DESIGNING COLD IRONING POWER SYSTEMS

Electrical safety during ship berthing

BY DEV PAUL, KEVIN PETERSON, & PENIAMIN R. CHAVDARIAN

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COLD IRONING POWER SYSTEM DESIGN requires unique components to supply shore power to ships for cold ironing operation. Currently, the development of new standards is in progress, and operating procedures are being written to maximize electrical safety, standardization of the process, and interchangeability from one location to another. This article describes the power system design, including a power system protection scheme, which should enhance the electrical safety by design. The power system grounding, equipment grounding, and touch potential that can impact personnel safety are described. A very basic outline of the operating procedures and training needed for the operators to maximize electrical safety during cold ironing operation are also included in this article. In addition, this article provides the current status of the draft International Electrotechnical Commission (IEC)/International Organization for Standardization (ISO)/IEEE Standards 80005-1 [5] and 80005-2 [6].

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Cold Ironing System

Due to environmental considerations, ships are being required to turn off their auxiliary generators and instead receive power from shore systems. This method of connecting ships to shore power-supply systems during berthing at the port is called cold ironing. (The term cold ironing originates from when ships equipped with onboard steam generators docked for repair. During repair, all of the pipes and boiler steel were cold, and thus the name cold ironing was used.) The true definition of cold ironing does not exactly apply to this process; however, connecting to shore power at a berth is becoming understood as cold ironing in the shipping industry. This method helps to minimize air pollution. The onboard crude oil generators are turned off while shore power is generated at a remote location, and a relatively less-polluting fuel is supplied to ships during cold ironing [1]–[4], [9]. Shore power rated at 6.6 or 11 kV at 60-Hz frequency is supplied to ships by the use of multiple parallel feeder circuits to supply the required power to match the auxiliary generator load requirements of various ships. Unlike other industrial or commercial power systems, which, once energized, are tripped only in case of maintenance or under fault conditions, the cold ironing power system requires turning breakers on and off, posing a safety concern for operators. In addition, the electrical power system infrastructure of a major port needs to be supplemented to meet this need through the addition of several cold ironing substations and a local bulk-power substation (BPSS) with a high-voltage (HV) primary. The latter poses the additional safety concern of dangerous touch potential. This article provides a cold ironing power system design using draft standard IEC/ISO/IEEE 80005-1 [5] criteria. The current status of this draft standard is also addressed.

Shore-to-Ship Power-Supply System

Shore-to-ship power-supply systems go by a variety of names: cold ironing, alternative maritime power (AMP), onshore power supply, shore-to-ship power supply, and shore-side electricity. The variations in name are strictly due to the usage adopted by the different organizations involved in this application and have no other significance. In this article, the authors recommend the adoption of the name shore-to-ship power supply, which is descriptive of the application implemented.

During berthing, vessels will require different power, depending upon the type and size of the vessel. The power requirements of various vessel types and sizes presented in Table 1 are taken from current draft standard IEC/ISO/IEEE 80005-1 [5].

TABLE 1. THE POWER REQUIREMENTS AT BERTH.

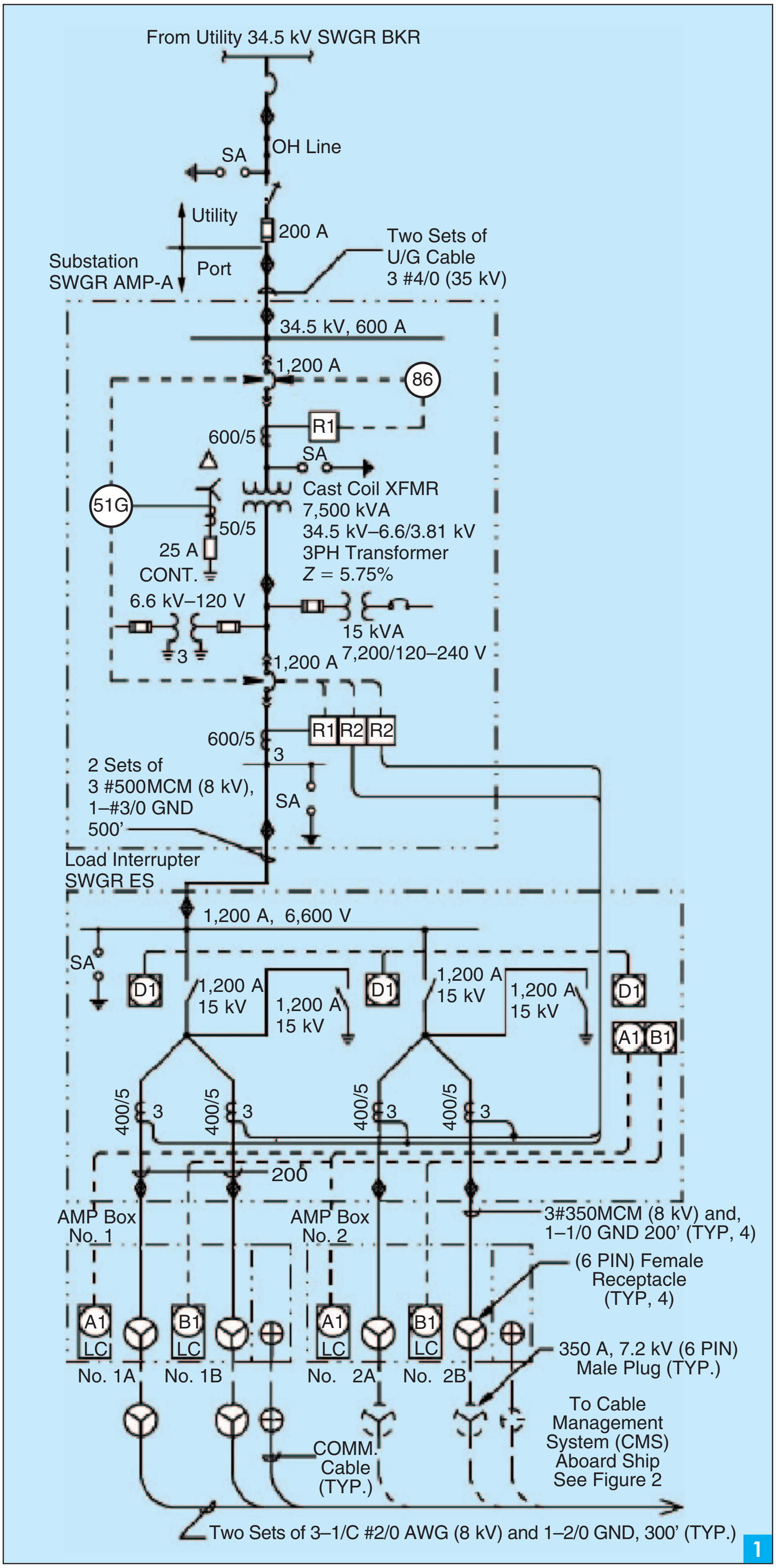
Ship Type	Voltage (kV)	Power (MVA)
Cruise ships	6.6 or 11	16–20
Container ships	6.6	7.5
Liquefied natural gas carriers	6.6 or 11	10.7
Ro-Ro ships	11	6.5
Tankers	6.6	7.2

