应将以下文件、资料提交 CCS 批准：

2.2.1 电缆结构图；

2.2.2 电缆技术条件或等效文件。

2.3 应将以下文件、资料提交 CCS 备查：

2.3.1 电缆型号、规格的命名规则；

2.3.2 电缆结构数据表，或等效文件；

2.3.3 标明质量控制点的生产工艺流程图；

2.3.4 生产工艺文件清单；

2.3.5 生产设备清单；

2.3.6 检测设备清单；

2.3.7 主要原材料牌号及其供方清单；

2.3.8 质量证明书模板；

2.3.9 无石棉声明；

2.3.10 出厂检验大纲，或等效文件；

2.3.11 出厂检验报告格式；

2.3.12 产品使用说明书；

2.3.13 其他需要提交审批的文件。

3 技术要求

3.1 船用电缆应满足以下标准：

3.1.1 船用用电缆应满足 IEC60092-350(2008-02)要求。

3.1.2 额定电压 1kV 和 3kV 船用电力电缆应满足 IEC60092-353(2011-08)要求。

3.1.3 额定电压 6kV 至 30kV 船用电力电缆应满足 IEC60092-354(2003-06)要求。

3.1.4 船用控制和仪表电路用电缆应满足 IEC60092-376(2003-05)要求。

3.2 电缆绝缘、非金属护层和护套、填充、绕包带等非金属聚合物中不应含有石棉。

3.3 载流超过 20A 的交流单芯电力电缆或电缆线芯应为无金属铠装的或为非磁性材料铠装或覆盖的。

3.4 电力电缆的屏蔽应符合 IEC60092-353 第 5.5 条规定。金属屏蔽层应包覆在芯线绞合（最少为 2 根芯线的绞合组）外。2 芯、3 芯及多芯船用电力电缆的每一单独绝缘线芯外应为无金属屏蔽或覆盖的（即：分屏蔽电缆是不被允许的）。

3.5 当使用镀锌钢丝编织铠装时，2 芯、3 芯及多芯船用电力电缆的线芯成缆后应有挤出型内护层。

3.6 船用电力电缆的绝缘聚合物材料和名称应是 IEC60092-351 中规定的。额定电压为 0.6/1(1.2)kV 及以下的电力电缆的绝缘材料应使用 EPR、HEPR、XLPE、HF 90 或 S 95；额定电压为 1.8/3(3.6)kV 及以下的电力电缆的绝缘材料应使用 EPR、HEPR、XLPE。

