NAVAL SEA SYSTEMS COMMAND
What's changing in nonskid?

NSRP

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Proposed Specification Update Task
Update MIL-PRF-24667

- **MIL-PRF-24667C, "COATING SYSTEM, NON-SKID, FOR ROLL, SPRAY, OR SELF-ADHERING APPLICATION" last updated on 22 May 2008. Need update based on lessons learned and new materials.**

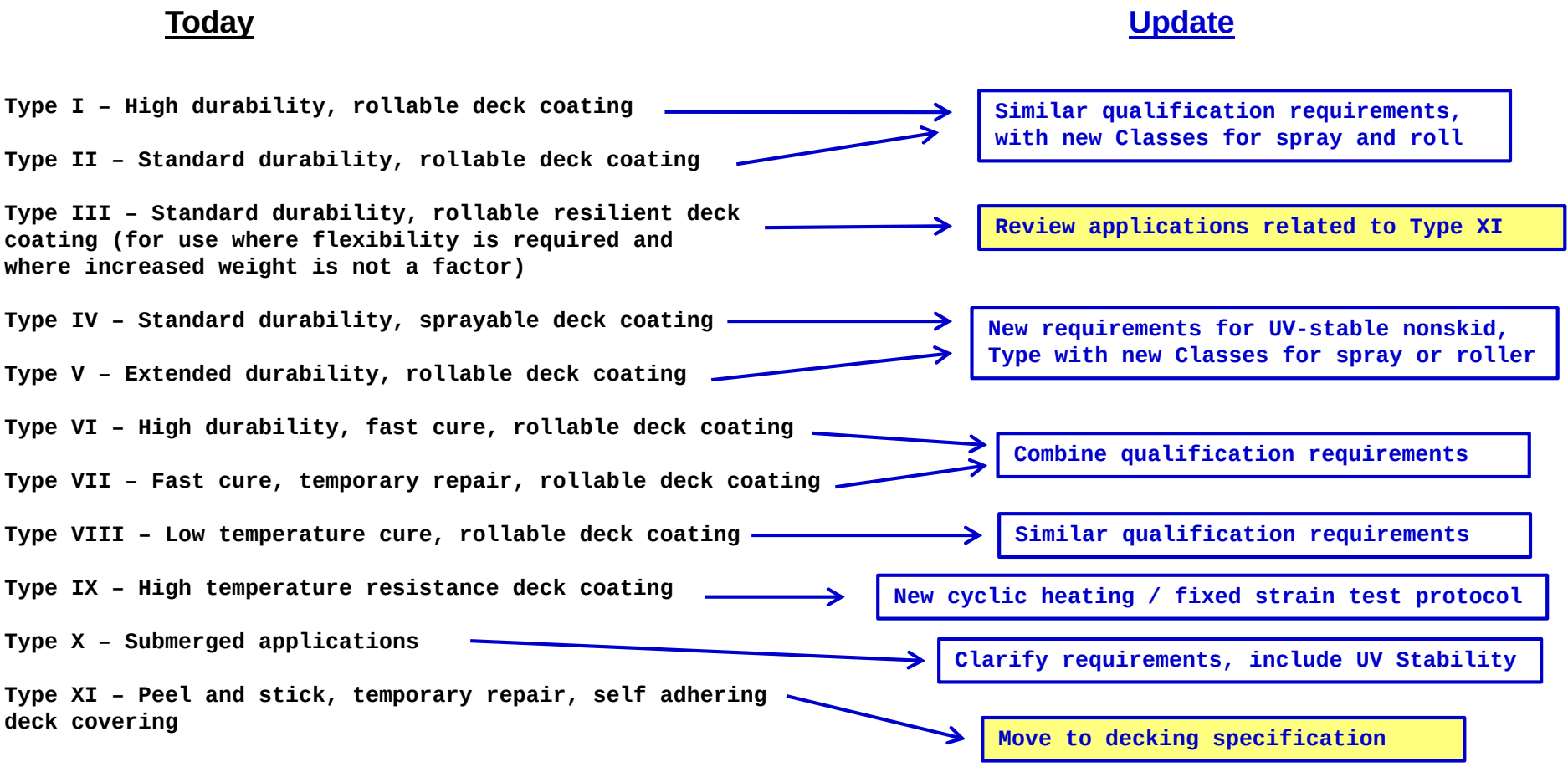
  - **NSWC-PD to lead update.**
  - **Simplify Types/Classes to reflect material-specific performance requirements.**
  - **Update Coefficient of Friction measurement processes.**
  - **Add performance tests for heat resistant nonskids.**
  - **Cite new mixing and spraying equipment by Commercial Item Description.**
  - **Add categories for new UV stable nonskids (change entire life cycle approach).**
  - **Add new flight-deck qualification options.**

