



NSRP ETP MEETING

Switchgear & Circuit Breaker
Specification Developments
For
U.S. Navy Ships

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Code 429

NAVY COTS CIRCUIT BREAKER SPECS

> Background

*** DDG 91AF**

- **Ship spec/purchase spec required Commercial-Off-The-Shelf (COTS) circuit breakers to meet IEC/UL 489 Supplement SB component specs**
- **COTS circuit breakers were also qualified as subcomponents as part of switchboard/load center First Article testing**
- **In addition, NSWCCD-SSES (now NSWCPD) was tasked by PMS 400 to conduct Risk Reduction testing on several Cutler-Hammer (now Eaton) COTS circuit breakers from 2000-2002**
 - **Included mil-spec QPL type testing for endurance, interruption, and temperature rise**
 - **This testing has not been performed again since 2002**

*** LCS and DDG 1000**

- **Programs invoked Naval Vessel Rules (NVR) requirements for COTS circuit breakers**
- **NVR requirements not very clear**
- **Risk Reduction testing not performed for these programs**

NAVY COTS CIRCUIT BREAKER SPECS

> **Background** (*continued*)

* **Circuit Protection Integrated Product Team (CPIPT)/Circuit Protection Technical Advisory Board (CPTAB)**

- **CPIPT was chartered by NAVSEA in 2006 to address circuit protection issues across the fleet**
- **CPIPT transitioned to the CPTAB in 2013**
- **Membership includes NSWCPD, SEA 05Z, SEA 08K, BPMI, Puget Sound Naval Shipyard, SUBMEPP, Electric Boat, HII-Ingalls, and HII-Newport News**
- **NAVSEA directed the CPTAB to develop COTS circuit breaker specs for Navy applications to standardize requirements**

NAVY COTS CIRCUIT BREAKER SPECS

> **UL 489D**

- * **For low voltage molded case type circuit breakers**
- * **Published in April 2012**

> **UL 1066A**

- * **For low voltage power type circuit breakers**
- * **Published in April 2013**

> **UL 2831**

- * **For medium voltage vacuum type circuit breakers**
- * **Published in May 2013**

> **DoD Adoption Notices for each spec were published in October 2014**

> **Specs invoke more stringent requirements than IEC or UL specs in some areas to be more in-line with Mil-Spec type testing (*see Figure 1 on Slide 6 for an example*)**

> **Goal is to demonstrate compliance of existing COTS designs without major design changes**

> **Specs include electrical ratings (frame sizes, voltage, interruption, and etc.) but do not address dimensions/size of circuit breakers; for a given frame rating, one OEMs design may not be a form-fit replacement for another OEMs design**

NAVY COTS CIRCUIT BREAKER SPECS

- > **Each spec includes requirements for requalification testing at periodic intervals (*see Figure 2 on Slide 7 for an example*)**
- > **UL will oversee all testing and maintain an “Online Certifications Directory” for each specification that lists qualified products similar to the QPL for Mil-Spec circuit breakers**
- > **UL and NAVSEA have an agreement that specs will not be changed without approval from NAVSEA 05Z Tech Warrant Holder (TWH) for Electrical Systems**
- > **Revisions are planned for 2016 based on lessons-learned since publication including clarification of endurance and silver plating requirements and following name conventions (“XXXX” will denote frame rating):**
 - * **UL 489D: MCCB-XXXX**
 - * **UL 1066A: PWRCB-XXXX**
 - * **UL 2831: NCVCB-XKV-XXXX**
- > **NAVSEA will issue a clarification letter for any program that invokes the specs before the official revisions have been published**

NAVY COTS CIRCUIT BREAKER SPECS

Table 6.1

Initial qualification test programs

Test program Q1	Test program Q2	Test program Q3
Vibration	High available fault current test sequence	Electromagnetic interference (circuit breakers with electronic devices only)
Voltage spike (circuit breakers with electronic devices only)	Temperature rise @ 50°C ambient	Shock Fragility
Circuit breaker endurance load operations ("with current") and selected accessory temperature rise		
Verification of accessories		
Circuit breaker and selected accessory temperature rise @ 50°C ambient		
Calibration @ 50°C ambient		
Dielectric voltage withstand		

Figure 1 – Excerpt from UL 489D

NAVY COTS CIRCUIT BREAKER SPECS

Table 7.1

Requalification test programs

Test program RQ1 (5-year intervals)	Test program RQ2 (7-year intervals)	Test program RQ3 (9-year intervals)
Voltage spike (circuit breakers with electronic devices only)	High available fault current test sequence	Vibration
Circuit breaker endurance load operations ("with current") and selected accessory temperature rise	Temperature rise @ 50°C ambient	Electromagnetic interference (circuit breakers with electronic devices only)
Verification of accessories		Verification of accessories
Circuit breaker and selected accessory temperature rise @ 50°C ambient		Shock Fragility
Calibration @ 50°C ambient		
Dielectric voltage withstand		