3.7 船用电力电缆的内、外护套材料不应是 IEC60092-359 中规定的 ST1 型 PVC。

4 认可和试验

4.1 用于 CCS 级船舶的电缆应经 CCS 工厂认可。工厂认可包括图纸和技术文件的审批、认可型式试验和现场审核。

4.2 船用电缆应按规定进行型式试验，具体试验应满足 1.4.2.1 至 1.4.2.4 的要求。

4.2.1 若无其它规定，所有试验均应在下述大气条件下进行：

- (1) 环境温度：15℃～35℃；
- (2) 相对湿度：30%RH～90%RH；
- (3) 气压：86～106 kPa。

4.2.2 额定电压 1kV 和 3kV 船用电力电缆应按表 1.4.2.2 要求进行型式试验；

4.2.3 额定电压 6kV 至 30kV 船用电力电缆应按表 1.4.2.3 要求进行型式试验；

4.2.4 船用控制和仪表电路用电缆应按表 4.2.4 要求进行型式试验。

额定电压 1kV 和 3kV 电力电缆型式试验

表 4.2.2

序号	试验项目/Test	技术要求/Requirement	试验方法/Testing Method
1	电性能/Electrical		
1.1	绝缘电阻试验 (20℃)/Insulation resistance test	IEC60092-351:2004 表 2	IEC60092-350:2008 第 7.2.1 条
1.2	最高工作温度(90℃)时 绝缘电阻测量/Insulation resistance measurement at maximum rated temperature	IEC60092-351:2004 表 2	IEC60092-350:2008 第 7.2.2 条
1.3	浸水后电容增值测量 /Increase in a.c. capacitance after immersion in water	IEC60092-350:2008 第 7.3 条	IEC60092-350:2008 第 7.3 条
1.4	4h 高压试验 /High-voltage test for 4 h	IEC60092-350:2008 第 7.4 条	IEC60092-350:2008 第 7.4 条
2	非电性能/Non-electrical		
2.1	导体检查/Conductor examination	IEC60092-353:2011 第 5.2 条 IEC60228:2004 表 II、III	IEC60092-350:2008 第 6.4 条
2.2	电缆结构尺寸检查 /Check of cable dimensions . 绝缘厚度/Thickness of insulation . 非金属护套(包括内护 层)厚度/Thickness of non metallic sheaths (excluding inner coverings) . 外径/External diameter	IEC60092-353:2011 第 5.3.3 条 IEC60092-353:2011 第 5.5.2 条 IEC60092-353:2011 第 5.7.3 条	IEC60092-353:2011 第 8.1 条 IEC60092-353:2011 第 8.2 条 IEC60092-353:2011 第 6.7 条
2.3	热延伸试验/Hot set test (HEPR, EPR, XLPE, HF 90, S 95 insulations and SE1, SHF2 sheaths)	IEC60092-351:2004 表 4 IEC60092-359:1999 表 II	IEC60092-350:2008 第 6.8 条
2.4	编织覆盖密度(编织铠装 电缆)/Coverage density of braid (Braid armoured Cables)	IEC60092-353:2011 第 5.8 条	IEC60092-350:2008 第 4.8.2 条

续表 4.2.2

2.5	空气箱老化前和老化后绝缘的机械性能试验 /Mechanical properties of insulation before and after ageing	IEC60092-351:2004 表 3	IEC60092-350:2008 第 8.3 条
2.6	空气箱老化前和老化后护套的机械性能试验 /Mechanical properties of sheath before and after ageing	IEC60092-359:1999 表 II	IEC60092-350:2008 第 8.4 条
2.7	附加老化相容性试验 /Additional ageing compatibility test	IEC60092-351:2004 表 3	IEC60092-350:2008 第 8.5 条
2.8	失重试验(ST2 护套)/Loss of mass test (ST2 sheath)	IEC60092-359:1999 表 III	IEC60092-350:2008 第 8.6 款
2.9	高温下性能试验(压力试验)(ST2、SHF1 护套)/Behaviour at high temperature (ST2 and SHF1 Sheaths)	IEC60092-359:1999 表 III	IEC60092-350:2008 第 8.7 款
2.10	低温下性能试验(ST2、SHF1 和 SHF2 护套)/Behaviour at low temperatures (ST2, SHF1 and SHF2 sheaths)	IEC60092-359:1999 表 III	IEC60092-350:2008 第 8.8 条
2.11	铜丝镀层试验/Test for coating of copper wires	IEC60092-350:2008 第 8.10 条	IEC60092-350:2008 第 8.10 条
2.12	镀锌试验/Galvanizing test	IEC60092-350:2008 第 8.11 条 ISO 7989-2:2007 第 5.3 条	IEC60092-350:2008 第 8.11 条 ISO 7989-2:2007 第 5.3 条
2.13	抗热冲击试验(抗开裂试验)(ST2 和 SHF1 护套)/Resistance to cracking heat shock (ST2 and SHF1 sheaths)	IEC60092-359:1999 表 III	IEC60092-350:2008 第 8.12 条
2.14	耐臭氧(绝缘和护套)/Ozone resistance (Insulations and sheaths)	IEC60092-351:2004 表 4 IEC60092-359:1999 表 III	IEC60092-350:2008 第 8.13 条

续表 4.2.2

2.15	浸热油(SE1、SH 和 SHF2 护套)/Hot oil immersion (SE1, SH and SHF2 sheaths)	IEC60092-359:1999 表 II	IEC60092-350:2008 第 8.14.1 条
2.16	播焰(燃烧)试验 /Flame-spread tests: IEC 60332-1-2 and IEC 60332-3-22	IEC60092-350:2008 第 8.16.1 条 IEC60332-1-2:2004 IEC60092-350:2008 第 8.16.2 条 IEC60332-3-22:2009	IEC60092-350:2008 第 8.16.1 条 IEC60332-1-2:2004 IEC60092-350:2008 第 8.16.2 条 IEC60332-3-22:2009 in which case cables shall be installed in touching configuration on the front of the ladder
2.17	硬度测定(HEPR 绝缘)/Determination of hardness (HEPR insulation)	IEC60092-351:2004 表 4	IEC60092-350:2008 第 8.17 条
2.18	弹性模量测定(HEPR 绝缘)/Determination of modulus of elasticity (HEPR insulation)	IEC60092-351:2004 表 4	IEC60092-350:2008 第 8.18 条
2.19	标识耐久性/Durability of marking	IEC60092-350:2008 第 8.19 条 IEC60092-353:2011 第 4.2 条	IEC60092-350:2008 第 8.19 条 IEC60092-353:2011 第 4.2 条
3	无卤电缆附加试验/Additional tests required for halogen-free cables		
3.1	酸气逸出/Acid gas emission	IEC60092-350:2008 第 4.1.4 条	IEC60092-350:2008 第 8.16.4 条 IEC60754-1:1994
3.2	pH 值和传导率/pH and conductivity	IEC60092-350:2008 第 4.1.4 条	IEC60092-350:2008 第 8.16.5 条 IEC60754-2:1991+ Amd1:1997
3.3	氟含量试验/Fluorine content test	IEC60092-350:2008 第 4.1.4 条	IEC60092-350:2008 第 8.16.6 条 IEC60684-2:1997 + Amd1:2003
4	低烟电缆附加试验/Additional test required for low smoke cables		