Enhance Options

Update to conventional nonskid specification as compliment to expanded applications for thermal spray nonskid.

Proposed Specification Update Task
MIL-PRF-24667 – Redefine Types

- **MIL-PRF-24667C update to rev D will simplify Types/Classes to reflect material-specific performance requirements and not "durability" which is related to in-service wear & tear.**

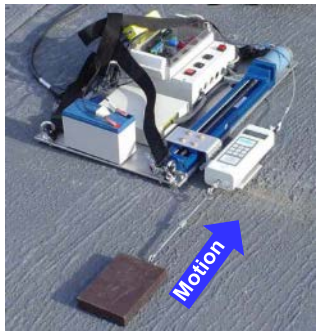


Condense nonskid Types & Classes focus on laboratory measurable performance eliminate notional service life.

Proposed Specification Update Task
Historical Background on Sliding Block

REQUIREMENT: MIL-PRF-24667C requires Flight deck Coefficient of Friction (CoF) to be measured when a nonskid product is qualified for flight deck service.

- Sliding block test method using neoprene rubber pad,
  Type "A" Durometer hardness of 57±2,
  22 mm radius block edge,
  block weight 6.0 ±0.5 lbs.



- CoF testing conducted during <u>material qualification</u>:
  - Laboratory: validate 0.95 (dry), 0.90 (wet), and 0.80 (oily)
  - CVN shipboard test for minimum one year: validate 0.76 (dry), 0.72 (wet), due to 20% allowable reduction in in-service CoF, oily waived because ship's force had to clean-up.

- CoF testing conducted on qualified material as <u>conformance test</u> on:
  - First lot supplied.
  - Every 5,000 gallons.

<u>No current or historical requirement to validate as-applied nonskid CoF on in-service decks.</u>

SYSTEM LIMITATIONS: NAVSEA has been studying/adjusting CoF measurement techniques since 1961.

- Current sliding block method and requirements since 1986.

Issues with sliding block

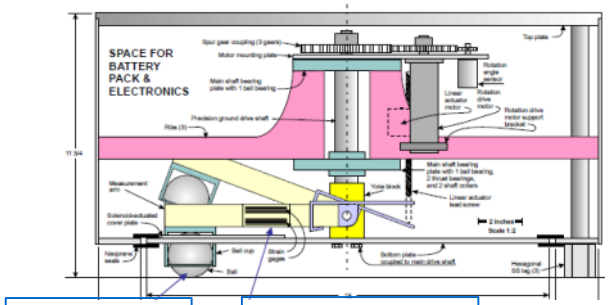
- Sliding block method does not correct for heat – increased temperature, softer rubber, lower measured CoF.
- Block can rock, skip, or fish tail.
- Must pull block in two or more directions to characterize roller-applied nonskid with ridges.
- Poor reproducibility – neoprene rubber friction response varies by lot, formulation, and manufacturing method.
- Obsolete material – Neoprene sheet with 57 Durometer hardness no longer manufactured.

