



Repair, Recondition, or Replace? A Safety Driven Guide to Water-Exposed Electrical Equipment

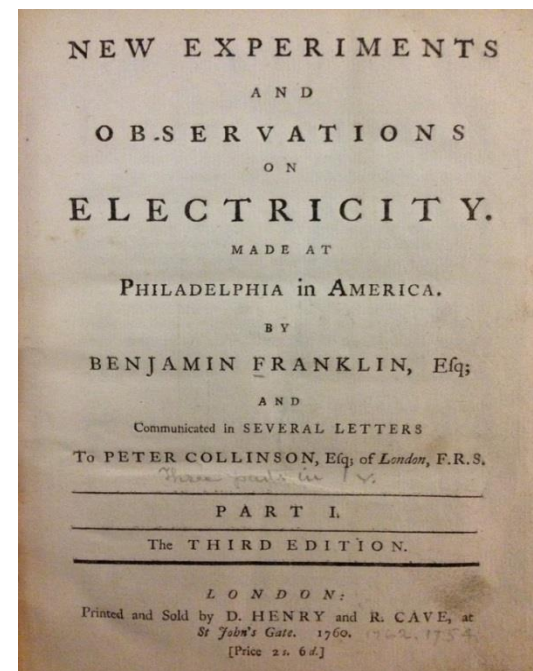
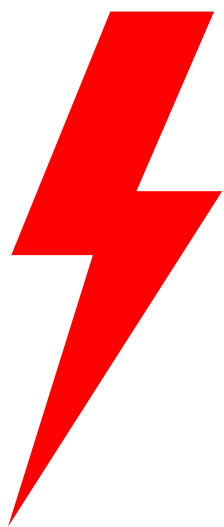
Bryan Holland, MCP, CSP.

National Electrical Manufacturers Association (NEMA)



INDEPENDENT ELECTRICAL CONTRACTORS

**What was
the first
practical
electrical
system?**





Superstorm Sandy (2012)

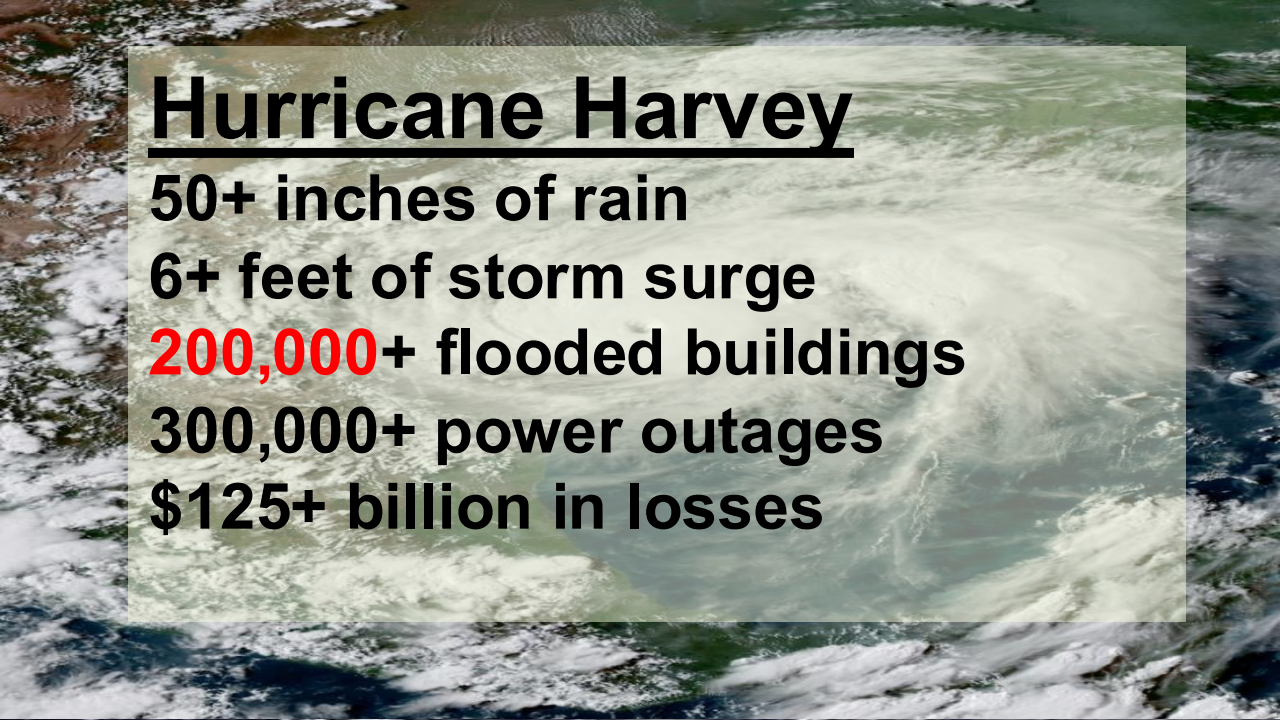
- 10+ inches of rain
- 12+ feet of storm surge
- 500,000+ flooded buildings
- 8.5+ million power outages
- \$81+ billion in losses
- 233 deaths

Funtown Pier Fire (2013)

- 50 buildings destroyed
- 1,000 ft of boardwalk destroyed
- 400 firefighters deployed





A satellite image of Hurricane Harvey, showing a large, well-defined eye and a dense, swirling cloud structure over the Gulf of Mexico.