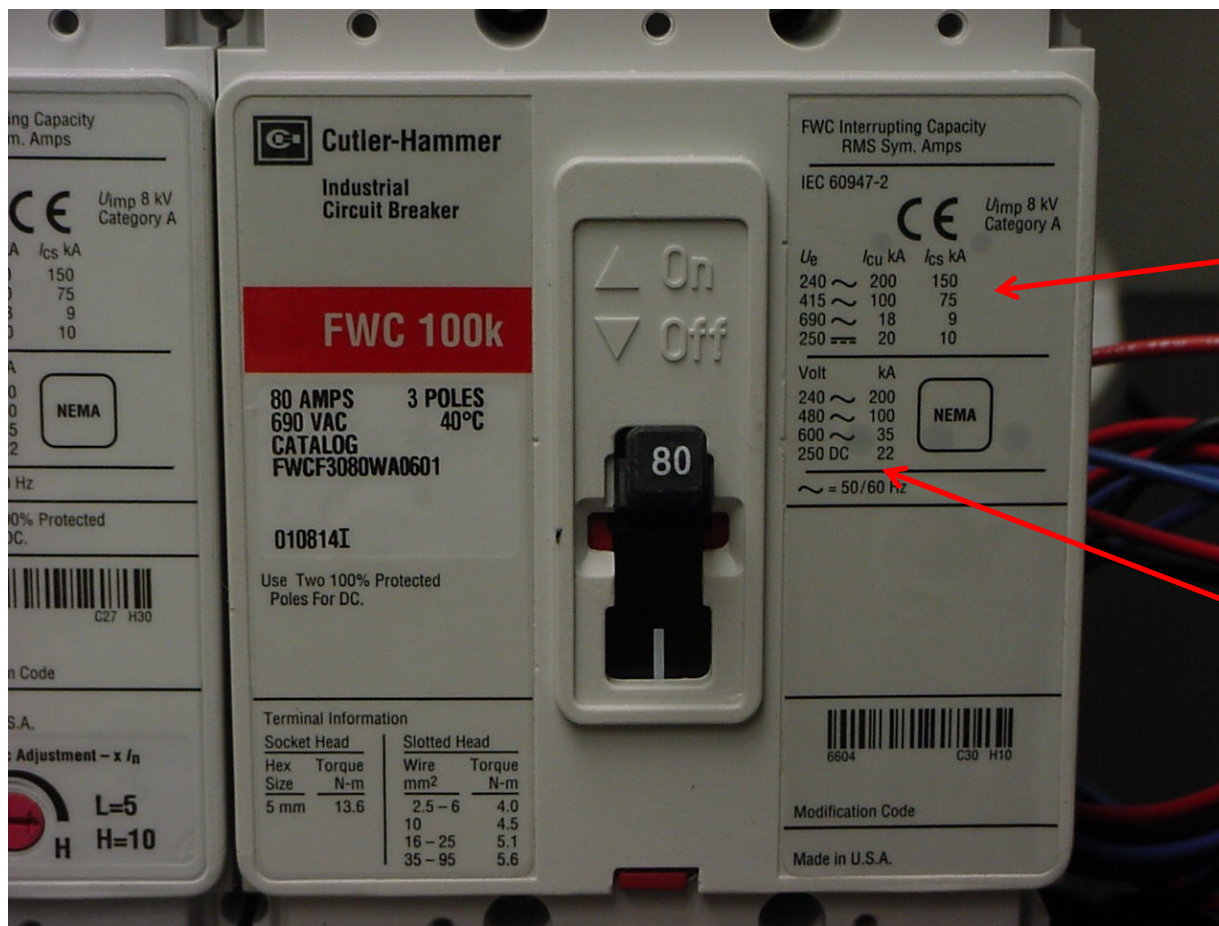
Figure 2 – Excerpt from UL 489D

NAVY COTS CIRCUIT BREAKER SPECS

> Nameplate info

- * **Standard nameplates for DDG 91AF COTS circuit breakers currently include the following info (*also see Photos 1 and 2 on Slides 9 and 10, respectively*)**
 - **IEC interruption ratings at different voltages**
 - **UL/NEMA interruption ratings at different voltages (if dual-rated)**
 - **Frame rating**
 - **De-rating has to be taken into account for Navy applications**
 - **For example, L-frame rated for 600 amps commercially is used in 400 amp shore power application on DDG 91AF**
- * **Designs qualified to Navy COTS circuit breaker specs will have a different nameplate that includes the following info**
 - **One interruption rating at one voltage rating (480VAC for low voltage molded case and power circuit breakers)**
 - **Frame rating**
 - **NO derating has to be taken into account for Navy applications**
 - **For example, a circuit breaker qualified at 400 amps to UL 489D can be used in 400 amp shore power application on DDG 91AF**