<u>NAVSEA initiated development of more reliable, reproducible CoF measurement tool in late 1990s.</u>

Proposed Specification Update Task
MIL-PRF-24667 – Cite Improved Measurement Methodology

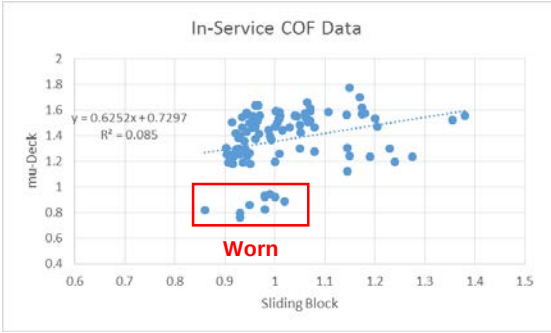
NEW METHOD: MIL-PRF-32577 on thermal spray nonskid will require flight deck deck Coefficient of Friction (CoF) to be measured when a nonskid is qualified:

- CoF measured between NAVSEA standard rubber ball (NAVSEA DWG NO. 8418020) based on aircraft tire rubber composition and nonskid surface.
- Rotating ball method measures consistent, dynamic CoF over 360 degrees in one measurement.
- Based on commercial pin-on-disk approach.
- Similar to UK method.
- Commercially available unit under trade-name μ-Deck from Vision Point Systems since 2008.



- CoF testing to be conducted during <u>material qualification</u>:
  - Laboratory: validate 1.2 (dry) and 1.0 (wet)
  - Ship test to allow 20% reduction in CoF.
  - Eliminate wet due to inconsistent wetting on deck.
  - Eliminate oily because of ship's force clean-up issue.

- CoF testing conducted on qualified material as <u>conformance test</u> on:
  - First lot supplied.
  - Every 5,000 gallons of liquid nonskid produced.



<u>No proposed requirement to validate as-applied nonskid CoF.</u>

SYSTEM IMPROVEMENTS: Automated, portable, reproducible data across broad temperature range.