Hurricane Harvey

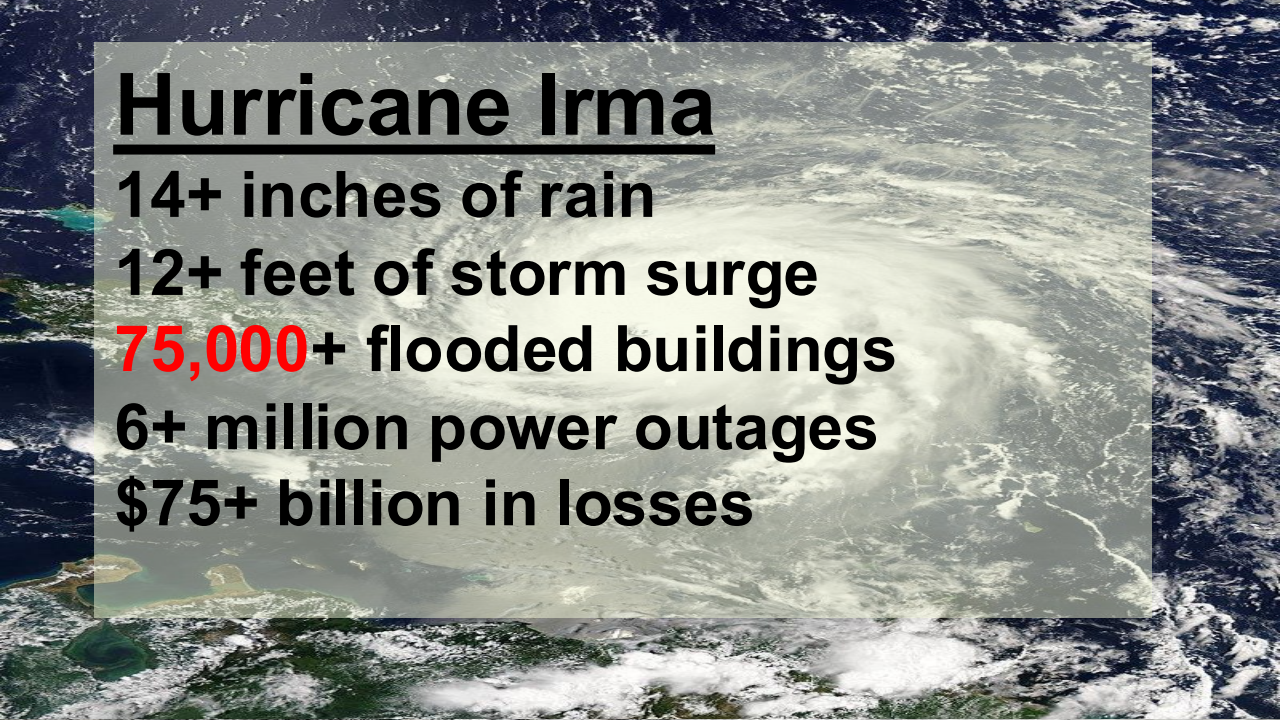
50+ inches of rain

6+ feet of storm surge

200,000+ flooded buildings

300,000+ power outages

\$125+ billion in losses

A satellite image of Hurricane Irma, showing a large, well-defined eye and a dense, swirling cloud structure over the Caribbean Sea.