续表 4.2.2

4.1	烟密度试验/Smoke emission test for cables insulated and sheathed with halogenfree materials. When tested according to IEC 61034-1 and IEC 61034-2	IEC60092-350:2008 第 8.16.3 条 IEC61034-1:2005 IEC61034-2:2005 The test is satisfactory for the finished cables if the levels of light transmittance exceeds 60% throughout the test	IEC60092-350:2008 第 8.16.3 条 IEC61034-1:2005 IEC61034-2:2005
5	耐火电缆附加试验/Additional tests required for fire resistant cables		
5.1	耐火试验(电路完整性), 试验时间最少 90 分钟 /Test for fire resistance (limited circuit integrity), The test shall be carried out in accordance with IEC 60331-21 or IEC 60331-1 or IEC 60331-2 and the minimum time to failure shall be 90 min	IEC60092-350:2008 第 8.16.7 条 IEC60331-1:2009(电缆外径大于 20mm/Overall diameter exceeding 20mm) IEC60331-2:2009(电缆外径不大于 20mm/Overall diameter not exceeding 20mm) IEC60331-21:1999	IEC60092-350:2008 第 8.16.7 条 IEC60331-1:2009(电缆外径大于 20mm/Overall diameter exceeding 20mm) IEC60331-2:2009(电缆外径不大于 20mm/Overall diameter not exceeding 20mm) IEC60331-21:1999
6	特殊性能附加试验/Additional tests required for specific performances		
6.1	低温性能特殊试验 /Special test for low temperature behaviour	IEC60092-350:2008 第 8.9 条	IEC60092-350:2008 第 8.9 条
6.2	加强浸热油试验 /Enhanced hot oil immersion	IEC60092-359:1999 表 II	IEC60092-350:2008 第 8.14.2 条
6.3	耐钻井泥浆试验/Mud fluid drilling test	IEC60092-350:2008 第 8.15 条	IEC60092-350:2008 第 8.15 条

额定电压 6kV 至 30kV 挤出固体绝缘单芯和三芯电力电缆型式试验 表 4.2.3

序号	试验项目	技术要求	试验方法
1	电性能试验		
1.1	局部放电试验	IEC60092-354:2003 第 18.3.3 条	IEC60092-354:2003 第 18.3.3 条 IEC60885-2:1987
1.2	弯曲试验	IEC60092-354:2003 第 18.3.4 条	IEC60092-354:2003 第 18.3.4 条
1.3	有关电压函数 Tan δ 的测量	IEC60092-354:2003 第 18.3.5 条	IEC60092-354:2003 第 18.3.5 条