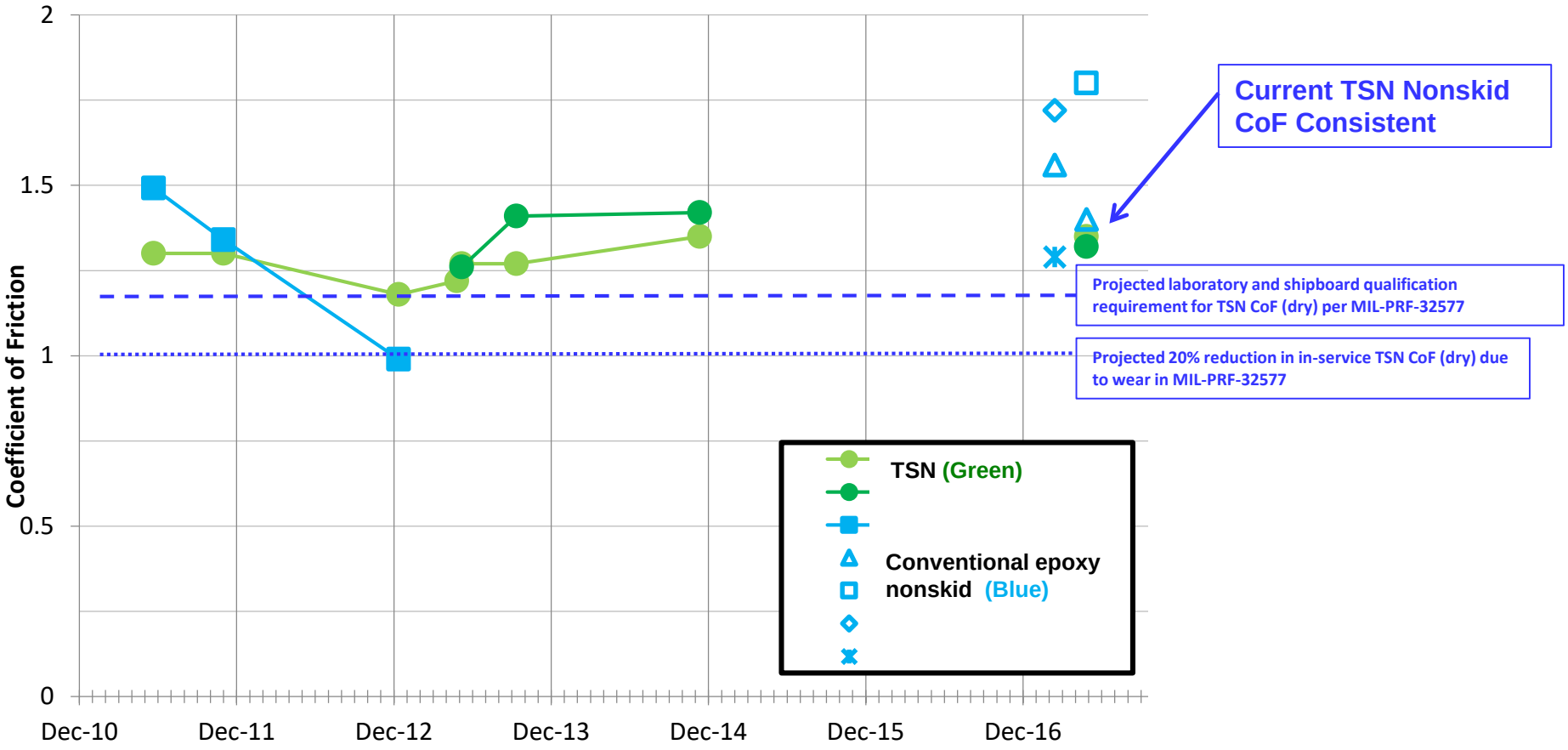
- Affordable using COTS parts design.
- Automated calibration (may need plate standards and strain gage validation).

<u>NAVSEA transitioning new rotating ball technology to standard practice in MIL-PRF-32577 but need fleet input.</u>

Navy Nonskid Coefficient of Friction Measurement
Historical Data (dry) Using μ-Deck Meter

RESULTS: Flight deck Coefficient of Friction (CoF) on flight deck and has been tracked with μ-Deck meter since 2011.

