

Powertrain	Development Phase	SubPhase	Certification Homologation	Feature Variations	Test Strategy	Test Type	Test Infra Deployment
E/E	Major Development releases	System Design	Functional Safety (ISO 26262)	SW Configurations, HIL Setup	Model-Based Testing	SIL/HIL, Fuzz Testing	Cloud HIL, Virtual ECUs
E/E	Proto releases	Integration	EMC/EMI Compliance	Sensor Fusion Variations	Fault Injection	Environmental Testing	Portable Test Rigs
E/E	Pre-Development releases	Feasibility	Cybersecurity (UNECE R155)	ECU Network Topologies	Requirements Validation	Bench Validation	CANoe/CANalyzer Setup
E/E	Production releases	SOP	Regional Standards (e.g., FCC)	Production Tolerances	End-of-Line Testing	Conformity Testing	Automated Test Benches
E/E	Post-Production releases	Maintenance	Recall Compliance	OTA Update Variants	Field Monitoring	Diagnostic Trouble Code Tests	Remote Diagnostics Tools
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ICE	Major Development releases	Combustion Calibration	Euro 7/EPA Tier 4	Fuel Injection Strategies	Durability Simulation	Engine Dyno Tests	Engine Test Cells
ICE	Proto releases	Thermal Validation	Noise Regulations	Turbocharging Configs	NVH Analysis	Emission Cycle Tests	Chassis Dyno, Acoustic Chambers
ICE	Pre-Development releases	Concept Design	Crash Safety (NCAP)	Exhaust Aftertreatment	CFD Analysis	Component Fatigue Tests	3D Simulation Suites
ICE	Production releases	Mass Production	On-Board Diagnostics (OBD)	Manufacturing Tolerances	Statistical Process Control	Leak Testing	Calibration Robots
ICE	Post-Production releases	Warranty	Recall Campaigns	Service Kits	Field Failure Analysis	Warranty Claim Validation	Dealer Service Tools
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HEV	Major Development releases	Power Split	HEV-Specific Certification	Battery Sizing Options	Energy Management Simulation	Hybrid Mode Switching Tests	Battery Emulators
HEV	Proto releases	Regenerative Braking	Electrical Safety (IEC 60664)	Motor-Generator Configs	Thermal Runaway Analysis	High-Voltage Isolation Tests	HV Test Labs
HEV	Pre-Development releases	Component Sourcing	Battery Transport Cert.	Transmission Variants	Cost Optimization	Cold Start Tests	Climate Chambers
HEV	Production releases	Assembly	End-of-Life Recycling	Production Cell Chemistry	Charge/Discharge Cycling	On-Road Fuel Economy Tests	Automated Assembly Lines
HEV	Post-Production releases	EOL Service	Second-Life Battery Compliance	Remanufactured Parts	Battery Health Monitoring	Capacity Degradation Tests	Service Center Diagnostics

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BEV	Major Development releases	Pack Integration	Battery Safety (GB 38031)	Charging Profiles (AC/DC)	Range Simulation	Thermal Propagation Tests	Battery Test Chambers
BEV	Proto releases	Thermal Mgmt	Grid Compliance (ISO 15118)	Cell Chemistries (NMC/LFP)	Fast-Charge Validation	DC Charging Stress Tests	Supercharger Test Stations
BEV	Pre-Development releases	BMS Algorithm	Recyclability Cert.	AWD/RWD Configurations	Cell Balancing Strategy	Cell Aging Tests	Cyclers, Environmental Chambers
BEV	Production releases	Final Assembly	WLTP/Range Certification	Software-Defined Features	EOL Functional Test	HV Safety Checks	Robotic Assembly
BEV	Post-Production releases	Battery Repurposing	Second-Life Cert.	Refurbishment Packs	Fleet Data Analytics	OTA Update Rollback Tests	Cloud-Based Monitoring
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FCEV	Major Development releases	Stack Integration	H ₂ Safety (SAE J2602)	Fuel Cell Stack Sizing	Efficiency Simulation	Hydrogen Leak Tests	H ₂ Leak Detectors
FCEV	Proto releases	Cold Start	Refueling Protocol (SAE J2601)	Thermal System Configs	Transient Response Analysis	Cold-Climate Tests	Cryogenic Test Bays
FCEV	Pre-Development releases	H ₂ Storage	UN GTR 13 Compliance	Tank Material Variants	Pressure Cycling	Burst Pressure Tests	Pressure Vessel Test Rigs
FCEV	Production releases	System Test	Emission Certification (ZEV)	Production Stack Tolerances	Catalyst Coating Validation	Performance Endurance Tests	Automated Stack Assembly
FCEV	Post-Production releases	Decommissioning	H ₂ Tank Recycling	Service Kits	H ₂ Purity Monitoring	Membrane Degradation Tests	Field Monitoring Sensors
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CDC	Major Development releases	Architecture	Functional Safety (ASIL B)	OS/Hypervisor Configs	Virtual Prototyping	Cybersecurity Penetration	Virtualization Platforms
CDC	Proto releases	Sensor Fusion	Data Privacy (GDPR)	HMI Variants	Latency Testing	Real-Time Performance Tests	Edge Computing Clusters
CDC	Pre-Development releases	SW Partitioning	Regional Navigation Laws	Display Resolutions	Over-the-Air Update Tests	Fail-Over Tests	CI/CD Pipelines
CDC	Production releases	Integration	E-mark Certification	Production Firmware	HW-SW Compatibility	EMI/ESD Tests	EMC Chambers

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CDC	Post-Production releases	Updates	Recall Compliance	Software Patches	Bug Tracking	User Experience Surveys	Telematics Data Analytics
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PHEV	Major Development releases	Mode Switching	PHEV-Specific Cert. (RDE)	Battery Size/ICE Combos	Charge-Sustaining Simulation	All-Electric Range Tests	Dual Dyno Testbeds
PHEV	Proto releases	Transition Calibration	Plug Safety (IEC 62196)	Charger Types (Type 1/2)	Energy Distribution Logic	Mixed-Mode Efficiency Tests	HVIL Testers
PHEV	Pre-Development releases	Component Synergy	Tax Incentive Compliance	Transmission Designs	Cost-Performance Trade-off	Thermal Stress Tests	Thermal Imaging Drones
PHEV	Production releases	Calibration	OBD Hybrid Compliance	Production Tuning	Charge-Depleting Validation	On-Road Emissions Tests	Calibration Fleets
PHEV	Post-Production releases	Battery Service	Warranty Extensions	Refurbished Batteries	Usage Pattern Analysis	HV Component Lifetime Tests	Dealer Diagnostic Suites