Hurricane Irma

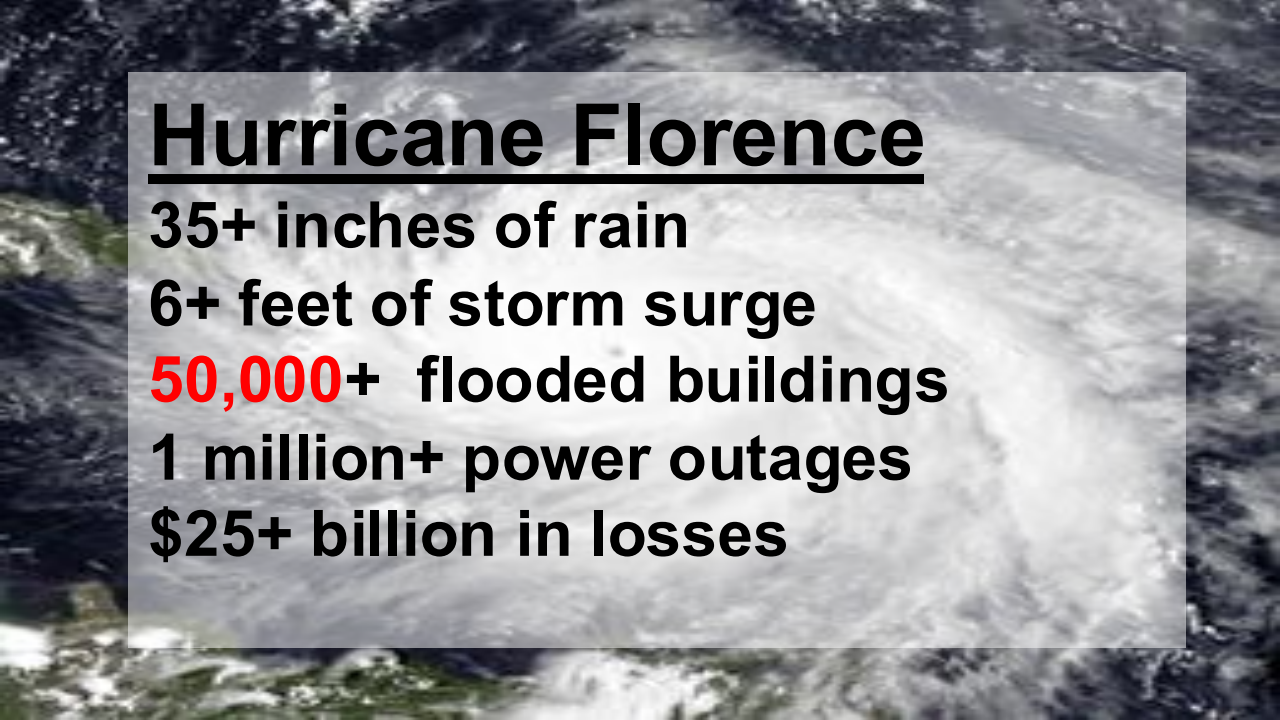
14+ inches of rain

12+ feet of storm surge

75,000+ flooded buildings

6+ million power outages

\$75+ billion in losses

A satellite image of Hurricane Florence, showing a large, well-defined eye and a dense, swirling cloud structure over the Atlantic Ocean.

Hurricane Florence

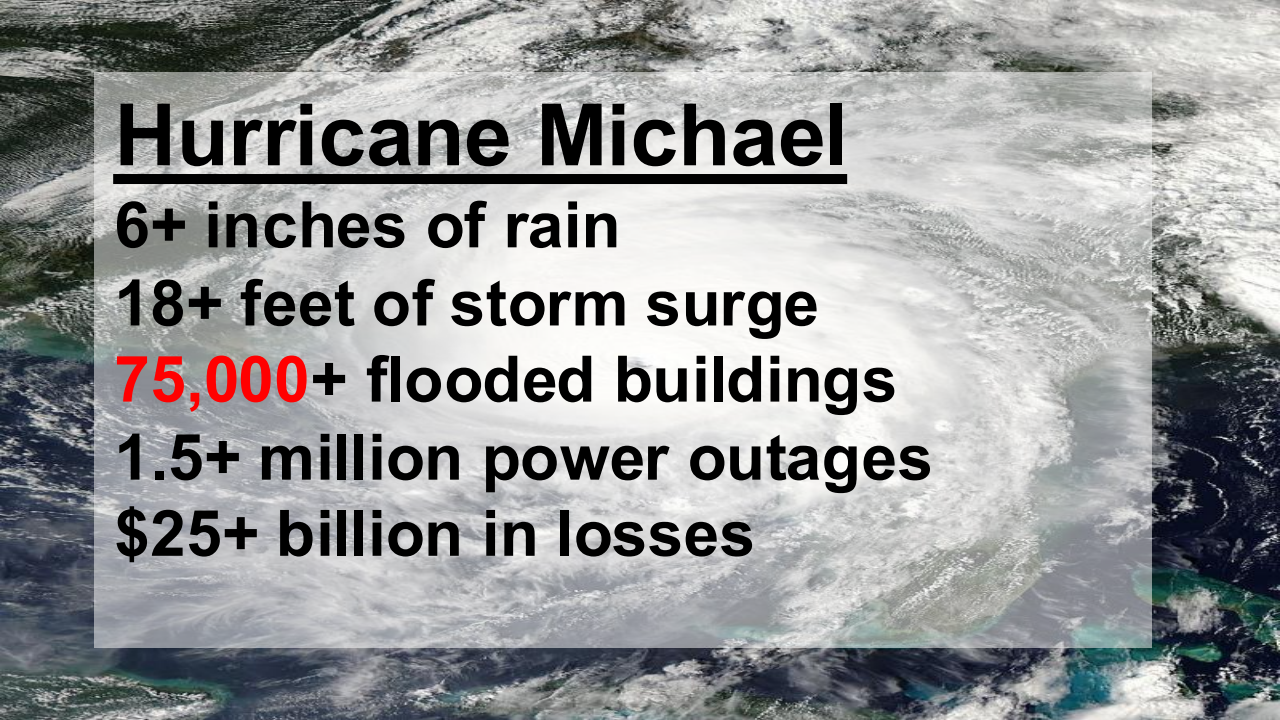
35+ inches of rain

6+ feet of storm surge

50,000+ flooded buildings

1 million+ power outages

\$25+ billion in losses

A satellite image of Hurricane Michael, showing a large, well-defined eye and a dense, swirling cloud structure over the Gulf of Mexico.