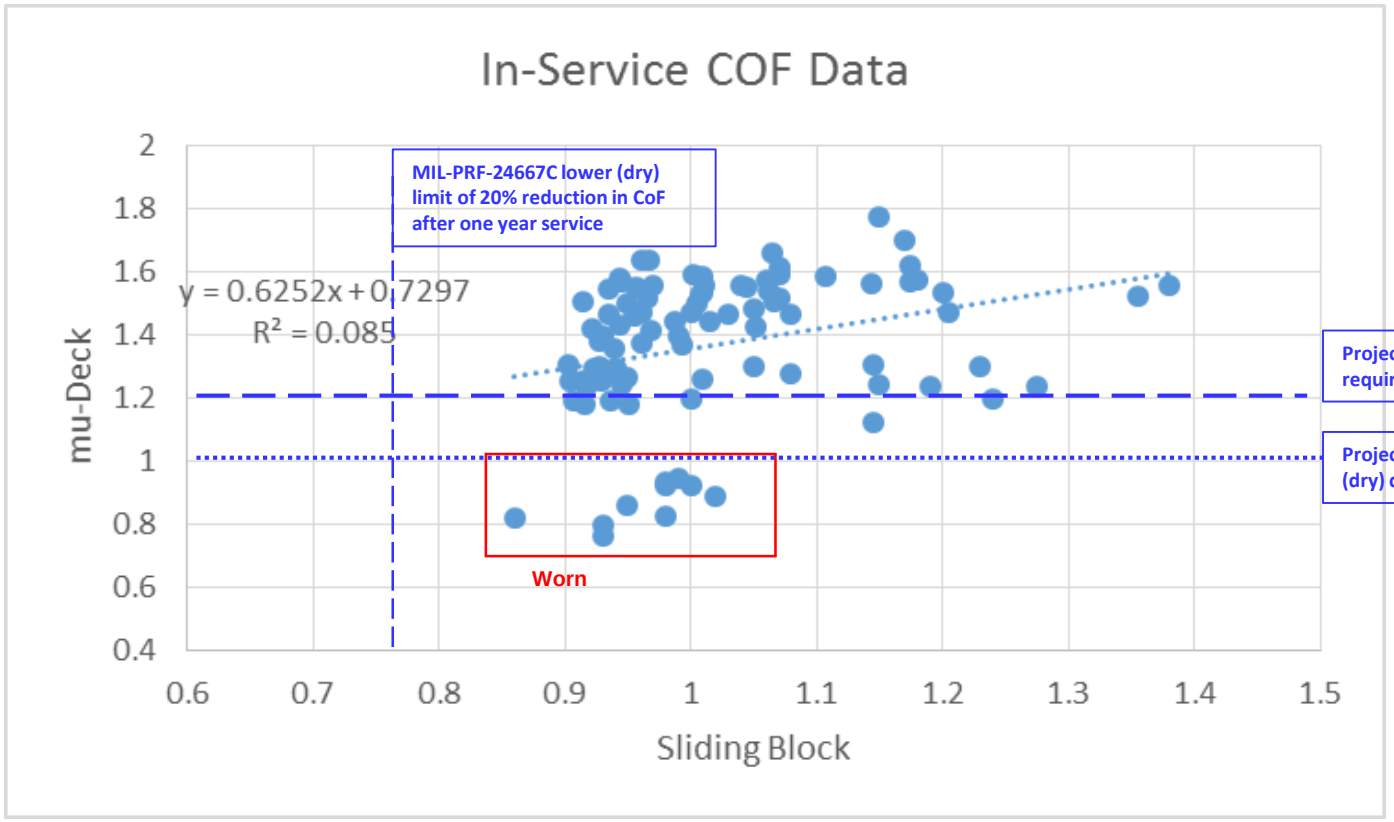
- **Data used to set μ-Deck Meter limits based on 776 data points (roll and spray nonskid) at five temperature ranges for seventeen nonskid systems since mid-2000s.**
- **Thermal spray nonskid (TSN) shows slower variation in CoF.**
- **MIL-PRF-24667C nonskid, Type I and Type V on same deck.**



TSN CoF has been consistent over time while wear & tear degrades CoF of conventional nonskid more readily.

Navy Nonskid Coefficient of Friction Measurement
Historical Data on Flight Deck CoF

RESULTS: Flight deck Coefficient of Friction (CoF) tracked using μ-Deck Meter and sliding block. Data collected from general use, roller-applied, MIL-PRF-24667 nonskid in dry conditions.



Correlation between different CoF measurement techniques is inconsistent.

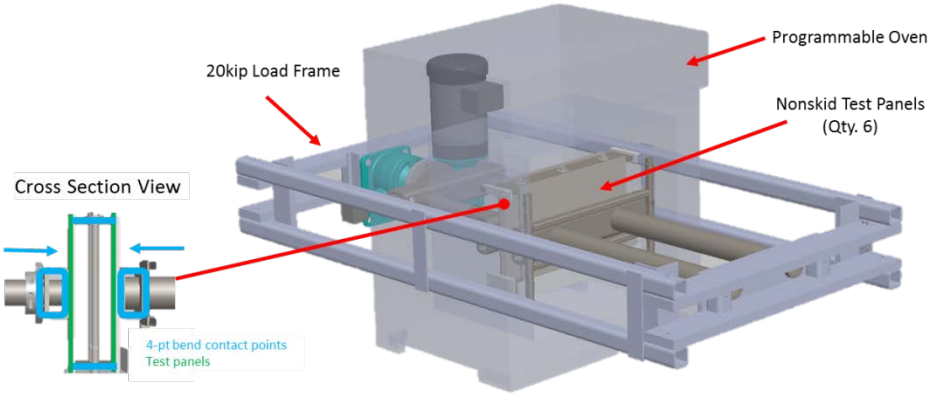
Proposed Specification Update Task
MIL-PRF-24667 – Heat Resistance