To connect a berthing ship to shore power for cold ironing operation, a dedicated substation transformer of adequate rating with secondary voltage of either 6.6 or 11.0 kV is required. The term dedicated substation transformer means only one ship connection to one transformer to satisfy the galvanic isolation requirements of the current draft standard [5]. Such a design will protect the ship power system from abnormalities in the shore power system, especially if the shore power system is used for power distribution to other facilities within the port area. Many power system grounding problems and stray currents associated with other port facilities can affect the ship power-supply ground fault protection, unless the shore power system has its own grounding zone provided by a dedicated transformer with a neutral grounding resistor (NGR), as shown Figure 1, for connection to the ship, as shown in Figure 2.

Most of the ships under construction today are designed for 60-HZ operation a standard order. At an added cost, 50-HZ ships are considered a special order and require an additional footprint for the 60–50-Hz frequency converters (FCs) on the ship for connection to 60-Hz shore power. Therefore, it is expected that the majority of ships will require a 60- and not 50-Hz power supply. Where the utility power supply is 50 Hz, FCs will be required on shore before the shore power substation transformer [7]. The design of a cold ironing project requiring FCs is the subject of another article and thus will not be addressed here. A major port with several cold ironing projects may require a BPSS with the HV primary close to the port facilities. (See Figure 3.) A dangerous touch potential can be caused by high line–ground fault on HV side of such a BPSS without appropriate design considerations. This article provides a design method for mitigating such dangerous touch potential.

Unique Features

The shore power transformer is kept energized even when a ship is not connected to draw shore power, and thus a transformer with low no-load losses is desirable. Each cold ironing operation requires the power circuit breakers of both the shore and ship power systems to close and then open, posing unusual strain on the breakers. Operators perform connections of shore power to ships by using cable management systems (CMSs), a combination of flexible cables and power plugs/receptacle assemblies. The power plugs are very heavy and require cranes to maneuver them before being plugged into the receptacles. Applications such as cruise ships require continuity check wiring monitoring of emergency trip circuits and separate plug and receptacle assemblies. Each cold ironing operation requires two synchronizing operations, one for transferring the ship's auxiliary generator load to shore power and the second for transferring the ship's load back to the ship's auxiliary generator. Physically, the substation switchgear alternative maritime power (AMP)-A and the load interrupter switchgear emergency shutdown (ES) and AMP boxes shown in Figure 1 may all be physically far apart from each other. These unique features of the power system design and operation pose many safety concerns. The design approach presented here considers and mitigates these safety concerns. If the movement of the ship causes the flexible cable to pull the continuity circuit pin that breaks the



The cold ironing power system—one-line diagram.

continuity of the circuit, then the circuit breakers would open automatically on both the shore and the ship systems. Emergency trip push buttons are also installed on the shore and the ship at specific locations to manually trip the circuit breakers in case of emergency.

Unique Power System Components

What follows is a list of the unique components of cold ironing power systems.