Hurricane Michael

6+ inches of rain

18+ feet of storm surge

75,000+ flooded buildings

1.5+ million power outages

\$25+ billion in losses

Installation Decision-Making Hierarchy

Prevention



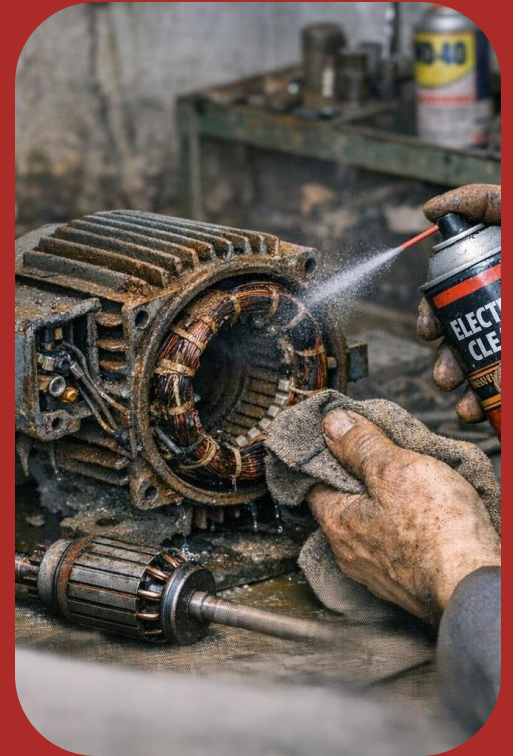
Resilience



Replacement



Recondition



Preventative/Resiliency Measures

✦ **FEMA – National Flood Insurance Program (CFR Title 44, Part B)**

- ❖ FEMA 348 – Protecting Building Utilities From Flood Damage
- ❖ NFIP Community Rating System (CRSresources.org)

✦ **Building Codes & Standards**

- ❖ ASCE 24 – Flood Resistant Design & Construction
- ❖ International Building Code (Section 1612)
- ❖ International Residential Code (Section R306)

✦ **NFPA 70 - National Electrical Code**

- ❖ The term “wet location” is used 144 times in Chapters 1-4 alone

✦ **Product Safety Standards**

- ❖ Suitability for the environmental conditions and other “wet” exposures is a fundamental performance criteria in nearly every electrical product safety standard (NEMA, UL, IEEE IEC, etc.)



HAZARDS ASSOCIATED WITH WATER-DAMAGE



corrosion

loss of lubrication

foreign particle
obstruction

dielectric insulation
breakdown

mechanical failure

structural failure



INDEPENDENT ELECTRICAL CONTRACTORS

Evaluating Water-Damaged Equipment



CONSULT YOUR LOCAL AHJ

The local authority having jurisdiction may:

- ✦ include the building department, fire marshal, or insurance company
- ✦ have licensing, permitting, and inspection requirements
- ✦ have additional requirements in the locally adopted building codes

Evaluating Water-Damaged Equipment



STEP #1

IDENTIFY THE WATER SOURCE

Identifying the Source(s) of Water



⚡ Rainwater

- ❖ The duration of exposure is the key factor

⚡ Floodwater

- ❖ Fresh water versus sea water
- ❖ Other contaminants (chemicals, oil, dirt/debris, etc.)

⚡ Fire Fighter Operations (Hose Spray)

- ❖ Potential of contaminants or physical damage

⚡ Fire Sprinklers / Water Service / Sanitary Drainage

- ❖ Exposure due to operating, leaking, or damaged systems

⚡ Condensation

- ❖ Accumulation of moisture in or on electrical equipment

⚡ Other Liquid Contaminants

- ❖ Fire suppression liquids, fuel-gas, refrigerants, food ingredients

Evaluating Water-Damaged Equipment

STEP #2

CONDUCT THE EVALUATION

What Does Evaluation Mean?

⚡ Visual Observations:

- ❖ Discoloration, Signs of Rust or Oxidation, Water Marks, Deposits (debris, chemicals, minerals), Material Fatigue, etc.