- **Add performance tests for heat resistant nonskids. Current epoxy nonskid coatings are not designed to survive heat from exhaust gas impingement on deck.**

  - **FY-18, Change 1, Standard Item 009-32 eliminated use of MIL-PRF-24667C, low temperature cure nonskid on LHA/LHD flight deck.**

  - **New requirements for heat-resistant nonskid to be based on the small-scale heat and deck flexure tests developed by NRL.**

  - **Simulate the flight deck environmental and mechanical conditions that result in premature coating failure using new, automated, cyclic test apparatus.**
    1. **Age nonskid - 300 hours of UV degradation.**
    2. **Flex nonskid under simulated exhaust heat - 50 deflections in 4-pt bend test while at elevated temperatures (15 min hold cycle).**
    3. **Stress nonskid with corrosive conditions - 150 hours of salt spray.**



Small scale lab test

20 heat cycles
Cracking – Rating 4, short line/irregular
Substrate Corrosion – Yes
FAIL

Full scale MCASNR test

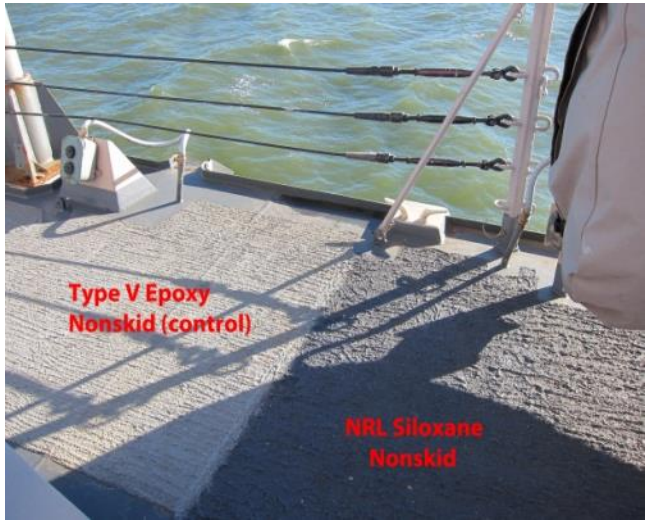
30+ heat cycles (estimated)
Cracking – Yes
Substrate Corrosion – Yes
FAIL

Updated specification performance requirements based on successful products demonstration on LHA/LHD.

Proposed Specification Update Task
MIL-PRF-24667 – Define Measurable Color Stability

- **MIL-PRF-24667C currently provides notional service life for nonskid materials based on in-service test "durability." Difficult to align notional service life with platform schedule.**
  - **Define color retention by laboratory testing.**
  - **More consistent appearance may result in longer life coating.**

6 months service



Replace? **Retain?**

10 months service

Replace All?

Specification to define the color stability not "durability."

Notional service life greater than 1 year. Ships can retain coating if intact and adherent.

Update to conventional nonskid specification to define measurable nonskid performance like color stability.