- A three-pole grounding switch is used to discharge medium-voltage (MV) cables [16].
- A three-pole main disconnect switch (DS) is used for the isolation of AMP boxes.
- The standard ratings of the female power receptacle are 350 or 500 A at both 6.6 and 11.0 kV. They consist of six pins: three power, one ground, and two pilots. The ground and pilot pins make the last and first break for safety. Pilot pins are used for the continuity check circuit and the emergency trip circuits [5].
- Matching male power plugs assembled at the end of flexible power cables are designed to make safe connections. The power plug standard ratings are also 350 or 500 A at both voltage ratings 6.6 and 11.0 kV [5].
- A CMS is used for reeling and unreeling the flexible power cable. Figure 2 shows the CMS located on ship, but it can be on shore on a movable trolley. Safety limit switches are built into the cable reel system to avoid pulling tension on the cable system and the plug/receptacle assembly [5].
- Separate receptacle and matching plug assemblies are implemented for the communication and emergency trip circuits.
- Mechanically keyed interlocks between the power receptacle cover, grounding switch, and main DS are implemented to ensure that the power system is de-energized and the cable

system is discharged by grounding switches [16] when shore-to-ship connections are performed.

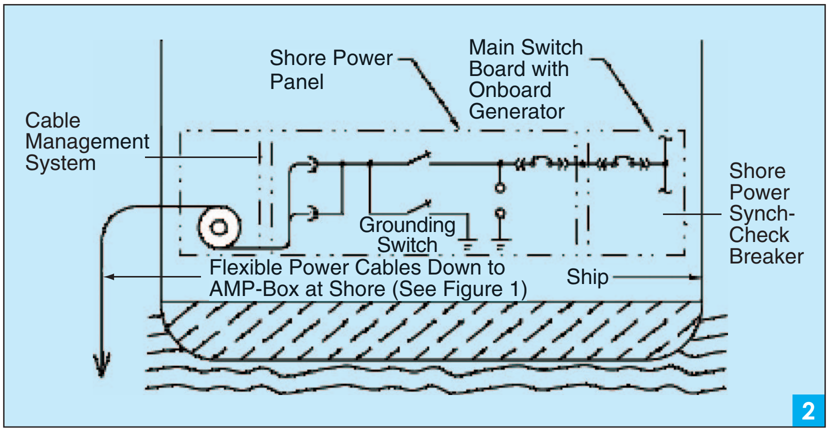
- A high-resistance grounded (HRG) power system with an NGR and associated ground fault protection relay is used [13]. The NGR is monitored continuously for open- or short-circuit conditions, and breakers open automatically on both sides if any of these abnormalities are detected.
- Multifunction individual protection relays on each feeder to the power receptacle include a minimum device 50/51, 50/51N as well as a live line showing lights for the protection of the equipment and safety of the operators.
- The transformer primary protection includes multifunction relays with minimum devices 50/51, 50/51N, 59, and 27.
- The transformer secondary power system protection includes multifunction relays with minimum devices of 50/51, 50/51N, 32, 59, 27, 47, 46, 81O, 81U, and 25.
- The power transformer protection devices include 49W for a dry-type cast-coil transformer and devices 49W, 71Q, 26Q, 63SR, and 63PR for the oil-filled transformer. All of the devices listed here for the oil-filled transformer are not in the current draft standard [5]. Considering the application of the upcoming FCs where the utility power frequency is 50 Hz will require additional power transformers on the line side of the FC, whereas the dedicated shore power transformers will still be required for the cold ironing power-supply system. These additional transformers may require all of the protection devices associated with the oil-filled transformer, depending upon the configuration and design of the FC package at a particular port.

Substation Transformer Rating

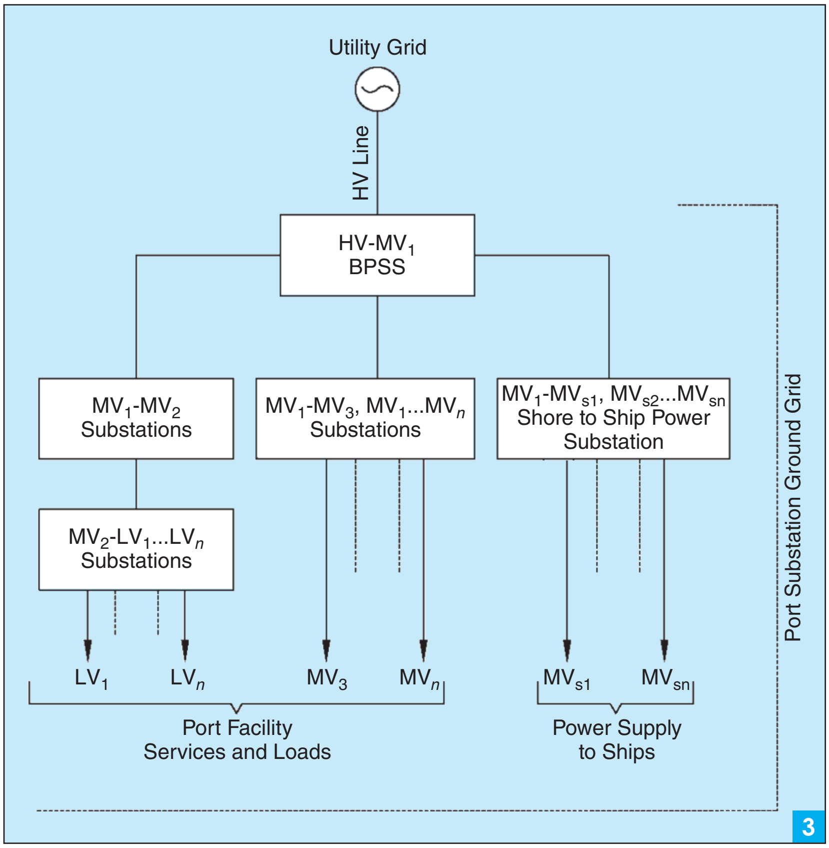
To accommodate the varying load requirements of the ships shown in Table 1, the overload capability of the transformer should be considered. Both the liquid-immersed and the dry-type transformer overload guides are contained in American National Standards Institute/IEEE C57.91 and C57.96 [7]. Forced-air (FA) cooling is a common method that can increase the loading of both types of transformers. For a liquid-immersed transformer, FA options can offer 12% overload at ≤ 2.5 MVA and 25% for anything larger. For a dry-type transformer, FA options can offer 33-1/3% overload at ≤ 3.75 MVA and 25% for anything larger.