续表 4.2.3

1.4	有关温度函数 $\tan \delta$ 的测量	IEC60092-354:2003 第 18.3.6 条	IEC60092-354:2003 第 18.3.6 条
1.5	热循环加局部放电试验	IEC60092-354:2003 第 18.3.7 条	IEC60092-354:2003 第 18.3.7 条
1.6	耐脉冲试验后再做工频电压试验	IEC60092-354:2003 第 18.3.8 条	IEC60092-354:2003 第 18.3.8 条
1.7	4 小时电压试验	IEC60092-354:2003 表 5	IEC60092-354:2003 第 18.2 f)条
2	非电性能试验		
2.1	绝缘厚度测量	IEC60092-354:2003 表 1 IEC60092-350:2008 第 4.3.3 条	IEC60092-350:2008 第 8.1 条
2.2	非金属护套厚度测量	IEC60092-354:2003 第 14.2 和 15.2 条 IEC60092-350:2008 第 4.7.3 和 4.9.3 条	IEC60092-350:2008 第 8.2 条
2.3	空气箱老化前和老化后绝缘的机械性能试验	IEC60092-351:2004 表 3	IEC60092-350:2008 第 8.3 条
2.4	空气箱老化前和老化后护套的机械性能试验	IEC60092-359:1999 表 II	IEC60092-350:2008 第 8.4 条
2.5	成品电缆试样的附加老化试验（相容性试验）	IEC60092-351:2004 表 3	IEC60092-350:2008 第 8.5 条
2.6	PVC 绝缘和 ST1、ST2 护套失重试验	IEC60092-351:2004 表 4 IEC60092-359:1999 表 III	IEC60092-350:2008 第 8.6 款
2.7	PVC 绝缘和 ST1、ST2、SHF1 护套在高温下性能试验(压力试验)	IEC60092-351:2004 表 4 IEC60092-359:1999 表 III	IEC60092-350:2008 第 8.7 款
2.8	PVC 绝缘和 ST1、ST2、SHF1、SHF2 护套在低温下的性能试验	IEC60092-351:2004 表 4 IEC60092-359:1999 表 III	IEC60092-350:2008 第 8.8 条
2.9	低温性能特殊试验	IEC60092-350:2008 第 8.9 条	IEC60092-350:2008 第 8.9 条
2.10	铜线的金属镀层试验	IEC60228:2004 表 II、III	IEC60092-350:2008 第 8.10 条
2.11	镀锌试验	IEC60092-350:2008 第 8.11 条	IEC60092-350:2008 第 8.11 条
2.12	PVC 绝缘和 ST1、ST2、SHF1 护套抗开裂试验(热冲击试验)	IEC60092-351:2004 表 4 IEC60092-359:1999 表 III	IEC60092-350:2008 第 8.12 条
2.13	热固性绝缘和护套热延伸试验	IEC60092-351:2004 表 4 IEC60092-359:1999 表 II	IEC60092-350:2008 第 6.8 条

续表 4.2.3

2.14	EPR、HEPR、HF EPR、HFHEPR、HF 90 绝缘和 SE1、SH、SHF2 护套耐臭氧试验	IEC60092-351:2004 表 4 IEC60092-359:1999 表 III	IEC60092-350:2008 第 8.13 条
2.15	热固性外护套浸油试验	IEC60092-359:1999 表 II	IEC60092-350:2008 第 8.14 条
2.16	单根阻燃试验	IEC60092-350:2008 第 8.16.1 条 IEC60332-1-2:2004	IEC60092-350:2008 第 8.16.1 条 IEC60332-1-2:2004
2.17	成束阻燃试验	IEC60092-350:2008 第 8.16.2 条 IEC60332-3-22:2000	IEC60092-350:2008 第 8.16.2 条 IEC60332-3-22:2000
2.18	电缆耐火试验	IEC60092-350:2008 第 8.16.7 条 IEC60331-1:2009 IEC60331-21:1999	IEC60092-350:2008 第 8.16.7 条 IEC60331-1:2009 IEC60331-21:1999
2.19	成品电缆烟密度测量	IEC60092-350:2008 第 8.16.3 条 IEC61034-1:2005 IEC61034-2:2005	IEC60092-350:2008 第 8.16.3 条 IEC61034-1:2005 IEC61034-2:2005
2.20	绝缘、护套、填充物及其他非金属材料卤酸气体酸度测定	IEC60092-350:2008 第 4.1.4 条	IEC60092-350:2008 第 8.16.5 条
2.21	绝缘、护套、填充物及其他非金属材料卤酸气体含量测定	IEC60092-350:2008 第 4.1.4 条	IEC60092-350:2008 第 8.16.4 条
2.22	绝缘、护套、填充物及其他非金属材料氟含量测定	IEC60092-350:2008 第 4.1.4 条	IEC60092-350:2008 第 8.16.6 条
2.23	HEPR 和 HF HEPR 绝缘的硬度测定	IEC60092-351:2004 表 4	IEC60092-350:2008 第 8.17 条
2.24	HEPR 和 HF HEPR 绝缘的弹性模数测定	IEC60092-351:2004 表 4	IEC60092-350:2008 第 8.18 条
2.25	电缆外观检查	IEC60092-354:2003 第 7 条	IEC60092-350:2008 第 8.19 条 IEC60092-354:2003 第 17.1 条