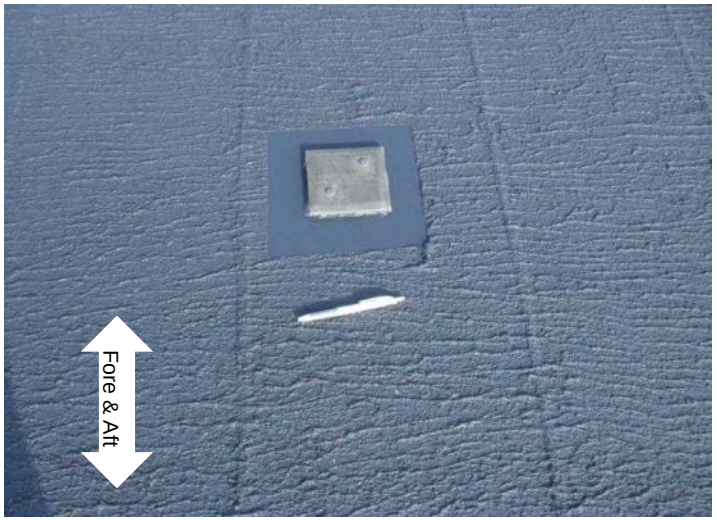
Proposed Specification Update Task
MIL-PRF-24667 – Aluminum Substrate

- **MIL-PRF-24667 update to include qualification of nonskid system over aluminum decks.**

  - **Key issue to be addressed is metal loss/damage when nonskid is removed. Likely a change to Standard Item 009-32.**

  - **Waterjet pressure used to strip nonskid can affect thermal spray aluminum.**

  - **FY-16, Change 1, update to Standard Item 009-32, paragraph 3.11.7.1 included requirements for cross-rolling nonskid on extruded aluminum flight deck.**

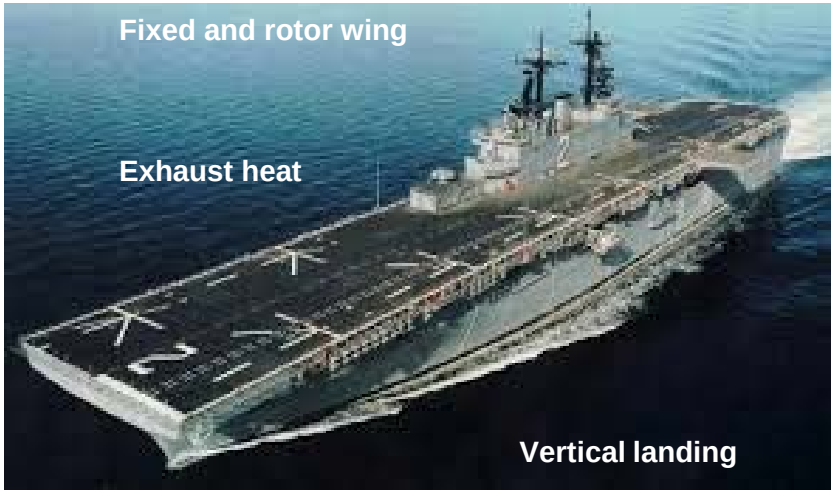


Update to nonskid specification and/or update to Standard Item 009-32 essential to address softer substrate material.

Proposed Specification Update Task
MIL-PRF-24667 – Shipboard Testing

- **MIL-PRF-24667C currently requires all nonskid materials to be qualified on a CVN flight deck.**

Today	Tomorrow
a. Wear-through showing the primer or steel deck; b. b. ASTM D660 checking rated less than 8; c. ASTM D661 cracking rated less than 8; d. Breaking (flaking); e. Loss of adhesion (peeling); f. COF values less than 80 percent of the initial value; g. Other deficiency which would adversely affect its performance.	ALLOW FLIGHT DECK NONSKID QUALIFICATION ON LHA/LHD Retain current performance criteria Add heat resistance requirements Add requirements for chips/flakes



Nonskid materials experience different challenges on CVN and LHA/LHD and QPD must reflect all ship classes

Summary

- **NAVSEA goal is to ensure all coating and nonskid applications satisfy performance requirements.**

- **NAVSEA transitioning new thermal spray nonskid to fleet service to support V-22 and F-35 operations and to reduce the risk of aircraft engine FOD.**

