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sense and simplicity

NEMA White Paper - Recommendations for Solid State Lighting Sub-Assembly Interfaces for Luminaires

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CORM May 8, 2009

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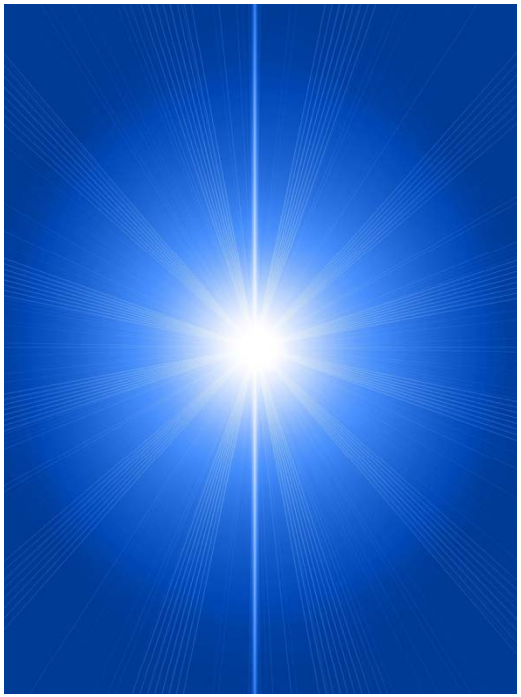
Recommendations for Solid State Lighting Sub-Assembly Interfaces for Luminaires

- Background
- Scope
- Mechanical Considerations
- Electrical Considerations
- Thermal Considerations
- Drive for Standards



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Solid State Lighting Sub-Assembly Interfaces for Luminaires – Background

- Sockets and bases for lighting are a modular component strategy
  - secure the lamp mechanically
  - provide electrical connections
  - flexibility for replacement
- This strategy has been successful – the Edison base has been in use for over 125 years. An E26/E27 lamp base of today will fit a socket from the 1880s!
- The advent of solid-state lighting requires a re-examination of base and socket technology.
- Existing sockets are designed to provide a mechanical connection and an electrical connection but no provision is made for thermal considerations—a necessity for efficient, long life SSL.

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Solid State Lighting Sub-Assembly Interfaces for Luminaires – Background

- What is an SSL Interconnect?
  - A physical connection between two separate devices within an SSL luminaire
  - Intended to provide electrical contact, mechanical support and/or transfer of heat between devices
  - Requirements for devices to operate within the manufacturer's specifications for current, voltage, power, orientation and temperature.
- What should be considered?
  - Mechanical considerations
  - Electrical considerations
  - Thermal considerations

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Solid State Lighting Sub-Assembly Interfaces for Luminaires – Background

- SSL interconnects must consider electrical, mechanical and thermal requirements
  - Primary issue for direct replacement SSL – Improper thermal connections cause diminished life, decreased reliability, shift in color, and lower light output
- While LEDs can last longer than other light sources, they are not immortal and replacement will be necessary
  - SSL system failures do occur – many times, not LED failures
  - Luminaire designs that preclude replacement will become unacceptable as understanding and experience with SSL continue to grow
  - Interconnect flexibility within an SSL fixture will become a necessity!
    - Drivers, controls, modules, optics, etc

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Solid State Lighting Sub-Assembly Interfaces for Luminaires – Background

- What interconnects mean for the SSL industry
  - Rapid growth and adoption of SSL
  - Modular approach economics
  - Rapid fixture and luminaire innovation
  - Innovative product platform designs

- What interconnects mean for lighting
  - Novel and creative applications of lighting
  - Embedded options for lighting through replacement with color and other dimensions of lighting
  - New dimensions to the lighting market
  - Repair/replace components – economics
  - Choice!