注：电性能试验应按 1.1~1.7 顺序进行。

船用控制和仪表电路用电缆型式试验

表 4.2.4

序号	试验项目/Test	技术要求/Requirement	试验方法/Testing Method
1	电性能/Electrical		
1.1	绝缘电阻试验 (20°C)/Insulation resistance test	IEC60092-351:2004 表 2	IEC60092-350:2008 第 7.2.1 条
1.2	最高工作温度(90°C)时绝缘 电阻测量/Insulation resistance measurement at maximum rated temperature	IEC60092-351:2004 表 2	IEC60092-350:2008 第 7.2.2 条
1.3	耦合电容测量/Mutual capacitance	NIL	IEC60092-350:2008 第 7.5 条 IEC60092-376:2003 第 17.4 a)条
1.4	电感电阻比(L / R)/ Inductance to resistance ratio (L/R ratio)	NIL	IEC60092-350:2008 第 7.6 条 IEC60092-376:2003 第 17.4 b)条
2	非电性能/Non-electrical		
2.1	导体检查/Conductor examination	IEC60092-376:2003 Table 6 IEC60228:2004 表 II、III	IEC60092-350:2008 第 6.4 条
2.2	电缆结构尺寸检查 /Check of cable dimensions 绝缘厚度/Thickness of insulation 非金属护套(包括内护 层)厚度/Thickness of non metallic sheaths (excluding inner coverings) 外径/External diameter	IEC60092-376:2003 第 10.4 条 IEC60092-376:2003 第 13.2 条 IEC60092-376:2003 第 14.1 条	IEC60092-353:2011 第 8.1 条 IEC60092-353:2011 第 8.2 条 IEC60092-353:2011 第 6.7 条
2.3	热延伸试验/Hot set test (HEPR, EPR, XLPE, HF 90, S 95 insulations and SE1, SHF2 sheaths)	IEC60092-351:2004 表 4 IEC60092-359:1999 表 II	IEC60092-350:2008 第 6.8 条
2.4	屏蔽层检查(屏蔽电缆)/ Electrostatic screen (Screened Cables)	IEC60092-376:2003 第 12 条	IEC60092-350:2008 第 4.8.2 条

续表 4.2.4

2.5	编织覆盖密度(编织铠装电缆)/Coverage density of braid (Braid armoured Cables)	IEC60092-376:2003 第 15 条	IEC60092-350:2008 第 4.8.2 条
2.6	空气箱老化前和老化后绝缘的机械性能试验 /Mechanical properties of insulation before and after ageing	IEC60092-351:2004 表 3	IEC60092-350:2008 第 8.3 条
2.7	空气箱老化前和老化后护套的机械性能试验 /Mechanical properties of sheath before and after ageing	IEC60092-359:1999 表 II	IEC60092-350:2008 第 8.4 条
2.8	附加老化相容性试验 /Additional ageing compatibility test	IEC60092-351:2004 表 3	IEC60092-350:2008 第 8.5 条
2.9	失重试验(ST2 护套)/Loss of mass test (ST2 sheath)	IEC60092-359:1999 表 III	IEC60092-350:2008 第 8.6 款
2.10	高温下性能试验(压力试验)(ST2、SHF1 护套)/Behaviour at high temperature (ST2 and SHF1 Sheaths)	IEC60092-359:1999 表 III	IEC60092-350:2008 第 8.7 款
2.11	低温下性能试验(ST2、SHF1 和 SHF2 护套)/Behaviour at low temperatures (ST2, SHF1 and SHF2 sheaths)	IEC60092-359:1999 表 III	IEC60092-350:2008 第 8.8 条
2.12	铜丝镀层试验/Test for coating of copper wires	IEC60092-350:2008 第 8.10 条	IEC60092-350:2008 第 8.10 条
2.13	镀锌试验/Galvanizing test	IEC60092-350:2008 第 8.11 条 ISO 7989-2:2007 第 5.3 条	IEC60092-350:2008 第 8.11 条 ISO 7989-2:2007 第 5.3 条
2.14	抗热冲击试验(抗开裂试验)(ST2 和 SHF1 护套)/Resistance to cracking heat shock (ST2 and SHF1 sheaths)	IEC60092-359:1999 表 III	IEC60092-350:2008 第 8.12 条