Major Electrical Upgrades at Port Facilities

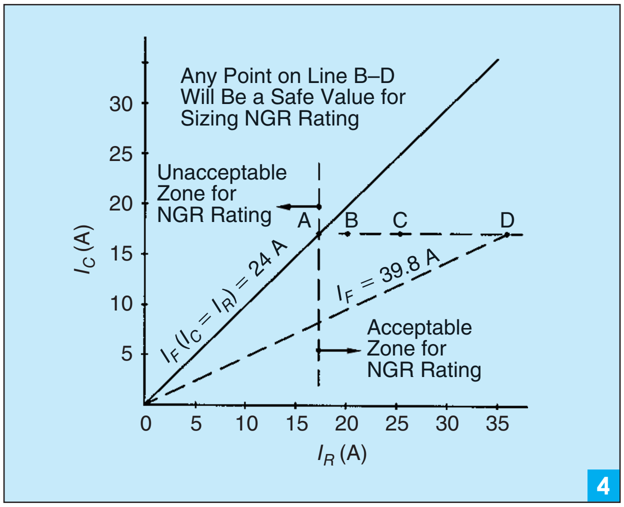
Major ports with several cold ironing berths may require a utility power supply at an HV ranging from 34.5 to 230 kV. Such an HV supply system with an associated BPSS located within the port facility can pose additional challenges associated with safety to operators during line-to-ground fault, especially on the primary side of the BPSS. With the application of an equipotential grounding conductor between the shore and the ship, the voltage at the ship hull may rise to



The shore power panel on ship.



The BPSS within port facilities (LV: low voltage).



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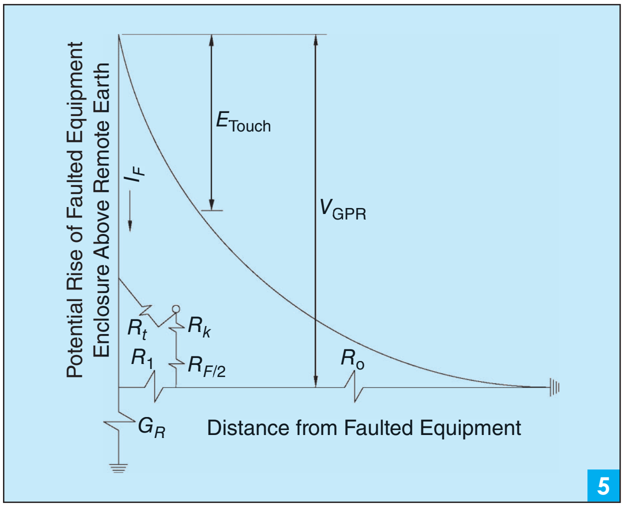
The representation of an HRG power system criterion.



5

The V_{GPR} voltage profile and touch potentials.

dangerous touch voltage during a line-to-ground fault on the primary HV side of the BPSS.

Grounding and Touch Potential

To make an HRG power system, ship generators are either grounded by individual neutral resistors or kept ungrounded to use one common homopolar grounding scheme [2]. The connection of a dedicated ship to a dedicated shore power substation has led the design of the shore power system to be an HRG with a ground fault sensor relay at the NGR to minimize equipment damage during line–ground faults [5], [10], [13].

Grounding Criterion

The criterion of an HRG system is that, during bolted line-to-ground fault condition, the neutral resistor should allow the resistive component of the fault current to be equal to or greater than the total system charging current [10], [13]. The combined system charging current of the ship and the shore power system should be known to determine the rating of the NGR. This criterion is shown in Figure 4 [8]. For example, assuming a total system charging current of 17 A, this will result in a maximum line-to-ground fault current of 24 A if the NGR is rated at 17 A. If the actual installed system charging current becomes higher than 17 A, then this NGR rated at 17 A may become unacceptable, as the fault current point will fall in the unacceptable zone. This can cause transient overvoltage and equipment damage. To avoid such an uncertain situation, a multiplication safety factor of 1.25 should be applied to the estimated or calculated system charging current to determine the NGR rating by (1). Measurement of the system charging current in the case of a cold ironing project is also recommended to ensure a correct NGR rating [10]. Such measurements should involve the largest expected ship for cold ironing project. Such measurements may be avoided if the NGR ampere rating is increased; however, the ship authority may not allow such a design. Therefore, the best approach is that the ship authority should provide the ship's onboard power system charging current for the correct NRG rating. Using some safety factors for NGR rating, taking an example of 17-A total systems charging current, all points, such as B, C, or D in Figure 4, will be in the acceptable zone for NGR rating

$$R_N = E_{\mathrm{LN}}/(1.25 I_C)\Omega, \tag{1}$$

where R_N is the transformer NGR, E_{LN} is the line-to-neutral voltage, and I_C is the total (combined) system charging current of the shore and the ship power system.