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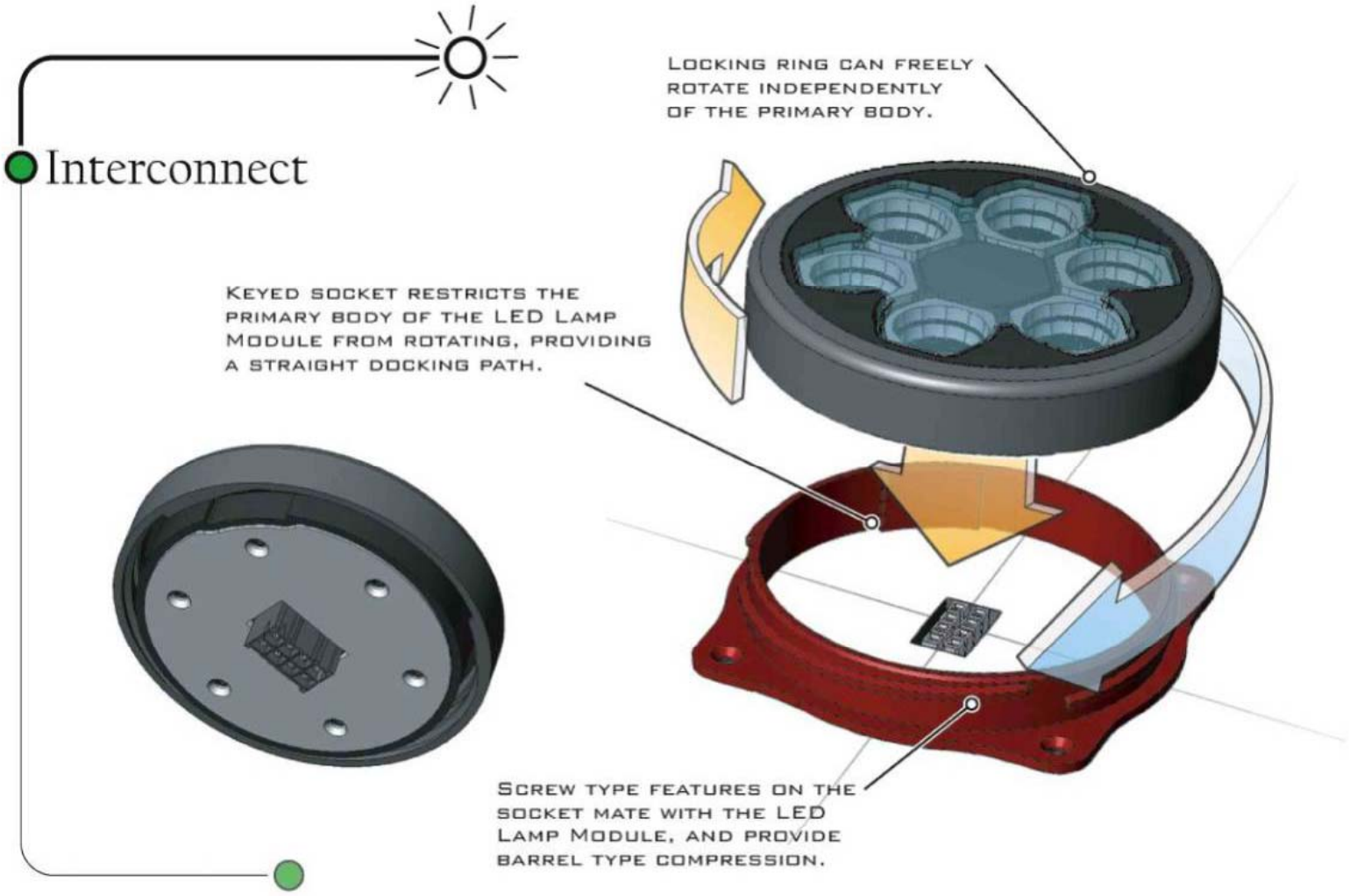
SSL System Components - Example



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Solid State Lighting Sub-Assembly Interfaces for Luminaires – Scope

- NEMA White Paper – a starting point
  - Intended to document existing and up to date industry best practices related to SSL Sub-Assembly Interfaces for Luminaires
  - Intended to provide a spring board for the creation of future ANSI, IESNA, and other SSL interconnect standards.
- Scope:
  - Guidelines for SSL interconnects enabling the repeated insertion and the withdrawal of components
  - Intended for use in general lighting.
  - Focus on Mechanical, Electrical and Thermal interfaces. Interfaces to both branch circuitry and low voltage sources will be included.