- **NAVSEA published FY-18, Change 1, Standard Item 009-32 in Mar 2017.**

- **NAVSEA published DRAFT Standard Item 009-BB on TSN for industry comment on 25 Jan 2017.**

- **NAVSEA published new Thermal Spray Nonskid material requirements in MIL-PRF-32577 and applicator training/qualification in Technical Publication 1687.**

Coefficient of Friction Measurement Methods for Navy Nonskid Historical Background

- **Historical Coefficient of Friction (CoF) requirements varied since 1961.**
  - **Current requirements and sliding block test method from 1986.**
  - **Rubber contact surface on sliding block varied over the years.**

Reference	Contact Material	Coefficient of Friction (minimum)		
		Dry	Wet	Oily
MIL-D-23003, 12 September 1961	Leather Static	0.85	0.85	---
	Rubber Static	1.00	1.00	1.20
	Leather Sliding	0.50	0.60	---
	Rubber Sliding	1.00	1.00	1.00
NASL Friction Test Apparatus, circa 1967	Leather Static	0.50	0.60	---
	Rubber Static	0.40	0.45	0.25
	Leather Sliding	0.35	0.35	----
	Rubber Sliding	0.90	0.80	0.30
MIL-D-23003A, 25 February 1980 Olson Slipmeter—vulcanized neoprene rubber, 85 (+/- 5) durometers	Rubber Static, Types III & V	0.90	0.90	0.90 SAE 10W
	Rubber Static, Type IV After Cable Wear Test	1.00	0.95	0.95 SAE 10W
MIL-D-24483A, 19 August 1974 Olson Slipmeter—vulcanized neoprene rubber, 60-80 durometers	Rubber Static , Initial	1.15	1.00	0.95 SAE 10W
	Rubber Static, After wear test	1.10	1.00	0.95 SAE 10W
	Rubber Static, After Cable Wear Test (Type II only)	1.00	0.90	0.50 SAE 10W
DOD-C-24667, 11 September 1986 NAVSSES Slipmeter—vulcanized neoprene rubber, 65 (+/- 5) durometers	Rubber Static, Grade A initial condition	0.95	0.90	0.80 MIL-L-23699
	Rubber Static, Grade B initial condition	0.90	0.85	0.75 MIL-L-23699
	Rubber Static, Grade A After cable Wear	0.90	0.85	0.75 MIL-L-23699
	Rubber Static, Grade B After cable Wear	0.80	0.75	0.65 MIL-L-23699
MIL-PRF-24667A, 14 August 1992 NAVSSES Slipmeter—vulcanized neoprene rubber, 57 (+/- 2) durometers	Rubber Static, Type I initial condition	0.95	0.90	0.80 MIL-L-23699
	Rubber Static, Type II, III & IV initial condition	0.90	0.85	0.75 MIL-L-23699
	Rubber Static, Type I After cable Wear	0.90	0.85	0.75 MIL-L-23699
	Rubber Static, Type II, III & IV After cable Wear	0.80	0.75	0.65 MIL-L-23699
MIL-PRF-24667B, 3 June 2005 NAVSSES Slipmeter—vulcanized neoprene rubber , 57 (+/- 2) durometers Sled w/front edge radius; Force gauge output to PC; Data capture & analysis program	Rubber Static, Type I, V, VI, VII, VIII & IX initial condition	0.95	0.90	0.80 MIL-L-23699
	Rubber Static, Type II, III, IV & X initial condition	0.90	0.85	0.75 MIL-L-23699
	Rubber Static, Type I, V, VI, VII, VIII & IX After cable Wear	0.90	0.85	0.75 MIL-L-23699
	Rubber Static, Type II, III, IV & X After cable Wear	0.80	0.75	0.65 MIL-L-23699

Current CoF Requirements Established

Note: Sliding block CoF test method design details evolved since 1986.