Touch Potential

During the line-to-ground fault condition, a ground potential that rises (V_{GPR}) above the remote earth (zero reference point) takes place, and all electrical equipment enclosures bonded to the same ground are exposed to this voltage V_{GPR}. Touch potential will be a certain percentage of V_{GPR}, depending upon the voltage delay profile of V_{GPR} (see Figure 5). This V_{GPR} in volts is shown

$$V_{\mathrm{GPR}} = G_R I_G, \tag{2}$$

where G_R is the ground grid resistance in ohms, and I_G is the portion of ground fault current penetrating through the ground grid to return to the power system grounding location. In the case of a BPSS, the power system grounding location is the neutral of the HV source, which will be away from the port facility.

Both the ground grid resistance (G_R) and grid current (I_G) should be made low to make the touch potentials less than tolerable voltages. The practical low limit of G_R is $\sim 1\ \Omega$. On the other hand, I_G can be made low by installing a ground conductor with the HV primary overhead line or the underground HV cable system such that this ground conductor is grounded on both sides at the BPSS ground grid and at the HV primary source neutral. For example, if the impedance of this ground conductor is $0.25\ \Omega$ and G_R is $1\ \Omega$, then I_G will be 20% of the line-to-ground fault current. This can help in designing an economical, safe ground grid at the BPSS.

Tolerable step and touch potentials are a function of the surface resistivity, and, generally, crushed rock is used at the

HV substation ground grid design due to its higher resistivity [11]. IEEE Standard 80 is used by the industry to provide a safe substation ground grid design based upon the tolerable touch and step potentials versus calculated touch and step potentials during a line-to-ground fault within the substation. To be considered safe without the electric shock hazard, this safety analysis is related to how much current from hands to feet (touch potential) or foot to foot (step potential) flows through the human body and for how long. The maximum line-to-ground fault current, clearing time of the fault by the ground fault protection device, and resistivity of the earth surface in the substation and around the energized electrical equipment are needed for safety analysis. IEEE Standard 80 establishes the safe limits of potential differences (tolerable voltages) between points that can be contacted by the human body. The tolerable voltage equations provided in IEEE Standard 80 are derived from the research work of Dalziel. The standard provides simplified formulas for calculating 50- and 60-Hz ac voltages that can be tolerated by 99.5% of the population. Step voltages are generally three times higher than the touch voltage for similar conditions. A simplified formula for tolerable touch voltage is

$$E_{\text{Touch}} = I_B (R_B + 1.5p), \tag{3}$$

where R_B is the human body resistance generally assumed as 1,000 Ω (equivalent resistance of the human body), p is the electrical resistivity in ohm-meters for the material on which the person is standing (assumed here to be homogeneous material), and I_B is the tolerable body current in amperes for a person weighing 110 lb (equal to $0.116/\sqrt{t}$), where t is the tripping time of the circuit breaker in seconds or the duration of the touch voltage.

TABLE 2. THE TOLERABLE AC TOUCH VOLTAGES.

Time (s)	Wet Concrete Low Range p = 21 Ω m	Wet Concrete Low Range p = 100 Ω m	Dry Soil p = 1,000 Ω m	Remarks
0.03	691	770	1,674	Note 1
0.03	691	770	1,674	Note 1
0.05	535	597	1,297	Note 1

Note 1: This table conservatively assumes that the hand and foot contact resistances are equal to zero and that glove and shore resistances are also equal to zero.

TABLE 3. THE TOLERABLE AC TOUCH VOLTAGES.

Time (s)	Wet Concrete Low Range p = 21 Ω m	Wet Concrete Low Range p = 100 Ω m	Dry Soil p = 1,000 Ω m	Remarks
0.03	2,700	2,779	3,684	Note 2
0.05	2,092	2,153	2,853	Note 2
0.10	1,479	1,522	2,018	Note 2

Note 2: This table was developed assuming that the person in the substation has proper gloves and shoes with an assumed resistance of 3,000 Ω. This will change the value of human body resistance in (3) to 4,000 Ω.

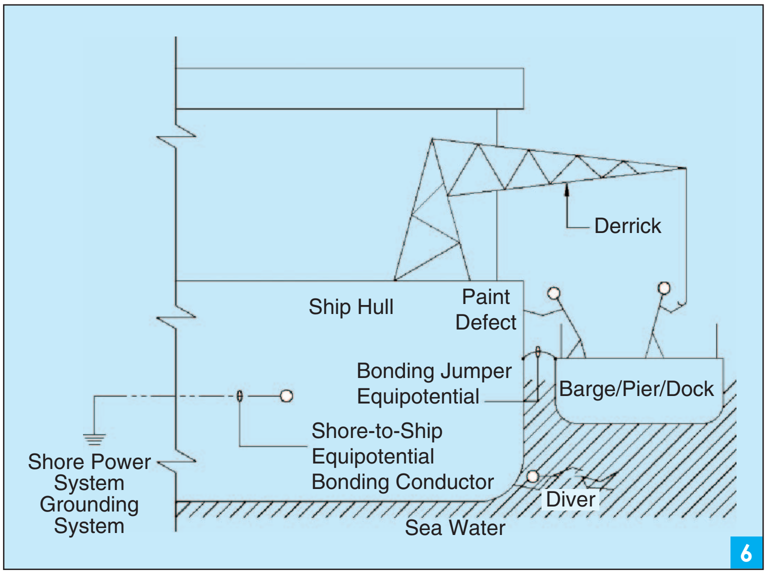
Using (3), Tables 2 and 3 provide the tolerable ac touch voltages in volts (rms), where a line-to-ground fault current is such that current flow through the grounding grid I_G is 6.78 kA (~1/3 of 20-kA ground fault current). This is based upon the assumption that, due to the split factor of ground fault return current, 2/3 of the ground fault current returns to the power source via the grounding conductor installed with the supply conductors.