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Solid State Lighting Sub-Assembly Interfaces for Luminaires – Scope

Piggyback off existing luminaire/lighting standards. Normative References include:

- ANSI_NEMA_ANSLG C78.377-2008 American National Standard for Electric Lamps—Specifications for the Chromaticity of Solid State Lighting Products
- IESNA LM-79 Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products
- IESNA LM-80 IES Approved Method for Measuring Lumen Maintenance of LED Light Sources
- IESNA RP-16 Nomenclature and Definitions for Illuminating Engineering
- UL153 UL Standard for Safety Portable Electric Luminaires
- UL 840 UL Standard for Safety for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment
- UL 924 Emergency Lighting and Power Equipment
- UL 1012 UL Standard for Safety Power Units Other Than Class 2
- UL 1310 UL Standard for Safety Class 2 Power Units
- UL 1573 UL Standard for Safety Stage and Studio Luminaires and Connector Strips

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Solid State Lighting Sub-Assembly Interfaces for Luminaires – Scope

- UL 1574 UL Standard for Safety Track Lighting Systems
- UL 1598 UL Standard for Safety Luminaires
- UL 2108 UL Standard for Safety Low Voltage Lighting Systems
- OI 8750 UL Outline of Investigation for Light-Emitting Diode Light Sources for Use in Lighting Products
- National Electrical Code, International Electrical Code Series, NEC 2008, NFPA 70
- NEMA LSD-44 Solid State Lighting and Interconnects; A Background Summary.
- NOM-001-SEDE Mexican National Electrical Code
- NOM-064-SCFI Electrical Appliances – Lamps for indoor and outdoor use- Safety Specifications and Test Methods
- NMX-J-307/1 ANCE Luminaires
- C22.1 Canadian Electrical Code, Part 1 (CEC)
- C22.2 No. 9 Lighting Fixtures
- C22.2 No. 250.0 Luminaires
- ANSI/IESNA RP-27.1-05 Photobiological Safety for Lamps and Lamp Systems-General Requirements
- ANSI/IESNA RP-27.2-00 Photobiological Safety for Lamps and Lamp Systems - Measurement Systems
- ANSI/IESNA RP-27.3-07 Recommended Practice for Photobiological Safety for Lamps - Risk Group Classification

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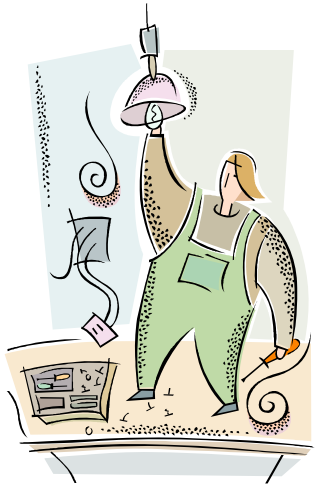
Solid State Lighting Sub-Assembly Interfaces for Luminaires – Mechanical

- Dimensions
  - Field replaceable considerations for manual handling
- Tolerances
  - Considerations for mating surfaces, where mechanical fit is critical to function or safety
- Weight
  - Force rating on interconnects where support or retention is critical to function or safety
  - Load Test where applicable



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Solid State Lighting Sub-Assembly Interfaces for Luminaires – Mechanical

- Coupling
  - Mating of SSL interconnect parts shall provide a tactile, audible or visual indication of proper engagement
  - Consider positive mechanical interference restriction to allow only the proper method of engagement
- Materials
  - Provide sufficient mechanical strength and permanence to prevent access to hazardous voltages, contain electrical failures, allow proper function and prevent unintentional disengagement
  - Consider compliance with UL material requirements for safety
  - Consider application dependent thermal and UV stability requirements as well as flammability rating of materials

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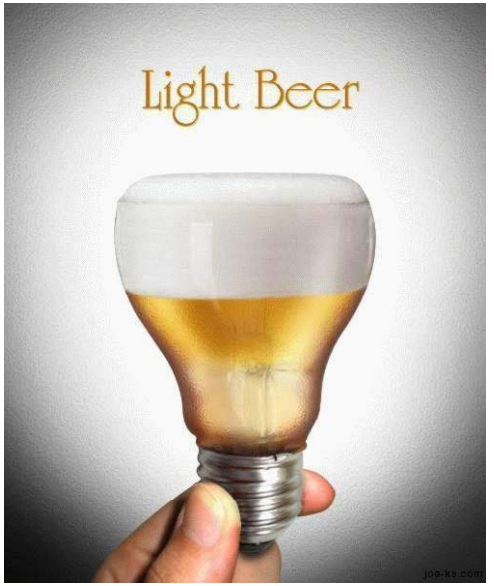
Solid State Lighting Sub-Assembly Interfaces for Luminaires – Mechanical

- Glass
  - Glass shall be reliably held in place.
  - Edges that are subject to manual manipulation shall be smooth and free of sharp edges.