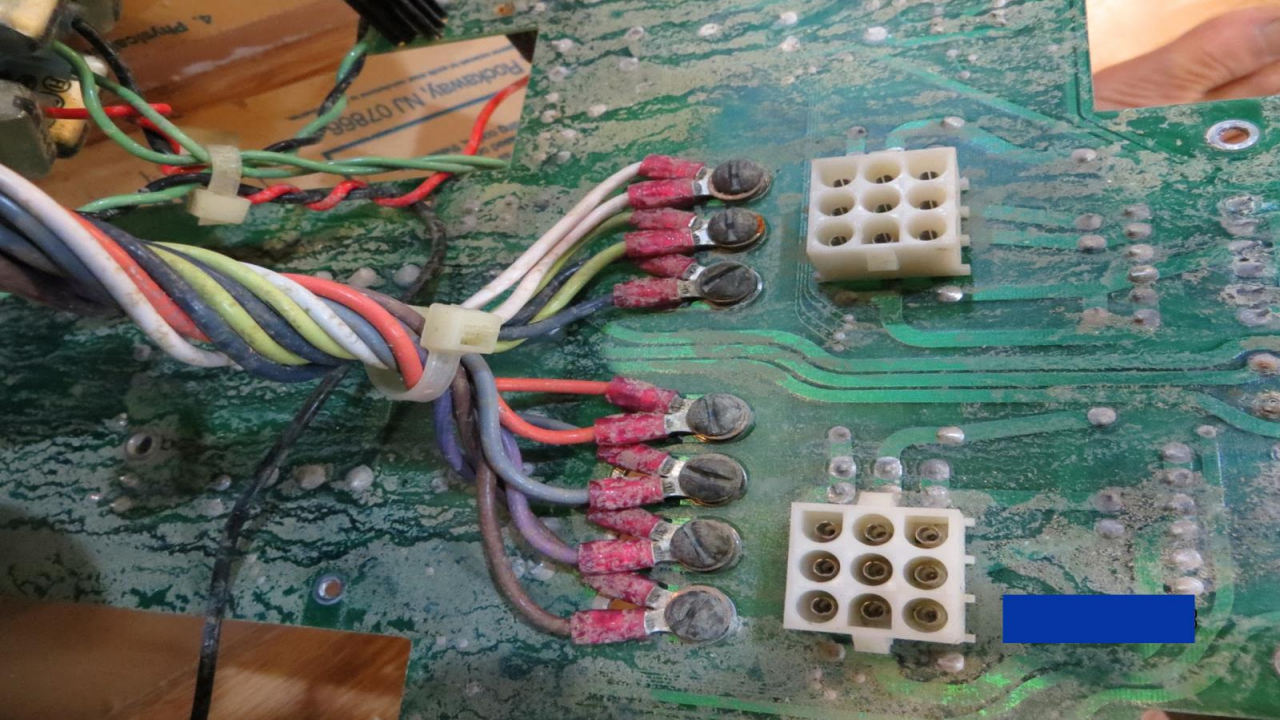
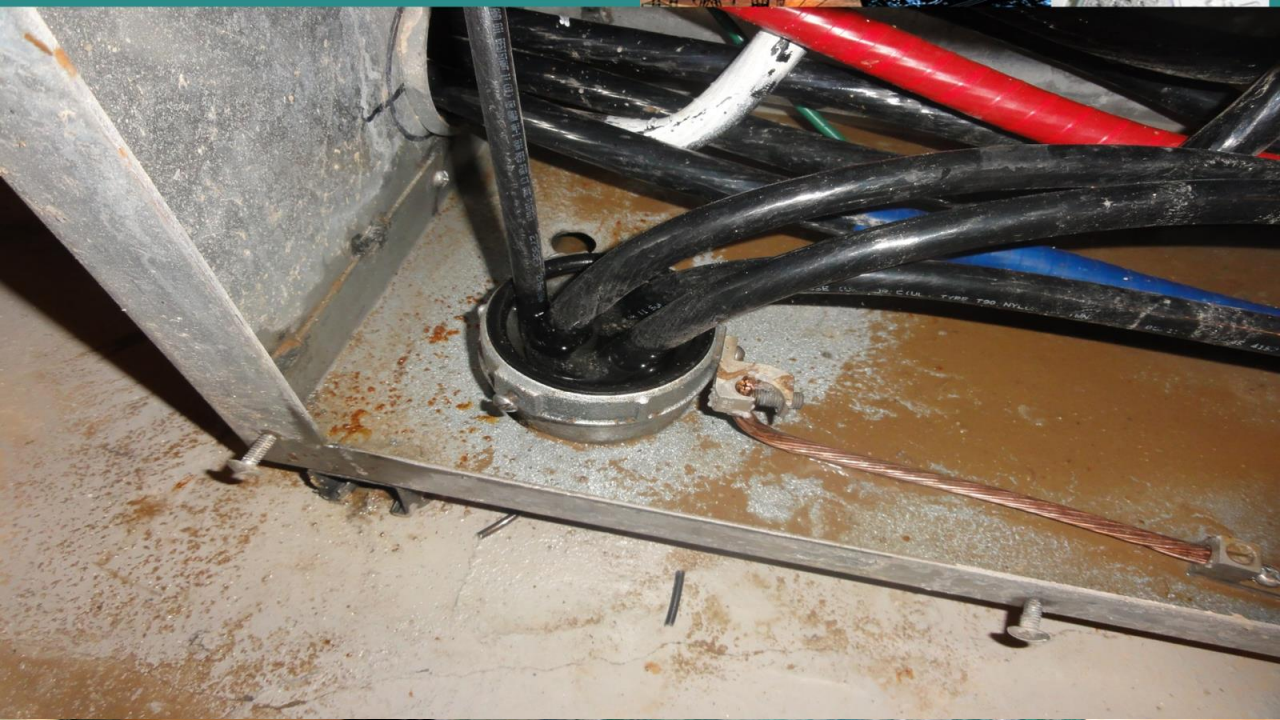
⚡ Operational Tests (De-energized Manual Functions):

- ❖ Abnormal switch or disconnect operation (sound and feel)
- ❖ Abnormal friction or resistance of rotating parts or motors
- ❖ Abnormally tight or loose contact devices (receptacles, knife blades, bus clips, racking systems, etc.)

⚡ Performance Tests:

- ❖ Insulation Resistance Testing / Dielectric Absorption Testing
- ❖ Infrared Thermographic (IRT) Imaging





Evaluating Water-Damaged Equipment IEC

STEP #3

CONTACT THE MANUFACTURER

Contact the Manufacturer

- ⚡ The original manufacturer of the equipment should be contacted if any questions arise or specific recommendations are needed.
- ⚡ Have the information or findings in Step #1 and Step #2. Document the nameplate data, product labels, or any other identifying marks on the equipment. Photos &/or video are a plus. An onsite visit may be necessary.
- ⚡ Attempts to recondition equipment without consulting the manufacturer can result in additional hazards.
- ⚡ NEMA member companies are committed to safety. Contact information is provided at www.makeitelectric.org