续表 4.2.4

2.15	耐臭氧(绝缘和护套)/Ozone resistance (Insulations and sheaths)	IEC60092-351:2004 表 4 IEC60092-359:1999 表III	IEC60092-350:2008 第 8.13 条
2.16	浸热油(SE1、SH 和 SHF2 护套)/Hot oil immersion (SE1, SH and SHF2 sheaths)	IEC60092-359:1999 表 II	IEC60092-350:2008 第 8.14.1 条
2.17	播焰(燃烧)试验 /Flame-spread tests: IEC 60332-1-2 and IEC 60332-3-22	IEC60092-350:2008 第 8.16.1 条 IEC60332-1-2:2004 IEC60092-350:2008 第 8.16.2 条 IEC60332-3-22:2009	IEC60092-350:2008 第 8.16.1 条 IEC60332-1-2:2004 IEC60092-350:2008 第 8.16.2 条 IEC60332-3-22:2009 in which case cables shall be installed in touching configuration on the front of the ladder
2.18	硬度测定(HEPR 绝缘)/Determination of hardness (HEPR insulation)	IEC60092-351:2004 表 4	IEC60092-350:2008 第 8.17 条
2.19	弹性模量测定(HEPR 绝缘)/Determination of modulus of elasticity (HEPR insulation)	IEC60092-351:2004 表 4	IEC60092-350:2008 第 8.18 条
2.20	标识耐久性/Durability of marking	IEC60092-350:2008 第 8.19 条 IEC60092-376:2003 第 7.3 条	IEC60092-350:2008 第 8.19 条 IEC60092-376:2003 第 16.2 条
3	无卤电缆附加试验/Additional tests required for halogen-free cables		
3.1	酸气逸出/Acid gas emission	IEC60092-350:2008 第 4.1.4 条	IEC60092-350:2008 第 8.16.4 条 IEC60754-1:1994
3.2	pH 值和传导率/pH and conductivity	IEC60092-350:2008 第 4.1.4 条	IEC60092-350:2008 第 8.16.5 条 IEC60754-2:1991+ Amd1:1997
3.3	氟含量试验/Fluorine content test	IEC60092-350:2008 第 4.1.4 条	IEC60092-350:2008 第 8.16.6 条 IEC60684-2:1997 + Amd1:2003

4	低烟电缆附加试验/Additional test required for low smoke cables		
4.1	烟密度试验/Smoke emission test for cables insulated and sheathed with halogenfree materials. When tested according to IEC 61034-1 and IEC 61034-2	IEC60092-350:2008 第 8.16.3 条 IEC61034-1:2005 IEC61034-2:2005 The test is satisfactory for the finished cables if the levels of light transmittance exceeds 60% throughout the test	IEC60092-350:2008 第 8.16.3 条 IEC61034-1:2005 IEC61034-2:2005
5	耐火电缆附加试验/Additional tests required for fire resistant cables		
5.1	耐火试验(电路完整性), 试验时间最少 90 分钟 /Test for fire resistance (limited circuit integrity), The test shall be carried out in accordance with IEC 60331-21 or IEC 60331-1 or IEC 60331-2 and the minimum time to failure shall be 90 min	IEC60092-350:2008 第 8.16.7 条 IEC60331-1:2009(电缆外径大于 20mm/Overall diameter exceeding 20mm) IEC60331-2:2009(电缆外径不大于 20mm/Overall diameter not exceeding 20mm) IEC60331-21:1999	IEC60092-350:2008 第 8.16.7 条 IEC60331-1:2009(电缆外径大于 20mm/Overall diameter exceeding 20mm) IEC60331-2:2009(电缆外径不大于 20mm/Overall diameter not exceeding 20mm) IEC60331-21:1999
6	特殊性能附加试验/Additional tests required for specific performances		
6.1	低温性能特殊试验 /Special test for low temperature behaviour	IEC60092-350:2008 第 8.9 条	IEC60092-350:2008 第 8.9 条
6.2	加强浸热油试验 /Enhanced hot oil immersion	IEC60092-359:1999 表 II	IEC60092-350:2008 第 8.14.2 条
6.3	耐钻井泥浆试验/Mud fluid drilling test	IEC60092-350:2008 第 8.15 条	IEC60092-350:2008 第 8.15 条

4.4 取样原则

4.4.1 试验样品的型号、规格应能覆盖申请工厂认可的产品范围。一般情况下应对每一系列的电缆产品抽样试验。

4.4.2 试验样品的型号、规格应具有技术代表性。即：试验样品通过认可型式试验的难度较大。

4.4.3 试验样品的数量（长度）应满足相关标准的要求。

4.4.4 试验样品应由 CCS 验船师到申请方工厂抽取。

4.5 试验机构

4.5.1 初次工厂认可时，应由经 CCS 认可的试验机构承担认可试验。

4.5.2 工厂认可证书换新时，如制造厂具备标准规定的试验环境、试验设备，并具有适任的检验、试验人员，经 CCS 同意，可以考虑在制造厂的试验室进行工厂认可型式试验、CCS 验船师现场见证。