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Solid State Lighting Sub-Assembly Interfaces for Luminaires – Electrical

- Safety
  - Address/prevent risk of shock and access to hazardous live parts
    - Cannot be accessed by a test pin and articulate probe (defined in UL1310) or they shall be appropriately enclosed.
  - Maximum voltages that may be accessible are those as defined in appropriate UL standards.
  - The NEC applies to all electrical installations
- Number of Connections
  - Number of connections must be sufficient to allow for power, for analog control and for digital control
  - Shall comply with the appropriate UL and NEC standards

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Solid State Lighting Sub-Assembly Interfaces for Luminaires – Electrical

- Number of Connections (Example)
  - 2 for power
  - 2 for analog signals (e.g. dimming)
  - 2 for digital bi-direction communication enabling controls (e.g. color tuning)
- Types of Connections – considerations
  - Application specific UL classification
    - Damp and wet location requirements
  - Resistance of electrical contacts.
  - Potential for contacts being shorted or cross connected
  - Contact force requirements
  - Materials – Lead-free, RoHS compliant

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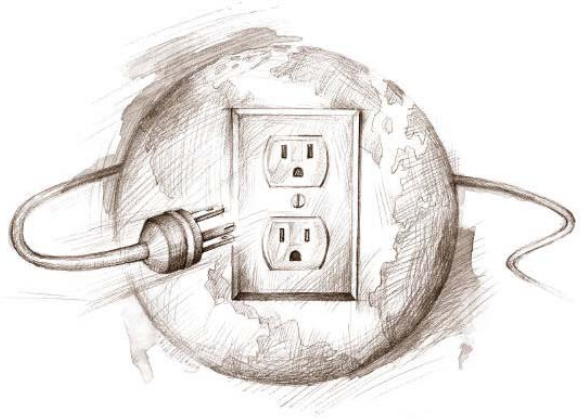
Solid State Lighting Sub-Assembly Interfaces for Luminaires – Electrical

- Types of Connections – considerations
  - Dielectric withstand voltages
  - Isolation between signal and power pins
  - Shock & vibration resistant
  - Environmental resistance – thermal, chemical, UV
  - Polarization and keying for different current & voltage levels as well as AC versus DC operation
  - Wire terminations and wire retention
  - Min/max insertion forces



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Solid State Lighting Sub-Assembly Interfaces for Luminaires – Thermal

Thermal management – most critical for performance

- Luminous flux and lumen maintenance strongly decrease as the LED junction temperature increases.
- SSL interconnect designs will effectively allow heat to be conducted from one device (the module for example) to another (the luminaire/ heat sink) through the interconnects
- System designs must maintain the LED junction temperature at or below the manufacturer's specified rating(s)

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Solid State Lighting Sub-Assembly Interfaces for Luminaires – Thermal

Thermal management – Considerations

- Safe operation – LED modules
  - Defined thermal test points
  - Thermal power dissipation
  - Markings
- Proper operation
  - Performance characteristics vs. Temp

T_p [°C]	**...**	**70**	**80**	**90**	**...**
Luminous flux [lm]	...	700	800	900	...
Life time [h]	...	50.000	40.000	30.000	...
Constant input parameter (current voltage, or power)	...	...	...	...	

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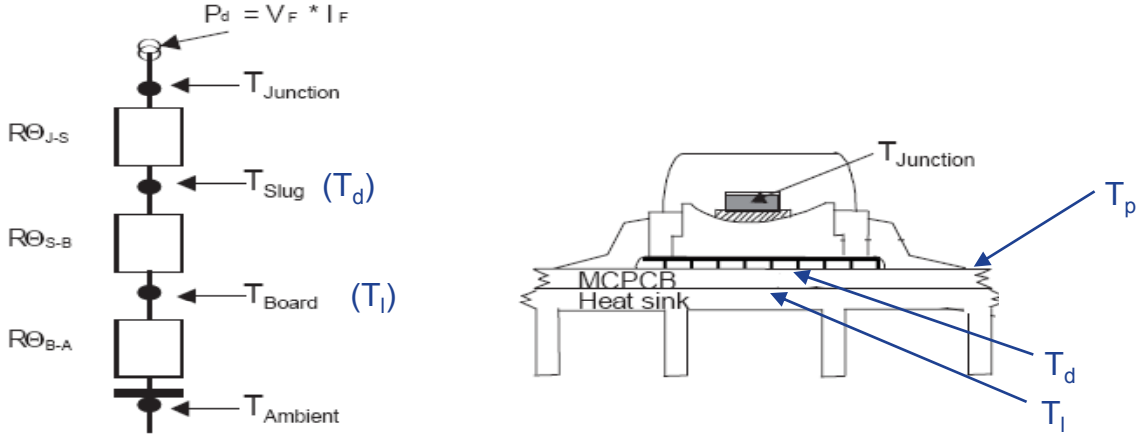
Solid State Lighting Sub-Assembly Interfaces for Luminaires – Thermal

Thermal management – Considerations

- LED Module interconnects - LED module thermal power is dissipated though interconnects
  - The physical size and material of the interconnect must be chosen to facilitate proper heat transfer across the interconnect surface
  - Design of the interconnect (thickness and effective surface area) as well as its thermal conductivity determine the temperature drop ΔT = Td - Tl measured across the interconnect.