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Powering Progress



3M	GE Lighting	Prolec GE	Cummins, Inc.	Lutron Electronics Company, Inc.	Specialty Cable Corporation
A.O. Smith	Generac Power Systems, Inc.	ProSource Industries, Inc.	Current	MacLean Power Systems	Steel Electric Products Co., Inc.
ABB Inc.	Gentex Corporation	Prysmian Group	Daktronics, Inc.	Maddox Industrial Transformer	The Okonite Company
Acuity Brands, Inc.	GM Energy	Q-Free American	Danfoss, LLC	Marine Tech Wire and Cable, Inc.	The Swatch Group US-
Advanced Cable Ties, Inc.	Hammond Power Solutions, Inc.	Quirk Wire Company, Inc.	Delta Electronics (Americas) Ltd.	Marmon Aerospace & Defense, LLC	Renata Batteries
Adventech, LLC	Hellenic Cables	Radix Wire & Cable, LLC	DENSO Products and	Marmon Electrical	Titan3 Technology, LLC
Allied Moulded Products, Inc.	HellermannTyton	Raycap, Inc.	Services America	Master Control Systems, Inc.	TMSS US, LLC
Alubar Metals Missouri	Hendrix Molded Products	Regal Rexnord Corporation	DENT Instruments, Inc.	Maverick Power	Tornatech, Inc.
Alva Manufacturing, LLC	HICO America	Reinhausen Manufacturing	Dialight Corporation	MDF Cable Bus Systems	Toshiba International Corporation USA
AmberSemi	Hitachi Energy USA, Inc.	Representative Materials, Inc.	DITEK Surge protection	Meiden America	Trane Technologies
Anamet Electrical, Inc.	Honeywell	Rittal North America, LLC	DuPont	Meltric Corporation	Triacta Power Solutions LP
Armstrong	Honeywell Smart Energy	Ritz Instrument Transformers	Eaton	Mersen USA Newburyport-MA, LLC	Ubicquia, Inc.
ASK Products, Inc. / Sicame Corp.	Horizon Signal Tech., Inc.	Robroy Industries	Eberle Design, Inc.	MGM Transformer Company	Underground Devices, Inc.
ASSA Abloy	Hubbell Incorporated	Röchling Industrial Cleveland	EiKO Global, LLC	Miller Electric Mfg. LLC	Unitray Systems, Inc.
Atkore	Hyper Solutions	Rockwell Automation	ELANTAS PDG, Inc.	Milwaukee Tool	US Pole/US Outdoor Lighting
Atlas Lighting Products, Inc.	Hypertherm Incorporated	Rollease Acmeda	Electri-Flex Company	Mission Critical Group, LLC	VanTran Industries, Inc.
Atom Power	IDEAL Industries, Inc.	RSCC Wire & Cable, LLC	Electro Switch Corp.	Mitsubishi Electric Automation, Inc.	Vertiv Corporation
Benshaw	Industrial Electric Manufacturing	RYMCO USA	Elektrisola, Inc.	Mitsubishi Electric Power Products, Inc.	Victor Insulators, Inc.
Braeburn Systems, LLC	Innomotics	S&C Electric Company	Emerson	MP Husky, LLC	Virginia Insulated Products, Inc.
Bridgeport Fittings, LLC	InPower Solutions	Satco Products, Inc.	Emporia Energy	New Cosmos USA, Inc.	VoltServer
Brooks Utility Products	International Metals de Mexico	Schneider Electric	Enchanted Rock	Nexans	W.L. Gore & Associates, Inc.
Canadian Solar (USA), Inc.	IPEX USA, LLC	Schweitzer Engineering Laboratories, Inc. (SEL)	Enerlites, Inc.	NGK-LOCKE, Inc.	WAGO Corporation
Cantex	Iten Industries	Sdi, LLC	Eos Energy Storage	Nidec Motor Corporation	Walter Kidde Portable Equipment, LLC
CBM Lighting, Inc.	Itron, Inc.	SEA Wire and Cable, Inc.	EPD – Electric Power Design	NORD Gear Corporation	WEG Electric Corp.
Cerrowire	J&L Manufacturing	Sediver USA, Inc.	ESS Metron, Inc.	Norplex-Micarta	Weidmüller, Inc.
Chalfant Manufacturing Company	Jefferson Electric	Sensus, A Xylem Brand	Essex Solutions	Northern Cables	Western Tube
Champion Fiberglass, Inc.	JIE USA, Inc.	Service Wire Company	Exro Technologies, Inc.	NSI Industries, LLC	Westinghouse Lighting
Champlain Cable Corporation	John Thomas, Inc.	SEW-Eurodrive, Inc.	Fanlight Corp, Inc.	Nucor	Wheatland Tube Company
ChargePoint	Judd Wire, Inc.	Shemar T&D Solutions	Federal Pacific	nVent	Wieland Electric, Inc.
Cisco Systems	K-Line Insulators USA, Inc.	Siemens Industry, Inc.	Felt Electric Company, Inc.	OmniOn Power	Winnie Industries
CITEL Inc.	Kaneka	Sigma Engineered Solutions	Fenecon	Panduit Corporation	WireMasters, Inc.
Colonial Wire & Cable Co., Inc.	L.H. Dottie	Signify North America Corporation	Figaro USA, Inc.	Parsons	Wolong Electric America, LLC
Comtran Cable LLC	Lafert	Sky Technologies	Firetrol, Inc.	PFISTERER North America, Inc.	Worldwide Electric Corporation
Conductores Monterrey SA DE CV (Xignux Corporativo)	Landis+Gyr	Skyline Products, Inc.	Fuji Electric Corporation of America	Philips	Worthington Steel
Condumex	Lapp Insulators, LLC	Snake Tray	G&W Electric Company	Phoenix Contact	Yaskawa America, Inc.
ConnectDer	Larsen Manufacturing	SnapPower	Galvan Industries, Inc.	PLP (Preformed Line Products)	Yunex Traffic USA
Construction Innovations, LLC	LEDVANCE, LLC	Socomec North America	Gavan Graham	Post Glover Resistors, Inc.	Z Power & Distribution, Inc.
Copeland	Legrand, North America	South Atlantic, LLC	GE Grid Solutions	Power Grid Components	
Copeland	Leviton Manufacturing Co., Inc.	Southern Pipe, Inc.			
Copperweld Bimetallics, LLC	Lincoln Electric	Southwire Company, LLC			
Cree Lighting	Littelfuse, Inc.	Sparkstone Electrical Group			
CSE-W Industries	LS Cable & System USA				