Suppose the substation ground grid resistance is 1 Ω and the ground grid current is 7 kA, then the V_{GPR} will be 7 kV, which may result in not exceeding the tolerable touch voltage, as the touch voltage is a fraction of V_{GPR}, as shown in Figure 5. The voltage decay profile V_{GPR} is related to the characteristics of soil under the ground grid and the surrounding area.

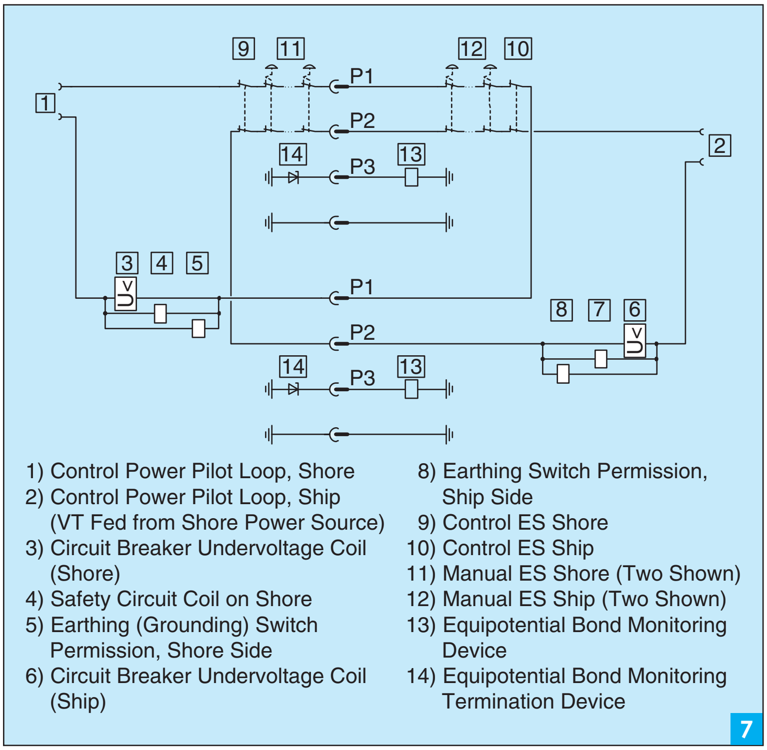
For the BPSS, it can be assumed that the HV line can have a ground fault close to the BPSS and that it will be the utility upstream breaker's protection device that will clear this fault. For a short period until the fault is cleared, it can raise the BPSS to a dangerous V_{GPR}, and touch potential at the ship hull may also be high due to the equipotential grounding conductor. To minimize such a problem of dangerous touch potential, if there is a ground conductor with the HV feeders, then V_{GPR} may be only 20% (as explained earlier in the example using ground grid resistance of 1 Ω and ground conductor resistance of 0.25 Ω), which is 1.4 kV (0.2 × 7 kV) less than the tolerable touch potential.

In the case of a ship hull bonded to the shore by equipotential bonding, the conductor voltage on the ship can be 1.4 kV—in the absence of an insulating surface around swimmers. The barge operators may be exposed to dangerous touch potential due to the potential difference between the ship hull and the barge, as shown in Figure 6. To solve such a problem, the application of safety bonding conductors between the ship hull and the barge is recommended. Swimmers should use gloves and swim suits made of nonconducting material, or warning signs should be posted to direct swimmers away from the busy port facility. The fault current at shore power facilities, especially the BPSS, should use a ground conductor installed with HV feeders where it is an overhead line or the underground HV feeder cables.

In a certain port area where it is not possible to use crushed rock for the BPSS, another option is to work with the utility company that provides power to the port to perhaps change the BPSS delta-wye transformer secondary windings grounding configuration to a low-resistance grounding instead, solidly grounding. This will limit



The ship touch potential during berthing.



The safety circuits—container ship [5].