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Solid State Lighting Sub-Assembly Interfaces for Luminaires – Thermal

Thermal management – Considerations

- Luminaires and LED Modules
  - The luminaire manufacturer must clearly identify the intended application on the luminaire or on its packaging
  - The luminaire shall be marked with the maximum Thermal and electrical ratings for acceptable LED modules
- Luminaire Safety
  - Requirements are dependent upon the luminaire configuration and upon the intended use.
  - The SSL luminaire shall be tested according to appropriate safety standards.
  - Applicable certification marks shall be labeled according to the intended use.

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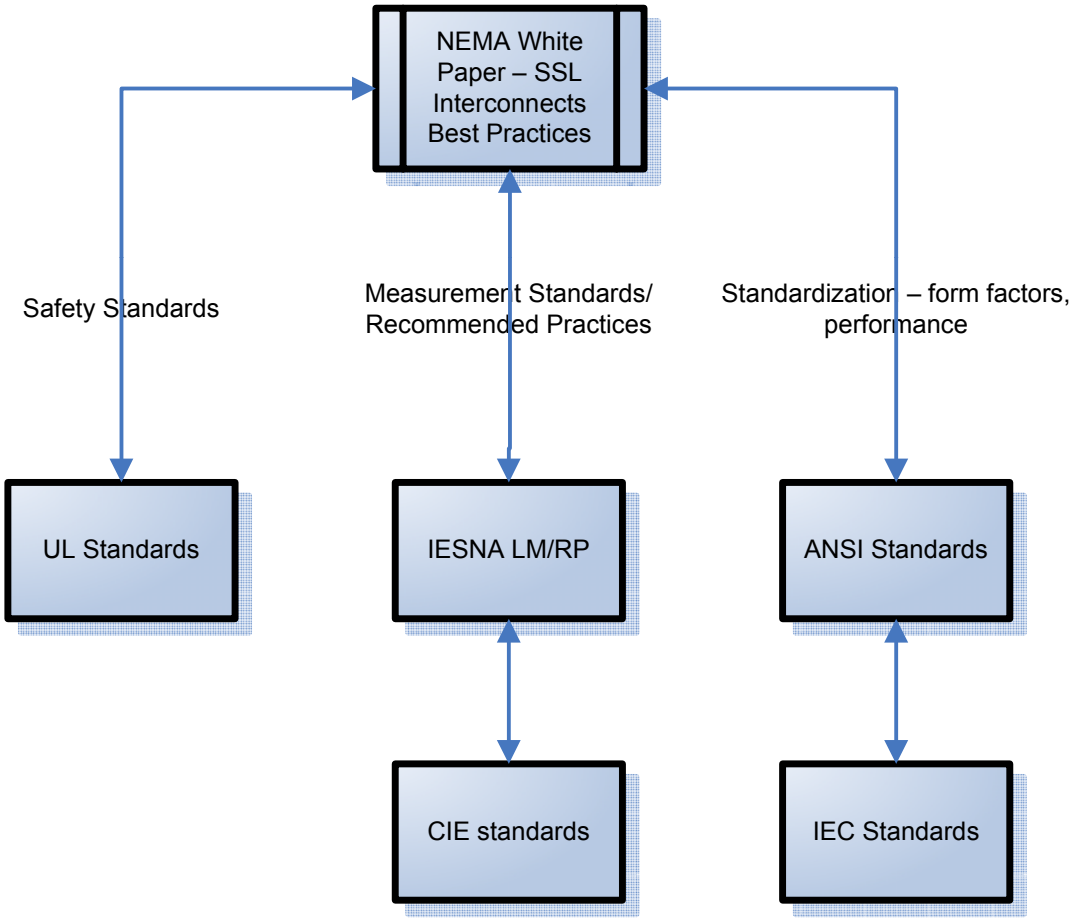


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