2

4

3

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Evaluating Water-Damaged Equipment

STEP #4

REFER TO NEMA'S EVALUATING WATER-DAMAGED ELECTRICAL EQUIPMENT GUIDELINES



Evaluating Water-Damaged Electrical Equipment

NEMA CS 70006-2026
(Formerly NEMA GD 1)

Published by:
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1. **USE OF THIS PUBLICATION**
2. **CONTACT THE MANUFACTURER**
3. **ELECTRICAL EQUIPMENT
REPLACEMENT/RECONDITIONING
REQUIREMENTS & THE HAZARDS
ASSOCIATED WITH WATER-
DAMAGED ELECTRICAL
EQUIPMENT**
4. **CONSOLIDATED TABLE**

INDEPENDENT ELECTRICAL CONTRACTORS

Evaluating Water-Damaged Equipment

THE GUIDE INCLUDES (8) ELECTRICAL PRODUCT CATEGORIES:

- ❖ ELECTRICAL DISTRIBUTION EQUIPMENT
- ❖ MOTOR CONTROL EQUIPMENT
- ❖ POWER EQUIPMENT
- ❖ TRANSFORMERS
- ❖ RACEWAYS, CONDUIT, TUBING, FITTINGS, ENCLOSURES, OUTLET BOXES, AND JUNCTION BOXES
- ❖ WIRE, CABLE, AND FLEXIBLE CORDS
- ❖ AFCIs, GFCIs, GFPEs, SURGE PROTECTION EQUIPMENT, AND WIRING DEVICES
- ❖ OTHER DEVICES (LIST OF 16 EQUIPMENT TYPES)

INDEPENDENT ELECTRICAL CONTRACTORS

3.1 Electrical Distribution Equipment

Equipment	Replace equipment	May be reconditioned (contact the manufacturer)	Additional standards reference (if available)
Molded-case circuit breakers	X		ANSI/NEMA AB 4 <i>Guidelines for Inspection and Preventive Maintenance of Molded-Case Circuit Breakers Used in Commercial and Industrial Applications</i>
Low-voltage fuses	X		BI 50009 <i>Low Voltage Cartridge Fuses</i>
Switches	X		ANSI/NEMA KS 3 <i>Guidelines for Inspection and Preventive Maintenance of Switches Used in Commercial and Industrial Applications</i>
Busway (Mylar wrapped bars)	X		NEMA BS 31050 <i>General Instructions for Handling, Installation, Operation, and Maintenance of Busway Rated 600 Volts or Less</i> , par. 3.4.4, 9.2.4.2
Busway (powder-coated bars)		X	
Cablebus	X		NEMA BI 50052 <i>Metal Cable Bus Systems</i>
Flexible bus systems	X		

3.6 Wire, Cable, and Flexible Cords

Equipment	Replace equipment	May be reconditioned (contact the manufacturer)	Additional standards reference (if available)
Wire or cable listed for dry locations (such as NM-B)	X		
Wire or cable that is suitable for wet locations (provided the ends of the wire or cable have not been exposed to water, and the wire is not damaged)		X	

3.8 Other Devices

Equipment	Replace equipment	May be reconditioned (contact the manufacturer)	Additional standards reference (if available)
Batteries (refer to 3.8.5)	X		
Cable tray (refer to 3.8.1)		X (Replace damaged labels)	

3.8.1 Cable Tray

Carefully inspect the cable tray system to determine if its mechanical and/or electrical integrity has been compromised. Repair or replace any damaged portions according to original installation requirements. Remove all debris from the cable tray. If any labels warning against the use of the cable tray as a walkway have been damaged, obtain new labels from the manufacturer and apply as required.

Evaluating Water-Damaged Equipment IEC

STEP #5

**REPLACE OR RECONDITION THE
ELECTRICAL EQUIPMENT
(BY QUALIFIED PERSONS ONLY)**

INDEPENDENT ELECTRICAL CONTRACTORS



NEMA Technical Position on Reconditioned Equipment

NEMA CS 70011-2026

Published by:
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1. Introduction
2. Reconditioned Equipment in 2026 NEC
3. Normal Servicing, Maintenance and Repair
4. NEMA Guidance on Reconditioned Equipment
5. Fundamental Tenets for Reconditioning
6. Determining if Equipment is Suitable for Reconditioning
7. Appendix Information

Use of Cleaning Agents

❖ 110.11 Deteriorating Agents, Informational Bulletin No. 2:

Some cleaning and degreasing compounds can cause severe deterioration of many plastic materials used for insulating and structural applications in equipment.