NAVY COTS CIRCUIT BREAKER SPECS



IEC ratings

UL/NEMA ratings

Photo 1 – Cutler-Hammer COTS F-Frame circuit breaker

NAVY COTS CIRCUIT BREAKER SPECS



IEC ratings

UL ratings

Photo 2 – Cutler-Hammer COTS L-Frame circuit breaker

NAVY COTS CIRCUIT BREAKER SPECS

> Current/Future Status

- * Based on publication of Adoption Notices, SEA 05Z expects that all future programs using COTS circuit breakers will invoke these specs as applicable**
- * Naval Combatant Design Specification (NCDS) (*replacement for NVR*) will be updated to reference the new specs**
- * CPTAB has met with Eaton to discuss testing DDG 91AF COTS circuit breakers in accordance with the new specs**
 - Eaton likely to start with molded case frame sizes (L-frame, F-frames)**
 - Based on prior Risk Reduction test results and performance of DDG 91AF circuit breakers to date, NSWCPD believes that Eaton designs should pass the new Navy COTS circuit breaker spec testing**

MIL-SPECS FOR SHOCK MOUNTED (COTS) SWBDS

> Background

*** DDG 91AF**

- **MIL-S-16036 used as baseline and then tailored through the particular ship spec / purchase specs**
- **In addition to OEM First Article testing, Risk Reduction testing was conducted by NSWCCD-SSES (now NSWCPD) on switchboards/load centers**

*** LCS and DDG 1000**

- **Programs invoked Naval Vessel Rules (NVR) requirements**
- **NVR requirements not very clear**
- **Risk Reduction testing not performed for these programs**

- * **NAVSEA directed the CPTAB to develop mil-specs for Low and Medium Voltage shock-mounted COTS switchboards to standardize requirements**

MIL-SPECS FOR SHOCK MOUNTED (COTS) SWBDS

> MIL-DTL-XX653

- * Applies to Low Voltage shock-mounted COTS switchboards**
- * Government/Industry Review (GIR) comments currently being adjudicated**
- * ECD for publication is January 2016**
- * Selected features of spec**
 - Requires use of UL 489D molded case circuit breakers and UL 1066A power circuit breakers**
 - Allows the use of selected COTS components other than circuit breakers**
 - Allows use of jam nuts**
 - Prohibits use of lock washers except as an integral part of a component such as a terminal board**
 - Requires incremental torque method for locking devices and a torque sequence for multiple bolt connections**
 - Allows use of selected NEMA HP5 and HP6 control wire or equivalents**
 - Allows use of alternate methods of construction that differ from the traditional welded frame**
 - Cybersecurity requirements will be included.**

MIL-SPECS FOR SHOCK MOUNTED (COTS) SWBDS

> **MIL-DTL-XXXXX (TBD)**

- * **Will apply to Medium Voltage shock-mounted COTS switchboards**
- * **NSWCPD submitted a funding proposal to NAVSEA to develop and publish this spec in FY16**
- * **Will require use of UL 2831 Vacuum Circuit Breakers and have many of the same MIL-DTL-XX653 features shown on Slide 13**

OTHER MIL-SPECS FOR MEDIUM VOLTAGE SWGR

> Background

- * HII-Newport News developed a spec for CVN 78 hard-mounted Medium Voltage switchgear since Mil-Specs did not exist at that time**
- * NAVSEA directed the CPTAB to develop specifications for hard-mounted Vacuum Circuit Breakers, protective relays, and Medium Voltage switchboards to standardize requirements**

> MIL-DTL-32485

- * Applies to hard-mounted Vacuum Circuit Breakers**
- * Published in November 2013**
- * Includes initial QPL and requalification test requirements**
- * Designs developed by SPD and DRS for possible current new ship programs which are the first to be tested in accordance with initial QPL requirements**
- * SEA 05Z issued an August 2014 letter clarifying silver plating, endurance, and other requirements**

OTHER MIL-SPECS FOR MEDIUM VOLTAGE SWGR

> MIL-PRF-32484

- * Applies to hard-mounted and shock-mounted Protective Relays used with vacuum breakers**
- * Published in November 2013**
- * Expected to be invoked by current new ship programs**
- * Includes initial QPL and requalification test requirements**

> MIL-DTL-32483 and MIL-DTL-32483A

- * Applies to Medium Voltage hard-mounted Switchboards**
- * MIL-DTL-32483 published in November 2013**
- * Government/Industry Review (GIR) comments for Rev A currently being adjudicated**
- * ECD for Rev A publication is January 2016**
- * Expected to be invoked by current new ship programs**
- * Requires use of UL 2831 vacuum circuit breakers, MIL-PRF-32484 protective relays, and will have many of the same MIL-DTL-XX653 features shown on Slide 13**

SUMMARY/CONCLUSIONS

- > Use of switchgear specs will ensure all vendor products are tested to the same requirements and Ship Programs will no longer need to conduct risk reduction testing**
- > UL will ensure that Navy COTS circuit breaker spec products are requalified at regular intervals and maintain a list of qualified products**
- > Current and future programs should invoke new Low Voltage and Medium Voltage specs for switchboards, circuit breakers, and protective relays as applicable**
- > MIL-DTL-16036 will be requested to be revised as necessary based on lessons-learned from development of MIL-DTL-XX653**