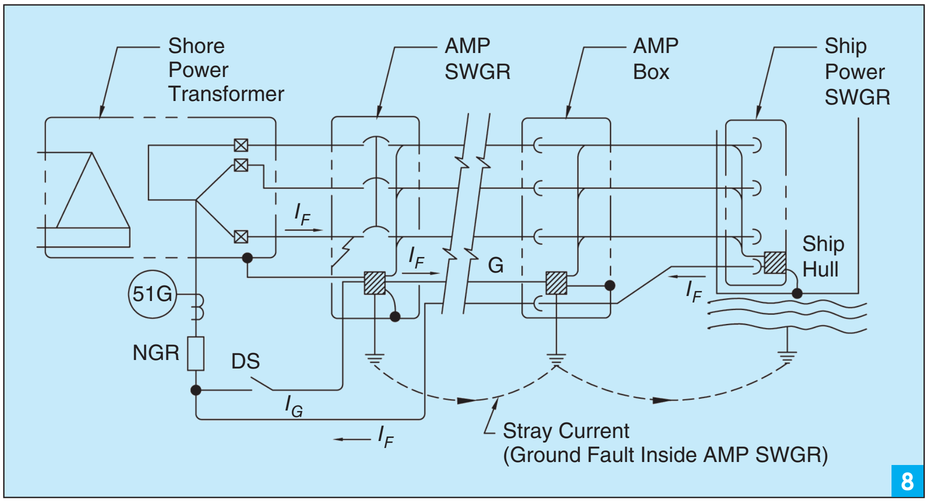
higher voltage exposure at the ship hull in case of line–ground fault on the primary side of the BPSS, as the source grounding location is at the BPSS. On the secondary side, a low-resistance grounded secondary of the BPSS will result in fewer ground fault hazards at all other downstream substations as well as use of less copper in the ground designs. Such a design change recommendation of making an MV power system a low-resistance grounded system instead of a solidly grounded system will have no impact on power system reliability and protection other than the higher insulation level of the MV system and line–line rated surge protection devices. The cost impact of such a change may be minimal when weighed against the benefit of the increased safety and economical ground grid designs.

Cold Ironing Standards

Various standards organizations have been working for the past five years on developing standards for implementing shore power. The three international bodies include the IEC, the ISO, and the IEEE. Initially, all three bodies worked independently on developing new standards. IEEE Standards Working Group P1713—Electrical Shore-to-Ship Connections was formed in 2006. All three organizations have now combined their efforts to issue one joint standard, IEC/ISO/IEEE 80005-1 [5], for HV shore connection systems. A committee draft for a vote of 80005-1 was issued in March 2011.

Committee members from 26 countries are involved in this triple-logo standard. The authors of this article originally worked on IEEE draft standard P1713, which now has been integrated with IEC/ISO/IEEE 80005-1 [5]. Some of the technical difficulties and issues that still need resolution are as follows:

- The equipotential bonding conductor is described as the conductor that makes the connection between the electrical equipment enclosures on shore to the electrical equipment enclosures on the ship. In other words, this conductor bonds the shore substation to the ship hull. Through the application of continuous monitoring of this conductor and upon sensing of its open-circuit condition, an automatic alarm at the ship and shore and tripping the both the shore and ship power circuit breakers require further reviews because there is another parallel path to this conductor. In the shore-to-ship power system, there are other inherent parallel paths to the equipment enclosure grounding conductor between the shore and the ship. These parallel paths are: a) each power cable's semiconducting shield and b) the low-resistivity earth path at port sites. These parallel paths will make continuous monitoring of the equipotential bonding conductor shown in Figure 7 inappropriate. (Figure 7 is taken from draft standard IEC/ISO/IEEE 80005-1 [5] for discussion purposes.) The working committee of this draft standard [5] should review this circuit thoroughly and determine whether there is a need of such a design in the standard. Based upon using an HRG scheme of the shore power substation with NGR rating of 25 A, there will not be a dangerous situation if equipotential grounding conductor breaks as the maximum touch voltage will be far fewer than 30 V in a line-to-ground fault anywhere on shore-to-ship power system. The ground fault relay at the NGR will still operate properly as the current will return via cable shield and earth if the equipotential grounding conductor is lost.



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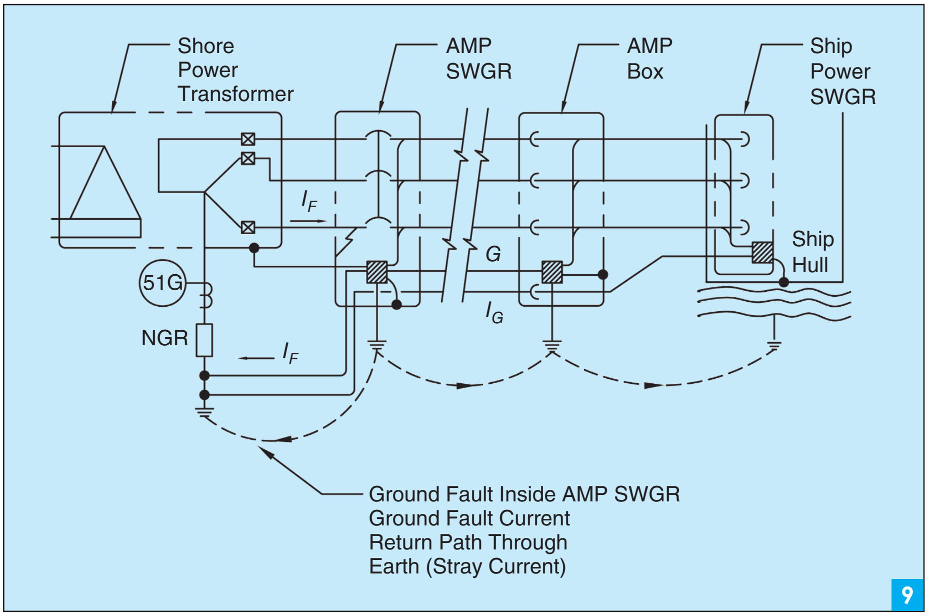
The cruise ship grounding with an NGR DS.