4.6 认可证书

4.6.1 工厂认可证书的颁发、保持、更改、换新及取消请见《钢质海船入级规范》第1篇第3章相关要求。

5 单件/单批检验

5.1 额定电压 1kV 和 3kV 船用电力电缆在制造厂至少应进行以下检验和试验：

额定电压 1kV 和 3kV 电力电缆单件/单批检验试验大纲

表 5.1

序号	试验项目/Test	技术要求/Requirement	试验方法/Testing Method
1	例行试验/Routine Tests		
1.1	导体电阻测量 /Measurement of electrical resistance of conductors	IEC60228:2004 表 II、III	IEC60092-350:2008 第 5.2.2 条
1.2	电压试验/Voltage test	IEC60092-350:2008 第 5.2.3 条	IEC60092-350:2008 第 5.2.3 条
1.3	护套电压试验(铠装电 缆)Voltage test on sheath (Armoured cables)	IEC60092-350:2008 第 5.2.3.4 条	IEC60092-350:2008 第 5.2.3.4 条
1.4	绝缘电阻试验/Insulation resistance test	IEC60092-351:2004 表 2	IEC60092-350:2008 第 5.2.4 条
2	抽样试验/Sample Tests		

续表 5.1

2.1	绝缘电阻试验/Insulation resistance test	IEC60092-350:2008 第 7.2.4 条	IEC60092-350:2008 第 5.2.4 条
2.2	导体检查/Conductor examination	IEC60092-353:2011 第 5.2 条 IEC60228:2004 表 II、III	IEC60092-350:2008 第 6.4 条
2.3	电缆结构尺寸检查 /Check of cable dimensions . 绝缘厚度/Thickness of insulation . 非金属护套(包括内护层)厚度/Thickness of non metallic sheaths (excluding inner coverings) . 外径/External diameter	IEC60092-353:2011 第 5.3.3 条 IEC60092-353:2011 第 5.5.2 条 IEC60092-353:2011 第 5.7.3 条	IEC60092-353:2011 第 6.5 条 IEC60092-353:2011 第 6.5 条 IEC60092-353:2011 第 6.7 条
2.4	热延伸试验/Hot set test (HEPR, EPR, XLPE, HF 90, S 95 insulations and SE1, SHF2 sheaths)	IEC60092-351:2004 表 4 IEC60092-359:1999 表 II	IEC60092-350:2008 第 6.8 条

