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A Study on Model Development Guidelines for MBD

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Automotive controllers face increasing functional complexity and stringent safety requirements. While Model-Based Development (MBD) offers significant advantages over traditional code-based approaches—including visual requirement representation, automated code generation, and systematic verification—the absence of comprehensive MBD guidelines comparable to MISRA-C standards presents a critical implementation challenge. This research systematically addresses guideline selection and validation for MBD-based automotive controller development.

MISRA AC SLSF: 2023 comprises three rule classification levels: Required (mandatory compliance), Advisory (recommended practices), and Document (design justification). MAB standards emphasize modeling consistency and collaborative efficiency. From 187 total MISRA AC SLSF rules, 72 mandatory rules were systematically selected based on priority classification and empirical design experience.

Validation was performed through dual mechanisms: (1) Model Advisor verification for rules with direct MAB 5.0 equivalency, and (2) custom verification procedures for 21 rules lacking automated support. Development environment: MATLAB/Simulink 2024b on Windows 10 with Intel® Xeon® processor and 32GB RAM.

Block Execution Sequencing (MISRA SLSF 009_B): Arbitrary block priority assignments impede control flow analysis and introduce unpredictable behavior. Custom verification procedures systematically audit and enforce inherited execution scheduling, preventing timing anomalies.

Sample Time Specification (MISRA SLSF 009_D): Inconsistent sample time configurations across blocks introduce temporal synchronization errors. Mandating uniform "inherited" sample time settings ensures deterministic block execution synchronization and reliable data transmission timing.

Data Precision Management: Floating-point precision variations between double-precision (8 bytes, high accuracy) and single-precision (4 bytes, low accuracy) operands introduce computational inaccuracies. Enabling Simulink's Parameter Quantization Advisor in warning mode facilitates early detection of precision losses during development, preventing runtime malfunctions.

This research establishes a systematic framework for MBD guideline selection applicable to safety-critical automotive controllers. The identified 72 mandatory rules from 187 MISRA AC SLSF specifications, validated through Model Advisor and custom procedures, were systematized in *.m and *.json formats for multi-developer accessibility. While this investigation focused on a single thermal energy system controller project, ongoing application across diverse automotive control systems will necessitate guideline refinement and dynamic evolution to ensure practical efficacy and sustained relevance.