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The container ship grounding without an NGR disc switch.

- For a cruise ship, an application of an NGR DS to ground the NGR at the ship's hull during the cold ironing period and then to ground the NGR on shore during noncold ironing periods has no technical explanation in the current draft standard [5]. See Figure 8 for such a DS at the NGR. A separate plug and receptacle assembly is needed for the implementation of such a DS, which can pose an additional task for the operators and safety concerns and should be evaluated by the committee to see whether there is a need for such a DS. In the draft standard [5], for a container ship and other ships, there are no such requirements for an NGR DS.
- For a cruise ship, an NGR rating of 540 Ω as shown in the draft standard [5] will allow a maximum of 7-A system charging current at 6.6 kV and 11.8 A at 11.0 kV. This rating may prove to be inadequate if the combined total system charging current of the shore and the ship power system exceeds the 7- or 11.8-A ratings for the 6.6- or the 11.0-kV power-supply system, respectively. The previously discussed grounding criteria section should be stated in the standard, and the current ratings should be made close to 20–25 A, which will make the NGR ohm rating much lower than the 540 Ω recommended in the standard [5]. In examining the discussion on equipment damage at the fault location during a line-to-ground fault on an HRG power system where impedance is at the fault location, we may conclude that a 25-A NGR is better than an NGR rated at 540 Ω [10]. See Figure 9 for the shore power transformer grounding configuration with NGR.
- Not all applicable IEEE standards appear to be listed in the draft IEC/ISO/IEEE 80005-1 standard. This may cause project installation approval delays in the United States, where the interpretation of all IEC-listed standards in the draft standard [5] may not apply. A review of normative IEC references listed under Section 2 of the draft standard [5] should be conducted by working members to add applicable IEEE standards to correct this situation.
- The authors do not believe that the IP-based communications system of the draft standard 80005-2 [6] is necessary, especially for container ships in the United States where FCs are not required. It is not clear what is perceived as so critical about the shore power transformer and other associated power system switching equipment where all protection devices are properly sized and set to protect the equipment during fault conditions. This assumes that the equipment is adequately sized and then trained operators are on duty both on the port and at the ship during cold ironing

period. Control monitoring and communication system between shore and the ship should be kept simple and practical to facilitate cargo loading and unloading operations without an unnecessary burden to the business.

- The IP-based communication system currently described in IES/ISO/IEEE 80005-2 [6] features a secure IP address for each ship and the alarm signal uses a user datagram protocol. This approach will require IT professionals to develop a system that will be compatible with open protocols for interface devices on the ship and the shore to avoid being limited to proprietary equipment from one manufacturer. This current draft communication system standard between ship and shore perhaps should consider some changes to the wording prior to its enforcement to various categories of ship's cold ironing projects. Such a change of wording may simply be "if any cold ironing project needs to implement such a requirement, they should do so outside of this standard."

Basic Safety Training

Ports that have installed cold ironing projects have realized the need for special training for the shore and ship operators involved in the cold ironing operations. This section provides the basic training needed for the operators to enhance safety.

- All persons must go through the arc-flash hazard training.
- All installed equipment must meet IEEE Standard 1584 [14] and National Fire Protection Association Standard 70E [15] and have proper energy labels and danger signs.
- All operators must go though the training for basic technical knowledge and understanding of cold ironing power systems.
- Training on the sequence of operation and steps needed for cold ironing operation must be required for all operators.
- The person in charge (PIC) on the shore and the PIC on the ship must make all communications during cold ironing operation.
- Preassigned contact lists for electrical emergencies on shore or the ship must be clearly defined to avoid delays in case of emergency.

Conclusion and Recommendations

- The unique features and components of the cold ironing power system that have a direct impact on the safety have been discussed. To enhance safety through the design of the power system requires the use of ground-discharging DSs, mechanically keyed interlocks, component safety devices to automatically trip the power system under abnormal operating condition, emergency trip stations, and an HRG system and appropriate power system protection.
- Mitigating the dangerous touch potential caused by a line-to-ground fault on the HV side of the local BPSS can be achieved by installing a grounding conductor between the BPSS and the utility supply substations. The port authority needs to coordinate and work with the local utility to see if a grounding conductor with an HV incoming line can be implemented. It also appears that there are benefits in requesting the utility company to allow the use of a BPSS transformer with the primary winging solidly grounded, delta winding in the middle, and the secondary winding with resistance grounded configuration.
- Operator training for the operation of the cold ironing power system and a need for a PIC on both the shore and ship is highly recommended. Port and ship authorities are working on standardizing such procedures.
- This article also provides the current status of both IEC/ISO/IEEE draft standards 80005-1 [5] and 80005-2 [6].

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Dev Paul (dev.paul@aecom.com) is with AECOM in Oakland, California. Kevin Peterson is with P2S Engineering in Long Beach, California. Peniamin "Ben" R. Chavdarian is with the Port of Long Beach in California. Paul and Chavdarian are Senior Life Members of the IEEE. Peterson is a Senior Member of the IEEE. This article first appeared as "Cold Ironing Power System Design and Electrical Safety" at the 2012 IEEE IAS Petroleum and Chemical Industry Technical Conference.