注：例行试验应在交货的全长度上进行；抽样试验的频率和试样数量详见 IEC60092-350:2008 第 6.2 条。

5.2 额定电压 6kV 到 30kV 船用电力电缆在制造厂至少应进行以下检验和试验（全数）：

5.2.1 导体直流电阻测量（IEC60092-350:2008 第 5.5.2 条）；

5.2.2 局部放电试验（IEC60092-354:2003 第 18.1(b)条）；

5.2.3 高压试验（IEC60092-350:2008 第 5.5.3 条）；

5.2.4 导体检查（IEC60092-350:2008 第 6.4 条，试验频率见 IEC60092-350:2008 第 6.2 条）；

5.2.5 结构检查（IEC60092-350:2008 第 6.5～6.7 条，试验频率见 IEC60092-350:2008 第 6.2 条）；

5.2.6 热固性绝缘和护套的热延伸试验（IEC60092-350:2008 第 6.8 条，试验频率见 IEC60092-350:2008 第 6.2 条）。

额定电压 6kV 到 30kV 电力电缆单件/单批检验试验大纲

表 5.2

序号	试验项目/Test	技术要求/Requirement	试验方法/Testing Method
1	例行试验/Routine Tests		
1.1	导体电阻测量 /Measurement of electrical resistance of conductors	IEC60092-354:2003 第 9 条 IEC60228:2004 表 II、III	IEC60092-350:2008 第 5.2.2 条
1.2	局部放电试验/ Partial discharge test	IEC60092-354:2003 第 18.1b)条	IEC60092-354:2003 第 18.1b)条
1.3	电压试验/Voltage test	IEC60092-354:2003 第 18.1c)条	IEC60092-350:2008 第 5.2.3 条
2	特殊试验/Special Tests		
2.1	导体检查/Conductor examination	IEC60092-354:2003 第 9 条 IEC60228:2004 表 II、III	IEC60092-350:2008 第 6.4 条
2.2	电缆结构尺寸检查 /Check of cable dimensions . 绝缘厚度/Thickness of insulation . 非金属护套(包括内护层)厚度/Thickness of non metallic sheaths (excluding inner coverings) . 外径/External diameter	IEC60092-354:2003 第 10.3 条 IEC60092-354:2003 第 14.2 条 IEC60092-354:2003 第 15.2 条	IEC60092-353:2011 第 6.5 条 IEC60092-353:2011 第 6.5 条 IEC60092-353:2011 第 6.7 条
2.3	热延伸试验/Hot set test (HEPR, EPR, XLPE, HF 90, S 95 insulations and SE1, SHF2 sheaths)	IEC60092-351:2004 表 4 IEC60092-359:1999 表 II	IEC60092-350:2008 第 6.8 条
2.4	低温下性能试验(ST2、SHF1 和 SHF2 护套)/Behaviour at low temperatures (ST2, SHF1 and SHF2 sheaths)	IEC60092-359:1999 表 III	IEC60092-350:2008 第 8.8 条
2.5	编织覆盖密度(编织铠装电缆)/Coverage density of braid (Braid armoured Cables)	IEC60092-354:2003 第 16 条	IEC60092-350:2008 第 4.8.2 条
2.6	工频 4U ₀ 耐电压试验 /Power-frequency voltage of 4 U ₀	IEC60092-354:2003 第 18.2f) 条	IEC60092-354:2003 第 18.2f)条

注: 例行试验应在交货的全长度上进行; 特殊试验的频率和试样数量详见 IEC60092-350:2008 第 6.2 条。

5.3 船用控制和仪表回路用电缆在制造厂至少应进行以下检验和试验:

船用控制和仪表回路用电缆单件/单批检验试验大纲

表 5.3

序号	试验项目/Test	技术要求/Requirement	试验方法/Testing Method
1	例行试验/Routine Tests		
1.1	导体(包括泄电线)直流电阻测量/ Measurement of electrical resistance of conductors, including drain wires	IEC60092-376:2003 第 17.1.a) 条	IEC60092-350:2008 第 5.2.2 条
1.2	电压试验/Voltage test	IEC60092-376:2003 第 17.1.b) 条	IEC60092-350:2008 第 5.2.3 条
1.3	绝缘电阻试验/Insulation resistance test	IEC60092-376:2003 第 17.1.c) 条	IEC60092-350:2008 第 5.2.4 条
1.4	屏蔽绝缘电阻测量/ Screen insulation resistance	IEC60092-376:2003 第 17.1.d) 条	IEC60092-350:2008 第 5.2.4 条
1.5	铠装电缆的屏蔽与铠装层之间绝缘电阻测量/ The insulation resistance between any screen and the armour for armoured cables	IEC60092-376:2003 第 17.1.e) 条	IEC60092-350:2008 第 5.2.4 条
2	特殊试验/Special Tests		
2.1	导体检查/Conductor examination	IEC60092-376:2003 第 9 条	IEC60092-350:2008 第 6.4 条
2.2	电缆结构尺寸检查/Check of cable dimensions . 绝缘厚度/Thickness of insulation . 非金属护套(包括内护层)厚度/Thickness of non metallic sheaths (excluding inner coverings) . 外径/External diameter	IEC60092-376:2003 第 10.4 条 IEC60092-376:2003 第 13.2 条 IEC60092-376:2003 第 14.1 条	IEC60092-353:2011 第 6.5 条 IEC60092-353:2011 第 6.5 条 IEC60092-353:2011 第 6.7 条

续表 5.3

2.3	热延伸试验/Hot set test (HEPR, EPR, XLPE, HF 90, S 95 insulations and SE1, SHF2 sheaths)	IEC60092-351:2004 表 4 IEC60092-359:1999 表 II	IEC60092-350:2008 第 6.8 条
2.4	低温下性能试验(ST2、 SHF1 和 SHF2 护 套)/Behaviour at low temperatures (ST2, SHF1 and SHF2 sheaths)	IEC60092-359:1999 表 III	IEC60092-350:2008 第 8.8 条
2.5	屏蔽层检查(屏蔽电缆)/ Electrostatic screen (Screened Cables)	IEC60092-376:2003 第 12 条	IEC60092-350:2008 第 4.8.2 条
2.6	编织覆盖密度(编织铠装 电缆)/Coverage density of braid (Braid armoured Cables)	IEC60092-376:2003 第 15 条	IEC60092-350:2008 第 4.8.2 条

注：例行试验应在交货的全长度上进行；特殊试验的频率和试样数量详见 IEC60092-350:2008 第 6.2 条。