Cleaning and Disinfecting Guidance for Electrical Equipment

NEMA CS 70009-2025
(Formerly NEMA GD 4-2020)

Published by:
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1812 North Moore Street, Suite 2200
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www.nema.org

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- ⚡ **Use of Disinfectants on Electrical Equipment**
- ⚡ **Guidance for Cleaning and Disinfecting Electrical Equipment**
- ⚡ **Recommendations**
- ⚡ **References**



NFPA 70 (NEC) Reconditioned Equipment

- ⚡ **Section 110.20:** General requirements for listed equipment, equipment not required to be listed, and the approval of reconditioned equipment
- ⚡ **Section 110.21:** Marking requirements for reconditioned equipment
- ⚡ **XXX.3:** Article (equipment) specific reconditioning requirements
- ⚡ **Section 110.17:** The **repair** or **servicing** of equipment is NOT considered reconditioning nor is the **maintenance** of equipment (NFPA 70B)
- ⚡ **“Reconditioned”** is the same as rebuilt, refurbished, or remanufactured

FLOOD SAFETY: HIGH WATERS, HIGH STAKES

Flooding can occur anywhere, but water and electricity don't mix. Because electrical hazards may linger after flood waters recede, it's important to take precautions before, during, and after flooding takes place.

KNOW THE DANGER



On average, more **deaths** occur due to flooding each year than from any other severe weather related hazard.



In the past 5 years **ALL 50 STATES** have experienced floods or flash floods.



A car can easily be carried away by just **TWO FEET** of floodwater.

Nearly half of all flood fatalities occur in **vehicles**.



Those living **outside** of mapped "high-risk" flood areas file nearly 25% of all flood insurance claims and receive 1/3rd of Federal Disaster Assistance aid.

From 2003 to 2012, total flood insurance claims averaged nearly **\$4 BILLION** per year.

www.esfi.org/disaster-safety

OFF

also need to shut off the main valve for your home's gas and water.



Be aware that submerged outlets or electrical cords may **energize standing water**. Do not enter a flooded area until it has been determined safe to do so by a professional.



Do not go near any **downed power lines** especially if there is standing water nearby.

If your home experienced flooding, keep the power off until an **electrician** has inspected your system for safety.



Have an electrician inspect electrical appliances that have been wet, and **do not turn on or plug in appliances** unless an electrician tells you it is safe.



A **trained professional** may be able to recondition some devices while others will require replacement.



Do not touch a circuit breaker or replace a fuse with **wet hands** or while standing on a wet surface.

REMINDER



ESFi recommends portable generators be installed by qualified electricians. When not used properly you could be at risk for shocks, fires or dangerous levels of carbon monoxide.

ESFi For more severe weather and portable generator safety tips visit www.esfi.org.



www.facebook.com/ESFi.org



www.twitter.com/ESFIdotorg



www.youtube.com/ESFIdotorg

Flood Safety

Flooding can occur from the coast to several hundreds of miles inland as a result of tropical downpours from hurricanes. Floodwater contaminants can create serious fire hazards if electrical wiring and equipment have been submerged in water. Ocean water and salt spray can be particularly **damaging** to electrical equipment due to the corrosive and conductive nature of the salt water residue. Even with professional cleaning and drying, sediments and toxins from floodwater are difficult to remove.

In the aftermath of a flood, there may be hidden electrical hazards. Before beginning the cleanup effort, have a qualified electrician check the house wiring, assess other damages and proceed with repair work. Then, follow these important safety tips:

- Take care when stepping into a flooded area. Be aware that **submerged outlets** or electrical cords may energize the water, posing a potentially lethal trap.
- Have an electrician inspect electrical appliances that have been wet, and **do not turn on** or plug in appliances unless an electrician tells you it is safe. Electrical equipment exposed to water can be **extremely dangerous** if reenergized without proper reconditioning or replacement.
- A **qualified service repair dealer** should examine all electrical equipment that has been wet. Certain equipment will require replacement, while a trained



Replace or Recondition?

Source: UL

After a serious flood, some items may be reconditioned, while others will need to be completely replaced to protect you and your family. It is recommended that you allow an electrician or electrical inspector to guide the restoration or replacement of any electrical wiring or equipment.

Corrosion and insulation damage can occur when water and silt get inside electrical devices and products. Water can also damage the motors in electrical appliances. Therefore, you should be prepared to replace:

▪ **Circuit breakers and fuses**



▪ **All electrical wiring systems**



▪ **Light switches, thermostats, outlets, light fixtures, electric heaters and ceiling fans**



▪ **Furnace burner and blower motors, ignition transformers, elements, and relays for furnaces and hot water tanks**



▪ **Hot water tanks**



▪ **Washing machines, dryers, furnaces, heat pumps, freezers, refrigerators, dehumidifiers, vacuums, power tools, exercise equipment and similar appliances**



▪ **Electronic equipment, including computers and home entertainment systems**





**Corrosion
College**

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Corrosion Prevention Information

Corrosion College is a hands-on, 2-day course that provides proven solutions for the prevention of industrial corrosion through classroom and hands-on experience.



THANK YOU FOR ATTENDING

